20. TERRESTRIAL & FRESHWATER ECOLOGY

Overview

The Project traverses a highly modified landscape characterised by agricultural land and lifestyle blocks with few localised areas of naturally occurring indigenous vegetation remaining. The designation area (study area) contains no natural waterways or wetlands but does contain a number of manmade water races of limited ecological value. There are also no sites of conservation significance such as ecological heritage sites, recommended areas for protection ("RAPs") or significant natural areas within the Project area.

Potential adverse effects on terrestrial ecology will be most pronounced during construction when sections of shelterbelt, stands of trees and areas of pasture are removed. The disturbances associated with construction, coupled with loss of habitat, will lead to a localised displacement of resident bird populations and may lead to loss of potential resident lizard populations. The effect of vegetation removal on indigenous fauna arising from the loss of those habitats is considered to be no more than minor given the similarity of nearby habitats, wide ecological tolerances and adaptability of the affected indigenous bird species.

Potential adverse effects on aquatic ecology during construction relate to potential sedimentation (and contamination) of water races; and habitat disturbance, with mitigation measures proposed to ensure these effects are avoided, remedied or mitigated. Long term effects on aquatic ecology primarily relate to habitat modification associated with the closure, piping and realignment of water races; and stormwater runoff once the Project is operational.

The Project provides an opportunity to enhance terrestrial and aquatic ecology through appropriate mixed indigenous and exotic plantings within the Project area. This includes along the riparian margins of water races. These plantings will enhance habitat quality for indigenous birds, lizards, invertebrates, fish and aquatic life and will assist in offsetting the loss of habitat arising from the Project.

20.1. Introduction

This chapter outlines the findings of investigations undertaken to determine the likely effects of the Project on terrestrial and freshwater ecology. It also contains measures to avoid, remedy or mitigate any potential adverse effects that have been identified.

Further details on the methodologies carried out for these ecological investigations and assessments are contained in Technical Report No. 17 and Technical Report No. 18, appended in Volume 3.

20.2. Existing terrestrial receiving environment (baseline ecological character)

The Project is located within pastoral farmland used primarily for grazing sheep and horses and has been largely cleared of indigenous vegetation cover. The Threatened Environments

Classification ("TENZ") helps identify land where much reduced and poorly protected terrestrial indigenous habitats/ecosystems are more likely to occur. This includes land within the Project area that is classified as acutely threatened with little indigenous vegetation remaining[85]. This is reflective of this intensively managed environment.

There are no natural water courses or sites of aquatic ecological significance noted within the Project area. The study area contains no land administered by the Department of Conservation or any designated areas of natural significance.

An ecological heritage site exists on the corner of Wilmers and Springs Road. This includes an area of semi-natural Danthonia grassland and a recommended area for protection ("RAP"). The RAP encompasses an area of flax and swamp kiokio (*Blechnum minus*) by a water race adjacent to Marshs Road. However, both these areas lie outside the designation footprint and as such will not be adversely affected by the Project.

20.2.1. Terrestrial habitat categories

In general terms, the current land cover could be described as farmland habitat. However, within this habitat, further categories exist which reflect the different land uses and vegetation types encountered along the Project alignment. These are:

- improved/developed pasture;
- rough pasture;
- market gardens and other cultivated areas;
- orchards;
- rural-residential gardens/amenity plantings;
- small plantations/woodlots (radiata pine, Eucalyptus spp., macrocarpa);
- shelterbelts (radiata pine, Eucalyptus spp., macrocarpa, Leyland cypress, willow, poplar);
- stands/groves (radiata pine, poplar, crack willow, silver wattle);
- hedgerows (gorse); and
- road, shelterbelt, fence and water race margins (rank sward grasses and herbaceous vegetation).

These habitats are of varying quality in terms of the shelter, roosting, feeding and breeding opportunities they provide for indigenous and exotic avifauna, herpetofauna and invertebrates.

20.2.2. Indigenous vegetation

Naturally occurring indigenous vegetation affected by the Project is confined to very localised areas, where individual specimens or small groups of indigenous plants occur. These include

[85] Refer to Technical Report 18 for more details

kohuhu (*Pittosporum tenuifolium*), ferns such as swamp kiokio (*Blechnum minus*) and sedges (*Carex spp*.) which grow along the edge of the water race beside Weedons Road.

