BEFORE THE INDEPENDENT COMMISSIONER
APPOINTED BY THE SOUTHLAND REGIONAL COUNCIL

Under	The Resource Management Act 1991
And	
In the matter of	a resource consent application by ES Catchment Management Division to dam and divert coastal waters and to occupy the coastal marine area with tide-gates and a weir upstream of the Titiroa River
Application No.	Southland Regional Council: APP-20211135

STATEMENT OF EVIDENCE OF JANE BOWEN (FRESHWATER) ON BEHALF OF THE DIRECTOR-GENERAL OF CONSERVATION

Dated 22 August 2024

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Introduction

1. My full name is Jane Elizabeth Bowen.

2. I have been asked by the Director-General of Conservation (DGC) to provide ecological/technical evidence on the potential effects on fish passage and īnanga spawning of the proposal.

Qualifications and experience

3. I am employed by the Department of Conservation as a Freshwater Technical Advisor for the national freshwater species team. I have worked for the Department of Conservation (DOC) since August 2016 in a variety of roles including Community Ranger (focussing on processing RMA affected party approvals on behalf of DOC) and Senior Ranger/Supervisor Awarua Waituna Wetlands (planning and implementing the freshwater restoration programme). I have also completed a secondment to The Nature Conservancy NZ as Senior Conservation Advisor, leading feasibility of TNC's freshwater work programme in 2019.

4. My qualifications are a Bachelor of Science in Biological Sciences (2009) and a Postgraduate Diploma in Ecology (2013), both from the University of Canterbury, and a Masters in Environmental Management (distinction) from Massey University (2016). I completed the "*New Zealand fish passage workshop for fish passage identification, design and construction*" run by NIWA, Australasian Fish Passage Services and Charles Sturt University, in June 2024 as professional development.

5. I have worked in my current role for four years, and as part of this role I provide advice and support on a vast range of freshwater conservation topics. I work mainly within DOC's Ngā Ika e Heke/ Freshwater Migratory Species Programme, a programme which focuses on improving the security of four migratory species, including īnanga, lamprey/kanakana, longfin eel and shortjaw kōkopu. I am functional species lead for lamprey/kanakana, and was previous species lead for īnanga. As part of this I also work within DOC's fish passage workstream, my involvement of which includes providing advice, support and direction, creation of and maintenance of fish passage guidance/resources, and assessment of fish passage related applications. I was a member of the DOC team providing review on the latest version of the New Zealand Fish Passage Guidelines, due to be released next month. I also work within DOC's Ngā Awa/River catchment

programme, which has included catchment wide fish passage assessments, and īnanga spawning surveys.

Code of Conduct

6. I confirm that I have read the code of conduct for expert witnesses as contained in clause 9 of the Environment Court's Practice Note 2023 (the Code). I have complied with the Code when preparing my written statement of evidence and will do so when I give verbal evidence before the Independent Commissioner. Although I note this is a Council hearing, I agree to comply with this code.

7. The data, information, facts and assumptions I have considered in forming my opinions are set out in my evidence to follow. The reasons for the opinions expressed are also set out in the evidence to follow. This includes, where relevant:

   a. why other alternative interpretations of data are not supported;

   b. any qualification if my evidence may be incomplete or inaccurate without such qualification;

   c. any knowledge gaps and the potential implication of the knowledge gap;

   d. if my opinion is not firm or concluded because of insufficient research or date or for any other reason;

   e. an assessment of the level of confidence and the likelihood of any outcomes specified in my conclusion.

8. Unless I state otherwise, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Scope of evidence

9. I have been asked to provide evidence in relation to the notified consent and the DGC's submission on the potential effects on freshwater conservation values of the proposal by Environment Southland (ES) Catchment Management Division to dam and divert coastal waters and to occupy the coastal marine area with tide-gates and a weir upstream of the Titiroa River.

10. My evidence addresses the following issues:

    a. Significant indigenous freshwater values of the area;

b. Potential adverse effects of the Titiroa tide gates, dam and diversion channel on fish passage;

c. Potential adverse effects of the Titiroa tide gates, dam and diversion channel on Fish passage īnanga spawning; and

d. Recommendations to address the adverse effects relating to the Titiroa tide gates, dam and diversion channel on both īnanga spawning and fish passage.

Material Considered

11. The key material that I have relied on in forming my opinions is listed/described/references are provided in **Appendix 1**.

12. I have read the following:

a. Resource consent application for continued occupation of the coastal marine area associated with Titiroa tide gate infrastructure and dam and divert water. Produced by WSP for Environment Southland (Lodged 8 March 2021).

b. Titiroa River tide gates fish survey and velocity profiles. Produced by Pattle Delamore Partners Ltd (PDP) for Environment Southland and included as appendix B with the original resource consent application. February 2021 (referred to in the body of this document as PDP 2021)

c. Titiroa tide gates – mitigation options. Produced by Pattle Delamore Partners Ltd (PDP) for Environment Southland. November 2022 (referred to in the body of this document as PDP (2022).

d. APP-20211135 Titiroa tide gates resource consent application -response to RFI. Produced by Luke McSoriley. 11 November 2022.

e. Titiroa tide gate positive effects. Produced by Colin Young. June 2023.

f. s95-95g recommending report APP-20211135. 9 August 2023.

g. s42A hearing report and appendices APP-20211135. 30 August 2024

h. Evidence in Chief of Laura Rose Drummond for Southland Regional Council, 16 August 2024

i. Evidence in Chief of Mathew James Gardner for Southland Regional Council, 16/08/2024

j. Submissions on the application from:

- Te Ao Marama Inc. on behalf of Ngā Rūnanga
- Fish & Game New Zealand
- Frisby, Les
- Golden, Phillip & Leigh
- Holms, Alexander
- Morton, Kerry
- Roger McNaughton on behalf of Southland Recreational Whitebaiters Association

13. I have undertaken site visits, including 2 site visits on the 10th of August, to view the structures at both low and high tide conditions.

