22 Freshwater ecology

Overview

The proposed Expressway traverses 5 separate freshwater catchments along the length of the alignment, and impacts on 15 freshwater habitats. As a result, the freshwater ecology within the Project area was the subject of comprehensive investigations. The investigations conclude that the existing aquatic fauna and physical habitat of the majority of the streams traversed by the proposed Expressway are degraded, with the exception of the Waikanae River, which is considered to be of high (regional) value for important fauna species and habitat integrity.

The construction of the proposed Expressway would involve building 22 culverts and 8 bridges within or over intermittent and perennial streams. The works required for these structures will potentially have adverse effects in terms of fish mortality in these habitats. There is also the potential for adverse effects to occur as a result of the loss of stream habitat due to the construction of the structures and other works required for the proposed Expressway. A total of 1,119m of perennial and intermittent stream habitat will be lost as a result of culvert and bridge construction, and 1,525m of stream habitat lost due to stream diversions and modifications.

Other potential adverse effects arising from the proposed Expressway include the hydrological impact on adjacent wetlands; notably the Raumati Manuka Wetland, Otaihanga Southern and Northern wetlands, El Rancho Wetland (Weggery), Ti Kouka Wetland and Ngarara Wetland, due to the potential damming and diversion of groundwater as a result of the Project.

The potential adverse effects on freshwater systems associated with culverting, bridging, diversions and modifications are proposed to be mitigated primarily through stream restoration on the waterbodies affected upstream and downstream of the Project.

Adaptive management is proposed to mitigate adverse ecological effects through the construction period. This tool is used to manage effects on complex ecological systems. Adaptive management gathers baseline ecological information pre-construction, monitors potential changes to freshwater ecosystems during construction and post-construction (3 years post completion), and initiates any necessary changes in mitigation. An adaptive management approach is also proposed to monitor and manage any potential hydrological effects on wetlands adjacent to the proposed Expressway alignment

Adherence to an Ecological Management Plan (Appendix M of the CEMP), which proposes mitigation for loss of stream habitat and fish mortality as well as limiting work to be carried out in streams during periods of fish migration, will ensure that the potential adverse freshwater ecology effects will be suitably mitigated.

22.1 Introduction

This Chapter presents the findings of investigations undertaken to determine the likely effects of construction and operation activities required for the proposed Expressway on freshwater ecology. It specifically includes the potential hydrological and de-watering effect on wetlands. This Chapter draws on the information and findings of the following Technical Reports and Appendices of the CEMP:

- Baseline Water and Sediment Quality Investigation Report, Technical Report 24, Volume 3;
- Contaminant Load Assessment, Technical Report 25, Volume 3;
- Ecological Impact Assessment, Technical Report 26, Volume 3;
- Freshwater Habitat and Species Description and Values, Technical Report 30,Volume 3;
- Erosion and Sediment Control Plan, Appendix H of the Construction Environmental Management Plan (CEMP), Volume 4 and,
- Ecological Management Plan, Appendix M of the CEMP, Volume 4.

The identification of effects on freshwater ecology required the assessment of the composition and values of existing aquatic ecosystems. There were two main methods of obtaining and collating this data:

- A desktop study was carried out which included reviewing a wide range of ecological databases, publications and previous ecological investigations; and
- Field surveys and analysis.

The description of existing freshwater ecology given in this section includes a brief overview of the investigations undertaken. Further details on the methods used and the findings of these investigations are contained in Technical Report 30 in Volume 3.

22.2 Existing freshwater ecosystems

There are five catchments affected by the proposed Expressway:

- The Whareroa catchment – includes the Whareroa Stream and a number of smaller tributaries and discharges to the Kapiti Coast. The total watershed area is 15.4km2;
- The Wharemauku catchment - includes the Wharemauku Stream and Drain 7 (Upper and Lower) and discharges to the Kapiti Coast at Paraparaumu. The total watershed area of this catchment is 12.7km2;
- The Waikanae Catchment – includes the Waikanae River, Mazengarb Stream, Wastewater Treatment Plant Drain and the Muaupoko Stream. This catchment has a total watershed area of 140.1km2 and discharges to the Waikanae Estuary;
- The Waimeha Catchment – includes the Waimeha Stream, Ngarara Creek, Kakariki Steam, Smithfield Drain and Paetawa Drain. This catchment has a total watershed of 21km2 and discharges to Waikanae Beach; and,

- The Hadfield Drain/Kowhai Stream Catchment – this catchment has a total watershed of 10.2km2 and discharges to Peka Peka Beach.

22.2.1 Freshwater habitats

A freshwater habitat is considered to be a stream with permanent or intermittent flows which has the capacity to provide aquatic habitat. Sampling was not carried out for these investigations on ephemeral streams. This section provides a brief description of the 15 different freshwater habitats within the Project area.

22.2.1.1 Whareroa Stream Tributary

The Whareroa Stream Tributary is located 500m south of the Whareroa Drain (refer below) at Waterfall Road. This tributary has some high quality ecological features, including riparian cover in the upper catchment which naturally meanders through pine and native forest. Historically, a range of native fish has been found in this waterway. However, the tributary downstream of the sampling site is open to stock access at all times and high levels of sun exposure during summer allow high levels of algae growth reducing water quality.