Some sections of the water races are overtopped by shelterbelts which create favourable microclimate conditions. In conjunction with an absence of grazing, this has enabled the establishment of pioneer vegetation.

20.2.3. Avifauna values

At least thirteen indigenous and seventeen exotic bird species are likely to be present in the Project study area between 1999 and 2004, as recorded in the Atlas of Bird Distribution in New Zealand.

Only two of these species are classified as nationally endangered or at-risk through decline. During the site inspection conducted in September 2011, seven indigenous and eight exotic species were observed along the Project route. All of these species are categorised as either "not threatened" or "introduced and naturalised".

The majority of the indigenous bird species recorded in the study area are common and have wide habitat preferences such as farmland, orchards, gardens and urban areas.

The water races that intersect the alignments provide suitable food sources, such as aquatic vegetation and invertebrates, for waterfowl. The races along Weedons Road and Robinsons Road provide some degree of tree and shrub cover which may additionally afford suitable nesting conditions for these ducks. Other freshwater birds that have been recorded in the study area are pukeko, white faced heron and New Zealand kingfisher.

Farmland generally suits the wide dietary requirements of pukeko, white faced heron and kingfisher. However the population sizes of these birds within the Project area are likely to be lower than in surrounding pastoral areas due to limited water environments

20.2.4. Herpetofauna values

Investigations identified two species of skinks: Common skink (*Oligosoma polychrome*) and McCann's skink (*Oligosoma maccanni*) as being potentially present within the Project footprint. The current Threat Classification rank for both is 'Not Threatened'. However, lizard populations within the Project footprint represent relictual populations[86]. This is a result of large scale land use changes, habitat losses, and introduced predatory mammals.

Overall, the Project development footprint consists of low value habitats for lizards, due to the vast tracts of highly-developed pasture land. However, the proposed alignment runs parallel with

[86] The term "relictual" is used for local species that would have once been very widespread and well-connected across the Canterbury landscape. However extensive land development into a predominately agricultural and horticultural landscape has led to considerable habitat fragmentation of available habitat patches, whether native or exotic; this may have population abundance, persistence and genetic consequences.

some communities of riparian vegetation and rank exotic grasslands which may support lizard populations.

20.2.5. Invertebrate values

The terrestrial invertebrate fauna (including soil fauna) inhabiting the Project area is dominated by introduced species typically encountered on farmland and suburban gardens. The range of vegetation types in this area provides habitat for a variety of invertebrates, such as bees, dragonflies and damselflies, moths, beetles and spiders and a diverse assemblage of beetles, arthropods and amphipods .

20.3. Assessment of effects on terrestrial ecosystems

20.3.1. Operational effects

The on-going effects on terrestrial ecology from the operation of the Project are relatively limited and considered to be minor. The potential and actual effects are limited to the direct impacts on terrestrial fauna from the road and vehicular traffic.

Mortality or Injury from Traffic

Pukeko and introduced mammals that naturally forage over a wide area are most vulnerable to being injured or killed by vehicles using the Project. This includes brush tailed possums, hares and rabbits. Other birds at risk of mortality or injury from motorway traffic are the Australasian Harrier and Southern black-backed Gull as these birds regularly scavenge road killed animals.

Pukeko territories are generally restricted to within 50 metres of a waterbody or wetland. The absence of naturally occurring waterways on either side of the Project suggests that the potential risk to pukeko is low. Higher quality habitat is considered to exist in the Heathcote River headwaters and the interconnected stormwater retention areas and drains in that area, several kilometres to the east of the Project. However, pukeko may traverse the motorway in search of seasonally favoured areas of pasture. Pukeko can also be attracted to the wide stormwater swales and detention ponds established as part of the Project. However, the risk to pukeko is considered to remain low even with new swales and detention ponds. The land surrounding the motorway supports low numbers of pukeko due to a lack of suitable habitat. While the swales and detention ponds will create feeding habitat they will not be suitable as breeding habitat.

