Sediment Traps in Hill Country

Prepared for

Our Land and Water Toitū te Whenua, Toiora te Wai

Report prepared by

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1 Executive Summary

1.1 The Rural Professionals Fund has been made available to enable farmers/entrepreneurs, and rural professionals (who are members of the New Zealand Institute of Primary Industry Management – NZIPIM) to partner with scientists to test exciting and innovative ideas that could lead to significant improvements in farming systems aligned to maintaining and improving New Zealand's land and water quality for future generations, while enhancing the value of the primary sector.

1.2 This Sediment Traps in Hill Country project will evaluate the effectiveness of three different sediment traps located on three small within-farm catchments on three neighbouring properties (Nelson, Foss, and Proffit family farms) in the lower Mokau sub-catchment.

1.3 These farmers are members of the catchment group King Country River Care. They have a key goal of improving the quality of water that leaves their properties. Led by Blair Nelson, there two key questions that drove this project:

- "How can I create a simple low-cost structure that will capture the sediment before it hits the waterway and will it actually be effective?
- Did the many 'farm dams' that were a traditional source of stock water on the hill country farms in the area and that seemed to fill up with dirt if they were not cleaned out regularly actually act as effective sediment traps?"

1.4 In attempting to answer these questions the project will collate existing research and material available on sediment traps to provide a simple guidance document or 'cheat sheet' as an easily accessible resource to help other farmers to develop their own sediment traps on their own farms.

1.5 Two key aspects of previous work in this area in other farming areas with other soil types were a target sediment trap size of up to 120 m^3/ha of catchment and information on the exit pipe size for the size of the catchment.

1.6 Success of the project would be assessed by:

- Successful installation of three simple sediment traps with siphon samplers and sediment plates to monitor sediment concentrations entering and leaving the trap during six rainfall events.
- Water samples collected from six runoff events by the farmers and analysed for suspended sediment by a commercial laboratory.
- Results are shared (using King Country River Care) and discussed with farmers in the Mokau river catchment area and they become engaged in a discussion and learn more about how sediment traps work and how to identify size and placement in hill country catchments.
- Farmers in the wider Mokau river catchment area will feel more confident to install sediment traps on their own farms.
- If the measurements taken in this project show sediment traps can remove sediment from water runoff on farms, then sediment traps become a tool that can contribute to the long term reduction in sediment concentration within the Mokau catchment's waterways.

1.7 The sites chosen by the three farmers considered aspects like:

- Size of the catchment;
- Water flow during rain;

- Access;
- Shape and contour; and
- Existing structures in place.

1.8 The “sediment trap” used in this project was based on a small stock water dam concept that included a small dam wall that creates a small water storage area, a grassed overflow area away from the small dam wall so that in heavy rain any excess water can escape the water storage area without damaging the small dam wall, but with a riser pipe system to allow all the water to exit the sediment trap so when it is not raining vegetation can still grow in the sediment trap area.

1.9 Key results and conclusions from this project were:

- The three farmers each built different sediment traps.
- Whilst the target size was not achieved the measurements taken in the project did show that smaller farmer-built sediment traps do trap sediment i.e., they work!
- Actual specifications of the sediment trap will depend on the characteristics of the available sites within the individual catchments on the farm property.
- Completing accurate and scientifically comparable measurements with on-farm sediment traps proved to be difficult to achieve.
- The catchment area should not be too large so the resulting sediment trap does not trigger resource or building consent requirements and the cost of individual on-farm projects is kept relatively low;
- The sediment trap surface area should be as large as possible with a shallow depth but keeping within the 120 m^3/ha of catchment.
- The riser set up is an important influence on creating the buffering/sediment drop of the sediment trap – pairs of 25 mm holes every 200 mm up the riser pipe worked well on the sites involved in this project.
- The riser pipe system will handle different inflow rates but a grassed overflow pathway out of the sediment trap should always be included to allow for any very heavy rainfall events.
- A farmer-cheat sheet has been created.

1.10 The farmers involved in the project did have some remaining questions that involved:

- How can the size and frequency of the small holes to be installed in the riser pipe, to allow the sediment trap to be emptied within three days, be calculated with more certainty?
- With the sampling bottle method of collecting sediment entry and exit sediment concentrations being problematic, how can they more easily measure the effectiveness of a sediment trap on-farm and what is wrong with manually collecting both an entry and exit water sample at the same time during a rainfall event?
- Can nova-coil drainpipe be used in the bottom of a sediment trap area instead of a riser pipe system?
- Is there an easy way to estimate the volume of water held in the sediment traps without needing expensive volume monitoring or measuring equipment?

1.11 And if a similar project was to be repeated, the farmers would advise also including:

- Site specific rain gauges as there are localised rainfall events in rural areas.
- A formal or consistent sediment trap volume measurement process in place at both construction time and for when the traps are full of water.

- Designing a farmer sample collection and measurement process to be implemented alongside the scientific method to assess any correlation of results.

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2 Terms of Reference

2.1 The Rural Professionals Fund has been made available to enable farmers/entrepreneurs, and rural professionals (who are members of the New Zealand Institute of Primary Industry Management – NZIPIM) to partner with scientists to test exciting and innovative ideas that could lead to significant improvements in farming systems aligned to maintaining and improving New Zealand's land and water quality for future generations, while enhancing the value of the primary sector.

