WSP Opus

Beaumont Bridge Replacement: Assessment of Ecological Effects

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Cover photo: The Clutha River/Mata-Au and surrounding area in the vicinity of the proposed bridge realignment.

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1. Introduction

The NZ Transport Agency have identified that the single lane bridge over the Clutha River/Mata-Au at Beaumont on State Highway 8 requires replacement. Of the proposed options, the recommended approach is for a new 200 m long two-lane bridge located approximately 40 m downstream of the existing bridge structure (Figure 1). The recommended approach also includes road alignment and improvements to adjacent intersections, shared paths, and facilities (Figure 1).

Figure 1 Artists impression of the new State Highway 8 bridge over the Clutha River at Beaumont, looking downstream showing the existing bridge in the foreground.

Activities associated with the bridge replacement have the potential to impact the water quality and aquatic ecology of the Clutha River/Mata-Au. Potential effects on water quality and aquatic ecology include disturbance of the river bed (e.g., drilling, temporary structures, extraction of alluvium, bed alteration) and disturbance to the water (e.g., diversion of water, discharge of stormwater and sediments, potential discharge of other contaminants). This report considers measures to avoid/minimise any effects of the proposed activities, including the timing of the construction works (including consideration of fish spawning and migration periods) as well as measures to ensure that any discharges to the Clutha River/Mata-Au meet the water quality requirements of the Otago Regional Council Regional Plan: Water for Otago.

In addition to potential effects on the river, there is potential for the bridge replacement to impact terrestrial values.

This report presents information relevant to the assessment of the environmental effects of the construction of the proposed new bridge on aquatic and terrestrial ecosystems including presenting information on the existing environment, an assessment of potential effects and discussion of mitigation options.

2. Ecological values

2.1 Aquatic ecological values

Schedule 1A of the Regional Plan: Water identifies the natural and human use values of surface water bodies in Otago. The section of the Clutha River/Mata-Au (Island Block to Balclutha) that the Beaumont bridge works will fall within is identified as containing significant habitat for adult and juvenile trout and salmon, trout and salmon spawning, eel, rare fish and fish diversity (Table 1).

Table 1 Natural and human use values of the Clutha River/Mata-Au in the vicinity of the proposed bridge works.

Water body	Ecosystem Values	Outstanding natural feature or landscape	Significant iindigenous vegetation and significant habitat of indigenous fauna	Areas with a high degree of naturalness
Clutha River /Mata-Au *between Island Block and Balclutha*	Psize, Ppass, Psand, Pgravel, Hspawn(t&s), Hjuve, Eel, Trout, Salmon, Sigveg, Birddiv, Rarefish, Fishdiv, Gbird between Balclutha and Tuapeka River mouth	Beaumont and Rongahere Gorge.	Significant habitat: Remnant indigenous ecosystem at Birch Island. Significant vegetation: Rare association of aquatic plants above confluence with Tuapeka.	
Clutha River /Mata-Au *between Balclutha and the sea*	Psize, Ppass, Psand, Pgravel, Hspawn(s), Hjuve(t&s), Trout, Eel, Salmon, Fishdiv, Rarefish, Gbird			

2.2 Terrestrial Ecology

2.2.1 Ecological Region/District

Beaumont is located in the Lawrence Ecological District (ED), within the Lammerlaw Ecological Region. The Lawrence ED consists primarily of low, rolling, dissected hill country surrounding the town of Lawrence. It has a maximum elevation of 687m on the northern boundary. The climate is semi-continental with rainfall of 700-800mm p.a. The district is drained by three major rivers; the Clutha, Tuapeka and Waitahuna Rivers.

The pre-human vegetation of the district would have consisted primarily of forest, along with some scrub and shrubland. Silver beech forest was probably the dominant forest type on the hillslopes, with red and mountain beech locally. On warmer, more fertile sites (e.g. river terraces, riparian zones and lower north facing slopes) broadleaf, ribbonwood, lacebark and kowhai would have been prominent canopy trees, along with podocarps such as matai, kahikatea and true totara.

The original vegetation of the ED has been largely lost or modified due to human activities. Early Maori burning resulted in large areas of fire-induced tussock grassland. Vegetation clearance continued with European occupation. Today, much of the lower parts of the district are farmed (semi-intensive sheep and cattle). Exotic plantation forestry is also a significant land use (McEwen 1987). Consequently, few, large areas of indigenous vegetation or habitat remain. Significant protected areas are mainly administered by DOC and are located to the north and east of Beaumont in the northern portion of the ED. These include Tuapeka Conservation Area, Bowlers Creek Scenic Reserve, Gabriel's Gully Bush Reserve Conservation Area and Cotton Scenic Reserve. In the south are Tuapeka West Scenic Reserve, Beaumont Conservation Area and Blue Mountains Conservation Area (the latter mostly within Tapanui Ecological District with small portions within the Lawrence ED). Throughout the district, land cleared of forest and subsequently allowed to revert carries secondary shrubland and low forest, generally kanuka/manuka, hardwoods and Scotch broom.

3. Existing Environment

3.1 Aquatic ecology

3.1.1 Hydrology

The Clutha River/Mata-Au is New Zealand's largest river by flow, with a mean flow of 614 m^3/s and a 7-day mean annual low flow of 309 m^3/s (Duncan & Woods 2013). The lower Clutha/Mata-Au is subject to significant flow fluctuations as a result of flood events and hydro-electric power generation at Roxburgh Power Station (e.g., Figure 2).

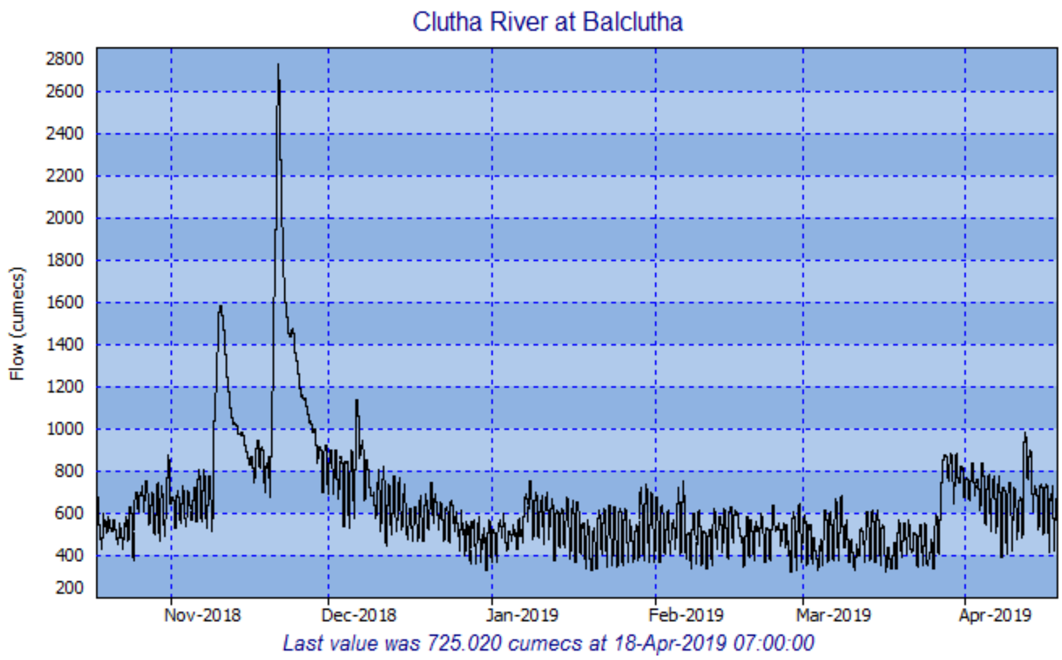

Figure 2 Hydrograph from the lower Clutha River at Balclutha hydrological site showing flood events and frequent daily flow fluctuations over the November 2018 to April 2019 period resulting from hydroelectric power generation at Roxburgh Power Station. Figure from the ORC website[1].

