KAHAHAKURI SUB-CATCHMENT PLAN

DRAFT

TLC The Big Picture: Tackling the big issues sub-catchment by sub-catchment

Tukituki Land Care

A COHESIVE VOICE FOR THE LAND

Final Draft 27 March 2025

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Tukituki Land Care
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TUKITUKI CATCHMENT: THE BIG PICTURE

1. Introduction to The Big Picture

1.1. Purpose of The Big Picture

In 2024 Tukituki Land Care (TLC) launched The Big Picture, a six-month project designed to create independent, science-based catchment plans for the 17 sub-catchments of the Tukituki River in Central Hawke's Bay. The initiative identified each sub-catchment's unique environmental challenges and developed practical, cost-effective solutions to address them. As TLC Chair Richard Hilson explained, "We tackled the big issues sub-catchment by sub-catchment, to piece together the bigger picture."

The project employed a comprehensive research approach that combined field investigations, insights from local farmers, and an in-depth analysis of existing studies and data on the Tukituki catchment. Environmental planning consultancy, Environment, Innovation and Strategy Ltd (EIS), led by Matt Highway, undertook this work.

This project reflects TLC's dedication to improving environmental health and farm productivity, paving the way for a sustainable future for the Tukituki community.

1.2. Freshwater status of the Tukituki catchment

Summary of State of the Environment reporting

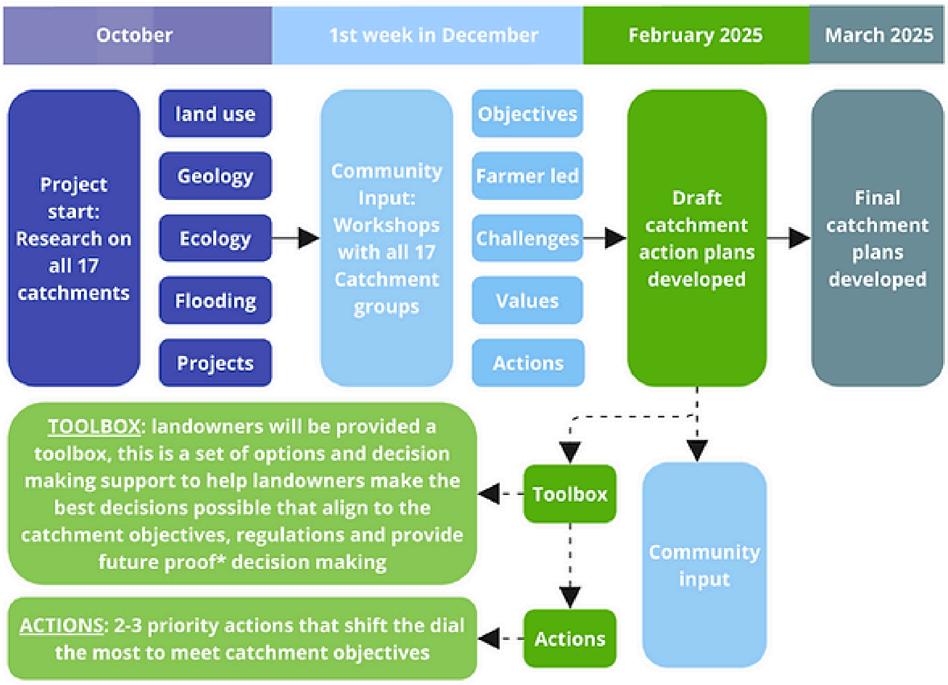
The Tukituki catchment faces water quality, land use, and climate challenges. The catchment, dominated by sheep and beef farming, has experienced significant modifications, leaving only about 10% of its land covered in indigenous vegetation. Water scarcity is a persistent issue, with decreasing river flows over the past three decades, exacerbated by droughts and climate change. Groundwater levels in the Ruataniwha Plains are under strict management to prevent further decline, but interannual variability and climate change pose ongoing risks.

Water quality is a major concern due to high levels of nitrogen, phosphorus, and sediment. The highest nitrogen concentrations in the region occur in streams draining the Ruataniwha Plains, and some areas exceed nitrogen targets by two to four times. Phosphorus and fine sediment issues, linked to erosion, contribute to poor water clarity and degraded aquatic habitats. Toxic algae, particularly Phormidium cyanobacteria, can proliferate in the river during low summer flows, posing a risk to both human and animal health. Despite these issues, the Tukituki River remains generally swimmable, except after heavy rainfall when contaminant levels rise.

1.3. Approach: creating priority actions in the Tukituki

The Big Picture project adopted a highly collaborative approach involving detailed catchment research, GIS mapping, and farmer engagement. Workshops were conducted with local farmers in each sub-catchment to better understand group dynamics, gather community values, and identify key issues and opportunities. Feedback from the workshops, survey results, and field investigations have been used to shape tailored catchment plans aligning with the local communities' specific landscape context and aspirations.

As part of the implementation phase, TLC introduced "THR3E"—three actionable steps designed for farmers in each sub-catchment to implement over three years. The TLC Farmer Toolbox was also launched, providing practical resources to help landowners make informed decisions and maximise the impact of their efforts. Additionally, monitoring strategies are to be implemented, and demonstration sites will be identified to help showcase best practices, ensuring that the plans remain relevant and actionable.



2. Tukituki's Overall Big Picture

2.1. Summary of sub-catchment challenges and priorities

The Big Picture project team has worked with farmers to identify challenges and opportunities in each of the 17 sub-catchments. While each sub-catchment has an individual plan, it is the big picture of the people, the land and the water within the Tukituki that we are trying to collectively support. The approach is reminiscent of a jigsaw puzzle where many pieces fit together and form something greater than themselves as an individual piece. Figure 1 below shows how the Tukituki sub-catchments fit together as a big picture, showing the sub-catchments that are aligned in similar top priorities. Note that the image only shows the proposed highest recommended priority area for each catchment, and all catchments will have multiple outcomes they are seeking.

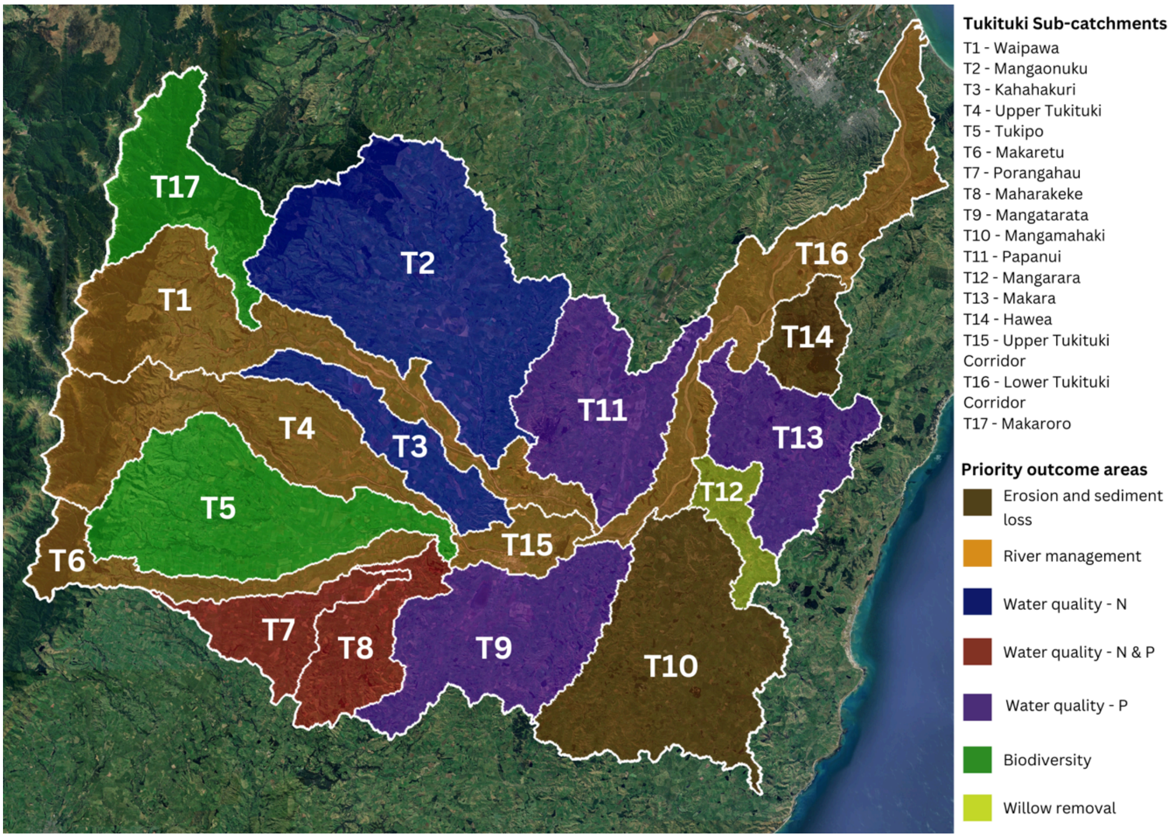


Figure 1 – sub-catchment map for the Tukituki. Coloured areas highlight the recommended priorities for each catchment.

2.2. Outcome areas most sought by farmers (from workshops)

During workshops, farmers were asked to vote on a selection of outcome areas. Below are the top five outcomes:

- Support landowners with the knowledge to make informed decisions to improve the environment
- Improve the flood resilience of the catchment, including upstream and downstream to reduce effects on community in adverse weather events
- Protect and enhance the economic viability of the area
- Protect and enhance the quality, ecology, mauri of waterways and wetlands
- Represent farmers interests in future regional government setting of rules and regulations

KAHAKAKURI CATCHMENT: CONTEXT AND CHALLENGES

3. The Kakakauri Catchment Context

3.1 Background

The Kahahakuri Catchment, covering approximately 7,778 hectares, is situated near the village of ONgaonga. This area features a mix of pastoral farming, cropping, and orchards, with a range of soil types.

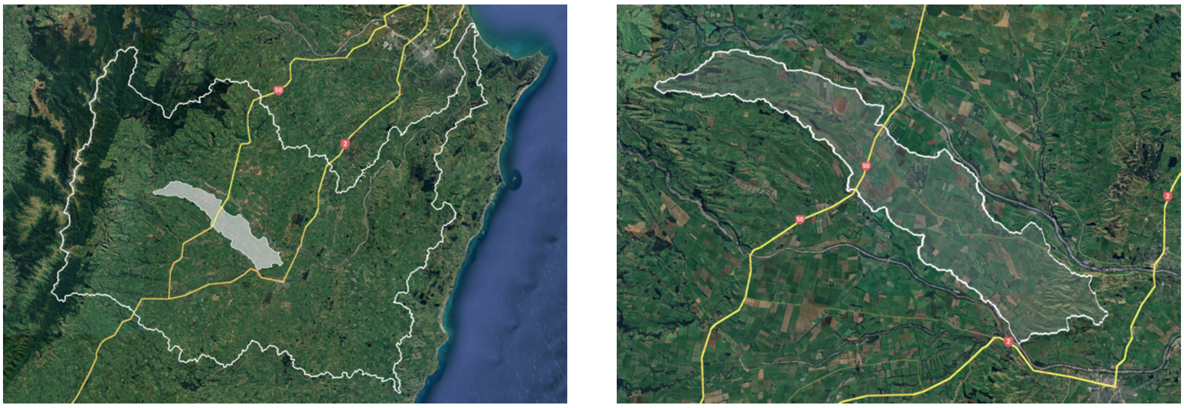


Figure 2 - Location of the Kahahakuri catchment in the wider Tukituki

The spread of cow cress, a fast-growing aquatic weed, has become a significant problem. It blocks streams, lifts the water table and its bulk leads to blocked culverts and damage during floods. In some parts of the catchment, streambank erosion and shingle build-up threaten productive farmland and water quality.

Recognising the need for a long-term solution, farmers in the catchment have accessed expert advice through the Access2Experts programme, working alongside technical experts from Massey University.

In early 2024, the Massey team visited the Kahahakuri catchment with local farmers, regional council representatives, and TLC members. They assessed the extent of cow cress spread, streambank erosion, and sediment movement in the waterways. Through water quality sampling and catchment data analysis, they identified that high nutrient levels in the water contribute to cow cress's rapid growth. They also found that erosion and sediment transport have been exacerbated by past flooding events, particularly in the middle and upper reaches of the stream.

