15 March 2024

Job No: 1019502

Environment Southland
Private Bag 90116
Invercargill 9840

Attention: Bianca Sullivan

Dear Bianca

APP-20233670 - Manapōuri Lake Control Improvement Project
Response to post-lodgement queries

Introduction

Following formal acceptance of the resource consent applications made by Meridian Energy Limited (Meridian) for the Manapōuri Lake Control Improvement Project (MLCIP) on 20 February 2024 (your reference: APP-20233670), and the workshop between Environment Southland's and Meridian's experts on 16 February 2024, this letter provides a response to the queries raised through subsequent correspondence.

Responses

1. How are Meridian proposing to monitor whether the project is successful?

As part of identifying constraints associated with delivering consented flows at the Manapōuri Lake Control Structure (MLC), Damwatch modelled different flow scenarios based on a new channel excavated through the Mararoa delta area.

The modelling work had a particular a focus on flushing flows to manage nuisance periphyton given that high lake levels are required to produce these flows, and so are the most constrained hydrologically. Modelling has confirmed an expectation that a new channel with a base width of 16 m at RL 172.0 m, would allow 160 m^3/s to be released at a Lake Manapōuri level of approximately RL 177.28 m. This is predicted to increase flushing flow reliability to approximately 70% from the existing approximately 30% reliability.

Meridian is required to comply with existing conditions of consent in relation to flows through the MLC, which are set out in Table 1 overleaf.

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Table 1: Existing consent conditions relevant to flows

Consent	Condition
Water Permit 96022	Condition 2 – Minimum Flows
	Condition 5 – Mararoa Turbid Water
	Condition 8 – Recreational Flows
	Condition 9 – Other Flows
Water Permit 206156	Conditions 3-5 of Water Permit 96022
	Condition 6 - Waiau Arm Water Quality
	Condition 7 - Lower Waiau River Voluntary Supplementary Flows

Annual compliance reporting to Environment Southland is required in relation to the flow-related conditions listed above. Particularly, Condition 7 of Water Permit 206156 requires extensive reporting on supplementary flows for nuisance periphyton biomass management, including the number of flows provided and the effectiveness of the same. Whether the MLCIP has delivered the anticipated improvements in flow conveyance and reliability will be readily apparent through this reporting.

In referencing the same, it is accepted there will still be times when supplementary flows will not be able to be provided, for instance when there are adverse hydrological conditions, or because of lake level management requirements in accordance with the Lake Manapōuri and Lake Te Anau Operating Guidelines.

2. You indicated that you would provide a table with MTADA v RMA and which effects apply where – this would be helpful.

Please refer to Table A1 in **Appendix A**.

3. What are the effects in the mixing zone, particularly on fish and bird species?

<u>Mixing zone</u>

For clarification, the effects of sediment upstream of the monitoring point at Excelsior have been considered, and have been assessed as minor and temporary, subject to the monitoring and trigger level regime proposed in draft conditions. Effects have been considered along the entire LWR, from the MLC to the coast, and the trigger levels have been chosen to manage effects along that whole stretch.

Excelsior has been chosen because practically it is the best point for safe and reliable access to monitor turbidity, and because it is upstream of further any tributaries which have their own inputs (e.g. the Excelsior itself). The management responses (stopping work or providing flushing flows) will address effects within the mixing zone as well as downstream of it.

In relation to section 107, Meridian accepts that there may be times where the criteria in that section (e.g. visual clarity) cannot be complied with after reasonable mixing. Instead, the temporary effects and exceptional circumstances exceptions apply, and a decision maker is not barred from granting consent.

The definition of "reasonable mixing zone" in the proposed Southland Water and Land Plan (the PSWLP) applies in relation to the water quality standards set out in Appendix E (here, for lake fed waterbodies), which Meridian accepts may not be able to be met at all times during construction of the MLCIP. The standards within Appendix E of the PSWLP are intended to apply to the assessment of effects after reasonable mixing. However, there is a specific exception to the standards for the MPS within Appendix E, where:

> *"…an ancillary activity associated with the maintenance of the Manapōuri hydro-electric generation scheme is proposed. This exception only applies where the activity requires a resource consent pursuant to a rule in this plan and will only result in a temporary change in the state of the water".*

This exception for temporary effects associated with maintenance of the Manapōuri Power Scheme was included via mediation in the plan review process. Evidence presented on behalf of Meridian pointed to the MLCIP as an example of the type of project to which the exception was intended to apply.

This exception affects how the rules and policies of the PSWLP apply to the Application, but does not preclude consideration of the effects of a proposed activity on water quality through a resource consent process, which the Appendix specifically notes. To reiterate the above, such effects have been considered along the length of the LWR from the MLC to the coast, and have been found to be temporary and minor, subject to the monitoring and trigger level response regime.

Effects on fish and bird species

Please refer to the memorandum prepared by NIWA in **Appendix B**.

4. What are the risks of fish stranding in the existing channel?

The Project area is located upstream of the MLC gates. The gates control the flow rate released into the Lower Waiau River, and in doing so control the flow rate and water level within the Project area.

In contrast to a typical river setting, the water level in the project area reduces as discharge increases. The level depends on the prevailing upstream lake level and energy losses as the flow passes through the relatively shallow channels in the Project area.

This phenomenon is illustrated by data recorded at site during a flushing flow release (Figure 1 overleaf). During a flushing flow release in May 2021, the headwater level immediately upstream of MLC dropped by some 800 mm over 9 hours as the flow release was ramped up. This is close to the highest drawdown currently experienced – where a large discharge is released at a relatively low lake level.

