28 Water quality

Overview

The construction and operation of the proposed Expressway has the potential to adversely affect water quality in downstream freshwater watercourses and the marine environment. Construction of the proposed Expressway will involve major earthworks, which have the potential to increase sediment run-off to streams/rivers and the coast. Once in operation, the proposed Expressway has the potential to increase contaminants levels in streams/rivers and the marine environment associated with stormwater runoff from road surfaces.

Existing freshwater quality in watercourses along the proposed Expressway alignment are characteristic of lowland waterways draining predominantly pastoral land use with elevated nutrient concentrations, bacteriological counts and low toxicant concentrations.

A high level of erosion and sediment control will be used to manage sediment generated from the construction of the proposed Expressway entering watercourses. All discharges will be treated to at least a minimum standard in accordance with best practice methodologies and will include retention devices, some chemical treatment, stabilisation techniques and monitoring.

Once operational, all stormwater generated from the proposed Expressway will pass through swales and / or wetlands that are explicitly designed to improve the water quality of stormwater prior to discharge. As traffic volumes and the congestion on the existing SH1 will be reduced, contaminant loading from that source will also be reduced. The fully operational Expressway is likely to lead to an overall reduction in contaminant loads generated from most catchments relative to the existing scenario.

There are not anticipated to be any direct effects on marine water quality values due to construction and/or operation of the proposed Expressway. The proposed Expressway alignment is located some distance from marine environments and stormwater will be suitably treated prior to being discharged.

The potential adverse environmental effects on the quality of water through both construction and operation of the proposed Expressway will be suitably avoided and / or mitigated. During construction, potential adverse effects will be suitably managed through an Erosion and Sediment Control Plan(s). During operation, potential adverse effects will be suitably managed through the use of swales and wetlands. Overall, there will be water quality benefits.

28.1 Introduction

Water quality refers to the physical, chemical and biological characteristics of water.

This Chapter discusses the actual and potential water quality effects arising from the construction and operation of the proposed Expressway. The information contained in this Chapter is based on the following Technical Reports in Volume 3:

- Assessment of Hydrology and Stormwater Effects, Technical Report 22, Volume 3;

- Baseline Water and Sediment Quality Investigation Report. Technical Report 24, Volume 3;
- Contaminant Load Assessment, Technical Report 25, Volume 3;
- Marine Habitat and Species, Technical Report 31, Volume 3; and,
- Erosion and Sediment Control Plan, Appendix H of the CEMP, Volume 4.

Effects were assessed by gathering information about existing water quality in both freshwater (i.e. streams/rivers) and coastal waters. The potential effects on water quality arising from the proposed Expressway were then modelled and assessed.

The potential ecological effects from changes to water quality on freshwater and marine ecology are discussed in Chapters 22 and 23 of this AEE, respectively. Potential stormwater and hydrology effects are discussed in Chapter 24 and contamination effects are discussed in Chapter 27.

28.2 Existing water quality

A baseline water and sediment quality investigation was undertaken to evaluate existing surface water and sediment quality within watercourses along the proposed Expressway alignment. The baseline investigation allowed the potential impacts of the proposed Expressway construction on water quality to be predicted. This investigation comprised the following:

- Literature review of existing information;
- Ambient water quality monitoring programme;
- Sediment and water quality investigation near the Otaihanga Landfill; and,
- Characterisation of groundwater associated with peat soils

28.2.1 Literature review

The literature review drew on a number of information sources as detailed in Technical Report 24, Volume 3. The results of existing information pertaining to each of the major watercourses through the proposed Expressway area are summarised in Table 28.1 below. Only those water quality parameters and / or contaminants which the literature showed as regularly exceeding ANZECC Guidelines[222] (the Guideline) are shown below.

[222] ANZECC Guidelines were principally used to provide a broad indication of water and sediment quality. All references to 'Guideline' values in this Chapter refer to the ANZECC 95% ecological guidelines.