22.2.1.2 Whareroa Drain

The Whareroa Drain is a farm drain located within the QE Park that flows into the Whareroa Stream tributary. It has been highly modified over time to assist in draining the expansive areas of peat within the Park. At the sample site, partially obstructed culverts restrict fish movement, and the water was still (unmoving) and a dark brown colour, indicating high levels of tannin. Sampling of the site showed that short and long finned eel are present in small numbers.

22.2.2 Wharemauku Stream

The Wharemauku Stream is a highly modified predominantly urban stream which originates from springs located in the forested upper reaches of the catchment in the Tararua foothills. There have been several studies undertaken on the stream (refer to Technical Report 30, Volume 3 for more detail). In summary, these show that:

- The stream (despite high levels of modification) provides valuable habitat for nationally threatened indigenous fish;
- The habitat is under considerable stress due to a number of culverts and other structures that are in place to prevent downstream flooding;
- Macro-invertebrate studies show a surprisingly high abundance of taxa[169]; and,
- The water quality in the stream is 'poor'.

[169] Taxa: a group of (one or more) organisms adjudged to be a unit.

22.2.3 Upper Drain 7, Wharemauku

Upper Drain 7 drains through the Raumati Peatlands, which has vegetation cover of blackberry bracken with some manuka, kanuka and flax. The Upper Drain 7 consists of a drain deeply cut through peat lands to assist with water drainage. Drain 7 is the largest tributary of the Wharemauku Stream.

22.2.4 Lower Drain 7, Wharemauku

Lower Drain 7 is a drain characterised by poor water and habitat quality and low velocity, located within an urban environment. At the sampling site, the drain is highly channelised, with large amounts of in-stream debris which create barriers for water and fish passage.

22.2.5 Mazengarb Stream

Mazengarb Stream (also referred to as the Mazengarb Drain) has a number of known point source discharges of contamination into its catchment from the Otaihanga Landfill and the Paraparaumu Wastewater Treatment Plant (WWTP). The upstream length of the stream is highly modified, running through grazed rural land and through ponds of a new housing development. Water quality is considered to be somewhat degraded around the sampling site due to its proximity immediately downstream of the confluence with the WWTP Drain. Historical studies have found a good diversity of native fish in the Mazengarb Stream, and the stream is listed as a locally important fish habitat. However, monitoring shows the water quality to be generally 'poor' downstream of the landfill and the WWTP.

22.2.6 WWTP Drain (Waste Water Treatment Plant)

The WWTP Drain is a small tributary of the Mazengarb Stream which originates from a shallow drain system but primarily consists of the outflow from the WWTP ponds. Due to the output from the WWTP, the water quality in the WWTP Drain is highly nutrient enriched. The WWTP Drain at the sampling location had stable stream banks with riparian cover from overhanging trees. Previous sampling has found algal growths including sewage fungus present near the wastewater outlet.

22.2.7 Muaupoko Stream

At the sampling site, the Muaupoko Stream has long pasture grasses, willow and blackberry growing along its banks. Vegetation along the banks provides good fish habitat for in-stream macrophytes[170]. The stream flows through an area that will become part of the Waikanae River restoration area – this portion of the Stream has unstable sand banks with no vegetation.

[170] an aquatic plant that grows in or near water and is either emergent, submergent, or floating.

22.2.8 Waikanae River

The Waikanae River is considered to be one of the most ecologically significant water bodies in the Kāpiti District, and is listed in the Proposed Wellington Regional Policy Statement (PRPS) as having significant amenity and recreational values. GWRC has listed the River has having 'significant indigenous ecosystems' and the Regional Council has an Environmental Strategy in place (in conjunction with KCDC) to co-ordinate activities of the various agencies, community groups and landowners in protecting and improving the river environment.[171]

The River's headwaters are within the Tararua Forest National Park, where they flow through regenerating native forest, rough and treeland pasture, rural development and farmland upstream of SH1. Downstream of SH1, the surrounding land use is predominantly residential with flood control plantings and scattered bush remnants. The River is buffered by KCDC reserve-land and flood control land until it reaches the coast.

Previous investigations have found that the River generally has good water quality, although exceedances of metal concentrations occur periodically and appear to be attributable to stormwater discharges. Faunal studies have historically returned varied results indicating MCI levels ranging from 76 (poor) to 118 (very good). A diverse number of fish species have been recorded in the River.

22.2.9 Waimeha Stream

The Waimeha Stream is a large 5 metre drain in grazing land formed by the confluence of two springs, both located within Waikanae Township. The Stream is listed in the GWRC PRPS as a water body with a 'significant indigenous ecosystem'. The Stream is also listed as containing habitat for threatened indigenous fish species. Previous studies have found elevated E Coli levels in water samples and high nutrient levels. Other parameters measured have been low (below guideline limits). At the time the sampling was undertaken, the entire extent of the Stream in the area traversed by the proposed Expressway alignment had been cleared by a digger for seasonal flood control purposes.

The Waimeha Stream is listed as containing habitat for threatened indigenous fish species and for 6 more indigenous fish species, and is listed as having inanga spawning habitat.

22.2.10 Ngarara Creek

The Ngarara Creek is a small, relatively natural meandering waterbody cut through a mix of peat and sand country that enters Te Harakeke/Kawakahia Wetland downstream.

