Arawhata Wetland Complex

Wetland Complex Options Assessment

July 2022

horizons REGIONAL COUNCIL

Prepared for:

Jobs for Nature Horowhenua FMU Water Quality Interventions Project Governance Group

Authors:

Kate Simmonds (Jacobs)

Siobhan Karaitiana (Kāhu Environmental)

Staci Boyte (Horizons Regional Council)

Acknowledgements to:

Kāhui Ārahi (Muaūpoko Mātauranga Advisory Group)

Muaūpoko Tribal Authority

Lake Horowhenua Trust

Roger MacGibbon (Tonkin + Taylor)

Chris Tanner (NIWA)

Kāhu Environmental

Jacobs

Neil Thomas (PDP)

Mark Leggett (RMG)

CONTACT	24 hr freephone 0508 800 80		Help@horizons.govt.nz		www.horizons.govt.nz
SERVICE CENTRES	Kairanga Cnr Rongotea and Kairanga-Bunnythorpe Roads Palmerston North Marton 19 Hammon Street Taumarunui 34 Maata Street	REGIONAL HOUSES	Palmerston North 11-15 Victoria Avenue Whanganui 181 Guyton Street	DEPOTS	Taihape 243 Wairanu Road Taihape Woodville 116 Vogel Street
POSTAL ADDRESS	Horizons Regional Council, Private Bag 11025, Manawatū Mail Centre, Palmerston North 4442				F 06-952 2929

TABLE OF CONTENTS

1 Executive Summary

The Arawhata Wetland Complex Project is a concept that involves the construction of a wetland complex at the bottom of the Arawhata catchment of Lake Horowhenua (Punahau). This project is one of the initiatives arising out of the Lake Horowhenua Water Quality Interventions Project which sits within the context of a wider need for a range of interventions to improve the health of Lake Horowhenua.

The Arawhata Stream is high in nutrients and sediment, which impacts the quality of Lake Horowhenua. The function of the wetland complex is to reduce the sediment and nutrient concentrations entering the lake to improve the lake health, while also restoring the former character and cultural health of the site.

The objectives of the wetland project are to:

- Enhance of the Mauri and water quality of Lake Horowhenua
- Reduce sediment and nitrogen loads into the Lake
- Ensure that the Wetland Complex is culturally appropriate with Muaūpoko Mātauranga input
- Ensure the project is feasible and can be phased to align with funding available
- Enable the proposed wetland complex to provide for future social amenity (kai, job creation etc.) and recreational opportunities and connectivity to other high amenity features in the local vicinity.

A number of wetland options have been identified and evaluated to support development of a long-list of options for assessment. These options include:

- **Surface Flow (Terraced) Wetlands:** water flow is directed horizontally through shallow and deep zones, from one cell to the next, with a combination of planted and open water areas.
- **Infiltration Wetlands**: water infiltrates though the wetland base.
- **Overland Flow (Irrigation) Wetlands**: water is directed over the surface, either via natural or man-made channels. They can include intervention via pumping and drip irrigation lines. They generate the formation of swampy areas, springs and pools.
- Natural restoration approaches through removing drains and allowing the site to naturally rewet.

These wetland types were used to generate seven wetland options, including hybrid options that combine different wetland types into the wetland complex:

1) Option 1: Terraced (Surface Flow) Wetlands
2) Option 2: Infiltration Wetlands
3) Option 3: Irrigation (Overland Flow) Wetlands
4) Option 4: Restoration Focus
5) Option 5: Hybrid "Natural"
6) Option 6: Hybrid "Managed"
7) Option 7: Hybrid with Surface Flow near Lake

These seven options were evaluated against the project objectives and a range of criteria as agreed by the specialist working group using a Multi Criteria Analysis (MCA) approach. Various specialists were assigned elements of the assessment and the group met to discuss the scores and calibrate these together. A Sensitivity Analysis was then performed on the outcomes of the MCA to verify the robustness of the decision making process.

The MCA results show that Option 5 was ranked as the highest scoring option under the original scenario and the sensitivity analysis scenarios. It is a combination of Options 1, 3 and 4 with a more engineered terraced wetland at the upper end of the site with a more "natural" wetland towards the lake.

Option 5 scored well under each objective and set of criteria. This is due to the flexibility that Option 5 offers, which enable us to deliver on the key success criteria, incorporate various cultural, social, and environmental benefits through use of different wetland types and applications, while maximising the nutrient and sediment removal across the site.

The next steps for this project are to:

1) Present the results of the MCA process to the Governance Group, including wetland option 5 as the highest scoring option.

2) Following Governance Group endorsement of a preferred option, commence conceptual design, with associated costings, technical assessment, and modelling work to be undertaken to determine the treatment effectiveness. This will include proposed timing and staging of the solution, to align with the project objectives.

2 Introduction

2.1 Project background

The Arawhata Wetland Complex project is a concept that involves the construction of a wetland complex on a 142 ha property, purchased by Horizons Regional Council at the base of the Arawhata catchment of Lake Horowhenua (Punahau). This project is one of the initiatives arising out of the Lake Horowhenua Water Quality Interventions Project, contracted by the Ministry for the Environment to Horizons Regional Council for delivery. The purpose of the Lake Horowhenua Water Quality Interventions Project is to improve understanding of the Horowhenua Freshwater Management Unit (FMU) having regard to the drivers of water quality and quantity and improvement in water quality and aquatic health. It sits within the context of a wider need for a range of interventions to improve the health of Lake Horowhenua.

Lake Horowhenua is a shallow hypertrophic dune lake that has degraded over many years. The lake outflows to the sea via the Hōkio Stream and has several tributaries, the majority being modified watercourses that pass through vegetable cropping land, dairy farms and the Levin township. Groundwater accounts for more than half the inflow into the lake.

The clearance of coastal forest, draining of swamps, intensification of land use, urban expansion, and the disposal of treated effluent in the lake between 1962 and 1987, has contributed to significant degradation of the lake.

Lake Horowhenua continues to receive large amounts of nutrients and sediment in addition to the ongoing internal processes influenced by past discharges into the lake.

The Arawhata is the largest tributary into Lake Horowhenua and contributes significant nitrogen, phosphorus and sediment loads to Lake Horowhenua. The objective of the wetland complex is to reduce the sediment and nutrient concentrations entering the lake.

In 2020, Horizons Regional Council commissioned Jacobs to complete a wetland feasibility study in the Arawhata catchment and Tonkin + Taylor to complete an integrated nutrient, sediment and drainage management plan for the Arawhata catchment. Both of these reports concluded that a treatment wetland at the bottom of the catchment before the stream enters the lake would be an appropriate and preferred location for a constructed wetland. Horizons Regional Council purchased a property at this location in 2021 as part of the Lake Horowhenua Water Quality Interventions Project for this purpose.

2.2 Purpose of this report

A Wetland Design Group, with input from Kāhui Ārahi (the Muaūpoko Mātauranga Advisory Group), has been tasked with the development of a wetland complex design that achieves the intended outcome for the health of Lake Horowhenua guided by the overall draft project objectives. This work will/has included the following tasks:

Brainstorm a long list of constructed wetland features (complete).
Shortlist potential wetland complex options (complete).
Complete a multi-criteria analysis of the seven shortlisted options.
Develop a conceptual wetland design following the endorsement of a preferred wetland option by the Governance Group to support the application to the Minister for Environment for approval as a 'referred project.'
Develop a detailed design to support the consent application for the construction of the wetland complex.

The purpose of this report is to present the process and outcomes of the multi-criteria analysis (MCA) of seven potential wetland options, as presented to the Governance Group on 24th May 2022. It describes the methodology and approach and reports on the outcomes of the MCA. The report is intended to be used as a guide for the Governance Group in their endorsement of a wetland option to allow progression of tasks 4 and 5 above.