Executive Summary

14. The Titiroa stream is home to a number of native migratory freshwater species that need to move between both freshwater and marine environments to complete their lifecycle. The tide gates, dam and diversion channel impact significantly on freshwater fish values and passage within this catchment. This includes preventing the passage of fish when they are closed, which occurs for approximately half of every tide cycle, and there is also likely adverse impacts on passage of some species and life stages even when they are open due to the velocity found within the diversion channel. In my opinion the Titiroa tide gates also likely impact detrimentally on īnanga spawning at this location.

15. All tide gates are considered barriers to fish passage, however, the Titiroa tide gates are an outdated passive tide gate design, that open and close passively dependent on the tide. The New Zealand Fish Passage Guidelines state that best practice, where tide gates are required, is the installation of active tide gates, which only close once water levels reach a critical level. Self-regulating (sometimes known as fish friendly) tide gates are considered minimum standard, and rely on a stiffener or counterweight, holding the gate open for a longer period of time, which allows for greater fish passage. Insufficient information, consideration or feasibility has been given to assessing these, or other alternative options, to improve fish passage in the Titiroa.

16. To mitigate against the impact of īnanga spawning various mitigation/off setting has been proposed by way of potential habitat restoration, however, I consider this proposed mitigation/offsetting to be insufficient. There is limited information provided on the location, methods or feasibility of these restorations, and there is potential underestimation of the area needed to be restored. No mitigation was proposed for the adverse effects of the structure on fish passage in the original application.

17. I provide recommendations to address the adverse effects relating to the Titiroa tide gates including:

    a. In an ecological sense, removing the structures would resolve the adverse impacts on fish passage and īnanga spawning

    b. However, if the gates are required in the present location, then I recommend:

        - Full feasibility, design and implementation of a fish passage design that is consistent with the New Zealand Fish Passage Guidelines, taking into account the hierarchy of fish passage solutions for tide gates listed in the guidelines, should a tide gate structure be conclusively shown to be required at this site and:
        - Reconsideration of the area needed to be off set or mitigated against, identification of these sites, and feasibility of īnanga spawning restoration given issues identified with proposed sites
        - Further investigations in regards to īnanga spawning, given current inconsistencies and uncertainties, to inform mitigation/offsetting and future management
        - Monitoring and reporting to further understand the impacts of the structure, ensure maintenance long term, and to inform any subsequent improvements once a fish passage solution is implemented

Context of application and observation at site visit

18. The application is for three passive side hung tide gates located within a diversion channel off the main stem of the Titiroa Stream, with the main stem dammed by the construction of, what is described as an “earth dam weir” or “weir” in the

application. The gates close on an incoming tide and open on an outgoing tide. The application states that the gates are reported to be open at least 50% of the time, the PDP (2022) report noted that on a site visit they observed that the gates were open for 51% of the 12.5 hour tide cycle. The applicant states that the purpose of the gates is to provide for ongoing drainage capability and to prevent flooding of the surrounding low lying farmland.

19. The set up of the structures is unusual. Generally, tide gates are located in the main stem of the waterway, however, at the Titiroa, a diversion channel has instead been created which is where the tide gates are situated (marked “B” in figure 1), with the flow in the main stem of the Titiroa dammed. The application refers to this dam (marked “A” in figure 1) as a “weir” in the application, however, in my evidence I will refer to this as a dam. This been built across the main channel of the Titiroa, which would exclude all fish passage under most conditions (unless overtopped) and results in fish seeking to migrate upstream having to instead navigate the diversion channel. The diversion channel could essentially be seen as a fish facility around the embankment; however, it does not provide effective fish passage due to the presence of the tide gates. The diversion channel itself may also represent a fish passage barrier due to potential high velocities being present due to the constriction of flow. I consider that the tide gates, diversion channel and the embankment contribute to impacts on fish passage, and īnanga spawning, and outline this in my evidence below.

Figure 1 The Titiroa tide gates, diversion and dam/weir

20. A site visit close to high tide, on the 10th of August, showed the gates completely closed (figure 2). No passage would be provided for fish at this point. While there was some leakage of waters around the hinge side of each of the three gates, these gaps would not be large enough to provide fish passage. No wetted areas, or flow over the structure, which would be required to allow passage for fish with climbing abilities, were seen over or around the structure. The angles/edges of the structure would likely exclude climbing opportunities for species such as lamprey. The visit was repeated close to low tide, when the gates were open (figure 3).

Figure 2 Photo of Titiria tide gates, close to high tide, taken on a site visit on 10th August 2024, standing on true right bank of diversion channel, downstream of the tide gates

Figure 3 Photo of Titiria tide gates, close to low tide, taken on a site visit on 10th August 2024, looking across the diversion channel while standing on the true left bank

Significant freshwater conservation values at site

21. Titiroa stream is a lowland stream located within the Southland plains. The Titiroa stream flows into Toetoes Harbour, which represents the eastern extent of the Awarua Waituna Wetlands complex. The Awarua Waituna wetlands is one of the largest remaining wetland complexes in New Zealand and is designated as having international significance under the Ramsar Convention. The Titiroa stream also comprises a popular whitebait fishery.

22. While there has been limited survey work carried out within the catchment, species identified in the New Zealand Freshwater Fish Database (NZFFD) include īnanga (*Galaxias maculatus*; at risk – declining), giant kōkopu (*Galaxias argenteus*; at risk – declining), common smelt (*Retropinna retropinna*; not threatened), longfin eel (*Anguilla dieffenbachii*; at risk – declining), shortfin eel (*Anguilla australis*; not threatened), redfin bully (*Gobiomorphus huttoni*; not threatened), common bully (*Gobiomorphus cotidianus*; not threatened), unidentified flounder, perch (*Perca fluviatilis*; introduced and naturalised), and brown trout (*Salmo trutta*; introduced and naturalised). Further up in the catchment eDNA has indicated the presence of Gollum galaxias (*Galaxias gollumoides*; threatened – nationally vulnerable) and kōaro (*Galaxias brevipinnis*; at risk – declining). Mr Alexander Holms provides evidence in his submission opposing the application, that lamprey (*Geotria australis*; threatened – nationally vulnerable) and yellow eyed mullet (not threatened) were also present before the tide gates were installed in their present form (Holms, 2023). Lamprey have been recorded in adjacent catchments in the NZFFD, so it is likely they may also be present in the Titiroa, however, they often evade traditional capture methods. This catchment is important habitat for at risk or threatened freshwater fish.

