Catchment SOLUTIONS

TIAKI WAI | CARING FOR LAND & WATER

Kahahakuri Erosion and Cow Cress Mitigations

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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.

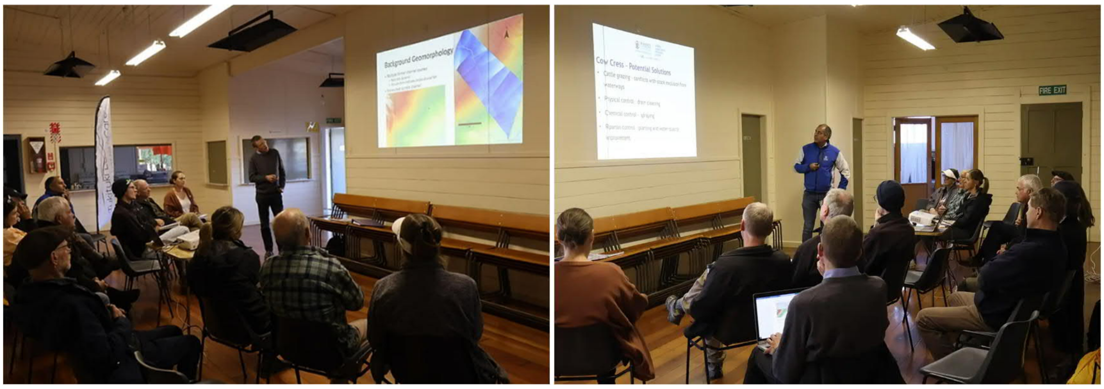

Photo 2: Professor Ian Fuller and A/prof. Ranvir Singh (Massey University) presenting and discussing their assessment with the catchment group (May 2024). Photos: Courtesy TLC Communication Coordinator.

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.

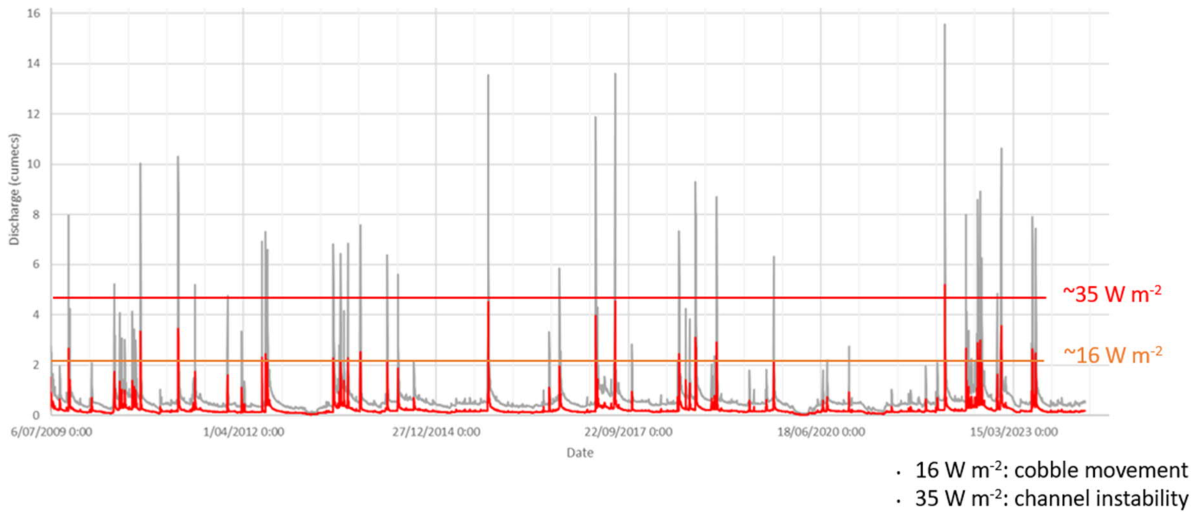

Figure 2.1 Floods and stream powers in Kahahakuri Stream, 2009-2024: daily flow maxima gauged at Ongaonga Bridge, data source: Hawkes Bay Regional Council.

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.