Options have been developed with a focus around sediment collection and wetlands for treatment and removal of nutrients. To aid the assessment of the options, a set of assessment criteria have been utilised to inform an MCA of the options – supporting a robust and consistent evaluation approach. This MCA has been completed across a number of collaborative workshops where the options were discussed by the Wetland Design Group, Kāhui Ārahi, the project team and other technical advisors. The seven options were scored and calibrated and the outcome of the MCA provides a highest scoring option and commentary around each criteria for all options.

2.3 Out of scope

Discussion around alternative locations for the wetland complex, detailed consenting and Assessment of Environmental Effects (AEE) matters, conceptual design development are out of scope for this report.

The wetland complex will be developed on the property purchased by Horizons Regional Council, and deemed the appropriate site for a constructed wetland by the Jacobs and Tonkin + Taylor reports. This site was historically a large swamp (the Arawhata Swamp) with the Arawhata Stream running its length along the western border Figure 1 and Figure 2. The site slopes from the southern end of the site towards the lake. This lower lying part of the site is one of the lowest areas in the catchment, and is often wet with a high groundwater table. Development of the wetland complex beyond the purchased property boundary is not considered in this report.

The MCA was completed at a high level assessing four distinct wetland options and three hybrids of those (total seven). Any option endorsed by the Governance Group will undergo consultation and further analysis. Refinements and adjustments will occur during the consent application process and development of the AEE.

3 Project objectives

The objectives of the wetland project are to:

- Contribute to the enhancement of the Mauri and water quality of Lake Horowhenua through reducing the impact of flows into the Lake, in combination with other measures in the Lake environs.
- Reduce sediment and nitrogen loads into the Lake.
- Ensure that the Wetland Complex is culturally appropriate with Muaūpoko Mātauranga input
- Ensure the project is feasible and can be phased to align with funding available.
- Enable the proposed wetland complex to provide for future social amenity (kai, job creation etc.) and recreational opportunities and connectivity to other high amenity features in the local vicinity.

Figure 1 and Figure 2 are sketches and maps showing the former extent of the wetlands in the Horowhenua area, as well as areas of significance, to help guide the options development and optimisation. Figure 3 shows the extent of the purchased property that is available for the wetland project.

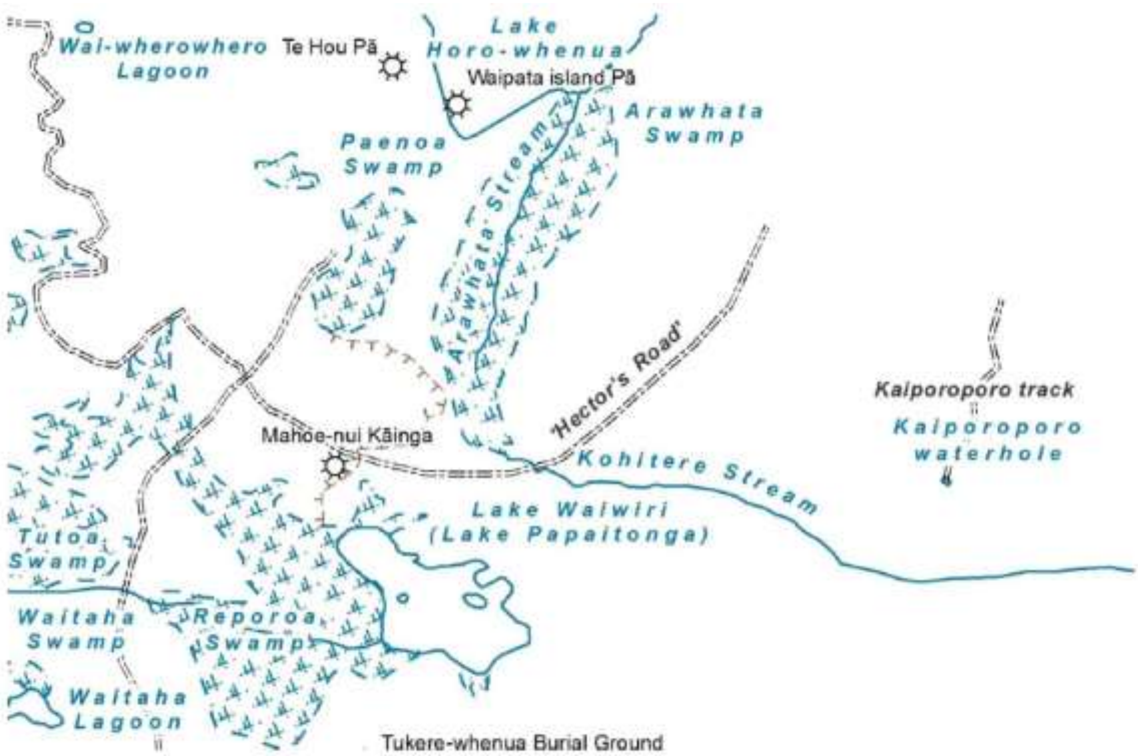

Figure 1. Historic Wetland Extent (LG Adkin, 1948)

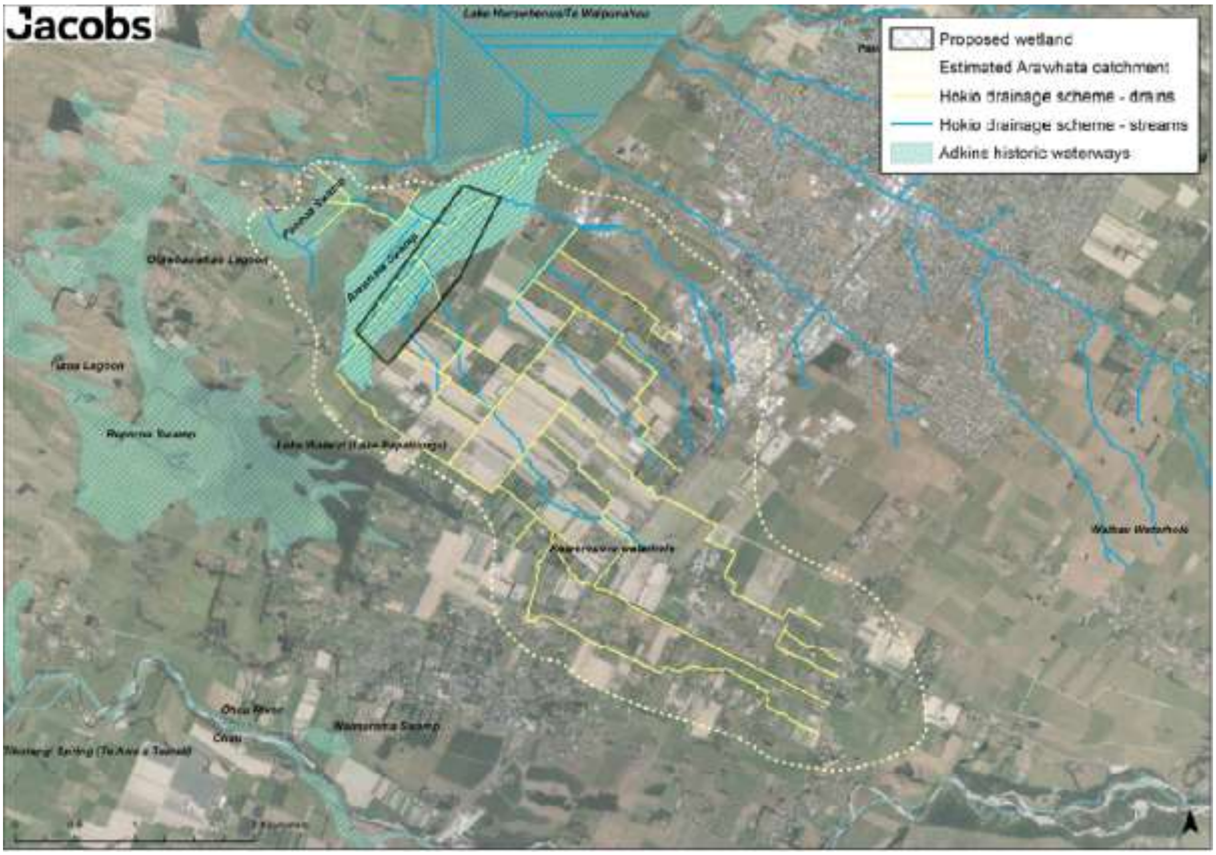

Figure 2. Map showing the southern end of Lake Horowhenua, approximate location of the proposed Arawhata wetland site, and the original swamp (historic waterways) areas.

