Christchurch Tide Gates and Other Fish Barriers

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EXECUTIVE SUMMARY

Christchurch City Council (CCC) initiated a fish barrier remediation programme in 2021, beginning with the development of a fish barrier prioritisation database. The purpose of the programme was to identify, prioritise, and remediate barriers in the Christchurch District. Since the programme's inception, it has received regular updates, to incorporate information as it has become available, and to reprioritise structures as barriers were remediated. Over the duration of the programme, several tide gate structures have been identified as priorities for further investigation. This report presents the results of a targeted investigation into tide gates in the Christchurch District. The aim of this investigation was to provide information on the current state and functioning of these tide gates, to identify potential risks and benefits to their remediation, consider values beyond fish passage, and to prioritise them for future actions. This information was then used to re-run an established fish barrier prioritisation model.

The tide gate investigation involved site visits and meetings with specialists from CCC, as well as reviews of relevant designs and reports. Through this process, information was gained to prioritise these structures for remediation and further investigation. Tide gates that were identified as the highest priority for future work included those that were assessed as being a high risk to fish passage, having abundant high-quality habitat upstream, or having the potential to enhance other ecological values in the area. Other factors that were considered when prioritising the tide gates included their condition (i.e., whether renewal was required soon), and whether the remediation could benefit other proposed projects in the area. Of the investigated tide gates, Sheppards Drain flap gate, gates on waterways draining Travis Wetland (Corser Stream and Lake Kate Sheppard), and the Linwood Canal flap gates were identified as the highest priorities for future action.

The barrier prioritisation update identified 59 structures from CCC's structure databases that were a high priority for further action. Of these, 19 were identified as high priorities for remediation, 4 as high priorities for fish surveys to assess their impact, and 36 as high priorities for fish passage assessment. Many of these structures are likely CCC responsibilities, however, ownership must be confirmed prior to remediation. An additional 196 structures were identified as high priorities, but are either not managed by CCC, or are of unknown ownership.

Recommendations included: confirming ownership of high priority structures; carrying out fish passage assessments, fish surveys, and remediation at high priority structures; and consultation with other stakeholders in the district to coordinate barrier remediation efforts. Further recommendations, including those specific to the studied tide gates, are also provided.

1. INTRODUCTION

Many of New Zealand's native fish species are diadromous, meaning they require access to and from the ocean to complete their life histories. However, artificial structures constructed within waterways can act as barriers, limiting fish passage between freshwater and marine habitats. Structures that frequently impede fish movement include tide gates, weirs, and culverts (Franklin *et al.* 2024).

To address this issue at a national level, the central government incorporated a requirement into the National Policy Statement for Freshwater Management (NPS-FM; Ministry for the Environment, 2020), directing councils to develop fish passage action plans (Section 3.26; Ministry for the Environment 2023). In response, Christchurch City Council (CCC) initiated a fish barrier remediation programme in 2021, which has been regularly updated since its inception (Instream Consulting 2021). The programme aims to identify, assess, and prioritise barriers for remediation, with relevant data maintained in CCC's Fish Barrier Prioritisation Database. Tide gates have often ranked among the highest priority structures for remediation. However, improving fish passage through tide gates requires careful consideration of several factors, including the current state of gate operation, as well as the potential impacts of remediation on stormflow conveyance and upstream habitats, due to changes in tidal influence and saltwater ingress.

This report outlines the findings of investigations into several tide gates within Christchurch City. The investigation involved a combination of site visits, discussions with CCC staff, and a desktop review of available information. The tide gates examined in this report have either been previously identified as priority sites for fish passage enhancement or are relevant to proposed CCC projects within their respective catchments. The purpose of these investigations was to collate existing information, understand the current state and functioning of the structures, identify potential benefits and risks associated with remediation, and to highlight any knowledge gaps. This information was then used to update CCC's Fish Barrier Prioritisation Database. Note that assessment of changes in flood risk associated with barrier remediation was beyond the scope of this report.

2. TIDE GATE INVESTIGATION

Tide gates were investigated in several waterways within the Christchurch District (Table 1, Figure 1). Site visits were conducted between September and December 2024[1], involving Instream and CCC staff. During these visits, information was collected on the operation and functioning of the structures, notes were made on their potential risk to fish passage, and other values in the area were considered. Structures that had not previously received fish passage assessments were assessed using the Fish Passage Assessment Tool (FPAT) mobile application. Site visits were completed at all structures, except for the Bells Creek structures. This was because the Bells Creek pumpstation is subsurface. In lieu of a site visit, construction drawings for the pumpstation were reviewed and discussed with CCC staff.

The sections below summarise the information gained during these investigations.

Table 1: Structures included in the tide gate investigation. ID refers to the labels used in Figure 2.

ID	Catchment	Waterway	Structure	FPAT ID	Easting	Northing
1	Pūharakekenui–Styx River	Pūharakekenui–Styx River	Flap gate	187594	1575012	5195032
2		Sheppards Drain	Flap gate	187054	1574628	5190069
3	Ōtākaro–Avon River	Corser Stream	Flap gate	134904	1575464	5183514
4		Kate Sheppard Stream	Flap gate and control structure	134904	1575944	5183562
5	Ōpāwaho–Heathcote River	Bells Creek	Flap gate and pump station	134108	1573948	5178398
6	Ihutai–Avon-Heathcote Estuary	Lovetts Drain	Flap gate	136501	1576214	5178239
7		Charlesworth Drain	Flap gate	136467	1576544	5178346
8		Linwood Canal	Flap gate	187027	1575992	5178009
9		Ferrymead waterways[1]	Flap gates and a control structure	134680 134911 134677	1576132	5176442

Note: There are several structures in the Ferrymead area that may impact fish passage. These are mapped and described in detail in Section 2.7.

[1] Instream also completed a second, follow-up, visit to Lovetts Drain and Charlesworth Drain on 1 September 2025, to collect additional information.

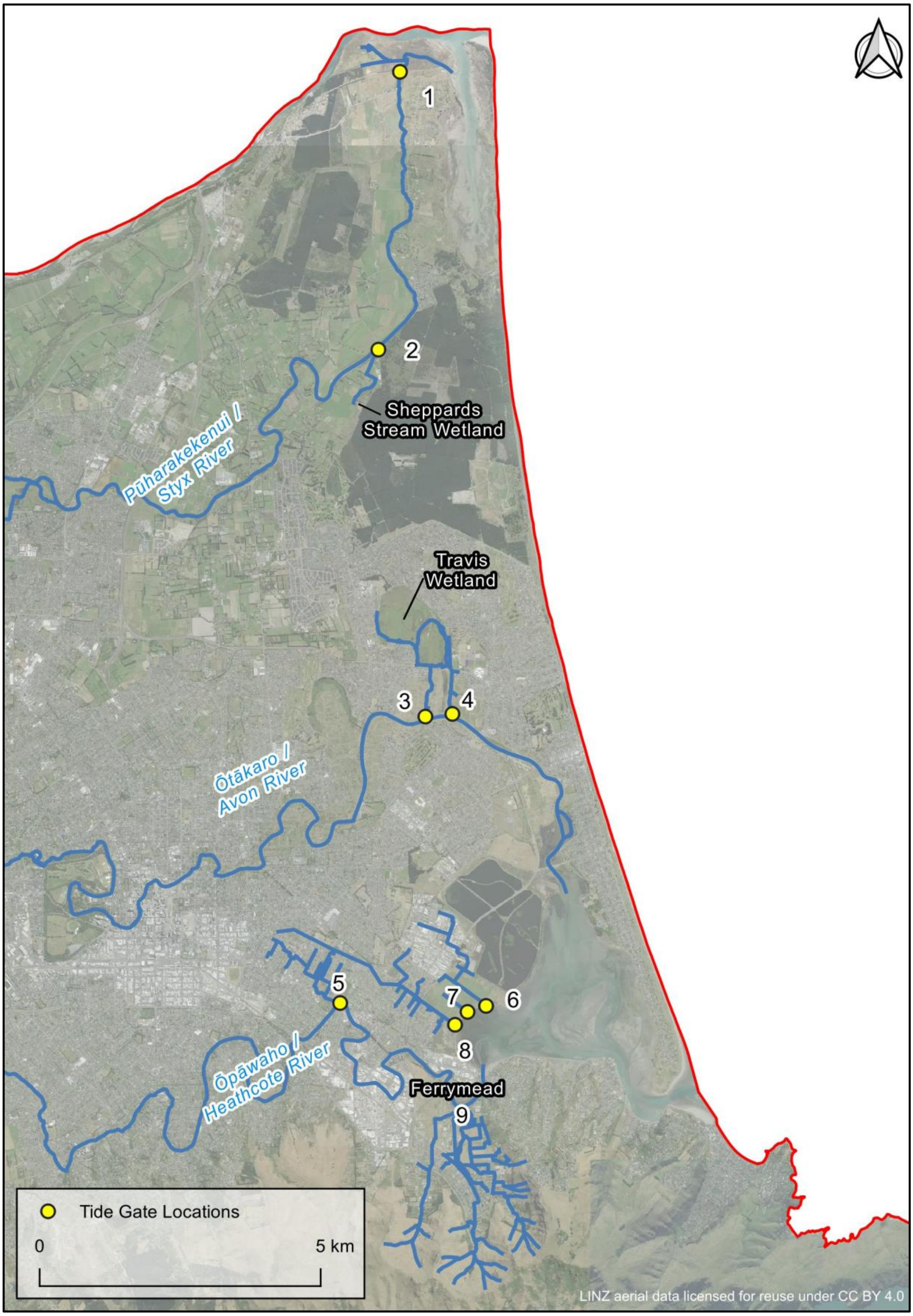


Figure 1: The location of the investigated tide gate structures. Note that several structures were investigated in the Ferrymead area, and the location point is indicative.

2.1. Pūharakekenui–Styx River Main Tide Gates

2.1.1. Description, State, and Function

The Pūharakekenui–Styx River main tide gates are located at the outlet of the Styx River, near where the waterway discharges into Brooklands Lagoon. The structure features four, large, side-hinged gates (Figure 2). During a site visit on 2 September 2024, the gates appeared to be in good condition and were functioning as intended.