Following this assessment, the Massey team analysed river flow data, historical land use patterns, and digital elevation models (LiDAR) to better understand erosion processes and how sediment moves through the catchment. This work has helped pinpoint where erosion is most active and where interventions like riparian planting, sediment traps, and erosion control structures could be most effective.

Massey also provided insights into the best ways to manage cow cress, drawing on experiences from other parts of New Zealand. They recommended a combined approach, including:

- Carefully planned mechanical removal to clear problem areas while minimising bank disturbance
- Selective herbicide trials to test the effectiveness of different spray options in controlling cow cress while maintaining stream health
- Riparian planting with native sedges to shade out cow cress and stabilise streambanks
- Exploring shading techniques such as artificial covers to suppress weed growth in critical areas

With support from a TLC Demonstration Grant, a multi-pronged approach is now being tested to manage cow cress and improve waterway health. These trials are designed to find cost-effective and scalable solutions that can be used by other farmers facing similar issues.

3.2 Kahahakuri Catchment Context

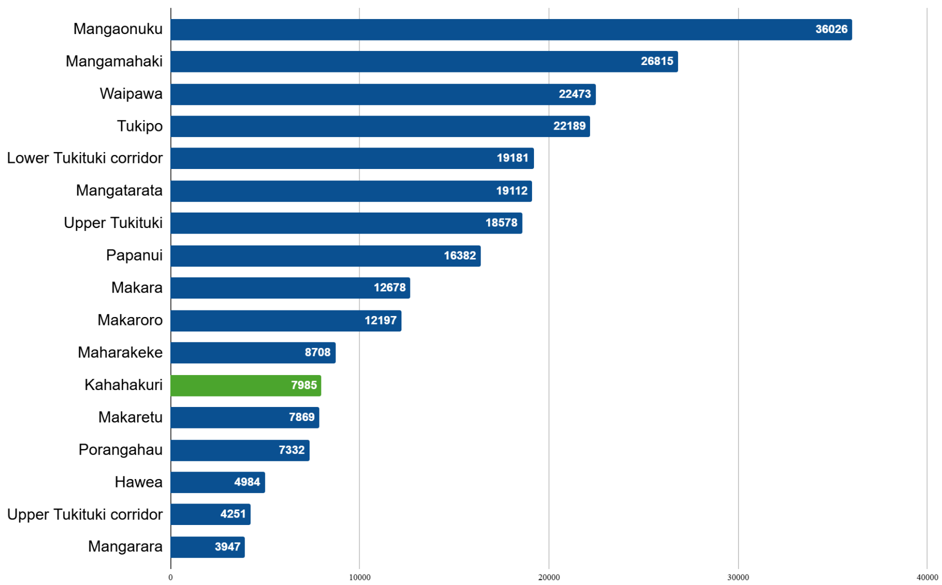


Figure 3 – Tukituki sub-catchment areas in hectares.

The Kahahakuri catchment is 7,985ha which amounts to 3.19% of the wider Tukituki catchment. The Kahahakuri is a smaller sized sub-catchment of the Tukituki, which is 250,000ha in total (figure 3).

Land use in the Kahahakuri is typical of the wider Tukituki catchment with 92% of the catchment in pasture, 3% in orchard and vineyards and 2% in indigenous forest (figure 4).

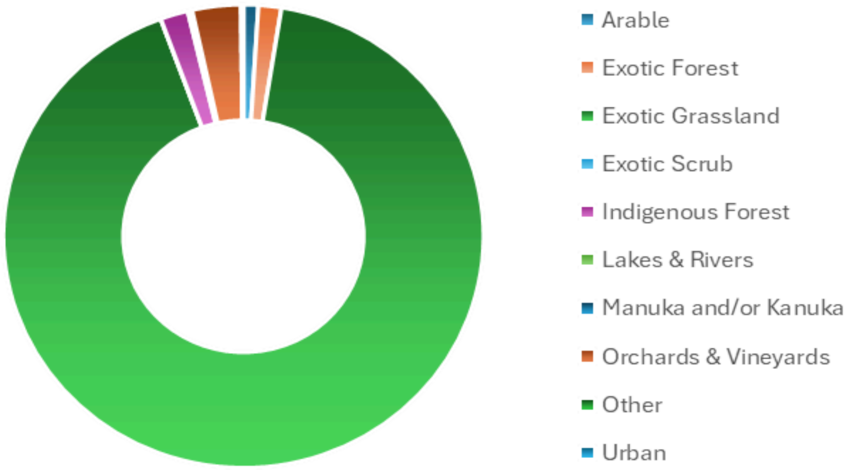


Figure 4 – Land use in the Kahahakuri catchment

3.4 Catchment Challenges and Key Focus Areas

In December 2024 farmers from the Kahahakuri catchment came together to discuss the key challenges affecting their catchment and explore practical solutions. The discussions focused on three main areas: cow cress control, water quality concerns, and engagement with Hawke's Bay Regional Council (HBRC).

Cow cress remains a major issue, though it affects individual farms rather than the whole catchment. Cyclone Gabrielle caused large amounts of cow cress to flow downstream, blocking culverts and adding to farm drainage issues.

Spraying has provided temporary relief, but ongoing spraying is necessary. There were also concerns that while spraying was effective at clearing cow cress, it had left behind organic matter that may have affected any aquatic life in the streams.

Concerns were raised about restrictions on grazing waterways under Fonterra rules, even though limited grazing once a year was seen as a viable cow cress control option.

Water quality remains a concern, particularly high nitrogen levels in the lower catchment (table 1). Springs across the area show varying nitrogen levels and groundwater and surface water levels fluctuate significantly. Questions remain about how water moves through the system and where water quality testing should be focused.

Water Quality Parameter	Kahahakuri	Standard*
Nitrogen (DIN)	3.27 mg/ L	0.8 mg/ L
Phosphorus (DRP)	0.03 mg/ L	0.015 mg/ L
Bacteria (E.coli)	140 (count)	260 (count)
Freshwater invertebrates (MCI)	88.85 (index)	100 (index)
Sediment (Turbidity)	1.51 mg/ L	5.6 FNU (light)

*Table 1 - Kahahakuri catchment water quality indicators over a five-year rolling average. * The standard represents water quality levels based on the Tukituki plan or national standards. See Link to the Kahahakuri dashboard[1] for more information.*

Frustration was voiced about HBRC's lack of communication and engagement with the local community. Farmers want clearer information from HBRC on water quality testing, including where, when, and why samples are taken, especially in summer when parts of the river dry up. They also see an opportunity to work more closely with Waipawa and Tukituki catchment groups on flood response and gravel management.

Overall, the workshop highlighted a strong desire for practical solutions, better communication from HBRC, and more coordinated efforts to manage waterway health and farm impacts in the Kahahakuri catchment.

[1]https://www.hbrc.govt.nz/environment/farmers-hub/in-the-tukituki-catchment/tukituki-dashboard/kahahakuri-dashboard

3.5 Landscape Constraints

From a geophysical standpoint, the catchment can be divided into upper and lower sections, distinguished not only by elevation but also by differences in soils, geology, and associated environmental risks.

The upper catchment is characterised by gravel-based geology and Allophanic soils. Beneath this area lies an unconfined aquifer, which presents a high risk of nitrogen loss due to the permeability of the soil and shallow groundwater. Due to the soil and geology the upper catchment conditions there is limited opportunity for denitrification, increasing the potential for nitrogen loss to water (figure 5).

In contrast, the lower catchment sits above a confined aquifer, where an impermeable layer separates farming activities from groundwater. The soils in this are primarily Gley, Melanic, and Pallic, which contribute to a significantly lower nitrogen loss risk compared to the upper catchment. This distinction has important implications for land management and agricultural practices within the catchment, as well as how the group might focus efforts to manage currently high DIN levels (figure 6).

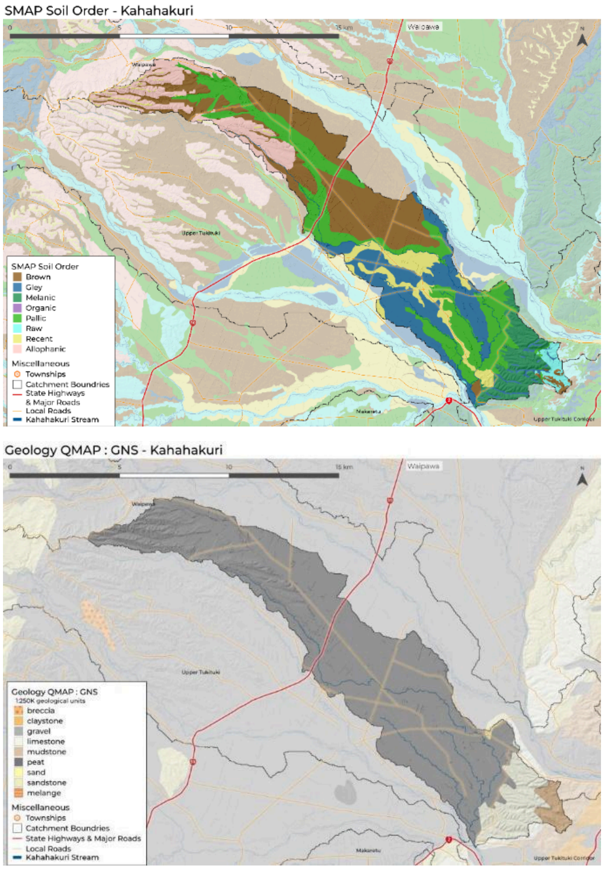


Figure 5 – Soil order (left) and geology (right) in the Kahahakuri.

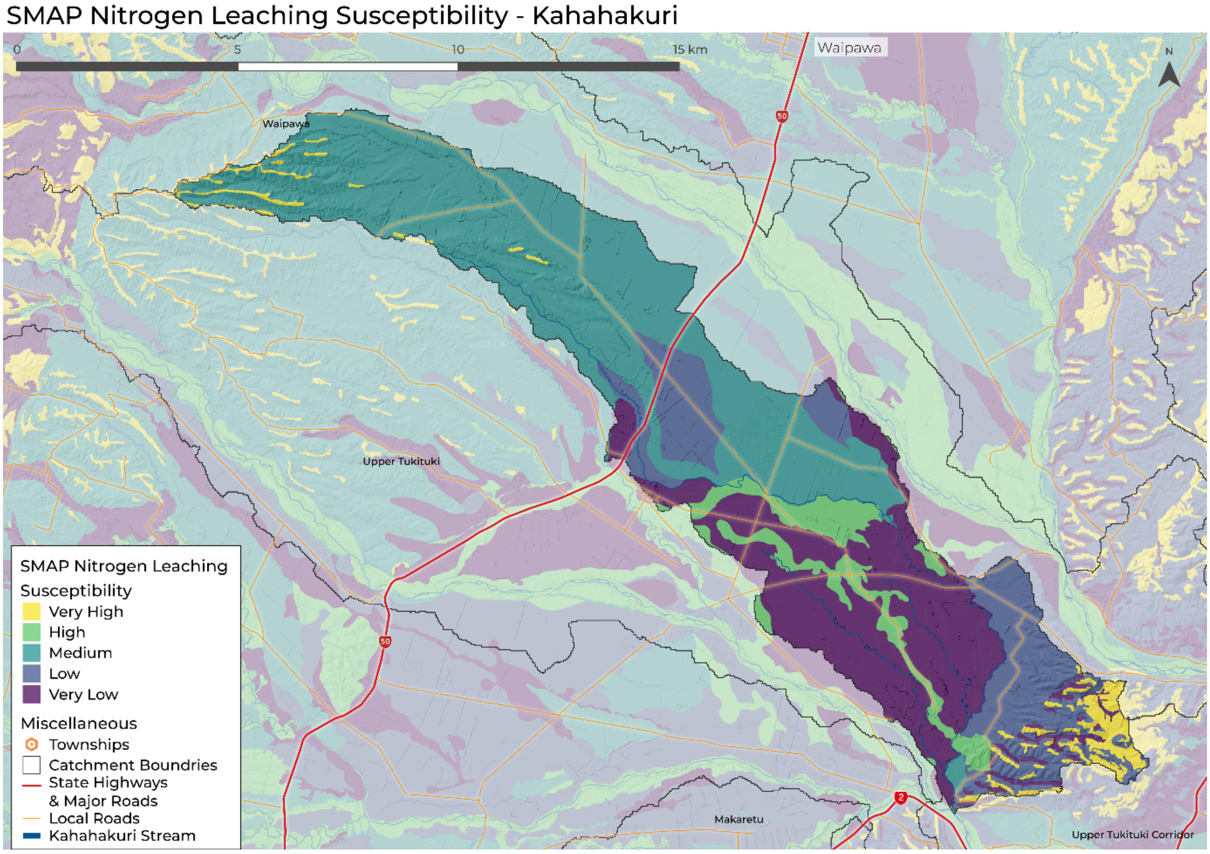


Figure 6 – Left: Soil orders in the Kahahakuri. Right: Nitrogen loss risk in the Kahahakuri. Both data sets have been sourced from SMAP (Manaaki Whenua).