Figure 3. Yellow highlight indicates extent of the area available for Arawhata Wetland Project

4 Wetland Types

A wetland is a permanently or intermittently wet area, with shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions. The intent of a wetland is to slow the water flow to allow solids to settle out, cool the water down, and provide nutrient removal through settling, plant uptake, and conversion of contaminants to less harmful forms.

The two main types of constructed wetlands in NZ are surface flow and subsurface flow. In surface flow constructed wetlands, water flows above ground. Subsurface flow constructed wetlands are designed to keep the water level below the top of the rock or gravel media. Nutrient removal rates vary for different wetlands types, and are dependent on soil conditions, flow rates, contact time, plant types, and climatic factors. For this reason indicative ranges of nutrient removal are provided.

4.1 Surface Flow (Terraced) Wetlands

Surface Flow (terraced) wetlands are a series of constructed wetlands where flow is directed horizontally through each zone, as well as flowing “downhill” from one wetland cell to the next. The wetlands are surface flow wetlands in that water is seen at the surface. These wetlands have shallow and deep zones, to reduce the risk of short-circuiting, and enhance treatment. The wetland cells have a combination of planted and open water zones. The benefits and risks of terraced wetlands that apply to the Arawhata Wetlands are summarised in Table 4-1.

Table 4-1 Benefits and Risks of Surface Flow Wetlands

Benefits	**Risks**
Good sediment and P removal (up to 90% P reduction)	Moderate earthworks – some clearing, excavation and shaping required
Higher hydraulic loadings possible	Higher capital cost
Moderate N removal (up to 80%)	Reduced likelihood of directly “naturally” intercepting groundwater unless deep zones introduced
Reduced drainage and flooding risk	Deep excavation has higher earthworks and cost but could naturally intercept groundwater
Opportunity for excavated material to be re-used as part of the project design.	Uncertainty if deep excavated wetland is feasible due to shallow groundwater table.

The following figures provide examples of terraced wetlands.

Figure 4. Huie Wetland Complex in Clayton County, Georgia, USA

Figure 5. Wetland at Lake Okaro, Rotorua, New Zealand during construction (below) and once vegetated (over page).

4.2 Infiltration Wetlands

These wetlands are designed for water to "infiltrate" through to the groundwater aquifers, recharging the water following treatment. These wetlands passively remove nitrogen. The benefits and risks of Infiltration Wetlands that apply to the Arawhata Wetlands are similar to those for surface flow wetlands with the construction process and treatment achieved being very similar. Some additional benefits and risks specific to infiltration wetlands are summarised in Table 4-2.

Table 4-2 Benefits and Risks of Infiltration Wetlands

Benefits	**Risks**
Excellent N removal – reduces to virtually undetectable amounts	Dependent on suitable soils
	Lower hydraulic loadings able to be treated
Opportunity to replenish depleted groundwater sources	Shallow groundwater may prevent infiltration
	Potential risk of flooding impacts beyond the site boundary

The following example (Figure 6) has restored the ecological functions of the historically degraded onsite lakes and wetlands, and create new wildlife habitat within the 15 constructed wetland cells.

The wetlands passively remove Nitrogen. https://www.aaees.org/e3scompetition/2018honor-design.php

Figure 6 4G Infiltration Wetlands, Florida, USA

4.3 Irrigation (Overland Flow) Wetlands

Irrigation wetlands are where the water to be treated is irrigated via microsprays, drip irrigation, and the use of natural or man-made surface water flows, and soil contact. The rate of irrigation is high and the treatment of P, N, and other pollutants, as well as temperature balancing, similar to for the other wetland types is achieved. Wetlands and ponds form in low lying areas where water pools. The benefits and risks of Irrigation (Overland Flow) Wetlands that apply to the Arawhata Wetlands are summarised in Table 4-3.

Table 4-3 Benefits and Risks of Irrigation Wetlands

Benefits	Risks
Less earthmoving and associated costs	May require pumping
Excellent TSS and BOD removal	Higher operating costs
Primarily overland flow wet meadow marshes with open water surface flow wetlands in natural depressions	
Can include forested wetlands	

Benefits	Risks
Very good N removal (close to 100% of nitrate)	

The following figures (Figure 7 and Figure 8) provide examples of overland flow/irrigation wetlands.

Figure 7. Roseburg Urban Sanitary Authority (RUSA) wetlands, Oregon, USA

Figure 8. RUSA Wetlands formed stream (left) and irrigation sprays (right)

5 Arawhata Wetland Complex Options

The identified wetland types were utilised to generate a long-list of viable and constructable wetland options for the Arawhata Wetlands in a collaborative workshop. These options are summarised in the following sub-sections. The options include single wetland types across the whole site using each of the three main wetland types identified for consideration. An option focussed on site restoration was also included as a fourth option.

Three hybrid options, which combine elements from each of the four options, were also included for consideration, with differing levels of engineered and restoration wetland elements. Hybrid options are well suited to staged construction and different elements can be funded separately as each element can have a clear demarcation.

All options include sediment traps upstream of the wetlands, with the exception of Option 4, the restoration option. Each options was investigated to confirm the benefits and risks, to outline the options at a high level to support options comparison, and a workshop was held to review and agree these findings.

A number of criteria were identified collaboratively by the Wetland Design Group and the project team for the purpose of carrying out an initial screening of the options. If options could not support these criteria, they were considered "fatally flawed" and excluded from further consideration.

Initial screening criteria

- Must support primary objective – sediment / nutrient removal – treating water in catchment to support improved lake health
- Must have a low GHG footprint (constructed and operating)
- Plants must be NZ native – suitable to the area
- Must construct a minimum 15 ha initially
- Is designed according to Muaūpoko Mātauranga.

At the workshop where the options were initially identified and discussed, the following processes were discounted as fatally flawed:

1. Floating Wetlands – due to high cost and low and unpredictable treatment performance, these were discounted from further consideration. However, they may prove to be more suitable to use upstream (i.e. in Drains in the catchment) or downstream in the lake as part of other initiatives.
   Subsurface Flow Wetlands – due to cost, considered less suitable than surface flow / irrigation, with an increased risk of clogging. Risk was also identified around upward percolation of low-quality groundwater into the wetland (if unlined).
   Removal of water from the lake to recycle through the wetlands as this will not be acceptable to iwi – noting that water can still be considered for extraction from the groundwater feeding the lake to enhance treatment and increase the improvement impact to the lake health.

5.1 Option 1 – Terraced Wetlands

This option features the most common type of constructed wetlands we see in New Zealand. It would require design and land shaping to enable water to flow to the site in the elevated (south-western) area. An alternative is to pump / irrigate to this location.

This option would require some land shaping to form wetlands in the desired location, including some more significant and deeper excavations. The wetlands can either be in a single location or spread over multiple locations. Planting would be riparian and marsh type vegetation.

5.2 Option 2 – Infiltration Wetlands

This option is where the wetland is designed to allow water to "infiltrate" through the base into the groundwater below. The key benefit is restoration of depleted groundwater sources. This option would require similar interventions to Option 1, and would look similar at the surface.