23. There is significant freshwater habitat extent upstream of the Titiroa tide gates. For example, measurements using GIS predictive models (Leathwick et al., 2010) indicate that the total extent of available īnanga habitat upstream of the tide gates totals approximately 100 km as shown in figure 4. Probability of capture models (Leathwick et al., 2008) indicate that there is habitat upstream of the gates particularly suitable for īnanga, longfin eel, shortfin eel and common bully as shown in Figure 5.

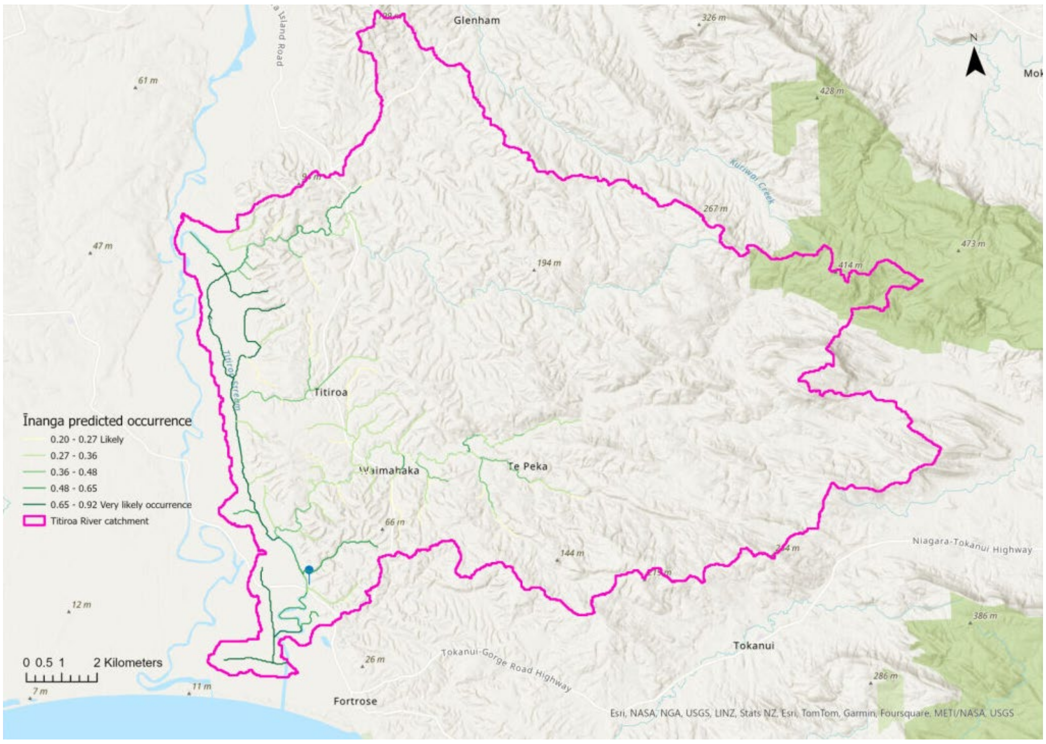

Figure 4 Total extent of predicted īnanga habitat within the Titiroa catchment

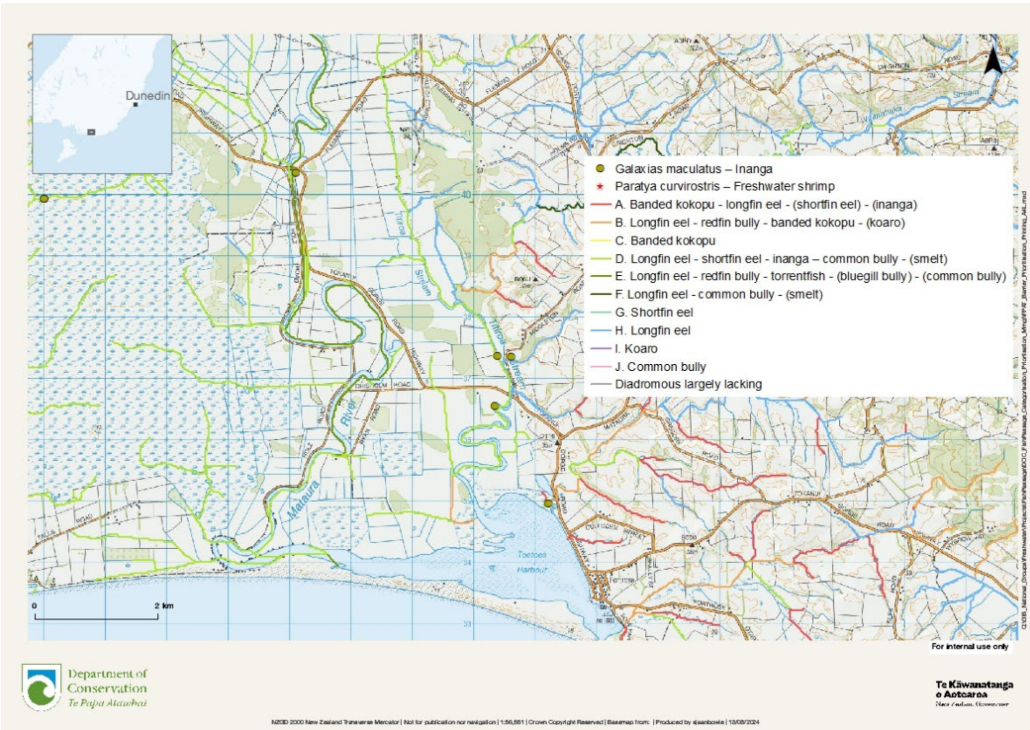

Figure 5 Probability of capture models indicate that the Titiroa is considered suitable habitat for īnanga, longfin eel, shortfin eel and common bully.

