Appendix F1

Ecological Assessment

District Plan change for Lincoln South Development Area; Aquatic Ecology

Prepared for:

Rolleston Industrial Developments Ltd.

AEL Report No. 183

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Final Report

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Contents

1 Executive Summary

A private plan change is proposed for a rezone of an approximate 186 Ha land parcel south of the Lincoln Township. The area is currently zoned for rural land use, and is currently used largely for dairying and grazing.

There is some ecological information available in the region to be rezoned and the surrounding area. These indicate the presence of several common fish, many with marine lifecycles, and a compromised aquatic macroinvertebrate fauna and low stream health metrics. Some fish in the receiving waters have a conservation status, this includes the longfin eel and inanga (the common whitebait). There is a historic lamprey record, a threatened species, but it is unknown if this species still exists in the catchment, let along the receiving waters. It is considered the freshwater crayfish (koura) may reside in flow-stable waterways in the region, especially where the banks are stable.

A zone change, per se, does not, in isolation guarantee aquatic habitat improvement degradation or improvement. However, in Canterbury, there is an increasing number of successful restorations of degraded aquatic habitats in rezoned rural land which demonstrates improved ecological values from residential watersheds under a regime of treated stormwater restored habitats, and consideration of ecological dispersal and life-cycling.

Notwithstanding zone change issues, a number of habitats in the region need to be ecologically surveyed. This is required prior to a detailed assessment of environmental effects at a future subdivision consent stage and/or in the event that works are undertaken within the District Plan's 10m waterbody setback for earthworks and development. These habitats are specified in the recommendations.

2 Introduction

Rolleston Industrial Developments Ltd. is proposing to develop rural land for residential use on the immediate south boundary of the Lincoln township (Fig. 1). It lies directly south of the Verdeco Park and Te Whariki developments. The area, based on the topographic maps, is relatively flat, of approximately 186 Ha, and at an elevation of about 9 m a.s.l. It is bounded to the north by the Verdeco Park and Te Whariki residential developments and to Collins Road to the south. The west boundary is an ephemeral waterway termed Western Boundary Drain and the area extends eastwards to the setback boundary of the LII River, south of Moirs Lane. The land is currently zoned as rural, and its current land use is primarily for dairying and grazing.

3 Objectives

In support of the private plan change application, and the section 32 (RMA) evaluation, the overall scope of this study is to provide an assessment of the following matters:

- An assessment of the existing ecological values of the Lincoln South Area,
- An assessment of the ecological effects associated with the type of development likely to result from the proposed residential zoning.

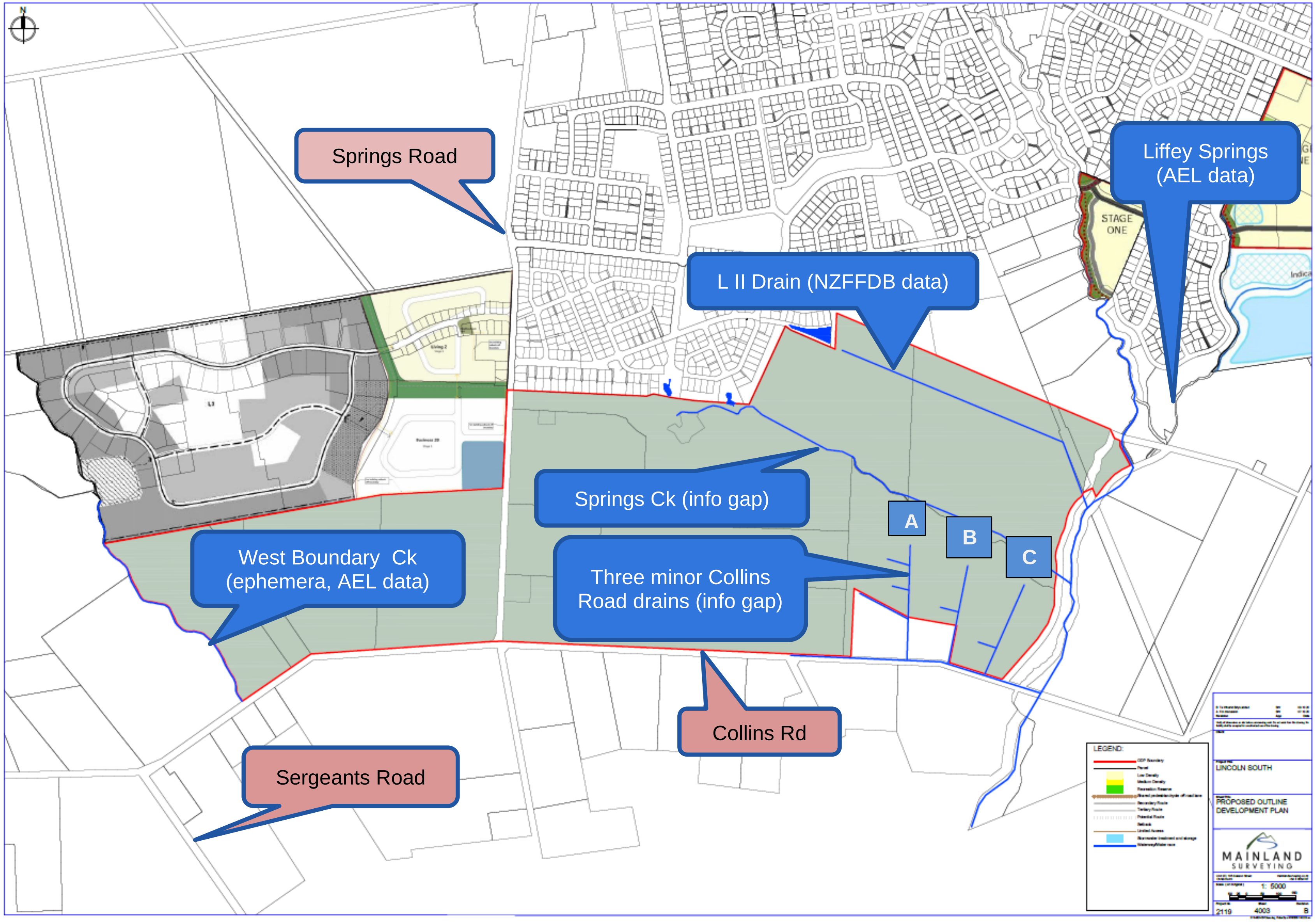

Figure 1. Red polygon = proposed plan change area, with major waterways and roads indicated.

