Raglan Wastewater Treatment Plant - Assessment of Effects of Pond Seepage to Land

Prepared for Waikato District Council
Prepared by Beca Limited

1 November 2019

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Contents

Appendices

Revision History

Revision Nº	Prepared By	Description	Date
1	**Garrett Hall**	Draft for client review	25/10/19
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Document Acceptance

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on behalf of	Beca Limited		

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1 Introduction

1.1 Background

The Raglan Wastewater Treatment Plant (WWTP) operated by Waikato District Council (WDC) contains ponds used both for treatment and storage of wastewater and sludge. Seepage of treated wastewater from those ponds to ground may potentially result in groundwater contamination, and eventually contaminate surface water when the groundwater seeps into nearby surface water bodies. Accordingly, under the Resource Management Act 1991 (RMA), a resource consent is being sought under section 15(1)(a) of the RMA for the discharge of treated wastewater from the ponds to land where it may enter water.

Within the Raglan WWTP site, the two anaerobic ponds, the four enhanced ponds (providing aerobic treatment) and storage ponds (including sludge storage ponds) are the potential sources of wastewater seepage to ground. The day pond stores treated wastewater prior to discharge and is lined. A full process description is included in the Assessment of Environmental Effects (AEE). These treatment units are shown in Figure 1.1 below.

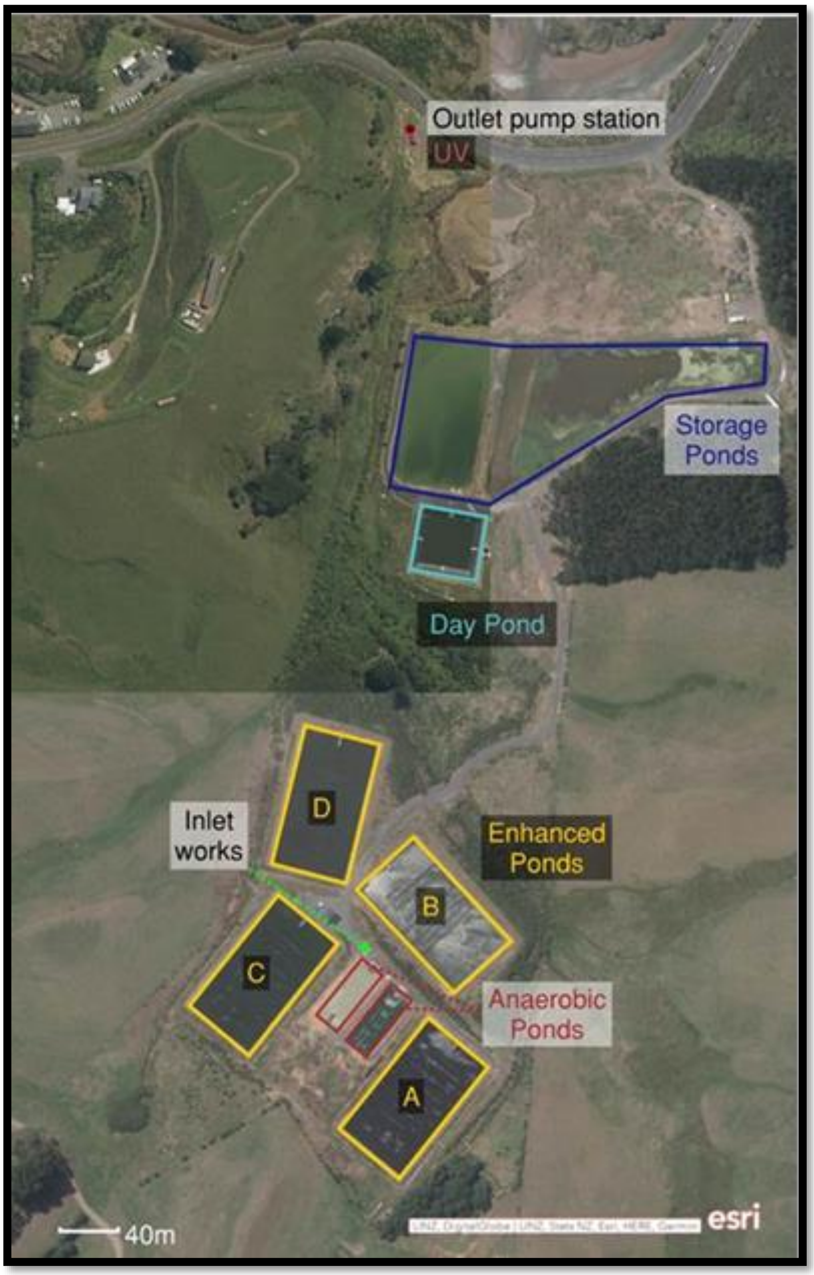

Figure 1.1 Wastewater Treatment Processes at the Raglan Wastewater Treatment Plant

1.2 Description of Treatment Processes

1.2.1 Historic Wastewater Treatment Plant

The Raglan WWTP was originally commissioned in 1977[1] and consisted of two oxidation ponds. The treated wastewater was then pumped to an outfall at the harbour mouth for discharge on the outgoing tide. An aerial photograph showing the ponds as they existed in May 1996 is shown in Figure 1.2.

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[1] Fisher, M. (2014). The Environmental Management of Whāingaroa/Raglan Harbour with a Focus on the Period since 1970. Case-study commissioned by the Waitangi Tribunal for the Wai 898 Te Rohe Potae Inquiry.