[171] GWRC, 1999: Waikanae River Environmental Strategy: Opportunities to Enhance the Waikanae River Environment. Publication No. WRC/FPSA-G-99/05.

At the time of sampling, large sections of Ngarara Creek had riparian vegetation made up of pine, willow, bracken and a few natives. At the sampling site, a culvert allows for fish passage; however, due to a build-up of organic material under pine forest and still water, the water quality downstream of the culvert has become highly degraded. The upstream section of Ngarara Creek is subject to regular stream maintenance to improve flows.

22.2.11 Kakariki Stream

The Kakariki Stream meanders through grazed agricultural land around the sampling site. The upper Stream catchment also contains areas of native forest and shrub wetland, forest areas and the Nga Manu Nature Reserve. The Reserve is hydrologically connected to the Kakariki Stream upstream of the sampling location. Previous studies have shown the Stream to have high levels of turbidity, low dissolved oxygen and pH – indicative of organic matter and degradation. The GWRC Regional Policy Statement listed the Kakariki Stream as one of the "Waterbodies with Water Quality Identified as Needing Enhancement for Aquatic Ecosystem Purposes".

At the location of the sampling site, riparian vegetation consisted of some scrub, Carex geminata, willow, flaxes, bracken and blackberry. The deep sided channel with overgrown vegetation provides some shading for fish species.

22.2.12 Smithfield Drain

Smithfield Drain is a deep, channelised farm drain tributary of the Kakariki Stream cut through large areas of peat north of Kakariki Stream. Some of the stream is currently fenced from stock, including at the location of the sampling site. The Drain is regularly cleared to maintain flows, and there is one culvert within this reach which provides for fish access.

22.2.13 Paetawa Drain

At the sample site the Paetawa Drain runs through pasture and has some stock fencing. The Drain is highly modified and channelised along most of its length until the confluence with the Ngarara Stream. Overhanging vegetation is predominantly pastoral weeds and grasses and the banks are heavily grazed and pugged from dairy cattle. The substrate is mostly deep mud over sand with a high level of suspended solids. This Drain is also regularly cleared to maintain flows.

22.2.14 Hadfield/Kowhai Stream

This is the most northerly waterway in the Project area. The Stream's headwaters originate in pine and native forest in a steep upper catchment, before crossing under SH1 through culverts and through farmland. There is a small area of native vegetation which is the only natural riparian planting along the stream. It has good water quality.

22.2.15 Water quality

Technical Report 24 (Volume 3) details the existing baseline water quality of the catchments within the Project area. A brief summary of this information as it is relevant to the freshwater ecology, is described below.

Sampling within the Project area found that five of the six watercourse sites[172] showed nutrient (phosphorus and nitrogen) levels higher than the ANZECC 2000 guideline values.

Elevated levels of heavy metals were found in the Ngarara and Mazengarb Streams (base flow sample) and the Wharemauku and the Mazengarb Streams (in stormwater flushes). All samples sites had turbidity levels higher than are biologically acceptable over long periods. The samples collected for the investigation all had high levels of heavy metals, dissolved oxygen and E coli.

These results suggest that many of the streams along the proposed Expressway alignment currently present challenging biological environments for indigenous flora and fauna.

22.2.16 Freshwater fish species

Freshwater fish have been recorded in the Freshwater Fisheries Database (FFDB) in 6 of the 15 streams within the Project area. The FFDB has 18 species of fish recorded in these waterways.

Electric fish surveying (EFS) recorded 11 of the 18 species that had been identified in the FFDB. Fish species not found in the Project sampling included Cran's bully, giant bully, torrent fish, shortjawed kokopu, yellow eyed mullet and brown trout. The freshwater fish species recorded at the study sites are shown in Table 22.1 below (note sites have been grouped into catchments below).

The sampling found less fish species than previously recorded in the FFDB. This may be due to sampling being carried out in discrete areas where the Project will affect the streams. This result may also be associated with the habitat being sub-optimal in these locations to support several species of native fish that require good quality habitats.

[172] The six watercourse sites sampled are identified in Figure 2 of Technical Report 24, Volume 3

Table 22.1: Fish recorded in the study area (from New Zealand Freshwater Fish Database, NIWA, 2011 and KCDC et al, 1999) and national threat classification

Common Name	Threat Classification	Waimeha Stream	Waikanae River	Wharemauku Stream	Whareroa Stream	Ngarara Stream	Ngarara Stream Tributary
Yellow eye mullet	Not threatened		Y	Y			
Short fin eel	Not threatened	Y	Y	Y	Y	Y	Y
Long fin eel	Declining	Y	Y	Y	Y	Y	Y
Torrent fish	Declining		Y	Y			
Giant kokopu	Declining			Y	Y	Y	
Koaro	Declining			Y			
Banded kokopu	Not threatened			Y	Y	Y	Y
Inanga	Declining	Y	Y	Y	Y	Y	Y
Short-jaw kokopu	Declining			Y			
Lamprey	Declining		Y	Y			
Common bully	Not threatened	Y	Y		Y	Y	
Giant bully	Not threatened	Y			Y	Y	Y
Cran's bully	Not threatened					Y	
Red fin bully	Declining	Y	Y	Y	Y	Y	
Estuarine triplefin	Not threatened						
Smelt	Not threatened		Y	Y			
Black flounder	Not threatened		Y				
Brown trout	Introduced		Y				

22.2.17 Aquatic macroinvertebrates

Aquatic macroinvertebrate surveys were undertaken across waterbodies within the Project area to determine the levels of insects, snails and worms that were present; this information helps assess the ecological health of the streams. Six different invertebrate indices were calculated according to accepted practice at each of the sample site locations, including taxa richness, EPT taxa, total and EPT true abundance, macroinvertebrate community index (MCI), and Quantitative MCI (QMCI).