3.6 Waterway Constraints and Opportunities

Given the challenges around cow cress and the impacts of nitrogen in streams, improving the riparian condition is likely to be important. EIS has used LiDAR to model where in the catchment riparian vegetation is likely to be shading waterways. This could be used as a guide as to where riparian planting efforts could be prioritised (appendix 2).

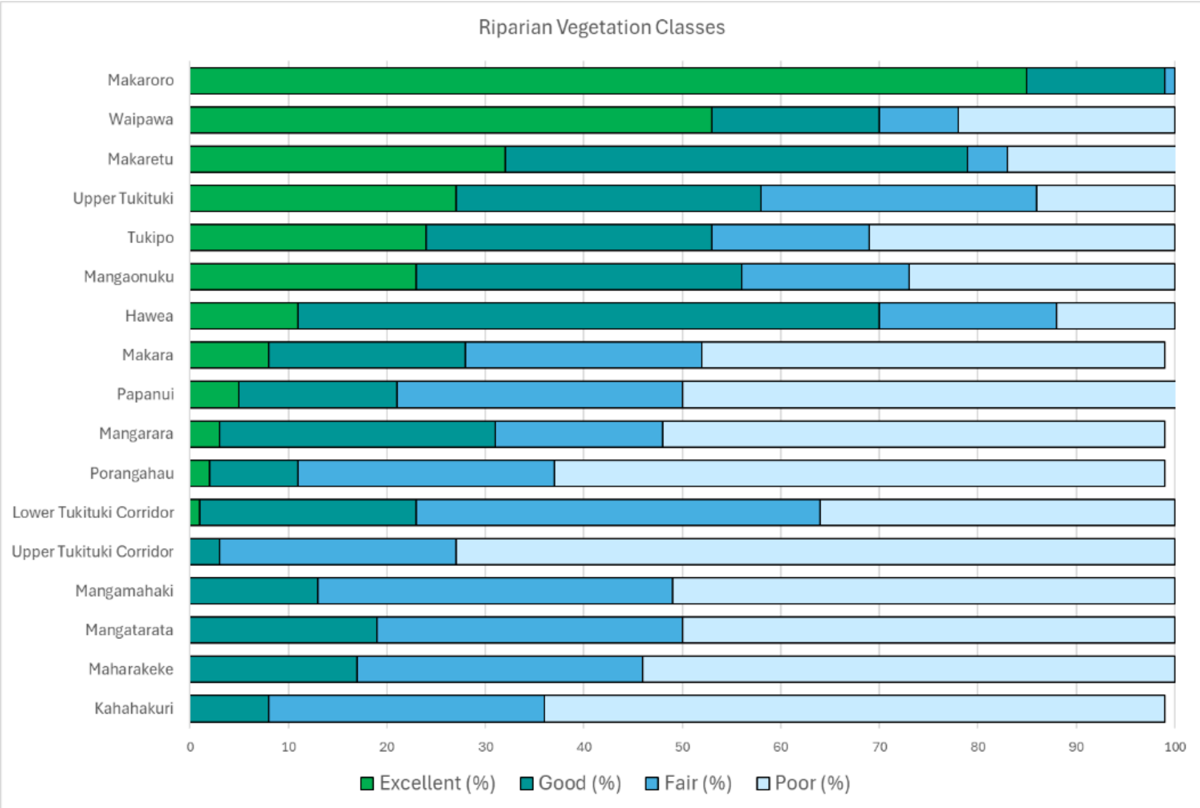


Figure 7 – Riparian Vegetation Classes

4 Summary of Challenges, Impacts and Priority Actions

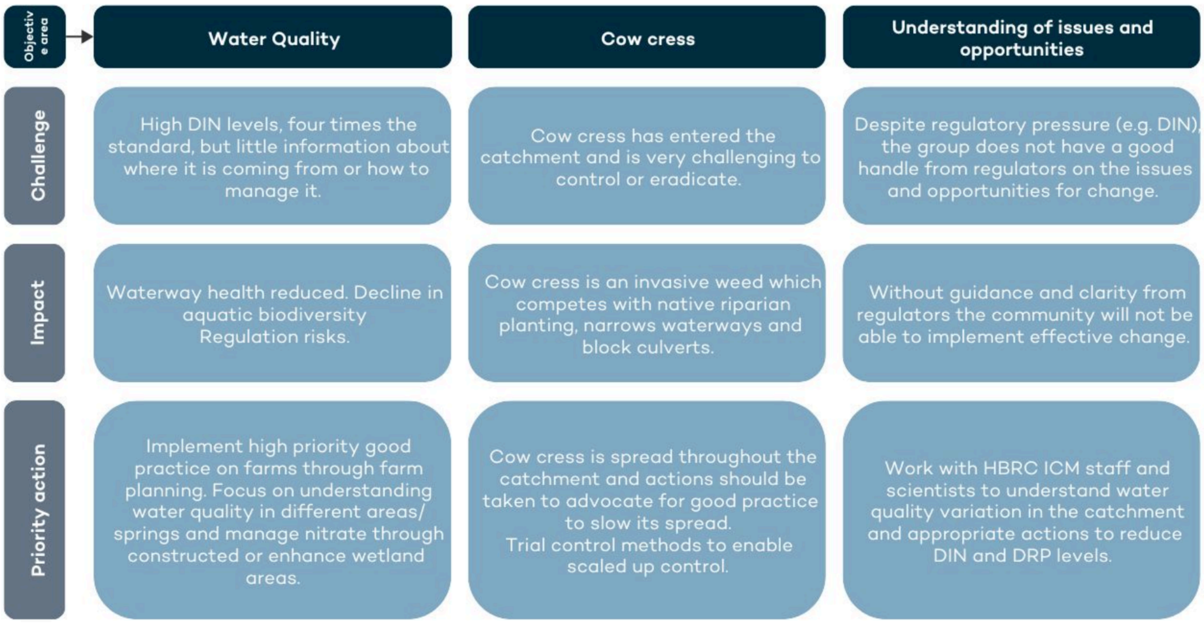


Figure 8 – Summary of the challenges, impacts and recommended priority actions for the Kahahakuri catchment, farmed against three major objective areas

5 Reduce Nitrogen Loss

5.1 Upper catchment

The upper part of the Kahahakuri catchment (above State Highway 50) features well-drained soils that allow water and nitrogen to be lost through the soil relatively easily. Farmers in the upper catchment could focus on further implementing good farm management practices suited to their land. To support farmers, the Kahahakuri catchment group may wish to facilitate farmer-to-farmer learning opportunities or engage specialist advice to enhance sustainable land management practices. Additionally, TLC has developed a good practice guide to assist farmers in prioritising good practices actions (see Appendix 1 for further details).

There are key practices that could be implemented that often reduce N loss and reduce expenditure including soil nitrogen testing, planting cool-season grasses, optimising fertiliser use, and upgrading irrigation infrastructure. Effective irrigation scheduling, ideally through soil moisture monitoring can further support plant growth while minimising nutrient runoff through excessive drainage.

While there is no easy fix, studies in New Zealand have shown implementing good practice in farm planning can reduce nitrogen loss to water.

5.2 Lower catchment

The lower part of the Kahahakuri catchment (below State Highway 50) features heavier moderate to poorly drained soils that allows for denitrification in the right conditions. As in the upper catchment farmers in the lower catchment could focus on further implementing good farm management practices suited to their land. Additionally there could be an opportunity to treat high nitrate water moving its ways through the catchment and appearing in springs in the lower part of the catchment through constructed wetlands or management of spring areas.

To support farmers, the Kahahakuri catchment group could test the spring fed water to help prioritise which springs to focus edge of field mitigations. Starting with the spring that has the highest nitrogen load and constructing wetlands or detention bunds can reduce nitrate in water by up to 95%, a typical response for a constructed wetland would be 50-70% nitrate reduction (e.g. figure 8).

The constructed wetland practitioner guide has useful information to help with design and construction of an appropriate wetland (figure 8).

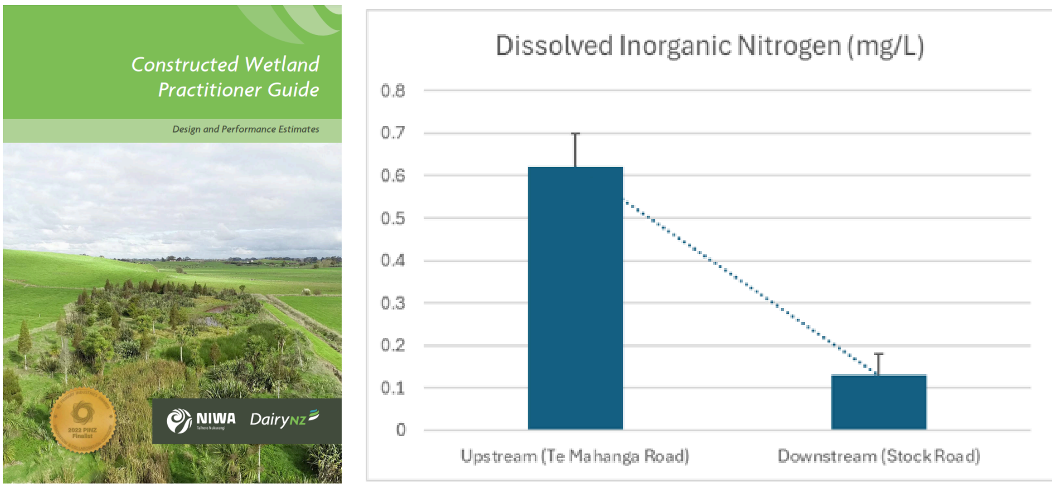


Figure 9 – Left -Constructed wetland practitioner guide[2]. Right- Monitoring from the Pekapeka wetland demonstrating the potential effectiveness of DIN reduction of a wetland.

[2] https://niwa.co.nz/sites/default/files/Constructed%20wetland%20practitioner%20guide-web%20-Final%20Rev1.1.pdf

6 Waterway Management: Reduce the impacts of Cow Cress

6.1 Understanding of Cow Cress

There have been two commissioned studies looking at cow cress control in the Tukituki catchment. The documents relating to this work can be found in the appendices. It is a challenging weed, with no proven examples to date of eradication in New Zealand waterways.

6.2 Understand the extent of the challenge

Implementing a monitoring programme in major waterways within the catchment is recommended to assess the extent of cow cress and track changes over time. This can be achieved cost-effectively through farmer observations and reporting or more accurately via drone surveys and on the ground mapping. Gaining a clearer understanding of the rate of spread will not only inform local management efforts but also provide valuable insights for the wider Tukituki catchment and other regions in New Zealand facing similar challenges.

6.3 Demonstration sites

A TLC Demonstration trial is currently underway within the catchment to assess the effectiveness of weedmat and *Carex secta* in suppressing and replacing cow cress. Previous trials elsewhere in the country on riparian weed control have also explored the use of *Carex geminata*, which has shown promising results in managing aquatic weeds (figure 9). Unlike *Carex secta*, which grows in a rounded, elevated form, *Carex geminata* produces multiple shoots from the base, forming long, tough, sharp blades (figure 10). These blades not only provide shading of weeds but also contribute to physical disturbance, hindering weed growth. While *Carex secta* remains one of the most valuable species to be used in riparian management, it is recommended that TLC also trial *Carex geminata* to determine its effectiveness in reducing the impact of cow cress. A new planting site near to the *Carex secta trial is recommended.*

Figure 10 – Waikato Regional Council drain planting trial using C.secta, C.virgata, and C.geminata. Foreground is the much larger Carex geminata, which due to its height, and form covers a larger area of the waterway and suppresses weeds.