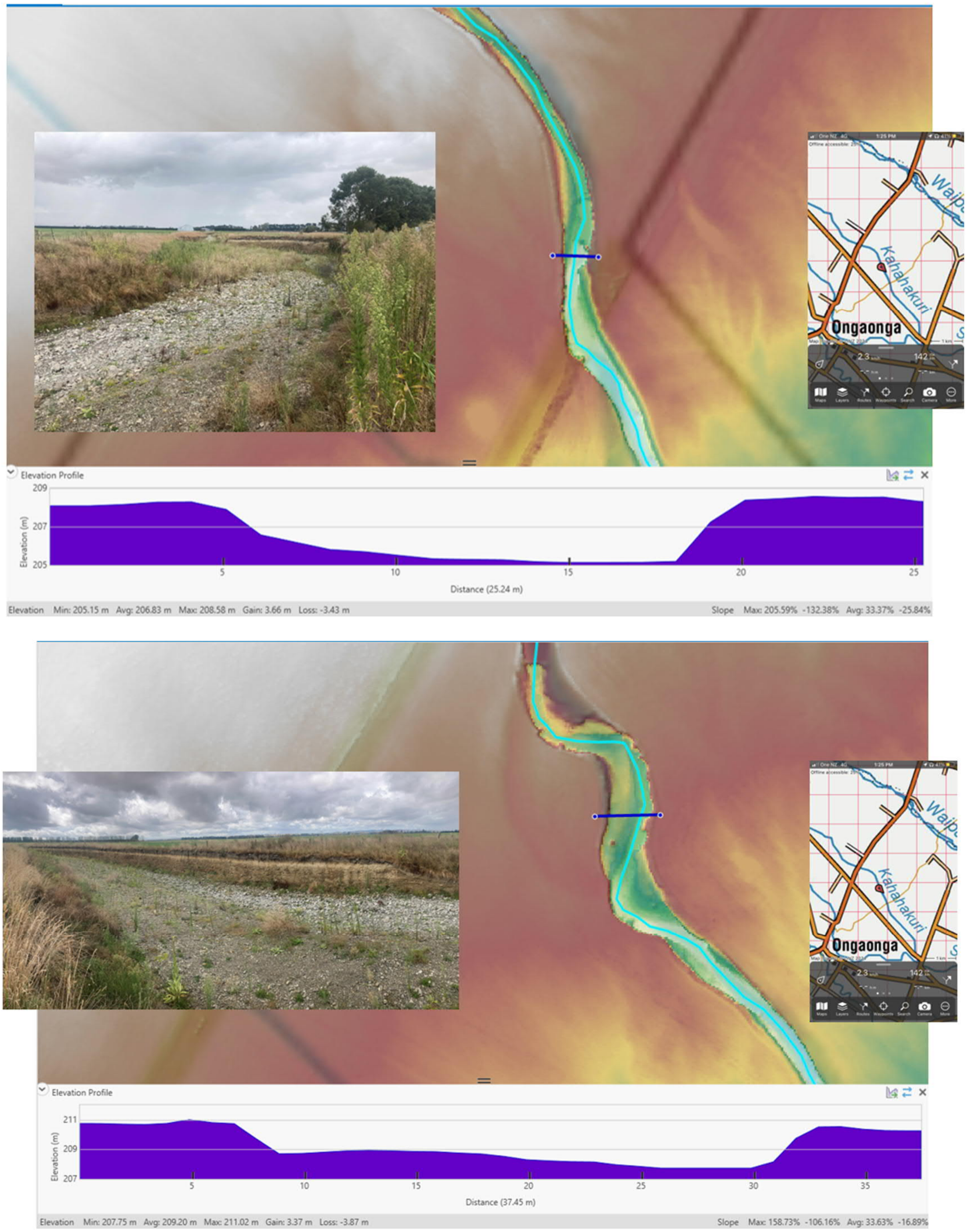

Figure 2.2 Channel entrenchment downstream from SH50.

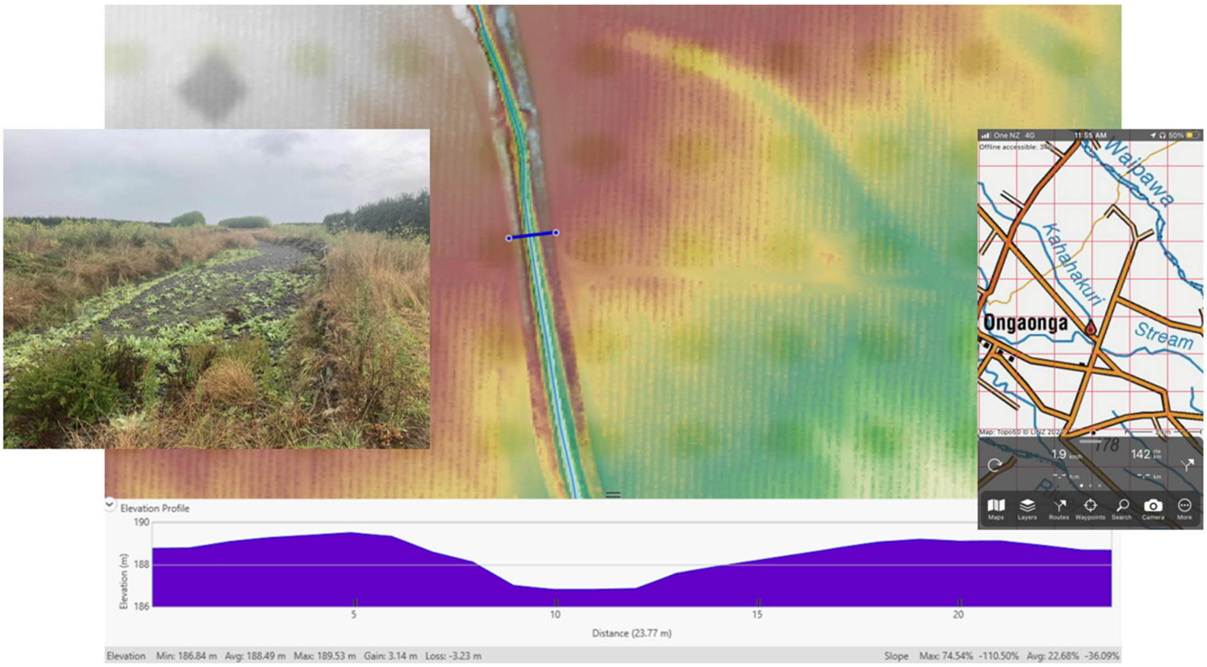

Figure 2.3 Channel infilling adjacent to Orchard.