The key difference for this option is that water filters through the bottom to replenish groundwater supplies. This could be a risk due to shallow water tables and may not be feasible at the lower parts of the site where the water table may not support downwards water flow paths. Similar to Option 1, the wetlands can either be in a single location of spread over multiple locations. Planting will be riparian and marsh type vegetation.

5.3 Option 3 – Irrigation (Overland Flow) Wetlands)

Overland flow or irrigation wetlands can use drip lines or shaped channels to direct flow. This enables the supply of water to land or crops to help growth, typically by means of channels.

There will be less excavation works with this option, with the water flowing naturally to low points. Some shaping can be done to reflect what existed there historically and create these low points to maximise treatment.

Similar to other identified options, intervention to get water onto the site at the required location is required. This could be through removing manmade drains and creating a new channel / river at the upper end to feed the site, or through pumping.

Similar to Option 1, the wetlands can either be in a single location of spread over multiple locations. Planting would be riparian and marsh type vegetation or could include marsh and forest type planting.

5.4 Option 4 – Restoration Wetlands

This option is similar to Option 3, however, the land shaping would be minimal and focused on returning the site to what it was rather than on maximizing treatment. The risk with this approach is that the treatment achieved through the design ouldl not be as optimised as other options.

This option would remove man-made elements (drains) and allow the site to naturally flood / restore. It would consider the impacts on land beyond the boundary, which may necessitate flow diversion to manage the risk of flooding at those points.

Similar to Option 1, the wetlands can either be in a single location of spread over multiple locations. Planting would be marsh type and this option will encourage the natural formation of springs and pools.

5.5 Option 5 – Hybrid Option (Natural)

Hybrid options are a combination of:

- Irrigation
- Infiltration
- Surface flow wetlands

The first hybrid option is a combination of Options 1, 3 and 4. The upper end of the site would be an engineered / managed wetland being a purposefully designed surface flow wetland to remove contaminants. Water would flow from there over the site, which would be shaped slightly to restore the former character of the site. The site would become increasingly "natural" towards the lake.

Under this option it would be possible to complete the restoration stage first within the current funding authorised for the wetland complex. The design will be staged and look to complete the engineered wetland(s) at a later stage.

5.6 Option 6 – Hybrid Option (Managed)

This hybrid option is very similar to Option 5, but is more "managed" with more engineered wetlands being introduced. It comprises a series of wetland types over the site. Surface flow wetlands are proposed at each end of the site, with grassy "swamp" type (overland flow) wetlands in the middle.

5.7 Option 7 – Hybrid Option – Large wetlands near Lake

This option is effectively Option 5 in reverse. The surface flow wetlands are in the lower point of the site towards the lake. This has the benefit of maximising capture of contaminants and contaminated flows in storm events as this is where the water naturally accumulates. The rest of the site is focused on restoration of the former character of the site.

5.8 Options Summary

The options are summarised in Table 5-1.

Table 5-1 Summary of Wetland Options

Option		Description	Water Treated	Treatment Mechanism				Nutrient Load Treatment to Lake Horowhenua	Vegetation Type
				Sedimentation (additional to sediment traps)	Denitrification in Soil	Denitrification in Surface Wetland	Passive Phosphorus Sequestration		
1	Terraced Wetland (surface flow)	Shallow and deeper zones; surface flow	Surface water	X		X	X	Intermediate	Riparian and marsh
2	Infiltration Wetlands	Infiltration through base of wetland; restores depleted groundwater sources	Surface water and groundwater	X	X	X	X	High	Riparian and marsh
3	"Irrigation" wetlands	Overland flow with drip lines or channels to direct flow	Surface water and groundwater		X	X	X	High	Riparian and marsh; forested
4	Restoration Focus	Remove drains and allow site to naturally restore over many years	Surface water and possible groundwater if water level increases producing springs		X		X	Low	Riparian and marsh
5	Hybrid ("natural")	Constructed Option 1 upland; Option 2 towards lake will be established over many years forming naturally without construction	Surface water and groundwater	X	X	X	X	Intermediate - High	Riparian and marsh
6	Hybrid ("managed")	Constructed Option 1 upland; Constructed Option 2 towards lake	Surface water and groundwater	X	X	X	X	High	Riparian and marsh
7	Hybrid with Surface Flow near lake	Constructed Option 1 upland (could include forested area); Constructed Option 2 for	Surface water and groundwater	X	X	X	X	High	Riparian and marsh; forested

			Treatment Mechanism					
Option	Description	Water Treated	Sedimentation (additional to sediment traps)	Denitrification in Soil	Denitrification in Surface Wetland	Passive Phosphorus Sequestration	Nutrient Load Treatment to Lake Horowhenua	Vegetation Type
	Arawhata Stream; surface flow wetland near lake							

horizons
REGIONAL COUNCIL

6 Multi-Criteria Assessment

6.1 Assessment criteria

A series of workshops have been held to agree the project objectives and the criteria to use to assess options. The agreed criteria for the MCA are provided in Table 6-1.

Table 6-1 Assessment Criteria

Objectives	Criteria
Enhances the mauri of Lake Horowhenua / Punahau	Supports Muaūpoko fishery through improvements in water quality and creation of habitat.
	Promotes natural wetland restoration and enhances processes such as puna formation.
	Is resilient to the effects of climate change (flows and loads) and minimises greenhouse gas production.
	Contributes to the reconnection of Punahau and Waiwiri through green corridors, wai connections and traditional pathways.
	Minimises adverse effects on existing freshwater and ecological habitats.
Promotes sediment and nutrient removal	Ability to remove nitrogen.
	Ability to remove sediment.
	Maintains or reduces phosphorus.
	Ability to treat groundwater.
	Minimises effects of sediment discharge into waterways during construction and ongoing maintenance.
Is designed according to Muaūpoko mātauranga	Supports the traditional connections of Muaūpoko with the natural character of the landscape, including recreation of the shape, depth and planting of Arawhata stream, wetlands, open water and connecting waterways.
	Enables cultural expression opportunities through design.
	Enables Muaūpoko kaitiaki to freely access their ancestral lands and to participate and make decisions in the project.
	Creates habitat for taonga species and mahinga kai, including the kotuku and watercress.
	Minimises risk of disturbing Muaūpoko tupuna who lost their lives in the Arawhata area.
Is feasible	Capital cost.
	Able to be phased to align with funding.
	Delivery on the Deed of Funding – must construct a wetland at least 15 ha in size within timeframes.
	Level of consenting complexity, including fast track eligibility.
	Ongoing operational / maintenance costs.
	Suitability of local environmental conditions – versatile soil, groundwater, geology, etc.
	Resilience to natural hazards.
	Extent of effects on existing infrastructure (drains and utilities).
	Extent of construction effects – noise, nuisance, and disruption to public and services.
	Constructability – skills available in current market and access to materials and technology in a timely manner.
Provides for social and amenity values	Potential impacts on adjoining / neighbouring properties.
	Potential for noise effects.
	Potential for nuisance (e.g., midges and mosquitoes).
	Potential to create odour.
	Community job creation, education and training.
	Enables amenity such as connection for boardwalk between the two lakes.

6.2 Scoring guidance and methodology

The assessment criteria were allocated to members of the Wetland Design Group and other specialists aligned to their expertise. For example, technical design elements such as nutrient removal and feasibility criteria were allocated to Jacobs, NIWA and Tonkin + Taylor for assessment. Mātauranga Maori and lake mauri restoration objectives were allocated to Kāhui Ārahi and Kāhu Environmental.

The criteria and suggested scoring guidance (Table 6-1) was shared with all participants and a workshop was held to discuss and agree the scoring approach. Each specialist group then completed scoring of each option against the allocated criteria. The Wetland Design Group and specialists then re-grouped to review the scores and complete a calibration of these scores, to obtain alignment on the outcomes.