2.2 The aim of this multi-party subcontract is to extend what has been learned from these funded projects to the wider rural profession and farming community.

2.3 This project will evaluate the effectiveness of three different sediment traps located on three small within-farm catchments on three neighbouring properties (Nelson, Foss, and Proffit family farms) in the lower Mokau sub-catchment.

2.4 The project will collate existing research and material available on sediment traps to provide a simple guidance document or 'cheat sheet' as an easily accessible resource to help other farmers to develop their own sediment traps on their own farms.

2.5 The project team consists of the Challenge Party, the Rural Professional and the entrepreneurs/farmers (Entrepreneur), along with the Challenge Contractor and relevant third parties (where applicable) to carry out the project.

2.6 The members of this project are:

2.6.1 Challenge Contractor for Our Land and Water:

- AgResearch Limited.
- Michelle Van Rheede, Snr Advisor Research.
- michelle.vanrheede@agresearch.co.nz
- Lincoln Science Centre, Christchurch.

2.6.2 Challenge Party:

- Massey University.
- Dr Lucy Burkitt and Professor Ian Fuller.
- L.Burkitt@massey.ac.nz and i.c.fuller@massey.ac.nz
- Palmerston North.

2.6.3 Rural Professional:

- Perrin Ag Consultants Ltd.
- Peter Keeling, Principal Consultant.
- peter@perrinag.net.nz
- King Country.

2.6.4 Entrepreneur:

- Blair Nelson.
- muntanelson@gmail.com

- Nelson Farms
- Aria

2.7 Success of the project will be assessed by:

2.7.1 Successful installation of three simple sediment traps with siphon samplers and sediment plates to monitor sediment concentrations entering and leaving the trap during six rainfall events.

2.7.2 Water samples collected from six runoff events by the farmers and analysed for suspended sediment by a commercial laboratory.

2.7.3 Results are shared (using King Country River Care) and discussed with farmers in the Mokau river catchment area and they become engaged in a discussion and learn more about how sediment traps work and how to identify size and placement in hill country catchments.

2.7.4 Farmers in the wider Mokau river catchment area will feel more confident to install sediment traps on their own farms.

2.7.5 If the measurements taken in this project show sediment traps can remove sediment from water runoff on farms, then sediment traps become a tool that can contribute to the long term reduction in sediment concentration within the Mokau catchment's waterways.

2.8 The target audience are King Country hill country livestock farmers looking to reduce their environmental impact in a cost-effective manner.

2.9 Results were presented to the King Country River Care catchment group on completion – November 2021.

2.10 Further field days and conference presentations may be given by the farmers involved e.g.; NZ Grasslands.

2.11 A project summary will be supplied to Beef+Lamb NZ and DairyNZ for their information and they will be encouraged to promote the project in the wider Waikato region.

2.12 The NZIPIM will also provide a platform to communicate the results throughout its network of ten branches across New Zealand, and through its quarterly journals.

3 Project Background

3.1 At the farm level

3.1.1 Several farmers in this area (including the Nelsons, Foss and Proffits) are members of a local catchment group - King Country River Care Inc ("KCRC"). KCRC is facilitating farmer engagement for the development of farm plans and associated water quality improvement activities in the Mokau river catchment area.

3.1.2 While improving the water quality of the Mokau and her tributaries is a high level goal of the farmers involved in KCRC, there is recognition that this starts with water quality on individual farms and the waterways that exit their respective properties.

3.1.3 Fencing waterways and creating retired riparian buffer strips to act as filters adjacent to these waterways is a strategy to improve water quality that is well publicised.

3.1.4 However, as a farmer on a hill country sheep and beef farm Blair Nelson also knows in rainfall events, the water running off the hills forms into small short-term channels that then flow into the permanent waterways, often skipping the "riparian filter" area so carrying sediment directly into the nearby waterway.

3.1.5 Blair's initial thought and question was **"how can I create a simple low-cost structure that will capture the sediment before it hits the waterway and will it actually be effective"?**

3.1.6 His second question related to what he had seen on nearby hill country properties before reticulated stock water systems had been installed on the farms - which was "did the many 'farm dams' that seemed to fill up with dirt if they were not cleaned out regularly actually act as sediment traps?"

3.1.7 These farm dams were of different size, location, and wall height depending on the contour of the paddock. So, the third question was "which type of sediment trap would work best and what size was needed – while still keeping to the key requirements of being simple to build and being low-cost"?

3.1.8 These questions then became the basis of the 'Sediment Traps in Hill Country' trial.

3.2 At the soil level

3.2.1 Sediment deposition, along with nutrient enrichment, are two major stressors that agricultural land use places on New Zealand waterways.

3.2.2 In hill country sheep and beef farms, surface runoff and erosion are key drivers of sediment delivery to waterways.

3.2.3 Any management activity that will reduce the volume of sediment transfer from the land to water should be a benefit for both the farm and the receiving waterbody.

3.3 At the science level

3.3.1 There are a variety of sediment trap methodologies that can be used, but there are no guidelines on which ones are best and in what circumstances should different types be used.

3.3.2 It was agreed that something similar to a small farm dam can be constructed relatively simply and quickly with minimal cost and can act as a sediment trap, if it designed correctly, is placed in the right location, and the right infrastructure is installed.