[1] https://www.orc.govt.nz/managing-our-environment/water/water-monitoring-and-alerts/lower-clutha/clutha-river-at-balclutha-flow

3.1.2 Water quality

National River Water Quality Network data

The National River Water Quality Network (NRWQN) includes two sites in the Clutha River/Mata-Au downstream of Lake Roxburgh: Clutha River at Millers Flat and Clutha River at Balclutha (Figure 3). Water quality at the Millers Flat site is generally good, with relatively low water temperatures, high levels of dissolved oxygen, low levels of nutrients and generally low levels of *E. coli* present (Table 2). However, water clarity at this site is generally low (average 2 m, maximum 5.95 m), and, conversely, turbidity is generally quite high[2] (Table 2). Water quality at the Millers Flat site complies with all corresponding Schedule 15 limits when applied as a 5-year 80th percentiles.

The values for many of the water quality variables at the Clutha River at Balclutha are similar to those at Millers Flat, although nutrient concentrations (particularly nitrate-nitrite nitrogen and total nitrogen) and average *E. coli* concentrations are markedly higher at Balclutha than at Millers Flat (Table 2). Water quality at the Balclutha site complies with all corresponding Schedule 15 limits when applied as a 5-year 80th percentiles, with the exception of nitrate-nitrite nitrogen (), which exceeds the Schedule 15 limit of 0.075 mg/L.

Of the two sites, water quality measured at the Millers Flat site is likely to be most representative of the water quality in the reach affected by the construction of the bridge at Beaumont, as the Millers Flat site is 22 km upstream of Beaumont and no major tributaries or discharges that are expected to have an appreciable effect on water quality in the Clutha/Mata-Au enter it between these two locations.

[2] Water clarity and turbidity are inversely related. Turbidity is a measure of how "cloudy" the water is, whereas water clarity measures how far light travels through the water.

Table 2 Water quality parameters for two sites in the lower Clutha River over the period February 1989-September 2018. Data from the NRWQN, downloaded 9 April 2018[3].

		Clutha River at Millers Flat (AX4)			Clutha River at Balclutha (DN4)		
Variable	**Unit**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
Water temperature	°C	11.8	4.7	19.6	12.0	4.5	20.5
pH		7.76	7.12	8.19	7.79	7.34	8.41
Specific conductance	µS/cm	71.7	63.5	89.3	73.8	40.8	118.3
Dissolved oxygen	mg/L	10.9	8.8	13.1	11.0	9.0	13.4
Dissolved oxygen	%	101.1	90.0	113.0	101.2	94.4	110.6
Ammoniacal nitrogen	µg/L	0.004	<0.001	0.026	0.005	<0.001	0.034
Nitrate-nitrite nitrogen	µg/L	0.037	0.007	0.203	0.093	0.002	0.748
Total nitrogen	µg/L	0.097	0.040	0.483	0.186	0.045	1.255
Dissolved reactive phosphorus	µg/L	0.001	<0.001	0.016	0.002	<0.001	0.032
Total phosphorus	µg/L	0.010	0.002	0.213	0.017	0.002	0.558
E. coli	cfu/100 ml	40.4	<1	2419.2	193.1	2.0	2613.0
Turbidity	NTU	4.1	0.3	120.0	5.7	0.3	135.0
Water clarity	m	2.00	0.05	5.95	1.45	0.03	5.93

[3] Downloaded from https://hydrowebportal.niwa.co.nz/

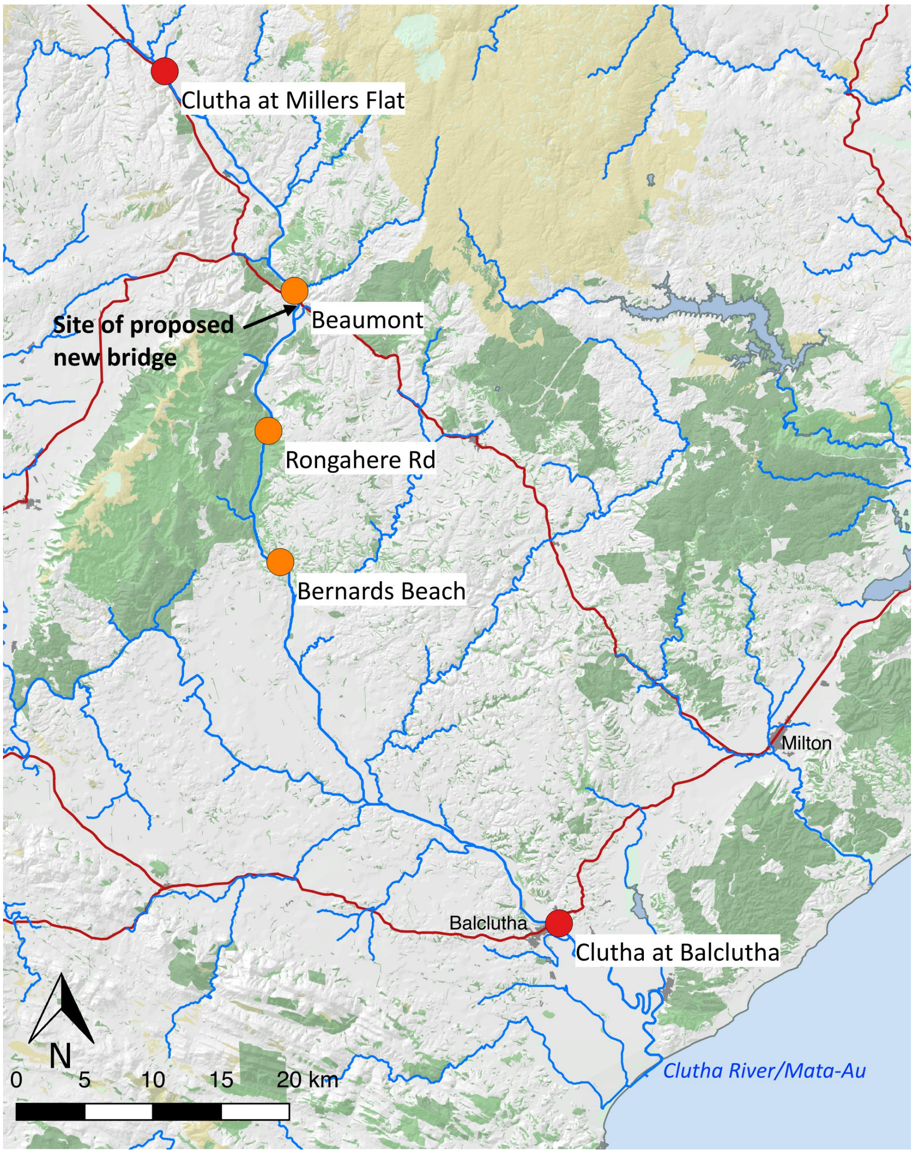

Figure 3 Water quality and invertebrate sampling locations on the mainstem of the Clutha River/Mata-Au from the National River Water Quality Network (NRWQN; red dots) and Ludgate & Ryder (2014) (orange dots).

3.1.3 Periphyton

There is limited information on the periphyton community of the lower Clutha River/Mata-Au given its very large size and the practical and safety challenges this creates for assessing its periphyton communities. Ludgate & Ryder (2014) undertook surveys in 10 riffle/beach sites in the lower Clutha/Mata-Au, when flows were lowered by Contact Energy to facilitate the surveys. They recorded that the invasive stalked diatom *Didymosphenia geminata* (didymo) *"covered large areas of the river bed at most sites, with only the Roxburgh, Rongahere Road and Manuka Island sites generally clean of didymo"*. A photograph of Didymo at the Beaumont monitoring site is shown in Figure 4.