Table 6-1. Proposed scoring approach

Score	Description of score
0	Does not support / undermines / presents significant difficulties (please include discussion on degree of difficulty including if you consider this fatally flawed)
0.25	Minor alignment only / presents aspects of difficulty and limited benefits
0.5	Partially supports / there are minor difficulties and / or some benefits to this criteria
0.75	Supports in most regards / presents only very minor difficulties and may have a range of benefits
1	Full supports / exceeds / significant benefits to this criteria

6.3 Outcomes of assessment

The results are presented in Tables 6-2-7. A summary of the scoring for each of the project objectives, against the identified criteria, is provided in the following sub-sections. The criteria were initially assessed by the technical experts and mātauranga advisors per the allocations in Table 6-1 and then a collaborative MCA workshop was held where scores were discussed and agreed as a group. The following sections present the outcomes of the collaborative assessment process.

6.3.1 Enhances the Mauri of Lake Horowhenua / Punahau

There are five criteria under this objective:

- Supports Muaūpoko fishery through improvements in water quality and creation of habitat. (NOTE: surface flow wetlands have greater opportunity for this than overland flows)
- Promotes natural wetland restoration and enhances processes such as puna formation
- Is resilient to the effects of climate change (flows and loads) to protect the lake and minimises greenhouse gas production
- Contributes to the reconnection of Punahau and Waiwiri through green corridors, wai connections and traditional pathways
- Minimises adverse effects on freshwater and ecological habitats.

The discussion to support the scoring is provided in Table 6-2.

Table 6-2 Mauri Enhancement Scoring

Criteria	Basis for scores
Supports Muaūpoko fishery through improvements in water quality and creation of habitat. (NOTE: surface flow wetlands have greater opportunity for this than overland flows)	Options 1-4 scored lower than the hybrid options. Options comprising only one treatment type were not considered sufficient to achieve treatment across the range of contaminants that is needed to improve the mauri of the lake. The hybrid options are better placed to deliver improvements to the mauri of the lake and to support a broader range of habitat creation.

Criteria	Basis for scores
Promotes natural wetland restoration and enhances processes such as puna formation	The more engineered or "managed" a solution is, the lower the alignment with this criteria. Therefore the overland flow options and the more natural hybrid option scored better than the other options. The infiltration option was recognised as having the potential benefit of increased puna formation and therefore was scored well, even though the solution is quite engineered initially.
Is resilient to the effects of climate change (flows and loads) to protect the lake and minimises greenhouse gas production.	All options were found to support or partially support with the exception of the restoration option (Option 4) which was considered to only have minor alignment due to not improving the ability to mitigate storm flows. Infiltration and irrigation systems will reach application limits before other options. Surface flow wetlands in the upper catchment can be designed to withstand high flows, natural wetlands less so. At the other end of the spectrum drought can also have an impact, and therefore options that include terraced wetlands scored slightly better as they will maintain permanently wetted areas to support plants.
Contributes to the reconnection of Punahau and Waiwiri through green corridors, wai connections and traditional pathways	The hybrid options better supported this criteria, by allowing greater flexibility in creating connection corridors between the two lakes. The hybrid options also better support a connection pathway of the water between the two lakes than use of a single wetland type. The overland flow wetland scored slightly better than Options 1, 2 and 4 due to the ability to transport the water across the surface and create wetlands and green corridors along the water pathway.
Minimises adverse effects on freshwater and ecological habitats.	All options were found to support this criteria, ranging from partial to full support. This is because the design employed for all options should seek to minimise adverse effects. The restoration and overland flow options will be less disruptive to construct, and therefore scored better. The hybrid options also scored well as they provide the flexibility to locate disruptive works away from sensitive areas.

6.3.2 Promotes Sediment and Nutrient Removal

There are five criteria under this objective:

- Ability to remove nitrogen
- Ability to remove sediment
- Maintains or reduces phosphorous
- Ability to treat groundwater
- Minimise effects of sediment discharge into waterways during construction and maintenance.

The discussion to support the scoring is provided in Table 6-3.

Table 6-3 Sediment and Nutrient Removal Scoring

Criteria	Basis for scores
Ability to remove nitrogen	The more engineering, the better the N removal. Infiltration has greater N removal but high water table influences ability to do this. Any wetlands that include downward percolation/infiltration will have the highest N extraction. Note that the two infiltration options (2 and 3) are limited because of the shortfall of suitable areas for good infiltration, therefore they scores similarly to the other options when typically, they would score higher. Option 4 which focuses purely on restoration scores the lowest against this criteria.
Ability to remove sediment	Assumes all options except Option 4 have sediment detention structures at the upstream end. This also assumes the flood flow sediment will exceed the capacity of the detention structures and be transported onto the rest of the wetland area. The overland flow options therefore have lower ability to detain sediment. Option 7 which has the larger wetland just prior to the lake also scored lower as the detention basin will be closer to the Lake than for other options.
Maintains or reduces phosphorous	Wetlands that include infiltration will increase P removal. The high groundwater table will impede the ability to maximise P removal potential in infiltration wetlands. It will also depend on the P balance across the system - i.e. how much removal can be achieved? It is a very large site and plant uptake should be good and a relatively long life can be expected. A lot of P will be bound to sediment captured in sedimentation traps. Most options were considered to partially meet this criteria. Option 1 scored slightly lower due to flow being more open water than through percolation or infiltration. Option 4 also scored lower as it is less engineered and therefore there is less opportunity to enhance P removal.
Ability to treat groundwater	The assessment assumes any engineered options could include pumping of groundwater to the wetland bays. Option 4 does not support this approach and therefore scored slightly lower. Wetlands that receive upward percolating groundwater, especially in winter, will have contaminant extraction effectiveness (especially Nitrogen) reduced. Down-catchment surface flow wetlands will face this problem more than up-catchment. For this reason, Option 7 scored lower than the others. All other options were found to partially meet this criteria. The design can look to optimise the potential of any engineered wetland to treat groundwater.
Minimise effects of sediment discharge into waterways during construction and maintenance	Assumes any option that can be excavated in dry soil conditions can manage sediment discharge. Excavation near the lake edge may pose a greater risk of sediment loss to the lake. For this reason, Option 7 scored slightly lower than the other options, which all were found to support this criteria in most regards.

6.3.3 Is designed according to Muaūpoko Mātauranga

There are five criteria under this objective:

- Supports the traditional connections of Muaūpoko with the natural character of the landscape, including recreation of the shape, depth and planting of Arawhata stream, wetlands, open water and connecting waterways
- Enables cultural expression opportunities through design
- Enables Muaūpoko kaitiaki to freely access their ancestral lands and to participate and make decisions in the project
- Creates habitat for taonga species and mahinga kai including the kotuku and watercress
- Minimises risk of disturbing Muaūpoko tupuna who lost their lives in the Arawhata area.

The discussion to support the scoring is provided in Table 6-4.