3.3.3 However, the sediment trapping effectiveness of these simple structures has been rarely studied on hill country farms.

3.3.4 This project will recognise and have a connection with existing guidelines on sediment traps and will focus on hill-country only. (For example: Hudson, H.R. 2002. Development of an in-channel coarse sediment trap best management practice, Environmental Management Associates Ltd Report 2002-10. Ministry of Agriculture and Forestry Project FRM500; Ministry for the Environment (2001) Soil Conservation Technical Handbook. New Zealand Association of Resource Management)

3.4 The proposed project

3.4.1 Using the geomorphological and sediment loss and water quality expertise of the Challenge Party (with the assistance of John Paterson – Phosphorus Mitigation Project Inc.) it was proposed to demonstrate the effectiveness of simple sediment traps on three neighbouring hill country farms in the King Country.

3.4.2 An outcome of the John Paterson led Phosphorus Mitigation Project was the proposal that the optimum size of the sediment trap was 120 m^3/ha of the catchment area that would flow into the sediment trap.

3.4.3 That project also identified suitable outlet pipe size relative to the catchment area. The project farmers decided to use this information for their sediment traps.

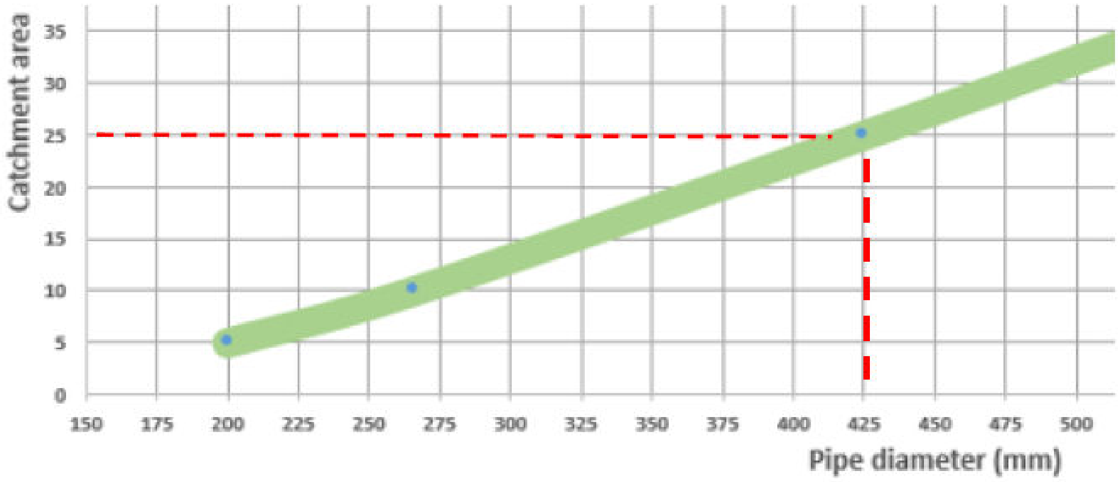

Figure 1: Suggested size of outlet pipe for different catchment areas. Source: Paterson et al. (2019).

3.4.4 While this was determined on farming areas around the Rotorua district, would this be practical and needed in the hill country farming environment of Aria?

3.4.5 Through demonstration, the aim is to create farmer discussion and a greater awareness of what factors need to be considered when installing sediment traps and to measure the effectiveness of three traps in reducing the sediment concentrations leaving hill country sub-catchments within these farms.

3.4.6 The effectiveness of the three sediment traps would be measured by installing simple siphon samplers (Diehl, 2008) to monitor the sediment concentrations entering and leaving the sediment trap (from approximately three different flow heights) during six rainfall events.

3.4.7 Water samples would be collected by the farmers after six runoff events and couriered to Hills Laboratory for suspended sediment analysis.

3.4.8 Sediment trays would also be installed in the base of the sediment trap to estimate the weight of sediment captured by the sediment traps over the study period.

4 Sediment Traps Constructed On-Farm

4.1 Introduction

4.1.1 The three farming families involved in the project were:

i. Nelson – Blair and Anna;
ii. Foss – Peter and Caroline; and
iii. Proffit – Russell and Mavis.

4.1.2 The sites are situated on properties located on the Potaka and Totoro roads not far from the Mokau River. (Figure 2)

Figure 2: Location of the three on-farm sites

4.2 The sites

4.2.1 The sites chosen by the three farmers considered aspects like:

- Size of the catchment;
- Water flow during rain;
- Access;
- Shape and contour; and
- Existing structures in place.

4.2.2 For example, the Left Poplars site on the Nelson property had an approximate catchment area of 3.6 ha (Figure 3). This information is used to calculate the target size of the sediment trap for that area.