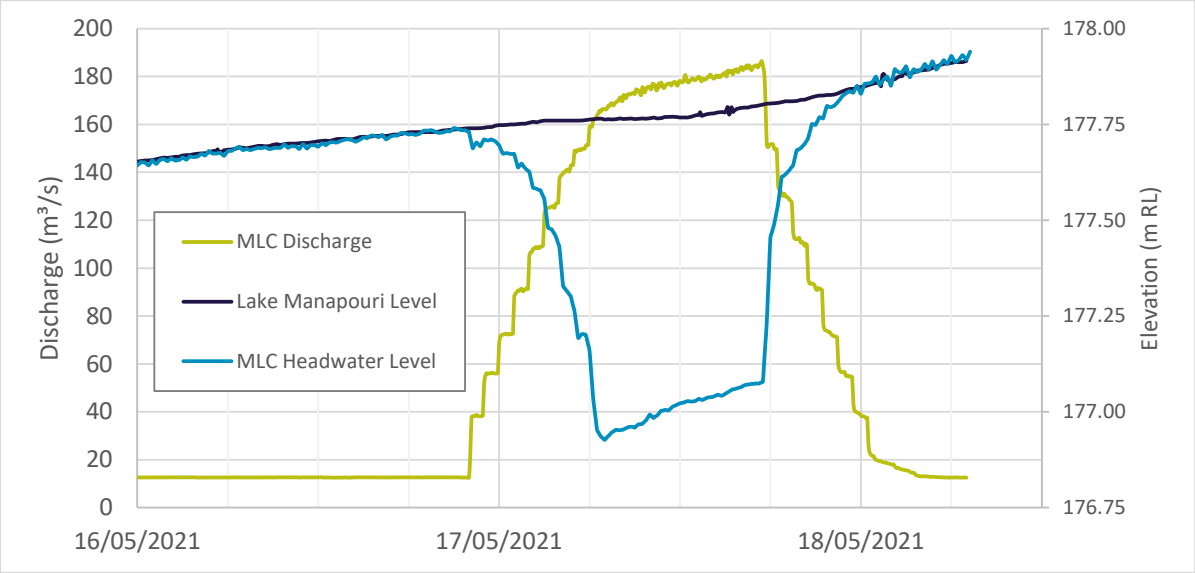


Figure 1: Water level recorded at Lake Manapōuri and at MLC during flushing flow release, May 2021

The Project aims to provide greater flow conveyance in the approach to the MLC control gates, which will reduce this drawdown effect. Post construction, in the same conditions as the May 2021 flushing flow release the water level in the new and existing channels is expected to draw down only some 200-300 mm. Meridian will retain procedures for slowly ramping up changes in such flow releases to prevent rapid changes in water level within the river.

The potential risk of fish stranding upstream of MLC is minimised with reduced water level drawdown rates and magnitude occurring during flow releases and is no greater than currently exists. There have been no fish strandings in the existing channels reported to Meridian.

5. Table D1 of the freshwater appendix contains the bird species that are present. Could the additional memos that were discussed be provided please – we understand that these contain information on frequency and types of visits.

Please refer to the memorandum prepared by NIWA in **Appendix B**.

6. An error was acknowledged in table 7-2 of the freshwater appendix. Could a corrected table be provided?

The error in Table 7-2 of Appendix D to the AEE was that the expected magnitude of effect of the Project for periphyton in the Lower Waiau River was listed as Minor. Given the existing state of periphyton in the LWR (i.e., frequent nuisance growths in summer) and the relatively short duration of potentially elevated sediment inputs, these effects should instead be considered less than minor. A replacement Table 7-2 is provided in **Appendix C**.

7. Could a statement be provided on the overall impact on biodiversity, ie loss, maintain or gain?

The Project's primary purpose is to improve the conveyance and reliability of flows through the MLC. The Project will have temporary adverse effects of a short duration on both terrestrial and aquatic ecology during the construction period, and will result in the permanent removal of one very small low value wetland area. However, biodiversity values, including aquatic ecology below the MLC are expected to recover quickly post construction to the same or similar levels prior to the work being undertaken. There may also be effects during future maintenance activities, but these are

anticipated to be of a lesser degree. These effects are comprehensively described in the technical reports attached to the Assessment of Effects on the Environment (AEE) and are summarised within the AEE.

The Project is expected to result in improved flow management as per existing resource consent requirements, and an ability to provide flushing flows more regularly than is currently achievable. This will lead to enhanced river health outcomes for the LWR and for freshwater ecosystems, particularly with respect to periphyton biomass management. The Project is expected to enable release of a higher proportion of the flushing flows as stated in the 'Controlled Releases of Voluntary Supplementary Flows from the Manapōuri Lake Control Structure (MLC) to the Lower Waiau River' (flushing flow protocol). Individual flushing flows almost always have a beneficial effect by reducing periphyton cover and thickness to some extent (depending on the characteristics of the flushing flow and the state of periphyton growth prior to the flush). When Microcoleus (nuisance cyanobacteria) is present the flushing flows almost always remove much of the cover. Reducing cover of thick periphyton (particularly didymo) exposes better habitat for macroinvertebrates and the food web in general.

Overall, the Project is expected to lead to a net gain in river health, particularly from an aquatic ecology perspective.

8. Could additional information be provided on the expected maintenance requirements of the channel – what is expected to be needed, where, how often and what will the triggers be?

Maintenance of the new channel refers to the removal of gravels that deposit within the channel footprint, to maintain the flow conveyance of the channels.

There is expected to be minimal maintenance required along most of the new excavated channel, given that there is negligible sediment load transported from Lake Manapōuri via the Waiau Arm, and that a significant portion of the new channel area would need to be blocked to have a noticeable effect on flow conveyance, i.e. the need for maintenance would be triggered after there has been significant deposition within the new channel.

Gravels transported by the Mararoa River currently deposit upstream of the MLC gates and will require periodic removal. It is expected that there will also be some need for ongoing channel maintenance with some transported gravel material depositing in the Waiau Arm channels within the Waiau Arm delta area, including the new channel. The alignment of the new parallel channel directing large flow releases more directly toward the gates can, however, be expected to have a positive influence in re-entraining and 'flushing' deposited material.

Expected post-construction maintenance work will involve excavating deposited material using a long-reach excavator working from a low-level temporary gravel bund within the existing Waiau Arm channels and Mararoa River above the MLC gates. The work would aim to maintain the flow areas of the existing and new channels and Mararoa River.

It is expected that the maintenance would be undertaken as required and at approximately 5-10 year intervals.

9. In an extreme flood event in the Mararoa flow might run around the old river course and presumably drop into the new diversion channel. What scour/ erosion might result from that?

In an extreme flood event from the Mararoa River, flow may overtop the right-hand bank of the 'Mararoa Cut' and spill into the historical Mararoa channels. This is not known to have occurred in the 35 years since the Mararoa was diverted.

In such an event, the MLC gates will be opened to pass the incoming floodwaters as effectively as possible, and most of the flow will remain in the Mararoa cut and will flow directly toward the gates. Water that overtops the right bank and spills into the historical Mararoa channels will flow into the new Waiau Arm channel.

Flows spilling into the historical Mararoa channels may mobilise sediment and debris within the area, but are not expected to cause significant scour/erosion damage to the new channel due to:

- The wide area over which the historical Mararoa channels intersect the new excavated Waiau Arm channel;
- The likely high concurrent water level within the Waiau Arm; and
- The gentle 1V:3H side slopes of the new excavated channel.