Underwater video footage collected by Underwater Solutions Ltd. in August 2018 showed that bedrock outcrops had cover of didymo and bryophytes (aquatic mosses), while gravels generally had little or sparse periphyton cover.

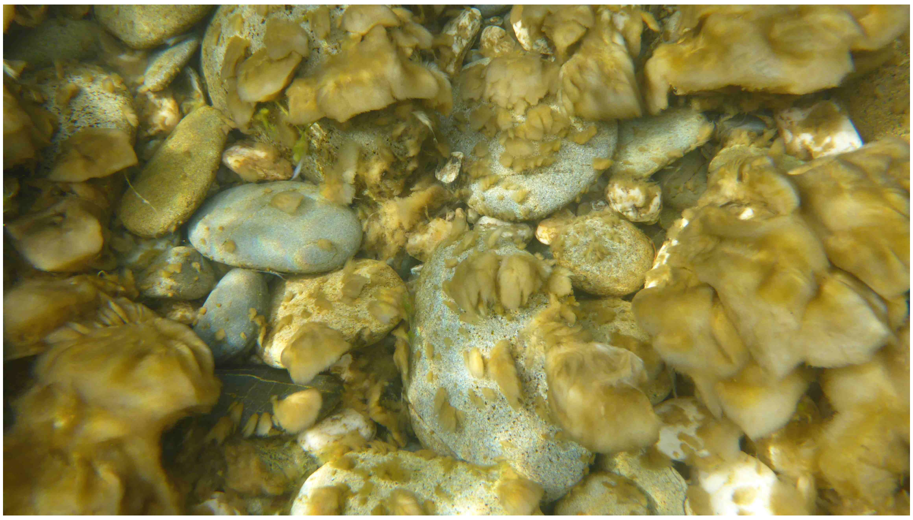

Figure 4 Photograph of the bed substrate and representative algae cover at the Beaumont sampling site in April 2014 by Ludgate & Ryder (2014).

Periphyton communities in the Clutha River/Mata-Au downstream of Roxburgh Dam are affected by daily flow fluctuations resulting from power generation at the Roxburgh Power Station (see Section 3.1). This creates a "varial zone", an area of the riverbed that is intermittently wetted and dried, which reduces the suitability of this area for aquatic life. Ludgate & Ryder (2014) noted that the varial zone at sites in the lower Clutha River/Mata-Au was covered with large mats of drying didymo.

3.1.4 Macroinvertebrates

Ludgate & Ryder (2014) presented the results of macroinvertebrate sampling undertaken at 10 sites in riffle/beach habitats in the mainstem of the Clutha River/Mata-Au between Roxburgh Dam and Balclutha. Of these, sites at Beaumont (1 km upstream of the site of the proposed new bridge), Rongahere Road (11 km downstream) and Bernards Beach (22 km downstream) are relevant to the proposed works at Beaumont Bridge. The locations of these sites are shown in Figure 3.

The sampling by Ludgate & Ryder (2014) found that the macroinvertebrate fauna at Beaumont and Rongahere Road (near Birch Island) was dominated by nymphs of the common mayfly *Deleatidium*, while chironomid larvae (Orthocladiinae and Tanytarsini) and the cased-caddis *Pycnocentrodes* were also abundant at the Beaumont site. The composition of the macroinvertebrate fauna at Bernards Beach was slightly different in that it was numerically dominated by chironomid larvae (Orthocladiinae and Tanytarsini), the common mudsnail *Potamopyrgus antipodarum* and the cased-caddis *Pycnocentrodes,* with *Deleatidium* mayfly nymphs being less abundant at this site. The raw results of the macroinvertebrate sampling done by Ludgate & Ryder (2014) is attached as Appendix A.

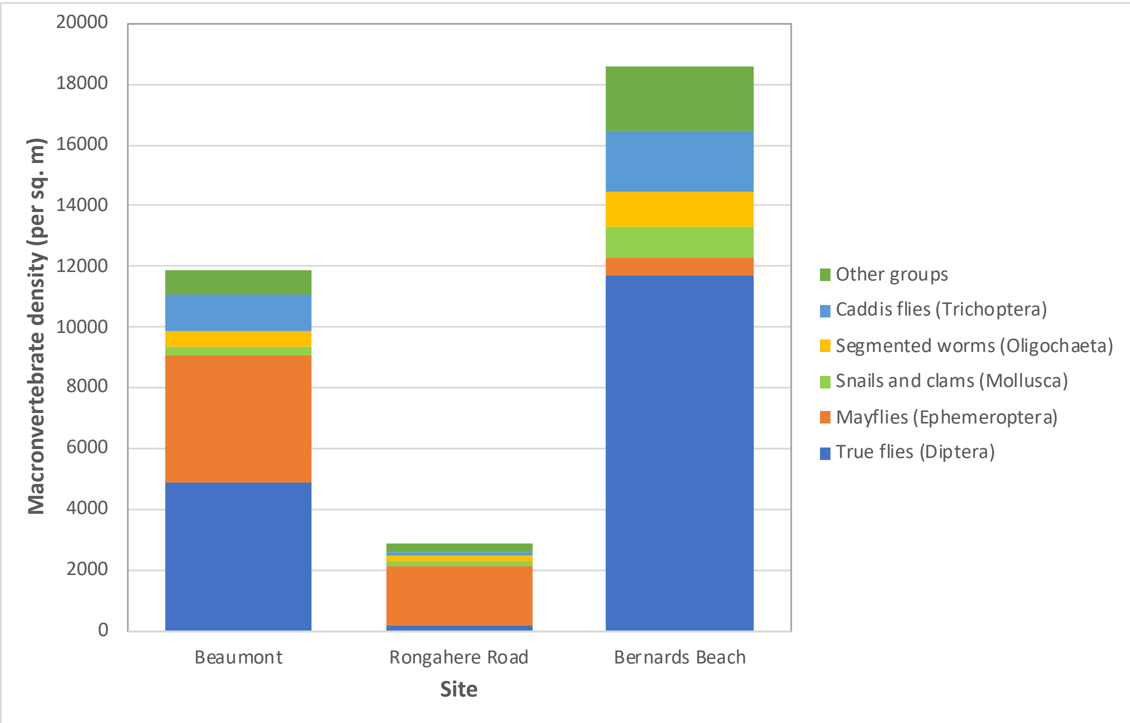

Figure 5 Density of macroinvertebrate groups at three sites in the Clutha River. From Ludgate & Ryder (2014).

As discussed above, the Clutha River/Mata-Au below Roxburgh Dam is affected by daily flow fluctuations as a result of power generation (see Section 3.1), which creates a "varial zone", an area of the riverbed that is intermittently wetted and dried. Such wetting and drying can result in low densities and diversity of macroinvertebrates, as few freshwater invertebrates are adapted to frequent wetting and drying (Fisher and LaVoy 1972, Baxter 1977, Stark & Suren 2003).

3.1.5 Fish

Five species of fish have been recorded as being present in the mainstem of the Clutha River/Mata-Au in the immediate vicinity of the proposed works: longfin eel (*Anguilla dieffenbachii*), torrentfish (*Cheimarrichthys fosteri*), common smelt (*Retropinna retropinna*), quinnat salmon (*Onchorhynchus tshawytscha*) and brown trout (*Salmo trutta*) (New Zealand Freshwater Fish Database, downloaded 12 April 2019). In addition, several other species are expected to reside in or pass through this area including lamprey (*Geotria australis*), shortfin eel (*Anguilla australis*), common bully (*Gobiomorphus cotidianus*), upland bully (*Gobiomorphus breviceps*), kōaro (*Galaxias brevipinnis*) and rainbow trout (*Onchorhynchus mykiss*). The conservation status (from Dunn *et al.* 2018) of these species is listed in Table 3.