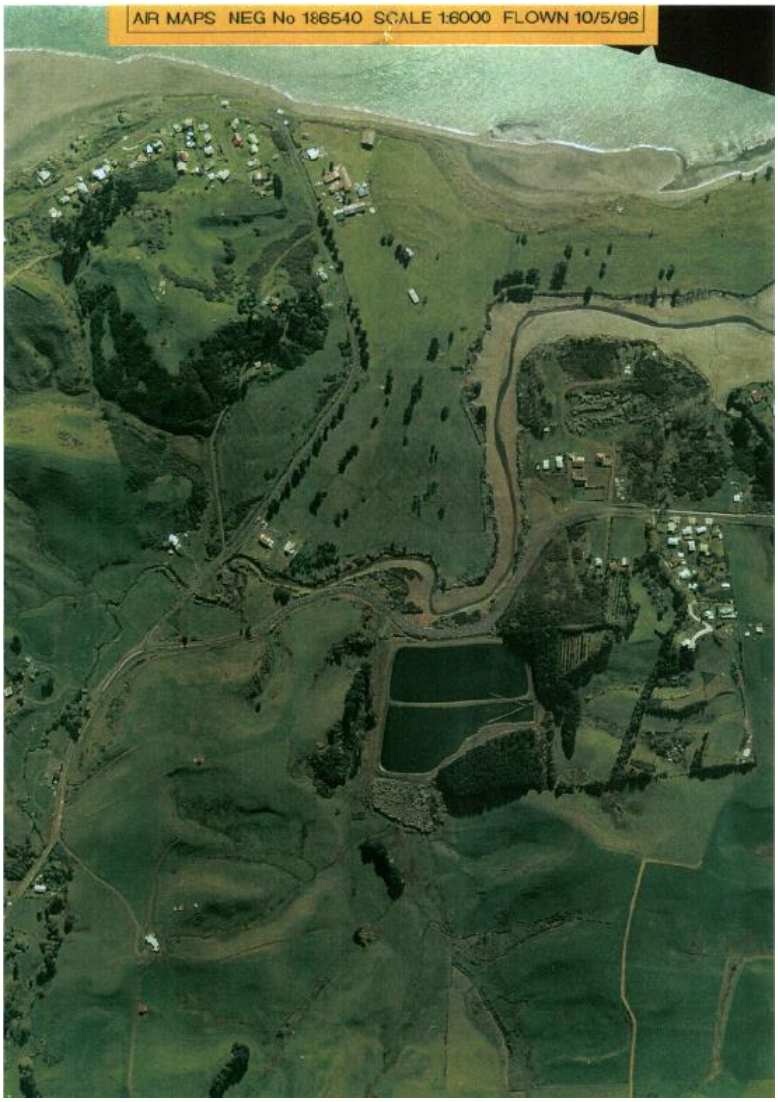

Figure 1.2: Raglan Wastewater Treatment Plant Oxidation Ponds as at May 1996[2]

It is not known whether the original ponds were built with a constructed liner. However, it is assumed they were formed into the underlying natural ground which is dominated by clay soils.

1.2.2 Existing Wastewater Treatment Plant

The WWTP was first upgraded in 2007[3] to the existing multiple stage treatment process and constructed into the hillside at the southern end of the WWTP site.

As part of the Environment Court decision granting the consents required for the WWTP discharges in 2005, WDC agreed to remove the northern most oxidation pond and restore this to tidal estuary. As part of this process, sludge excavated from the northern-most pond originally constructed in 1977 was stored in a section of the southern-most oxidation pond. This historic sludge remains on-site.

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[2] Waikato District Council (1997). Raglan Wastewater Treatment and Disposal System Upgrade. Resource Consents Applications and Assessment of Environmental Effects – Volume 1.

[3] Waikato District Council (2009). Raglan Wastewater Treatment Plant Operation and Maintenance Manual. Prepared by Global Environmental Engineering for Waikato District Council.

For the anaerobic ponds, the O&M manual for the WWTP states that:

> "*The anaerobic ponds are built into the existing clay rich ground. They have been designated Pond 1 and Pond 2. Pond 2 was initially leaking, but work was undertaken to seal it prior to commissioning. Some leakage may still occur for the first year of operation, but experience shows that biological ponds and lagoons self-seal very rapidly once the biological community establishes*."

The O&M manual does not state how the enhanced ponds were constructed, but it is assumed they were constructed in a similar fashion to the anaerobic ponds.

The treated wastewater storage pond was constructed in a refurbished section of the southern-most original oxidation pond. It has a constructed clay base and embankments with rip-rap rock protection against erosion.

The day pond was constructed in 2015 and has an impermeable synthetic liner.

In summary, discharges to land through seepage from on-site treatment processes may include discharges from the following treatment process units:

- Anaerobic ponds – constructed in existing ground;
- Aerobic ponds – constructed in existing ground;
- Treated wastewater storage pond – constructed with a clay liner (western section of storage ponds); and
- Sludge storage pond – constructed in existing ground (eastern section of storage ponds).

2 Description of Receiving Environment

2.1 Site Geology

Beca has undertaken a desk-top review of likely geological conditions at the WWTP site[4]. The site geology is presented in Figure 2-1.