In an extreme Mararoa flood such as would be required to result in overtopping of this nature, a significant sediment load will be transported down the Mararoa River, and cleanup/maintenance work in the Mararoa cut, upstream of the gates, and generally throughout the catchment will be inevitable.

10. Do Meridian have a plan if there is a lot more of the grey pug and a lot less of the river gravels than has been assumed?

Given the geomorphological origin of the area, being an alluvial fan, there is reasonable certainty that the ground material, to some level below the natural Waiau water level, will be alluvial sediments (gravels and sands). This was confirmed by test pitting and trial excavations undertaken.

If the underlying clay is encountered at a higher elevation than expected, no issues are foreseen in constructability of the Project. The channel will still be excavated to the same plan and dimensions. The clay is consolidated and cohesive, and is not expected to settle with earthmoving machinery working above. Trial excavations did not reveal any issue with excavators working from gravel bunds built atop underlying clays.

The trial excavations showed the *in situ* clay material to be very cohesive and it remained largely intact when excavated, producing lower levels of suspended sediment than construction and removal of bunds from gravelly material (refer Figure 2 below). The proposed suspended sediment monitoring and mitigation will ensure that downstream effects are managed regardless of material encountered.

Figure 2: Clay material excavated from Waiau Arm in 2023 trial excavation

The main effect of a greater-than-expected proportion of clay compared to alluvium within the excavated volume is expected to be in the spoil area. The clay will likely need blending with alluvial materials and partial drying to allow it to be trafficked and compacted without becoming sludgy.

11. What types of wetlands are present, e.g are they rainfall fed, connected to groundwater (or seasonally so), on original land surfaces? Will there be a prolonged period of low flows that will impact on downstream wetlands by removing their water source?

Table D1 (**Appendix D**) provides information on the type of wetland present (hydrosystem and wetland class), hydrological drivers and whether they are on original land surfaces for each wetland within the Project site.

Figure D1 (**Appendix D**) below shows an aerial image of Project site in 1974 (during construction of the MLC) with the current location of wetlands within the Project site. This illustrates which wetlands are on original or modified / constructed land surfaces.

Table D2 (**Appendix D**) provides the same information for each downstream riparian wetland that could potentially be affected by the Project. All downstream riparian wetlands are on original land surfaces.

Flows over the MLC will continue to be managed in accordance with all existing consent conditions, which include environmental flow requirements. The Project will not change the already consented flow rates, and flows will be maintained at or above the environmental flow requirements at all times during construction.

12. Ecological significance – provide clarification on effects framework used, and how a conclusion of minor effects was arrived at (and an evaluation of ecological significance).

<u>Wetlands Assessment</u>

To determine the level of ecological effects on wetlands and terrestrial habitats we used the Environmental Institute of Australia and New Zealand's (EIANZ) Ecological Impact Assessment (EcIA) Guidelines (Roper-Lindsay et al. 2018). In summary, these guidelines require assessments of the values of communities, habitats / ecosystems and species, the magnitude of impact and the level of ecological effect based on ecological value and magnitude of impact.

The ecological significance of terrestrial vegetation and habitats, including wetlands, was also assessed against the criteria for determining significant indigenous vegetation and significant habitats of indigenous biodiversity listed in Appendix 3 of the Southland Regional Policy Statement (SRPS, Environment Southland 2017). Following Appendix 3 of the SRPS, areas or habitats were significant if they meet one or more of the criteria.

With regard to the level of residual effects (following implementation of Project shaping and recommended effects management measures) the level of effect for all actual or potential effects on wetlands and terrestrial habitats was Very Low, Low or No Effect - slight Net Gain.

The EIANZ EcIA guidelines note that the level of effect can be used as a guide to the extent and nature of the ecological management response required. For example:

- '**Low'** and '**Very Low'** should not normally be of concern, although normal design, construction and operational care should be exercised to minimise adverse effects. If effects are assessed taking impact management measures developed during project shaping into consideration, then it is essential that prescribed impact management is carried out to ensure low or very low-level effects.
- **'Very Low'** level effects can generally be classed as 'not more than minor' effects.

Freshwater Assessment

Please refer to the memorandum prepared by NIWA in **Appendix B**.

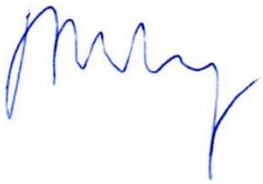
13. Avifauna assessment - provide further information on the species which are present, and the frequency and types of visit, if this information is known. Assess the effect of birds avoiding the areas during construction, i.e. are there other suitable locations nearby which they could go to?

Please refer to the memorandum prepared by NIWA in **Appendix B**.

Closing

We trust these responses satisfactorily address the queries raised. If there are any further queries please do not hesitate to contact the writer (email: dmurray@tonkintaylor.co.nz) or Andrew Feierabend at Meridian Energy (email: andrew.feierabend@meridiannergy.co.nz).

Yours sincerely



Daniel Murray
Technical Director - Planning

15-Mar-24
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Appendix A: RMA vs MTADA effects (Query 2)

Table A1: RMA vs MTADA effects

Activity	Location	Potential effect	Governing Legislation
Excavation / disturbance of bed of a lake, and removal of plants within the bed of a lake (section 13).	New channel within the Waiau Arm, and construction of bunds and haul roads, and contractor's establishment area as per Figures 5.1 to 5.3 of the AEE. The bunding and the footprint for the new channel is the 'bed of a lake' as per the definition in the RMA. Parts of this area may also be wetland and natural inland wetland (see below).	Landscape and visual effects. Construction-related effects – Noise, light, vibration, vegetation removal.	MTADA
Deposition of substances (excavated material) on the bed of a lake, and reclamation of bed of a lake (s 13).	Spoil area to the east of the Project site, some of which is below the maximum operating level of Lake Manapōuri, and so is the 'bed of a lake' as per the definition in the RMA.	Landscape and visual effects. Construction-related effects - Noise, light, vibration, vegetation removal. Any ecological effects.	MTADA
Discharges of contaminants to air (s 15(2) or (2A))	Generally across the Project site, where construction activities take place.	Construction-related dust effects	MTADA (noting that this would not contravene a regional rule or NES, and so is also not restricted under s 15(2) or (2A) of the RMA)
Section 9 construction-related activities	Generally across the Project site, where construction activities take place.	Construction Effects – Earthworks, noise, lighting, vibration, vegetation clearance. Related landscape and visual effects.	MTADA (nothing that these effects are also largely permitted under the Southland District Plan)
Use and erection of structures (culverts) within the bed of a lake (s 13), and associated bed disturbance.	As per plans provided in the AEE.	Construction-related effects - Noise, light, vibration, vegetation removal. NB: these are also within a natural inland wetland, so will engage the RMA as per Regulation 47 of the NES-F.	MTADA
Vegetation clearance, earthworks / land disturbance, and the take, use diversion and discharge of water in and near a natural inland wetland (Regulation 47 of the NES-F)	Removal of Wetland 1 (palustrine wetland) and disturbance of small parts of the lacustrine wetlands over which the haul road and culverts will be placed.	All effects relating to the vegetation clearance, earthworks / land disturbance within a natural inland wetland, and the take, use, diversion and discharge of water near a natural inland wetland.	RMA