Table 3 *Conservation status of fish recorded from, or expected to be present in the Clutha River/Mata-Au in the vicinity of the Beaumont Bridge. Conservation status from Dunn* et al. *2018.*

Species	Scientific name	Conservation status
Shortfin eel	*Anguilla australis*	Not threatened
Longfin eel	*Anguilla dieffenbachii*	Declining
Torrentfish	*Cheimanrrichhthys fosteri*	Declining
Upland bully	*Gobiomorphus breviceps*	Not threatened
Common bully	*Gobiomorphus cotidianus*	Not threatened
Kōaro	*Galaxias brevipennis*	Declining
Lamprey	*Geotria australis*	Nationally vulnerable
Common smelt	*Retropinna retropinna*	Not threatened
Rainbow trout	*Onchorhynchus mykiss*	Introduced and naturalised
Quinnat salmon	*Onchorhynchus tshawytscha*	Introduced and naturalised
Brown trout	*Salmo trutta*	Introduced and naturalised

The lower Clutha River/Mata-Au is recognised as a regionally significant fishery (Otago Fish & Game Council 2015), supporting substantial angler effort (23,520 ± 5,470 angler days in the 2014/15 season) (Unwin 2016). Trout fishing accounts for the majority of angler usage (16,660 ± 2,770 angler days in the 2014/15 season), although angler effort for salmon is also substantial (6,760 ± 2700 angler days in the 2014/15 season) (Unwin 2016).

As discussed above, flow fluctuations resulting from power generation (see Section 3.1) create a "varial zone", an area of the riverbed that is intermittently wetted and dried. These fluctuations will reduce the suitability of available habitat for fish within the varial zone as well as resulting in low densities of macroinvertebrates (see Section 3.1.4), which will reduce local food availability for any fish present.

3.2 Terrestrial ecology

3.2.1 Site Description

Beaumont is situated approximately 60km inland at an altitude of 60m. The areas affected by the proposed realignment (the 'footprint') are located on terraces either side of the Clutha River/Mata-Au, and include minor areas of riparian habitat. Soil information, derived from S-Map (Landcare Research), indicates soils on the upper terrace, on both sides of the river, are shallow, stony, silt loams (cemented firm brown soils). Lower lying areas near the Clutha River/Mata-Au are poor to well drained silty loams derived from alluvium, schist and/or sandstone (weathered fluvial recent soils or typic orthic gley soils).

Surrounding Landuse

The land-uses surrounding the footprint are primarily sheep and beef farming, short rotation cropping and exotic plantation forestry.

Nearby Natural Habitats and Connectivity

Affected areas have no connectivity with any adjoining indigenous vegetation. The nearest substantial indigenous habitat remaining is protected within the Beaumont Conservation Area, located c. 800m north of the Beaumont Bridge on the true left of the Clutha River/Mata-Au. This area consists of a mosaic of beech forest, manuka/kanuka scrub, exotic grassland and gorse and/or Scotch broom. Extensive mixed exotic and indigenous scrub (kanuka/manuka) is found on some of the adjoining hillslopes.

The Clutha River/Mata-Au is an important landscape feature. Riparian vegetation in the vicinity of Beaumont Bridge, however, is highly modified. Upstream, it consists primarily of crack willow with some hawthorn (*Crataegus monogyna*), khasia berry (*Cotoneaster* *simsonii*), occasional kanuka and exotic grasses/herbs. Crack willow dominates the Clutha River margin downstream. Further afield, the Rongahere Gorge and Beaumont Gorge areas (*c.* 10km downstream and 3km upstream respectively from Beaumont) have significant natural character values. The Rongahere Gorge supports remnant indigenous forest, including hardwood-podocarp forest and stands of red and mountain beech (Clutha District Plan 1998).

3.2.2 Vegetation

Vegetation in the vicinity of the area of the proposed works was surveyed on 3 April 2019. At the time of this survey, the flow in the Clutha River/Mata-Au was relatively high and therefore some low-lying vegetation normally exposed at moderate to low flows was underwater and could not be inspected. Three dominant vegetation types occurred over the areas affected by the proposed realignment; riparian crack willow treeland, developed pasture grassland and roadside vegetation. All vegetation types were highly modified and dominated by exotic plant species.

Riparian area – west of river (Figures 6-8)

East of Rongahere Road, between the Beaumont Bridge and the boat ramp, vegetation was highly modified and consisted of a scrubland/grassland dominated by Scotch broom (*Cytisus scoparius**), blackberry (*Rubus fruticosus**), bracken (*Pteridium esculentum*), convolvulus (*Convolvulus arvensis**), gorse (*Ulex europaeus**), various rank grasses (exotic species) and some small crack willow (*Salix fragilis**). A little further south, a tall (c. 14m) crack willow treeland occurs over a range of exotic grasses and herbs, primarily cocksfoot (*Dactylis glomerata**) and tall fescue (*Schedonorus arundinaceus**).

Riparian area – east of river (Figure 9)

Crack willow (c. 8m tall) dominated the riparian zone east of the river. Pasture grasses, with scattered exotic weeds such as Californian thistle (*Cirsium arvensis**), foxglove (*Digitalis purpurea**) and blackberry dominated the understory ground cover. A few small clumps of gorse and Scotch broom provided some protection for indigenous plants from grazing stock, allowing a few small native species to persist including pohuehue (*Muehlenbeckia australis*), pennyworts (*Hydrocotle* spp.), bitter cress (*Cardamine deblis*), shield fern (*Polystichum vestitum*) and little hard fern (*Blechnum penna-marina*). Scattered rushes (*Juncus* spp.) within exotic pasture-grasses, occupied wet low-lying areas nearest to the river..

Pasture grassland (Figures 10-12)

Developed pasture land occurred on the eastern side of the river, north of SH8, in a line roughly between Stonewall Street and Weardale Street; and through the small square paddock south of the bridge and west of SH8. On the western side of the river, areas affected by the proposed realignment are primarily on the northern side of SH8; the vegetation over these areas was primarily introduced pasture grasses dominated by brown top (*Agrostis capillaris**), crested dogstail (*Cynosorus cristatus**), barley (*Hordeum vulgare**), perennial ryegrass (*Lolium perenne**) and *Phleum pratense**, with occasional mouse-ear chickweed (*Cerastium fontanum**), thistles (*Cirsium** spp.), woolly mullein (*Verbascum thapsis**) and other exotic herbs.

Roadside Vegetation (Figures 13 & 14)

The largest areas of roadside vegetation within the footprint are along SH8 west of the river. The vegetation here was dominated by exotic grasses and herbs, including cocksfoot*, tall fescue*, brown top*, and sweet vernal (*Anthoxanthus odoratum**). Herbs included clover (*Trifolium repens**), convolvulus*, creeping buttercup (*Ranunculus repens**), yarrow (*Achillea millefolium**), birdsfoot trefoil (*Lotus pedunculatus**), plantains (*Plantago* spp.*) and broad-leaved dock (*Rumex obtusifolius**). Occasional pampas (*Cortaderia sp.**), flax (*Phormium tenax*), crack willow saplings, broom, and khasia berry (*Cotoneaster simsonii**) were also found here.

Figure 6 Riparian area (west of Clutha River/Mata-Au) showing an overview of the area south of Beaumont Bridge towards the existing boat ramp.

Figure 7 Riparian area (west of Clutha River/Mata-Au) showing a close-up view of vegetation immediately south of the existing Beaumont Bridge.

Figure 8 Riparian area (west of Clutha River) c. 20m below existing Beaumont Bridge. Taller crack willow and rank grass dominated the vegetation at this location.

Figure 9 Riparian area (east of Clutha River/Mata-Au) showing crack willow dominant with pasture grassland..

Figure 10 Pasture Grassland (east of Clutha River/Mata-Au). View looking north-west towards Beaumont Bridge. The adjacent hill-slope primarily supported Scotch broom, gorse and other scattered exotic trees.