Observations from Steve Leiataua (CCC), suggest that the gates shut very slowly on the incoming tide, taking several hours to fully close. During our September site visit, water was actively flowing upstream on the incoming tide, while the gates remained almost completely open. Once closed, they remain in this state for approximately six hours, or half the tidal cycle (i.e., the gates are closed approximately 50% of the time; Pers. Comm. Steve Leiataua, CCC, September 2024).

Figure 2: The tide gates in the Styx River, near the outlet into Brooklands Lagoon.

2.1.2. Risk to Fish Passage

Based on the observations described above, fish migration is likely to be substantially impacted by the gates, approximately 50% of the time. When the gates are open, fish have free passage upstream. Weak swimming and climbing inanga (*Galaxias maculatus*) are known to be abundant upstream of the structure, and the waterway supports a productive whitebait fishery. When the gates are closed, there is no alternative passage, and all fish species are likely impacted, including upstream and downstream migrants.

During these times, upstream migrant fish likely accumulate downstream of the gates, which can result in increased predation rates from bird predators (Franklin et al. 2024). Mr Leiataua reported often seeing predatory birds perched around the gate structure. Thus, the Styx tide gates are likely a partial barrier to fish passage, while also potentially lowering survival rates of upstream migrants. The priority of these gates for further investigation is raised by the large size of the waterway, and consequently the number of fish impacted, as well as the extensive upstream catchment, which includes over 25 km of the Styx River mainstem.

Side-hinged gates are suggested to present a lower risk to fish passage, when compared to top-hung gates (see Section 4.8.4; Franklin et al. 2024). This is because they may result in less throttling than top-hung gates, and thus, there is a lower risk of velocity related barriers forming. They also provide access to the full depth of the water column through all stages of the opening sequence. While no velocity barriers were observed during our site visit, throttling and associated increases in velocity may still occur during early stages of the opening sequence, and late stages of the closing sequence. This has potential to impact upstream, and downstream, fish migration, respectively.

2.1.3. Other Considerations

- **Inanga spawning:** At Risk inanga are known to spawn immediately upstream from the gates (Taylor and Main 2011). Inanga spawn among riparian vegetation, during spring high-tide sequences, near the upstream extent of saltwater influence. They are highly selective regarding vegetation spawning habitat, choosing areas with dense ground cover that retains moisture, preventing eggs from desiccating during the period between spring tides. Modification of these gates has the potential to shift this spawning, by altering the extent of the saltwater influence. Careful consideration would be required to determine if gate modifications would shift the spawning zone to an area with suitable habitat for inanga spawning.
- **Environment Canterbury Collaboration:** Environment Canterbury (ECan) has recently (December 2024) carried out fish passage assessments on several structures in the Styx River catchment, including these tide gates[2]. We recommended that discussions are held with ECan to understand any plans they may have for improving fish passage in the catchment and to explore potential opportunities for collaboration.

2.1.4. Knowledge Gaps and Recommendations

- Further study is required to confirm temporal impacts of these gates, including confirmation of the duration during which they are closed, and potential velocity barriers that may occur during different stages of the tidal sequence.
    - A telemetered river height gauge is located immediately downstream of the structure[3]. A review of the associated data was undertaken; however, no clear patterns were identified that could be used to infer gate operation. Targeted monitoring of the gates would therefore be required to confirm their operation.

- Taylor and Main (2011) confirmed that inanga spawn immediately upstream of these gates (See Section 2.1.3). Remediation of the structure therefore has the potential to affect local spawning. Any remediation options should be assessed, via modelling or trials, for their effects on saltwater ingress. If remediation is expected to alter the upstream extent of saltwater intrusion, a survey should be undertaken to evaluate the suitability of the new location for supporting inanga spawning.

[2] FPAT ID's: 187594, 187059, 187057, 187056, 187054, 187037
[3] https://www.ecan.govt.nz/data/riverflow/sitedetails/66422

2.2. Sheppards Drain Flap Gate

2.2.1. Description, State, and Function

Sheppards Drain flap gate is located at the confluence of Sheppards Drain and the Styx River, approximately 5 km upstream from the Styx main tide gates. The structure includes a single top-hung flap gate, on the downstream end of the culvert under Lower Styx Road. The gate is in poor condition, and there is some active erosion around the concrete headwall (Figure 3). The gate was heavily imbedded in the surrounding fine sediments at the time of our site visit on 2 September 2024 and was unable to be moved, thus, it was not functional. The bolts associated with the flap gate hinge were replaced in September 2025; however, at the time of writing, it was not known whether the accumulated sediments have continued to impact gate operation (Pers. Comm. Colin Hill, September 2025). We understand that CCC's maintenance team is investigating this issue.

Figure 3: The Sheppards Drain flap gate (left) and Sheppards Drain upstream of the structure (right).

2.2.2. Risk to Fish Passage

At the time of our site visit, the gate was jammed in a closed position, which would prevent passage of most fish, in both directions. Small eels may be able to find passage through gaps around the gate, while upstream migration of inanga is likely limited, and downstream migration of large eels may be prohibited. A fish survey in March 2023 (Instream Consulting 2023a) confirmed that the structure is excluding inanga from the upper reaches of the waterway, while shortfin eels (*Anguilla australis*) and At Risk longfin eels (*A. dieffenbachii*) were abundant upstream. With the gate currently jammed closed, adult eels may be trapped upstream, unable to migrate to the ocean to complete their life cycles, unless during high flood conditions, if the banks overtop.

While Sheppards Drain is a small waterway, the amount of aquatic habitat is augmented by the presence of a wetland upstream. This area is included as a Site of Ecological Significance in the District Plan (Sheppards Stream[4]; Site number SES/LP/31), recognised for its remnant

[4] Note that we refer to the waterway as 'Sheppards Drain' for consistency with the CCC waterways layer, and to the wetland as 'Sheppards Stream Wetland' for consistency with the District Plan.

wetland vegetation values. The area has potential to provide a large amount of natural wetland habitat for fish, which is rare in Christchurch. Facilitating fish passage into this existing habitat is an easy win for improving aquatic ecological values in the district, when compared to creating or restoring other habitats.

2.2.3. Other Considerations

- **Water quality:** A fish survey carried out in March 2023 (Instream Consulting 2023a), identified that Sheppards Drain had poor water quality. Dissolved oxygen levels were very low (2.93 mg/L, 30.2%), and eels caught during the survey displayed signs of hypoxia (i.e., sluggish behaviour, surface breathing). Remediation of the tide gate may provide better flow through the waterway, and consequently, improve water quality.
- **Flood Control:** Members of CCC's land drainage team have confirmed that this structure is required for flood control (Pers. Comm., Emily Tredinnick, CCC, September 2025). Thus, complete removal of the flap gate is not feasible.
- **Condition and renewal:** Given the condition of the flap gate, and the scouring around the concrete headwall, it may require remedial work in the future. CCC's asset management team have confirmed that there is scope for the replacement of this structure (Pers. Comm., Emily Tredinnick, CCC, September 2025).

2.2.4. Knowledge Gaps and Recommendations

- Franklin et al. (2024) provides *six options* for remediating existing tide and flood gates. These are outlined below with considerations specific to the Sheppards Drain gate:
  1) *Remove the gate.*
     - Not an option, as the gate is required for flood control (see Section 2.2.3).
  2) *Remove a single gate if there are many in parallel.*
     - Not applicable.
  3) *Replace with active (and automated) gate control system.*
     - Feasible, but financially costly relative to the ecological benefit of improving fish passage at this site.
  4) *Modify gate with designed stiffener, float, or counterweight with specified opening duration on the flood tide, and opening size.*
     - Stiffeners and counterweights require sufficient baseflow to generate fish passage openings. Sheppards Drain is unlikely to provide this baseflow, so these options are not recommended.
     - A float design involves attaching a buoyant float to the gate, encouraging the gate to open and delaying closure. While this is feasible, it does not address the issue of sediments accumulating around the gate, and rendering it nonfunctional. Furthermore, it is likely to be more expensive, and have higher ongoing maintenance requirements, than options 5 and 6, below.
  5) *Modify management so gate is always chocked partially open.*
     - Feasible and comparatively cost-effective.
  6) *Add orifice to gate.*
     - Feasible and comparatively cost-effective.

- Based on the assessment above, further investigation of options 5 (partial chocking) and 6 (orifice installation) is recommended. As the flood-control function of the gate is essential, hydrological modelling will be required to assess potential flood impacts.
- Any effects on upstream water levels, including within the Sheppards Stream wetland, must be considered. If a control structure is required to maintain water levels, a 'fish-friendly' rock riffle weir could be installed.

2.3. Bells Creek Flap Gate and Pump Station

2.3.1. Description, State, and Function

The Bells Creek flap gate is situated at the end of Bells Creek, at the confluence with the Ōpāwaho–Heathcote River. The structure includes a single, top-hung gate. Bells Creek receives stormwater from the surrounding residential area, via Te Oranga Waikura stormwater wetland (Figure 4). Located between the wetland and the flap gate outlet is a stormwater treatment facility, including a pumpstation (SwPump 83). A schematic of this facility is provided in Appendix 1.

Figure 4: The Bells Creek tide gate (left; photo provided by Colin Hill, CCC) and the upstream Te Oranga Waikura stormwater wetland (right).

During baseflow, flows are conveyed directly into the Heathcote River, via a culvert under Richardson Terrace. The culvert terminates in a top-hung flap gate, which seals shut when the water is high in the Heathcote River (i.e., during higher stages of the tidal sequence, and during stormflow). When the gate is shut during Heathcote River stormflows, water accumulates in the piped section of Bells Creek and in the wet well of the treatment facility. Once a critical height is reached in the wet well, and 2 mm of rain has fallen[5], three impellor pumps are activated. These drive flows through a contaminant filtration system, before discharging into the Heathcote River. A recent review of this system confirmed that the pumpstation was functioning in response to the triggers described above, as intended (Pers. Comm., Iris Brookland, CCC, October 2024).

[5] Measured at a local rain gauge.

2.3.2. Risk to Fish Passage

The Bells Creek flap gate presents a high risk to upstream migrating fish, as it is frequently closed, both during stormflows, and during high-tide stages in the Heathcote River. However, fish surveys in Te Oranga Waikura carried out in 2022 revealed an abundant eel population, confirming upstream passage of elvers (young eels; Instream Consulting 2022b). The 2022 study recorded low abundances of other fish species, suggesting that the flap gate and associated pipe exclude most weaker swimming and climbing species.