Activity	Location	Potential effect	Governing Legislation
Diversion of water into the new channel (s 14)	New channel within the Waiau Arm	Hydrology and hydrogeology Ecological effects	RMA
Discharge of contaminants (sediment) and water into water and onto land where it might enter water (s 15(1))	Construction of the new channel within the Waiau Arm, and entering the LWR downstream of the MLC.	Hydrology and hydrogeology Ecological effects	RMA
Discharge of contaminants (sediment) and water onto land where it might enter water (s 15(1))	Construction areas and runoff from spoil disposal area.	Hydrology and hydrogeology Ecological effects	RMA
Take of water and use (for dust suppression) (s 14)	From the Waiau Arm, Mararoa River or seepage pond.	Hydrology and hydrogeology effects Ecological effects	RMA
Discharge of water to land (for dust suppression) in circumstances where it might enter water (s 15(1)).	On dust-prone areas on the Project site, as required for dust suppression.	Hydrology and hydrogeology effects Ecological effects	RMA
Take and use of water (for dewatering of excavated material) (s 14)	From the new excavated channel.	Hydrology and hydrogeology effects Ecological effects	RMA
Discharge of water (taken for dewatering) to land in circumstances where it might enter water (s 15(1))	Discharge into dewatering ponds, and into groundwater and surface water (Mararoa River and Waiau Arm).	Hydrology and hydrogeology effects Ecological effects	RMA

Appendix B: NIWA memorandum

Responses to:

- Query 3: What are the effects in the mixing zone, particularly on fish and bird species?
- Query 5: Table D1 of the freshwater appendix contains the bird species that are present. Could the additional memos that were discussed be provided please - we understand that these contain information on frequency and types of visits.
- Query 12: Ecological significance – provide clarification on effects framework used, and how a conclusion of minor effects was arrived at (and an evaluation of ecological significance).
- Query 13: Avifauna assessment - provide further information on the species which are present, and the frequency and types of visit, if this information is known. Assess the effect of birds avoiding the areas during construction, i.e. are there other suitable locations nearby which they could go to?

Memo

From	**Jo Hoyle**
To	Andrew Feierabend
CC	Ellie Taffs Daniel Murray
Date	15 March 2024
Subject	Manapōuri Lake Control Flow Improvement Project - Response to questions from Environment Southland Technical Experts
File path *(right click to update)*	*O:\MEL23523\Working\ES_AEE response\Memo Re MLC Flow Improvement AEE - Further information from NIWA.docx*
Report Number	*2024061CH*

This memo relates to Meridian Energy Limited's proposed Manapōuri Flow Improvement Project (hereafter 'the Project') and provides responses to questions from Environment Southland's Technical Experts regarding the Assessment of Environmental Effects (AEE) and in particular Appendix D to the AEE, which provides NIWA's assessment of effects on freshwater ecology.

Environment Southland Questions

What are the effects in the mixing zone, particularly on fish and bird species?

We have considered the effects in the mixing zone as part of the downstream effects of the Project in the Lower Waiau River (LWR), i.e., we have not separated out the effects in the mixing zone. See Section 6 in Appendix D to the AEE for discussion of effects within the Project Area and downstream of the Project Area in the LWR. See Table 7-1 for a list of key ecological values in the Waiau Arm and LWR and Table 7-2 for an assessment of the expected magnitude of effects of the Project on ecological values in the Project Area and downstream in the Lower Waiau River.

Fish potentially found in the mixing zone (LWR) are listed in Table 5-5 of Appendix D to the AEE. Minor and temporary effects relating to elevated suspended sediment concentration (SSC) or deposited fine sediment (DFS) are expected for salmonids, longfin and shortfin eels and non-migratory galaxiids. We note that whilst non-migratory galaxiids may be present in the mixing zone, they are unlikely to be present in high numbers as they are predated by salmonids. They are more typically found in the tributaries.

The mixing zone is not a known roosting or nesting area for freshwater birds, so effects in the mixing zone relate to the effects of elevated SSC on feeding. We anticipate that birds will move to better feeding areas during periods when SSC is elevated, such as may be found in the Mararoa River. Therefore, the effects on feeding are expected to be less than minor.

Birds Effects Assessment - Provide information on species present, frequency and type of visit.

Species present – Information on freshwater birds present in the Waiau catchment is based on bird observation data which were obtained from the Department of Conservation, the eBird website (Sullivan et al. 2009) and the grey literature, as summarised by Whitehead (2021). There are three key datasets containing abundance data from formal freshwater bird surveys at the Manapōuri Lake Control structure (MLC) between 2000 and 2020 (Table 1).

Table 1: Summary of available freshwater bird survey data for the Manapōuri Lake Control structure. Survey type: site surveys = ground-based surveys at a localised site; walk-through surveys = longitudinal transects along the river corridor (e.g., O'Donnell and Moore 1983). Table from Whitehead (2021).

Location	Period	Survey type	Source
Key sites in Lower Waiau River	2000 – 2001 2020	Site surveys	McClelland (2001, 2002) NIWA (Amy Whitehead, *Personal observation*)
Upper and Lower Waiau River	2009	Walk-through surveys	Department of Conservation (Colin O`Donnell, *Personal communication*)

As outlined in Section 5.7 in Appendix D of the AEE, the bird fauna observed at the MLC is characteristic of South Island freshwater habitats, with 20 freshwater bird species identified (Table D-2 in Appendix D of the AEE). Three species are listed as threatened (black-billed gull - critically endangered; black-fronted tern - nationally endangered; banded dotterel - nationally vulnerable) on the New Zealand Threat Classification System. Twelve bird species not dependent on freshwater habitats have also been recorded at the MLC. Coastal waders, aerial gulls and terns are most prevalent in the lower reaches of the river, while dabbling waterfowl and open water divers are present in areas of deeper, slow-flowing water.