EPT taxa richness – this calculates the number of *Ephemeroptera* (mayfly), *Plecoptera* (stonefly) and *Tricoptera* (caddisfly) taxa at the sample site. EPT are most diverse in natural streams and the number and diversity typically decline with increasing watershed disturbance.

MCI and QMCI consider the whole macroinvertebrate population structure and provide a score that indicates general water quality, as set out in Table 22.2 below.

Table 22.2: MCI & QMCI score classification meanings[173]

Quality Class	Stark (1998) description	MCI	QMCI
Excellent	Clean	>120	>6.0
Good	Possible mild pollution	100–120	5-6
Fair	Probably moderate pollution	80-100	4-5
Poor	Probable severe pollution	<80	<4

22.2.17.1 EPT results

In total 60 different aquatic invertebrates were sampled from the 15 water bodies within the Project area. Sample sites ranged between 3-22 EPT taxa, with the Waikanae River having the highest number of taxa present. Figure 22.1 below shows the percentage representation of the total taxa richness which is made up of EPT taxa (%EPT) present at each site.

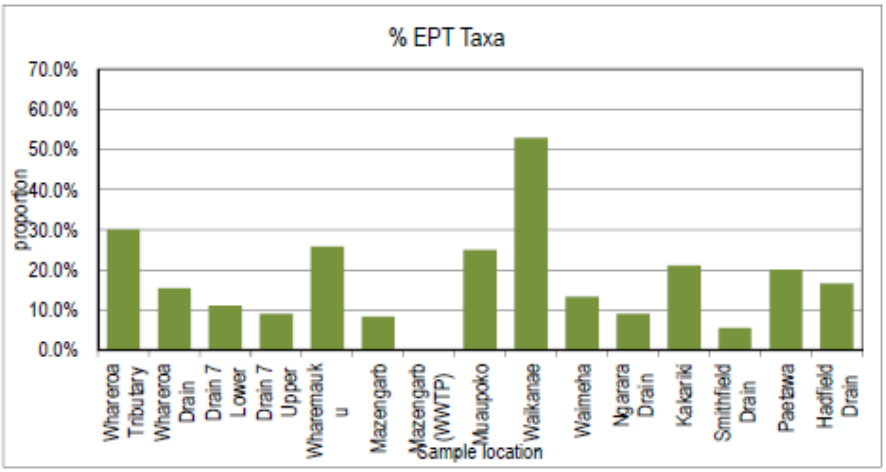

Figure 22.1: Averaged proportion (%) of EPT taxa present at each site

22.2.17.2 MCI and QMCI results

Figure 22.2 below shows the mean MCI score from each of the sampling sites. Mean MCI scores across the Project area were generally low i.e. less than 100 and typically under 90. Of the sites sampled, 13 of the 15 show 'probable moderate pollution' or 'possible mild pollution' using the indexes. The Waikanae River and Muaupoko Stream were the only samples to score over 100, indicating 'good to possible mild pollution'.

[173] Stark and Maxted. 2004. Macroinvertebrate Community Indices for Auckland Soft-bottomed Streams. ARC Technical publication 303.

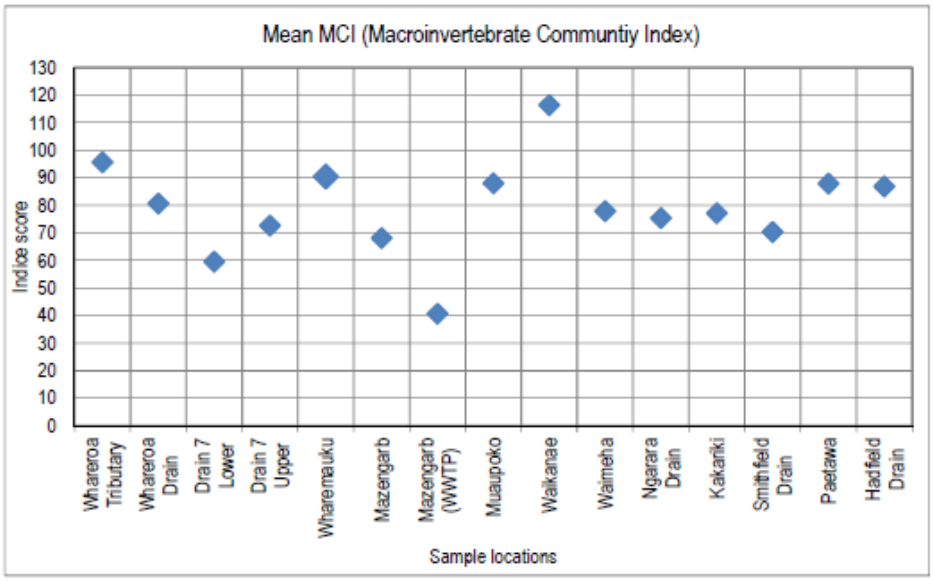

Figure 22.2: Mean MCI Score from each sampling site

Figure 22.3 below shows the mean QMCI score from each of the sampling sites. The QMCI accounts for the freshwater community 'condition'. QMCI scores for the 15 sites range from 1.7 (poor) through to 6.9 (excellent). The Waikanae River has the highest QMCI score of all of the sites sampled.