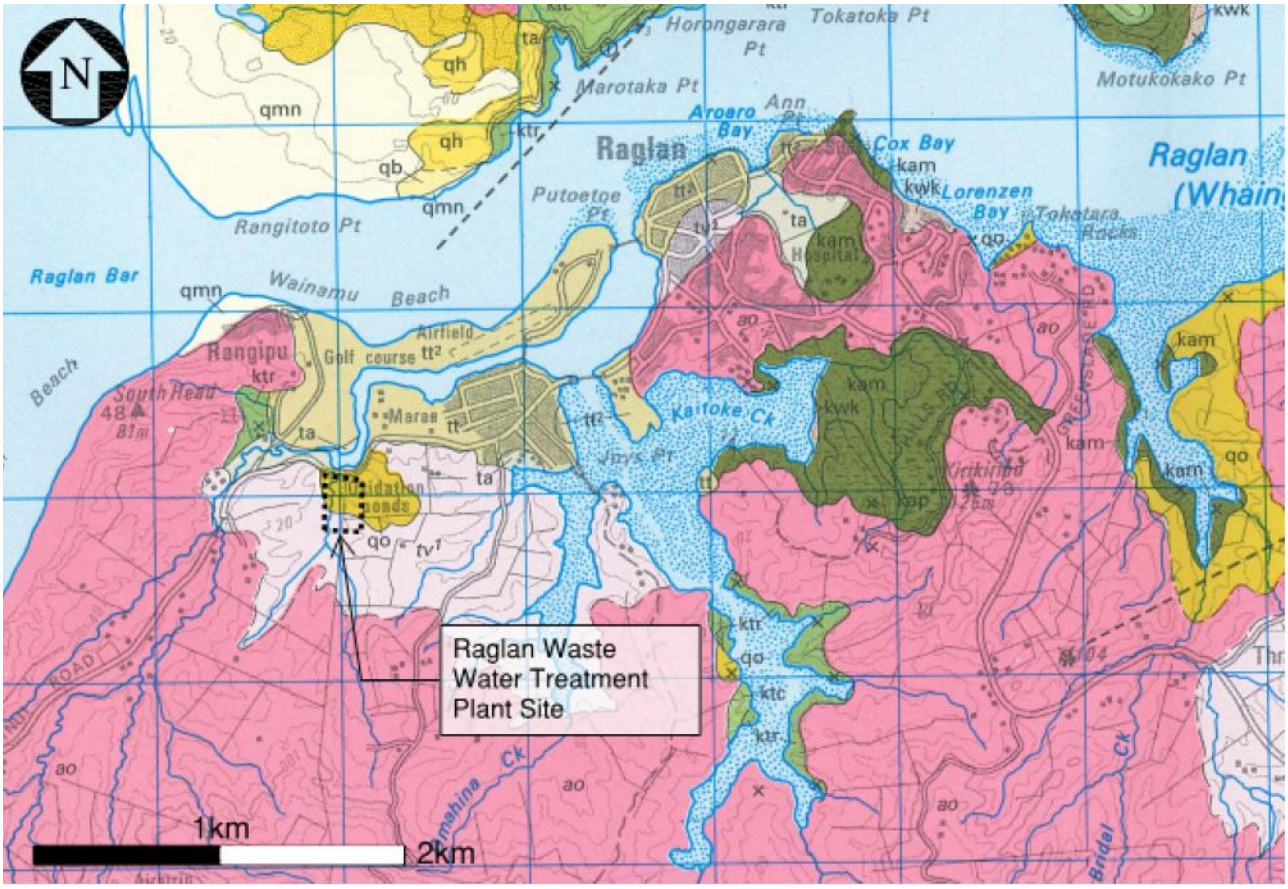

Figure 2.1: Extract from 1:50,000 Geological Map[5]

The site is expected to be underlain by the Haroto Formation (qo) in the base of the valley/estuary. Kauroa Ash Formation (tv1) is expected in the gently sloping hills adjacent and under the southern portion of the WWTP site.

The Haroto Formation comprises interbedded estuarine and terrestrial silts, pumiceous sands, carbonaceous beds with wood and conglomerates of Mid-Pleistocene age (approx. 1 million to 100,000 years ago). The Kauroa Ash formation is clay-rich with silt, pumice and coarse sand of late Pliocene to mid Pleistocene age (approx. 2.5 to 1.5 million years ago).

The surficial material within the pond fill embankments observed during a site visit in August 2019 comprised silt / clay material, with cobbles and gravel of highly weathered siltstone.

[4] Raglan Wastewater Treatment Plant - Treated Wastewater Storage Preliminary Geotechnical Assessment. September 2019.

[5] Waterhouse and White (1994). Published Geological Map.

2.2 Groundwater

Groundwater levels are expected to vary across the WWTP site and will be influenced by tides, existing water level in the unlined ponds, streams and other overland flow. Water levels were observed within the stream adjacent to the west of storage ponds as approximately R.L.1.6m; and within the stream adjacent to the east of the storage ponds as approximately R.L. 5.7m. High tides are typically expected to be up to R.L. 2.2m and recent records of past storm surge levels recorded at Raglan Wharf in January 2018 were around R.L. 2.6m. There are no known users of groundwater locally.

2.3 Surface Water

A water quality and ecology baseline assessment has been undertaken for the streams flowing through the WWTP site (attached as **Appendix A** to this Report). This included a habitat assessment of watercourses within the WWTP site and analysis of water quality samples. Fish records were also reviewed.

The ecological values of the watercourses adjacent to the Raglan WWTP are variable. Steep banks and incised channels are characteristic, particularly in the downstream reaches, reducing floodplain connectivity. Some riparian planting provides shading to the channels, but minimal pools and riffle zones are present, restricting the number of stream habitat types available.

Based on fishing observations within the wider Wainui Stream catchment, native fish species in the site watercourses are likely to include native eels and galaxids. The wetland environment within the WWTP site was identified as a suitable fish spawning area. Overall, the ecological values of the watercourses adjacent to the Raglan WWTP are moderate to low (based on an assessment against the relevant criteria described in the report).

Water quality samples were collected at five sites upstream and downstream of the WWTP ponds as shown in Figure 2.2.