The Bells Creek pump station poses a significant risk to downstream-migrating eels. Eel migrations are known to coincide with rainfall events (Mitchell 1996). Given the large eel population upstream in Te Oranga Waikura, it is likely that many attempt to migrate downstream during stormflows. However, as noted in Section 2.3.1, this passage is blocked during such events due to the flap gate closing in response to elevated Heathcote River levels.

Furthermore, from our review of the pumpstation drawings and discussions with CCC staff, we understand that there is no mechanism to stop fish from entering the wet well and subsequently becoming entrained in the stormwater pumps. While the grit chamber associated with the pump station wet well is inspected monthly by CCC contractors, it has only been dewatered once in the past five years. During recent correspondence, the contractor confirmed that no fish have been observed during either the regular inspections or the dewatering event (Pers. Comm., Iris Brookland, CCC, November 2024). Provided they do not become entrained in the pumps, fish can move freely back out of the wet well and into Bells Creek (Pers. Comm., Peter Christensen, September 2025).

Despite this, the system appears accessible to fish, suggesting that some are likely entrained through the pumps. Based on studies of eels passing through impeller-style pump stations elsewhere in New Zealand (White *et al.* 2024), we expect that most eels passing through the pumps will die. While there is currently no way to determine the number of fish affected, these pumps operated an average of approximately 110 hours per year, over 2022–2024, and thus, there is a high risk of eel mortality. Further investigation is required to assess this risk and determine whether mitigation is required (e.g., trap and transfer of adult migrant eels prior to migration).

Given the high risks to fish health associated with the pump facility, the Bells Creek flap gate is considered a low priority for barrier remediation. In contrast, quantifying and mitigating the risks the pump station poses to downstream-migrating eels should be treated as a high priority.

2.3.3. Knowledge Gaps and Recommendations

- Based on discussions with CCC, and a review of the Bells Creek pumpstation drawings, it appears that fish have access to the treatment facility, with an associated risk of mortality. However, the number of fish potentially impacted is not known.
- Feasibility of retrofitting a fish screen to the facility were discussed with CCC engineers. While feasible, it was suggested that there would be high costs associated with the installation and ongoing maintenance of a physical screening device (Pers. Comm., Peter Christensen, CCC, September 2025).
    - Behavioural screening devices (e.g., strobe lighting, bubble curtains, underwater speakers) were also considered; however, there is limited evidence to suggest they

would be effective at this site. Although downstream-migrating eels have shown some response to such deterrents, their effectiveness is generally lower than for other species and life stages[6].

- Another remediation option that is sometimes utilised at pump stations is replacement with 'fish-friendly' pump designs (see Section 4.9 of Franklin et al. 2024). However, this option would involve substantial costs, and may not be compatible with the filtration system.
- Options to delay the onset of pump operation, to provide a fish migration window, were discussed with CCC. This was determined to be impractical as it would impact first-flush stormwater treatment efficiency (Pers. Comm., Iris Brookland, CCC, November 2024).
- Due to the high costs associated with the potential remediation options, further investigation and quantification of the potential risk to fish is recommended. This could involve setting traps upstream of the pumps during baseflow and stormflow, to assess the relative number of fish attempting to migrate under each of these conditions.
- If the risk to fish health is confirmed to be high, exclusion options should be investigated in more detail. These could include screening fish from the pump station or preventing fish entry into Bells Creek. Should exclusion from Bells Creek be pursued, a trap-and-transfer programme for fish in Te Oranga Waikura would be required.

2.4. Lovetts Drain and Charlesworth Drain Tide Gates

2.4.1. Description, State, and Function

The Lovetts Drain and Charlesworth Drain tide gates are located at the outlet of their respective waterways, where they discharge into the Ihutai–Avon-Heathcote Estuary. Both structures feature single, top-hung flap gates (Figure 5, Figure 6). Both flap gates were confirmed to be operating as intended; i.e., opening on the outgoing tide, and closing on the incoming tide. However, we understand that the Charlesworth flap gate is in poor structural condition and CCC is investigating its renewal (Pers. Comm., Colin Hill, CCC, October 2024). The earth banks around the upstream headwalls of both culverts were actively eroding.

Figure 5: The flap gate outlet of Lovetts Drain (left) and upstream habitat (right), during the October 2024 visit (incoming tide).

[6] https://niwa.co.nz/freshwater/bio-acoustic-fish-fence

Figure 6: The culvert outlet of Charlesworth Drain (left) and internal flap gate (right), during the October 2024 visit (incoming tide).

2.4.2. Risk to Fish Passage

Both structures were visited twice to assess their risk to fish passage; once in October 2024 during an incoming tide, and once in September 2025, during an outgoing tide. During the October 2024 visit, both flap gates were closed, and thus, they were a very high risk to fish passage. During the September 2025 visit, both of their respective flap gates were partially open[7]. During the outgoing tide, flows were slow through the culvert and around the Lovetts Drain flap gate, resulting in a low risk to fish passage.

In Charlesworth Drain, velocities were swift through the culvert and around the flap gate, which would likely exclude weaker swimming fish species including inanga. Thus, the Charlesworth structure was considered a moderate risk to fish passage during the outgoing tide. The Charlesworth structure also includes an adjacent culvert, that was intended to provide fish passage (Pers. Comm., Colin Hill, CCC, October 2024). However, this culvert has collapsed, filled with gravels, and is no-longer effective.

Although the exact duration of tide gate closure is unknown, it is reasonable to assume they remain closed for approximately 50% of the tidal cycle (i.e., during the incoming tide). On this basis, the Lovetts Drain flap gate is considered a moderate risk to fish passage, while the Charlesworth structure presents a high risk, due to the additional velocity barriers during the outgoing tide.

Aquatic habitat is limited upstream, comprising mostly tidally inundated reaches in Lovetts Drain. Charlesworth Drain provides a small amount of generally low-quality, freshwater, aquatic habitat. A fish survey in Charlesworth Drain in 2022 recorded low numbers of shortfin eels (Instream Consulting 2023a). Thus, these structures are a low priority for remediation based on their potential benefits to fish passage; nevertheless, their removal may still facilitate other ecological gains (see Section 2.4.3).

[7] Maximum width of openings: Lovetts Drain = 110 mm, Charlesworth = 170 mm.

2.4.3. Other Considerations

- **Naturalisation of the Linwood Paddocks:** The low-lying area surrounding Charlesworth Drain and Lovetts Drain are owned by CCC. While they are currently managed for low production farming, CCC is investigating options for restoring this area into an array of wetland and dryland habitats. Removal of these gates would facilitate saltwater intrusion, and the establishment of wetland and salt-marsh habitats.

- **Inanga Spawning:** In 2025, inanga spawning surveys were undertaken in Lovetts and Charlesworth Drains (Instream Consulting 2025a). Although suitable spawning habitat was abundant, no active spawning was observed. This absence was attributed to a combination of limited high-quality adult inanga habitat and potential migration barriers associated with the flap gates. Remediation of the Lovetts and Charlesworth gates is therefore unlikely to have detrimental impacts on inanga spawning, and may instead enhance spawning opportunities.
- **Condition and renewal:** Both structures were in functional, but structurally poor condition, including erosion around the upstream headwall. If the structures are unable to be removed, renewal may be required.

2.4.4. Knowledge Gaps and Recommendations

- The most ecologically preferable outcome is for the removal of both gates, which would enhance fish passage, while also supporting CCC's proposed naturalisation of the Linwood paddocks.
- If removal of the gates is not feasible, then alternative remediation options could be considered.
- Due to the currently limited and low quality aquatic habitat upstream, it is likely not cost-effective to implement many potential flap gate remediation options (see Section 2.2.4 for potential options).
    - Remediation options involving delaying gate closure rely on adequate baseflows that are not present in these waterways.
    - Therefore, chocking the gates partially open, or installing an orifice in the face of each gate, are likely the only cost-effective and practical remediation options.

2.5. Linwood Canal Tide Gates

2.5.1. Description, State, and Function

The Linwood Canal tide gates are located at the outlet of Linwood Canal, where it discharges into the Ihutai–Avon-Heathcote Estuary. The structure comprises four, top-hung gates including counterweights (Figure 7). The gates are in poor condition, and CCC is currently investigating their renewal as part of a Linwood Canal restoration project. To inform this proposed renewal, a trial is underway to understand how these gates currently operate, and to assess the potential impacts of remediation options on fish passage and stormflow conveyance. This trial involves sensors monitoring gate angle and water levels upstream and downstream of the gates (Figure 7).

The ongoing investigation confirmed that the gates are not functioning as intended and are in poor condition. Several are leaky and fail to seal fully on the incoming tide. Most notably and until recently, the true right gate left a 420 mm gap during incoming tides (Pers. Comm., Colin Hill, CCC, January 2025). It was later discovered that this gate had been intentionally jammed open with a wooden structure, without CCC's knowledge (Pers. Comm., Colin Hill, CCC, February 2025).

This gate appears to have been leaky for several years and was identified in 2018 as the main source of tidal ingress (Orchard 2018). Without CCC intervention the obstruction was removed and the gate resumed closing on the incoming tide. At the time of writing, the largest observed gap was associated with Gate 3 (third from the true right), which remains at least 100 mm open throughout the tidal cycle. Monitoring of the gates is ongoing and will be reported independently.

Figure 7: The tide gates in Linwood Canal (left), including the water level and gate angle sensors associated with the ongoing study (right).

2.5.2. Risk to Fish Passage

These gates present a high risk to fish passage, as opportunities for passage are very limited when the gates close on an incoming tide. Historically, the jammed gate on the true right has provided passage through most of the tidal cycle, and weak swimming and climbing species such as inanga have been recorded in large numbers upstream. However, since this gate resumed functioning in May 2025, passage opportunities are further restricted. Gate 3 (third from the true right) continues to provide some degree of passage on incoming tides via an approximately 100 mm gap. The heavy construction of the gates is likely to result in a large degree of throttling, increasing the risk of velocity barriers during the outgoing tide.