20.3.2. Construction effects

The potential effects on terrestrial ecological values will be most significant during construction. The two direct impacts on terrestrial ecology are:

- loss of habitat through clearance and earthworks; and
- disturbance, displacement, injury and mortality of birds and lizards.

Loss of habitat

Sections of shelterbelt, hedgerows, stands of trees, areas of pasture and rank grassland cover occurring along pasture, roadside and water race margins will be removed to accommodate the Project construction. This will result in a loss of habitat for birds, lizards and invertebrates.

The loss of habitat for common native and introduced passerines will be more pronounced for those species with small territories and home ranges. This includes fantails and grey warblers. The overall adverse effects of the construction activities and associated habitat loss is considered minor for indigenous and visitor bird populations.

Lizards will be affected by habitat loss or habitat fragmentation. This is notably pronounced due to the relictual nature of the lizard populations and their habitat preferences, particularly within a highly developed landscape. The quality of lizard habitat adjacent to the Project footprint could be adversely affected through increased exposure to edge effects. Due to the relictual nature of the common skink and McCann skink, there is the potential for adverse effects on these populations to be more than minor.

Habitat loss will result in a minor loss of connectivity or ecological functionality at a local level. This habitat loss is considered to be minor due to the small proportion of woody and grassland vegetation that would be lost, compared to the extent of similar habitat that exists in adjoining areas of farmland. However, the proposed plantings as identified in Technical Report No. 7 will provide new areas of habitat for the terrestrial ecosystem.

Disturbance, displacement, injury and mortality

Loss of habitat in conjunction with disturbances arising from construction activities will lead to displacement of the affected bird populations into the surrounding countryside. It could also lead to mortality and injury to lizards due to their sedentary nature. Native and introduced insects will be similarly affected.

Displacement of resident bird populations will lead to an increased amount of competition between displaced individuals and resident populations in adjoining areas. The effects of competition may lead to some low-scale mortality. This is considered to be of low-scale due to the large area of similar habitat that exists beyond the motorway footprint and wide habitat preferences of the species. Therefore the adaptability of the affected species is noted.

There are low populations of freshwater birds due to the absence of any naturally occurring waterways (e.g. streams, ponds or wetlands) and lack of suitable riparian vegetation. This reduces the likelihood that species such as pukeko, white faced heron, kingfisher and waterfowl would be adversely affected to any significant degree during construction.

Potential indirect impacts

Construction activities and particularly, heavy machinery, present an opportunity for problem weed species not currently present in the area to become established. Seeds of problem weed species can be introduced inadvertently when machinery has been previously working in locations where these plants exist. These species could potentially pose a threat to the indigenous plantings proposed along the motorway corridor and to surrounding farmland.

20.4. Proposed mitigation measures – terrestrial ecology

20.4.1. Indigenous and exotic plantings

The Project presents an opportunity to enhance the ecological value of the affected and surrounding land, which is highly modified and contains little in the way of naturally occurring indigenous vegetation. The proposed landscape measures will also mitigate the adverse effects of the Project resulting from habitat loss and disturbance.

Extensive landscape enhancement measures[87] are proposed as part of the Project. These incorporate a large component of totara/matai forest and shrubland plantings. In conjunction with mixed indigenous/exotic woodland plantings, this will significantly enhance ecological values within a highly modified landscape. Species selection and composition of the plantings conform to ecological principles, reflecting the original vegetation cover of the area and the underlying ecological conditions. Low plantings of Purei (*Carex secta*), jointed rush and coastal flax proposed along sections of stockwater races will improve the habitat value of the riparian margins and their connectivity at a landscape scale[88].

The landscaping will also incorporate the development of boulder fields and boulder strips that include plantings of *Copromsa crassifolia, C. propinqua, Muehlenbeckia astonii, Corokia cotoneaster* and silver tussock (*Poa cita*) to mitigate against the habitat loss as a result of the development, and encourage natural re-colonisation by resident lizards.

20.4.2. Minimising vegetation clearance

To minimise the loss of woody and rank grassland vegetation, it is recommended that the extent of vegetation to be cleared is defined on the ground using stakes, pegs and tape in advance of construction. This would include definition of the boundary of the construction zone and any accessways required from existing roads. These markers will assist in minimising damage to surrounding vegetation and should remain in place until construction has been completed.