Figure 11 - Forms of Carex geminata (left) and Carex secta (right)

7 Engagement with HBRC

7.1 Gaining understanding

This priority area is straightforward in concept but complex in execution. At its core, it involves building strong relationships with HBRC to enhance communication and develop a shared understanding of the challenges within the catchment. However, implementation may be difficult due to technical complexities in understanding water quality variability, potential regulatory constraints, and limited resourcing.

A more collaborative relationship between HBRC and the catchment group is expected to improve environmental outcomes by ensuring more targeted and effective advice for landowners, as well as fostering a clearer understanding of key issues and actions. One initial step is to invite HBRC to participate in catchment meetings, where they can provide technical guidance on emerging concerns. Over time, their role may evolve, potentially including participation in governance discussions. In the medium term, the Kahahakuri catchment group could also explore opportunities to support HBRC in achieving its environmental objectives. This could be to support monitoring or pest control efforts as an example.

Key challenges include the limited capacity of HBRC staff to engage with catchment groups effectively. To address this, a broader TLC engagement and partnership strategy with HBRC may be required to ensure long-term collaboration and alignment of goals. Establishing clear lines of communication and identifying mutual priorities will be essential in navigating these challenges and achieving meaningful progress.

8 Implementation

8.1 Proposed Implementation Steps and Estimated Costs

1. In identified high nutrient loss parts of the catchment, identify spring areas and waterways that could support nutrient management actions like constructed wetlands to be implemented.

    a. Use existing mapping tools provided by The Big Picture to identify these sites
    b. Undertake a prioritisation of remediation of these sites to ensure the most cost-effective sites are implemented first
    c. Create a demonstration site. Include cost effective monitoring design
    d. Estimated cost: Prioritisation: $2,000; demonstration: $35,000; monitoring $5,000

2. Support farmers to implement good practice actions that are most suited to their conditions

    a. This could be in-kind through TLC coordinators or local farmers or through consultants
    b. Estimated cost: $0 (recommend using existing communication channels)

3. Enhance cow cress demonstration sites by including alternative species and weed control techniques to be implemented alongside existing demonstration sites

    a. This should include *Carex geminata* trials
    b. Ideally, using selective herbicide to control broadleaf aquatic weeds in areas with *Carex*. This may require a consent or working with HBRC under existing consents.
    c. Setting up this trial: Work with new experts to design the planting and control techniques in the alternative demonstration site.
    d. Estimated cost: Expert planning: $5,000; planting: $2,000; monitoring $5,000

APPENDICES

1 Appendix 1- TLC On-Farm Action Planning Tool

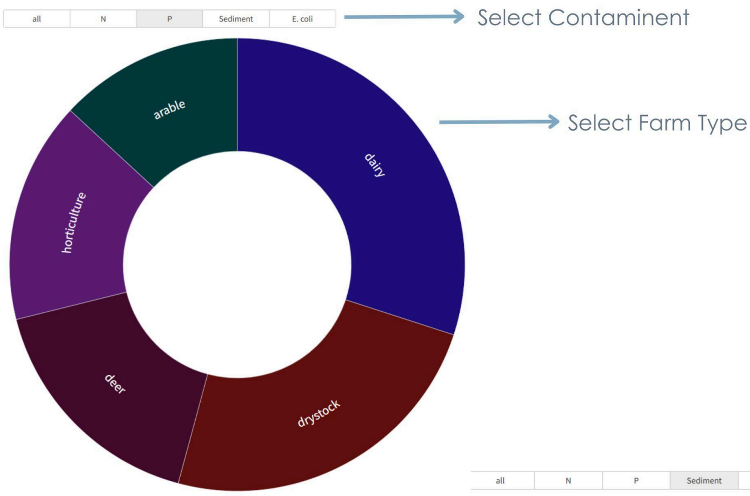
This decision-support tool is designed to help farmers identify and prioritise cost-effective environmental actions on their farms. Use the filters to explore mitigation options by contaminant and farm type.

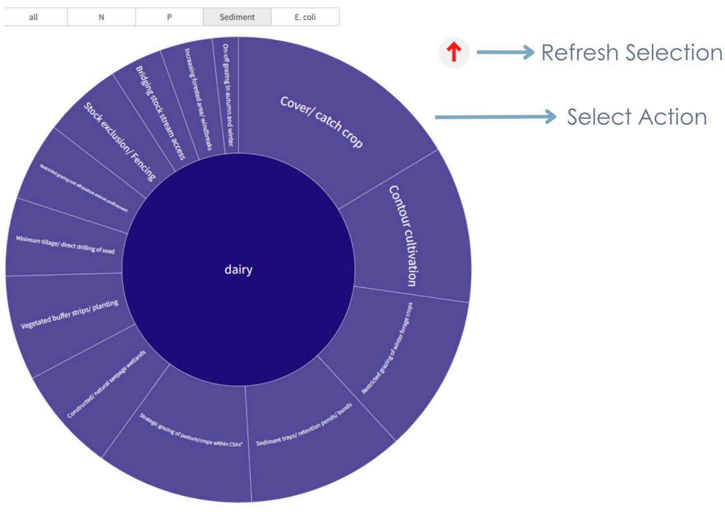
The larger the section, the greater the impact and cost-effectiveness of the mitigation. Recommended actions are displayed in descending order, starting from the top and progressing clockwise around the circle.

How to use the tool:

Visit the TLC Farmer Toolbox at www.tukitukilandcare.org/toolbox, select the On-Farm Action Planning Tool and follow these steps:

1. Select a contaminant.
2. Choose your farm type.
3. Select an action to view more details.
4. Click the red arrow to reset your selections.





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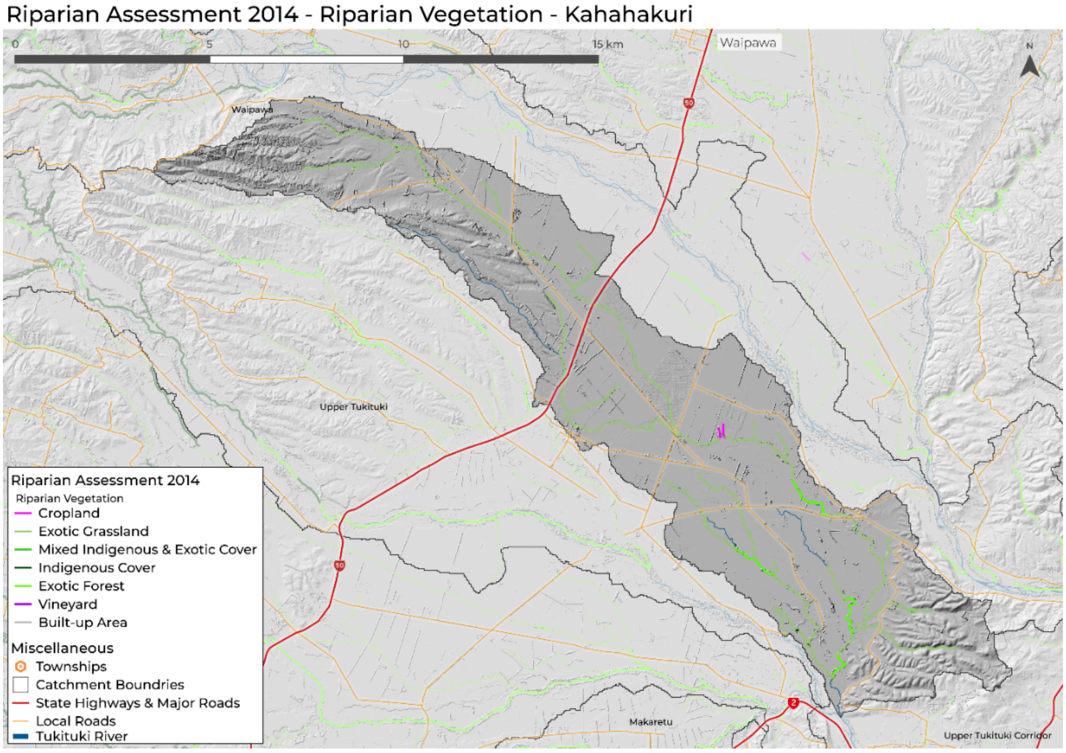
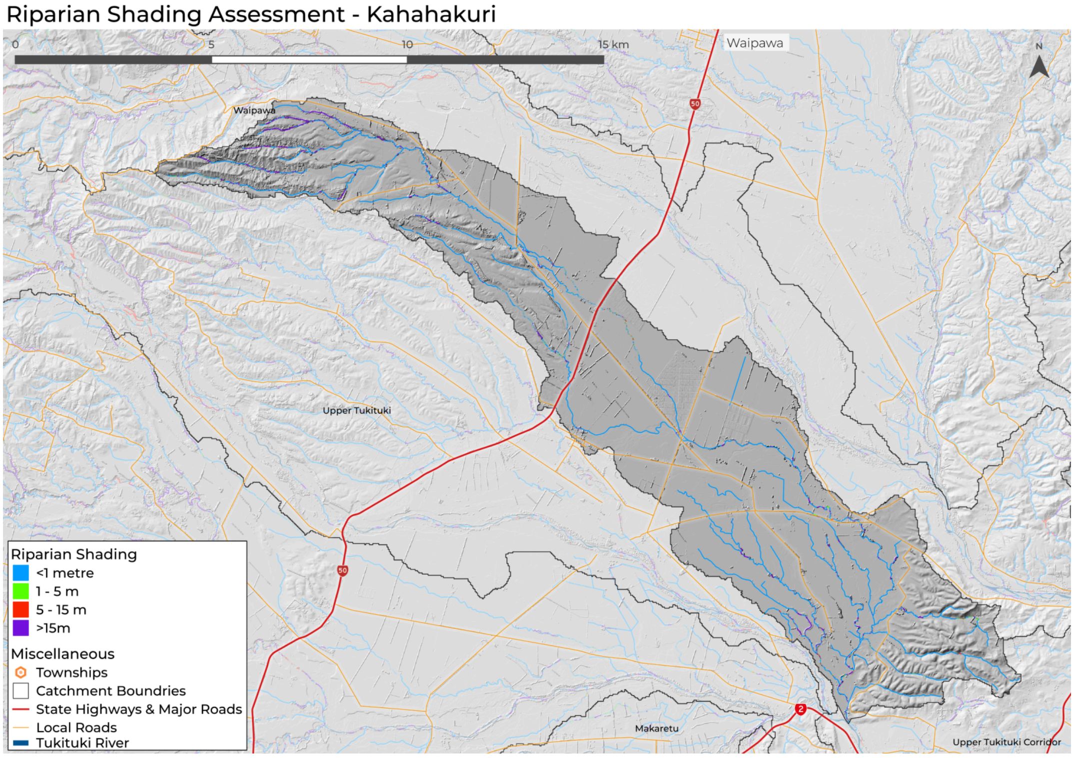
2 Appendix 2 - Waterway management areas

Maps have been created through The Big Picture that enable each catchment group to understand riparian condition and vegetation class along waterways. These maps enable the catchment group to prioritise where riparian management should occur. TLC coordinators have access to these maps and can provide them to each group.

Riparian Assessment 2014 - Riparian Vegetation - Kahahakuri



Riparian Shading Assessment - Kahahakuri



3 Appendix 3 -Flow mapping to understand sites for edge of field management

3.1 Identification of sites for edge of field mitigations (wetlands, dams, bunds)

Topographic Wetness Index (TWI) is a measure of how likely an area is to accumulate and retain water based on its slope and contributing upslope area. TWI identifies wet or poorly drained areas in a landscape, making it useful for understanding placement of edge of field[3] mitigations like bunds and wetlands.