Table 28.1: Literature Review Summary of Water Quality Parameters / Elevated Contaminants

Watercourse	General Water Quality	Base Flow Water Quality Exceedances	Stormwater Quality Exceedance (in sampled watercourse)
Whareroa Stream	Poor	Nutrients, TSS, turbidity, water clarity, bacteriological counts	
Wharemauku Stream	Poor		pH, dissolved oxygen, E coli, aluminium (acid soluble), copper (dissolved), zinc (dissolved)
Mazengarb Drain	Poor	Boron, nutrients, suspended solids, Biochemical Oxygen Demand	DO, E coli, aluminium (acid soluble), copper (dissolved), zinc (dissolved)
Waikanae River	Good	Dissolved reactive phosphorus	E coli, aluminium (acid soluble)
Waimeha Stream	Fair	Nutrients	E coli
Ngarara Stream	Poor	pH, dissolved oxygen, nutrients, suspended solids, turbidity, bacteriological counts, aluminium	

28.2.2 Ambient water quality monitoring programme

Complementing the literature review, an ambient water quality monitoring programme at key sites on the major watercourses[223] along the extent of the proposed Expressway area generated a database of information from which the existing water and sediment quality could be assessed. The programme included the collection and analysis of water and sediment samples over a 7-week period between 2 May 2011 and 16 June 2011 (detailed information relating to the water quality monitoring programme is contained in Technical Report 24, Volume 3).

Information on the following indicators and parameters was collected:

- Dissolved and total heavy metals (aluminium, arsenic, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel and zinc)
- Total petroleum hydrocarbons (TPH)
- Semi volatile organic compounds (SVOC)
- Carbonaceous biological oxygen demand (cBOD)
- Chemical oxygen demand (COD)
- Nutrient suite (dissolved reactive phosphorus, nitrate, total nitrogen oxides, nitrite, TKN, total nitrogen, total phosphorus and ammoniacal-nitrogen)
- Total suspended solids; and,
- E. coli.

[223] Whareroa Stream, Wharemauku Stream, Mazengarb Drain, Waikanae River, Waimeha Stream and Ngarara Stream

The results showed that water quality in the watercourses sampled along the proposed Expressway area is generally characteristic of lowland waterways draining predominantly pastoral land use, with elevated nutrient concentrations, bacteriological counts and low toxicant concentrations. Nevertheless, there were some clear differences in the water quality between the watercourses, which generally reflected the differences in the catchment areas they drain.

Detailed results of the ambient water quality monitoring are contained in Technical Report 24, Volume 3. In summary:

- All metal and organic contaminant concentrations in the bed sediment samples were below the Guideline value;
- Water quality at the sampling location in the Wharemauku Stream, west of the proposed Expressway, was 'poor' due to upstream pastoral, residential and industrial/commercial land use activities. The base and high flow waters had elevated nutrient concentrations, ammoniacal-nitrogen, and dissolved and total zinc relative to the corresponding Guideline values.;
- Base flow and stormwater quality at the sampling location in the Mazengarb Drain was 'poor' with elevated nutrients, ammoniacal-nitrogen, suspended solids, organic matter, copper and zinc. The water quality in the drain is probably impacted by in-catchment urban land uses and in part, by the 'eastern' tributary that drains the former Otaihanga Landfill and which discharges into the Mazengarb Drain upstream of the sampling location;
- Water quality at the site sampled in the Kakariki Stream west of SH1 was 'poor' due to elevated nutrient concentrations, suspended solids and bacterial counts. While water quality in the Waimeha Stream was generally good, there were some slightly elevated nutrient concentrations and suspended solids in some of the water sampled. Water quality of both sampled sites is likely to be impacted by agricultural land use activities;
- Water quality of the base flow waters in the Waikanae River and Hadfield Drain/Te Kowhai Stream was generally good, with most indicators and contaminant concentrations within the limits of the corresponding Guideline values. However, during high flow conditions due to elevated stormwater run-off from agricultural land uses in the draining catchment, water quality in the Hadfield Drain/Te Kowhai Stream appeared to be 'poor' due to elevated suspended solids, ammoniacal-nitrogen, nutrients and bacterial counts;
- Organic and total petroleum hydrocarbons concentrations in all samples taken were below analytical detection limits across the proposed Expressway extent;
- Total and dissolved aluminium was above the corresponding Guideline value at many of the sites sampled in the watercourses across the proposed Expressway area, which is likely to be due to general elevated background soil concentrations of aluminium across the Wellington region. The concentration of total aluminium was higher in almost all stormwater samples relative to base flow waters due to eroded soils from the wider catchment area and a corresponding increase in the aqueous suspended solids concentration;
- All organic contaminants (SVOCs and TPH) were below the analytical detection limits except for TPH (C7 – C36), which was present as a low, but measurable, concentration in the Wharemauku Stream during one low flow sampling event; and,