Figure 11 Pasture Grassland (east of Clutha River/Mata-Au) looking south-east towards Low Burn..

Figure 12 Pasture Grassland (east of Clutha River/Mata-Au). View across a small paddock towards the Clutha River showing a large macrocarpa tree (centre) adjacent to a small totara (not visible), both of which will likely be removed for the realignment.

Figure 13 Roadside vegetation (west of river). View west towards Beaumont Hotel.

Figure 14 Roadside and pasture grassland (west of Clutha River/Mata-Au). View west towards Beaumont Hotel.

3.2.3 Flora

In total, eighty plant species (16 native, 64 exotic) in total were recorded within the footprint (see Appendix B for a full plant species list, and Table 4). The flora within the footprint was typical of pasture, road-side and disturbed riparian vegetation, being dominated by exotic grasses and herbs with a scattering of mainly introduced trees and shrubs (Table 4). Native plants comprised <1% of the total cover. No nationally, or regionally, threatened or at-risk plant species were detected, but several large English oak trees were present near the intersection of Weardale Street and State Highway 8, some of which are on the Clutha District Council's Register of Significant Trees (see planning map Beaumont North U8 and Table 13.2 of operative Clutha District Plan). However, based on information to hand, these appear to be outside the footprint.

Table 4 Lifeform of indigenous (native) and exotic flora recorded from all areas affected by the proposed realignment (the footprint).

Life form	no. exotic species	no. native species	Total no. species
Herbs	32	6	38
Trees/Shrubs	14	3	17
Grasses	11	0	11
Rushes/Sedges	3	2	5
Climbers/Scramblers	3	1	4
Ferns	0	3	3
Other monocots	1	1	2
Totals	**64**	**16**	**80**

3.2.4 Fauna

Avifauna recorded were primarily exotic species, and included mallard duck, blackbird, hedge sparrow, thrush, starling, magpie, spur-wing plover and chaffinch. Native species present over the areas affected by the proposed realignment were bellbird, Australasian harrier and grey warbler.

Potential lizard and invertebrate fauna-habitats were not assessed; lizard species may occur within the footprint given the presence of suitable habitat along the edges of pasture and existing roads. All lizard species are protected under the Wildlife Act (1953), administered by the Department of Conservation, and a dedicated lizard survey is required prior to works commencing.

3.2.5 Terrestrial Ecology Significance Assessment

The Clutha District Plan (1998) requires Council to recognise and provide for the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna, where significance is determined by the criteria outlined in POLICY HER.2B of the operative Clutha District Plan:

In assessing any application for resource consent that involves the clearance, modification or removal of indigenous vegetation, the significance of the resource shall be determined by regard to the following matters:

a. The representativeness, rarity and distinctiveness, naturalness, diversity and pattern and its relationship with other areas of indigenous vegetation and habitats of indigenous fauna (ecological context) of the indigenous vegetation or habitat of indigenous fauna.

b. Whether the affected indigenous vegetation or habitat of indigenous fauna is one of the four priorities specified in the Statement of National Priorities for Protecting Rare and Threatened Indigenous Biodiversity on Private Land (Ministry for the Environment 2007). These priorities are:

1. National Priority 1: To protect indigenous vegetation associated with land environments, (defined by Land Environments of New Zealand at Level IV), that have 20 percent or less remaining in indigenous cover.

2. National Priority 2: To protect indigenous vegetation associated with sand dunes and wetlands

3. National Priority 3: To protect indigenous vegetation associated with 'originally rare' terrestrial ecosystem types not already covered by priorities 1 and 2.

4. National Priority 4: To protect habitats of acutely and chronically threatened indigenous species.

c. Whether the area has been identified as a Significant Wetland in (Table 13.5) or as an Area of Significant Habitat of Indigenous Fauna (Table 13.8).

An assessment of the vegetation significance of the affected areas against the above criteria is provided in Table 5. A full assessment of significance, combining both flora and fauna values of the site, can only be completed following the lizard survey referred to above. In terms of vegetation-significance, the vegetation of the footprint was dominated, in terms of both composition and structure, by introduced grasses, herbs and trees characteristic of improved pasture, roadside and disturbed riparian vegetation. Native species comprised only <1% of the total cover, and 20 % of plant species recorded (Table 4). As such, all areas had very low naturalness and representativeness, to the extent that the vegetation could not be categorised as an "indigenous ecosystem" using the national classification system of Singers and Rogers (2014).

No nationally or regionally rare/threatened species were detected and the footprint plays a negligible role in ecological connectivity at larger scales. The area, therefore, failed to meet any of the ecological criteria for significance (i.e. representativeness, rarity, distinctiveness, diversity/pattern, ecological context) detailed in Policy HER.2B of the operative Clutha District Plan. Furthermore, the areas affected by the proposed realignment have not been identified by the Clutha District Council as a significant wetland (Table 13.5 of operative Clutha District Plan), or an area of significant habitat of indigenous fauna (Table 13.8 of operative Clutha District Plan). It should also be noted that no regionally significant wetlands, as identified in the Regional Plan: Water are identified as present at the site.

The footprint, however, does occur within a Category 1 Acutely Threatened land environment, and as a result, the area does meet one of the four Ministry for the Environment (2007) criteria for the protection of indigenous vegetation on private land (Table 5). However, given the highly modified nature of the vegetation and its negligible representativeness, this has limited practical application except for the area's potential to be restored, post-development.

Table 5 Vegetation ecological significance assessed against the Clutha District Plan (1998) and the National Priorities for Protection on Private Land (Ministry for the Environment 2007).

Terrestrial Ecology Significance Assessment		
Significance Criteria for Indigenous Vegetation (Clutha District Plan 1998)		
Criteria	*Assessment*	*Comments*
Representativeness	Very low	The vegetation of the areas affected by the proposed realignment (the 'footprint') were highly modified and vegetation structure and composition are dominated by exotic species. Indigenous plant cover is <1%.
Rarity/Distinctiveness	Nil	No rare or threatened plant species, plant communities or ecosystems were detected over the footprint, or are likely to be present.
Diversity/Pattern	Low	Low native plant diversity; moderate exotic plant diversity; low vegetation-habitat diversity. No ecological gradients or patterns were discernible.
Ecological Context	Very low	The footprint does not buffer or connect to any adjacent areas of indigenous terrestrial vegetation.
Significant Wetland (Table 13.5 Clutha District Plan)	No	No wetlands were present. The area is not identified as a significant wetland in Table 13.2 of the Plan.
Area of Significant Habitat of Indigenous Fauna (Table 13.8 Clutha District Plan)	No	The area is not identified as a significant habitat of indigenous fauna in Table 13.8 of the Plan. Note: No formal fauna field assessment has been carried out.
Protecting our Places – National Priorities for Protection on Private Land (MFE 2007)		
Criteria	*Assessment*	*Comments*
National Priority 1: To protect indigenous vegetation associated with land environments (LENZ level IV) that have 20 percent or less remaining in indigenous cover.	Yes	The area occurs over a Category 1 Acutely Threatened land environment where less than 10 % of indigenous vegetation remains.
National Priority 2: To protect indigenous vegetation associated with sand dunes and wetlands.	No	The area does not contain indigenous vegetation associated with sand dunes or wetlands.
National Priority 3: To protect indigenous vegetation associated with 'naturally uncommon' ecosystem types.	No	The area does not comprise a 'naturally uncommon' ecosystem type.
National Priority 4: To protect habitats of acutely and chronically threatened indigenous species.	No	No acutely or chronically threatened indigenous plant species were detected. No formal fauna field assessment has been carried out.