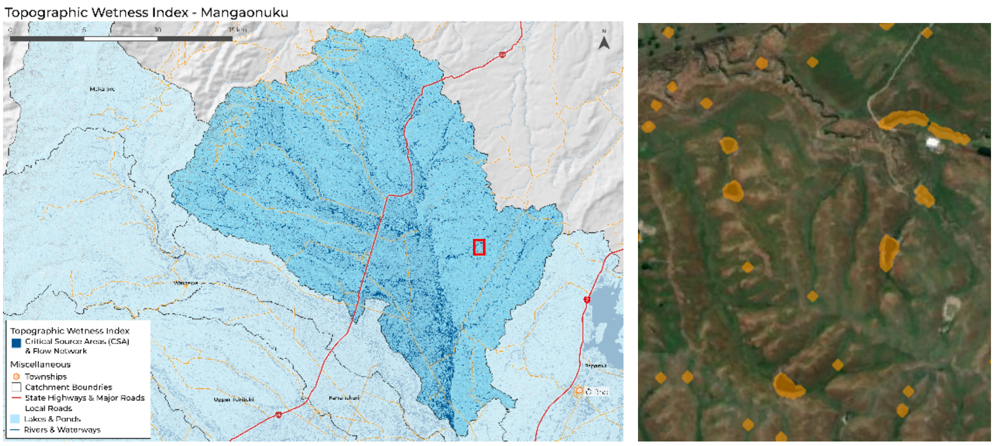


Figure 11- TWI example in a sub-catchment. Using the data layers supplied by EIS will enable exploration of the data using GIS or Google Earth.

TWI can be a very useful tool in catchment and farm planning for those wanting to implement over and above farm actions. It does need ground truthing but can be useful in finding appropriate sites, with an estimate of water accumulation areas and volumes.

It is important to note that the edge of field mitigation needs to suit the outcome each catchment is seeking. TLC will have to be aware of single focus edge of field, which has become a common narrative in New Zealand. For example, promotion of single solutions like installing only constructed wetlands or detention bunds (detainments bunds) was common in freshwater management during the 2010s.

[3] Edge of field tactics are a group of mitigations that operate downstream of a contaminant source, and capture water to treat it. They are normally placed in overland flow path channels before water enters main waterbodies.

Figure 12 – Examples of edge of field mitigations, from large detention bunds, large wetlands through to in-line or off-line sediment traps.

4 Appendix 4 - TLC Plant Selection Tool

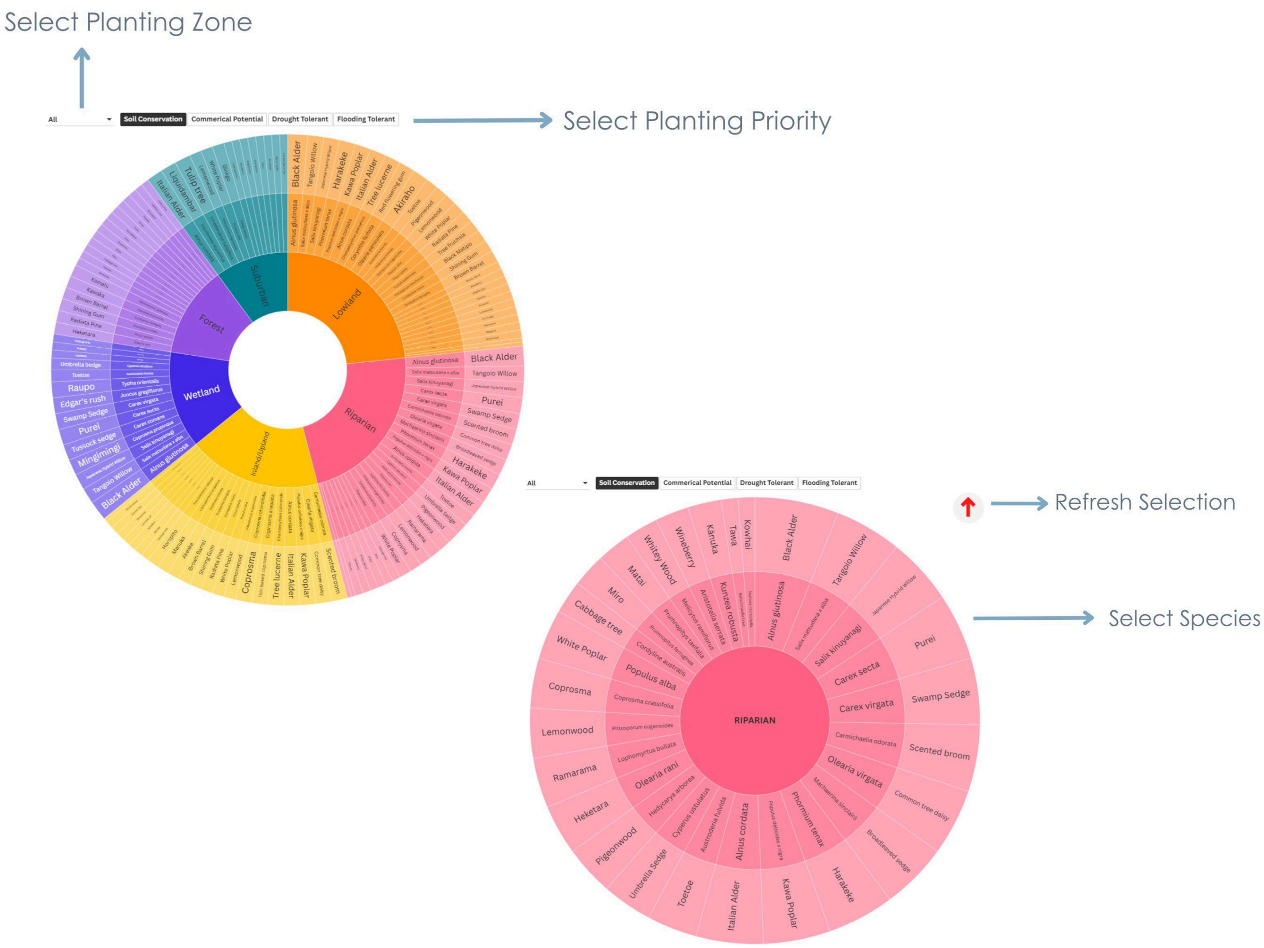
This decision-support tool is designed to help farmers choose the right plants for on-farm environmental projects by matching the planting zone and soil type with suitable species.

Use the filters to explore options based on your specific conditions and requirements. The larger the section, the better suited the plant is to the selected environment. Recommended plants are displayed in descending order, starting from the top and progressing clockwise around the circle.

How to use the tool:

Visit the TLC Farmer Toolbox at www.tukitukilandcare.org/toolbox, select the Plant Selection Tool and follow these steps:

1. Select the planting zone from the drop down list.
2. Select your planting priority.
3. Select a species for more information.
4. Click the red arrow to reset your selections.



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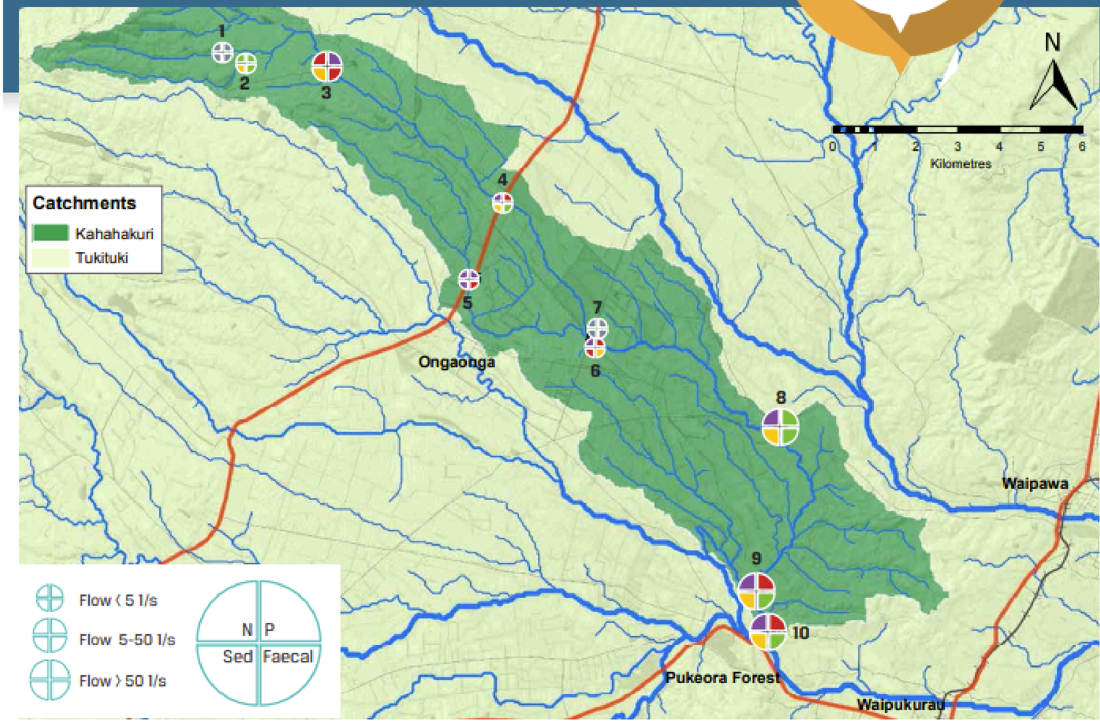
5 Appendix 5-HBRC Summary of water quality in the Kahahakuri

Kahahakuri

Kahahakuri results

HAWKE'S BAY REGIONAL COUNCIL
hbrc.govt.nz



Indicator	Measure	Unit	Statistic	Good	Warning	Bad	Extreme
Nitrogen	Dissolved Inorganic Nitrogen	mg/l	Mean	<0.64	0.64 - 0.8	0.8 - 1.6	>1.6
Phosphorus	Dissolved Reactive Phosphorus	mg/l	Mean	<0.012	0.012 - 0.015	0.015 - 0.03	>0.03
Sediment	Turbidity	NTU	Median	<0.9	0.9 - 4.1	4.1 - 8.2	>8.2
Faecal	*Escherischia coli*	cfu/100ml	Median	<130	130 - 260	260 - 540	>540

DIN and DRP fuel algal growth, turbidity shows how muddy the water is, *E. coli* indicates risk of pathogenic infection

cfu = colony forming units
NTU = nephelometric turbidity units

SITE	NITROGEN	PHOSPHORUS	SEDIMENT	FAECAL	FLOW	SAMPLES
1. Kahahakuri Stream Tributary at McLeod Road (Woodfields Station)	Not flowing enough for sampling					1
2. Kahahakuri Stream Tributary at McLeod Road, Springhill Reserve	0.29	0.005	1.56	50	3	6
3. Kahahakuri Stream Tributary at McLeod Road, Springhill	2.06	0.020	1.71	530	7	7
4. Kahahakuri Stream Tributary at SH50, Chestermans Bridge	4.61	0.016	1.72	40	0	2
5. Kahahakuri Stream at SH50	3.89	0.064	11.80	345	0	6
6. Kahahakuri Stream at Plantation Road Bridge	7.80	0.021	4.70	220	2	3
7. Kahahakuri Stream Tributary at Plantation Road	Not flowing enough for sampling					1
8. Kahahakuri Stream at Ongaonga (Fairfield) Road	4.83	0.011	1.01	80	551	7
9. Black Stream at Kahahakuri Confluence	3.82	0.027	2.00	70	530	7
10. Kahahakuri Stream at Lindsay Road	4.00	0.023	1.55	99	1434	8

Sampling undertaken 2015/16.

For more information contact one of our catchment advisors at the HBRC Waipawa office on 0800 108 838

Appendix 6 - Current Understanding of Cow Cress

Carex Secta Trials for the Control of Cow Cress for Kahahakuri catchment, Tukituki Landcare

Prepared By
Nathan Burkepile
Hawke's Bay Regional Coordinator
New Zealand Landcare Trust

History and Issues

The Kahahakuri Stream is a stream that flows through the flats around Ongaonga and enters the Upper Tukituki River. During the summer, cow cress grows in these streams causing issues with the stream ecology and land management. The landowners in this catchment are looking for a long-term solution to controlling cow cress and improving the ecology of the waterway.

The cow cress fills the waterway, impedes stream flow, reduces habitat for native fish and increases sediment deposition. In the past cow cress was managed using mechanical clearance or use of herbicides. Mechanical cleaning can create over-steepened banks, release sediment, damage in-stream habitat, and require on-going maintenance. Herbicide use also has detrimental impacts on waterways and use can require a consent.