4 Existing ecological knowledge of waterways

4.1 West Boundary Drain

West Boundary Drain borders the west boundary of the development area (Fig. 1), and the reach bordering the Verdeco Park Development Area to the north was surveyed by Aquatic Ecology Limited (AEL) in April 2019. This reach was found to be ephemeral, thus, conveying rainwater during rain events, but drying out between rain events. It was fished during a rain event, to check for transitory aquatic values, including fish, but none were caught.

The reach bordering the plan change area is also suspected to be dry. At the south-east corner of the development area, at Collins Road, West Boundary Drain was dry in October 2020 (Fig. 2a). The waterway was also dry in April 2019 during our Verdeco Park survey when the bed was similarly covered in willow weed and creepers (Figs.2 b,c).

Collins Road Drain appears ephemeral too, but during rain events would flow south-west to the intersection with Sergeants Road, and with inflows form further west, would appear to provide permanent flowing water southwards along Sergeants Road. During the recent October reconnaissance, the channel of Collins Road Drain was filled with tall fescue grass, indicating a normally dry channel (Fig. 3a).

Figure 2a. West Boundary Drain looking north from Collins Road (9/10/20).

Figure 2b. The bed of West Boundary Drain at Collins Road (April 2019)

Figure 2c. Looking south-west along Collins Road Drain, no surface water, damp bed with willow weed (April 2019).

Figure 3a. Looking eastwards along Collins Road Drain (9/10/20).

4.2 LI Creek (Liffey Stream)

The L1 rises north of the Lincoln township, flows south through the town, and enters the LII River below its headwaters. AEL ecologically evaluated the L1 headwaters upstream of the proposed development area in March 2018. This work was undertaken in pursuit of civil works required for the construction on a new school in the area and consenting for the dewatering discharge for trenching operations.

The waters were very clear at baseflow, with a measured mean baseflow turbidity of 2.4 NTU (n=3). A temperature and dissolved oxygen logger indicated that the autumnal diel (i.e. over a 24 hr period) temperature regime varied between approximately 12.9-15.5 degrees, and dissolved oxygen levels varied between 94% in the mid-afternoon to a minimum of 72% just after dawn. We considered that the LI Creek is a thermally stable spring-fed river exhibiting normal variation in dissolved oxygen concentrations typical for a well-vegetated and shaded waterway.

Physical habitat scores for the LI headwaters, compared to national values, were low, but in well-shaded habitats, the lack of sunlight appeared to inhibit the growth of weeds like watercress and monkey musk in some places, and native charophytes (*Nitella* sp.) were prominent. The physical habitat scored highly for bank stability, low erosion, and high levels of shade. Hydraulic variation and habitat abundance for invertebrates and fish cover abundance was usually low.

Koura were quite common, 5 caught in the fishing catch, and one with eggs (in berry). Invertebrate stream health metrics based on previously available data indicated poor stream health in the upper L1 River (MCI-sd = 65). A total of 200 fish were caught, composed of 6 species, common bully, longfin eel, upland bully, brown trout, bluegill bully, and shortfin eel. Of these, the longfin eel and bluegill bully have a conservation status of "declining". The bluegill bully record was a first for this catchment, and adopts habitats in particularly fast water. Therefore, it is currently unknown, but considered unlikely, if it would inhabit resident habitats in the receiving waters of the LII River for this Plan-change area.

The upper reach of the L1 provided stable gravels downstream of the Gerald Street culvert (Taylor & Good 2006), and the New Zealand Freshwater Fish Database (NZFFDB) lists a historic (1920) record of lamprey in the upper reaches of the LII Creek (Edward Street, Lincoln, Card No. 50483). There is a recent (2015) giant bully record from the Lincoln township, surprisingly inland (33 km) for this species, and I consider that this record may be a misidentification.

4.3 LII River

The outline development plan depicts the development area extending to approximately 10 m (not counting the proposed green space along the boundary) of the LII River, a waterway with significant instream values. As noted above, the District Plan requires a 10m setback for earthworks from waterbodies.

The LII River, nears its confluence with the LI tributary, forms the eastern boundary of the development area. In 2007, AEL was involved in the plan change, stormwater AEE and monitoring of the Liffey Springs residential development between Liffey Stream (the spring-fed headwaters of the LII River) and the LI tributary.

At the time of the 2007 survey, the upper reaches of the LII, at the north-east corner of the development area, was composed of four common native fish species, shortfin eel, longfin eel (some large), common bully, and upland bully. Of these, the longfin eel has a conservation status of "declining" (numbers) (Dunn *et al.* 2017).

The invertebrate fauna contained koura (freshwater crayfish), but the remaining macroinvertebrates were commonly encountered species, with a stream health metric indicating 'poor' stream health (MCI-sb = 67.6), where a score less than 80 is categorised as poor (Stark & Maxted 2007).

4.4 New Zealand Freshwater Fish Database Records

Currently (19/10/20), there are 32 fish records in the LII catchment on the New Zealand Freshwater Fish Database (NZFFDB), with a species list provided below (Table 1). Within the LII dataset, the 5 most frequently encountered species are the common bully, upland bully, longfin eel, inanga (the common whitebait) and the shortfin eel.

Of these 32 records, 4 are quite recent (September 2020), and from an unnamed aligned waterway which passes through the development area and discharges into the LII River (Figs. 1, 4). These records indicate that this waterway provides habitat for a number of common lowland species: longfin eel, shortfin eel, inanga, upland bully, and common bully. Of these the longfin eel and inanga have a national conservation status of declining (numbers) Dunn *et al.* (2017).

The fish pest rudd was recorded near the mouth at Te Waiora/Lake Ellesmere, distant from the plan change area. Rudd has been recorded from other rivers near the lake. Goldfish, which can form problematic wild populations, have been recorded near Te Waiora/Lake Ellesmere, and in a pond near Templeton Hospital, both well away from the plan change area.