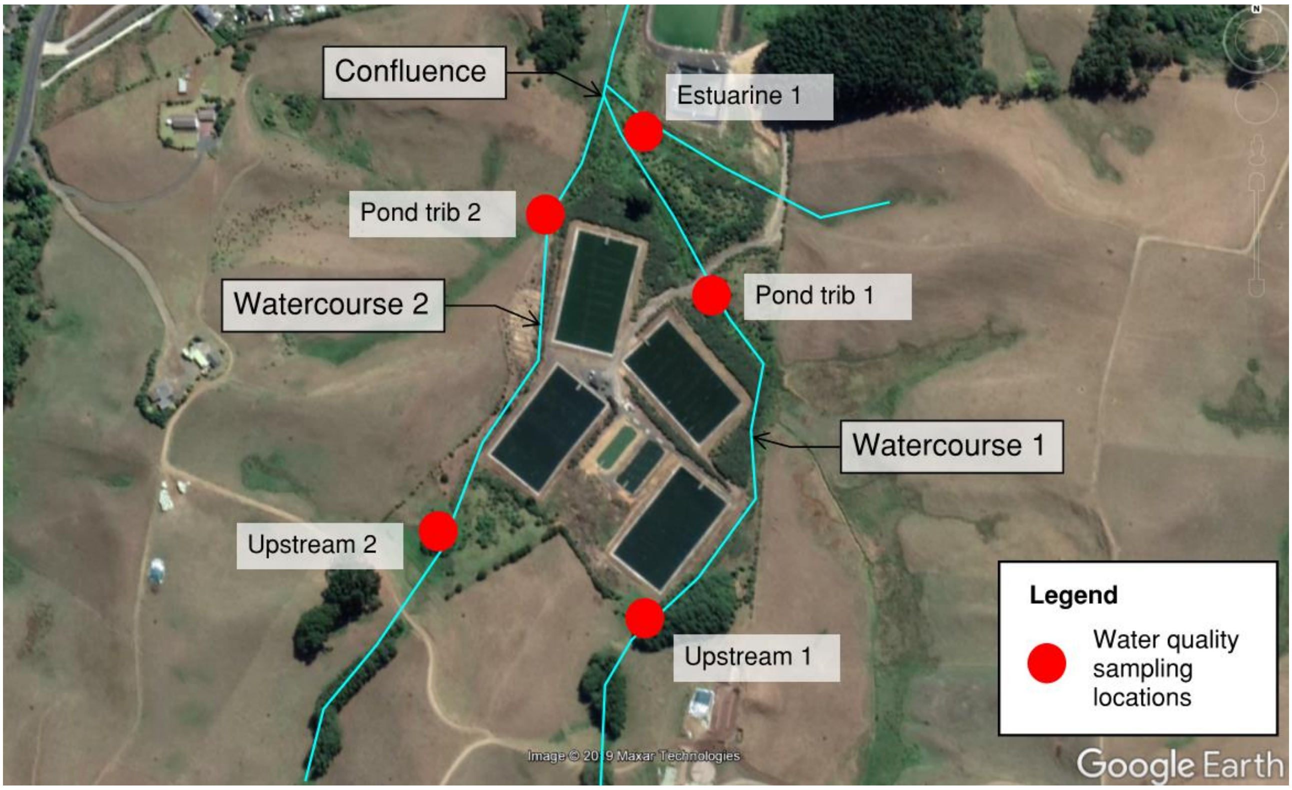

Figure 2.2: Water Quality Sampling Locations

Elevated concentrations of Total Nitrogen (TN) were observed in all samples, both upstream and downstream of the WWTP site as described in Table 2 of that report. This is not unexpected given the surrounding pastoral land use and the high number of water fowl roosting along the banks of the watercourses.

E. coli concentrations exceeded the recreational freshwater guideline value of 550 MPN/100mL in two locations (Upstream 1, Pond Trib 2), although noting that the public do not have access to these sections of the streams. A large number of ducks and other waterfowl were observed roosting along the banks of the streams during water quality sampling, and it is likely that faecal matter from these birds contribute towards the high *E.coli* concentrations.

Concentrations of Total Ammoniacal Nitrogen (NH_4-N) were low in all samples. Bird droppings are high in uric acid (i.e. mostly urine) but usually low in ammonia and nitrate. It can be assumed that any pond seepage is also low as wastewater in the ponds would be expected to have higher concentrations of ammonia.

3 Effects of Seepage on Groundwater and Surface Water

3.1 Storage Ponds (including Sludge Storage Ponds)

The eastern storage pond was converted from the original southern oxidation pond that was in operation since 1977. It is likely that the accumulation of sludge at the bottom of the pond has resulted natural sealing of the pond base to a significant extent. The natural sealing occurs by physical and chemical clogging of the soil pores with fine organic materials and by biological and organic clogging caused from microbial growth on the pond base. Field tests[6] have shown that natural sealing in more permeable soils reduced the leakage rates by a factor, tens to several hundred times and resulted in a permeability of 10^{-8} m/s. As a result of the natural sealing formed at the pond base, the seepage volume of water draining from the eastern storage is expected to be low.

The western storage pond was constructed in 2007 with a clay liner. It has been in operation since that time and is likely to have accumulated sludge at its base. Accordingly, the seepage volume of water is expected to be very low.

3.2 Anaerobic Ponds and Enhanced Ponds

As described in the O&M manual for the site, it is likely that the anaerobic ponds and enhanced ponds were constructed in the clay rich ground that dominates the southern section of the site (Kauroa Ash). Desludging of these ponds has not occurred since that time and it is highly likely that these ponds have a base of sludge which reduces any seepage through the base.

If these ponds were leaking to any significant extent, it is likely that elevated concentrations of NH_4-N would have been observed in the surface waters surrounding the site. Given no elevated concentrations were observed, this provides further evidence that any rates of seepage are low.

3.3 Day Pond

This day pond was constructed with an impermeable liner and is expected to retain all wastewater within it with no seepage to groundwater.

[6] USEPA, 1983.Design Manual: Municipal Wastewater Stabilisation Ponds. U.S. Environmental Protection Agency, Ohio. EPA-625/1-81-013.

4 Summary of Effects

Overall, this assessment shows that the rate of wastewater seepage from the existing ponds is likely to be low given the underlying clay geology and likelihood of the base of the ponds being largely sealed by sludge. In the case of the day pond, which is lined, no seepage is expected.

This likely low level of seepage from the storage ponds, anaerobic ponds and enhanced ponds is expected to have a low adverse effect on surrounding waterways. Potential contaminants of concern from any wastewater seepage relate to ammonia and microbial contaminants (*E. coli*). No evidence of elevated concentrations of ammonia were observed in surface water samples taken from waterways within the site which supports this conclusion. Elevated concentrations of *E. coli* were observed at two surface water sampling locations however, a large number of ducks and other waterfowl were observed roosting along the banks of the streams during water quality sampling. It is likely that faecal matter from these birds contribute towards the high *E.coli* concentrations.

Appendix A – Water Quality and Ecology Baseline Assessment

Raglan Wastewater Treatment Plant - Water Quality and Ecology Baseline Assessment

Prepared for Waikato District Council
Prepared by Beca Limited

1 November 2019

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Revision History

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Document Acceptance

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Prepared by	**Sarah Blair**		1.11.2019
Reviewed by	**Claire Webb**		1.11.2019
Approved by	**Garrett Hall**		1.11.2019
on behalf of	Beca Limited		

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1 Introduction

Beca Limited (Beca) has been commissioned by Waikato District Council (WDC) to undertake a baseline ecological and water quality assessment of the streams located adjacent to the Raglan Wastewater Treatment Plant (WWTP), as shown in Figure 1.

Figure 1. Location of the Raglan WWTP and adjacent streams.