The abundance of freshwater bird species observed during formal surveys at the MLC is summarised in Table 2. These formal surveys were all completed within the primary breeding season for most freshwater bird species associated with the MLC (Figure 1).

Table 2: Abundance of freshwater bird species observed during formal surveys at the Manapōuri Lake Control structure (MLC). Columns represent data from the individual surveys identified in Table 1. Note that the McClelland surveys (2000, 2001) only recorded black-billed gulls at the MLC and it is unknown whether other species were present. Table from Whitehead (2021).

Species	October 2000	October 2001	December 2009	November 2020	December 2020
Black-billed gull	1435	1255	3250	37	107
Black shag			1	0	0
Grey teal			5	0	0
Little shag[1]			0	0	0
Mallard			0	0	30
Pied stilt			2	0	10
South Island pied oystercatcher			54	0	0
Southern black-backed gull			2	0	0
Spur-winged plover			4	0	0
Swamp harrier			1	0	0

[1] We note that the recorded numbers for Little shag are all zeros, but this is how they are reported in Whitehead (2021).

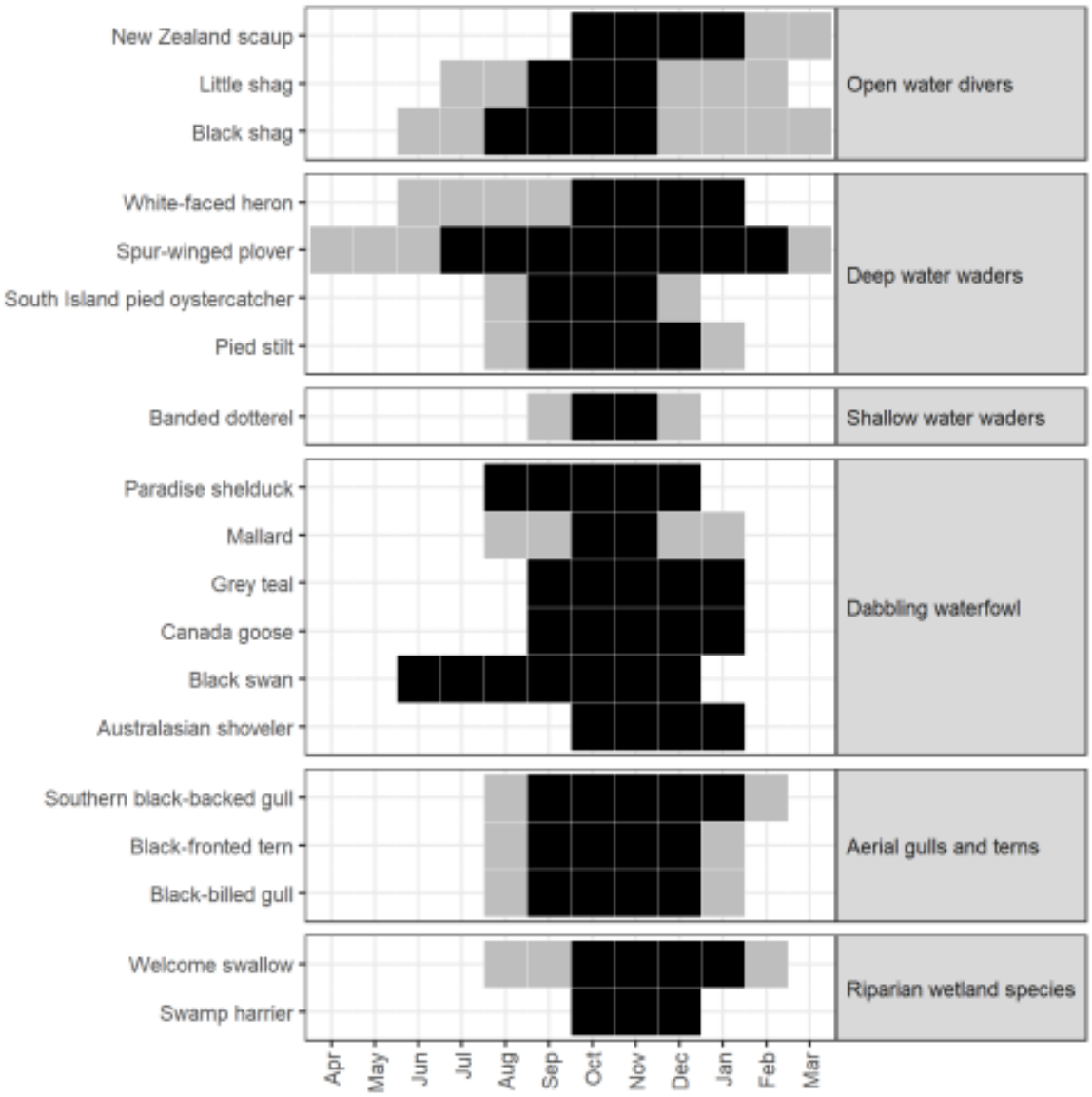

Figure 1: Breeding season of freshwater bird species associated with the Manapōuri Lake Control. Black squares indicate primary breeding season, while grey squares represent months in which some breeding occurs in most years. Adapted from O'Donnell (2000) by Whitehead (2021).

Frequency and type of visit – We can infer the type of visit for different species based on the type of habitat present. Table 3 outlines the types of microhabitats associated with the Waiau River catchment that are likely to be used by freshwater birds. The Project Area includes all the river microhabitats listed, however, downstream in the Lower Waiau River from the MLC to Excelsior Creek (i.e., mixing zone) generally only comprises a major channel with narrow riparian areas. Key feeding and breeding microhabitat for freshwater bird species recorded in formal surveys of the Waiau River catchment are outlined in Figure 2. For example, Figure 2 shows that the three species of concern (black-billed gull, black-fronted tern and banded dotterel) only use river habitats for feeding during the summer breeding season.

Table 3: Key microhabitats associated with the Waiau River catchment that are likely to be used by freshwater birds. Definitions from O'Donnell (2000).