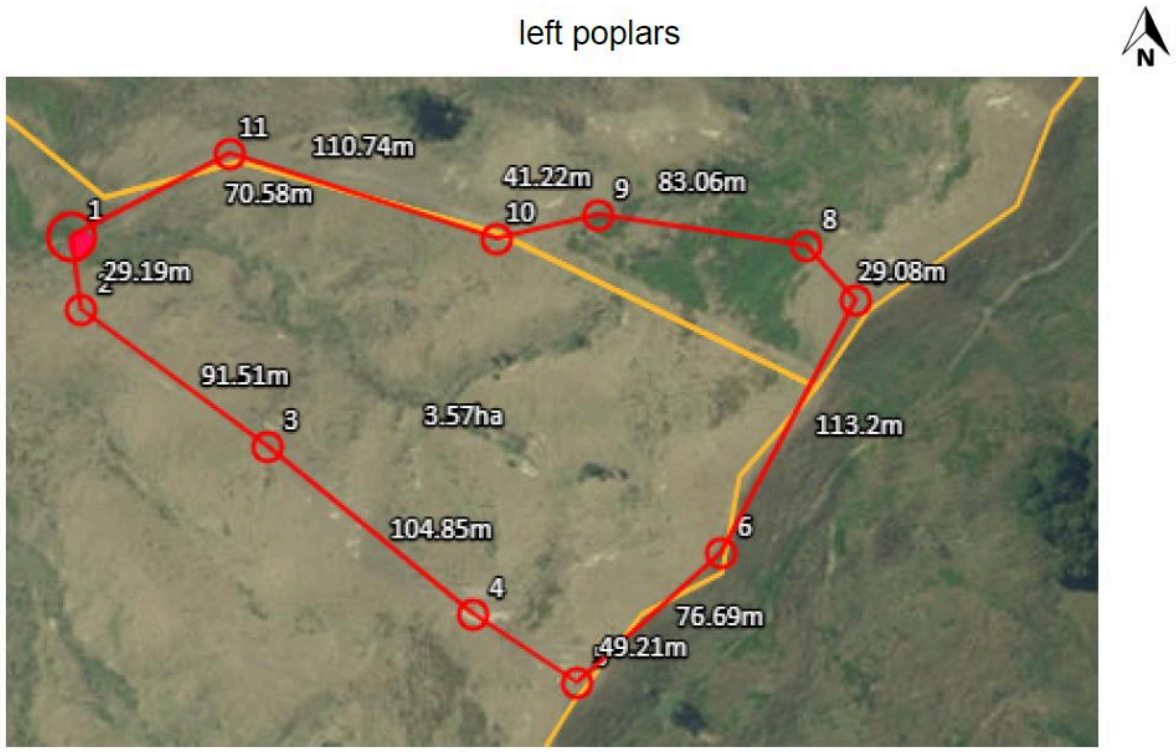

Figure 3: Nelson property - Left Poplars site catchment area

Figure 4: Nelson Left Poplars site

4.3 The sediment trap concept (Figure 5)

4.3.1 The most common existing "sediment trap" on-farm either already is, or is based on, a small stock water dam concept.

4.3.2 There is a small dam wall that creates a small water storage area, a water pipe near the top of the wall to let water out as water flows in, and a grassed overflow area away from the small dam wall so that in heavy rain any excess water can escape the water storage area without damaging the small dam wall.

4.3.3 However, the sediment traps discussed for this project needed to allow all the water to exit the sediment trap so when it is not raining vegetation can still grow in the sediment trap area – and ideally this is pasture. This would provide ground cover on the sediment trap floor - potentially catching extra sediments and minimising the risk of the sediment trap floor contributing extra sediment.

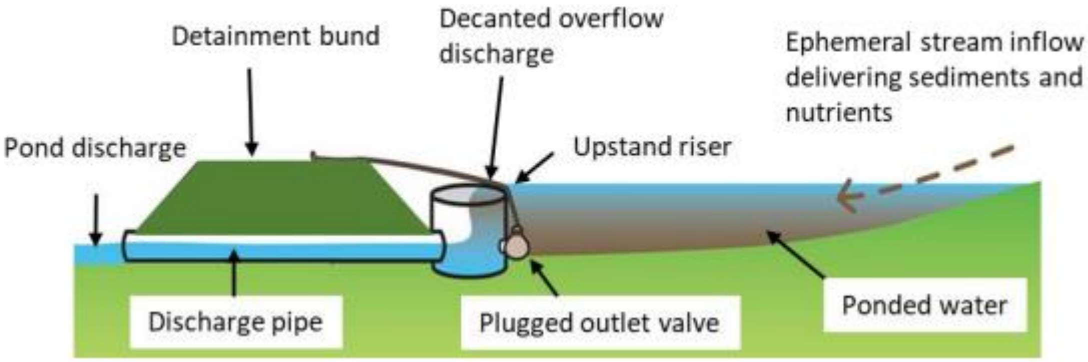

Figure 5: Diagram showing the stream inflow ponding behind an earthen wall or detainment bund. Acknowledgement: John Paterson and Brian Levine.

4.3.4 This means the piping system to allow the water out needs to be based on a 'riser pipe system', rather than an overflow situation, resulting in:

- At no inflow the sediment trap would be empty;
- At a certain inflow the water builds up and there is a slow outflow through the riser pipe;
- Once the water has built up to the top of the riser, the outflow would be greater; and
- There is still an overflow path so in very heavy rainfall events the sediment trap wall was protected.

4.3.5 In the work completed in the Lake Rotorua catchment (Paterson et al. 2019) the sediment traps were emptied by removing a 'plug' (see Figure 5) that was part of the riser pipe. However, the farmers involved in this project wanted the emptying system to be more automatic as in a hill country situation there could be many sites on the one farm and it would be a time consuming job created after each rainfall event.