Koura have been infrequently recorded from the catchment (Table 1), but because they are difficult to catch, are often more common and well-distributed than records indicate.

Table 1. Freshwater Fish Species List from the LII River (NZFFDB), sorted from the most commonly recorded to the least recorded.

Common name	Scientific name	No. of records
Common bully	*Gobiomorphus cotidianus*	28
Upland bully	*Gobiomorphus breviceps*	24
Longfin eel	*Anguilla dieffenbachii*	23
Inanga	*Galaxias maculatus*	20
Shortfin eel	*Anguilla australis*	14
Brown trout	*Salmo trutta*	8
Unidentified eel	*Anguilla sp.*	8
Koura	*Paranephrops*	3
Unidentified bullies	*Gobiomorphus sp.*	3
Unidentified galaxias	*Galaxiid*	3
Goldfish	*Carassius auratus*	2
Common smelt	*Retropinna retropinna*	1
Freshwater mussel	*Hyridella menziesi*	1
Giant bully	*Gobiomorphus gobioides*	1
Rudd	*Scardinius erythrophthalmus*	1
Southern lamprey	*Geotria australis*	1
Torrentfish	*Cheimarrichthys fosteri*	1

Figure 4. The four NZFFDB records (red pins) in, or close, to the development area (green polygon).

4.5 Ecological values and sensitivity of the wider receiving environment

There is some information on the ecology of the LII River. Historically in the Te Waihora catchment, after the Selwyn River, the lower reaches of the LII was the most heavily fished for brown trout (Hardy & Taylor 1989).

There are two routes which stormwater can discharge from the site into the LII River. One is via Collins Road, Sergeants Road drain, finally discharging into the LII River near Yarrs Road. The identified fish fauna downstream of that point is composed of longfin eel, shortfin eel, inanga, common bully, and near the lake, goldfish and rudd, .However, there is fishing method bias in these records, and a number of other native and introduced fish will be present, including brown trout and common smelt.

Stormwater discharge to the east enters the LII River more directly and further upstream than *via* the Collins Road drain. The LII was apparently well-fished by the Department of Conservation in 2015 downstream of this potential discharge point (NZFFDB 10468). At that point, common native fish species were identified, specifically common bully, longfin and shortfin eels, inanga, upland bully and brown trout.

The most sensitive fish will be the common smelt which has been only electric-fished from the roadside drain along Days Road, but not the mainstem. However, this sea-migratory fish must migrate up the main river to reach the Days Road drain, but this location is well downstream of the Lincoln South area. Given that this fish is sensitive to urban contaminants (Cd, Zn, phenols *in* Hickey 2000) , in terms of an eventual assessment of environmental effects (AEE), it is important to know the upstream limit of common smelt in the LII River.

In almost all situations, NZ's aquatic invertebrates are more sensitive to urban contaminants than the fish. In this potential receiving environment, and based on available information (Hickey 2000) the freshwater shrimp (*Paratya curvirostris*) is likely to be the most sensitive.

4.6 Ecological knowledge gaps in the proposed development area

There are information gaps about the ecological values in three principal locations as indicated in Fig. 1. This information will be required to assess the level of protection these habitats require because of a Zone change, and potential assessment of ecological effects following potential residential development. The ecological issues surrounding these three locations are discussed below.

4.6.1 Springs Creek

Based on the recent photographic reconnaissance, and the recent survey in an adjacent waterway (see Sec. 4.4), I expect ecological values to be moderately high in Springs Creek. This opinion is based on the observation that the waterway is mostly fenced, with stable banks, and at least around the homestead, the margins are well vegetated with a wide riparian strip (Google Earth imagery, Drop boxed INOVO, e2 field photographs).

The discharges from the springheads at the top of the system form the basis of the baseflow, but augmented by more (fenced) spring-head inflows further downstream and eastwards. The waterway is subject to surface-water abstraction for dairy production. There is some gravel in the vicinity, which would form particularly valuable habitat for bullies and juvenile eels.

The fish fauna is currently unknown, but expected to be quite similar to that in the LII Drain indicated in Fig. 1 (i.e. longfin eel, shortfin eel, inanga, upland bully, and common bully). Where the hydraulics are suitable, there may be some trout spawning gravels, and these may be utilised for spawning by the upland bully. However, the linear nature of the channel, along with even gradient would suggest any trout spawning habitat is quite limited. Where the banks are stable, it is quite possible freshwater crayfish are present.

4.6.2 Isolated permanent and semi-permanent waterbodies

Along with Springs Creek, and the minor lateral drains, several isolated waterbodies require further investigation. These are located north-east of the intersection of Collins Road and Springs Road, and are comprised of 5 ponds visible on imagery in the recent past (i.e. since 2004, Fig. 5). These waterbodies align with old fluvial channels possibly dating back to the old course of the Waimakariri River.

Isolated ponds in Canterbury may form habitats of the Canterbury mudfish, a species with high conservation status. No Canterbury mudfish records exist on the NZFFDB in the LII catchment. However, at the time of writing, few suitable habitats appear to have been surveyed in this catchment. Maintenance of Canterbury mudfish habitat is not necessarily at odds with a plan change, but identification of habitats is critical as early as possible in the planning process.

Figure 5. The five isolated ponds which warrant ecological survey in the eastern half of the area proposed for re-zoning.

4.6.3 Collins Road Drains

These three spring-fed waterways discharge to Collins Road Drain, and recent imagery suggests that they are currently well-fenced from stock (Figs. 6 a, b). Collectively, these 3 waterways appear to be fed by approximately 10 (or so) springs heads. There also appears to be number of springs heads along the bank of the L II River, but which for the most part, may be protected by the waterway setback.

Given the evident stability of the channel form, these stable channels may form habitat for koura, inanga, common bully and upland bully. Given easy fish access to the LII, freshwater mussels may also be present. Freshwater mussels have a juvenile lifestage which attaches to fish for the purpose of dispersal.