The Carex Group in North Canterbury successfully used native sedges to control aquatic weeds in drainage ditches (Collins, K.E., Hogsden, K.L., Febria, C.M., Devlin, H.S., Goeller, B.C, Harding, J.S., and A.M. McIntosh. 2018. Aquatic Weeds – Use riparian planting to control weeds, CAREX Toolbox Handout 2, University of Canterbury, Christchurch). New Zealand Landcare Trust has been working with the Pianko Catchment Forum and Environment Waikato in planting native sedges in drainage ditches to reduce aquatic weeds and provide habitat for native fish and birds.

Results from this work indicate that if growth can be established, shading the stream edge, aquatic pest weeds like cow cress have a hard time establishing, therefore keeping these pest weeds out of the stream.

Use of Native Sedges in Riparian Planting

Native sedges are key plants to used as they:

- Bind the banks together and prevent sediment from entering water.
- Provide shading of the water to suppress nuisance aquatic weeds growth, reduce water temperatures and increase dissolved oxygen concentrations.
- Incorporate nutrients into their leaves and roots systems preventing those nutrients from entering water and causing algal blooms and excessive aquatic weed growth.
- Grow quickly so that these benefits are rapidly achieved.
- Are cost effective and easily maintained through the use of selective herbicides.

Issues with Riparian Planting

Establishing vegetation along a streambank to control aquatic weeds can be challenging. Spraying the whole bank before planting is not an option as it leaves sections of the bank bare and unprotected which leads to erosion issues. The options are either to spot spray where you want to plant or spray the vegetation and use a weed mat to stop erosion until the sedges are established.

Spot spraying is time consuming but may be the least expensive option. However, just spot spraying may not give native sedges enough room to establish and shade the bank due to competition with other plants.

Weed mats are a tool that can be used in the short-term (1-2 years) to help control the growth of aquatic weeds that grow from the bank while riparian plants establish. Weed mat works by limiting light and suppressing weed growth. Use of weed matts can be a less expensive option as it does not require the time and effort to reduce competing vegetation.

Goals and Objectives

The goal of this series of trials is to develop methodology to establish native sedges to control cow cress.

Objective 1: Determine if the planting of native sedges will be a cost-effective and long-term solution to control cow cress

Objective 2: Develop a cost-effective method of establishing native sedges on streambanks that is scalable

Trial Parameters and Site Selection

I am recommending picking at least 2 or more sites to replicate the trials. At each site will have 3 sections of similar lengths of streams. Each section will have one of the 3 treatments (Control, w/o weed mat, w/ weed mat). Each section will be monitored for plant establishment, survival and cow-cress establishment. The catchment group has identified 2 sections of the stream.

Control Section

Since there are large sections of the stream not being treated the control section can be anywhere.

Spot-spraying Section

Spot spraying should be done several weeks before planting. Spots sprayed should be no larger than 0.3m round to make sure vegetation between the plants are not impacted and help keep the soil protected until the sedges establish. Release spraying should occur about 2-3xs per year until the sedges are established. The recommended chemicals for spraying can be found in Appendix A.

Weed Mat Section

Along the sections that will be trialled for the use of weed mat the vegetation should be sprayed out and after the plants die. I recommend that the vegetation be levelled with a brush bar. After levelling the vegetation, weed mat should be placed on the riparian strip down to the stream edge.

When to Plant

I recommend planting late winter – early spring (August – September). This will allow for a shorter time between planting and when the plants start actively growing and establishing a root system depending on the soil moisture. I recommend planting sections that can be managed by the landowners.

Plant Spacing

There is a choice about plant spacing. I recommend a 0.5m spacing, so you are planting more densely at the beginning which will allow canopy closure earlier on and will help reduce maintenance costs by suppressing weeds. However this spacing is more costly, if 0.5m is too close, I would suggest a plant spacing at 0.75m which will require more maintenance, and costs may be higher as canopy closure will take longer.

Monitoring & maintenance

Monitoring of plant growth success and weeds should be done regularly. I recommend walking the sites and documenting survival of the sedges planted. This should be done at least once every 4 months.

Secondly, I recommend photo-monitoring occur on a monthly basis. To set up plots, markers should be placed that have a good view of the planting site and the photos taken from these spots.

Literature

Collins, K.E., Hogsden, K.L., Febria, C.M., Devlin, H.S., Goeller, B.C, Harding, J.S., and A.M. McIntosh. 2018. Aquatic Weeds – Use riparian planting to control weeds, CAREX Toolbox Handout 2, University of Canterbury, Christchurch.

Appendix A: List of Herbicides to Use to Control Weeds Around Sedge Plantings

Target plants to be controlled	Recommended herbicide*	Notes on use
General weed control	Glyphosate (e.g., Roundup®)	Non-selective, it will kill most plants. Careful spot application required to avoid impacts on wetland plantings. Generally low toxicity and non-residual, broken down rapidly. Only use formulations recommended for use over water e.g., Roundup Renew, Agpro Green Glyphosate. Also useful for cut stem/stump treatment of woody weeds (e.g., grey willow).
Selective control of grasses	Haloxyfop** (e.g., Gallant®)	Generally kills grasses only. Minimal damage to other monocots (sedges, cabbage trees, flax, rushes, etc.), but minimise overspray. Does not kill broadleaf plants, ferns, etc. Foliar active with minimal soil activity, moderately low toxicity, short soil residue.
Selective control of woody broadleaf plants (e.g., blackberry and willow)	Triclopyr triethylamine (e.g., Garlon® 360)	Kills many broadleaf species including shrubs, vines and trees. Does not kill grasses, but may cause limited damage to sedges, flax or other monocots or ferns. Moderately low toxicity, short soil residue. Also useful for cut stem/stump treatment.
	Metsulfuronmethyl** (e.g., Escort®)	Kills most broadleaf species including ferns, shrubs, vines and trees except Solanum species. Generally not effective on grasses or other monocots (e.g., sedges and flax) unless applied at very high rates. Moderately low toxicity, however, short but very active residue, apply with extreme care, works at very low rates. Also useful for cut stem/stump treatment.

Catchment SOLUTIONS

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Kahahakuri Erosion and Cow Cress Mitigations

Prepared by A/Prof. Ranvir Singh (Environmental Hydrology & S Science) and Prof. Ian Fuller (Physical Geography) at the School Agriculture and Environment, Massey University

Prepared for the Tukituki Land Care (TLC) group, Hawkes Bay

1 Context and key issues faced

Landowners and farmers in the Kahahakuri catchment are concerned with a rapid spread of cow cress (an aquatic weed, aka water celery), consuming waterways and causing blockages and damages to farm culverts and creating flooding issues during high flows. They are also concerned with channel erosion and shingle accumulation posing risks to productive cropping farms and orchards in the catchment.

In collaboration with the local catchment collective, Tukituki Land Care (TLC), farmers in the Kahahakuri catchment are seeking practical solutions to control spread of cow cress and manage stream bank erosion and its potential effects on nearby productive land uses and water quality in the catchment.

TLC and Access to Experts (A2E) engaged Massey University Environmental Sciences Panel (A/Prof Ranvir Singh and Prof. Ian Fuller) to help assess and advise on potential mitigations for managing stream channel bank erosion and spread of cow cress in streams and drains in the Kahahakuri catchment.

2 Field visit, catchment data analysis and workshop

Ranvir and Ian conducted a field visit (in February 2024) with the TLC coordinator, Hawkes Bay Regional Council (HBRC) representative, and farmers and land managers (see Photo 1) for in-field assessment and collating relevant field information to focus their assessment.

Photo 1: Kahahakuri field visit and sites assessment (February 2024). *Photos: Courtesy TLC Communication Coordinator.*

Cow cress 'water celery' spread appears abundant in the visited drains and stream in middle and lower parts of the Kahahakuri catchment. Cow cress favours nutrient-rich environments, therefore Ranvir took some stream and drain water samples for their testing of nitrate levels. The stream channel erosion appears more severe in upper and middle lengths of the stream, where reworking or erosion of the secondary sediment stores in the bed and banks (floodplain) is active during high flow events.

Ranvir and Ian further collated and analysed relevant catchment geographical and water quality data to inform their assessment and develop recommendations for the catchment group.

Ian collated and analysed records of river flows in the Kahahakuri gauged at Ongaonga Road Bridge from January 2009 to March 2024. To take some account for the smaller extent of the catchment being assessed for erosion, compared with the catchment contributing to flow at Ongaonga Bridge, gauged values were reduced. It was estimated that flows through the study reach might approximate a third of the gauged flow based on comparative catchment areas. This estimation was not based on any hydrological modelling or inputs and work would be needed to more accurately gauge flows in the study reach. It was noted that on the day of site visit the middle and upper reaches were dry, but a flow of 0.48 cumecs was gauged at Ongaonga Bridge. The relationship between flow in the upper and middle reaches and gauging site is likely to be far more complex than the impression a simple pro rata apportioning provides, particularly given the likely significant contribution to flow at the gauged site by groundwater flows from the nearby Waipawa. Nevertheless, flow data at Ongaonga Bridge provides at least some coarse approximation of flood magnitude and frequency in the reach of the Kahahakuri assessed, but the actual values should not be deemed accurate. A hydrological model for the reach assessed should be constructed by a qualified hydrologist.

Ian also assessed a 1 m digital elevation model (DEM) derived from a regional airborne LiDAR survey flown between November 2020 and January 2021 for Hawkes Bay Reginal Council to develop an initial assessment of channel erosion dynamics in the study reach.

Ranvir collated and analyzed relevant geographical data in terms of its soil types, main land uses, water flow pathways, and existing water quality in the catchment. The Kahahakuri stream catchment covers approximately 7,846 ha within the upper parts of the Tukituki River catchment. The soil types are texture wise mainly silty in upper and lower parts, loamy and sandy in middle parts, and small areas of clayey soils in lower parts of the catchment. Pastoral farming, orchards and cropping are major land uses in the catchment (See Ranvir ppt slides, including the catchment geographical maps).

Ranvir identified an on-going trial testing spray control to limit spread of water celery in Nelson area in upper South Island. He suggested and facilitated that TLC invited Mr. Richard Frizzell (from Nelson City Council) to present and share their trial's learnings with the Kahahakuri catchment group.

TLC organized a catchment workshop (in early May 2024), in which Ranvir Singh (Massey University), Ian Fuller (Massey University), Richard Frizzell (Nelson City Council) and Nathan Burkepile (NZ Landcare Trust) presented and discussed their assessments and recommendations with farmers, land managers and community member in the Kahahakuri catchment (see Photo 2). The key assessment learnings were also shared with wider public via a media release (by the TLC communication coordinator) published by CHB NZ Hearld, "Cow Cress concerns in Kahahakuri addressed" and the TLC Facebook page.

Photo 2: Professor Ian Fuller and A/prof. Ranvir Singh (Massey University) presenting and discussing their assessment with the catchment group (May 2024). Photos: Courtesy TLC Communication Coordinator.

2.1 Kahahakuri Water Quality: addressing cow cress and nutrient losses

Cow- cress (aka water celery) is considered native to Europe, Africa and parts of Asia, but classified as an invasive aquatic weed in New Zealand. Its spread appears abundant in drains and streams in the middle and lower parts of the Kahahakuri catchment. Ranvir has also noted its presence in some farm drains in a nearby Porangahau stream catchment in Central Hawkes Bay. It is noticed well-spread in North Island drains and streams and appears to becoming established in the upper South Island (see Richard Frizzell's ppt slides).

Cow cress is a perennial species, which grows fast during warmer spring and summer months and dies back during colder winter months. It favours nutrient-rich environments but appears intolerant to dense shading restricting its growth due to reduced sun light. Primarily growing on channel banks and islands (with roots generally below the water line) it can spread out into stream channels or drains covering the water surface. It spreads via seeds (flowering in summer) and vegetative break away stems.

Cattle grazing was suggested and discussed as a potential solution to keep growth of cow cress under control. However, this appears to conflict with the stock exclusion policy to protect quality of waterways. As per HBRC's rules, all stock (except sheep) must be excluding from access to waterways in the Kahahakuri catchment (HBRC, n.d.). Controlled grazing for weed control in fenced-off riparian areas could be allowed for a short duration (a total of 7 days) between 1 November and 30 April. However, HBRC states that a rule of thumb is that they "Do not want to see stock standing in water" (HBRC, n.d.).