Table 6-4 Muaūpoko Mātauranga Design Scoring

Criteria	Basis for scores
Supports the traditional connections of Muaūpoko with the natural character of the landscape, including recreation of the shape, depth and planting of Arawhata stream, wetlands, open water and connecting waterways	The hybrid options scored higher as these align with Muaūpoko aspiration to recreate the natural character of the site while providing treatment upstream, The restoration option (Option 4) also scored well under this criteria for this reason.
Enables cultural expression opportunities through design	All options that included engineering scored slightly higher as provides opportunity to shape the engineered solutions to align with cultural shapes and identity. Natural options still provided opportunity through planting.
Enables Muaūpoko kaitiaki to freely access their ancestral lands and to participate and make decisions in the project	All options scored well under this criteria due to the conversion of this land from a farm to a form of wetlands, which will enable Muaūpoko kaitiaki to freely access their ancestral lands. The inclusion of Muaūpoko to participate and make decisions in the project through this process is also enabled under all options.
Creates habitat for taonga species and mahinga kai including the kotuku and watercress	All options scored well under this criteria. However, options that included engineered wetlands, whether terraced surface flow or infiltration, scored slightly higher due to supporting habitats for both wetland birds and aquatic taonga. The overland flow options scored lower due to not being as suited to improving the habitat for aquatic taonga. The three hybrid options scored highest as they all allow provision of a variety of habitats.
Minimises risk of disturbing Muaūpoko tupuna who lost their lives in the Arawhata area	The engineered options scored lower under this criteria – particularly with deep or widespread excavation – as there is more risk of disturbing sites and increased risk of discoveries. The overland flow options, particularly the restoration focussed Option 4, scored better under this criteria. There is opportunity under the hybrid options to tailor those options to minimise disruption in areas that may have higher risk of discoveries.

6.3.4 Is Feasible

There are nine criteria under this objective:

- Capital Cost
- Able to be phased to align with funding
- Delivery on the deed of funding (must construct a wetlands >15Ha within timeframes)
- Ongoing operation and maintenance costs
- Suitability of local environmental conditions – versatile soil, groundwater, geology etc
- Resilience to natural hazards
- Extend of effects on existing infrastructure (drains and utilities)
- Extent of construction effects – noise, nuisance, and disruption to public and services
- Constructability – skills available in current market and access to materials and technology in a timely manner.

The level of consenting complexity including fast track eligibility was initially proposed as a tenth (10^{th}) criteria. However, upon assessment of the options against the consentability of the project works (RMA, One Plan, District Plan, etc) and eligibility for fast tracking, there was little to distinguish between the options (i.e., all were able to be consented). The other criteria were also found to address some of the factors and it was felt that inclusion of this criteria would risk double counting. It was therefore agreed to exclude this criteria from the options scoring under the MCA process.

The discussion to support the scoring is provided in Table 6-5.

Table 6-5 Feasibility Scoring

Criteria	Basis for scores
Capital Cost	All engineered wetlands will have higher capital cost. Where excavation is reduced pumping and piping costs will be higher. All options will require earthworks to correct current drainage. Excavation costs for deeper surface flow wetlands are similar to the cost of planting. $6M min capital cost for 15 ha ($300K/ Ha NZD plus 25%). All options were found to have minor alignment only as the cost of the project will exceed the current available funding. The restoration only option (Option 4) scored slightly higher than the other options.
Able to be phased to align with funding	All options were found to support this criteria. Hybrid options have increased ability to be phases. Sediment capture is part of all options (except Option 4). Opportunities to support phasing / cost improvements where we can utilise equipment needed for sediment capture to support first phase works - i.e. more of the "engineering" early. Use of the existing sediment trap to be considered.
Delivery on the deed of funding (must construct a wetlands >15Ha within timeframes)	The restoration option (Option 4) is more likely to deliver 15 ha within budget / programme than the others. However all options can be designed to deliver on the 15 ha within the budget constraints and therefore all other options were found to partially support this criteria. Note that due to the budget constraints this may look like a demarcated 15 ha section on the site completed as the first phase that contains a small wetland with surrounding restoration/planting/access.

Criteria	Basis for scores
Ongoing operation and maintenance costs	All wetlands will have substantial on-going maintenance costs to ensure they continue to function optimally. Therefore, all options were scored minor alignment only as the ongoing operational costs are a significant factor to consider in the impact to ratepayers and the whole of life cost of the project.
Suitability of local environmental conditions – versatile soil, groundwater, geology etc.	Lack of a large area suitable for infiltration is the only major factor here – resulting in Option 2 scoring lower. Heavily vegetated options have potential for delays due to seed harvesting season. Need to maintain site as farm until ready to construct to decrease consenting risk.
Resilience to natural hazards	More engineered systems will have greater capacity to survive natural hazards (Option 4 therefore scores lower). Wetlands at the bottom of catchment will be more prone to flood hazards (Option 7).
Extent of effects on existing infrastructure (drains and utilities)	All options will require some alteration to the current drainage system in order to have them function as wetlands, but all will need flood bypass channels installed too. Need to consider ecology in the drains. There is also a vector gas pipe through the middle of site with an easement ~20 feet either side. Therefore all options were found to partially support this criteria.
Extent of construction effects – noise, nuisance, and disruption to public and services	Construction should have minimal impact on neighbours and public services. All options were found to support this criteria in most regards.
Constructability – skills available in current market and access to materials and technology in a timely manner	Resourcing in the construction sector, and supply chain issues, are causing some project programmes to be impacted. This is a risk to all options. The two overland flow options scored slightly better due to irrigation skills in the area being considered higher than this type of construction.

6.3.5 Social Amenity Values

There are six criteria under this objective:

- Potential impacts on adjoining / neighbouring properties
- Potential for noise effects
- Potential for nuisance (e.g. midges and mosquitoes)
- Potential to create odour
- Community job creation, education and training
- Enables amenity such as connection for boardwalk between the two lakes.

The discussion to support the scoring is provided in Table 6-6.

Table 6-6 Feasibility Scoring

Criteria	Basis for scores
Potential impacts beyond the boundary	If the engineered wetlands are well designed and constructed, the risk of flooding and other impacts beyond the site boundary should be

Criteria	Basis for scores
	managed. The less engineered options (especially Option 4) and those involving installation of wetlands at lake level (Option 7) may increase flood risk. These options therefore scored slightly lower.
Potential for noise effects	Noise should not be an issue for any option
Potential for nuisance (e.g. midges and mosquitoes)	Any option with sizeable areas of open water will increase the risk of wetland insects. Bigger open bodies of water attract ducks – we will aim to keep open water bodies smaller to reduce this risk. All options scored well against this criteria with Option 7 scoring lower due to the larger wetland at the bottom end of the site, and Option 4 scoring lower due to not being able to be engineered to minimise open water areas.
Potential to create odour	Odour should not be an issue for any option
Community job creation, education and training	There is potential for jobs in growing wetland plants (onsite nursery), maintenance and operation, construction, education & training programmes – these exist for all options. Option 4 - restoration focus - scored slightly lower as there is slightly less opportunity under this option.
Enables amenity such as connection for boardwalk between the two lakes	The only constraint for the community and public is to avoid irrigators, sediment ponds, wetland sills and bunds. Designed walkways can help avoid this. Open water bodies have higher health and safety risk than overland flow wetlands. Mitigation could be via railings along boardwalks, but this may detract from the amenity values. All options scored well against this criteria.

Table 6-7: MCA Assessment Results

		Option 1 – Surface Flow	Option 2 - Infiltration	Option 3 – Overland Flow	Option 4 - Restoration	Option 5 – Hybrid (natural)	Option 6 – Hybrid (engineered)	Option 7 – Hybrid – surface flow near lake
Objectives	**Criteria**	**Manual Score**	**Manual score**	**Manual Score**	**Manual Score**	**Manual Score**	**Manual Score**	**Manual Score**
Enhances the Mauri of Lake Horowhenua/ Punahau	Supports Muaūpoko fishery through improvements in water quality and creation of habitat. (NOTE: surface flow wetlands have greater opportunity for this than overland flows)							
	Promotes natural wetland restoration and enhances processes such as puna formation.							
	Is resilient to the effects of climate change (flows and loads) to protect the lake and minimises greenhouse gas production.							
	Contributes to the reconnection of Punahau and Waiwiri through green corridors, wai connections and traditional pathways.							