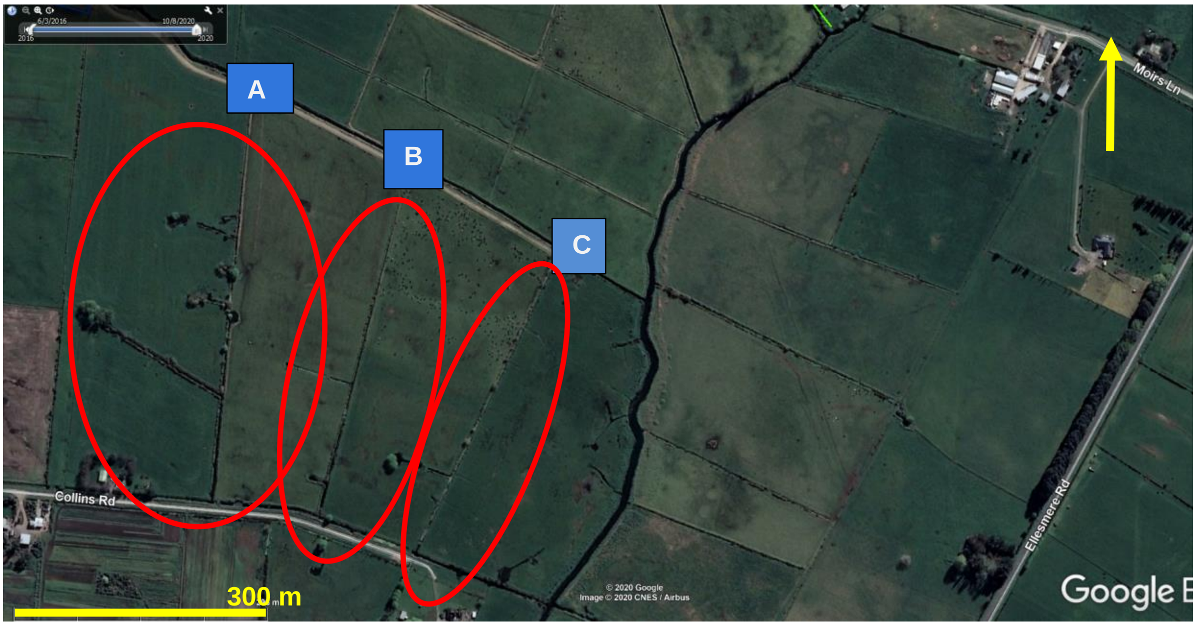

Figure 6a. The three springfed drains discharging into Collins Drain.

Figure 6b. The confluence of a Minor Collins Road Drain and Collins Road Drain "A". The waterway and springheads appear to be well-fenced based on the Google imagery. The fencing around the waterways "B" & "C" were similar.

5 General notes to protect ecological values and plan change level

5.1 Physical habitat notes

Spring fields are aquatic habitats sensitive to hydrological changes potentially manifested by change in land use. Maintaining groundwater flow to the springs is paramount to their future viability, and often at odds with high density development, where stormwater may be diverted away from areas of groundwater and springwater recharge.

It is apparent most of the spring heads and outlets in the proposed development area are already partially protected by fencing, and they are otherwise protected by the 10m setback for waterbodies in the District Plan. The riparian vegetation suggests they have been fenced in the recent past, but possibly not historically. The now-stable banks form important refuge habitat for all of the native fish and the native freshwater crayfish, but also form refuge and roosting areas for the native invertebrates upon which the fish feed. Koura require extensive cover, as they are vulnerable to cannibalism, but also predation from eels and trout.

Gravel substrate is important for native bully spawning, as they adhere their eggs to the large stones and cobbles, but coarse substrate is also valuable for fish cover, and bully abundance has been experimentally demonstrated to increase (and decrease) with the amount of available stony substrate (Jowett & Boustead 2001).

5.2 Possible change in ecological values associated with Plan Change

A plan rezoning from pervious rural land to residential will inevitably lead to higher stormwater discharge, because the proportion of impervious land will increase. The quality and quantity of the stormwater discharge will be dictated by the development intensity, the quality of the stormwater treatment train, the degree to which stormwater volumes are retained, and their discharge rate to surface waters. However, ultimately, all surface stormwater discharge will enter the LII River. Thus, quantification of ecological impacts, as for an AEE approach will be set out when stormwater design and flow rates are available.

Generally, the more peaked storm hydrograph associated with discharge from urbanised catchments which lack storm discharge attenuation can be quite averse to ecological values in the receiving environment (Suren & Elliott 2004). However, with improvements in stormwater treatment, along with physical habitat enhancements, within a development, and along the local receiving waterway, these adverse impacts can be reduced.

However, often rural waterways, at least in New Zealand, have been ecologically compromised in the past by the lack of fencing. While recent fencing is a welcome change for the natural environment, often the years of stock-accelerated bank erosion has meant the channel have already become over-widened in relation to the baseflow and prone to further sedimentation due to adverse hydraulics. The sediment, often nutrient rich, facilitates weed growth to the point it must be mechanically dredged causing further bank damage and widening.

Over time, Plan change from rural to residential can lead to further baseflow loss in channels which are already artificially widened as described above. Ecologically, this change is manifested by the gradual sedimentation of any stream gravels and its diverse habitat-specific fauna (i.e. caddisflies, mayflies, abundance of small native fish). With baseflow loss, even with banks now stabilised, this leads to a shallow, warm, silted channel inhabited by little else but midge larvae, segmented worms, and mud snails.

On a positive note, the development phase, and the associated mechanisation, provides a unique opportunity to reduce and restore effective wetted widths of waterways for low baseflows, yet still engineer hydraulic capacity for stormflows. An example of rural-to-residential land use change with good ecological outcomes is the spring-fed Kaputone Stream catchment of the Styx River in Christchurch where both ecological and water quality parameters indicate improving stream health. However, this beneficial change does take some years to manifest, probably largely due to access issues for instream inhabitants.

Invertebrate and fish dispersal are important elements to maintain life cycles. There is an increasing body of knowledge about dispersal and fish migration requirements to ensure restored habitats are available for colonisation. The recent MFE specifications on culvert placement in waterways will allow sea-migratory fish to colonise restored habitats.