[87] Refer Technical Report 7 – Landscape Design Report
[88] Refer Technical Report 18 – Aquatic Ecology Assessment Report

20.4.3. Weed management

A preventative measure involving water blasting of all machinery at a suitable facility prior to entry on site is recommended to minimise the risk of problem weed species establishing. Such measures are included in the CEMP.

20.4.4. Lizard recovery

Given the potential adverse effects that construction may have on resident lizard habitat, there is a potential requirement to capture and translocate affected lizard populations to suitable habitat prior to construction works commencing.

In order to meet the legislative requirements of both the Wildlife Act 1953 and the mitigation recommended in Technical Report 18, it is proposed to undertake the following activities:

- prior to construction at least one season of lizard monitoring is to be undertaken to determine the extent of lizards present within riparian vegetation and rank exotic grassland habitats. If lizards are present in numbers and locations that put them at risk, a Lizard Management Plan will be prepared to avoid, remedy or mitigate the identified motorway impacts on lizards; and
- if required, a Wildlife Permit will be sought from the Department of Conservation for the capture and relocation of affected lizards prior to the commencement of earthworks; and for the unintentional killing or injury of lizards as a result of the earthworks.

20.4.5. Monitoring

Over a period of two years following construction it is proposed that monitoring is undertaken to detect any new problem weed species that may have been accidentally introduced to the site. Should plants of these species be detected, a programmed round of eradication would need to be implemented, involving a combination of spraying and hand-pulling depending on the species involved and extent of the infestation.

20.5. Existing aquatic environment (baseline ecological character)

There are no natural water courses or sites of aquatic ecological significance noted within the Project area, although there is a network of stockwater races, with several running adjacent to the existing roads that intersect with the CSM2 alignment, and along parts of SH1.

The water races have poor overall riparian vegetation characteristics, with silt and fine sediment dominating the in-stream habitat. Pollutant tolerant species of macro-invertebrates are mostly found here, such as snails. Macrophytes are also present, with pondweed and watercress being the dominant observed species in the races.

Three species of fish have been observed within the Project area; the native common and upland bullies and brown trout. Both common and upland bullies are found throughout New Zealand

waterways. Upland bullies (along with shortfin eels) were found to be the most common and abundant species in a survey of the waterways associated with CSM1[89] and within the SWAP ecology study[90]. In addition, the waterways, wetland and drainage guide developed by CCC[91], identifies these species as being common in Christchurch waterways.

20.5.1. Existing downstream receiving environment

Although outside the Project area, consideration is still required of the downstream receiving environment. Montgomery's Drain is within the Halswell catchment, flowing into Upper Knights Stream which then flows into the Halswell River.

Knights Stream

Knights Stream headwaters are situated to the south of Halswell Junction Road, just downstream of Springs Road. The upper reaches of Knights Stream have been previously assessed as having low value for both fish and invertebrates. The waterway has been modified and the removal of riparian vegetation has reduced bank stability, causing bank erosion and sediment inputs into the waterway[92].

In a survey carried out by EOS Ecology et al.93, pollutant tolerant macro-invertebrate taxa (e.g. snails) tended to dominate with more sensitive species such as mayflies, caddisflies and stoneflies only recorded in very low numbers. Upland bullies were recorded as being present in the stream. The stream in its upper reaches has large amounts of aquatic macrophytes, mainly Elodea, with some watercress at the margins. In the downstream reaches, the Elodea is covered in long strands of filamentous algae and at the confluence with the Halswell River, emergent watercress dominates.