4. Assessment of Environmental effects

4.1 Aquatic environment

4.1.1 Disturbance to the river bed

Much of the river bed in the vicinity of the works is comprised of bedrock, with periphyton cover dominated by didymo and bryophytes. Areas within a few metres of the banks (especially on the true right (western) bank) are likely to be within the varial zone created by flow fluctuations resulting from power generation, which will reduce the likelihood of adverse ecological effects of construction activities, given that this area of the riverbed already has reduced ecological values (reduced macroinvertebrate densities and diversity) and will be dominated by taxa that are tolerant of disturbance (see Sections 3.1.3 & 3.1.4).

In addition, any disturbance to the riverbed will be limited to the duration of construction activities, and recolonization of disturbed areas by periphyton and macroinvertebrates is expected to be rapid.

4.1.2 Temporary structures

During the construction of the bridge, it may be necessary to construct structures to divert water away from/around working areas as well as the construction a temporary trestle bridge to facilitate construction, which will require bed disturbance during installation / removal. There may be some disturbance to the bed during the placement and removal of these structures, but the extent of such disturbance is expected to be limited. There is the potential to strand fish if water is diverted away from or pumped out of previously wetted areas. The risk of fish stranding could be minimised by erecting such temporary structures when flows are low and fish are not present and/or by salvaging any fish present during dewatering.

4.1.3 Potential discharges

Sediment

The works associated with the construction of the proposed new bridge will result in the disturbance of land on both banks of the Clutha River/Mata-Au, which may, under some circumstances, result in sediment entering water. There is also the potential for stormwater run-off during heavy rainfall that may transport sediment from disturbed areas of land and transport this to water.

Fine sediments can have significant negative impact on aquatic life, especially at high concentrations or where they form deposits on the stream bed. High suspended solid concentrations can lead to sedimentation of gill surfaces (of fish and invertebrates), the smothering of eggs or redds (nests), and lead to abrasive damage of skin or respiratory surfaces. Indirect effects include changes in invertebrate prey resulting from sedimentation of substrates.

Suspended sediment can also lead to changes in the clarity and colour of receiving waters, with flow-on effects on ecosystems. For example, reduced water clarity can reduce the effective feeding range of trout and juvenile salmon by reducing their ability to see and intercept prey. Changes in clarity and water colour can also reduce light penetration, which can affect the depth range of macrophytes and periphyton. The community in the vicinity of the works includes species that are known to be sensitive to fine sediments, including macroinvertebrates such as the common mayfly *Deleatidium* which was among the most abundant taxa at most sites surveyed by Ludgate & Ryder (2014), and many of the fish recorded from or likely to be present in the vicinity of the works are also expected to be sensitive to high levels of suspended sediment/turbidity.

Rowe *et al.* (2004) determined the maximum turbidity levels that could be tolerated by four native fish species over a 24-hour period. Of the species likely to be found in the Clutha River/Mata-Au in the vicinity of the proposed works, only smelt were considered by Rowe *et al.* (2004), with 50% mortality rates for smelt ranging from 1,700 to 3,000 NTU. However, the turbidity resulting from the activities associated with the construction of the new Beaumont bridge are unlikely to reach such levels.

Rowe (2008) also provided a brief overview of effects of suspended sediment levels on salmonids. He noted studies where juvenile chinook salmon, exposed to a suspended sediment concentration of 1,400 g/m^3 over 36 hours, incurred a 10% mortality rate, 50% mortality at an exposure of 9,400 g/m^3 and 90% mortality at 39,000 g/m^3 exposure (Newcomb & Flagg 1983). Rowe (2008) also noted a study where feeding rates of juvenile chinook salmon were not reduced by turbidities of up to 320 NTU (approximately 350 g/m^3 suspended solids) (Gregory and Northcote 1993), and migratory adult salmon still homed to their natal stream despite exposure to suspended solids levels of 650 g/m^3 (Whitman *et al.* 1982, cited in Rowe 2008). As stated above, the levels of turbidity expected resulting from the activities associated with the construction of the new Beaumont bridge are unlikely to reach such levels.

Given the very large volume of flow in the Clutha River/Mata-Au (see Section 3.1), the water velocities and the natural sediment load and low water clarity of the lower Clutha River/Mata-Au, the effects of the inputs of sediments from activities associated with the construction of the new bridge are expected to be short-lived and less than minor. Any potential effects of sediment discharge on incubating ova or alevin[4] from spawning that may have occurred in close proximity to the proposed works could be avoided by undertaking works outside of the main spawning and incubation period for brown trout and salmon in the Clutha River/Mata-Au (April-September), however, it is arguable that such a restriction is not necessary given the expectation that the effect of any discharge

[4] Alevin are newly hatched larval trout that still have a yolk sac attached.

is expected to be short-lived and less than minor.

The Regional Plan: Water (RPW) prohibits the discharge of sediment from disturbed land to any waterbody where no measure is taken to mitigate sediment runoff (Rule 12.C.0.3). The discharges of fine sediment should be minimised by limiting the amount of disturbance of the bed or banks of the Clutha River/Mata-Au and by using sediment controls that comply with good management practices, such as those outlined in Auckland Council's erosion and sediment control guideline document (Leersnyder *et al*. 2018).

Rule 12.C.1.1(d)(i) of the Regional Plan Water makes it a permitted activity to discharge sediment to water providing the discharge does not result in a conspicuous change in colour or visual clarity; or a noticeable increase in local sedimentation, in the receiving water. The phrase "conspicuous change" is somewhat ambiguous, although Ministry for the Environment (1994) goes some way to defining what would constitute a "conspicuous change" in clarity, with a 20% reduction in clarity likely to be noticed by the casual observer.

It is possible that in the event of heavy rainfall, sediment discharges from areas disturbed as part of the proposed works will result in a conspicuous change in visual clarity in the Clutha River/Mata-Au, although such discolouration is expected to be localised. Therefore, there is a risk that they would not comply with the permitted activity rule and consent for any such discharges should be sought. However, given the very large flow in the Clutha River/Mata-Au in the vicinity of the works, the relatively low existing water clarity particularly during flood events (which are likely to be associated with heavy rainfall) (see Section 3.1.2), the limited duration and extent of the proposed works, the effects of such discharges are not expected to be more than minor.

Concrete works

Construction of the bridge is likely to include the use of concrete in close proximity to water. Concrete and wastewater from concrete are very toxic to aquatic life, largely due to their alkalinity (pH 12-13) (Auckland Regional Council, undated), which can cause burns to fish and can kill aquatic life. Given the very large volume of flow in the Clutha River/Mata-Au (see Section 3.1), any discharge is expected to be quickly diluted and/or buffered, meaning that any effect of the discharge of concrete or concrete water is expected to be extremely localised and limited. In any case, all steps should be taken to avoid concrete or concrete wastewater from entering water and any water that seeps from the boxing during curing of the concrete should be disposed of onto a grassy area away from waterbodies or pumped into storage containers and removed from the site and disposed of appropriately elsewhere away from watercourses.

Other potential discharges

Without appropriate environmental management plans, the presence of construction machinery presents a risk of contaminants (e.g. diesel, lubricants) entering watercourses with the potential to harm aquatic life. This matter can be appropriately addressed by way of an appropriate on-site contaminant management plan. Any possible contaminants stored on site should be kept away from watercourses, bunded and stored in appropriate containers (e.g. double skinned tanks). Refuelling of machinery should also take place away from watercourses.

Run off from the new bridge will be captured on the bridge and then discharged to land on the eastern bank. There is the potential stormwater may then find its way to the Clutha River/Mata-Au. The main contaminant likely to be present in such stormwater is sediment, although it may also contain other contaminants present in road run-off (such as PAHs, metals). It is difficult to quantify the effects of this, as disposal of this stormwater to land will result in a level of retention of these contaminants in vegetation and soils prior to it entering water. However, given the very large flow in the Clutha River/Mata-Au, the relatively low existing water clarity particularly during flood events (which are likely to be associated with heavy rainfall) (see Section 3.1.2), the effects of such discharges are expected to be no more than minor.