Rivers	Lakes and estuaries
Riparian areas: Terrestrial habitat adjacent to rivers and lakes that are used by freshwater birds. Includes paddocks, riparian willows and riverbanks.	**Open water:** The open water of lakes, ponds, bar-type lagoons and estuaries at high tide.
River terraces: Raised level areas immediately adjacent to the river floodplain resulting from successive down-cuttings by the river. Younger, low-level terraces may develop mid-channel.	**Edge water:** The shallow waters (<200 mm) along the margins of lakes, lagoons and ponds. May be overhung by riparian vegetation.
Shingle bars and flats: Areas of mud, sand, gravel or cobbles on the active riverbed. May be surrounded by water.	**Mud and sand flats:** Open areas of mud or sand that are usually saturated or covered in a surface water film after being exposed following the receding of open water.
Major channels: Runs and riffles of major channels, which carry a high proportion of the river flow. Generally >160 mm deep, and may be slow or swift, with broken or unbroken water.	**Wetland turf or vegetated saltmarsh:** Saturated wetland flats covered in a prostrate vegetation. Sometimes flats are covered in a shallow surface film.
Shallow channels, backwaters and seeps: Runs and riffles of minor channels, which carry a small proportion of the river flow (generally <5%). Less than 160 mm deep and often <80 mm. Usually slow or moderate water speeds. These sometimes arise from, or shrink into, seeps where water level becomes shallower until disappearing underground.	**Swamplands:** Emergent wetland vegetation, usually in standing shallow water, dominated by sedges and rushes.

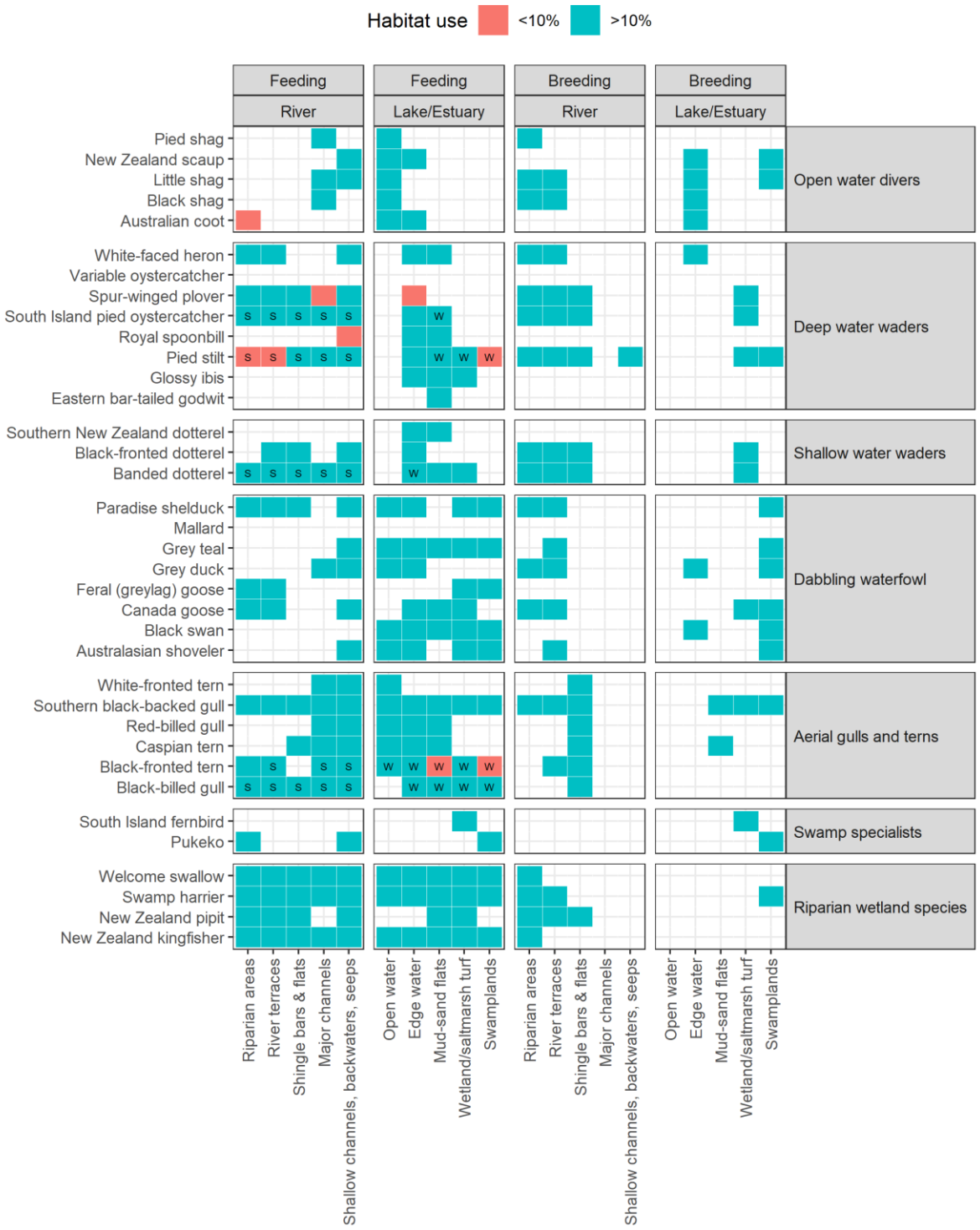

Figure 2: Key feeding and breeding microhabitats for freshwater bird species recorded in formal surveys of the Waiau River catchment. Coloured cells indicate microhabitat use >10% (blue) or <10% (red) of the time, while letters show seasonal habitat use patterns (S = summer breeding season habitat use; W = winter habitat use). Panel rows represent bird species grouped by feeding guild (O'Donnell 2000), while panel columns represent river and lake or estuary microhabitats nested within feeding and breeding. Adapted from O'Donnell (2000) by NIWA.

Birds Effects Assessment - Include effects of birds avoiding the areas during construction. Are there other suitable locations they could go?

Figure 1 tells us that if the Project site establishment does not begin until after the end of January then the species that could be affected are Spur-winged plover (end of primary breeding season), Welcome swallow, Southern black-backed gull, Black shag, Little Shag and New Zealand Scaup (all outside of primary breeding season). There have been few observations of any of these species at the MLC (Table 2) and none of these species are threatened (Robertson et al. 2021). Therefore, as long as the Project construction does not commence until after January, the effect on roosting and breeding of freshwater birds is considered less than minor.

As construction will be timed to avoid the breeding season, the effect of the Project during construction is limited to potential disturbance of bird feeding. The feeding habitat for species associated with the Waiau River catchment is outlined in Figure 2. All of these habitats can be found nearby in the Mararoa River and further downstream in the Lower Waiau River. Therefore, we consider that birds have nearby alternative options if disturbed, leaving the effect on feeding as also less than minor.

Ecological significance – provide clarification on effects framework. How did you get to 'minor'?