Halswell River

The Integrated Catchment Management Plan [94] states that riparian vegetation within the Halswell River catchment has been reduced and highly modified. Overall it is of poor quality. Flow in the Halswell River is derived from springs sourced within Knights Stream and Marshs Road Drain. From the confluence with Knights Stream, the channel is quite uniform (about 5 – 6 m wide) and choked with aquatic macrophytes. In a survey carried out by EOS Ecology et al, over 80% of the invertebrate abundance in the Halswell catchment was represented by three pollutant tolerant species and only one EPT taxa was found (caddisfly species). However, despite this low EPT

[89] EOS Ecology, 2008, Assessment of Environmental Effects: Christchurch Southern Motorway: Aquatic Ecology
[90] EOS Ecology et al., 2005, Appendix 4: Aquatic Values and Management. South-west Christchurch Integrated Catchment Management Plan. Technical Series. Report Number 3.
[91] Christchurch City Council. 2003. Waterways, Wetlands and Drainage Guide, Part B – Design.
[92] EDS Ecology, CSM1 Assessment of Environmental Effects.
[93] EOS Ecology et al. 3 July 2005. Appendix 4: Aquatic Values & Management. South-west Christchurch Integrated Catchment Management Plan Technical Series. Report No. 3.
[94] Golders Associates (NZ) Limited on behalf of Christchurch City Council. May 2008. Integrated Catchment Management Plan for South-West Christchurch

abundance, average taxa richness was present. In addition, freshwater crayfish have been caught in the middle reaches of the river[95].

Fish species diversity declined significantly with distance upstream from Lake Ellesmere. Short and long-fin eels, upland bully (*Gobiomorphus breviceps*) and inanga were recorded. Eels, upland bully (*Gobiomorphus breviceps*) and brown trout (*Salmo trutta*) have been recorded in the upper reaches and eels, common bully, inanga and brown trout recorded in the lower reaches.[96]

20.5.2. Existing aquatic environment within the Project area

Five main water races were selected to be sampled (referred to as sites 1 to 5), chosen as they will remain (in an altered form) with the construction of the Project. In addition, observations were made of four smaller races (referred to as site A to D) that flow into the five main races. These were not sampled as they were considered to be representative of the five main races sampled.

Summary of sampled water races

The races sampled included Weedons Road water race, Robinsons Road water race, Hamptons Road water race, Trents Road water race and Marshs Road water race. All five sites are located within the designation area.

All sampled water races had a marginal overall habitat, with a poor catchment area dominated by rural/rural residential and intensive horticulture/pastoral land use and poor riparian vegetation of approximately 6 m width (although relatively complete cover of what was there). The riparian cover at Marshs Road (site 5) was only about 2 m wide. In addition, being a modified environment, the races has poor reach scale features typical of a race such as constant width (approximately 1 m), depth (approximately 0.2 to 0.3 m deep) and flow (0.1 to 0.4 m/s, bank edge to mid race) and a straight channel. In-stream habitat parameters were marginal with a substrate dominated by silt and fine sediment.

Weedons Road (site 1) had some cover available for fish in undercut banks and limited overhanging vegetation. Hamptons Road (site 3) and Trents Road (site 4) had some available habitat in the way of overhanging vegetation and in-stream macrophytes. However Robinsons Road (site 2) and Marshs Road (site 5) had minimal cover available. Whilst shading was available by way of riparian planting at two of the sites (Robinsons Road and Hamptons Road, sites 2 and 3), the three other site exhibited little in the way of shading.

Three fish species were observed during the sampling including brown trout, upland bully and common bully, although no fish were observed at Marshs Road (site 5). All three species are common in other water races and streams around Christchurch. Upland bullies are non-migratory and therefore do not require access to the sea, although it is important to maintain access for

[95] EOS Ecology et al. 3 July 2005. Appendix 4: Aquatic Values & Management. South-west Christchurch Integrated Catchment Management Plan Technical Series. Report No. 3.
[96] EOS Ecology et al. 3 July 2005. Appendix 4: Aquatic Values & Management. South-west Christchurch Integrated Catchment Management Plan Technical Series. Report No. 3.

other fish species. The common bully is a migratory species so requires access to the sea, although brown trout can also spend their entire lives in freshwater.

Macro-invertebrate presence at four of the sites was dominated by snails and a taxonomic richness dominated by pollutant tolerant species. However, macro-invertebrate presence was dominated by the caddisfly and hudsonema, at Hamptons Road (site 3).

Water quality parameters measured were within the relevant guideline limits except for two exceedances, turbidity and total phosphorus, both recorded at Marshs Road (site 5).