There could be several issues associated with cattle grazing to control growth of cow cress in waterways. Cattle grazing is more of a growth control, not a spread prevention strategy. Cattle could only graze control when cow cress is already well established. Moreover, cattle grazing risks the spread of weed by physical disturbance causing seed spread and vegetative break away stems. Also, as cow cress generally grows on channel banks and islands (roots generally below the water line) and spreads out over water in stream channels or drains, it would be practically impossible to graze it without stock accessing and standing in the waterways, conflicting with the rule of thumb, "Do not want to see stock standing in water".

We suggest the catchment group further clarify with HBRC about the controlled cattle grazing rules for weed control purposes. However, we do not assess cattle grazing as long-term cow cress spread prevention strategy in the catchment.

Other potential practices to control cow cress could include the physical (mechanical harvesting and drains cleaning), chemical (spraying), ecological (riparian planting and water quality improvements), and biological control (Champion *et al.*, 2019).

Richard Frizzell highlighted a study conducted by Manaaki Whenua Landcare Research on feasibility for biological control of water celery (Groenteman *et al.*, 2020). A "biological control has never been attempted against water celery (H. Nodiflorum)" in the New Zealand environment (Groenteman *et al.*, 2020), and a potential biological control strategy would require further comprehensive research and development, which appears beyond the scope of a catchment group's capability and capacity. However, Richard made suggestions for a potential discussion among relevant stakeholders to further explore this option.

The *chemical control by spraying* was discussed as a practical and effective practices to control the weed growth. Richard Frizzell presented and discussed use of Garlon 360 (triclopyr triethylamine) in a chemical spaying trial to eradicate cow cress emerging in the Sexton creek and Orphanage stream in Nelson City area. The Garlon 360 spray appears effective suppressing the weed growth in 3 to 4 weeks post-spray. However, the use of Garlon 360 (triclopyr triethylamine) required the EPA permission and resource consent, requiring annual notification, monitoring and reporting of the spray programme. Use of other chemicals such as Glyphosate was also discussed.

We suggest the catchment group further discuss with HBRC representatives about permission and resource consent requirements for potential use of chemical spraying such as Garlon 360 and Glyphosate for spray control of cow cress growing in running waters in drains and streams. Also, a potential spray control needs a careful design and application (better multiple sprays over small stretches moving upstream to downstream instead of single spry over large length/area) as potentially dead/rotting biomass could severely impact water quality by changing dissolved oxygen and pH levels in drains and streams.

The *physical control by mechanical harvesting or drain cleaning* could be a quick and effective practice, but requires continuous seasonal effort/work and appears to be difficult to eradicate the weed growth. It also poses risk of enhanced weed spread by physical disturbance causing seed spread and vegetative break away stems. However, it would be better done during early spring / summer months, and require removal of biomass away from the stream or drain as potentially dead/rotting biomass could severely impact water quality by changing dissolved oxygen and pH levels in drains and streams.

The *ecological control by riparian planting and water quality improvements* appears to be more environmental-friendly and effective in long-term suppressing the weed growth. However, this is a slow-process and requires catchment-wide efforts to restore riparian areas and improved quality of water flowing in drains and streams. Growth of cow cress favours nutrient-rich environments but appears intolerant to dense shading restricting sun light. Collins et al. (2018) investigated potential effects of artificial shading (> 80% light reduction) in supressing growth of macrophytes (within 5 months of shading) in small agricultural waterways in Canterbury.

Recommendation: We recommend the catchment group conduct a trial at 2 or 3 sites (about 20 – 30 metres each), combining strengths of the above discussed measures, as (1) carefully mechanically harvesting/removing the weed growth, (2) target spray of a suitable/allowed herbicide, and (3) potentially cover the site with ecological wed mats and plant with natives (e.g., sedges carex secta) to provide shade and supress growth of cow cress on water edges along drains and streams in the catchment. Nathan Burkepile (from NZ Landcare Trust) made a brief presentation on this and offered further assistance to help develop the trial.

Ranvir took a few on-spot water quality samples during the field visit (Photo 3) and later collated and analysed long-term monthly water quality data (from 2011 to 2022) at the Kahahakuri stream u/s Tukituki River (Data Source: LAWA https://www.lawa.org.nz/, accessed in April 2024). HBRC representative also shared the results of their water quality survey conducted in 2015/16 across the Kahahakuri catchment. A preliminary analysis of this collated water quality data clearly highlights the elevated concentrations of dissolved reactive phosphorus and inorganic nitrogen, and nitrate-nitrogen as a main form of dissolved inorganic nitrogen in waterways the Kahahakuri catchment.

Photo 3: Ranvir Singh (Massey University) taking a drain water sample and demonstrating its testing for nitrate-nitrogen during the field visit (Feb 2024).

We recommend further assessment of water quality flows and potential in-field and edge-of-field mitigation practices to help reduce leaching and runoff of dissolved nutrients in critical water flow pathways. A preliminary assessment of catchment geography, soil types, land uses and water flow pathways suggest for potential of conservation drainage management, practices such as controlled (managed) drainage, woodchip bioreactors, and constructed wetlands in middle and lower parts of the catchment area may be effective.

A/Prof. Ranvir Singh is leading a Jobs for Nature MfE and HBRC co-funded project, 'Catchment Solutions' focused on enhancing rural capability for improved freshwater quality outcomes https://catchmentsolutions.co.nz/. The Catchment Solutions project has been collaborating with several catchment groups, including Pōrangahau Mahahakeke Streams and the Lake Whatuma catchments in Central Hawkes Bay, developing pilot demonstrations of novel edge-of-field practices such as controlled drainage, woodchip bioreactor, controlled drainage, and sediment detainment bund to reduce sediment and nutrient losses from farming paddocks to waterways.

We recommend the catchment group engage and make use of under-development Catchment Solutions resources, such as catchment workshops, field days, virtual tours of pilot demonstrations, and upcoming professional training classes to help develop capability and collaborative work programme to improve riparian and water quality in waterways of the catchment.

2.2 Kahahakuri Geomorphology: addressing channel erosion

River catchments are connected entities in the landscape. This means river channels convey both water and sediment supplied to them by the catchment. Sediment is sourced from primary and secondary sources within the catchment. Catchment slopes constitute a primary source of sediment, with sediment delivered into the stream network by e.g. landslides. The channel and its adjacent floodplain constitute a secondary source of sediment, i.e. sediment that has been delivered into the channel network and conveyed downstream and then stored in the bed of the river, or on the adjacent floodplain.

A key issue identified in the Kahahakuri Stream is channel erosion, i.e. reworking or erosion of the secondary sediment stores in the bed and banks (floodplain) of the river. Channel erosion is a natural part of the way rivers and streams function: a river is in effect an erosional landform, with a channel carved out by water flowing along a defined pathway. Some erosion is therefore to be expected in a river channel. How much erosion is to be expected depends on an array of variables including channel slope, confinement, discharge, stream power, sediment load, sediment calibre, channel pattern. Floods are important drivers of erosion. Most channel and bank erosion take place during floods. The occurrence of a large flood, or a sequence of frequent floods is therefore likely to be accompanied by channel erosion as the river channel adjusts to convey the larger volume of water during the flood.

Critical to the behaviour of a stream channel is the balance between impelling and resisting forces. Impelling forces relate to the power of the flow in a river to move sediment and erode its bed and banks, which is the 'geomorphic work' performed by a river. Resisting forces dissipate energy of the flow and can limit the geomorphic work that can be achieved by a given flow. A channel with a high degree of resistance will in turn reduce the flow energy available for erosion. Conversely, if resistance is reduced, more energy is available for erosion.

The Kahahakuri Stream was impacted by a sequence of floods between March 2022 and June 2023, which were estimated as being capable of transporting large cobble-sized material (Figure 2.1). The March 2022 event is estimated to have been of sufficient magnitude to result in channel instability (refer to hydrograph in slide sequence). Channel instability occurs where the amount of energy in an event is sufficient to cause significant changes to the channel, usually widening and or deepening. This response introduces more sediment into the river channel and in turn these floods effectively mobilise the bedload of the Kahahakuri Stream along its length. Where a reach of river sits within its catchment must be considered when assessing its characteristics, behaviour and responses to floods in order to identify a likely trajectory, which should inform channel management. Since rivers act as ‘sediment conveyors’ in their catchment, the sediment conveyor is not smooth, but jerky, which means sediment is conveyed often as a series of steps, resulting in progressive waves of gravel moving through a river, mobilised during flood flows.

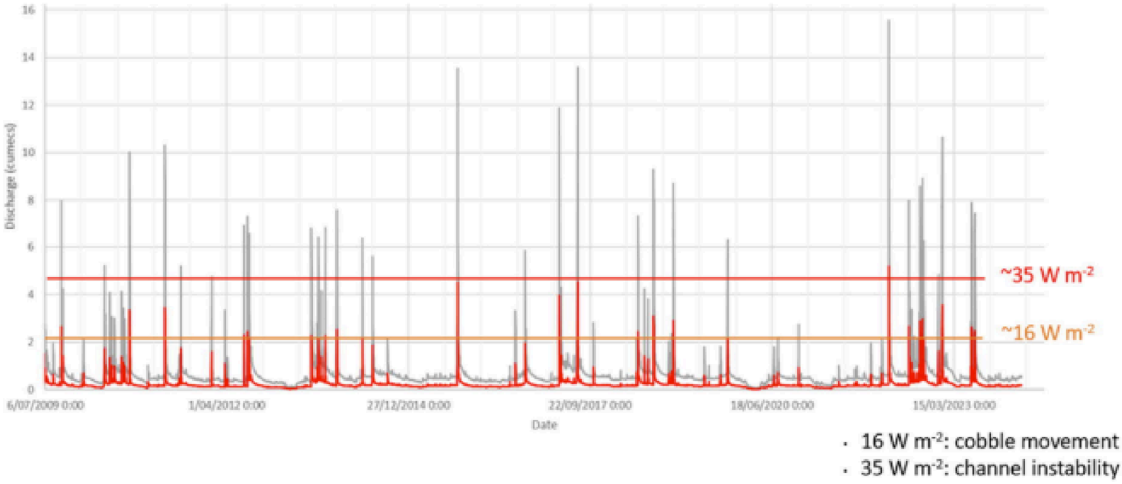

Figure 2.1 Floods and stream powers in Kahahakuri Stream, 2009-2024: daily flow maxima gauged at Ongaonga Bridge, data source: Hawkes Bay Regional Council.

In the Kahahakuri Stream the reach between SH 50 and the Mr Apple Thornton Orchard has become entrenched (Figure 2.2) while the reach downstream of this through the orchard appears to indicate the channel is infilling with gravel (Figure 2.3). Critical to managing the Kahahakuri is an understanding the flux of gravel in the system. The delivery of gravel to the channel varies over time and the conveyance of gravel along the channel will fluctuate as flood magnitudes and frequencies fluctuate and gravel is pulsed through the system in a series of bed waves / gravel slugs / gravel sheets.