4.3.6 So, in this sediment trap project, the farmers created holes in their riser pipes which further spread out the outflow from the sediment trap and allowed the pond to be emptied almost 'automatically' but slowed the flow enough to allow sediments to settle.

4.3.7 For the project the farmers could chose to use existing sites and dam wall infrastructure if this was the most suitable location.

4.3.8 However, although all the farmers used a riser pipe approach, the outcome of this approach was three different types of sediment traps ended up being constructed:

i. Nelson – more like a small stock water dam where the water did not empty out unless there was a longer period without rain (like in the summer) and consequently the cattle were excluded from the area by a single wire electric fence;
ii. Foss – the sediment trap did empty out and the area remained open to grazing by all stock; and

iii. Proffit – the sediment trap was installed at the bottom of wetter area that was also targeted for retirement and planting so this site was almost like a retired wetland area.

4.4 **Nelson sediment trap:**

Figure 6: New sediment trap on Nelson's filling up.

4.4.1 Blair's and Anna's focus for their site was being able to achieve the targeted storage of 120 m^3/ha and with a small catchment area of 3.6 ha this had a good chance of being achieved. They also wanted to complete an adjacent fencing project – so it was a "two birds with one stone' outcome. There was also good access to the site.

4.4.2 Catchment area: 3.6 ha.

4.4.3 Approximate sediment trap size: 290 m^2 area and 390 m^3 volume

4.4.4 Sediment trap volume to catchment area ratio: 108 m^3/ha.

4.4.5 Riser pipe 450 mm wide and outflow pipe 225 mm wide.

Figure 7: New sediment trap on Nelson's is slowly receding.

4.5 Foss sediment trap:

Figure 8: Foss riser pipe about to be tested!

4.5.1 Peter's and Caroline's focus for their site was being able to have an open site that had ability to be continuously grazed with good access.

4.5.2 Catchment area: 20.3 ha;

4.5.3 Approximate sediment trap size: 830 m^2 area and 850 m^3 volume;

4.5.4 Sediment trap volume to catchment area ratio: 42 m^3/ha; and

4.5.5 Riser pipe 1,050 mm wide and outflow pipe 450 mm wide.

Figure 9: Flow through the riser system

Figure 10: Foss site after it has slowly emptied through the riser pipe system

4.6 **Proffit sediment trap:**

Figure 11: Proffit use of existing site with riser pipe installed

4.6.1 This site was chosen due to this area being naturally wet with some steep country in behind – Russell and Mavis had already targeted this area for retirement and further planting. There was already a crossing and associated culverts in place so it was a relatively easy area to modify to build up the crossing and install a riser pipe system to slow the normal water flow down.

4.6.2 Catchment area: 15.0 ha.

4.6.3 Approximate sediment trap size: 525 m^2 area and approximately 1,300 m^3 volume;

4.6.4 Sediment trap volume to catchment area ratio: 87 m^3/ha; and

4.6.5 Riser pipe 1,050 mm wide and outflow pipe 325 mm wide.

Figure 12: Proffit riser at installation

Figure 13: Water flowing into the riser pipe slowly as the water level increases

4.7 The water sampling systems

4.7.1 The aim was to get a measurement of the concentration of sediment in the water entering the sediment trap and again as the water exited the sediment trap at different flow levels to give an indication what sediment was being left back in the sediment trap.

4.7.2 To do this a sampling apparatus (Figure 14) was installed in the water flow path above the sediment trap and then in the water flow channel just below the riser pipe outflow pipe.

Figure 14: Water sampler set for low, medium, and high flow

4.7.3 The farmers then collected the samples and reset the sample bottles after different rainfall events.

4.7.4 The sampling system needed to be able to take water samples at different flow levels over a period of time.

4.7.5 The sample bottles used air pressure to slow down the collection of water.

4.7.6 Each bottle is for a different height on the sampler. As per Figure 14, Figure 15, and Figure 16 there are three heights – for low, medium, and high flow. The low bottle is set at a level to avoid sampling any normal 'background' water flow (Figure 16).