In summary, changes in ecological values associated with Plan and land use change, can be detrimental, or beneficial, to the associated waterways. It all depends on utilising the critical time window when waterways are available for design and construction in respect to ecological function.

6 Recommendations

Overall, from a plan change/rezoning perspective if the development incorporates key design items such as:

- Stormwater discharging via first flush basins, detention basins and wetlands to attenuate stormflow and reduce contaminants to appropriate SDC & ECan guidelines.
- Reserves/green space placed directly adjacent to key ecological waterways to protect them (i.e. western boundary drain, Springs Creek, LII River, natural springs and isolated waterbodies)
- Fencing waterways with ecological value from further stock access.
- Adherence to the 10m waterbody setback rules, or detailed assessment through a resource consent process

then the possibility of the plan change/rezoning ecological impacts being beneficial to the environment are likely to be increased. Currently, the draft outline development plan (ODP) proposed for the Lincoln South plan change shows many of these key design items proven to protect aquatic ecology.

As a prerequisite to a submission of any subdivision consent application and subsequent land development, AEL recommends ecological assessment of the following habitats, in order to identify any ecologically significant biota, and construct mitigation measures to maintain and protect ecological values:

- isolated waterbodies east of Springs Road
- minor drains in the south east corner of the development
- the LII River immediately downstream of the region proposed for re-zoning.
- Springs Creek

In summary, if the listed key design items are implemented, along with the further ecological assessments, AEL believes this plan change will not necessarily manifest adverse ecological effects.

7 References

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Appendix F2

Addendum Ecological Assessment

Aquatic Ecology

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Jocelyn Lewes
Selwyn District Council

15 February 2021

Dear Jocelyn

RFI Response in respect to Request for Further Information for SDC Plan Change 69; paras. 80-83

Fishing survey methods

In order to gain an understanding of the aquatic species present in the springs and wetlands in the proposed development area (Lincoln South, PC 69), a fish netting and trapping operation was undertaken. This was undertaken using baited Gee Minnow™ traps (App. I, Fig. i) and baited mini fyke nets (App. I, Fig ii) were utilised.

One, two or five traps were set per spring, based on the size and likely abundance of fish. A total of 28 traps were set across 18 locations (App. I, Fig iii), overnight on the 13th Jan 2021. Three small fyke nets (App. I, Fig. ii) were also set overnight to assess the presence of rudd in Spring Creek, the main waterway on the property. The so-called mini fyke nets have a hoop size of 0.35 m, a leader length of 1.5 m, and a stretched-mesh size of 20 or 25 mm. Nets were set in the evening of 14th Jan 2021, and raised during the following morning.

All captured fish were anesthetised, identified, measured, and after recovery, released back into their resident habitat.

In lotic (i.e. flowing) waters, electric fishing was conducted under AEL's electric fishing permits (MPI Permit 605, DOC 70754-FAU and under authority from NCFGC). In combination, these reaches encompassed all hydrological habitat types in the area, including pool, riffle, fast run, and slow run habitats. The total sample time (i.e., the total time that the machine was actively electrifying the water) for these reaches was 18 minutes. Captured fish were then anaesthetised, identified, measured, and upon recovery from anaesthesia, released back into their resident habitats.

Sites EF 1 and EF 2 were electro-fished on the 19th Jan 2021, and sites EF 3 and EF 4 on the 20th Jan 2021, all using a conventional Kainga EFM300 electric fishing machine at an operating voltage of 100-200 V. D.C. The voltage provided a sufficient electrical field size to prevent escapement. Electric fishing serves to briefly (approx. 3 seconds) render fish unconscious to facilitate their capture in nets for identification. The machine incorporates a timer, allowing the effective fishing time to be recorded. Overall conditions for fish capture using electric fishing were adequate, with high water conductivity and excellent water clarity.

Mussel Survey methods

In order to assess the presence of freshwater mussels (Kākahi) in the LII River, a boat survey was attempted in order to observe and record the presence of mussels embedded in the fine sediments. The proposed method involved gradually working up the river in a small outboard boat, using a bathyscope to visually assess the riverbed for the presence of kākahi. This method was therefore abandoned, as the soft sediment in the LII meant the waterway was unsafe to survey by food.

However, visual mussel surveys were able to be carried out in Spring Creek, and three other drains on the property (i.e. Collins Road drains). At each of these locations, 5-minute visual surveys were executed at 50 metre intervals along the waterway. A bathyscope was used to accurately examine the bed of each waterway. 15 sites along Spring Creek were surveyed, along with 1-3 sites in each of the three drains (App. I, Fig. v).

Invertebrate collection

Two macroinvertebrate samples were taken during an ecological survey of the proposed development area. One sample was collected using the sampling protocol required for hard substrate, and one was collected using the sampling protocol required for soft sampling.

The first collection method used was a semi-quantitative collection technique called "protocol C1", appropriate for riffle habitat in stony streams (Stark *et al.* 2001). This methodology is consistent with data collection for compliance monitoring for AEE (Assessment of Environmental Effects) and SOE (State of the Environment) reporting. Stream invertebrates are affected by flood flows, and published protocols advise that sampling should not be undertaken within 3-4 weeks of floods. In this instance, no significant rainfall events occurred in the three weeks prior to collection.

The mechanics of collecting macroinvertebrates using Protocol C1 are detailed in Stark et al. (2001), and it is not necessary to provide further detail here. One macroinvertebrate composite sample was collected from Spring Creek (App. I, Fig. iii, vi). This was composed of eight kick-net sub-samples with a combined habitat area of approximately 0.72 m^2 (8 x 0.3 m x 0.3 m). The kick net sample was collected across the stream transect, working upstream in a zigzag manner.

The second collection method used was a similar semi-quantitative collection technique called "protocol C2", appropriate for soft-bottomed streams (Stark *et al.* 2001). Macroinvertebrates were collected using a standard 0.3 m wide, 500-micron kicknet. Protocol C2 involves jabbing along the overhanging vegetation on the bank margin, or macrophytes, with the kicknet for 1 m, then sweeping the kicknet through the disturbed section twice. This process was repeated 10 times to create a composite sample (total sample area = 0.3 m x 1 m x 10 m = 3 m2). From this composite sample a one-pottle subsample was taken.