- Except for aluminium, there was little difference in the concentration of most metal and organic contaminants between the base and high flow sampling events. However, copper and zinc were likely to exceed the Guideline values in some base and high flow waters (impacted by the 'eastern' tributary of the former Otaihanga Landfill, The Paraparaumu Waste Water Treatment Plant and urban land uses).

28.2.3 Sediment and water quality investigation near Otaihanga Landfill

A sediment and water quality investigation was undertaken in the stormwater/leachate drainage channel and wetlands along the western edge of the Otaihanga Landfill. The purpose of the investigation was to characterise the sediment quality in the wetlands within the footprint of the proposed alignment, and the water quality in the stormwater/leachate drainage channel. The results showed that:

- Sediment in the wetlands was predominantly organic with some elevated dieldrin (potentially through high insecticide use within the catchment), arsenic and zinc concentrations relative to the corresponding Guideline values;
- Metal and organic contaminant concentrations in the sediment sample collected from the stormwater/leachate drainage channel were at low concentrations; and,
- Water quality in the drainage channel was 'poor' with low dissolved oxygen and pH, and some elevated bacteriological counts, aluminium, manganese and zinc concentrations relative to the corresponding Guideline value.

28.2.4 Chemical characterisation of groundwater associated with peat soils

Groundwater associated with peat was tested for a range of water quality indicators and parameters. The results of the study found the following;

- The groundwater associated with the peat had low pH and dissolved oxygen;
- The groundwater run-off from peat may have elevated organic carbon and nutrient concentrations which may impart a 'tea' to dark brown coloured staining to receiving waterways (which may lead to reduced water clarity and increased turbidity); and,
- In waters with a high content of suspended solids, the groundwater may contain elevated metal concentrations.

28.3 Water quality modelling

Models were developed to assist in the assessment of potential water quality effects associated with the construction and operation of the proposed Expressway. These were:

- To assess construction effects:
  - A sediment yield estimate following procedures within the Universal Soil Loss Equation (USLE)) – see Appendix H (Erosion and Sediment Control Plan) of the CEMP, Volume 4.
- To assess operational effects:
  - A contaminant load model (CLM) – see Technical Report 25, Volume 3.

28.3.1 Construction effects modelling

A sediment yield estimate was used as a comparative tool to gain an appreciation of the expected increase in catchment-wide sediment yields as a result of the proposed earthwork activity. The sediment yield estimate was also used to provide a measure of the risk of sediment generation and yields, and to assist in identifying controls required for managing this risk to the environment from sediment discharges from earthwork sites. The sediment yield estimate followed procedures within the USLE and is described in the Erosion and Sediment Control Plan (Appendix H of the CEMP, Volume 4).

The USLE allowed for greater consideration to be given to areas which are likely to produce higher sediment yields (for example, areas of greater slope) and for these areas to be targeted with more comprehensive control methodologies.

28.3.2 Operational effects modelling

A contaminant load assessment (CLM) was undertaken for the following catchments through which the proposed Expressway will pass: Whareroa Stream, Wharemauku Stream, Waikanae River, and Ngarara Stream. The model provides a basis whereby the effects of the proposed Expressway, both with and without stormwater treatment, could be considered against the existing (without the proposed Expressway) land use scenario.

The model required input for the total area of the catchment including roof, road and paved surfaces associated with each residential, commercial and industrial land use area; road lengths; urban grass lands; exotic production forest; stable bush; farmed pasture; and, horticulture.

The CLM calculated the annual contaminant loads of sediment, zinc, copper and TPH (primarily oil and grease) within each of the defined catchments, based on the different land use types and their contaminant yields. The following scenarios were modelled:

- Existing scenario (Year 2011);
- Future scenario (Year 2031[224]) with full operation of the proposed Expressway (without stormwater treatment); and,
- Future scenario (Year 2031) with full operation of the proposed Expressway (with stormwater treatment).