2.5.3. Other Considerations

- **Linwood Canal enhancement project:** A project is currently proposed to enhance Linwood Canal, including riparian planting and realignment of sections. To maximise the ecological benefits of the project, remediation of the tide gates is being considered. Coinciding fish passage remediation with capital projects such as this, has the potential to create greater efficiency in ecological gains.
- **Inanga spawning:** Linwood Canal is a productive spawning ground for inanga. Modification to the tide gates has the potential to interact with inanga spawning, through

changes in the extent of the saltwater intrusion, and through alteration to the spring tide levels. These factors are being considered, both in the design of the waterway enhancement, and in the potential remediation of the gates.

2.5.4. Knowledge Gaps and Recommendations

- The primary knowledge gap limiting the remediation of these gates is understanding the relationship between current gate performance, gate performance under potential remediation options, and stormflow conveyance. The ongoing study aims to address these gaps.

2.6. Corser Stream and Lake Kate Sheppard Flap Gates

2.6.1. Description, State, and Function

Corser Stream and Lake Kate Sheppard flap gates are located at the outlets of their respective waterways, where they discharge into the Ōtākaro/ Avon River. The Corser Stream structure involves a top-hung flap gate, which appeared to be in functional condition during our site visit on 2 September 2024. At the time of this site visit, the tide was outgoing, and Corser Stream was discharging into the Avon River. Despite this, the gate hung almost completely vertical, with water flowing around the gate via two approximately 150 mm wide gaps at either side of the gate. Due to the heavy construction of the gate, and the moderate flows in Corser Stream, it is unlikely that the gate opens much wider than this under baseflow conditions.

The Lake Kate Sheppard outlet involves two culverts that run under New Brighton Road. At the upstream end of these culverts, there are two rubber flaps that are approximately half the height of the culvert inlets, restricting the outflow from Lake Kate Sheppard. Two aluminium flap gates are located internally within the structure, which are controlled by a float and trigger mechanism. These flap gates are activated when Lake Kate Sheppard reaches a relative level of greater than 10.6 m (Beca 2017); however, under baseflow conditions, these gates default to an open position. At the downstream end of the culvert are two stop-logs, which moderate the tidal influence from the Avon River. At high tide these are submerged, while a drop-off forms at lower stages in the tidal cycle (Figure 9).

Figure 8: The Corser Stream flap gate (left) and Corser Stream, upstream of the flap gate (right).

Figure 9: The Lake Kate Sheppard outlet structure, including the discharge into the Avon River (left) and the upstream flow-restricting flaps (right).

2.6.2. Risk to Fish Passage

The Corser Stream flap gate presents a high risk to fish passage on incoming tides, when it is closed, and a moderate risk to fish passage on outgoing tides, when it hangs slightly open. The Lake Kate Sheppard outlet structure presents a very high risk to fish passage during the outgoing and lower stages of the tidal cycle. During outgoing tides, whirlpools and high velocities are generated by the rubber flaps at the inlet (see Section 2.6.1). This is likely to prevent passage of weaker swimming species. At lower stages in the tidal cycle, the downstream stop logs at the outlet create a drop off, excluding most fish species and life stages.

During higher, incoming, stages of the tidal cycle, these stop logs are inundated, and water flows freely into Lake Kate Sheppard. Under these conditions, the structure presents a low risk to fish passage. How long this structure excludes fish is currently unknown; however, based on our field observations, it is likely to be over half the tidal cycle. Both structures have the potential to exclude weak swimming fish species during certain times in the tidal cycle when velocities are high. This risk is heightened by the flow restrictive nature of their designs.

Weak swimming and climbing inanga have been recorded upstream of both structures, in their respective waterways, as well as in Travis Wetland[8], confirming that both structures are passable by all fish species, during some points in the tidal cycle. Furthermore, inanga spawning surveys in both waterways confirmed inanga were spawning in Lake Kate Sheppard in 2025 (Burns 2025), and, while no spawning was recorded in Corser Stream during the same survey, there are historic records of spawning activity (Orchard 2017). Thus, these structures are partial barriers, providing fish passage to all species, at some point during the tidal sequence.

Both waterways provide potential passage to the upstream Travis Wetland. Travis Wetland provides a large amount of aquatic wetland habitat, which is rare in an urban landscape. The abundant aquatic habitat upstream of these structures elevates their priority for further investigation, and potential remediation.

[8] E.g., NZFFD cards: 30484, 117531, and 110684

2.6.3. Other Considerations

- **Inanga spawning:** Inanga spawning has been recorded upstream of both structures in their respective waterways, most recently in 2017 in Corser Stream, and in 2025 in Lake Kate Sheppard (Burns 2025). Modification of the outlet structures to improve fish passage has the potential to increase the saltwater ingress in these waterways, and thus, shift the potential spawning habitat upstream.
  - Orchard (2017) recorded inanga spawning in Corser Stream, near the tide gate outlet. This area, as well as most of the upstream reaches of the waterway, were assessed by Burns (2025) as providing 'bad' quality spawning habitat. Thus, potential increases in saltwater ingress are unlikely to negatively impact inanga spawning in the waterway, as the current spawning habitat is poor quality. Opportunities for enhancing spawning habitat quality in Corser Stream are high, as the waterway is situated within a reserve, surrounded by red-zoned land. Thus, restoration activities would not be limited by the proximity of residential properties.
  - Burns (2025) assessed that Lake Kate Sheppard provides large areas of high-quality inanga spawning habitat, extending most of the length along the eastern side of the lake. Thus, it is unlikely that modifications to the outlet structure would result in the extent of the saltwater intrusion shifting to an area that is not suitable for inanga spawning.

2.6.4. Knowledge Gaps and Recommendations

- The presence of inanga upstream of the Corser Stream and Lake Kate Sheppard outlet structures confirms that there is some degree of passage for all fish species. Despite this, observations from our site visit suggest that the structures likely limit passage during some stages of the tidal sequence.
  - Monitoring should be carried out to better quantify the risks to fish passage, through the tidal sequence. At the Lake Kate Sheppard outlet, this could involve installing a water level logger to identify when the stop logs are inundated. In Corser Stream an accelerometer could be installed to monitor gate angle through the tidal sequence, as well as investigating potential velocity barriers.
- The results of Burns (2025) suggests that inanga spawning is unlikely to be adversely affected by potential modification to the outlet structures. However, surveys of saltwater ingress, as well as modelling of potential future scenarios, may be required to confirm this.
- Options for relocating the Corser Stream control structure upstream towards Kingsbridge Drive could be considered.
  - This would provide flood protection to residential areas, while facilitating uninterrupted fish access, and a natural tidal regime, to the sections of the waterway through the non-residential area.
  - Modelling would be required to confirm the hydraulic impacts of this potential remediation option.
- Any improvements to fish passage at the Corser Stream flap gate should be accompanied by ecological enhancement of the upstream waterway.
  - The section flowing through non-residential land is a strong candidate for restoration and, when combined with fish passage improvements, could deliver significant ecological gains.

- Ecological enhancements must also ensure that high-quality inanga spawning habitat continues to be available in Corser Stream. This requires consideration of potential shifts in spawning location resulting from changes to the downstream flap gate and the effects of anticipated sea level rise.
- Remediating the Corser Stream structure may represent a more cost-effective solution to improving fish passage into Travis Wetland. This is because it is a comparatively simple structure, whereas the Lake Kate Sheppard outlet is complex, with internal mechanisms.

2.7. Ferrymead Structures

Numerous structures are in the Ferrymead area. Locations of investigated structures are provided in Figure 10, with photographs provided in Figure 11. The sections below focus on those structures that are likely to impede fish passage or provide other opportunities for ecological enhancement. Structure numbers used in the sections below refer to those presented in Figure 10 and Figure 11.

2.7.1. Structure 1: Unnamed Heathcote River Tributary Pumpstation

This structure is believed to be a disused private pumpstation (Pers. Comm., Emily Tredinnick, CCC, October 2024), with a small flap gate outlet. The flap gate appeared operational at the time of our site visit (10 October 2025). The structure is a high risk to fish passage, due to the default gate position being closed.

Aquatic habitat is minimal upstream of the structure, and thus, the structure is a low priority for fish passage remediation. However, removal of the structure would facilitate additional saltwater ingress into the surrounding paddock area, in line with CCC's long-term plans to enhance the ecological values of the area (Ferrymead Park Development Plan Stage 2, December 2023). Increased connectivity with the estuary would help restore the area to a more natural state, providing fish habitat, supporting the expansion of saltmarsh vegetation, and delivering significant benefits for shore and wading birds (Pers. Comm., Robbie Hewson, CCC, September 2025). Naturalisation of the upstream channel could further enhance these values.

The hydrological impacts of removal would need to be modelled to assess potential changes in upstream flood risk (Pers. Comm., Emily Tredinnick, CCC, September 2025). CCC is also considering a lidar survey to provide elevation data for the paddocks and to identify low-lying land suitable for wetland restoration (Pers. Comm., Robbie Hewson, CCC, September 2025). Together, hydrological modelling and lidar analysis would provide an understanding of the potential flood risk, while also identifying the potential ecological benefits, associated with the removal of the structure.