		Option 1 – Surface Flow	Option 2 - Infiltration	Option 3 – Overland Flow	Option 4 - Restoration	Option 5 – Hybrid (natural)	Option 6 – Hybrid (engineered)	Option 7 – Hybrid – surface flow near lake
Objectives	**Criteria**	**Manual Score**	**Manual score**	**Manual Score**	**Manual Score**	**Manual Score**	**Manual Score**	**Manual Score**
	Minimises adverse effects on freshwater and ecological habitats.							
Promotes sediment and nutrient removal	Ability to remove nitrogen							
	Ability to remove sediment							
	Maintains or reduces Phosphorus							
	Ability to treat groundwater							
	Minimise effects of sediment discharge into waterways during construction and ongoing maintenance							
Is designed according to Muaūpoko Mātauranga	Supports the traditional connections of Muaūpoko with the natural character of the landscape, including recreation of the shape, depth and planting of Arawhata							

		Option 1 – Surface Flow	Option 2 - Infiltration	Option 3 – Overland Flow	Option 4 - Restoration	Option 5 – Hybrid (natural)	Option 6 – Hybrid (engineered)	Option 7 – Hybrid – surface flow near lake
Objectives	**Criteria**	**Manual Score**	**Manual score**	**Manual Score**	**Manual Score**	**Manual Score**	**Manual Score**	**Manual Score**
	stream, wetlands, open water and connecting waterways.							
	Enables cultural expression opportunities through design							
	Enables Muaūpoko kaitiaki to freely access their ancestral lands and to participate and make decisions in the project							
	Creates habitat for taonga species and mahinga kai including the kotuku and watercress.							
	Minimises risk of disturbing Muaūpoko tupuna who lost their lives in the Arawhata area.							
Is feasible	Capital cost							

		Option 1 – Surface Flow	Option 2 - Infiltration	Option 3 – Overland Flow	Option 4 - Restoration	Option 5 – Hybrid (natural)	Option 6 – Hybrid (engineered)	Option 7 – Hybrid – surface flow near lake
Objectives	**Criteria**	**Manual Score**	**Manual score**	**Manual Score**	**Manual Score**	**Manual Score**	**Manual Score**	**Manual Score**
	Able to be phased to align with funding							
	Delivery on the Deed of funding – must construct a wetland at least 15 ha in size within timeframes							
	Ongoing operation and maintenance costs							
	Suitability of local environmental conditions – versatile soil, groundwater, geology, etc.							
	Resilience to natural hazards							
	Extent of effects on existing infrastructure (drains and utilities)							
	Extent of construction effects – noise, nuisance, and disruption to public and services							

		Option 1 – Surface Flow	Option 2 - Infiltration	Option 3 – Overland Flow	Option 4 - Restoration	Option 5 – Hybrid (natural)	Option 6 – Hybrid (engineered)	Option 7 – Hybrid – surface flow near lake
Objectives	**Criteria**	**Manual Score**	**Manual score**	**Manual Score**	**Manual Score**	**Manual Score**	**Manual Score**	**Manual Score**
	Constructability – skills available in current market and access to materials and technology in a timely manner.							
Provides for social and amenity values	Potential impacts on adjoining/neighbouring properties							
	Potential for noise effects							
	Potential for nuisance (e.g., midges and mosquitoes)							
	Potential to create odour							
	Community job creation, education and training							
	Enables amenity such as connection for boardwalk between the two lakes							

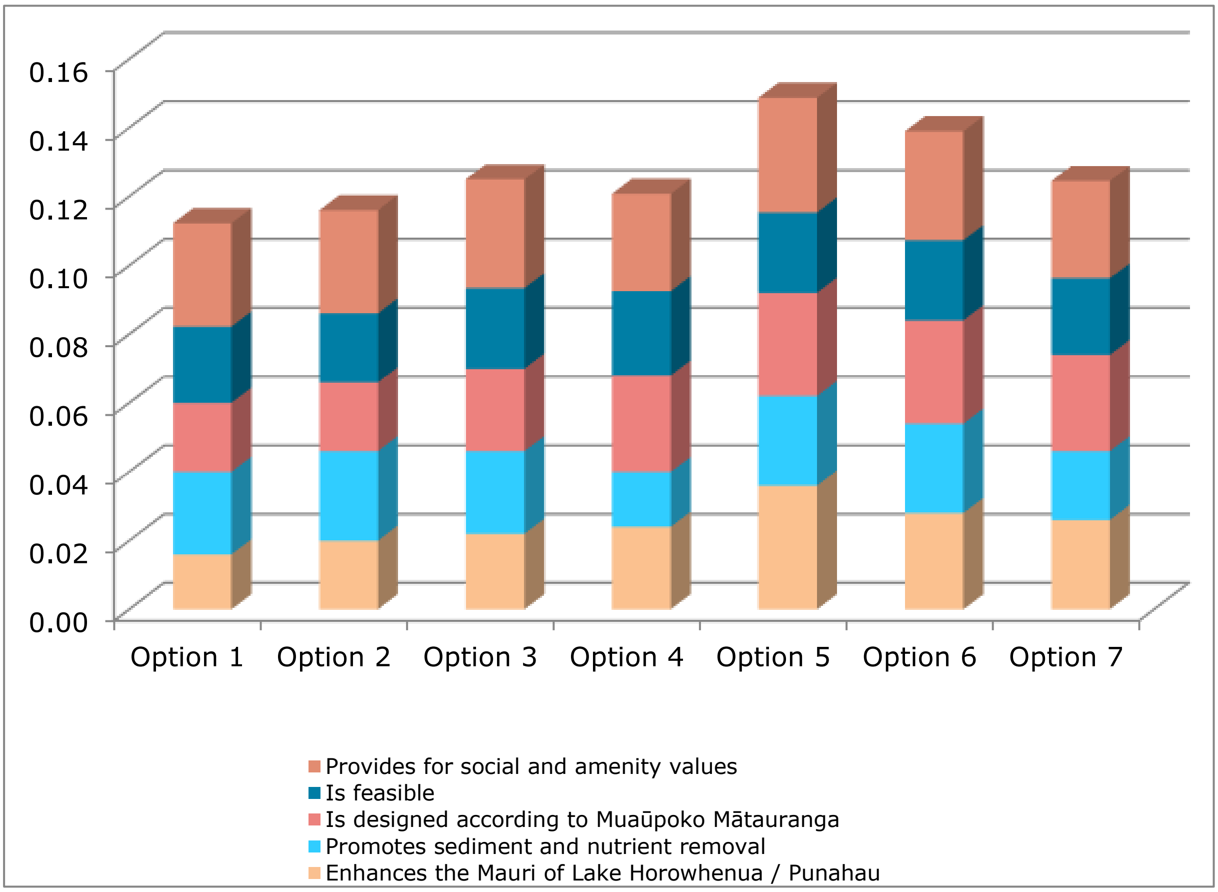

Figure 9. MCA Assessment Results

The MCA results show that the first two hybrid options (Option 5 and Option 6) are ranked as first and second respectively. Option 5 scores well under each objective and set of criteria. This is due to the flexibility that these options offer through the wetland complex design, which enable delivery on the key success criteria, incorporate various cultural, social, and environmental benefits through use of different wetland types and applications, while maximising the nutrient and sediment removal from Lake Horowhenua.

6.4 Sensitivity Analysis

To assess and confirm the robustness of the options assessment, Sensitivity Analysis has been applied. To do this the weightings of the criteria were adjusted to assess whether the preferred solution changes if emphasis is placed on certain elements of the assessment. The original scenario is where all criteria are equally weighted (as presented above). The first additional scenario increased the weighting on the cultural criteria, and in the second scenario more emphasis was placed on the ability to remove nutrients and enhance lake health. The Sensitivity Analysis weightings and outcomes are provided in Table 6-8 and Figure 11.