1.1 Background

WDC operate an existing WWTP in Raglan which discharges to the Whāingaroa harbour. The current resource consents for wastewater, air discharges and the outfall structure relating to the Raglan site are due to expire in February 2020. WDC are seeking to obtain a renewed resource consent from WRC in order to authorise short-term discharges from this plant, while concurrently planning for the establishment of a long-term sustainable wastewater treatment solution for the Raglan community.

The purpose of this assessment was to provide an understanding of water quality and current habitat values of the watercourses present adjacent to the Raglan WWTP to support the consent application.

2 Site Description

The subject site is within the Waikato District with pastoral farming forming the predominant land use (Figure 2). The watercourses that run past the Raglan WWTP feed into the Wainui Stream, which flows into the Raglan Harbour. These watercourses form part of a 138ha sub-catchment within the larger 1300ha Waipa Stream catchment (River Environment Classification, MfE data service).

Figure 2. Raglan WWTP and adjacent watercourses in the associated 138ha sub-catchment of the Wainui Stream.

3 Methods

3.1 Habitat Assessment

A habitat assessment of identified watercourses within the Raglan WWTP site was undertaken using the Watercourse Assessment Field Protocol 1: Ecoline Methodology[1]. The extent of each stream reach was determined by changes in linear characteristics (e.g. land use, channel morphology, overhead cover) that are maintained for a significant section downstream from that point. Assessments occurred on 11 September 2019, from mid-morning until mid-afternoon. Weather on the day was overcast, with some light rain. A field sheet was filled in for each reach noting observations of:

- riparian, bank and channel vegetation;
- algal cover;
- erosion and scour areas;
- adjacent land use;
- macrophyte and periphyton cover; and
- potential fish habitat.

3.2 Water Quality

Basic water quality parameters of pH, dissolved oxygen (DO), temperature, conductivity, and turbidity (NTU) were measured at each site using a hand-held meter (YSI ProDSS) at all locations indicated on Figure 3. Grab water samples were also taken at each location as indicated on Figure 3, chilled, and taken to Hill Laboratories at the end of the day for analysis of:

- Total Nitrogen
- Total Ammoniacal-N;
- Nitrite-N;
- Nitrate-N;
- Nitrate-N + Nitrite-N;
- Dissolved Reactive Phosphorus;
- Total Phosphorus;
- E.coli; and
- Chlorophyll a.

3.3 Aquatic Invertebrates and Fish

Records from the New Zealand Freshwater Fish Database (NZFFD) for sites within the same catchment were downloaded. The species recorded within the surrounding area were noted. This data was used to provide contextual information on the environmental conditions and values of the wider catchment rather than the specific reaches assessed in this survey. Literature on aquatic invertebrates for the area and typical of rural streams was also investigated. No native fish or macroinvertebrate surveys of the subject stream reaches were conducted as part of this assessment.

[1] http://www.knowledgeauckland.org.nz/assets/publications/TR2016-002-Watercourse-assessment-methodology-infrastructure-and-ecology-V2.pdf

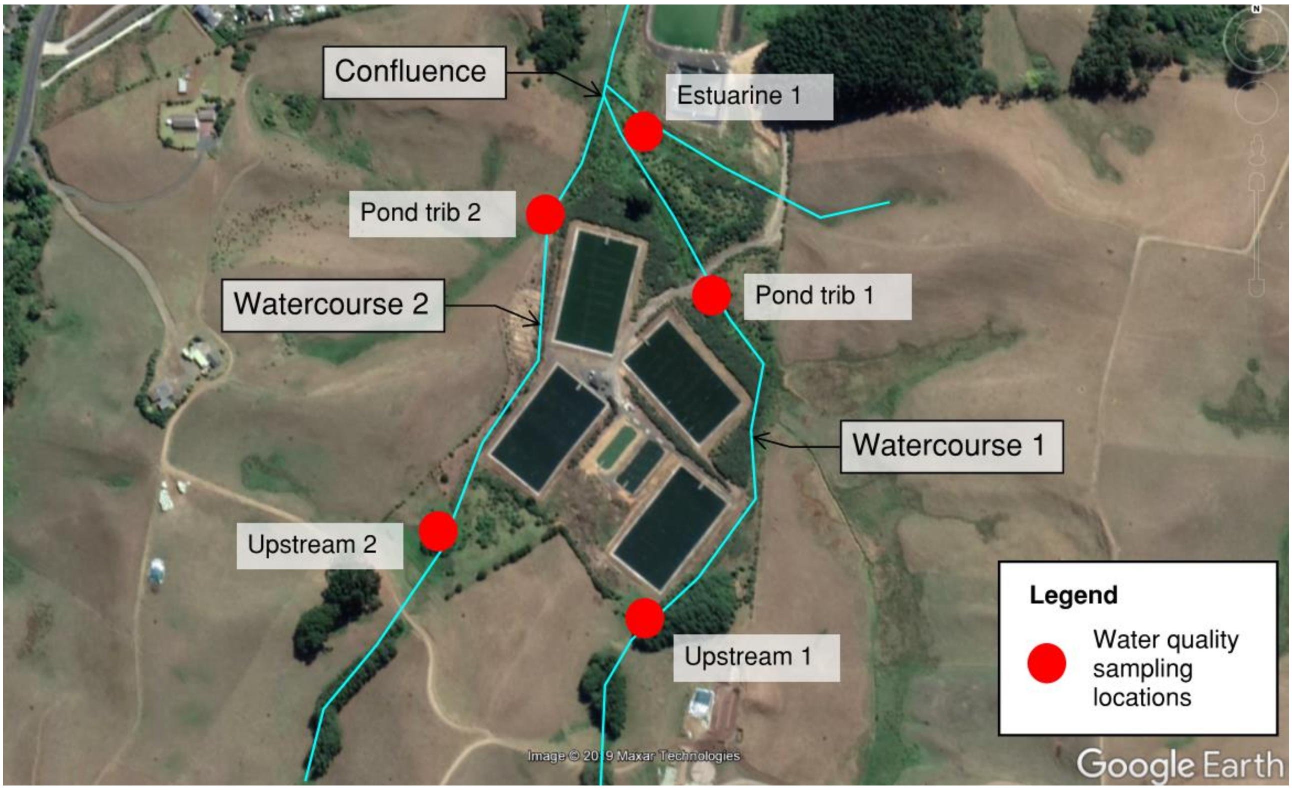

Figure 3. Water quality sampling locations.