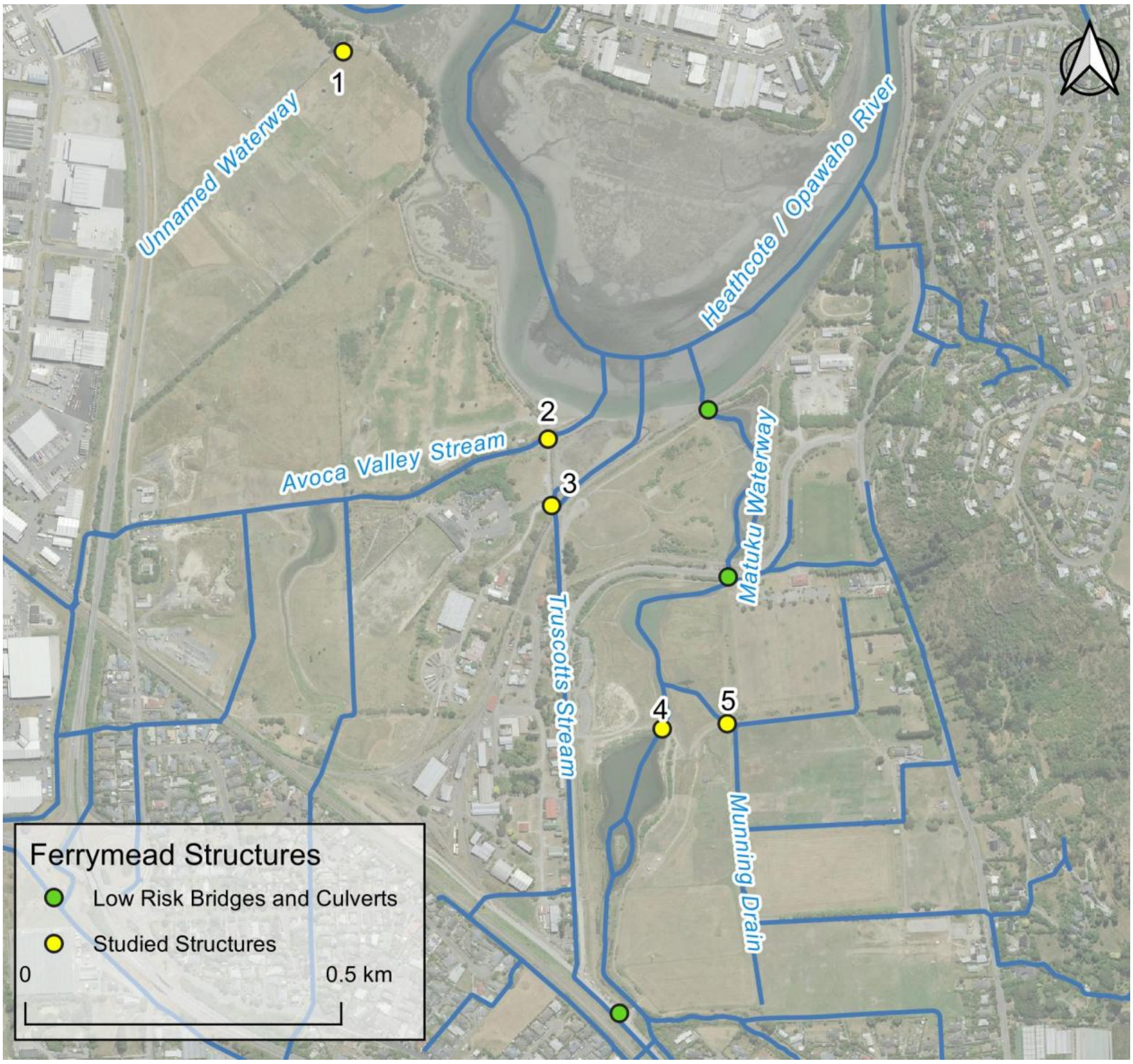


Figure 10: Structures investigated in the Ferrymead area. Structure labels refer to those used in Figure 11, and in the sections below.

2.7.2. Structure 2: Avoca Valley Stream Tide Gates

This structure includes two 'fish friendly' tide gates installed in June 2017, involving a cantilever design. At the time of our site visit (10 October 2024), three of the four counterweight cables were broken and thus, they were not effectively delaying gate closure. We understand that the cables on these tide gates have been replaced twice previously (Pers. Comm. Colin Hill, CCC, October 2024). A 2018 study including these gates found that they were effective at providing for fish passage when functional (Instream Consulting 2018). Solutions to prevent future cable breakages are required to ensure their ongoing function.

Instream Consulting (2018) acknowledged the interaction between these gates and the salt-marsh plant communities in the upstream catchment. Recommendations were made regarding future adjustments to the gates and achieving appropriate saltwater intrusion to support salt-marsh communities. In addition, these gates are held open for 48-hours, twice per year, to allow additional saline water to reach the upstream sections (Pers. Comm. Colin

Hill, CCC, October 2024). However, this has been inadequate to prevent the ongoing loss of salt-marsh vegetation (Pers. Comm, Andrew Crossland, CCC, October 2024). Saltwater intrusion is currently further limited, due to the non-functioning cantilevers, which could lead to additional losses in salt-marsh vegetation, if not remediated.

Figure 11: Investigated structures in the Ferrymead area, described in the sections below. Structure numbers refer to those used in Figure 10.

2.7.3. Structure 3: Truscotts Stream Tide Gate

This structure includes a single 'fish friendly' tide gate, involving a cantilever design. The gate was in functional operating condition during our site visit on 10 October 2024. It has been shown to effectively provide passage for all fish species, during targeted fish surveys (Instream Consulting 2025c, Instream Consulting 2018). However, Instream Consulting (2025c) suggested that many fish that enter the waterway may fail to complete their life cycles, due to a lack of adult habitat upstream, a high risk of bird predation, and a lack of appropriate spawning areas for inanga. Options for the renewal of the lining of Truscotts Stream, or the piping of sections of the waterway, are currently being considered by CCC, and this structure may be removed or relocated as part of this project Instream Consulting (2025c).

2.7.4. Structure 4: Matuku Waterway Pond Control Structure

This structure includes a throttled pipe control, which carries baseflow, as well as a series of wooden weirs, which water can spill over during stormflows. A fish survey completed in 2025 confirmed that this structure was having a substantial impact on native fish distributions, with reduced abundances of many migratory fish species upstream (Instream Consulting 2025c). The priority of this structure for remediation is increased by the abundant aquatic habitat upstream, including Ferrymead Pond, and the upper sections of Matuku Waterway.

CCC is currently considering options to enhance fish passage past this structure, including the construction of a bypass channel (Pers. Comm. Kevin Williams, CCC, September 2025). See Instream Consulting (2025c) for additional information.

2.7.5. Structure 5: Munning Drain Flap Gate

This structure includes two top-hung flap gates. At the time of our site visit (10 October 2024), they were moving freely and appeared to be functioning as intended. Under baseflow conditions, they rest in almost completely closed position and thus, they are a high risk to fish passage. Aquatic habitat is extremely limited upstream of the gates (Figure 11), and therefore, they are low priority for fish passage remediation. However, removal of these gates may increase saltwater ingress into the paddocks upstream, and facilitate the establishment of salt-marsh vegetation communities. While the removal of these gates is likely to improve ecological values in the area, through the promotion of salt-marsh vegetation, we recognise that the sections upstream are beyond the extent of the Ferrymead Park Development Plan Stage 2 (December 2023) and are currently actively grazed.

2.7.6. Knowledge Gaps and Recommendations

- The highest priority structure for fish passage remediation in the Ferrymead area is the control structure between the Ferrymead ponds (Structure 4 above).
  - CCC is currently investigating options for enhancing passage past this structure, including a bypass channel (Pers. Comm. Kevin Williams, CCC, September 2025).
  - The proposed bypass channel must be designed to facilitate the passage of weak swimming and climbing inanga, which are present downstream.
  - Refer to Franklin et al. (2024; Section 7.3.6; 'Nature-like bypass channels') for bypass channel design guidance.

- The Avoca tide gates (Structure 2 above) are currently not effective, due to broken cantilever cables.
    - This has been an ongoing issue, and options to prevent future breakages should be considered. Potential solutions include strengthening the cable design by increasing cable gauge and identifying and addressing sources of wear.
- Many of the structures in the area inhibit saltwater ingress and consequently limit salt-marsh vegetation values in the area.
    - Structures should be removed, where possible.
    - Where structures are required to maintain stormwater function (e.g., Avoca tide gates), options for improving the level of salt-water ingress under baseflow conditions should be investigated. Potential options include:
        - Relocating structures as far upstream as practicable.
        - Partial chocking of gates to prevent closure on incoming tides.
        - Adjusting cantilevers on fish friendly gates (i.e., Avoca and Truscotts tide gates) to further delay closure.
        - Increasing the number of times per year, and duration, that the Avoca tide gates are manually held open for.
    - All modifications to these gates would require modelling to ensure that there is no unacceptable increase in flood risk upstream.

2.8. Tide Gate Priorities

Based on information gained during the tide gate investigation and summarised above, we present what we consider to be the priority order for these structures in Table 2. Structures identified as highest priorities for further action included those that were a high risk to fish passage, had large amounts of quality habitat upstream, or were expected to provide beneficial outcomes for proposed enhancement projects in the area.

Table 2: Relative priority of structures investigated during the tide gate study.

Priority	Structure	Justification
1	Sheppards Drain flap gate	• Pūharakekenui–Styx River is considered by CCC to be a high priority catchment for restoration. • High risk structure, with confirmed impact on native fish distributions. • Structure is in poor condition and will likely require remedial works soon. • Established wetland habitat upstream. • Removal would alleviate risk of trapping fish upstream and may improve water quality.
2	Corser Stream and Lake Kate Sheppard flap gates	• Abundant high-quality habitat upstream. • High restoration potential in Corser Stream. • High potential to enhance inanga spawning. • Of the two structures, remediation of Corser Stream gate may represents a more cost-efficient solution to improving passage into Travis Wetland.
3	Linwood Canal tide gates	• High risk structure. • Potential to have a large impact on a productive inanga spawning ground upstream. • Opportunity to tie-in with existing capital project for improved cost efficiency.
4	Ferrymead: Matuku Waterway Pond control structure.	• High risk, with confirmed substantial impact on native fish distributions. • Large amounts of aquatic habitat upstream, including a wetland.
5	Ferrymead: Avoca Valley Stream tide gates	• Low risk when functional, but counterweight cables frequently break, resulting in a high risk to fish passage. This may also negatively impact salt-marsh values upstream.
6	Bells Creek flap gate and pumpstation	• Stormwater pumps likely present a risk to fish health, but further investigations required to quantify risk. • Low priority for fish passage enhancement, but high priority for fish health investigation.
7	Styx River Main Tide Gates	• Pūharakekenui–Styx River is considered by CCC to be a high priority catchment for restoration. • Suspected to be a partial barrier, but duration during which fish are excluded is not certain. • Remains a high priority for further investigation, due to the large size of the waterway, the potential number of fish affected, and the large upstream catchment.
8	Lovetts Drain and Charlesworth Drain flap gates	• Low priority for fish passage remediation due to limited aquatic habitat upstream. However: • Removal could facilitate restoration of the Linwood paddocks.
9	Ferrymead: unnamed Heathcote River tributary	• Low priority for fish passage remediation due to limited aquatic habitat upstream. However: • Removal could facilitate establishment of salt-marsh vegetation, in line with existing CCC plans for the area.
10	Ferrymead: Munning Drain Flap Gate	• Low priority due to limited aquatic habitat upstream. • Remediation could increase saltwater ingress, and facilitate establishment of salt-marsh vegetations upstream.
11	Ferrymead: Truscotts Stream Tide Gate	• Low risk. • Limited, low-quality habitat upstream, which may be piped in the future.