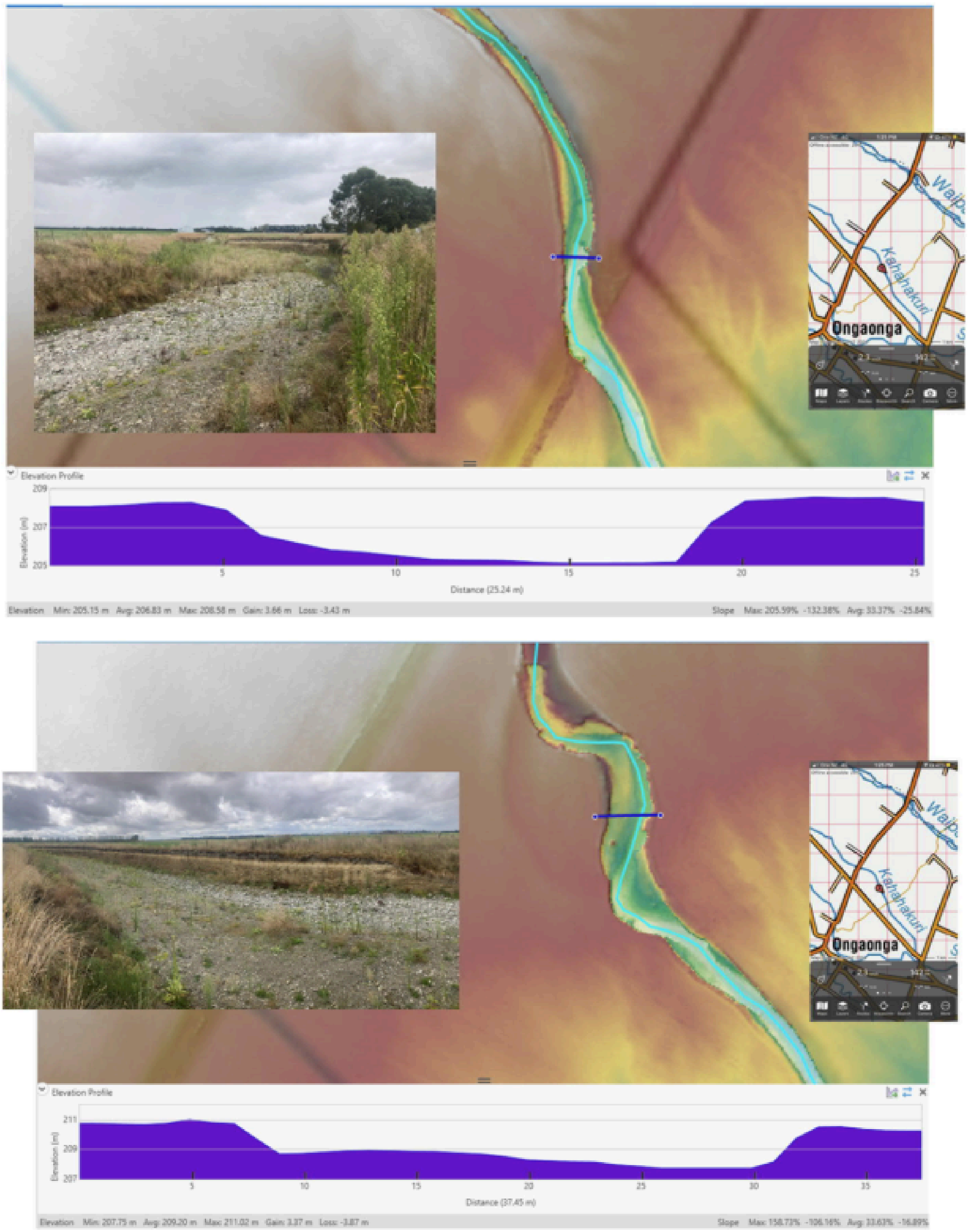

Figure 2.2 Channel entrenchment downstream from SH50.

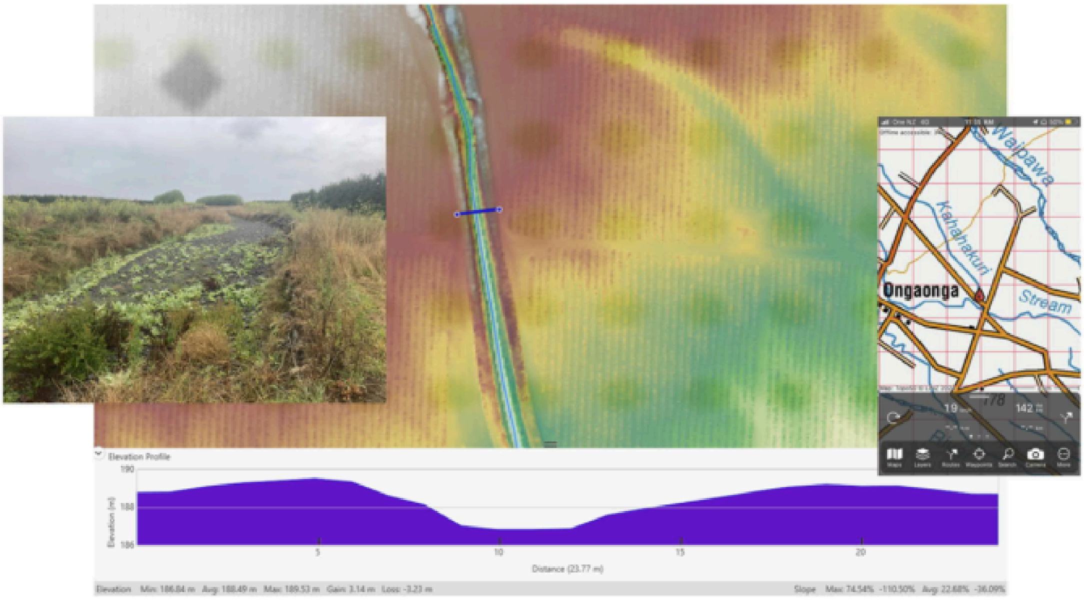

Figure 2.3 Channel infilling adjacent to Orchard.

Before any intervention takes place to address either the apparently eroding reaches, or the apparently aggrading reaches, reliable information on the gravel load and trends in the Kahahakuri Stream is required. To intervene without this understanding is to set up any intervention for possible failure, with a risk of making the situation worse. It is notable, for example, that a series of check weirs has been placed in the entrenched channel and the channel has responded to these by degrading its bed immediately downstream of each weir (the river is deeper, Figure 2.4). Deepening of the riverbed in turn risks destabilising the banks, making them more prone to erosion. It is also notable that a reach of the Kahahakuri Stream has been straightened immediately upstream of the orchard. Straightened channels lack the resistance features of bends and well-developed bars, which means that stream power during floods is not checked. In turn this also exacerbates erosion, because there is more energy for geomorphic work to take place. It is quite conceivable that straightening of the Kahahakuri has contributed to the apparently rapid accumulation of gravel in the orchard reach.

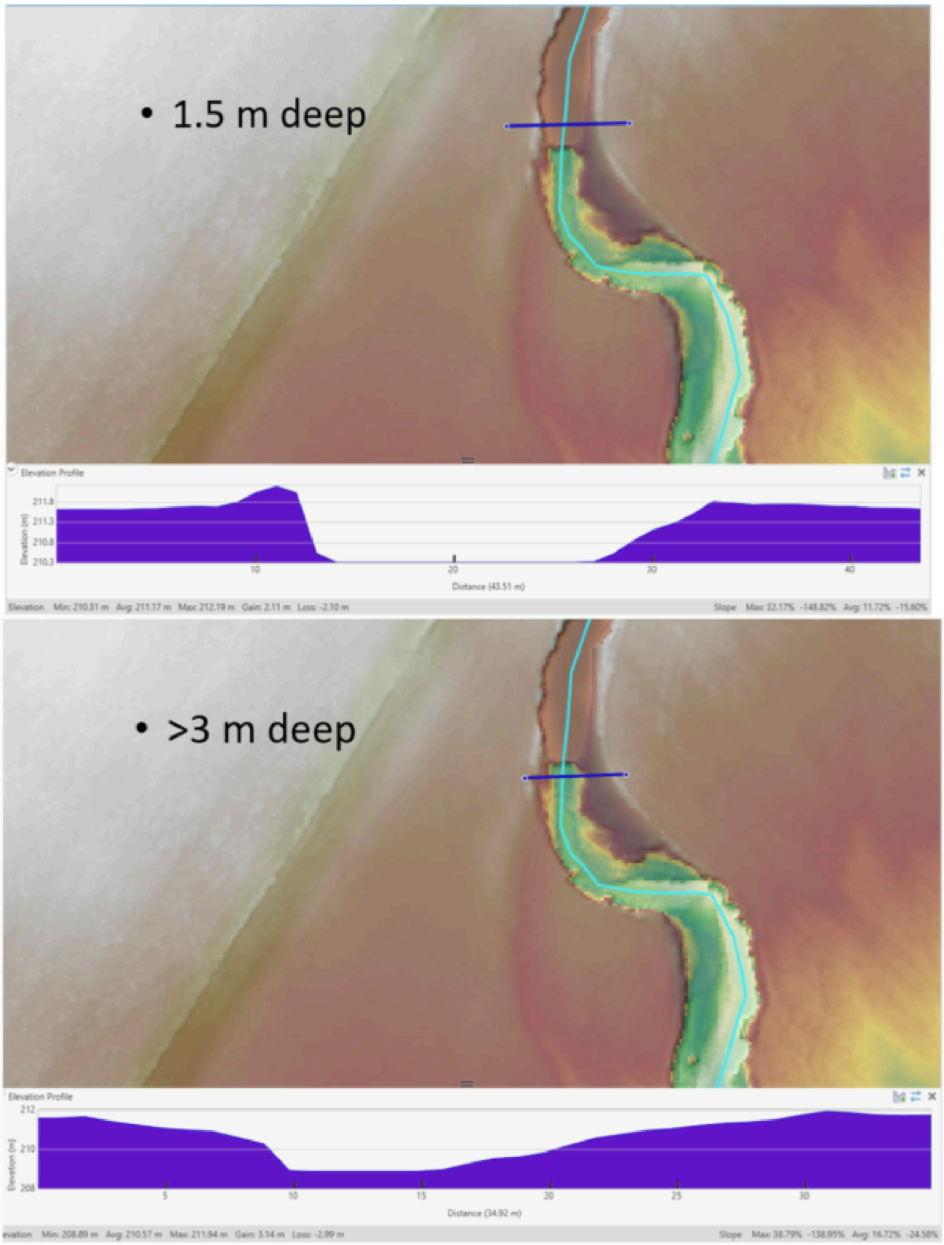

Figure 2.4 Impacts of check weirs (bed control structures) on channel entrenchment.

Therefore, a quantified gravel budget is needed to understand what intervention is best suited to each reach. Gravel extraction may be appropriate in reaches shown to be repeatedly filling up with gravel, but it may equally be unsustainable or likely to result in damage to the river corridor both downstream (by starving those reaches of sediment) and upstream (by generating a head cut). Similarly, planting along the margins of an entrenched channel will not have the desired effect of stabilising the banks if the bed is degrading. Bed lowering will continue to undermine the banks, regardless of planting along the edges. Furthermore, the extent of bed lowering is likely to mitigate

against the success of any riparian planting stabilising such steep and high banks as are found in the Kahahakuri: for vegetation to be effective, the root zone needs to extend below water (bed) level.

Recommendation: To tackle the issues of understanding gravel conveyance (erosion and deposition) and associated volumes of sediment eroded and stored in the Kahahakuri, as well as better understand the morphological trajectories of the channel (i.e. how and why it is changing shape), a morphological budget using digital elevation models (DEMs) of the channel is recommended. Channel DEMs provide a holistic approach to quantifying gravel budgets using survey approaches that generate topographic data from the river channel to generate a continuous surface visualised as a DEM. Differencing a surface (DEM) from one time to another generates a DEM of difference (DoD), from which volumetric change over time is determined. Analysis of channel morphology and its three-dimensional change along an extended length of river is most effectively undertaken using DEMs derived from repeat airborne laser scanning (LiDAR). Where the channel is wet, bathymetric LiDAR is recommended, however if the channel is dry (noting the Kahahakuri was dry on the date of a site visit at the end of February 2024) standard, 'red' LiDAR data will be sufficient.

It is important to work with the morphology of river channels and appreciate their natural processes of adjustment (e.g. cutoffs, bend development) to work with the river, rather than against it. Working with these processes of erosion, transport and deposition means the river is doing much of the work itself, without the need for large-scale intervention. Working with the river morphology entails informed understanding of channel dynamics and trajectories in any given reach. This level of understanding should be informed by good science and robust collection and analysis of data, assessing morphological development and changes in sediment storage (and gravel flux) in the system as a whole.

Relevant Resources:

- See attached slides of the catchment workshop presentations by Professor Ian Fuller (Massey University), A/Prof. Ranvir Singh (Massey University), and Mr. Richard Frizzell (Nelson City Council).

- HBRC Stock Exclusion - https://www.hbrc.govt.nz/environment/farmers-hub/stock-exclusion/#:~:text=low%20slope%20land.-,Stock%20crossings,or%20culvert%20must%20be%20installed

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