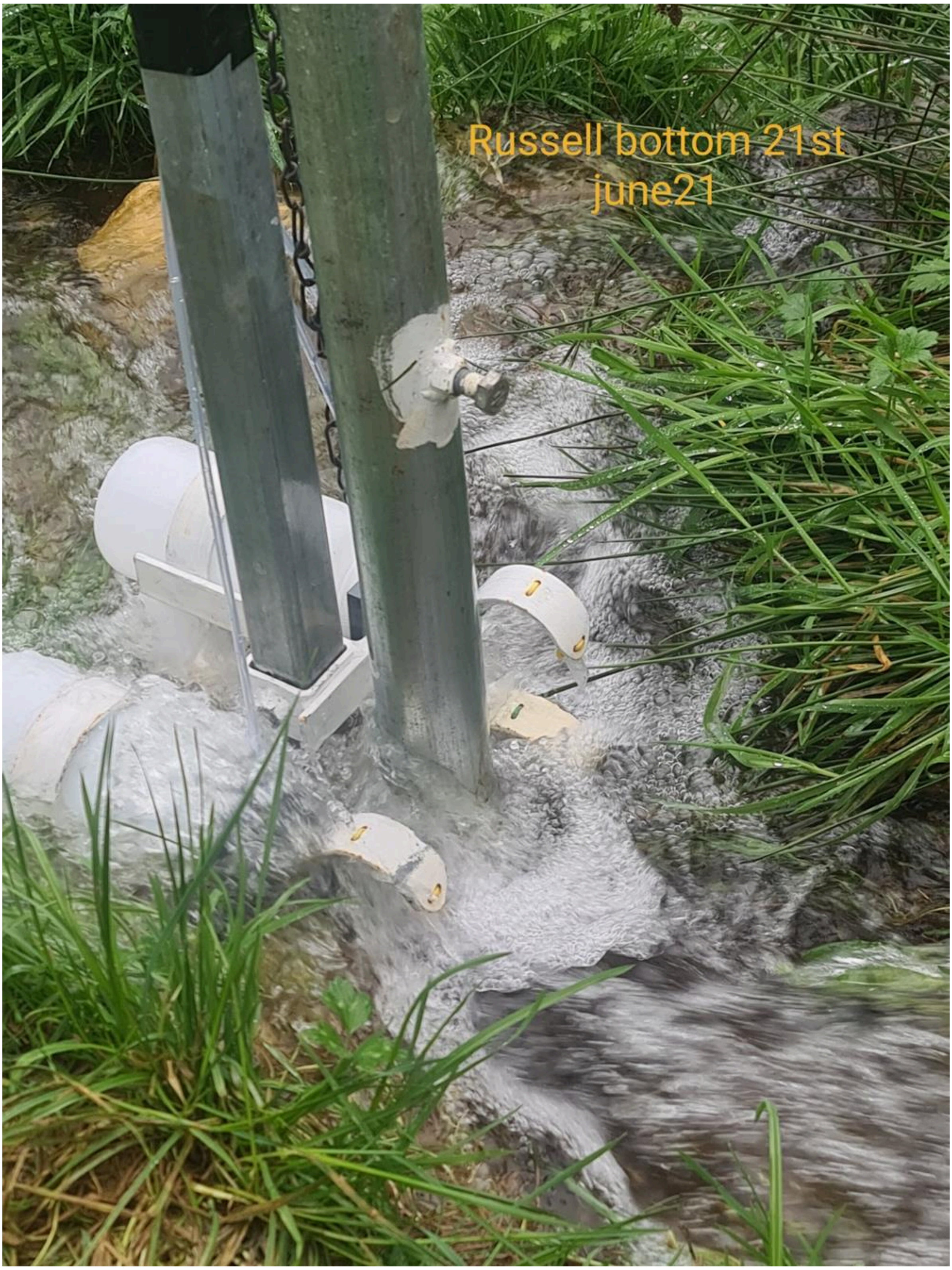

Figure 15: Water sampler working at higher inflow

Figure 16: Sampler set to avoid background inflow not associated with a rainfall event.

4.8 Sediment trays

4.8.1 Sediment trays were used as another method of estimating the weight/volume of sediment being collected in the sediment traps.

4.8.2 These were set in the bottom of the sediment traps to obtain a weight of sediment settling in the pond.

4.8.3 Trays were placed at the base of the pond with a tray close to the inflow and another tray close to the outflow point.

Figure 17: Sediment tray that came out of the bottom of the bottom.

4.8.4 Once the trays were collected (Figure 18) the sediment was allowed to dry before it was weighed.

Figure 18: Sediment trays prior to drying out and weighing the remaining sediment

5 The Measured Results and Discussion

5.1 Rainfall events

5.1.1 Samples were not able to be collected from every rainfall event and at every sample height due to the variability of the water volume that flowed into the sediment traps at different events and some sampling equipment malfunction.