3. BARRIER PRIORITISATION UPDATE

The Fish Barrier Prioritisation Database was updated following the methods described in Instream Consulting (2023a). This involved a review of CCC GIS layers for any new structures, downloading the Fish Passage Assessment Tool (FPAT) database[9] to identify any new structure assessments, and downloading the New Zealand Freshwater Fish Database[10] to find any new fish records[11]. The CCC's fish barrier prioritisation model (Figure 12) was re-run to assign priorities to all new structures, as well as updating priorities for structures for which there was new information available.

The only difference from the update methodology described in Instream Consulting (2023a) was that structures associated with offline stormwater systems were included for prioritisation. Previously these structures were excluded, as risks to fish health associated with stormwater habitats were poorly established. However, results of a recent CCC study on fish in stormwater wetlands suggested that risks to fish health were low for most fish species, in all but the most polluted wetlands (Instream Consulting 2024). Based on these findings, Instream Consulting (2024) recommended that fish passage be provided for in all wetlands where the risk was not perceived to be high. Thus, offline stormwater wetlands were included in the current prioritisation update.

[9] https://fishpassage.niwa.co.nz
[10] https://nzffdms.niwa.co.nz
[11] All data associated with the update was downloaded on 1 April 2025.

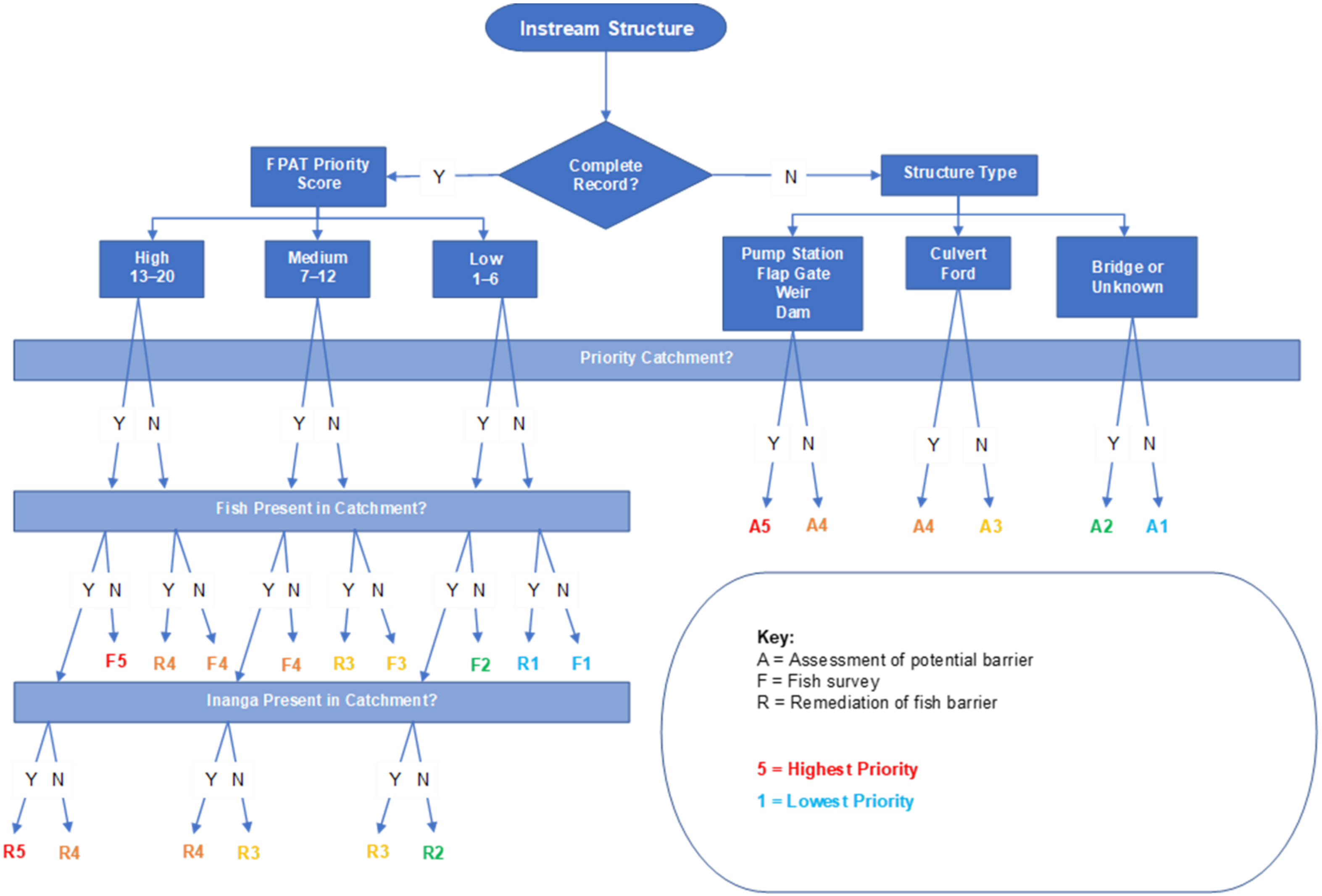


Figure 12: The decision tree model used to assign actions and priorities to structures in the prioritisation database, from Instream Consulting (2023a). Y=yes, N=no.

3.1. Priority Structures

The updated Fish Barrier Prioritisation Database included a total of 2,604 structures, including 13 new structures constructed since the previous update, and 144 new FPAT assessments. Of the 1,352 structures included in CCC's structure GIS databases[12], 59 were assigned a high priority for further action (i.e., priority 4 or 5), comprising 19 structures for remediation (R), 4 for fish surveys (F), and 36 for fish passage assessment (A; Table 3). Details of structures included in CCC's databases that were identified as high priorities for remediation or for fish surveys are summarised in Table 4, with locations indicated in Figure 13.

An additional 196 structures were identified as high priorities for further action but were not included in CCC's structure databases, or were recognised as not being owned by CCC. Of these, 15 were prioritised for remediation, 11 for fish surveys, and 170 for fish passage assessments. Details of these high remediation and fish survey priority structures are provided in Appendix 2.

While a ownership review was beyond the scope of the current project, many of the structures in Table 4, and some of the structures in Appendix 2, are likely to be CCC responsibilities. The CCC GIS databases also contains records of structures not owned by CCC, while conversely, some structures not included in the databases are known to be located on CCC reserve land and are therefore likely CCC responsibilities (Instream 2023a). We recommend that an ownership review is undertaken for all structures in Table 4 and Appendix 2 to identify potential CCC assets.

A notable non-CCC structure was identified during the current prioritisation update. This involved NZTA-owned flap gates, downstream of State Highway 1, on Wilsons Drain (FPAT ID 141120; Appendix 2). They were assigned a maximum remediation priority (R5), as they were assessed as being a high risk to fish passage, with a large amount of high-quality aquatic habitat upstream (including Ōtūkaikino Wetland), while fish records indicate that weak swimming and climbing inanga are excluded from the upper catchment. We understand this barrier is known to CCC, and that post-construction movement of the pipe under State Highway 1 may have further reduced fish passage through the pipe (Pers. Comm., Kevin Williams, CCC, September 2025). Although not a CCC asset, the barrier has the potential to reduce the effectiveness of CCC's planned restoration activities upstream, including naturalisation of sections of Wilsons Drain and wetland enhancements within the catchment.

Regardless of ownership, fish barriers can significantly limit the ecological outcomes of upstream enhancement projects, including waterway restoration and remediation of other barriers. Thus, multiple agencies are likely to have interest in addressing them. This presents valuable opportunities for collaboration, including co-funding and sharing technical expertise. To maximise efficiency and ecological benefit, it is essential that all relevant agencies work together, maintain strong lines of communication, share resources where possible, and coordinate remediation efforts.

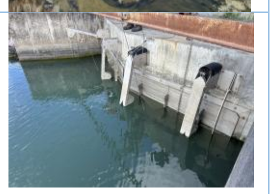
[12] Note that not all structures included in CCC's structure GIS databases are owned or managed by CCC. We are aware that ownership is unknown or contested for some structures. This project did not include a review of asset ownership, which must be confirmed internally by CCC before any actions to address fish passage issues are undertaken.

Table 3: The number of structures in each of the prioritisation categories, including those in CCC's structure databases, and those with other or unknown ownership. Note that many, but not all, structures included in CCC structure databases are owned by CCC. Structures in the 'Other' ownership category include assets belonging to New Zealand Transport Authority, ECan, Selwyn District Council, and private individuals.

Priority[1]	Included in CCC Databases	Other Owners	Unknown Ownership	Total
R5	6	1	0	7
R4	13	11	3	27
R3	34	0	15	49
R2	48	4	22	74
R1	192	7	94	293
F5	2	2	0	4
F4	2	7	2	11
F3	51	5	10	66
F2	55	2	25	82
F1	215	22	89	326
A5	19	4	32	55
A4	17	54	80	151
A3	432	49	115	596
A2	61	0	152	213
A1	205	1	444	650
Total:	**1,352**	**169**	**1,083**	**2,604**

Note: [1] 1 = low priority, 5 = high priority, 'R' = Remediation, 'F' = Fish survey, 'A' = FPAT Assessment.