24. Many of the species found within the Titiroa stream are diadromous, meaning that they need to move between freshwater and marine environments and within the Titiroa Stream to complete their lifecycles.

Fish passage

<u>The known impacts, of structures relevant to the application, on fish passage</u>

25. New Zealand is home to a variety of freshwater fish species with about 70% of these classified as at risk or threatened (Dunn et al., 2017). Many of these species require significant migrations to access habitat to support different life stages including for spawning, rearing, feeding or refuge (Franklin et al., 2018).

26. Instream structures, such as tide gates, can impact on freshwater fish migrations by preventing, restricting or delaying passage both upstream and downstream. The result of this is that fish cannot get to the habitats they need to complete their lifecycles and ultimately a reduction in the distribution and abundance of our freshwater fish species (Franklin et al., 2018). As of 2022, of the instream structures recorded, approximately 48% of structures in our waterways are likely to be impeding fish passage (Franklin et al., 2022). Some fish species are more affected by instream structures than others. For example, īnanga are weak swimmers, whereas kōaro whitebait and elvers can climb wet surfaces very effectively.

27. Migratory freshwater fish species have differing spawning ranges and peaks, and need both upstream and downstream passage at different times in their lifecycle. As can be shown in figure 6 passage for stage specific migrations, for the species recorded in the Titiroa catchment, is required throughout the year (species known to occur in the catchment are highlighted in yellow, species where there is only anecdotal evidence that they occur in the catchment are highlighted in red).

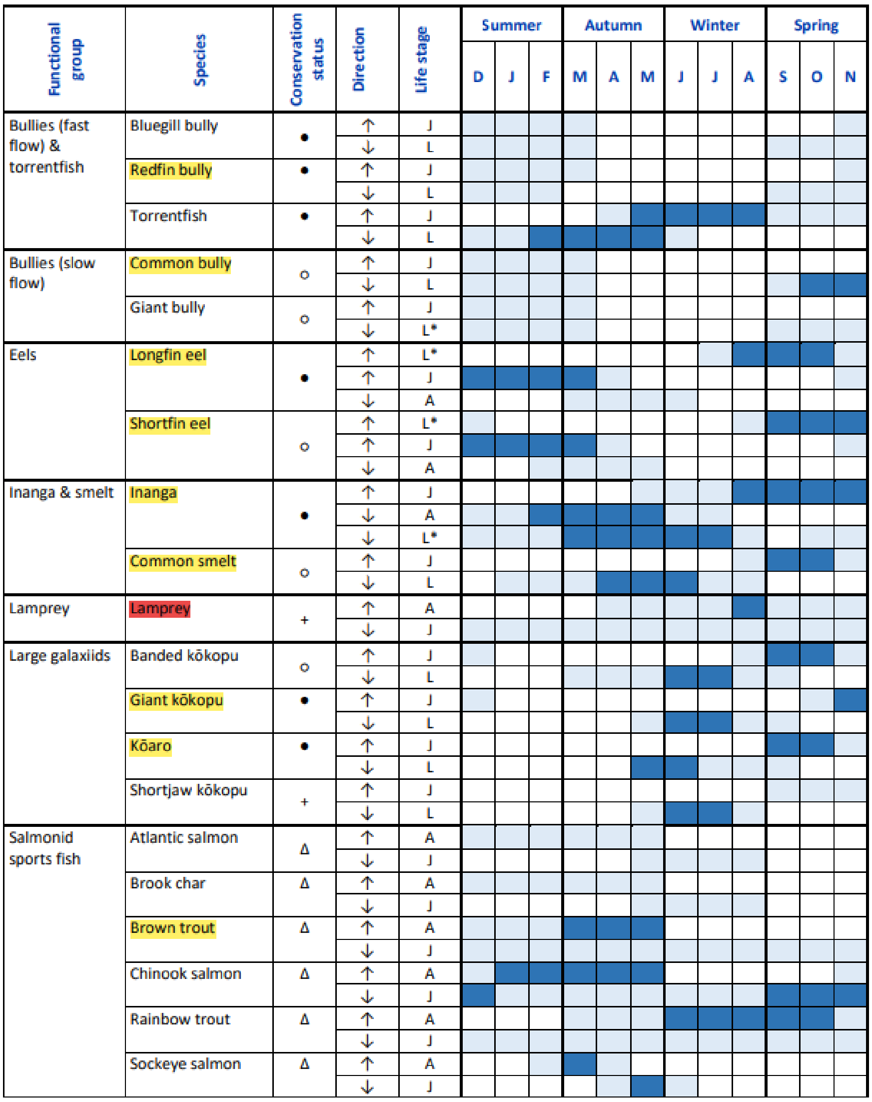

Figure 6 Freshwater fish migration calendar for key New Zealand fish species taken from The New Zealand Fish Passage Guidelines. Peak periods are shown in dark blue, migration range is shown in light blue. Life stages are indicate as follows: L=larval, J=Juvenile, A=adult. Species present within the Titiroa catchment have been highlighted in yellow. Those highlighted in red are possibly present in the catchment but have not yet been confirmed.

28. The application involves the use of side hinged passive tide gates in the Titiroa Stream. Passive tide gates open and close passively based on positive head differentials. A positive head differential on the downstream side, caused by higher water levels as experienced on high tides, will close the gate. A positive head difference on the upstream side, such as experienced in low tide conditions, will cause the gate to open and release water downstream (Franklin, 2018).

29. The use of passive tide gates is inconsistent with the New Zealand Fish Passage Guidelines, which state that the use of tide gates should be avoided, but where their use is necessary automated/active or self-regulating tide gates should be

used. Recognising the difficulty of providing fish passage at tide gates, structures which include flap gates have the automatic fish passage risk classification of "very high" for flap gates without a fish friendly design, and "high" for flap gates with a fish friendly design within the Fish Passage Assessment Tool (Franklin, 2022). The fish passage assessment tool is the national database for assessing and recording in stream structures in New Zealand, and it is endorsed by the Ministry for the Environment. Due to the impacts on fish passage the NES-FM defines the placement, use, alteration, extension or reconstruction of a passive flap gate in rivers, as a non-complying activity, however, this rule only applies to structures installed post 2020. The NPS-FM (3.26) includes a requirement that "*The passage of fish is maintained, or is improved, by instream structures, except where it is desirable to prevent the passage of some fish species in order to protect desired fish species, their life stages, or their habitats*." I believe that the continued use of an outdated passive tide gate structure is not consistent with this requirement.