NIWA's assessment of level of effect did not use a formal framework but is based on expert opinion combining the ecological value in question (i.e., does the value have special status, are there threatened species) with type and duration of effect. We outline our approach below.

The assessments for each component of the ecosystem (i.e., macrophytes, periphyton, macroinvertebrates, fish and birds) were made relative to the existing ecosystem. This approach generally followed that set out in the EIANZ guidelines on Ecological Impact Assessment (Roper-Lindsay et al. 2018). We relied on measured information from relevant sites in the river.

Each description of existing conditions describes the habitat conditions (in the Waiau Arm and Lower Waiau River), names taxa that are of special ecological value (i.e., Nationally Threatened, At Risk or uncommon species), and, where applicable, specifies gradings of sites against attributes in the National Policy Statement for Freshwater Management (NPS-FM).

We concluded that the current ecological status of macrophytes, periphyton, phytoplankton and macroinvertebrates in the Waiau Arm and Lower Waiau River was relatively low and the communities and habitats had few special ecological values (summarised in Table 7.1 of Appendix D to the AEE).

While the fish and bird communities include several species with conservation status of At Risk – Declining, Threatened – Nationally Vulnerable or Nationally Endangered (also summarised in Table 7.1 of Appendix D to the AEE), any direct effects of the Project on these species are mitigated by their mobility, and/or by their preference for locations (e.g., tributaries) not affected by the Project, or by timing the Project to avoid critical times (e.g., bird breeding season).

The assessments of minor effects or less (as summarised in Table 7-2 Appendix D to the AEE, and updated above) were considered appropriate in view of:

A. the relatively low ecological values of the Lower Waiau River currently (particularly in terms of macrophytes, periphyton, and macroinvertebrates);

B. mitigating factors that will enable avoidance of effects on fish and birds;

C. the relatively small effects expected from the Project (provided that the monitoring and mitigation of fine sediment inputs is carried out as proposed);

D. the temporary nature of the effects (for the duration of the project) with expected rapid recovery afterwards).

In summary, the effects are assessed as minor because they are small effects, for a small amount of time, on an ecosystem that is already relatively low quality. We note that the purpose of the Project is to improve ecological conditions in the Lower Waiau River.

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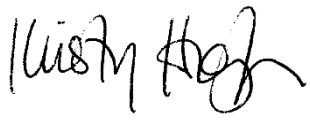
Quality Assurance Statement		
	Reviewed by:	Kristy Hogsden
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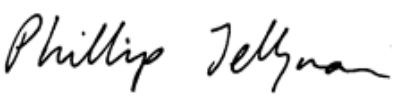	Approved for release by:	Phillip Jellyman

Appendix C: Corrected Table 7-2 (Query 6)

Community	Location	Sub-community	Expected magnitude of effects	Details
Water quality	Waiau Arm, Lower Waiau River	n/a	Minor	Potential temporary increase in water temperature and change in DO due to increased turbidity. Possible minor change to pH depending on sediment chemistry. Likely increase in TP and DRP associated with an increase in sediment input. Effects temporary (while sediment levels are elevated) and within natural variability.
Plant communities	Waiau Arm	Macrophytes	Minor	Temporary destruction in a small area; recovery expected after Project ends
		Periphyton	Minor	Temporary destruction in a small area; recovery expected after Project ends
		Phytoplankton	Minor	Potential small increased risk of blooms upstream in the Waiau Arm during the Project, but this will be monitored and mitigated under the existing summer programme. Post-Project effect of slightly increased risk of blooms in area upstream of MLC, but largely mitigated by extra flushing flows facilitated by the Project
	Lower Waiau River	Periphyton	Less than minor	Temporary exacerbation of an existing DFS problem. No discernible effect of additional DFS or SSC if thresholds are adhered to. Recovery from effects expected over time and after high flow events
Macro-invertebrates	Waiau Arm	n/a	Minor	Temporary destruction in a small area, with recovery (recolonisation) expected following the Project
	Lower Waiau River	n/a	Minor	Most effects from DFS expected in reaches closest to MLC. DFS kept within thresholds likely covers natural variability. Recovery expected (recolonisation) following the Project
Freshwater fish	Waiau Arm, Lower Waiau River	Salmonids	Minor	Minimal direct effects of elevated SSC as fish are mobile, especially if thresholds are adhered to. Minimal risk to spawning habitat as little is available in affected area. Timing of Project may partly coincide with migration times (April to September) but negligible effect in context of whole catchment if sediment release is concentrated into 5–7-week period.
		Longfin and shortfin eels	Minor	Potential effects of SSC and DFS, but can be mitigated by adhering to thresholds, modifying migrant trap-and-transfer programme, developing fish salvage programme during breakout channel excavation phase (where practicable and can be accommodated within the excavation methodology), and ensuring breakout channel excavation does not commence until after mid-March.
		Non migratory galaxiids.	Minor	Species considered to be highly sensitive to elevated SSC, but effect likely to be mitigated if SSC thresholds adhered to.
		Lamprey	Less than minor	Juveniles prefer fine sediment habitat
		Other fish species (e.g., perch)	Nil	n/a
Freshwater birds	Waiau Arm	n/a	Less than minor or Minor	Potential effect of elevated SSC on feeding, but birds will move to better feeding areas. Less than minor effect

Community	Location	Sub-community	Expected magnitude of effects	Details
			(timing dependent)	only if breeding season for valued species is avoided (September to January), otherwise minor.
	Lower Waiau River	n/a	Nil	No adverse effects predicted"

Appendix D: Wetland information (Query 11)