Table 4: *Structures that are a high priority to CCC for remediation or fish surveys, updated from Instream Consulting (2023a). Note that not all structures in this table are CCC assets. Structures are ordered firstly by action (i.e., remediation or fish survey) and secondly by priority score. Structures with the same priority score have been ordered from highest priority to lowest priority, based on expert ecological judgement and local knowledge. CCC GIS Asset Code refers to the relevant GIS layer and asset number of each structure. Structures that have only been identified as high priority during the current study, and those that have changed in priority since the previous prioritisation round, are indicated in with an asterisk (*). Merged Priority Score and Comments fields indicate that multiple structures would need to be investigated simultaneously to achieve the maximum ecological benefit.*

Site Code	Waterway (Catchment)	FPAT ID	Structure Type	CCC GIS Asset Code	Priority Score	Comments	Photographs
1*	Storer Diversion (Ōtūkaikino Creek)	130044	Pump station	WcWeirs 200	R5	A fish survey completed in 2025 confirmed that these structures are a high-risk to fish passage, collectively excluding fish from up to approximately 35 km of waterway length in the upper Ōtūkaikino Creek catchment (Instream Consulting 2025b). While remediation of either structure could facilitate upstream passage, weak swimming species such as inanga appear to preferentially select the Storers Diversion. Thus, it is a higher priority for remediation. See Instream Consulting (2025b) for more details.	
2	Ōtūkaikino Creek (Ōtūkaikino Creek)	130047	Weir	WcWeirs 199	R5		
3	Sheppards Drain (Pūharakekenui – Styx River)	187054	Flap gate with culvert	SwPipe 37486	R5	A high-risk flap gate and culvert at the confluence between Sheppards Drain and the Styx River. A fish survey in 2023 confirmed that the structure excludes most native species from the upper reaches of the waterway. See Section 2.2 for more details.	
4*	Styx Drain (Pūharakekenui – Styx River)	176638	Ford	WcFord 2	R5	A concrete ford with a drop-off at the downstream end. A survey in 2023 confirmed that this structure was excluding weaker swimming and climbing migratory species from the upper reaches of the Styx Drain catchment (Instream Consulting 2023b). Upstream there is abundant aquatic habitat, including two large wetlands in Styx Mill Conservation Reserve.	
5	Takamātua Stream Branch No 7 (Takamātua Stream)	1411	Weir	Unknown	R5	Upstream of CCC bridge A33. A fish survey in 2020 identified abundant native fish downstream, including bluegill bully, redfin bully, longfin eel, and whitebait. No fish were caught upstream, confirming restricted passage (Instream Consulting 2021).	
6	Wainui Valley Stream (Wainui Bay)	1140	Weir	WcWeirs 242	R5	The weir overtops during some high tides and inanga have been recorded upstream. However, fish accumulate downstream of the barrier at low tides, increasing their risk to predation. Therefore, although some fish are passing the weir, it remains a partial barrier. It is a high priority for remediation because it is the closest barrier to the coast, with a large upstream catchment.	
7	Corser Stream	141362	Flap gate with culvert	SwPipe 68303	R4	Kate Sheppard and Corser Stream are the two major outlets from Travis Wetland. Both structures are likely to restrict fish movements, during certain times in the tidal sequence. The large amount of aquatic habitat upstream makes these structures high priorities for remediation. See Section 2.6 for more details.	
8	Kate Sheppard Stream (Ōtākaro – Avon River)	134904	Flap gate with culvert	SwValve 320	R4		
9	Linwood Canal (Ihutai–Avon-Heathcote Estuary)	134909	Flap gate with culvert	SwValve 175	R4	These tide gates are expected to be a high risk to fish passage, for a large portion of the tidal cycle. The priority of this structure is elevated by the significant inanga spawning ground upstream, and the proposed restoration of Linwood Canal. The gates are currently being monitored to investigate remediation options. See Section 2.5 for more details.	
10*	Matuku Waterway (Ihutai–Avon-Heathcote Estuary)	136536	Control structure	SwValve 235	R4	This control structure has been confirmed to substantially impact native fish distributions. There is large amount of aquatic habitat upstream, including the upstream Ferrymead Pond. See Section 2.7.4 for more details.	
11*	Avoca Valley Stream (Ōpāwaho – Heathcote River)	134911	Flap gate	SwValve 170	R4	This structure includes 'fish friendly' tide gates, which, when functional, have been proven to be effective. However, the counterweight cables have broken several times, and they are currently non-functional. A permanent solution is required. See Section 2.7.2 for more details.	
12	Bells Creek (Ōpāwaho – Heathcote River)	134108	Flap gate	SwValve 576	R4	These structures include the Bells Creek pumpstation and associated flap gate outlet. Eels are abundant upstream, confirming passage of strong-swimming and climbing species. However, the fate of downstream migrant eels is uncertain, and the pumpstation appears to pose a potential risk to fish. Further investigation is required. See Section 2.3 for more details.	
13	Bells Creek (Ōpāwaho – Heathcote River)	1140	Pumpstation	SwPump 83	R4		

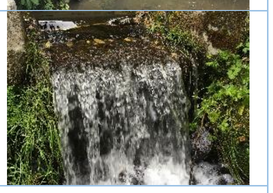
Site Code	Waterway (Catchment)	FPAT ID	Structure Type	CCC GIS Asset Code	Priority Score	Comments	Photographs
14	Totara Stream (Pigeon Bay Stream)	176977	Culvert	SwPipe 60168	R4	A 2023 fish survey confirmed this structure poses a high risk to weak climbers (Instream Consulting 2023a). Active scouring around the apron has created an overhang, increasing risk. Priority is elevated due to the high passage risk and need for apron remediation.	
15*	Pūharakekenui – Styx River (Pūharakekenui – Styx River)	187594	Flap gate with culvert	WcValve 27	R4	These gates may prevent fish passage during some stages of the incoming tide sequence. However, an investigation into how long the gates are closed for is required to assess impacts. The priority of this structure is elevated by the size of the waterway, and the large upstream catchment. See Section 2.1 for more details.	
16	Aylmers Stream (French Bay)	298	Bridge	RAMM A38	R4	Inanga were recorded up to, but not beyond, this bridge. Mussel spat ropes have been installed to enhance passage; however, assessors found them ineffective. The steep topography suggests natural upstream barriers. Remediation costs for providing passage for weak climbers should be weighed against the limited accessible habitat.	
17	Stream Reserve Drain (Lyttelton Harbour – Whakaraupō)	134866	Culvert	SwPipe 76048	R4	A fish barrier survey indicated that the structure is impacting fish passage, with reduced numbers of banded kōkopu (*Galaxias fasciatus*) and shortfin eel caught upstream (Instream Consulting 2023a).	
18	Carews Peek Stream Branch No 8 (Carews Peek Stream)	143153	Culvert	SwPipe 59620	R4	High risk culvert near the confluence with Carews Peek Stream mainstem. Longfin eels and kōaro have both been recorded downstream in the mainstem, but only shortfin eels have been caught upstream.	
19	Little Akaloa Stream Branch No 2 (Little Akaloa Stream)	152283	Culvert	SwPipe 60637	R4	Local fish records indicate that only strong climbing species are present at this elevation. However, the culvert includes a drop off and undercut that may prevent passage of even strong climbing species.	
20	Takamatua Stream (Takamatua Bay)	1413	Water supply intake weir	WsInlet 425	F5	These water intake weirs are <100 m apart. The downstream take (WsInlet 425) is no longer active and is listed as ‘abandoned’ in the CCC’s WsInlet GIS layer. The upstream take (WsInlet 443) is still active. There are no recent fishing records in the vicinity of these structures. A fish survey targeting both structures is recommended to determine the potential impact of the structures on fish distributions and to guide remediation.	
21	Takamatua Stream (Takamatua Bay)	1414	Water supply intake weir	WsInlet 443	F5		
22	Okana River Branch No 3 (Okana River)	174785	Water supply intake weir	WsInlet 475	F4	This water intake weir was assessed as presenting a high risk to fish passage. However, there are no fish records in the catchment to confirm this assessment. A fish survey is recommended to determine the structures impact on fish distributions and to guide potential remediation.	
23	Gibsons Drain (Pūharakekenui – Styx River)	152674	Weir	WcWeirs 85	F4	While fishing records (including inanga) are present nearby in the Pūharakekenui – Styx River, there are no upstream fishing data available. A fish survey is recommended to assess the structure’s impact. There are several culverts upstream (CCC-owned and private) that should be assessed at the same time, to determine the potential habitat gained through remediation.	

Figure 13: The location of structures that are a high priority to CCC for remediation or fish survey.

4. CONCLUSIONS AND RECOMMENDATIONS

Based on the results discussed above, the following conclusions and associated recommendations update those made previously by Instream Consulting (2023a):

- The tide gate investigation yielded information for prioritising structures for remediation and further investigation, with their relative priorities presented in Section 2.8.
    - Tide gates identified as the highest priorities in the district included those that were assessed as being a high risk to fish passage, had abundant high-quality habitat upstream, or had potential ecological benefits extending beyond fish passage.
    - For some of the structures, further investigation is required to confirm risks and to guide remediation design. These considerations are outlined in their respective Knowledge Gaps and Recommendations sections.

- The fish barrier prioritisation update identified 59 structures from CCC's structure databases that were high priorities to CCC for further action, including:
    - 19 structures for remediation. Remediation of these structures should be investigated.
        - For tide gates identified as high priorities, information gained during the tide gate investigation should be used to facilitate their remediation. These include the flap gates on Sheppards Drain, Corser Stream, Kate Sheppard Stream, Linwood Canal, Avoca Valley Stream, Pūharakekenui/ Styx River, and Bells Creek, as well as the Matuku Waterway control structure.
    - 4 structures for fishing. Fish surveys should be carried out at these structures to quantify risks to fish passage and to identify any species-specific remediation design considerations. These structures include:
        - Two water intake weirs in Takamatua Stream (FPAT ID's 1413 and 1414)
        - A water intake weir in a tributary of the Okana River (FPAT ID 174785)
        - A weir in Gibsons Drain (FPAT ID 152674)
    - 36 structures for fish passage assessment. These structures include assets constructed since the previous prioritisation update, newly constructed assets, as well as offline stormwater structures that were previously excluded from prioritisation (see Section 3). Fish passage assessments should be carried out on these structures to assess their potential as fish barriers.

- There are 26 structures that are high priorities for remediation or fish surveys, that are not owned by CCC or have unknown ownership. These structures are provided in Appendix 2.
    - CCC should complete an internal review of these structures to identify whether any are CCC assets that have not been able to be associated with features in CCC GIS spatial databases.

- There are 112 structures with a high priority for fish passage assessment in the Fish Barrier Prioritisation Database that are of unknown ownership.
    - Most of these are weirs, with locations held in CCC's WcWeir GIS layer. Some of these structures are located within CCC land. An ownership review of these structures should be completed to ensure that all CCC assets are identified in the database.