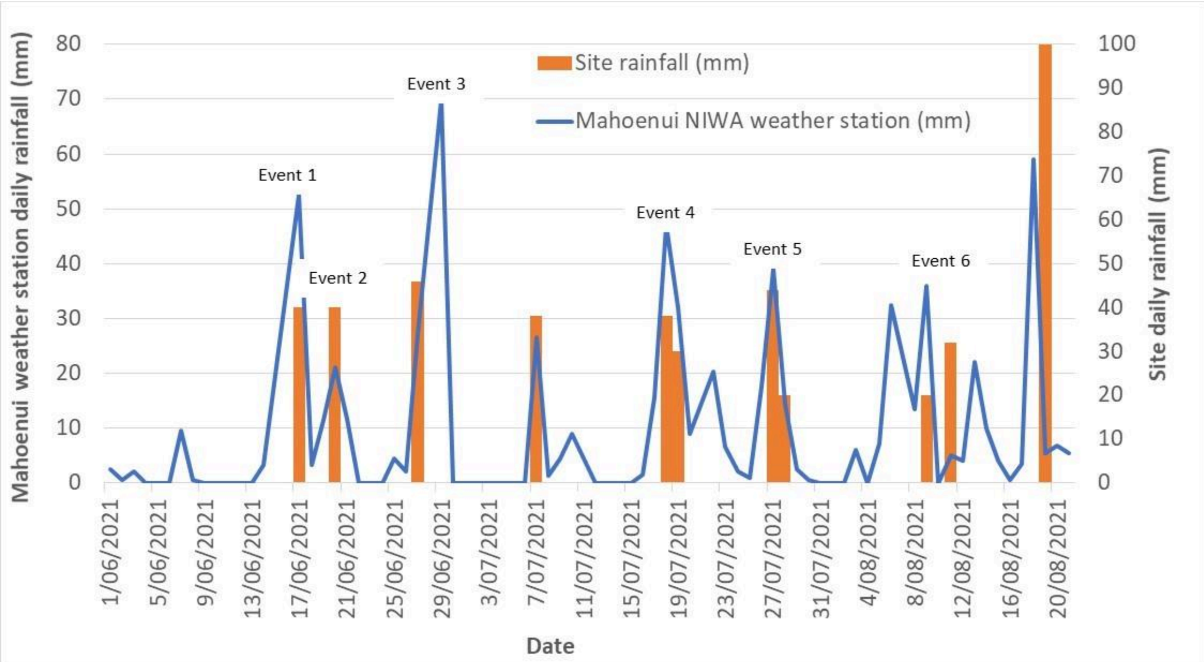

Figure 19: Rainfall events over the period of the project

5.1.2 The samples included in this report came from rainfall events between June 2021 and August 2021 inclusive.

5.2 Summary of water sampling result

5.2.1 Although there was variability in results, across all sites there was generally less sediment observed coming out of the sediment traps than was coming in.

5.2.2 The medium water height results suggested that during the events measured, and with the sampling process used, that the sediment concentration decreased by between 10% and 40% through the sediment trap.

Table 1: Average sediment concentrations (g/m^3 or g/1,000 L) in water from all events and sediment trap efficiency (%) calculation

	Low water height		Medium water height		High water height	
	Inflow	Outflow	Inflow	Outflow	Inflow	Outflow
Proffit	42	41 (2.3%)	335	200 (40.3%)	35	- (100%)
Nelson	513	356 (30.6%)	690	406 (41.2%)	1140	430 (62.3%)
Foss	202	53 (73.8%)	329	301 (8.5%)	669	724 (+8.2%)

5.3 **Sediment tray weights**

5.3.1 Only two sites were involved in this measurement and the results from the sediment trays were inconclusive.

5.3.2 The expectation was that settled sediment weights would be greater at the riser pipe (outflow) end of the sediment trap.

5.3.3 This occurred at one of the sites.

5.3.4 In review, these results may be significantly influenced by the flow pattern caused by the sediment trap size relative to the water inflow and the shape of the sediment trap. And there was no consistency in these sediment trap characteristics between sites.

Table 2: Settled sediment weights in trays

	Inflow end of pond (g)	Outflow end of pond (g)
Nelson	695	711
Foss	4,286	1,955

5.4 **Nelson site**

5.4.1 Generally, the water coming in had more suspended sediment than the water flowing out.

5.4.2 The exception was Event 4 – this could have been a sampling system error or have caused by different water turbulence patterns in the dam. The scientific feedback was "this is just what happens" with some trial readings.

5.4.3 There were less readings available for the medium and high flow settings which was expected due the riser system buffering the outflow of water from the sediment trap during a rainfall event.