The information from the CLM allowed the efficiency of proposed treatment measures to be assessed and the potential stormwater contaminant effects of the proposed Expressway to be identified.

[224] The year 2031 was selected as the basis for the future land use scenarios to align with the modelled future traffic counts.

28.4 Assessment of water quality effects during construction

Construction of the proposed Expressway will involve a number of activities that have the potential to generate sediment, including:

- Earthworks;
- Works in and around watercourses (such as construction of bridges, retaining walls and culverts);
- Temporary stockpiling of material; and
- Pumping of sediment laden water from excavations.

Sediment can be generated in two main ways:

- when rain falls on exposed earth (i.e. un-vegetated cut faces or fill slopes); or,
- When works in stream beds disturb and entrain sediment.

Increased sediment levels could have a number of adverse effects, including:

- Damaging aquatic (freshwater and marine) habitat;
- Altering the morphology of rivers / streams; and
- Reducing the aesthetic properties of water (e.g. visual clarity and odour).

Sediment has been assessed as the only contaminant with the potential to have adverse environmental effects during construction. There is always risk during a major construction project that accidental spills will result in other contaminants (such as fuel) entering waterways. While this risk can never be completely eliminated, it can be effectively managed through sound environmental management. The CEMP contains protocols for working with contaminants on-site, as well as emergency spill procedures to apply in the unlikely event that a contaminant is spilt near a waterway.

The limited areas of contaminated land identified within the proposed Expressway area are also a potential source of contaminants to waterways. The CEMP contains sound procedures for managing contaminated material safely, and this includes managing the risk to waterways. More detail in relation to the proposed measures to address risks arising from contaminated land is contained in Chapter 27 of this AEE.

Accordingly, contaminants other than sediment have not been considered further in the assessment of potential water quality effects during construction in this Chapter.

28.4.1 Sediment yields

USLE calculations (refer ESCP, Appendix H of the CEMP, Volume 4) have predicted the following sediment yields during earthworks:

Catchment	Tonnes
Whareroa	0.58
Wharemauku	4.50
Waikanae	3.97
Waimeha	0.77
Ngarara	6.38

This equates to a total sediment yield of 16.64 tonnes, with an estimated exposed area of 138.8ha over the construction duration (although on a proportion of this area would be fully exposed at any one time).

28.4.2 Erosion and sediment control (ESC)

A Erosion and Sediment Control Plan (ESCP) has been prepared. The ESCP provides the general principles and methodology for undertaking earthworks. As more detailed design occurs with progression of the proposed Expressway, site specific ESCPs (CESCP) will be prepared and implemented prior to construction commencing at the relevant site.

The ESCP is consistent with both the GWRC's erosion and sediment control guidelines[225] and the draft NZTA[226] erosion and sediment control guidelines. Fundamental ESC principles contained within the ESCP include, so far as is practicable:

- Minimising disturbance;
- Staging construction;
- Protecting steep slopes;
- Protecting waterbodies;
- Undertaking progressive and rapid stabilising of disturbed areas;
- Perimeter controls; and
- Deployment of detention devices[227].

---

[225] Wellington Regional Council, Erosion and Sediment Control Guidelines for the Wellington Region, September 2002 (GWRC Guidelines)

[226] New Zealand Transport Agency, draft NZTA Erosion and Sediment Control Standard for State Highway Infrastructure, August 2010

[227] Principles listed are contained in the draft NZTA Erosion and Sediment Control Standard for State Highway Infrastructure, August 2010

Table 28.2 below outlines key ESC measures (as outlined through Section 6 of the ESCP (see Appendix H of the CEMP, Volume 4)) and their proposed application to the proposed Expressway.

Table 28.2: Key ESC Measures for the proposed Expressway

Key ESC Measure	Applicability
Sediment retention ponds	Sediment retention ponds will be the main tool for retention and treatment of sediment laden run-off.
Chemical treatment (flocculation)	Chemicals will be utilised on a limited basis (as a risk management tool) to 'clump together' fine particles into a 'floc'. Sediment laden water may be treated with chemicals to help achieve necessary water quality thresholds on an 'as required' basis.
Decanting earth bunds	Treatment of sediment laden run-off via decanting earth bunds will be used when space requirements restrict the use of sediment retention ponds. This will typically be used on large cut slope faces.
Silt fences / super silt fences	Perimeter controls both around and within earthwork sites, especially in close proximity to watercourses.
Diversion channels	Perimeter controls around earthwork sites
Innovative measures	Innovative products may be used (e.g. filter socks).