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.

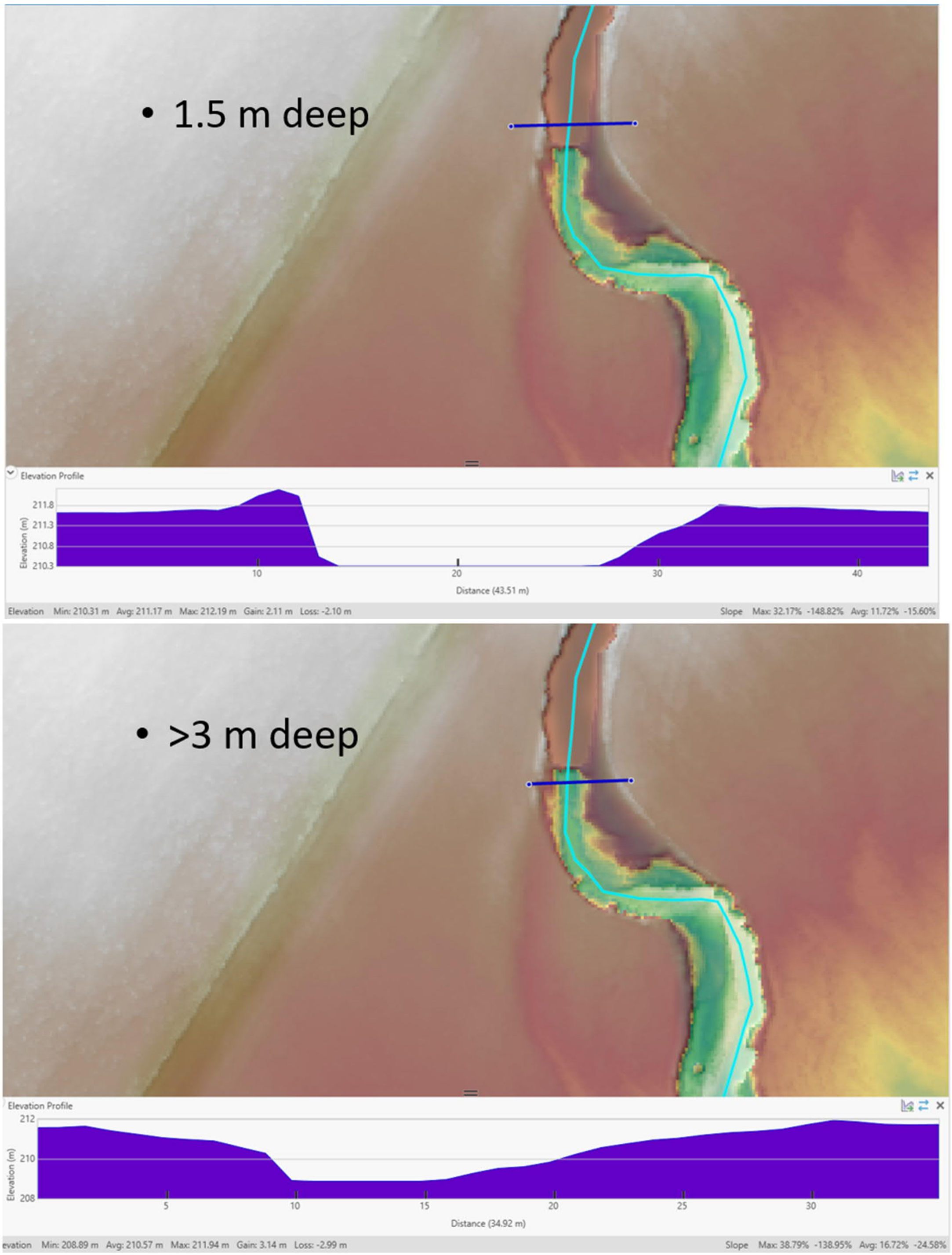

Figure 2.4 Impacts of check weirs (bed control structures) on channel entrenchment.

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

- Champion, P., Hofstra, D., & de Winton, M. (2019). Best Management Practice for Aquatic Weed Control. Envirolink NIWA Project Report: ELF17206, National Institute of Water & Atmospheric Research Ltd, Hamilton, New Zealand.

- Groenteman, R., Heenan, P. & Barton, J. (2020). Feasibility for biological control of water celery (Helosciadium nodiflorum). Envirolink Grant: 2042-NLCC111, prepared for Nelson City Council, Manaaki Whenua Landcare Research, New Zealand.

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