In summary, the overall aquatic ecosystem of the water races was quite poor and reflective of other race systems within Christchurch and the Canterbury Plains.

All sites had a relatively complete vegetation cover, but actual canopy and water race cover was minimal, providing little or no shading to the in-stream environment. In addition, in-stream cover (e.g. from logs, vegetation) was minimal and substrate diversity was very low, consisting largely of silt and mud. Further, water width and depth and flow varied little across all the races surveyed.

Macro-invertebrate species diversity in the five sites was reasonably high, however all sites were dominated by pollutant tolerant species as is reflective of the low EPT taxa numbers observed. Fish species presence and diversity was depauperate and only common fish species observed in other water races in the area were observed. No rare or threatened species were identified within any of the water races.

Summary of observed water races

The four sites where general observations were made included the race running along Main South Road (site A), Blakes Road water race (site B), Montgomery's Drain (site 3) and Springs Road open channel (site D).

Observations showed that these sites were similar in width to the five water races surveyed (about 1 m wide). Riparian cover consisted predominantly of a narrow strip (about 1 to 2 m wide) of mown grasses on the road side of the race. Residential dwellings provided more extensive riparian cover on the other side of the road at sites A and to a lesser extent site B. In areas not adjacent to residential dwellings, the non-road side bank consisted of rank pasture grasses. This was typical of three of the sites. However, Springs Road open channel (site D) showed evidence of bankside spraying with areas of no cover (grasses) present, just dirt.

Both Montgomery's Drain (site C) and the Springs Road open channel (Site D) were dry on all occasions they were visited and are not known to contain flow.

Montgomery's Drain is piped along Halswell Junction Road between SH1 and Springs Road for a distance of approximately 2 km. From Springs Road it runs along an open channel for a distance of approximately 500 m before going through an elevated inlet structure into another piped section (about 100 m) until it discharges into Upper Knights Stream (also dry in this stretch). The

inlet structure and long lengths of piped sections of the drain would form a barrier to fish passage if the drain did sustain a consistent flow.

20.6. Assessment of effects on aquatic ecology

20.6.1. Operational (on-going) effects

The two main potential on-going effects from the operation of the Project are:

- habitat modification associated with the closure, piping and realignment of water races; and
- sedimentation and contamination.

Habitat modification

The Project will result in the permanent modification (to varying degrees) of some water races within the Project area. Some sections will be terminated, realigned or piped. Where a new structure (i.e. culverts and piped sections of the water race) is constructed within a water race, there is the risk that it will reduce the carrying capacity of the water race.

The proposed piped sections will result in a reduction in light and riparian vegetation along these sections and may reduce spawning habitat, reduce bank stability, increase suspended sediments, alter the existing biological communities and reduce the availability of food sources. Associated loss of riparian vegetation may impact upon water temperature and flow regimes (i.e. water volumes and velocities).

The most significant habitat loss will occur with the piping of the race along SH1. The water races within the Project area provide a low value aquatic habitat that supports pollutant tolerant macro-invertebrate species and limited fish species. Nonetheless it is a significant length of aquatic habitat that is proposed to be piped in this location. From an ecological perspective, Technical Report 17 recommends that it would be preferable if this was retained. Technical Report 17 recommends that during the detailed design phase, the NZTA should investigate diverting the race into lateral races to eliminate the need for piping. If no alternative is possible, then light wells and resting areas should be included along the pipe lengths to assist with fish passage.

The proposed piping represents a net loss to the aquatic habitat within the Project area. However, there are other areas where new sections of race are being created. These areas provide an opportunity to enhance the riparian and in-stream habitat thus mitigating losses as set out in the proposed mitigation section below. With recommended mitigation it is considered that effects will be minor.

Effects on fish passage

The piping of water races is likely to form a barrier to fish passage. However it also has the potential to create a safe haven for fish on the upstream site of the barrier.

It is noted that the race network is extensive. Therefore if sections of race are un-accessible and passage along them is lost, there are numerous alternative routes available up and downstream of the network. It is also noted that there are already sections of piped water races, drains and physical barriers (weirs) to fish migration within the Project area. Existing piped sections along Trents Road and Marshs Road are much longer than those proposed for the crossing under CSM2. With recommended mitigation it is considered that effects will be minor.