Samples were field-preserved in iso-propyl alcohol, and the aquatic macroinvertebrates for the drain branches were transported to the Christchurch laboratory for identification using the standard identification keys.

Georeferencing the Outline Development Plan to field habitats.

A ruggedised electronic tablet was used in the field with an accurate Google Earth™ overlay of the development plan. These overlays are depicted in App. I. In this way, habitats in the field could be assessed in the context of the development plan. Particularly, all of the actual and possible springs from the ECan database were uploaded into the field GPS.

RESULTS

Para 80 Wetland identification, significance, and protection

During the field survey, almost all surface waterbodies were ecologically surveyed for fish values. All of the significant waterbodies were fenced with a single hot-wire from the grazing dairy herd. The luxuriant nature of the fenced vegetation suggested it was sufficient to dissuade dairy cows from grazing the riparian area. Regenerating vegetation was largely introduced common herbs around the water edge (e.g. monkey musk) with pasture grasses further away from the water's edge. Some wetlands had C. secta and *Juncus* species which appeared to be naturally regenerating.

Only one wetland coincided with a proposed residential development area, and this was categorised as possible high density on the current outline development plan. This wetland is depicted in the Appendix I (Fig. 1, GM 05, App. I, Fig. iii). This pond had a water connection to Springs Creek, but flow was not perceptible at the time. At the time of writing, it was unknown whether the waterbody was fed by groundwater (therefore a spring), or was a pond with a drainage outlet (Fig. 1). The pond appeared to be subject to riparian grazing, by sheep (landowner pers. comm.), but dairy cows were denied access to this wetland. This pond was fished with 2 baited Gee Minnow traps, but no fish were caught. For context, neighbouring pond (GM 06) provided habitat for upland bully (no significant conservation status), and no catch was recorded in GM07.

Some riparian flax was present at this location, and a number of introduced trees around the water's edge. The evident riparian grazing probably limits the development of an indigenous riparian border. Further investigation would reveal the hydrological nature and origin of the wetland. If it is a pond with little redeeming value, and possibly artificially created, the pond could be decommissioned. Should the wetland prove to be a spring, or a wetland with significant ecological value, protection by way of a reserve or other green space around the wetland could be provided.

Three wetlands are on land currently proposed for general residential land use, close to the border of the proposed higher-density residential zone. Wetland GM06 may be a spring, and had the common upland bully present. However, no fish were recorded from wetlands GM07 and GM08. GM07 was bordered with poplar and covered in pondweed/water fern, but the wetland at GM08 was encircled with large mature *Carex secta* (Purei), and had an outlet to Springs Creek.

Figure 1. Pond GM05 which coincides with a proposed high-density residential area. The water fern (*Azolla rubra)*, and the common duckweed (*Lemna minor*) obscures the water surface.

All other ponds and possible springs fell within proposed green space or stormwater management areas, well away from the proposed high-density residential area. Within the Springs Creek esplanade reserve, GM09 had some *C. secta*, but largely ringed by willow. It appeared to be suffering from an algal bloom, but common bully (conservation status of 'not threatened') were identified from the habitat.

Springs Creek itself is linear, possibly channelised in the past, with a uniform (engineered) cross section, and a sand substrate. Introduced grasses and the soft herb (Monkey musk) encroached to the water's edge. I suggest that it has significant enhancement potential. Large (T.L. 900, 1200 mm) specimens of the longfin eel (Conservation status, declining) were caught in fyke net set in the main channel (Fykes 1, 2, 3, App. I, Fig. iii), and these would benefit from physical habitat heterogeneity.

The swale immediately to the west of the Plan Change Area (informally referred to as "university drain", adjacent to Pendah farm, was completely dry, with the channel basin vegetated in terrestrial grasses. This is consistent with our survey of this swale (March 2019) as part of the consenting for the Verdeco Park development on Springs Road, and upgradient of this Plan Change area. We formally reported on the values of this waterway in a s92 response report on 11 April 2019.

With the Plan Change, the area will be destocked, and wetland riparian zones may benefit, depending on the effectiveness of current fencing around the wetlands. The current fenced riparian strip around each wetland is narrow, only a few metres in width, probably insufficient to provide the ecological buffering to sustain diverse wetland ecology. More green space around the springs and ponds, especially if planted in a diverse range of wetland species, will promote wildlife, aquatic ecology and amenity values. I understand from the Landscape/Urban Designer for the Plan Change that this intention of planted green space around the springs and ponds is the aim once further investigation at time of subdivision design takes place.

However, it is important that the geohydrological flow which feeds springs is respected. There are examples of the loss of flow into spring heads where the proportion of impervious area is high. An investigation of springhead flow loss in Ka Pūtahi Creek was attributed to multiple causes (low rainfall, low aquifer recharge from the Waimakariri River, but the inadvertent diversion of shallow groundwater (c. 45 L/s) into a neighbouring subcatchment was likely to be a major contributor (Nikora 2004).

In summary, with understanding of the local geohydrology, stormwater conveyance and treatment, along with the distribution of pervious land, springhead discharge can be preserved. If discharge can be preserved, when combined with a wider, more biodiverse riparian buffer, ecological values in the springs and wetlands can be protected and enhanced.

Para 81 Location, state and protection of springs

The entire Plan Change Area was then physically surveyed for springs (survey trace in App. I, Fig. iv), with the exception of the area to the west of Springs Road, which is known to be devoid of water bodies. I am confident no other surface water bodies exist that have not been logged in this physical survey.

All springs are all fenced from stock with hotwire fences, as discussed above. However, the lack of adventive saplings in the fenced areas would suggest that fencing has only been completed in the recent past (i.e. last 10 years). The comments made in respect to wetlands above would apply to springs, but there was difficulty in the field definitively categorising wetlands as springs, so my comments in regard to wetlands also apply to spring heads.