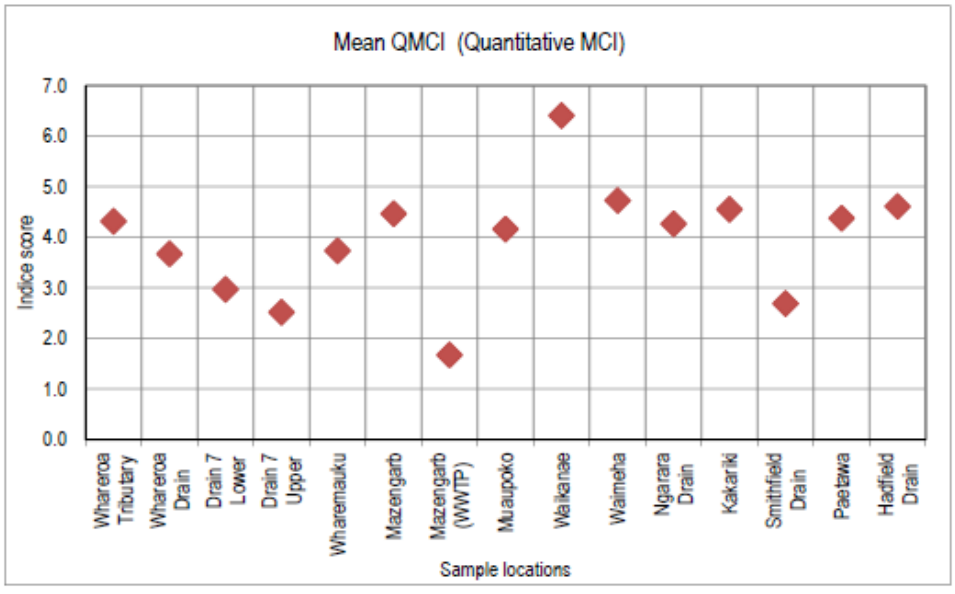

Figure 22.3: Mean QMCI Score from each sampling site

22.2.18 Stream Ecological Valuation (SEV)

The SEV model (developed by Landcare and adopted by GWRC for stream quality investigations in the Wellington Region) calculates a stream quality score based on the comparison of stream function parameters between test and reference sites. The SEV scores are produced on a scale of 0-1 (0 indicating no stream function and 1 indicating full and proper stream function). The purpose of these

scores is to provide a framework for calculating ecological mitigation for each of the streams sampled across the Project area. More detail on the SEV model and methodology is outlined in Technical Report 30.

SEV scores for the sampled sites ranged from a low score of 0.21 at the Whareroa Drain sampling site to 0.78 at the theoretical reference site[174]. The main factor influencing the SEV scores appears to be the absence of effective riparian margins.

A summary of the SEV results is provided in Figure 22.4 below.

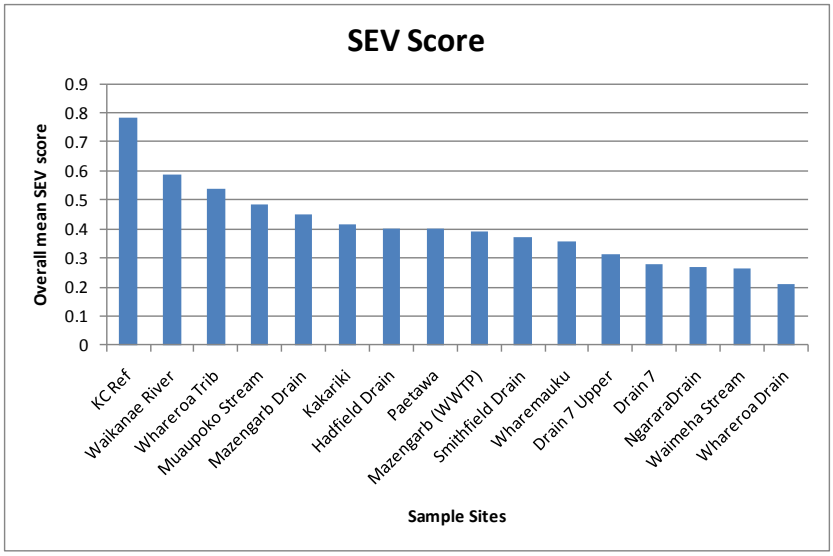

Figure 22.4: Calculated total SEV scores

22.2.19 Ecological values of streams

Based on the ecological assessment in Technical Report 30, Technical Report 26 summarises the ecological stream values of the 15 sampled sites in the Project area. Overall, the assessment concludes that:

- The Waikanae River is considered to be a regionally significant waterbody;
- The Wharemauku and Waimeha streams and the Waikanae river are considered to be of high ecological value; and,
- All of the streams sampled have high values in terms of the presence of indigenous freshwater fish species. However, the results suggest that with the exception of the Waikanae River, Wharemauku Stream and the Whareroa Stream tributary, the water bodies are low value, consistent with their highly modified and historically drained nature.