Sediment retention ponds (or decanting earth bunds if required) are likely to be the main sediment control device used to remove sediment prior to discharge to a receiving waterbody. Silt fences and / or other perimeter controls will be used to limit sediment laden water entering these devices.

Sediment retention ponds operate by allowing the sediment to settle out from suspension of the main runoff, and be retained in the pond. The rate at which sediment falls is called the particle settling velocity (or particle fall velocity). The settling velocity is governed by the flow regime in the pond, particle size and the density of the particle (relative to water). In general, as particles increase in size, they have an increased settling velocity – i.e. they settle faster. The effectiveness of ponds can be improved by adding a chemical agent which binds multiple particles together, forming a larger particle with accelerated settling properties.

28.4.3 Effects of sediment on stream water quality

All discharges will be treated to at least a minimum standard and methods used will include retention devices, some chemical treatment, stabilisation techniques and monitoring.

Overall, there are predicted to be negligible effects on water quality, provided the measures identified in the ESCP are appropriately installed, monitored and maintained.

28.5 Assessment of water quality effects during operation

Once the proposed Expressway is in operation, it will have the potential to adversely affect water quality in streams and coastal waters due to stormwater run-off from road surfaces.

28.5.1 Stormwater design philosophy

The stormwater design approach for the proposed Expressway is based on the application of a set of key principles and standards[228] as detailed in the Assessment Hydrology and Stormwater Effects (Technical Report 22, Volume 3). The approach aims for hydraulic neutrality[229], taking into account both increased runoff from the proposed Expressway footprint, and loss of flood plain storage under the footprint in some areas.

28.5.2 Attenuation

Stormwater attenuation will be generally provided by swales. Where swales are located in low-lying peat areas, wetland planting will be used in the base of the swale. Where swales are located in sand, grassed swales will be utilised.

Where swales are not able to provide for the treatment and/or attenuation required, wetlands and/or storage areas will be used to achieve the required performance before discharge. In some areas, both swales and wetlands will be utilised to achieve the required attenuation. The proposed Expressway will also use siphon sumps that trap gross litter more efficiently than do standard barrel sumps.

The swales and wetlands proposed at the current stage in the design of the proposed Expressway provide attenuation to varying degrees, ranging from 6% to 82% for the 1% annual exceedence probability (AEP) flows[230]. This generally achieves the NZTA's target of providing attenuation to achieve an average of 80% of the AEP flows; in some cases achieving results significantly better than this. Where results in some few areas do not achieve the 80% target, the final design will be optimised to achieve this target during later design stages.

At this stage of the design, attenuation is focused on the 1% AEP storm. Some of the swales do not currently achieve the 80% target for other potential storm events, but this is considered to be a reflection of how the outlet orifice has been modelled rather than indicative of a real effect. It is anticipated that further refinement of the outlet designs (through detailed design stage) will see the swales meet the target attenuation for all the events that have been assessed.

---

[228] Stormwater Treatment Standard for State Highway Infrastructure, 2010, NZTA; Bridge Manual, 2003, Transit NZ; Alliance/KCDC Guiding Objectives, 2010; Kāpiti Stormwater Management Strategy, KCDC; and Austroads Guidelines for the Collection and Discharge of Stormwater from Road Infrastructure, 1994, ARRB.

[229] Hydraulic Neutrality has been agreed with KCDC to mean, with respect to the proposed Expressway, not discharging greater than the existing peak flows and not causing a significant increase in flood levels by filling in more floodplain storage than is compensated for.

[230] Hydrologists define the likelihood of flood peak flows by their annual exceedence probability (AEP). A so-called 100-year flood does not mean that there is exactly one flood of this size every 100 years. It means that there is a 1 in 100 chance in any given year that a flood of this size or bigger will happen; it is therefore more correctly called a 1% AEP flood.