30. Franklin et al. (2018) states that all tide gates are considered barriers to fish passage, as when the gate is closed, no fish can pass, and even when the gates are open then passage can be limited by high velocities. Doehring et al. (2011) found temporal impacts to migration of native fish on gated culverts, with overall more than twice as many fish passing gated vs non gated culverts.

31. Many small migratory fish species in New Zealand migrate upstream on a rising tide (Bocker 2015, Franklin, 2018, McDowall, 1990). As the gates will be shut at this time, any fish seeking to migrate upstream at this time will be delayed until the gates are open, and velocities through the gate are appropriate to let them pass through. Downstream fish passage may also be impeded by fish seeking to migrate out to sea (e.g. longfin and shortfin eels, lamprey etc).

32. The impacts of delayed migration are not completely understood, however, known impacts include predation (Doehring et al., 2011), and it may also result in an energetic cost which could impact on overall fitness. It should be noted that tide gates are often the first in a long series of barriers that fish need to overcome in a catchment (Franklin et al., 2018), and therefore these costs may have a cumulative impact. "*Efficient and safe passage of all aquatic organisms and life stages with minimal delay*" is identified in the New Zealand Fish Passage Guidelines as a minimum design standard for fish passage at instream structures (Franklin, 2018).

33. In the Titiroa predatory fish are found downstream of the tide gate including perch (PDP 2021, 2022), an introduced piscivorous fish species, and longfin and shortfin eel (NZFFD). So predation is a key concern that needs consideration at the Titiroa gates.

Fish surveys, and other investigations, undertaken by the applicant, including assessment of results

34. The applicant commissioned PDP to undertake a fish survey in 2021 that found that the four migratory native fish species (including longfin eel, shortfin eel, īnanga and common bully) found downstream of the structure, were also found above the structure (PDP, 2021). They also found redfin perch (introduced and naturalised) below the structure. The survey found a higher abundance of each of the native species below the structure than above the structure, but despite this concluded that the tide gates only had a minor effect on fish passage.

35. An additional survey was undertaken in 2022, with some changes to methodology, which found similar results to the 2021 survey, that a higher abundance of each species was captured downstream of the structure than upstream, however, with the addition of Giant Kōkopu and Redfin Bully that were found upstream but not downstream of the structure (1 and 10 individuals respectively). PDP (2022) noted that for at least īnanga, this figure was significant, but they considered that this could be due to habitat preferences between the two areas. This is unsubstantiated.

36. PDP (2021) also undertook a flow profile assessment to understand if velocities through the structure allowed for the passage of fish. The assessment of flow profile was only undertaken 2 meters downstream of the structure, so may not be representative of the velocity through the tide gates themselves, which could be even higher due to greater constriction.

37. In addition to this water velocities were measured over only a 40 minute period from when the gates opened, however, PDP (2021) state that water velocity downstream of the tide gates appeared to peak at approximately 140 minutes after opening. If this observation is correct, I assume that water velocities are likely to be higher than what was reported, at certain times.

38. I do not agree that the diversion channel is not a velocity barrier to fish at times, as PDP (2021) suggests. PDP (2021) undertook very limited assessment at only

one location over one time period. The maximum water velocity through the gates was recorded as 1.328 m/s and the average velocity was recorded at 0.36m/s (PDP 2021). For fish, the ability to overcome velocity is dependent on many factors including differences between species, fish size, presence of low velocity refuge areas, environmental conditions and the distance to be travelled (Franklin et al., 2018). To make progress fish swim speed must be greater than the velocity within the water column. The PDP report (2021) makes no comparison to known swimming speeds of native fish species. Appendix D (table D-1) of the NZ Fish Passage Guidelines summarises fish swimming data for NZ species which shows that for small sized fish such as īnanga the maximum velocity is much higher than their reported swimming speed, and that some species would struggle to swim at even average reported velocities. It is therefore reasonable to assume that velocities within the diversion channel would impact on fish passage at certain times, however, insufficient information is provided to determine over what time period.

39. I note then that not only that fish passage will be impeded when the gates are physically closed but will also likely be impacted for sometime after the gates are open. There is insufficient information to quantify the migration period which is available to fish to navigate the tide gates.

40. Irrespective of the outcome of both the fish and velocity surveys, I dispute the conclusion from PDP (2021&2022) that fish passage is not impacted or is only impacted to a minor degree. This conclusion ignores the fact that the gates are shut for approximately 51% of every tide cycle which entirely prevents passage over this period, during high tide, which is the time that many species may preferentially migrate upstream. It also does not consider the impacts of delayed migration. While similar species assemblages are found up and downstream of the structure, indicating that passage is provided at some point, this survey does not provide evidence that species are navigating the gate in sufficient numbers to form viable populations, or investigate species which are hard to survey using standard methods, that may be present but have not been identified in the survey (e.g. lamprey/kanakana).

41. In addition to the above, I note that the fish surveys were carried out in January and March, outside of the peak upstream migration period for migratory galaxias. I note that the ability to navigate high velocities can be impacted on by size and life stage (Franklin et al., 2018), therefore assessment at this time would provide us with more information of how galaxias at “whitebait” stage, are able to navigate

the gates. As the surveys in PDP (2021, 2022) were undertaken outside key migratory periods it is likely that the surveys have only picked up resident fish, as opposed to those that are actively migrating.