[174] reference sites being comparable streams with low levels of disturbance by human activity as detailed in Technical Report 30.

22.3 Assessment of effects on freshwater ecology

Technical Report 26 (Volume 3) outlines the Ecological Impact Assessment of the Project on freshwater ecology. The potential effects of the construction and operational activities are described in more detail below.

22.3.1 Assessment of construction effects on freshwater ecology

The potential direct impacts of construction of the proposed Expressway on freshwater ecology results from the loss and modification of aquatic habitat through culverting, armouring and diverting of streams; and fish mortality during installation of culverts and diversions.

The potential indirect impacts of construction include the impact on streams through the discharge of construction contaminants (oil, cement, lubricants) from stores or vehicles and sediment discharges.

22.3.1.1 Physical habitat disturbance

Construction of the proposed Expressway will require approximately 30 intermittent or perennial stream crossings affecting 1,431m of stream. There will also be approximately 1,525m of stream diversions or shortenings. This will potentially result in loss of habitat, associated riparian margins and resident populations of freshwater flora and fauna.

The Project design proposes the installation of 48 culverts with a total length including armouring of 2.35km. Of the 48 culverts proposed, 26 will not affect permanent or intermittent watercourses: 20 culverts are located either where there is a risk of ponding upslope of the proposed Expressway or to connect stormwater treatment ponds to neighbouring watercourses (being formed in existing streams); 6 culverts are located in ephemeral watercourses, typically farm drains and existing roadside depressions or swales with little to no aquatic habitat value. The remaining 22 culverts lie within perennial or intermittent streams: 14 are new culverts and 8 are upgrades or replacements of existing culverts.

Nine diversions totalling 1,525m in length with associated reclamation are proposed in perennial or intermittent streams. While 1,525m of stream will be reclaimed, the total length of the diversion channels will be 2,016m, or 491m longer than will be lost. With the exception of Muaupoko Stream outlet, all diversions proposed consist of replacing straight channelised farm drains. New diversion lengths and new sections of stream being created have incorporated meanders in their design and will provide a quality of habitat that is better than that found in the existing watercourses..

Eight bridges are proposed to be constructed with an associated armouring of 312m of stream bank. The proposed bridges cross perennial or intermittent streams. Except for the bridge over the Waikanae River, all of the bridge structures will be single span, with no piers or piling within stream or river channels. Construction of all of the bridges will require rock armouring of the stream banks and bed to prevent movement of the stream and the risk of undermining the bridge foundations. The Waikanae Bridge will have five spans. Associated with construction of this bridge will be large scale earthworks to widen the existing floodplain, which is being carried out on instruction from GWRC.

22.3.1.2 New stream sections

In addition to the culvert, bridge and diversion construction, 7 new sections of stream are proposed to be created to connect the proposed Expressway works to stormwater pond outlets and to existing watercourses. This would result in approximately 2,016m of new stream habitat which will receive riparian planting of some form. This new habitat would provide opportunities for mitigation of the stream length lost as described above.

22.3.1.3 Summary of stream works

Technical Report 26 summarises the magnitude of aquatic habitat loss as a result of in-stream works required for construction of the Project. Table 22.3 below provides an assessment of impact significance of these works. Overall, the assessment concludes that 2.9km of stream habitat will be lost as a result of the Project. This length is distributed over 12 waterbodies of generally low value. The works required for armouring, diversion and culverting provide an opportunity to improve stream habitat if designed and installed properly. Therefore, good design is the critical component to ensuring that the in-stream works become, in themselves, mitigation for most of the stream modifications.

Table 22.3: Assessment of Impact Significance (without mitigation)

DESCRIPTION	Ecological Value	Assessment of Impact Magnitude	Assessment of Impact Significance
High Value Streams			
Waikanae River	High	Negligible	Low
Medium Value Streams			
Muaupoko Stream	Medium	Negligible	Very Low
Wharemauku Stream	Medium	Negligible	Very Low
Low Value Streams			
Whareroa	Low	Negligible	Very Low
Drain 7	Low	Medium	Very Low
Mazengarb	Low	Low	Very Low
Waimeha	Low	Medium	Very Low
Ngarara Creek	Low	Medium	Very Low
Kakariki	Low	Low	Very Low
Smithfield	Low	High	Low
Paetawa	Low	Medium	Very Low
Hadfield/Kowhai	Low	Low	Very Low

22.3.1.4 Effects on freshwater fish

18 native fish species have been recorded within the Project area. Of these, 8 have a national threat status. These species are potentially affected by:

- The loss of habitat (culverting) which will potentially reduce populations;

- Habitat changes associated with new diversion channels and lengths of new stream being created; and,
- Entrapment and mortality during reclamation of streams and the prevention of migration (culverting).

While much of the stream (2,956m of stream works) that will be affected by construction of the proposed Expressway is highly modified, the quantity of habitat that will be affected is large. This will result the risk of major losses to native freshwater fish.

Mitigation measures to address the potential effects of loss of freshwater fish and habitat are discussed below (Section 22.4 of this Chapter).

22.3.1.5 Contaminant discharges (chemicals, fuel and oil)

There is a risk of spills such as chemicals, fuel and oil during construction activities, in addition to the release of contaminants by disturbing contaminated soils.