Effects on water quality

The water races currently perform a land drainage function during heavy rainfall events, taking stormwater runoff from the surrounding roads and land thus affecting water quality. In addition, the races can be controlled and shutoff as required to perform this function, altering the flow in the system.

In addition, maintenance activities carried out by SDC and landowners disturbs the bed and banks of the races and contributes to sedimentation, with bank-side spraying reducing riparian cover for in-stream ecosystems.

There is no direct discharge of road stormwater to any water race or drain except in exceedance of a 100 year ARI design storm event, e.g. pond emptying into Montgomery's Drain. However this discharge will be infrequent and is of treated stormwater. As such, the water quality is expected to be of a quality that will not impact on the receiving environment. In addition, de-watering water (clean water) may be discharged into the Drain however as this is clean water it is not expected there will be any effect to water quality of this discharge.

The downstream reaches of the Halswell River have the potential to be positively affected by the quality of the proposed discharges from the Project. With the proposed stormwater treatment system in place (which is an improvement on the existing "no treatment" situation), there is potential for the downstream water quality to improve over time.

With recommended mitigation it is considered that effects will be minor.

20.6.2. Construction effects

Construction effects relate primarily to earthworks required for construction. This includes the realignment and construction of the piped sections of races. The two primary potential impacts of construction are:

- the effects of sedimentation and other contaminants on aquatic ecosystems; and
- habitat disturbance.

Sedimentation and other contamination

Activities such as works to divert and realign the water races and any stormwater discharged during construction from the Project area has the potential to contain high loads of sediment if

not controlled and managed appropriately. This can lead to negative impacts on macro-invertebrates and fish

Stormwater runoff or accidental spills may also contain a range of contaminants including nutrients, heavy metals and hydrocarbons, which can also negatively impact the aquatic ecosystem Measures will be in place as part of the CEMP to ensure that sediment and erosion and stormwater runoff is managed so as not to enter the water races. Therefore contamination from this source is considered unlikely and effects are considered to be minor. However it is noted that in extreme 100 year flood events there may be some discharge of treated stormwater or discharges of de-watering water. As both these discharges will be of treated or clean water, it is not expected that there will be any effects on the water quality.

The water races are highly modified environments that are already subject to activities that create sedimentation and increase turbidity in the water column. Biological communities in these environments are tolerant to a wide range of environmental events including increased flood flows and turbidity. Accordingly they have a good tolerance of a variable habitat. With the measures detailed in the CEMP and associated Erosion and Sediment Control Plan, it is considered that effects will be minor.

Habitat disturbance

Construction activities have the potential to affect aquatic habitats and fauna by degrading the habitat through physical disturbance and permanent and temporary closure of water races. As mentioned above, the habitat is currently disturbed by routine water race maintenance.

Construction of any water race diversions is recommended to be carried out in the dry bed to minimise disturbance to the aquatic environment. Observations should be made of the old race channel to ensure no fish are trapped in the confined section. Where fish are located, they should be captured and relocated into the diverted race channel.

Creation of new habitat in the diverted sections can be achieved by including instream features such as rocks and cobbles that provide instream variety. Remediation of race banks to encourage the colonisation of a healthy instream community can be achieved by riparian planting.

Culverts and piping which are proposed for sections of the water races, can potentially impede fish passage by creating velocity traps for upstream migratory fish. The reduction in light and riparian vegetation along the culverted/piped sections may reduce spawning habitat, reduce bank stability, increase suspended sediments, alter the existing biological communities and reduce the availability of food sources.

With recommended mitigation it is considered that effects will be minor.

20.6.3. Aquatic effects summary

It is considered that over time, areas of both new and existing water race habitat can be enhanced and water quality improved and a more natural character achieved. Some areas of aquatic ecosystem habitat will be lost but alternative routes along the race network will ensure that fish passage is maintained. Proposed plantings by way of mitigation will improve the existing environment in the areas that remain, such that the effects of the proposal will be minor on aquatic ecology values.

Overall, with appropriate culvert and pipe design, ensuring alternative routes along the race network are provided, implementation of sediment and erosion control measures and riparian planting, it is considered that the effects on this already modified environment will be minor.