28.5.3 Stormwater effects on stream water quality

Overall, the proposed Expressway will provide water quality benefits in two main ways: first in reducing traffic volumes on the existing SH1 which currently has no stormwater treatment; and second in having all of the stormwater generated from the proposed Expressway passing through swales and / or stormwater treatment wetlands that are explicitly designed to improve the water quality of stormwater prior to discharge. While there will now be two roads, the traffic volumes and the congestion on existing SH1 will be reduced, thereby reducing the contaminant loading.

The CLM assessment showed that, when fully operational, in 2031 the proposed Expressway without stormwater treatment would be likely to lead to an overall improvement over the existing situation in the contaminant loads (sediment, zinc, copper and total petroleum hydrocarbons (TPH)) discharging to the receiving environment from most catchments modelled (except for the Wharemauku, Ngarara and Waimeha stream catchments). However, when fully operational with stormwater treatment, the proposed Expressway is likely to lead to a further reduction in the contaminant loads generated across the proposed Expressway area. The sediment load is likely to reduce by < 2% in all catchments relative to the no-stormwater treatment scenario. This equates to a corresponding reduction for zinc, copper and TPH range of between 1 and 6% for zinc, 2 and 12% for copper and 1 and 21% for TPH.

The contaminant loads generated from the Wharemauku Stream catchment and Waimeha Stream sub-catchments for the stormwater treated future scenario are likely to increase relative to the existing land use scenario.

28.6 Assessment of marine water quality effects

There are not anticipated to be any direct effects on marine water quality values due to construction or operation of the proposed Expressway, as the alignment occurs at some distance from marine environments. However, potential indirect effects could occur due to the discharge of runoff, during both construction and operation phases, to streams and rivers that discharge to the marine environment.

Technical Report 31 (Volume 3) identified the potentially affected estuaries being: the Waimeha and Wharemauku Stream and the Waikanae Estuary.

The Waimeha and Wharemauku Streams discharge to high energy, open sandy beaches, affording significant and rapid dilution and removal of any stormwater discharges.

The Waikanae Estuary is lower energy and has more potential to accumulate sediment and associated contaminants. Therefore, it is particularly important to ensure that at both the construction and operational phases that stormwater discharged to the Waikanae River from the proposed Expressway is treated to a high standard to protect the ecological values of the estuary and the adjacent marine reserve.

All stormwater discharges during the construction period will be suitably treated prior to discharge. As outlined above, once operational, overall the proposed Expressway will provide water quality benefits due to the proposed level of stormwater treatment, and the reduction of traffic on the current SH1.

28.7 Measures to avoid, remedy or mitigate actual or potential adverse effects on water quality

28.7.1 Construction

During construction of the proposed Expressway, the need to avoid and mitigate construction effects and adhere to best practice has led to the preparation of management plans. The principal management plan relating to avoiding, remediating and mitigating water quality effects during construction will be the ESCP (contained in Appendix H of the CEMP). As more detailed design occurs, development of site specific CESCPs will be prepared and implemented prior to construction commencing at the relevant sites.

As detailed in the ESCP (section 5.3), and as part of the ESCP methodology, on-going monitoring of ESC measures will occur prior to, and throughout the duration of, the works to ensure that the proposed measures have been installed correctly and are functioning effectively. This will include regular monitoring of:

- ESC devices;
- Chemical treatments (flocculation);
- The visual appearance of receiving watercourses; and
- Weather forecasts.

28.7.2 Operation

During operation of the proposed Expressway, the need to mitigate the potential effects on water quality has led the design to make extensive use of swales (both wetland–planted and grassed) and treatment wetlands. These have been designed in accordance with NZTA's Stormwater Standard[231], which reflects current international best practice. Overall, once in operation, the proposed Expressway will provide water quality benefits.

28.7.3 Summary

The potential adverse environmental effects on the quality of water through both construction and operation of the proposed Expressway will be suitably avoided and / or mitigated.

This will be achieved through the implementation of management plans during construction of the proposed Expressway and the use of wetlands and swales for stormwater attenuation purposes during operation of the proposed Expressway.

[231] Stormwater Treatment Standard for State Highway Infrastructure, 2010, NZTA