4.1.4 Nuisance weed/algae introduction

Machinery and personnel involved in construction could potentially transfer nuisance weeds/algae to local watercourses. Didymo is currently present in the Clutha River/Mata-Au in the vicinity of the works and it is likely that the invasive oxygen weeds *Elodea canadensis* and *Lagarosiphon major* are also present. Despite this, it is recommended that equipment and other items are first inspected and if necessary cleaned prior to work being undertaken to prevent the introduction of any other nuisance species.

In addition, it is recommended that equipment and other items are inspected and cleaned prior to moving them from the worksite to any other waterway to prevent the species known/suspected to be present in the vicinity of Beaumont Bridge being spread to other waterways.

4.2 Terrestrial ecology

4.2.1 Terrestrial Vegetation and Avifauna

The effects of the proposed realignment are predicted here to have only a negligible impact on indigenous vegetation of the footprint; this negligible effect due to the scale of the effects and the limited existing natural values over the footprint. The footprint consisted of roadside verges, improved pasture grassland and riparian vegetation; all of which had very low ecological values locally, and also low value when the wider context was considered. The overall loss of indigenous plant species will be minimal, as the larger plants present (e.g. flax, toetoe, *Coprosma crassifolia*, totara and *Pittosporum tenuifolium*) are represented by 1-3 individuals at most; these losses can easily be offset with planting, post-development. The only conspicuous losses within the pasture grassland areas will be one large macrocarpa (*Cupressus macrocarpa**) and a small adjacent totara (*Podocarpus totara*) from the paddock on the eastern side of the Clutha River (Figure 12). In addition, approximately 12 crack willow* could be removed from the riparian areas. These localised losses represent a loss of potential roosting habitat or shelter for riverine birds such as grey teal or black shags. It is not known, however, how often these birds are present within the footprint (none were sighted at the time of the vegetation survey); and similar habitat exists for many kilometres upstream and downstream of the footprint.

4.2.2 Nuisance weed introductions - terrestrial

Existing weeds of the footprint include convolvulus*, blackberry*, periwinkle (*Vinca major**), pampas*, sycamore (*Acer pseudoplatanus**), silver birch (*Betula pendula**), khasia berry*, hawthorn*, Scotch broom*, Eucalyptus sp.*, apple (*Malus x domestica**), grey willow (*Salix cinerea**), crack willow*, elderberry (*Sambucus nigra**) and gorse*. Many of these species are environmental weeds of riparian zones, native and exotic shrublands, and regenerating forest; and are already present or naturalised within, or in close proximity, to the footprint. Gorse and broom are currently uncommon in the riparian areas of the footprint. An increase in these two species, locally, could impact on recreational use of the river and environs for swimming and cycling; gorse and broom should be controlled if disturbance during construction causes an expansion in their distribution.

Because the existing vegetation values of the footprint are very low, all of these weeds are not considered to pose a significant threat to the existing vegetation of the footprint. That said, the potential impact from any new weed introductions (i.e. those inadvertently introduced on machinery) as a result of the bridge realignment should be assessed on an individual basis e.g. buddleia (*Buddleja davidii*).

5. Conclusions

5.1 Aquatic ecology

The Clutha River/Mata-Au in the vicinity of the proposed works supports high aquatic ecological values including a regionally significant trout and salmon fishery (Otago Fish & Game Council 2015).

Any effects of the proposed works are expected to be short-lived, localised and should be viewed in the context of the environment affected – the Clutha River/Mata-Au is a very large river (mean flow of 614 m^3/s) meaning that it has a very high capacity to dilute and disperse any contaminants (particularly sediment) that may enter it. However, sediment control measures are necessary to ensure that the activity is not prohibited by Rule 12.C.0.3 of the Regional Plan: Water for Otago and such measures should comply with good management practices, such as those outlined in Auckland Council's erosion and sediment control guideline document (Leersnyder *et al*. 2018). Concrete water is highly toxic to aquatic life and steps should be taken to avoid uncured concrete or concrete water from entering water. The risks associated with other contaminants are low provided appropriate steps are taken to avoid or minimise the risk of these entering water in the case of a spill.

Much of the area of the bed of the Clutha River/Mata-Au potentially affected by the proposal is within the varial zone, the area affected by fluctuations in water level resulting from hydroelectric power generation at Roxburgh Dam. These short-term flow fluctuations adversely affect aquatic communities in the area subject to periodic wetting and drying, resulting in reduced macroinvertebrate densities and diversity and reduced habitat value for fish. As a result, the effects of bed disturbance associated with the proposed works are expected to be no more than minor.

It may be necessary to install temporary structures to divert water away from areas while works are undertaken. The disturbance of the bed associated with this is expected to be minor given the large flow in the Clutha River/Mata-Au and the fact that most areas likely to be affected will be within the varial zone. However, there is a risk of fish stranding if these temporary diversions result in the dewatering of previously wetted areas. This risk could be minimised by undertaking such diversions during low flows. If this is not possible, fish could be salvaged from affected areas during dewatering. Given the small footprint of the areas expected to be affected by such activities and that they largely occur within the varial zone, such effects are expected to be minor.

5.2 Terrestrial ecology

The areas affected by the proposed realignment consisted of small areas of crack willow in riparian areas; improved pasture grassland and roadside vegetation. The flora was typical of such areas, being dominated by exotic grasses and herbs with a scattering of mainly introduced trees and shrubs. Indigenous plants were scarce and comprised <1% of the total cover. No nationally/regionally threatened or at-risk plant species were detected. Casual observations of avifauna recorded primarily exotic bird species and no lizard survey was conducted, meaning significance assessments were vegetation-centric.

All areas affected by the proposed bridge realignment had very low ecological values, and do not play a major role in facilitating connectivity with the surrounding landscape. The footprint, as a consequence, failed to meet any of the ecological criteria for significance outlined in the Clutha District Plan. Furthermore, the footprint has not been identified by the Clutha District Council as a significant wetland or a significant habitat of indigenous fauna. The footprint area does occur within a Category 1 Acutely Threatened land environment, but given the highly modified nature of the vegetation and its negligible representativeness, the only implication is the importance of the site should it be appropriately restored, post development. At the very least, any indigenous trees, *Coprosma crassifolia* and *Phormium tenax* (flax) removed for the development should be replaced using ecologically appropriate plants, at a ratio of 1 removed, 5 planted. The planting of indigenous plants should be guided by a Planting Plan that also details the on-going maintenance schedule (and replacement of dead plants if necessary) required until plants are established. As well as planting of indigenous plants, the removal of crack willow, grey willow and pampas grass from riparian areas immediately above and below the new bridge, would improve the aesthetics and naturalness of the area. Management of weeds, particularly crack willow, will likely be the main ongoing issue.

Apart from the localised loss of potential roosting habitat and shelter for riverine birds, the very limited existing natural values of the footprint mean that the actual and potential impacts on indigenous flora or fauna locally, will be negligible.