Para 82 Canterbury Mudfish and aquatic ecology

Five fish species were caught at this property, with an overall total of 153 fish (App. II). The three species identified from the Gee Minnow™ (GM) traps were upland bully (*Gobiomorphus breviceps*), common bully (*Gobiomorphus cotidianus*) and inanga (*Galaxias maculatus*). One species was identified in the small fyke nets, the longfin eel (*Anguilla dieffenbachii*). Along with upland bully and longfin eel, the shortfin eel (*Anguilla australis*) was also identified during electric fishing. As documented by Dunn *et al.* (2017), the longfin eel and inanga have a conservation status of "At Risk – Declining". All inanga were caught in one GM trap, at site GM 10 (App. I, Fig. iii, vi).The upland bully, common bully and shortfin eel are considered "Not Threatened" (Dunn *et al.* 2017).

In particular, despite targeted trap placement, no Canterbury mudfish were recorded in any of the 17 locations sampled. Given the presence of potential predators (eels > 23 cm TL) in the Plan Change Area, we doubt they would survive cohabitation.

We note too, with some relief, that no pest fish were recorded in the Plan Change Area, as these are difficult to manage and eliminate. An illegal introduction of rudd (a member of the goldfish family) into the Lake Ellesmere catchment had led to spread in neighbouring catchments, including the Halswell River catchment. Unfortunately, the Plan Change raises the possibility of illegal introduction of pest fish (e.g. rudd or tench) into the area, although control methods were successful in eliminating rudd from the Travis Wetland in Christchurch.

A total of 11 species of invertebrate were identified in the macroinvertebrate sample at site IS 1, and 12 in the sample at site IS 2 (App. III). The samples found an abundance of *Potamopyrgus antipodarum*, also known as the New Zealand mud snail, at both sites. Also present were two young Koura (*Paranephrops zealandicus*, App. I, Fig. viii). Koura have a national conservation status in New Zealand of "At Risk – Declining" (Grainger *et al.* 2018). All other identified invertebrates are considered "Not Threatened". Another koura was identified during electric fishing, at site EF 4 (App. I, Figs. iii, ix). This individual measured 59mm. Koura require stable banks, steady flows, and refugia to form healthy populations. If the banks are stable, like along the LII River, koura will form burrows, which are quite evident along this reach.

The *Austridotea* isopods identified are likely to be *A. annectens* due to the range this species is found in. While of ecological interest, it does not possess significant conservation status. All other species within the *Austridotea* genus are confined to Otago and Southland (Chapman et al 2011).

<u>Para. 83 Mussels (kākahi)</u>

After a systematic survey of four waterways in the proposed area, all of which are connected to the LII River, no freshwater mussels (kākahi) were found. Given the amount of survey effort imparted as part of this study, we are currently confident that freshwater mussel populations are unlikely to be present in the Plan Change Area.

Partly because of the ignorance around their habitat requirements, the conservation status of freshwater mussel has changed from At Risk-Naturally Uncommon to now Data Deficient (Grainger *et al.* 2018). However, because the physical habitat characteristics of freshwater mussels are poorly known, and their distribution is very patchy in mid-Canterbury, there remains the possibility that some could be found in the future. Should they be identified, then it a fairly simple exercise to translocate the molluscs to a safe location. AEL has significant experience and permits in the translocation of mussels and fish.

Yours sincerely,

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Mark Taylor

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Appendix I.

Figure i. Line of five GM traps set at site GM 02.

Figure ii. Two small fyke nets set at Fyke 01/02, Spring Creek.

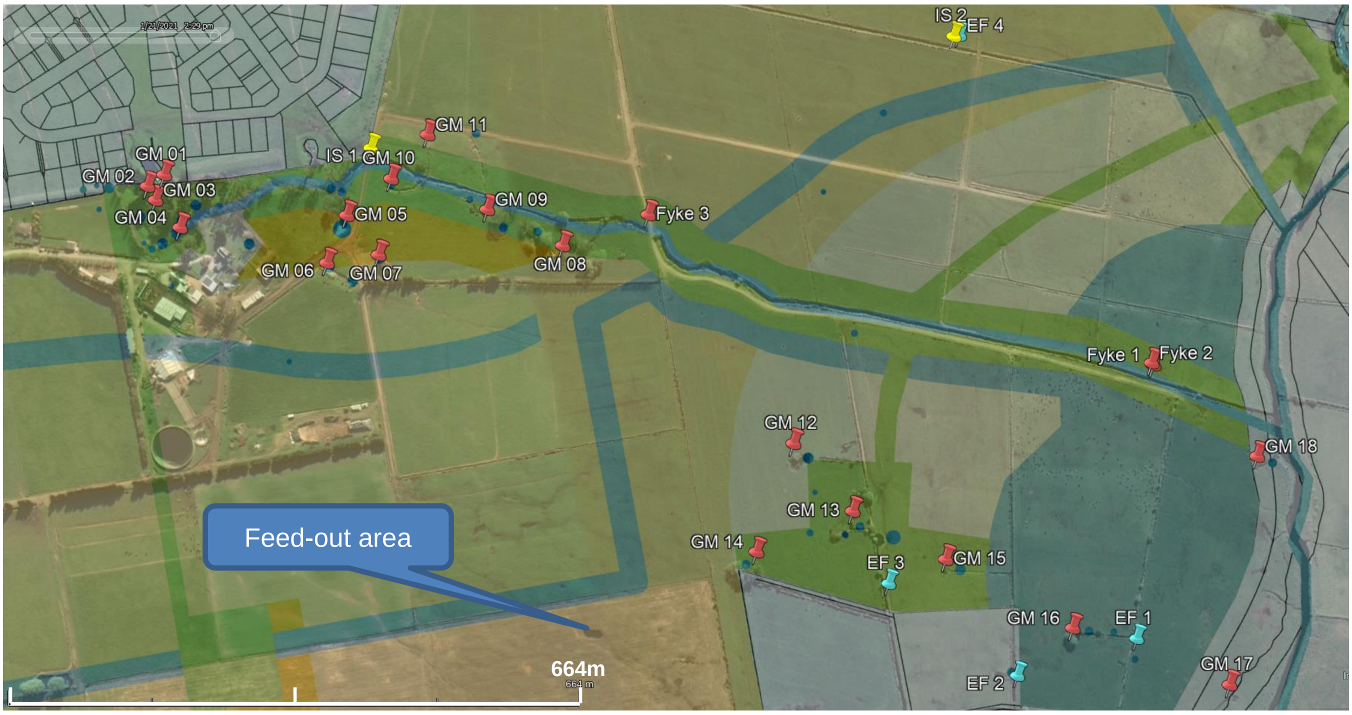

Figure iii. Map showing locations of Gee Minnow™ traps (GM), small fyke nets (Fyke), invertebrate samples (IS) and electric fishing sites (EF). The proposed development plan has been overlaid.