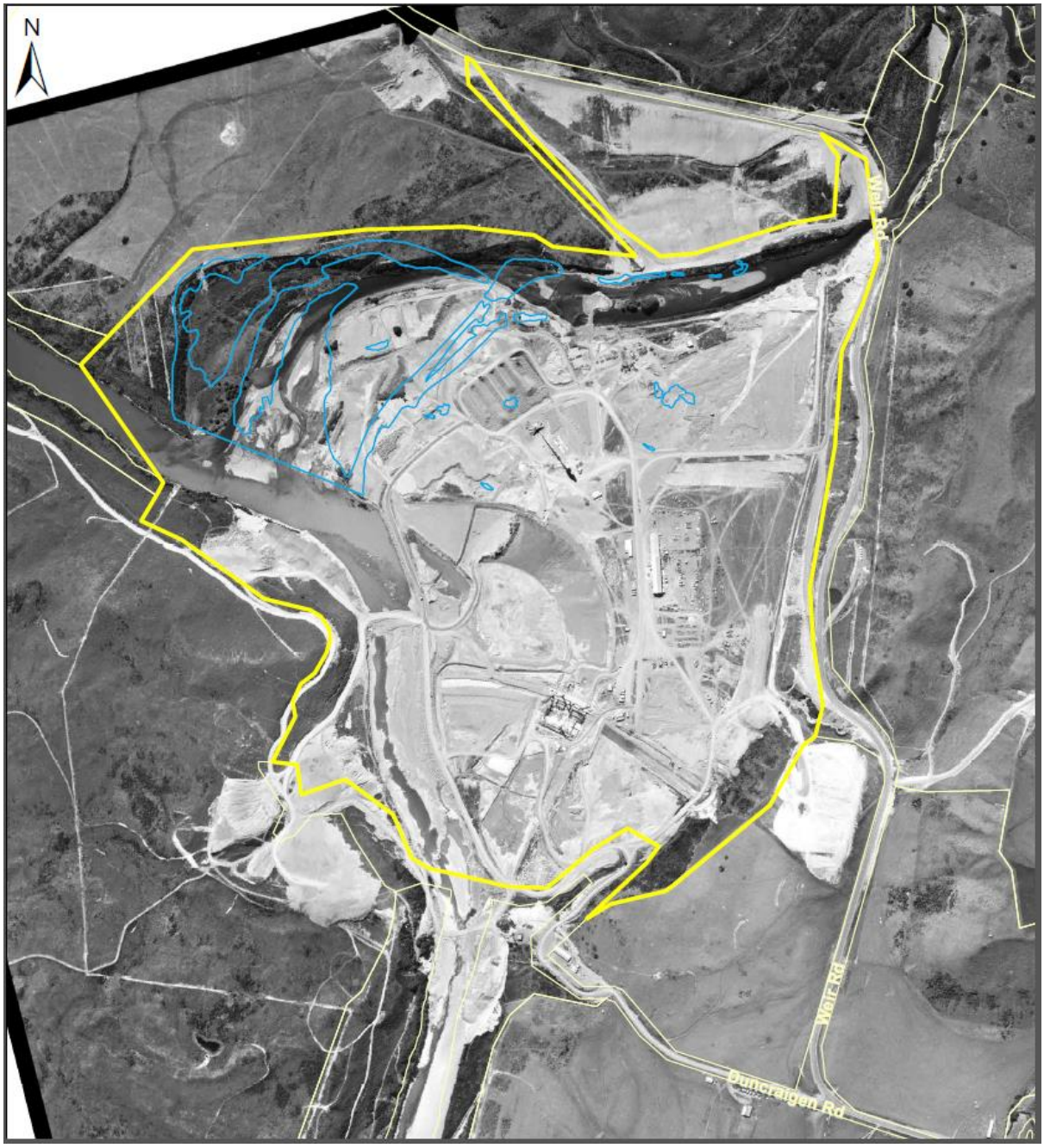

Figure D1: 1974 aerial image of the Project site
(sourced from http://retrolens.co.nz and licensed by LINZ CC-BY 3.0)

Table D1: Wetlands within the Project site

Wetland No. / Location	Wetland hydosystem	Wetland class	Hydrological drivers	Original Land Surface?
Wetland 1	Palustrine	Marsh	• Rainfall	No
Wetland 2	Palustrine	Marsh	• Rainfall	No
Wetland 3	Palustrine	Marsh	• Rainfall	No
Wetland 4	Palustrine	Marsh	• Rainfall (primary) • Groundwater, very infrequently during high lake levels and Mararoa River flood flows) • Terrace toe seepage?	Former Mararoa River bed
Wetland 5	Palustrine	Marsh	• Rainfall (primary) • Groundwater (very infrequently during high lake levels and Mararoa River flood flows) • Terrace toe seepage?	Former Mararoa River bed
Wetland 6	Palustrine	Marsh	• Rainfall (primary) • Groundwater (very infrequently during high lake levels and Mararoa River flood flows) • Terrace toe seepage?	Former Mararoa River bed
Wetland 7	Palustrine	Marsh	• Rainfall (primary) • Groundwater (very infrequently during high lake levels and Mararoa River flood flows) • Terrace toe seepage?	Former Mararoa River bed
Wetland 8	Palustrine	Marsh	• Rainfall (primary) • Groundwater (very infrequently during high lake levels and Mararoa River flood flows) • Potential lake inundation when Lake Manapōuri near maximum permitted operating level	No
Wetland 9	Palustrine	Marsh	• Rainfall (primary) • Groundwater (very infrequently during high lake levels and Mararoa River flood flows) • Potential lake inundation when Lake Manapōuri near maximum permitted operating level	No
Wetland 10	Palustrine	Marsh	• Rainfall	No
Wetland 11	Palustrine	Marsh	• Rainfall	No
Wetland 12	Palustrine	Marsh	• Rainfall	No
Eastern Lacustrine Channel	Lacustrine	Marsh	• Lake inundation	No (constructed cut)
Central Lacustrine Channel	Lacustrine	Marsh	• Lake inundation	Former Mararoa River delta
Western Lacustrine Channel	Lacustrine	Marsh, swamp	• Lake inundation (primary) • Terrace toe seepage	Former Mararoa River delta

Table D2: Downstream Riparian Wetlands

Wetland No. / Name	Wetland hydrosystem	Wetland class	Hydrological drivers
Mararoa Weir Wetland (13)	Riverine	Marsh, shallow water	• Groundwater (likely primary) • River inundation important during high flood flows due to overtopping of the weir and / or elevated water levels. • Terrace seepage (minor)
Tower Peak Terrace Toe Wetland	Riverine and palustrine	Swamp, marsh	• Terrace seepage (likely primary). • Not strongly connected with the LWR. • Lower wetland possibly influenced by flood inflows
North of Redcliff Wetland	Riverine	Shallow water	• River groundwater • Occasional river inundation • Terrace seepage (minor)
Rakatu Riparian Wetland	Riverine	Marsh / shallow water	• River groundwater • Flood inflows • Southern extent influenced by surface and groundwater outflow from the Rakatu wetland
Opposite Redcliff Creek Wetland	Riverine and palustrine	Shallow water, swamp	• River groundwater • Flood inflows • Surface water outflows
Redcliff Side Braid Wetland	Riverine	Marsh, shallow water	• River groundwater • Flood inflows • Surface water outflows
Jericho Road Island Wetland	Riverine	Marsh	• River groundwater • Flood inflows