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Appendix A Macroinvertebrate data

Table A1 *Macroinvertebrate community composition at three sites in the Clutha River/Mata-Au from Ludgate & Ryder 2014).*

TAXON	MCI score	Beaumont mean	Beaumont SE	Rongahere Road mean	Rongahere Road SE	Bernards Beach mean	Bernards Beach SE
COLEOPTERA							
Elmidae	6	0.0	0.0	0.2	0.2	0.0	0.0
CRUSTACEA							
Paracalliope fluviatilis	5	0.0	0.0	0.0	0.0	0.2	0.2
DIPTERA							
Austrosimulium species	3	0.2	0.2	0.2	0.2	0.0	0.0
Empididae	3	2.2	1.2	0.0	0.0	4.8	2.3
Maoridiamesa species	3	5.6	2.1	0.2	0.2	5.6	3.0
Orthocladiinae	2	254.6	63.8	9.6	1.8	648.6	346.5
Tanytarsini	3	174.4	29.4	5.6	1.4	393.4	176.4
EPHEMEROPTERA							
Austroclima species	9	0.4	0.4	0.0	0.0	0.0	0.0
Deleatidium species	8	380.4	50.5	178.4	15.9	54.2	12.6
HEMIPTERA							
Unidentified Hemipteran	5	0.2	0.2	0.0	0.0	0.0	0.0
MEGALOPTERA							
Archichauliodes diversus	7	0.0	0.0	0.0	0.0	0.2	0.2
MOLLUSCA							
Physa / Physella species	3	0.2	0.2	0.0	0.0	0.0	0.0
Potamopyrgus antipodarum	4	24.6	2.8	15.6	7.5	89.4	13.8
OLIGOCHAETA	1	44.2	4.9	13.6	2.0	103.2	51.5
PLATYHELMINTHES	3	0.2	0.2	1.4	0.6	16.8	8.4
PLECOPTERA							
Zelandobius species	5	5.0	1.8	0.4	0.2	9.6	3.9
TRICHOPTERA							
Aoteapsyche species	4	1.8	1.6	3.4	1.5	1.4	0.7
Helicopsyche species	10	0.2	0.2	0.0	0.0	0.0	0.0
Hudsonema amabile	6	1.4	0.5	0.6	0.2	8.2	4.0
Hydrobiosidae early instar	5	0.0	0.0	0.0	0.0	0.4	0.2
Hydrobiosis clavigera group	5	0.2	0.2	0.0	0.0	0.0	0.0
Hydrobiosis species	5	0.6	0.6	0.0	0.0	0.2	0.2
Hydrobiosis umbripennis group	5	0.0	0.0	0.0	0.0	1.0	0.8
Neurochorema species	6	5.2	2.4	0.4	0.2	1.8	1.1
Oxyethira albiceps	2	6.0	3.1	0.4	0.2	18.4	4.4
Psilochorema species	8	0.8	0.4	1.2	0.8	0.4	0.2
Pycnocentria species	7	24.2	6.0	0.2	0.2	35.8	8.0
Pycnocentrodes species	5	70.8	15.9	1.6	0.5	114.6	19.7
Number of invertebrates (per sample)		1003.4	90.0	233.0	27.4	1508.2	573.9
Number of invertebrates (per m2)		11148.9	1000.3	2588.9	305.0	16757.8	6376.5
Number of taxa		14.8	0.5	10.2	1.0	15.4	0.7
Number of EPT taxa		8.6	0.6	5.0	0.6	8.6	0.7
% EPT taxa		57.9	2.8	48.5	3.2	55.5	3.1
% EPT		50.3	6.3	81.4	3.0	25.1	6.9
MCI score		90.4	1.6	83.8	3.0	86.4	2.8
QMCI score		4.88	0.29	6.86	0.13	3.34	0.30

Appendix B List of plant species in the footprint of the proposed realignment

** denotes introduced species.*

Life form	Species Name	Common Name
Climber/Scrambler	*Convolvulus arvensis**	Convolvulus
Climber/Scrambler	*Muehlenbeckia australis*	pohuehue
Climber/Scrambler	*Rubus fruticosus**	blackberry
Climber/Scrambler	*Vinca major**	periwinkle
Fern	*Blechnum penna-marina*	alpine fern, little hard fern
Fern	*Polystichum vestitum*	puniu, prickly shield fern
Fern	*Pteridium esculentum*	aruhe, bracken
Grass	*Agrostis capillaris**	brown top
Grass	*Agrostis stolonifera**	creeping bent
Grass	*Anthoxanthus odoratum**	sweet vernal
Grass	*Cynosorus cristatus**	crested dogstail
Grass	*Dactylis glomerata**	cocksfoot
Grass	*Festuca rubra**	red fescue
Grass	*Holcus lanatus**	Yorkshire fog
Grass	*Hordeum vulgare**	barley
Grass	*Lolium perenne**	perennial ryegrass
Grass	*Phleum pratense**	timothy
Grass	*Schedonorus arundinaceus**	tall fescue
Herb	*Achillea millefolium**	yarrow
Herb	*Callitriche stagnalis**	starwort
Herb	*Cardamine deblis*	NZ bitter cress
Herb	*Cerastium fontanum**	mouse ear chickweed
Herb	*Cirsium arvense**	Californian thistle
Herb	*Cirsium vulgare**	Scotch thistle
Herb	*Conium maculatum**	hemlock
Herb	*Crepis capillaris**	hawksbeard
Herb	*Digitalis purpurea**	fox glove
Herb	*Epilobium ciliatum**	a willow herb
Herb	*Galium palustre**	a cleaver
Herb	*Galium perpusillum*	a cleaver
Herb	*Hydrocotyle heteromeria*	a penny wort
Herb	*Hydrocotyle moschata*	a penny wort
Herb	*Hydrocotyle novae-zelandiae*	a penny-wort
Herb	*Hypochoeris radicata**	catsear
Herb	*Jacobaea vulgaris**	ragwort
Herb	*Lotus pedunculatus**	birdsfoot trefoil
Herb	*Medicago sativa**	Lucerne
Herb	*Montia fontana*	Blinkswater chickweed, dwarf montia
Herb	*Mycelis muralis**	wall lettuce
Herb	*Persicaria maculosa**	willow weed
Herb	*Plantago lanceolata**	narrow leaved plantain
Herb	*Plantago major**	broad-leaved plantain
Herb	*Polygonum aviculare**	wireweed

Life form	Species Name	Common Name
Herb	*Prunella vulgaris**	selfheal
Herb	*Ranunculus repens**	creeping buttercup
Herb	*Rumex acetosella**	sheeps sorrel
Herb	*Rumex obtusifolius**	broad-leaved dock
Herb	*Solanum nigrum**	black nightshade
Herb	*Sonchus oleraceus**	sow thistle
Herb	*Stellaria media**	chickweed
Herb	*Taraxacum officinale agg. **	dandelion
Herb	*Trifolium dubium**	suckling clover
Herb	*Trifolium pratense**	red clover
Herb	*Trifolium repens**	white clover
Herb	*Verbascum thapsis**	woolly mullein
Herb	*Vicia sativa**	vetch
Monocot	*Cortaderia sp.**	pampas
Monocot	*Phormium tenax*	NZ flax
Rush/Sedge	*Eleocharis acuta*	sharp spike sedge
Rush/Sedge	*Juncus articulatus**	jointed rush
Rush/Sedge	*Juncus bufonius**	toad rush
Rush/Sedge	*Juncus edgariae*	wiwi, Edgar's rush
Rush/Sedge	*Juncus effusus**	
Tree/Shrub	*Acer pseudoplatanus**	sycamore
Tree/Shrub	*Betula pendula**	silver birch
Tree/Shrub	*Coprosma crassifolia*	
Tree/Shrub	*Cotoneaster simsonii**	khasia berry
Tree/Shrub	*Crataegus monogyna**	hawthorn
Tree/Shrub	*Cupressus macrocarpa**	macrocarpa
Tree/Shrub	*Cytisus scoparius**	broom
Tree/Shrub	*Eucalyptus sp.**	a gum tree
Tree/Shrub	*Juglans regia**	walnut
Tree/Shrub	*Malus x domestica**	apple
Tree/Shrub	*Pittosporum tenuifolium*	kohuhu
Tree/Shrub	*Podocarpus totara*	totara
Tree/Shrub	*Quercus* sp.*	English oak
Tree/Shrub	*Salix cinerea**	grey willow
Tree/Shrub	*Salix fragilis**	crack willow
Tree/Shrub	*Sambucus nigra**	elderberry
Tree/Shrub	*Ulex europaeus**	gorse