Mitigations measures to address these potential effects are discussed below in Section 22.4.

22.3.1.6 Sediment arising from earthworks

The main potential effect during construction that could have significant adverse effects on freshwater ecosystems is increased levels of sediment entering waterways from the large scale earthworks required for the Project. Sediment occurs naturally in streams in baseline levels; however, too much sediment can adversely affect ecosystems by smothering flora and fauna in waterbodies, interfering with the gills of fish and invertebrates, reduce periphyton growth (reducing food supply for many freshwater species); and restricting visual clarity in the water which affects the ability for fish to see their prey.

The preliminary ESCP (Appendix H of the CEMP) addresses sediment yield, transport and management during construction of the proposed Expressway and the Contaminant Load Modelling (Technical Report 25, Volume 3) addresses these matters during operation. Table 22.4 below shows predicted sediment increase in the various catchments as a result of the additional contribution from the earthworks footprint[175].

Table 22.4: Predicted sediment generation by catchment (pre and during construction)

DESCRIPTION	Baseline Sediment Whole Catchment (tonnes)	Total Contribution by Construction (tonnes)*	% Increase over baseline
Whareroa catchment	18.17	0.58	2.6%
Wharemauku catchment	38.02	4.50	9.5%

[175] The Universal Soil Loss Equation (USLE) was used to calculate sediment load generation. More information is provided in Volume 4, Appendix H.

DESCRIPTION	Baseline Sediment Whole Catchment (tonnes)	Total Contribution by Construction (tonnes)*	% Increase over baseline
Waikanae catchment	644.72	3.96	0.4%
Waimeha	2.37	0.77	25.3%
Ngarara catchment	50.56	6.83	9.8%

Overall, sediment yields are expected to increase to a total of 16.64 tonnes of sediment across the five affected catchments during construction. The preliminary ESCP provides for a range of mitigation measures to minimise sediment discharge levels, particularly where there are sensitive downstream receiving environments.

Based on the predicted sediment loads within the flat contours of the Project area, the effects on freshwater ecosystems will be low in the Whareroa, Wharemauku, Waikanae and Waimeha catchments. There is potential for greater effects as a result of the volume of sediment that could enter the Te Harakeke/Kawakahia wetland via the Ngarara Stream. If sediment is flushed through these waterways it may result in infilling of the stream and may have potential effects on low wetland vegetation and biological communities. Due to the difficulty of quantifying these effects, adaptive management and construction monitoring are recommended. These are discussed in further detail in the following sections.

22.3.2 Assessment of operational effects on freshwater ecology

22.3.2.1 Wetlands

Once the proposed Expressway is in operation, there is some potential to drawdown/dam or raise groundwater immediately surrounding the proposed Expressway which may result in potential adverse effects on wetland hydrology adjacent to the proposed Expressway. Wetlands identified as potentially at risk include the Raumati Manuka Wetland, Otaihanga Northern and Southern wetlands, El Rancho Wetland (Weggery), Ti Kouka Wetland and Ngarara Wetland, all of which include some proportion within 200m of the proposed Expressway alignment. An adaptive management approach is proposed to manage any adverse effects on these wetlands, as discussed below in section 22.4.

22.3.2.2 Stormwater discharge

The discharge of contaminated stormwater from the proposed Expressway to local streams and estuaries has the potential to impact on water and habitat quality. The Contaminant Load Modelling results (Technical Report 25) indicate that the effects of stormwater runoff to streams and estuarine systems is likely to lead to an overall reduction in contaminant loads generated from all catchments except for the Wharemauku and Waimeha stream catchments, largely as a result of the re-distribution of traffic from existing SH1 to the proposed Expressway and the increase of stormwater treatment proposed as part of the proposed Expressway. Mitigation for the potential adverse effects is discussed in detail below.

22.3.2.3 Fish passage

Due to the low-lying nature and low velocity of the majority of the watercourses traversed by the proposed Expressway, it is expected that fish passage can be provided to all streams traversed by the proposed Expressway where indigenous freshwater fish may be present.

With post construction monitoring and maintenance of culverts as outlined below, the risk of adverse effects on fish passage during the operation of the Project will be negligible, largely due to low gradients within the Project area.

22.3.3 Measures to avoid, remedy or mitigate actual or potential adverse effects on freshwater ecology

Section 11 of Technical Report 30 (Volume 3) identifies that mitigation, which may include management and monitoring, is required for a number of construction and operational aspects of the proposed Expressway, which are summarised below.

Further details relating to freshwater mitigation can be found in Technical Report 26 (Volume 3) and the Ecological Management Plan (Appendix M of the CEMP, Volume 4).

22.3.3.1 Adaptive management – overall approach

Adaptive management is proposed to be used as a tool to mitigate actual and potential effects of the Project on freshwater ecosystems throughout construction and in the first 3 years of proposed Expressway operation. This tool is used when a project may affect complex ecological ecosystems where it may be difficult to predict all the potential effects with absolute certainty. Adaptive management is an extension of the precautionary approach, and its application to this Project supports the continuous improvement processes that are increasingly best practice for large and complex construction projects.

The premise of adaptive management is to establish a baseline of pre-construction ecological conditions against which changes are measured. Technical Report 26 (Section 11) provides more detail on this approach. The mitigation described below outlines where adaptive management is proposed to mitigate the actual and potential effects of the Project.