4 Results

4.1 Habitat Assessment

The watercourses adjacent to the Raglan WWTP have minimal riparian vegetation and incised channels. A large number of ducks and waterfowl roost on the banks of the channels and adjacent wastewater ponds.

East of the Raglan WWTP (Watercourse 1)

Watercourse 1 flows around the eastern side of the Raglan WWTP (Figure 3), under the access road via a culvert before converging with the western channel. The upper reaches consisted of grassed banks and an overgrown channel with low levels of shading. Further downstream, the riparian margin consisted largely of flax, manuka, and hebe (Figure 4). The stream banks were largely stable, with very minor erosion scars observed in places and fair connectivity to the floodplain along the true right bank. Minimal pools or riffle zones were observed within the channel. The channel has retained some of its natural form but has been straightened to accommodate the wastewater treatment ponds.   Watercourse 1 includes flows from the neighbouring paddocks via ephemeral and intermittent flow paths draining the surrounding farmland.

Figure 4. Watercourse 1: ‘upstream 1’ sampling location (left) and ‘pond trib 1’ sampling location (right).

West of the Raglan WWTP (Watercourse 2)

Watercourse 2 flows around the western side to the Raglan WWTP (Figure 3) and along the boundary of the WWTP site before converging with the eastern channel. The upper reaches consisted of vegetated banks with a free-flowing channel. Shading is patchy along the reach and ranges from high at the upper-most section to low where native plantings are still maturing. A high level of macrophyte cover was observed.

Further downstream, the riparian margin consisted of a mix of native plantings and exotic weeds, including flax, manuka, and hebe (Figure 5). The stream banks were steep in places, with some minor bank slumping observed. Minimal pools or riffle zones were observed within the channel as the stream has been straightened and channelised to accommodate the treatment ponds. A tributary that flows from the neighbouring dairy farm enters Watercourse 2 above the confluence with Watercourse 1.

Figure 5. Watercourse 2: 'upstream 2' sampling location (left) and 'pond trib 2' sampling location (right).

<u>Downstream of the confluence between Watercourses 1 & 2</u>

Downstream of the confluence between Watercourse 1 and Watercourse 2, the channel was very incised with steep banks. Moderate levels of macrophyte and periphyton cover were surveyed. Erosion scars were observed along the banks, including slumping. Minor amounts of debris were present in the channel. Bank vegetation consisted mainly of dense flax, contributing to a high level of channel shading (Figure 6). Gorse and pampas were also present on the upper banks. The surrounding wetland was identified as a suitable fish spawning area.

Figure 6. Downstream of the confluence between Watercourse 1 and Watercourse 2.

4.2 Water Quality

4.2.1 Standards

The Waikato Regional Council (WRC) has water quality guidelines based on national standards and guidelines. Table 1 is provided on the WRC website detailing the water quality guidelines used for the region. The 'satisfactory' category is used as trigger values in this assessment. Where WRC does not provide trigger values, values from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018) and the National Policy Statement for Freshwater Management 2014 Appendix 2 Attribute State B value were used (NPSFW - amended 2017) (within results Table 2).

Table 1. Waikato Regional Council water quality guidelines

Water quality variable (units)	Relevance	Categories		
		Excellent	Satisfactory	Unsatisfactory
Dissolved oxygen (% of saturation)	Oxygen for aquatic animals to breathe	>90	80 – 90	<80
pH (acidity)	Can affect plants and fish	7 – 8	6.5 – 7 or 8 – 9	<6.5 or >9
Turbidity (NTU)	Can restrict plant growth	<2	2 – 5	>5
Total ammonia (g N/m^3)	Toxic to fish	<0.1	0.1 – 0.88	>0.88
Temperature (^{o}C)	Fish spawning May-Sep	<10	10 – 12	>12

	Fish health Oct-Apr	<16	16 – 20	>20
Total phosphorus (g/m^3)	Causes nuisance plant growth	<0.01	0.01 – 0.04	>0.04
Total nitrogen (g/m^3)	Causes nuisance plant growth	<0.1	0.1 – 0.5	>0.5
Human uses - recreation				
Baseflow water clarity (m)	Visibility	>4	1.6 - 4	<1.6
Escherichia coli, single sample (no./100mL)	Human health	<55	55 - 550	>550

4.2.2 Results

A results summary for the water quality of the streams adjacent to the Raglan WWTP is presented in Table 2 below. Original laboratory reports are provided in **Appendix A**.

Table 2. Results of water sampling adjacent to the Raglan WWTP.

	Upstream 1	Pond Trib 1	Upstream 2	Pond Trib 2	Estuarine 1	Guideline Values[2]
Field Measurements						
Temperature (°C)	**14.6**	**14.4**	**14.3**	**14.9**	**14.1**	**<12**
Dissolved Oxygen (mg/L)	9.4	9.55	8.34	9.93	9.05	**>7.0[4]**
Dissolved Oxygen (%)	93	93.6	81.5	98.2	88.2	**>80**
Specific Conductivity (µs/cm)	**185.6**	**173.4**	**162.9**	**170.1**	**183.1**	**<115[3]**
pH	8.1	7.4	6.9	7.5	7.4	**6.5 – 9**
Turbidity (NTU)	**7.9**	2.0	2.4	3.0	3.0	**<5**
Salinity	0.06	0.08	0.08	0.08	0.09	**-**
Lab Analysis[1]						
Total Nitrogen	**2.2**	**0.95**	**1.19**	**1.19**	**0.98**	**<0.5**
Total Ammoniacal-N	0.083	0.019	0.063	0.022	0.018	**<0.88**
Nitrite-N	0.025	0.005	0.008	0.008	0.004	**-**
Nitrate-N	1.82	0.66	0.92	0.84	0.62	≤ **2.4[4]**
Nitrate-N + Nitrite-N	**1.84**	**0.66**	**0.93**	**0.85**	**0.63**	**<0.5[5]**
Dissolved Reactive Phosphorus	**0.02**	< 0.004	0.009	0.009	0.007	**<0.014[3]**
Total Phosphorus	**0.094**	0.02	0.036	**0.102**	0.03	**<0.04**
Escherichia coli (MPN/100mL)	**700**	350	460	**1,600**	350	**<550**

Results in **Bold** denote exceedance of the guideline

[1]all units below are in g/m^3 unless otherwise specified

[2]Guideline values are from WRC ('unsatisfactory' values in Table 1) unless otherwise noted

[3]Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018) using the 80th percentile for warm-

wet, low elevation

[4]National Policy Statement for Freshwater Management 2014 (amended 2017) Appendix 2 Attribute State B value

[5]Total Nitrogen WRC guideline value used here as NNN makes up a significant portion of total nitrogen.