- Many but, not all, structures included in CCC's structure databases are owned by CCC. Conversely, some structures included in the fish barrier database are likely CCC assets, but have not been able to be associated with features from CCC's structure databases. Thus, ownership of structures included in Table 4 and Appendix 2 must be confirmed, prior to carrying out remediation activities.

- Fish barriers, regardless of ownership, can limit ecological outcomes of upstream restoration projects. Thus, all stakeholders involved in restoration in the district are likely to have interest in structure remediation. This generates opportunities for agencies to collaborate through co-funding, shared expertise, and coordinated planning to maximise efficiency and ecological impact.
    - Consultation should be held with other stakeholders in the district, including ECan and the Department of Conservation, to coordinate barrier remediation efforts.

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APPENDIX 1: BELLS CREEK PUMPSTATION SCHEMATICS

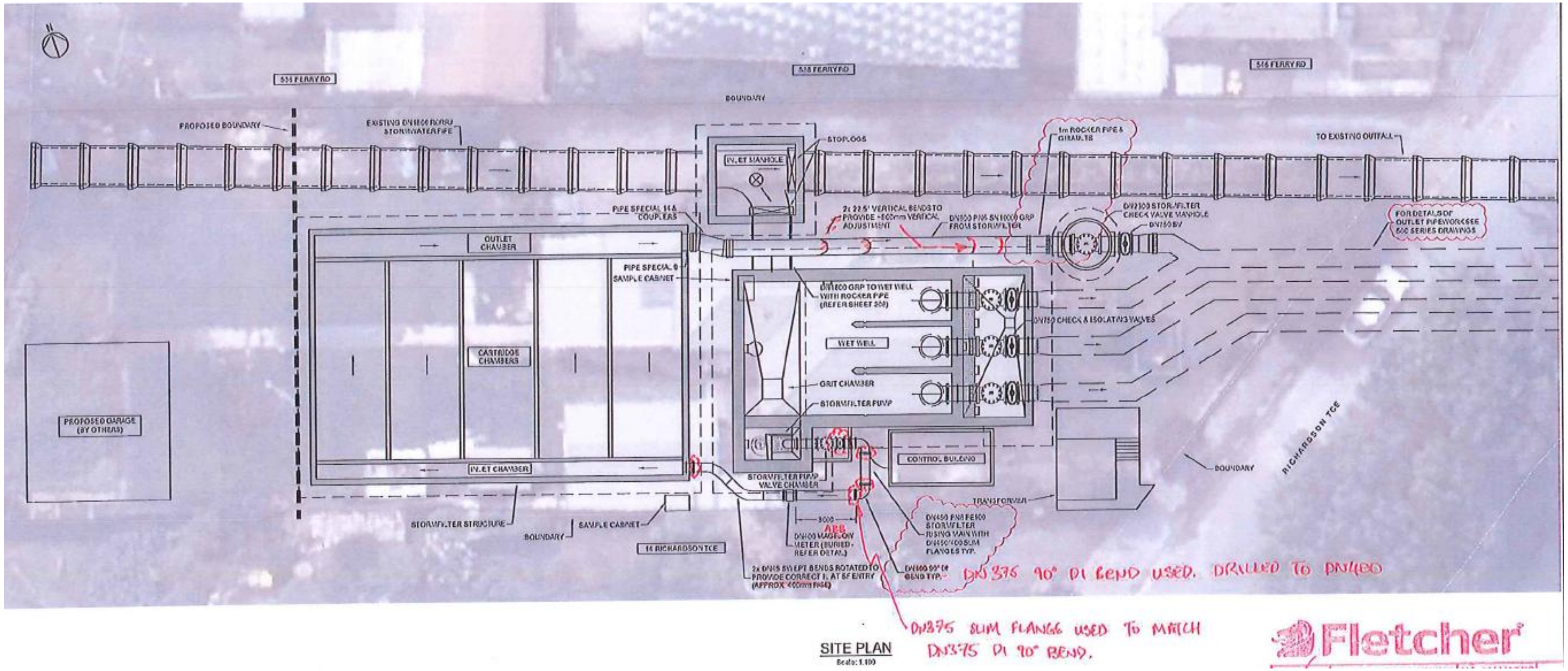

Figure 1: The layout of the Bells Creek pumpstation facility.

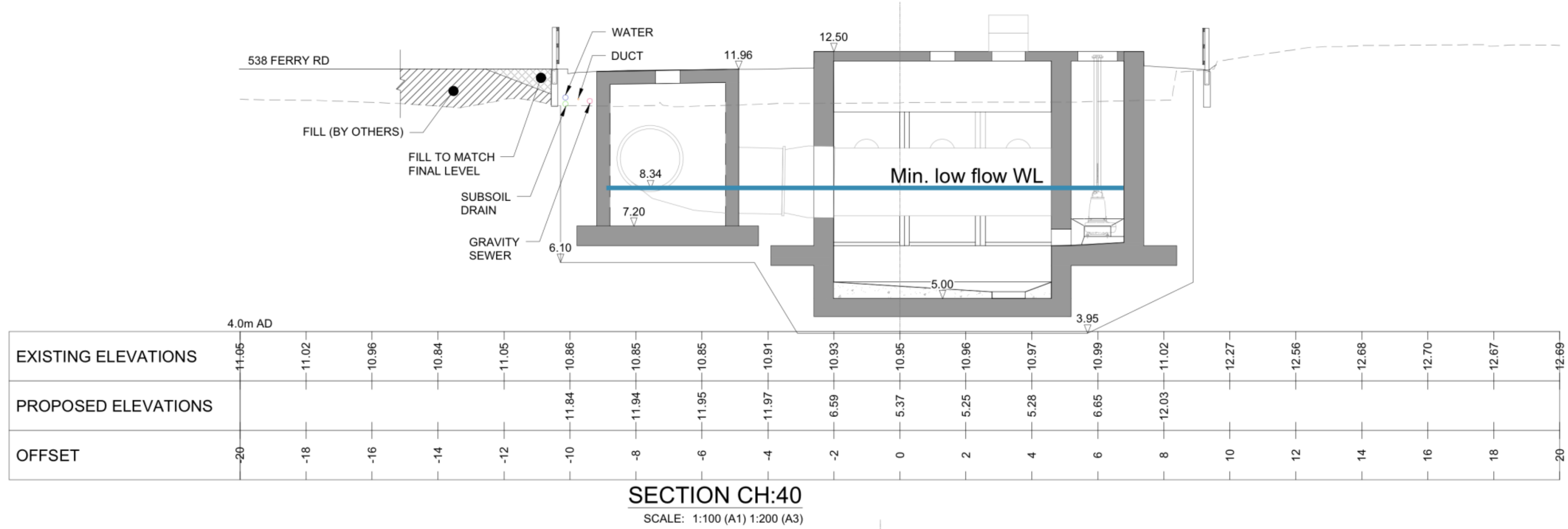

Figure 2: A profile view of the Bell Creek pumpstation. Note the direct connection between the piped section of Bells Creek (left chamber), and the pumpstation wet well (right chamber).

APPENDIX 2: OTHER PRIORITY STRUCTURES

Table 1: High priority structures for remediation and fish surveys with the following ownership status: 'U' = Unknown, 'P' = Private, 'E' = ECan, N = NZTA. Note that ownership is based off information from the publicly accessible FPAT database, and thus, it is indicative. Structures not identified during the previous prioritisation round indicated with an asterisk (*). Structures ordered by Priority Score.

Priority Score	Owner	Waterway	Catchment	FPAT ID	Structure Type	Easting (NZTM)	Northing (NZTM)
R5*	N	Wilsons Drain	Otukaikino	141120	Flap gate with culvert	1571209	5191411
R4	P	Te Wharau Stream	Te Wharau Stream	1174	Ford with culvert	1576306	5166132
R4	P	Pipers Stream	Pipers Stream	1428	Ford with culvert	1596242	5156506
R4	P	Pipers Stream	Pipers Stream	1440	Ford with culvert	1595984	5156008
R4	P	Pipers Stream	Pipers Stream	1435	Other	1595899	5155921
R4	P	Pipers Stream	Pipers Stream	1438	Ford with culvert	1595794	5155808
R4	P	Pipers Stream	Pipers Stream	1439	Ford with culvert	1595728	5155802
R4	P	Barrys Bay Stream	Barrys Bay Stream	1426	Ford with culvert	1591923	5155219
R4	P	Barrys Bay Stream	Barrys Bay Stream	1421	Ford with culvert	1592713	5154862
R4	P	Walnut Stream	French Bay	28207	Weir dam or flow restriction	1597266	5149027
R4	P	Walnut Stream	French Bay	1133	Bridge	1597262	5149012
R4	P	Walnut Stream	French Bay	28214	Weir dam or flow restriction	1597287	5148968
R4	U	Aylmers Stream	Aylmers Stream	304	Weir dam or flow restriction	1597307	5148257
F5	P	Bamfords Road Drain	Allandale	28208	Weir dam or flow restriction	1571520	5167657
F5	P	Te Wharau Stream	Te Wharau Stream	1177	Ford with culvert	1576552	5165478
F4	E	Coutts Island Drain West	Waimakariri River	140924	Culvert or pipe	1565765	5190581
F4	P	Bamfords Road Drain	Allandale	1196	Weir dam or flow restriction	1571532	5167612
F4	P	Bamfords Road Drain	Allandale	1184	Ford with culvert	1571534	5167559
F4	P	Little Akaloa Stream	Little Akaloa Bay	1241	Ford with culvert	1598640	5163935
F4	P	Opara Stream	Opara Stream	1107	Ford with culvert	1600148	5158584
F4	P	Pawsons Stream	Pawsons Stream	1412	Ford with culvert	1594698	5157143
F4	P	Hukahuka Turoa Stream	Hukahuka Turoa Stream	133560	Ford with culvert	1583594	5155952

Priority Score	Owner	Waterway	Catchment	FPAT ID	Structure Type	Easting (NZTM)	Northing (NZTM)
		Branch No 10					
R4*	U	Avon River	Avon River	1113	Weir dam or flow restriction	1567710	5180766
R4*	U	Waimairi Stream	Waimari Stream	1868	Weir dam or flow restriction	1566166	5181639
F4*	U	Unnamed Tributary	Otukaikino	177242	Culvert or pipe	1566844	5188443
F4*	U	Brooklands Lagoon	Brooklands Lagoon	187783	Culvert or pipe	1575727	5193958