22.3.3.2 Mitigation proposed for construction effects

a. Stream habitat loss or modification

Mitigation actions have been designed to fall immediately upstream and / or downstream, as far as practicable, within the waterbody(s) affected by the proposed Expressway. The potential adverse effects on freshwater systems associated with culverting and diversions are proposed to be mitigated primarily through stream restoration on the waterbodies affected upstream and downstream of the Project.

Ecological mitigation ratios were derived using the SEV model. The SEV model assesses how well the main ecological functions of a stream are being performed and represents a 'no net-loss' tool which

produces an ecological compensation ration (ECR) after taking these factors into consideration. This tool is discussed and applied in Section 11.3 of Technical Report 30 (Volume 3).

In order to mitigate the 1,431m of freshwater habitat loss and modification required for the construction of culverts and bridges, and the 1,525m of habitat loss through stream diversion and modifications, a total of 4,973m of stream restoration is calculated to be required. A range of mitigation (and management) actions are proposed covering a total of 4,716m of stream, the shortfall of which is proposed to be addressed by the additional ecological benefit provided by landscape planting and the development of large mass planted flood storage totalling 13ha in area (which have not been used for ecological mitigation elsewhere). The design for the mass planted flood storage areas will have habitat connections to adjacent waterbodies (the Wharemauku Stream and the Kakariki Stream) and this will provide a range of habitat benefits.

Riparian planting upstream and downstream is proposed at each of the 22 culvert locations within perennial and intermittent waterbodies. This would result in a total length of 880 lineal metres based on 20 lineal metres of planting (10m wide on both sides) upstream and downstream of the crossing. Where possible, these areas will be fenced and permanently protected.

Riparian re-vegetation of the Wharemauku, WWTP, Waimeha, Kakariki and Paetawa Streams and the Waikanae River will total 1,820 lineal metres (based on a minimum of 10m – 20m wide both sides of the waterbody). Areas of permanent restoration and retirement are also proposed along specific reaches of the Wharemauku, Waimeha, Kakariki and Paetawa Streams, and the Waikanae River in the vicinity of the proposed Expressway. The mitigation proposed will provide additional habitat enhancement immediately adjacent to the areas affected by the Project and long term benefits.

Diversions will total more than the lengths of stream lost and will include the construction of a number of new lengths of stream (totalling 1,260m) which will connect to the existing waterbodies.

Best practice erosion and sediment control mechanisms during construction will also assist in reducing potential sediment-laden run-off reaching the ecologically sensitive downstream receiving environments.

b. Effects on freshwater fauna

To assist in ensuring that detailed design allows for fish passage, ecological input will form an important component of the detailed design stage. All culverts in perennial or intermittent streams will be embedded and sized to allow stream bed habitat to pass through them. The methods used will ensure that fish passage is achievable.

Fish relocation will be carried out during the construction of culverts and stream diversions. Works in stream beds will be minimised during periods of fish migration (Spring 1 Oct – 30 Dec; Autumn 1 April – 30 May) to ensure work is only undertaken in short, prescribed periods during this time with appropriate ecological supervision.

c. Wetland hydrology

The long-term hydraulic effects on wetlands located in close proximity to the proposed Expressway remain uncertain. In order to monitor and manage these potential effects a number of measures are proposed. This includes adaptive management approaches to measure water levels in the Raumati/Manuka Wetland, Otaihanga Southern and Northern Wetlands and El Rancho Wetland (Weggery).

In addition to the baseline wetland condition monitoring undertaken as part of the ecological investigations, baseline hydrological monitoring will be undertaken in these wetlands prior to construction to determine existing water levels and the range of seasonal variation. The groundwater monitoring planned is outlined in the Groundwater (Level) Management Plan (Appendix I of the CEMP).

Through the construction phase, on-going monitoring of water levels and the ecological condition of wetlands will be undertaken as part of the adaptive management approach. If groundwater level changes are detected, potential effects on wetlands can be avoided by mitigating groundwater level change before the wetland is deleteriously affected. A range of options have been developed to manage construction-related effects associated with drawdown or damming, including consultation with statutory authorities.

Further details of the proposed adaptive management approach in relation to wetlands can be found in Technical Report 26 (Volume 3) and the Ecological Management Plan (Appendix M of the CEMP, Volume 4).

22.3.4 Mitigation proposed for operational effects

a. Stormwater Discharge

The Project design has incorporated a mix of linear stormwater swale treatments along the length of the Project and a number of larger treatment wetlands. These devices are expected to perform so that the levels of contaminants in stormwater discharging to streams (and out into the estuaries) will not increase. Overall, the level of stormwater treatment proposed, combined with the reduction in traffic from the existing SH1 (where untreated stormwater currently discharges directly into many of the waterbodies sampled for this assessment), is anticipated to lead to a reduction in the level of contaminants entering the waterbodies downstream of the Project alignment in the long-term.

A water quality treatment plan will require monitoring of the stormwater treatment devices during the first 3 years of operation to ensure these devices are operating effectively to meet the target removal rates.

b. Effects on freshwater fauna

Post construction monitoring (3 years) of fish passage in stream diversions and culverts will be undertaken to ensure the designs used are effective and continue to operate to their design standards.