The water quality results are reflective of waterways within the Waikato region[2]. Elevated concentrations of nitrogen are ubiquitous in waterways around Waikato, and generally far exceed the WRC guidelines. The WRC total nitrogen guideline value is 0.5 g/m^3, Nitrate-N + Nitrite-N (NNN) contributes to total nitrogen (along with TKN). Concentrations of NNN exceed this guideline on its own, indicating that total nitrogen would be far exceeding the 'satisfactory' guideline. This is not unexpected given the surrounding pastoral land use and the high number of waterfowl roosting along the banks of the watercourses.

E.coli levels exceeded the recreational guideline value of 550 MPN/100mL in two locations (Upstream 1, Pond Trib 2). A large number of ducks and other waterfowl were observed roosting along the banks of the streams during water quality sampling, and it is likely that faecal matter from these birds contribute towards the high E.coli levels. Waterfowl faeces also contain high amounts of phosphorus, and total phosphorus exceedences were observed in the same sampling locations as the E.coli exceedences (Upstream 1, Pond Trib 2).

Temperature and dissolved oxygen (DO) experience diurnal and seasonal fluctuations. Water temperature was warm (14.3 – 14.9°C) at the time of sampling, creating unsatisfactory conditions for fish spawning. However, the sampling was undertaken in mid-September at the end of the fish spawning season and overall the temperatures were low enough to maintain habitat quality for tolerant native fish species. Nevertheless, the minimal riparian habitat, particularly in the upstream reaches, will mean that water temperatures may exceed thermal tolerances during the summer months, especially where channel depths are shallower. Dissolved oxygen levels were within recommended guideline values. During summer, DO diurnal fluctuations would be expected to be greater due to anticipated macrophyte growth and temperature changes.

4.3 Aquatic Invertebrates and Fish

While invertebrate and fish surveys were not undertaken, data from the New Zealand Freshwater Fish Database (NZFFD) was downloaded and used along with the habitat assessment to determine the likely community present within these stream reaches.

The NZFFD did not have on record any fishing observations within the 138ha catchment that the site watercourses form a part of. However, a number of fishing observations by Waikato Regional Council (WRC) in 2013 were recorded in the Wainui Stream approximately 1km upstream of the confluence where the watercourses that flow past the Raglan WWTP join the Wainui Stream, as detailed in Table 3. A number of these have a conservation status of 'declining'[3].

Of note, the presence of a number of species in the Galaxias family were observed. Many galaxids have a conservation status of 'nationally critical' or 'nationally endangered' and while none of these threatened species were observed by WRC, their presence in the Wainui Stream catchment cannot be ruled out.

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[2] WRC technical report TR2017/33 titled 'Regional rivers water quality monitoring programme: Data report 2016'

[3] Dunn, N.R., Allibone, R.M., Closs, G.P., Crow, S.K., David, B.O., Goodman, J.M., Griffiths, M., Jack, D.C., Ling, N., Waters, J.M., and Rolfe, J.R. (2017). *Conservation status of New Zealand freshwater fishes*. New Zealand Threat Classification Series 24. Department of Conservation, Wellington. 11 p.

No incidental fish observations were recorded during the watercourse assessment. Visual observations by Fish and Game circa 2017 identified inanga present in the drains adjacent to the Raglan WWTP (**Appendix B**). Based on these records and the connectivity of the catchment, fish species in the subject site watercourses are likely to include native eels, galaxids, and pest fish.

Table 3: NZFFD fishing observations in the Wainui Stream approximately 1km upstream of the confluence of Watercourses 1 & 2

Species	Common name	Number	Conservation status
Paranephrops spp.	Koura	54	Data deficient
Anguilla spp.	Unidentified eel	12	At risk/not threatened
Paratya curvirostris	Freshwater shrimp	-	Not threatened
Galaxias maculatus	Inanga	2	At risk - declining
Galaxias argenteus	Giant kokopu	1	At risk - declining
Galaxias fasciatus	Banded kokopu	6	Not threatened
Anguilla australis	Shortfin eel	1	Not threatened
Anguilla dieffenbachii	Longfin eel	-	At risk - declining
Gobiomorphus huttoni	Redfin bully	82	Not threatened

4.4 Erosion and Scour

Minimal erosion and scour present within the streams or on the banks. Some minor bank slumping was observed in Watercourse 2 and downstream of the confluence point.

5 Summary of Stream Ecological Values

The ecological values of the watercourses adjacent to the Raglan WWTP are variable. Steep banks and incised channels are characteristic, particularly in the downstream reaches, reducing floodplain connectivity. Some riparian planting provides shading to the channels, but minimal pools and riffle zones are present, restricting the number of stream habitat types available. Additionally, the large number of waterfowl roosting along the banks are likely to contribute towards reduced water quality. Based on fishing observations within the wider Wainui Stream catchment, native fish species in the subject site watercourses are likely to include native eels and galaxids. The wetland environment near the confluence of the two subject watercourses was identified as a suitable fish spawning area. Overall, the ecological values of the watercourses adjacent to the Raglan WWTP are moderate to low.

6 Enhancement Opportunities

Key enhancement opportunities (in order of priority) include: riparian planting, stream enhancement and waterfowl control/deterrents.

Riparian planting will result in locally significant improvements to the habitat values by reducing temperature and longer term, increase woody debris inputs. Riparian restoration will also assist in mitigating the effects of nutrient and sediment run-off from adjacent paddocks. Removal of weed vegetation species, including gorse, will prevent these plants outcompeting preferred native riparian plants.

Stream enhancement opportunities may involve creating a more diverse range of water depths and velocities in the streams. This could be achieved by using rock formations to create pools and riffle zones within the stream channels.