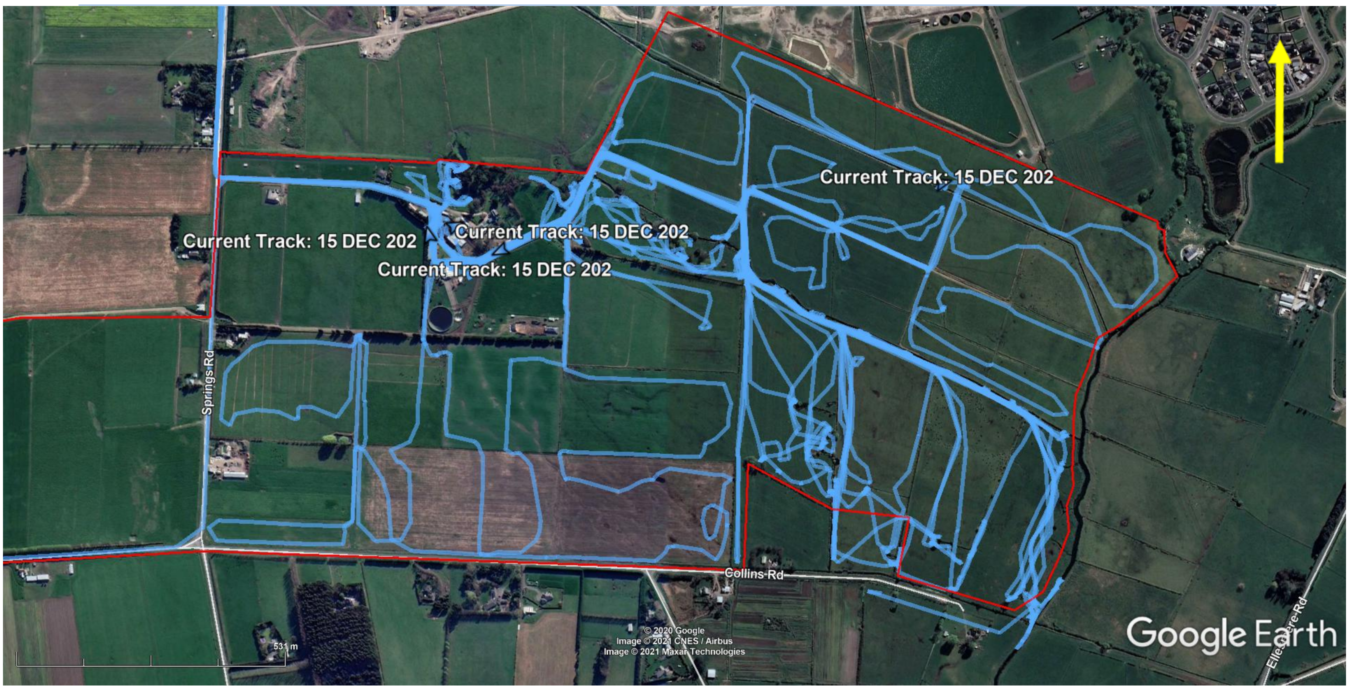

Figure iv. GPS track file for the survey for wetlands.

Figure v. Freshwater mussel (kākahi) survey locations. No mussels were identified during the survey. The LII River was not surveyable at the time of the field investigation.

Figure vi. Spring at site GM 10. The presence of inanga was recorded at this location.

Figure vii. Invertebrate sample location, Spring Creek. Between a culvert and a pumphouse.

Figure viii. Juvenile koura (*Paranephrops zealandicus*) from the Spring Creek invertebrate sample.

Figure ix. Koura caught during electric fishing, measuring 59mm.

Appendix II

- Fish Catch Table

Species	Gee Minnow™ traps	Fyke Nets	Electric Fishing	Total
Upland bully	82		28	110
Common bully	19			19
Unidentified bully	1		3	4
Inanga	15			15
Shortfin eel			1	1
Longfin eel		2	2	4
Koura			1	1
Total	**117**	**2**	**35**	**154**

Appendix III

- Invertebrate Table

	Species	Sample 1, hard substrate	Sample 2, soft substrate
ANNELIDA			
Oligochaeta		24	
Hirudinea		3	
MOLLUSCA			
Gastropoda			
Hydrobiidae	*Potamopyrgus antipodarum*	562	5
Physidae	*Physa acuta*	2	10
Planorbidae	*Gyraulus*		15
Bivalvia			
Sphaeridae	*Pisidium*	2	
CRUSTACEA			
Amphipoda			
Paracalliopidae	*Paracalliope fluviatilis*	104	385
Isopoda			
Idoteidae	*Austridotea*	7	
Decapoda			
Parastacidae	*Paranephrops zelandicus*	2	
Ostracoda		8	6
INSECTA			
Diptera			
Orthocladiinae		20	
Tanypodinae			14
Chironominae	*Tanytarsus*		2
Trichoptera			
Leptoceridae	*Hudsonema amabile*	3	
Hydrobiosidae	*Hydrobiosis*	1	
	Hydrobiosis parumbripennis		1
	Psilochorema	1	
Hydroptilidae	*Oxyethira albiceps*	58	18
Hemiptera			
Corixidae	*Sigara aguta*	2	
Veliidae	*Microvelia*		56
Odonata			
Coenagrionidae	*Xanthocnemis zelandica*		1
Coleoptera			
Dytiscidae	*Liodessus*		1
No. Scoring taxa		15	12
TOTAL No. of animals		799	514
MCI-hb		80.0	68.2