42. To further support that the structures impact on fish passage I point to anecdotal evidence from whitebaiters (DOC, 2019) and the submission in support of this application received from the Southland Recreational Whitebaiters Association (McNaughton, 2023) that discusses accumulation of whitebait below the tide gates. I also refer to the statement of evidence of Alan Christie, on behalf of the Director-General of Conservation, which provides information on the "dead end" the structures have created for upstream migrating whitebait species. Mr Christie has shared with me his observations of whitebait congregating downstream of the structures when the tide gates have been shut (personal communication, Alan Christie, August 2024).

Potential options to remediation not adequately explored by the applicant

43. The applicant has not offered any mitigation/off setting in regards to the adverse impacts on fish passage.

44. Franklin et al. (2018), in the New Zealand Fish Passage Guidelines, states that the removal of a fish passage barrier is the recommended first option if a structure is no longer required. Throughout this resource consenting process, the Department of Conservation requested information to determine if the tide gate structure is required, and what the impact of this would be, should it be removed. This information need has not been addressed until expert evidence, on behalf of Southland Regional Council, was made available to submitters on 16/08/2023 and this is considered further on in my evidence.

45. It is extremely difficult to provide effective fish passage at tide/flood gates, but where no suitable alternative is feasible, there are some design features which may help lower the potential impacts on fish passage (Franklin et al., 2018). Should no suitable alternative to tide gates be feasible, replacement of passive gates with an active gate design, which uses electric or hydraulically powered gates, that only open when water levels reach a critical height, is considered best practice (Franklin et al., 2018). The application provides insufficient information to show that the tide gates need to close on every tide. If the gates are required, but do not need to close on every tide, then this would be an appropriate solution.

46. Should the applicant provide sufficient information that the tide gates are required to shut on every tide then there are still other better options for this site that include replacement or modification of existing tide gates with self-regulating mechanisms (sometimes referred to as fish friendly gates) that delay gate closure, and keep the gates open for as long as possible. These rely on a stiffener, float or counterweight to control the gate based on the water level downstream of the gate (Franklin et al., 2018). In addition to this some success has been seen with modifications to tide gates for example a "letterbox" opening which can provide a pathway for migration when the gates are closed (ECAN, 2024), or installing newer aluminium or plastic gates which open more easily (Franklin et al., 2018). The applicant has not considered these options, or other solutions, which would improve fish passage at the Titiroa tide gates, as part of the original AEE, however, expert evidence, on behalf of the applicant, was made available to submitters on 16/08/2023 and is considered further on in my evidence.

47. I note that the Titiroa tide gates are side hung, which does provide some benefits in that they require a smaller hydraulic head to open them, and they open wider for longer, so any replacement or remediation should ensure this design feature is retained, however, I do not consider this design feature sufficient mitigation alone.

48. An alternative option may be to look at the feasibility of the provision of an effective fish pass around the embankment and tide gates. This would need initial feasibility work to determine the suitability at site, followed by careful design and construction. However, this is likely to result in the need for an additional similar diversion channel as is present, without the tide gate, so it may not be viable. Overall, it is likely better to improve the tide gate design and operating regime, to improve fish passage.

49. Given the difficulties of providing fish passage at tide gates, any remediation or replacement would need monitoring to show sufficient fish passage is ultimately provided.

Īnanga spawning

<u>The impact of the structures on īnanga spawning</u>

50. Īnanga (Galaxias maculatus), classified as at risk – declining (Dunn et al., 2017) are a small native fish species which makes up the majority of the whitebait catch

(Goodman, 2018, Hickford & Schiel, 2011). They are a lowland species, thought to be constrained in their upstream distribution by their weak swimming abilities. Adults īnanga live in freshwater, and migrate to the tidal reaches of rivers, wetlands and estuaries, to spawn amongst riparian vegetation which is inundated during high spring tides (Goodman, 2018). Īnanga usually spawn in close proximity to the saltwater wedge (the point where saltwater from the sea merges with freshwater in a waterway), but spawning can extend for some distance up and downstream of this point (Orchard & Hickford, 2018). Eggs develop terrestrially and are re-immersed on subsequent high tides, which triggers hatching, before larvae are washed downstream to the sea where they develop for 4-6 months before migrating back into freshwater systems as "whitebait" (Hickford and Schiel, 2011).

51. As the Titiroa tide gates shut on an incoming tide, this will likely detrimentally impact on īnanga spawning. The tide gates, by design, would hold back the vast majority of tidal inundation, which would likely impact on the extent of the saltwater wedge, and subsequent water level fluctuations which may provide spawning cues to īnanga, but also by reducing subsequent inundation which would trigger hatching of eggs and transport of larvae downstream. In addition to this, the gates could restrict fish from moving to spawning habitat, whether that be upstream, or downstream of the tide gates.

52. While there is uncertainty of the outcome of any spawning events in the Titiroa, it is likely that spawning habitat at this site is detrimentally compromised, and this has been accepted by the applicant. One potential risk of compromised stage-specific habitat can be the creation of sink populations, whereby local reproduction cannot sustain the population at the site, and instead populations only persist through migrations from more productive source populations, essentially becoming "ecological traps" (Hickford & Schiel, 2011).

<u>Investigations carried out by the applicant in regards to impact of the structures on īnanga spawning</u>

53. To investigate spawning in the Titiroa PDP (2022) completed a single salt wedge survey and found that the saltwater wedge was located approximately 158m upstream of the tide gate. However, previous salinity surveys have found that the salt wedge was located below the tide gates (Dare and van der Hurk (n.d). The position of the salt wedge will be influenced by the amount of tidal inundation

moving upstream, as well as the amount of freshwater moving downstream. At this site the position of the salt wedge will be further complicated by the tide gates. Repeated salinity surveys may be required to clear up these discrepancies, and account for temporal variations in salt wedge location, as this will be important for targeting any mitigation. I note that the PDP (2022) report states that at the time of their investigations there was a "prolonged and widespread dry period", and I believe that there is the potential that conditions such as these could potentially impact on the location of the saltwater wedge.