Ongoing control of the prolific waterfowl species should be considered to manage populations in the area and improve water quality.

A

Appendix A – Hill Laboratories Lab Reports

Hill Laboratories
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Certificate of Analysis

Client:	Beca Limited	**Lab No:**	2239794 SPv1
Contact:	Claire Webb	**Date Received:**	11-Sep-2019
	C/- Beca Limited	**Date Reported:**	19-Sep-2019
	PO Box 6345	**Quote No:**	100975
	Wellesley Street	**Order No:**	4286014/501/01
	Auckland 1141	**Client Reference:**	19:176
		Submitted By:	Claire Webb

Sample Type: Aqueous

Sample Name:		Upstream 1 11-Sep-2019 11:05 am	Pond Trib 1 11-Sep-2019 1:20 pm	Upstream 2 11-Sep-2019 12:15 pm	Pond Trib 2 11-Sep-2019 12:49 pm	Estuarine 1 11-Sep-2019 1:40 pm
Lab Number:		2239794.1	2239794.2	2239794.3	2239794.4	2239794.5
Total Nitrogen	g/m^3	2.2	0.95	1.19	1.19	0.98
Total Ammoniacal-N	g/m^3	0.083	0.019	0.063	0.022	0.018
Nitrite-N	g/m^3	0.025	0.005	0.008	0.008	0.004
Nitrate-N	g/m^3	1.82	0.66	0.92	0.84	0.62
Nitrate-N + Nitrite-N	g/m^3	1.84	0.66	0.93	0.85	0.63
Dissolved Reactive Phosphorus	g/m^3	0.020	< 0.004	0.009	0.009	0.007
Total Phosphorus	g/m^3	0.094	0.020	0.036	0.102	0.030
Escherichia coli	MPN / 100mL	700	350	460	1,600	350
Chlorophyll a	g/m^3	0.005	< 0.003	0.004	< 0.003	< 0.003

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.
Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	**Method Description**	**Default Detection Limit**	**Sample No**
Total Nitrogen Digestion	Caustic persulphate digestion. APHA 4500-N C 23rd ed. 2017.	-	1-5
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-5
Total Nitrogen	Alkaline persulphate digestion, automated Cd reduction/sulphanilamide colorimetry. APHA 4500-N C & 4500-NO_3^- I (modified) 23rd ed. 2017.	0.010 g/m^3	1-5
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) 23rd ed. 2017.	0.010 g/m^3	1-5
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) 23rd ed. 2017.	0.002 g/m^3	1-5
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N. In-House.	0.0010 g/m^3	1-5
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) 23rd ed. 2017.	0.002 g/m^3	1-5
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) 23rd ed. 2017.	0.004 g/m^3	1-5
Total Phosphorus	Total phosphorus digestion, ascorbic acid colorimetry. Discrete Analyser. APHA 4500-P B & E (modified from manual analysis and also modified to include a reductant to reduce interference from any arsenic present in the sample) 23rd ed. 2017. NWASCO, Water & soil Miscellaneous Publication No. 38, 1982.	0.004 g/m^3	1-5
Escherichia coli	MPN count in LT Broth at 35°C for 48 hours, TBX or EC MUG Broth at 44.5°C for 24 hours. APHA 9221 B & F (modified if TBX method used) 23rd ed. 2017.	2 MPN / 100mL	1-5
Chlorophyll a	Acetone extraction. Spectroscopy. APHA 10200 H (modified) 23rd ed. 2017.	0.003 g/m^3	1-5

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The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental

B

Appendix B – Fish & Game correspondence

Sarah Blair

From: Adam Daniel <ADaniel@fishandgame.org.nz>
Sent: Friday, 27 September 2019 12:15 p.m.
To: Sarah Blair
Subject: RE: Potential whitebait habitat at Raglan WWTP site

Sarah

I conducted weekly bird control at this site in 2015-2017 and visually observed Inanga in the drain next to the ponds on many occasions. The drain is very small, so they are easy to see. I have never been to the site at night to look for other species, but they are probably there. I work in Raglan on Wednesdays so if you need me to point them out I am happy to pop out there to assist. You could probably get them with a dip net but a Gminnow trap or spotlight would work better. There are plenty of fish bios out that way if you need to get a survey done.

Adam Daniel, PhD
Fisheries Manager
Fish & Game New Zealand
Auckland/Waikato Region
156 Brymer Rd.
RD 9
Hamilton 3289
Cell (022) 030 9033
Office (07) 849 1666

From: Sarah Blair <Sarah.Blair@beca.com>
Sent: Friday, 27 September 2019 11:52 AM
To: Adam Daniel <ADaniel@fishandgame.org.nz>
Cc: Claire Webb <Claire.Webb@beca.com>
Subject: RE: Potential whitebait habitat at Raglan WWTP site

Hi Adam,

Thanks for your call. Just confirming, you identified Inanga in this area during a hunting trip in circa 2017 (visual observations) but no surveys have been undertaken.

Cheers,
Sarah

From: Adam Daniel <ADaniel@fishandgame.org.nz>
Sent: Friday, 27 September 2019 11:40 a.m.
To: Sarah Blair <Sarah.Blair@beca.com>
Subject: RE: Potential whitebait habitat at Raglan WWTP site

Sarah

There are lots of Inanga in the drains shown on the map.

Hunting and Fishing

September 26, 2019

The sludge pond is also an incredibly productive wetland.

Adam Daniel, PhD
Fisheries Manager
Fish & Game New Zealand
Auckland/Waikato Region
156 Brymer Rd.
RD 9
Hamilton 3289
Cell (022) 030 9033
Office (07) 849 1666

From: Sarah Blair <Sarah.Blair@beca.com>
Sent: Friday, 27 September 2019 11:12 AM
To: Adam Daniel <ADaniel@fishandgame.org.nz>

Cc: Claire Webb <Claire.Webb@beca.com>
Subject: Potential whitebait habitat at Raglan WWTP site

Hi Adam,

I understand that Fish and Game have indicated that there is a potential whitebait habitat at the Raglan WWTP site.

Do you have any further information, data, or maps that you could supply to inform a baseline ecological assessment of the site?

Ngā mihi | Kind Regards

Sarah Blair
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