The outcomes of the Sensitivity Analysis show that under all scenarios Option 5 (the more natural hybrid option) remains the preferred option, followed by Option 6 (the more managed hybrid option). This demonstrates the robustness and certainty around the MCA process, which is considered to be working well. In any event, the options ranking remaining fairly consistent between them, regardless of the weighting applied.

Table 6-8. Sensitivity Analysis Weightings

Primary Criteria	SA 1	SA 2
Enhances the Mauri of Lake Horowhenua / Punahau	30%	25%
Promotes sediment and nutrient removal	13%	40%
Is designed according to Muaūpoko Mātauranga	30%	12%
Is feasible	13%	12%
Provides for social and amenity values	13%	12%
	100%	**100%**

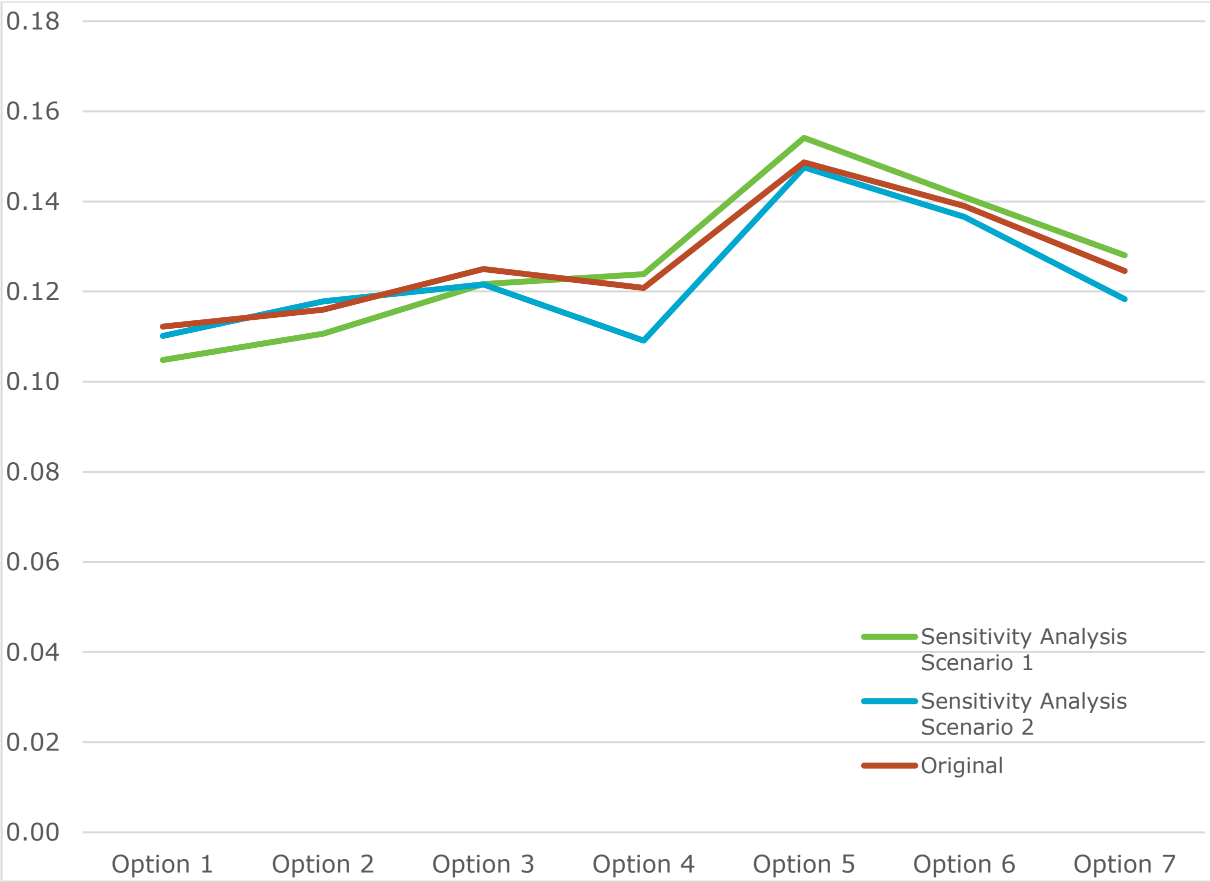

Figure 10. Sensitivity Analysis Outcomes

6.5 Benefits and risks

During the assessment workshops and investigations, a number of risks and opportunities have been identified by the team. These need to be explored, and where required mitigated, during the development of the preferred concept. The key risks identified include:

- Suitability of soils for wetland / irrigation – for example if the soils are not suitable, infiltration may occur where we don't' want it to (soil is too free draining) unless lining is applied. Alternatively if the soil does not support drainage, infiltration wetlands may not viable.
- There is a risk that the infiltration wetlands may raise the water table, resulting in the potential to cause springs or flooding outside the site boundary
- There is a risk that the topography of the site will not allow water to enter the wetlands without pumping. This will increase the costs of the project, particularly the ongoing operating costs
- There is a risk that there is phosphorous bound in the soils and peatland, which may be released when the farm soils are converted to wetlands
- Wetlands have the potential to generate NOx as part of the treatment process. Consequently there is a risk of increased greenhouse gas generation and carbon footprint.
- Wetlands have the potential to attract and promote the number of localized midges and other nuisance insects which may impact on recreational use
- The attraction of birdlife to the wetlands may result in potential *E.coli* impacts.

A number of opportunities have been identified that should be explored as the concept design is developed. These include:

- Peat wetlands have significant carbon sequestration and nitrification potential – this can reduce the greenhouse gas and carbon footprint of the project and potentially offset emissions from elsewhere if the wetlands are designed to address this
- The wetlands will create a park which will attract birdlife – providing cultural and social benefits
- There are opportunities for Mahinga Kai generation within the wetlands complex if the site is designed well, i.e. the design can incorporate pools for Tuna which also support fish passage
- The site can be designed to incorporate walking tracks to promote community and social value
- Groundwater can be withdrawn from the groundwater table and spread across the site to promote treatment of groundwater and support improved lake health
- There is an opportunity for job creation and skill development – i.e. nurseries to grow wetland plants, maintenance staff to keep the wetlands operating optimally, etc.
- Removed sediment from the sediment traps can potentially be reused. This sediment is often high in nutrients and could be seen as a valuable fertilizer.
- The site will provide education and research opportunities where schools can visit to learn about the wetlands process and observe different flora and fauna habitats
- Enduring project legacy.

7 Conclusions and next steps

7.1 Conclusion

The MCA results show that two hybrid options (Option 5 and Option 6) are ranked as first and second respectively, and did not change ranking during the sensitivity analysis. Option 5 was ranked as the highest scoring option under the original scenario and was confirmed following the sensitivity analysis scenarios completed by the design team. This option is where the more engineered wetlands are located further from the lake, in the elevated areas of the site. As the site nears the lake, more natural and less engineered wetlands are utilised, and the focus moves more towards restoration while still achieving contaminant reductions.

Option 5 scores well under each objective and set of criteria. This is due to the flexibility that Option 5 offers in design and implementation of the wetland complex, which enable delivery on the key success criteria for the project, incorporates various cultural, social and environmental benefits through use of different wetland types and applications and maximises the nutrient and sediment removal across the site.

7.2 Next steps

The next steps for this project are to:

1) Present the results of the MCA process to the Governance Group, including wetland option 5 as the highest scoring option.

2) Following Governance Group endorsement of a preferred option, commence conceptual design, with associated costings, technical assessment, and modelling work to be undertaken to determine the treatment effectiveness. This will include proposed timing and staging of the solution, to align with the project objectives.

horizons.govt.nz

24 hour freephone 0508 800 800
fax 06 952 2929 | **email** help@horizons.govt.nz
Private Bag 11025, Manawatu Mail Centre, Palmerston North 4442

horizons REGIONAL COUNCIL