54. PDP (2022) also completed a single īnanga spawning survey and located īnanga eggs in four locations, in close proximity of each other, directly upstream of the tide gate. The size of these spawning sites, or number of eggs found, were not reported in the results provided to us. Repeating īnanga spawning surveys monthly over peak spawning months (e.g. March-June) and quantifying īnanga spawning would give us a better understanding of the extent of īnanga spawning in the Titiroa and would help inform any mitigation actions.

55. In addition to this, at present there is insufficient information for me to understand what the outcome of any spawning event is in the Titiroa. Repeated visits to the identified egg patches may provide information about the outcome of any spawning event. Information which would be useful here would include observations on if eggs develop for the expected time period before being inundated and washed away, or if they become desiccated/non-viable over time. If issues are found, then the operating regime of the gate could be investigated to see if any changes could result in greater spawning outcomes. In addition to this, no spawning searches were carried out downstream of the tide gate, however, spawning areas can often be found some distance downstream of the saltwater limit (Orchard, 2022). For these reasons I believe there is insufficient information to adequately understand īnanga spawning in the Titiroa catchment.

Assessment of adequacy of mitigation/off setting proposed by the applicant

56. Habitat mapping was undertaken by PDP (2002) above the tide gate to quantify the amount of habitat potentially impacted, and therefore the amount of mitigation/offsetting required. Only areas identified as high or moderate suitability were included in this total. However, some of the areas PDP (2022) deemed unsuitable, for example photograph 3 & 4, look to be, in my opinion, entirely

suitable for īnanga spawning. Habitat mapping was also not included for areas downstream of the gate. Potentially the area of unsuitable spawning, and therefore area that should be mitigated and/or off set against, has been underestimated, therefore, I believe this needs to be reassessed.

Photograph 3: (WP 025 Unsuitable –Grass)

Photograph 4: (WP 050 Unsuitable – Steep Banks)

Figure 7 Photograph 3 and 4 from the PDP (2022) report deemed "unsuitable" for īnanga spawning

57. PDP (2022) proposes that 12.4 ha of current low quality or unsuitable habitat, above the tide gates, be enhanced for īnanga spawning. However, given the likely detrimental impacts of the tide gates on conditions required to trigger spawning events, and subsequent re-inundation of these eggs to trigger successful hatching and wash larvae downstream, the outcome of any īnanga spawning event is uncertain. In addition to this, more information is required on īnanga spawning to target any mitigation appropriately. Because of this, what the applicant has proposed may not adequately mitigate directly against lost spawning opportunity, however, could improve general freshwater habitat at this site.

58. The PDP (2022) report also proposes enhancement of īnanga spawning habitat downstream of the tide gates in drains/tributaries including sites identified as sites 5, 6 and 7 and the unnamed tributary immediately downstream of the tide gate on the true right hand side. However, when these sites were visited in March 2022 by PDP (2020), which is within the īnanga spawning period, sites 5 and 6 were dry, and site 7 was discounted because of water chemistry, which puts into question their suitability as spawning sites.

59. In addition to this, Fish & Game has identified that a perched culvert is located on this tributary on the downstream end of Middleton Rd (Smyth, 2022) which appears to be a significant barrier to fish passage. While they have targeted sites within 500m of the salt wedge that they measured above the tide gates, as these proposed sites for restoration are below the tide gates, the influence of saltwater inundation would likely differ here, and investigations would need to be undertaken to ensure these locations are suitable for spawning. The report suggests that there are potentially flap gates on these tributaries that they say would need to be replaced with Fish Friendly tide gates, or potentially another solution such as bunding. I note that while fish friendly tide gates may improve passage, they still present a barrier for fish species throughout many points of the tide cycle and will still impact on natural tidal fluctuations and therefore quite likely the outcome of any spawning events.

60. Another 1217.2ha of coastal wetland enhancement was also proposed, however, I am unsure if this still forms part of the application.

Response to the s42A report

61. I agree with the following matters in the s42A report:

   a. That the activity impacts on fish passage, īnanga spawning and water chemistry. While I have not covered the potential impacts on water quality in my evidence, I acknowledge that there is evidence that the installation and operation of tide gates can result in increasing sediment deposition, lower dissolved oxygen levels and higher water temperatures (Franklin, 2018; Franklin & Hodges, 2015). Therefore, I support the s42A reports recommendations to include monitoring of dissolved oxygen and temperature, with a requirement for assessment of measures to avoid or mitigate the adverse effect included as any future consent conditions.

Response to ecological evidence provided by Ms Laura Drummond

62. Prior to evidence provided by Ms Drummond, all information provided by the applicant (e.g. (PDP 2021 & 2022) has incorrectly stated, in my opinion, that there is no impact, or a less than minor impact, on fish passage, and no attempt has been made to mitigate against this effect specifically.

63. However, Ms Drummonds expert evidence states that fish passage and īnanga spawning are detrimentally impacted by the tide gate structures. She states that the best option from an ecological point of view is to remove the gates, but that is the gates can't be removed, automated (active) or FFG's (fish friendly gates, often referred to as self-regulating gates) are the best option available to minimise effects to fish passage. I strongly agree with Ms Drummond in regard to this.

64. I also agree with Ms Drummond in that velocities through the diversion channel likely impede the passage of some fish species. Her suggestion, to install baffles or rocks within the diversion channel, is a potential option to counteract this but I have reservations with installing traditional baffling in this location due to depth in the diversion channel. Any improvements here will need careful design and monitoring to determine effectiveness. There are other solutions that could be considered instead, including technical fish pass elements, which may be a better solution to reduce velocity in the channel.

65. While Ms Drummond points to evidence of Mr Gardner that may suggest that increasing the opening time by 1 and 2 hours may increase water levels within the drainage network, Ms Drummond does not discount the possibility of the installation of fish friendly gates, and states that additional hydraulic modelling is required to determine what level of opening times could occur without resulting in adverse effects to upgradient land. I support the need for these investigations as even small increases in opening times have been found to enhance upstream fish passage in some instances (Bocker, 2015).

66. I also agree that ecological enhancement, including enhancing native fish habitat including īnanga spawning habitat, remediation of perched culverts and improved riparian biodiversity values, will go some way to improve the natural values of the Titiroa Stream. Ms Drummond states that these enhancements will not address the restricted fish passage upstream when the gates are closed. I agree with this statement, which is why in my opinion the gates either need to be removed or replaced with an active or self regulating/fish-friendly tide gate.