20.7. Proposed mitigation measures – aquatic ecology

A number of mitigation measures are proposed to mitigate potential effects of the Project on aquatic ecology. Many of these will be implemented through the CEMP and associated Erosion and Sediment Control Plan and the remaining are recommended to be included as conditions of consent.

20.7.1. Prior to construction

The following measures are proposed in Technical Report No. 17, to be carried out prior to construction:

- development and implementation of a CEMP including Erosion and Sediment Control Plan (Volume 4);
- the alignment of the piped sections will be consistent with the water race environment and should not include any steep drops or perched sections; and
- during detailed design, provide for the inclusion of light wells, resting areas and baffles along the piped sections of water races to assist with fish passage.

20.7.2. During construction

The following measures are proposed to manage the effects of construction activities:

- implement the CEMP and ESCP during the works, which will include:
  - programming construction activities to avoid where practicable excavation of soils adjacent to freshwater environments during heavy rainfall and flood events;
  - establishing appropriate access corridors and ensure employees and vehicles do not leave the designated corridors;
- until impacted riparian margins have been stabilised and works completed on the piped sections, culverts and any realigned sections, erosion control mechanisms, such as silt fencing and straw mulching, should be maintained to limit sedimentation of waterways arising from the works in accordance with the CEMP and ESCP;

- works shall not affect the passage of fish or cause stranding of fish in pools or channels. If a section of water race requires dewatering to enable the pipe to be installed, then the section of race should first be closed off at one end and time allowed for fish to move down the system before works commence.;
- carry out all instream works in the dry bed, with water to the race network being shut off or bunds being put in place around the works area and water diverted around it;
- culvert inverts should be designed to be at or below bed level so as not to form a barrier to fish migration during low flows;
- construction activities related to the water races to be limited to designated areas within the culvert/pipeline construction sites. Where possible, heavy machinery should be kept away from the banks to minimise potential for bank collapse;
- works to install culverts and pipes should avoid unnecessary modification of the water race bed and channel. Avoid large areas of concrete channelling as this reduces the connectivity of the water race and eliminates instream habitat and potential food sources for instream organisms;
- re-vegetation plans to be underpinned by ecological principles and scientific advice ensuring stream quality and habitat integrity is maintained and effects mitigated; and where appropriate, riparian planting should promote ecological linkages and provide potential fish spawning habitat. This is included as part of Technical Report No. 7, associated Project landscape plans (Volume 5) and the Landscape Management Plan (SEMP005);
- all disturbed areas adjacent to the water races should be re-grassed as soon as practicable. If it is outside of the growing season, the disturbed areas should be covered with mulch; and
- no planned refuelling or maintenance of construction equipment to occur adjacent to a waterway, nor equipment to be parked adjacent to freshwater environments for a significant time. Readily available spill kits for land and water to be kept on site with trained personnel.

20.7.3. Site specific mitigation

The Aquatic Ecology Assessment, Technical Report 17 outlines site-specific riparian planting to potentially enhance in-stream habitats and mitigate effects with regard to habitat loss and disturbance. These water race sections are located adjacent to the Hamptons Road realignment, the Waterholes underpass, Weedons Road, the Trents Road underpass, the Marshs Road underpass and Springs Road / Halswell Junction Road. This planting is illustrated within the landscape plans (Volume 5) accompanying the Landscape Context Report, Technical Report 7. Riparian planting will be consistent with the SDC Planting Guide for water race margins.

It is also recommended that in-stream features such as rocks and boulders should be included where feasible. These would provide flow variation and enhance habitat.

20.8. Conclusion

Potential adverse effects are associated with both construction and operational activities. The Project provides an opportunity to enhance terrestrial and aquatic ecology through appropriate mixed indigenous and exotic plantings within the Project area, recommended as mitigation. This includes along the riparian margins of water races. These plantings will enhance habitat quality for indigenous birds, lizards, invertebrates, fish and aquatic life and will assist in offsetting the loss of habitat arising from the Project.

Overall, it is considered that with suitable mitigation measures in place, as recommended, the effects on terrestrial and aquatic ecosystems will be minor.