67. However, I note that mitigation/offsetting proposed by PDP (2022) included restoration of 12.4ha on the main stem of the Titiroa upstream of the gates 2.4ha downstream of the tide gates for spawning mitigation “islands” and 5.3ha for tributary spawning and habitat enhancement. 1217.2ha of coastal wetland enhancement was also proposed. Ms Drummond appears to only be suggesting 6.9ha in total, but she has only identified 1.4ha, with the rest she suggests to be determined in conjunction with submitters.

68. I do not consider what Ms Drummond has proposed to be sufficient mitigation/offsetting, I note that she considers that the estimate of lost spawning area is “conservative” herself, and I don’t believe enough detail has been provided, including feasibility, location and methods, for us to assess the adequacy of such mitigation/off setting. I am unsure if what is proposed by Ms Drummond is accepted by the applicant and now forms part of the application, in place of what PDP (2022) originally proposed, and if so why this has been significantly reduced.

<u>Response to evidence provided by Mr Mathew Gardner</u>

69. Assessing the validity and adequacy of Mr Gardner’s evidence is outside the scope of my expertise, however, I am concerned that the model utilised by Mr Gardner, in his evidence, may only rely on tide levels that we would expect to see only at spring high tide conditions and that alternative tide scenarios were not run. I would like to seek clarification on this aspect.

70. If I am correct in my assumption that only spring high tides have been modelled, then I recommend that other tide scenarios are modelled to determine the impact of tides on the drainage network at other times throughout the month. If lower tide levels indicate an acceptable impact, then active tide gates, the preferred remediation option under the New Zealand Fish Passage Guidelines should be considered. Active tide gates only operate when water levels reach critical levels, so the gates could be closed at levels that Mr Gardener has modelled as requiring tidal control but left open during lower tides to provide for fish passage. While this would still impact on īnanga spawning, it could significantly improve fish passage outcomes at the structure.

Conclusion

71. The best option ecologically for the tide gates, embankment and diversion channel is removal, as this would resolve the adverse impacts on fish passage and īnanga spawning.

72. However, if the gates are determined to be required in the present location then my recommendations to address the adverse effects relating to the Titiroa tide gate, dam and diversion channel, include:

    a. I recommend that a full feasibility assessment, design and installation in line with national guidance, should be undertaken by an experienced fish passage practitioner with specific experience in designing passage at similar structures. This should take into account specific site characteristics and hydraulic modelling. This should include, but not be limited to, assessments of: **automatic gates, self-regulating (fish friendly) gates, or a fish pass around the entire structure.** These should be considered within the hierarchy of options proposed by the New Zealand Fish Passage Guidelines (and outlined in my evidence above) to provide passage at tide gates, noting that a new revision of these guidelines is due to be released in August 2024 with additional content, considerations and further information in regards the order of preference for tide and flood gate installations.

        - If modelling produced in Mr Gardner's evidence only included spring high tide conditions (or levels close to it), I recommend that the range of tide scenarios are modelled to inform the potential use of active tide gates that can provide improved fish passage.
        - As recommended by Ms Drummond; hydraulic modelling should be undertaken to determine what level of opening times could occur without resulting in unacceptable effects to upgradient land, to inform the potential use of self-regulating/fish friendly tide gates.
        - Solutions to reduce the velocity through the diversion channel should also be investigated, which may include the installation of baffles or rocks, as recommended by Ms Drummond, or other options including technical fishway designs.

    b. That reconsideration of the spawning area that needs to be off -set and/or mitigated against is reconsidered in the context of my concerns of this being underestimated due to incorrect identification of total potential spawning habitat impacted by the presence of the gates.

- This should include clarification of whether past mitigation/offsetting/off sets proposed (e.g. PDP 2022) will be included, or if this has now been removed from the application

c. That the full areas and sites for restoration are identified prior to any consent being issued, and feasibility assessments, and more detail, is provided on how restoration is going to be undertaken, noting that some restoration activities may be complex and need to be undertaken carefully to mitigate against their own environmental effects.

- While I appreciate the suggestion that submitters should be engaged with to identify these areas, ultimate responsibility needs to sit with the applicant to identify and propose potential areas for discussion
- Feasibility will be important given the potential unsuitability of sites previously proposed by PDP (2020)

d. That īnanga spawning is investigated more thoroughly in the Titiroa catchment so effects can be properly understood, manged and mitigated against. This will better inform target areas for īnanga spawning restoration, which may include sites on the main stem, downstream of the structure. This should include:

- Repeated salinity surveys, given the discrepancies in salt wedge location between Dare & van der Hurk (n.d) and PDP (2022)
- Repeated spawning searches over peak spawning months (March-June) over a wider area than in PDP (2020)
- An attempt to determine the outcomes of any spawning events in the Titiroa Stream Including:
  (i) Survival of eggs to hatching stage
  (ii) Success of larvae being transported downstream, as opposed to larvae collecting in the dead zone directly upstream of the dam

e. That appropriate monitoring, maintenance, reporting and review conditions are required to ensure appropriate fish passage and īnanga spawning are provided for. This monitoring programme needs to be designed by a qualified and experienced person, and should be consistent with the most recent revision of the New Zealand Fish Passage Guidelines, and it is recommended that:

- Success of fish passage should not just be measured by simple presence/absence data, and instead should investigate different species and life stage's ability to move through the structure. The goal of this monitoring should be to quantify delays in movement through the structure, and to quantify the proportion of fish arriving at the structure that ultimately successfully pass.
- Monitoring should be undertaken of migratory species within the wider Titiroa catchment to determine abundance and viability of resident populations.
- Structure monitoring and operating regime of the structure should be included in monitoring requirements, to direct maintenance requirements, and to provide information to interpret fish monitoring results.

J. Bowen

Jane Elizabeth Bowen

DATED this 22nd day of August 2024

Appendix 1

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