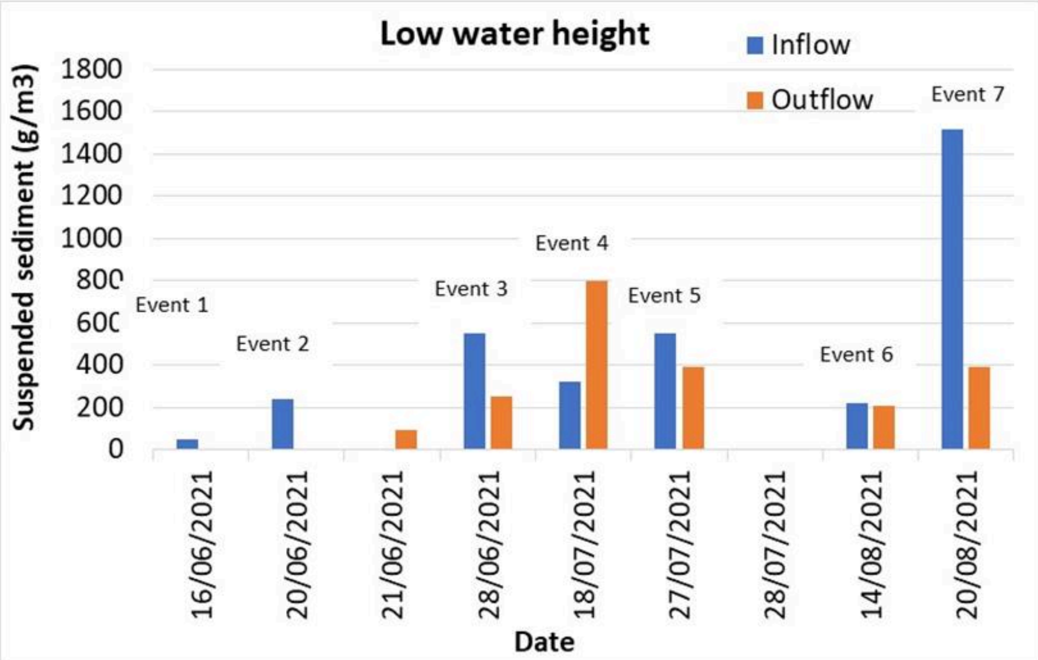

Figure 20: Nelson site - low flow water sample results

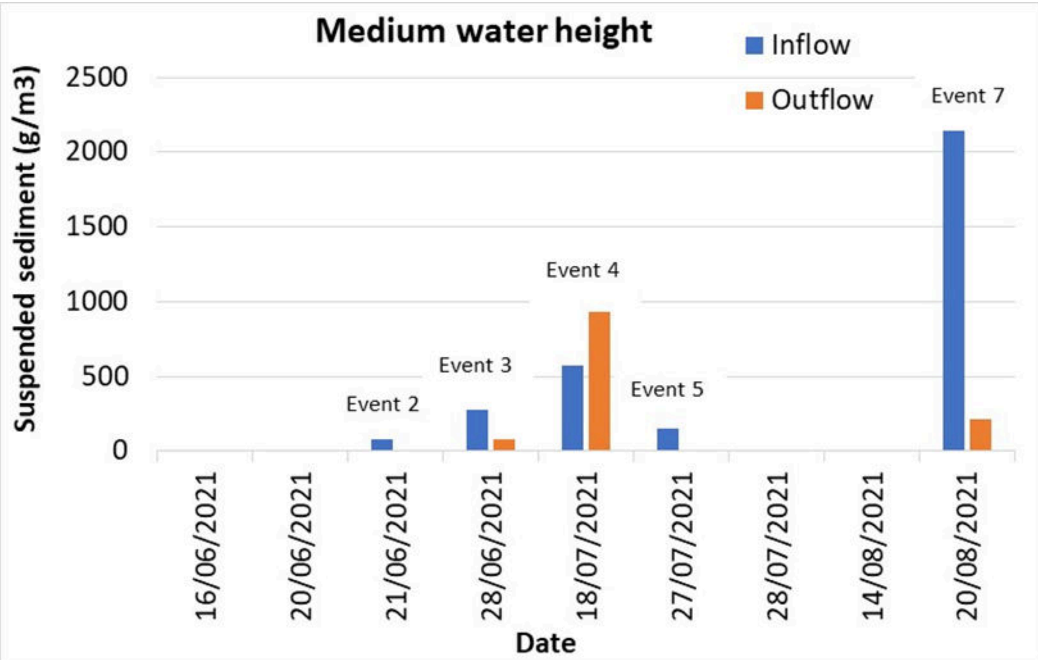

Figure 21: Nelson site - medium flow water sample results

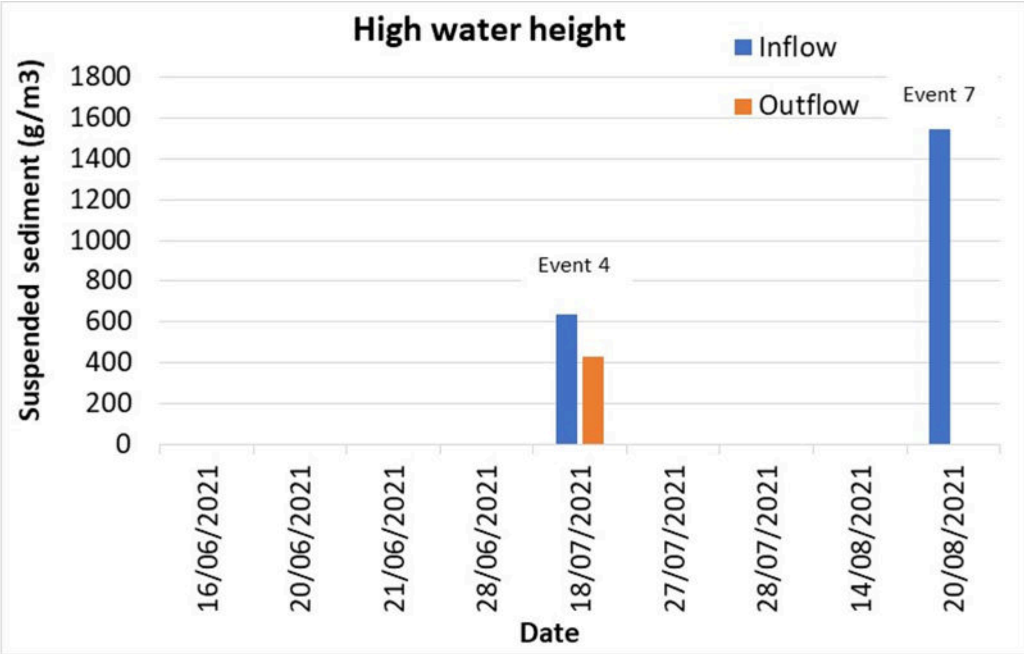

Figure 22: Nelson site - high flow water sample results

5.5 **Foss site**

5.5.1 Once above the low flow level, the results at this site were inconsistent.

5.5.2 An important side benefit at this site was the protection of 'downstream' infrastructure. During one particular high intensity rainfall event the more controlled water flow from this catchment area, i.e., through the sediment trap, meant there was no damage to downstream drains and fences unlike that observed on some other areas of the farm.

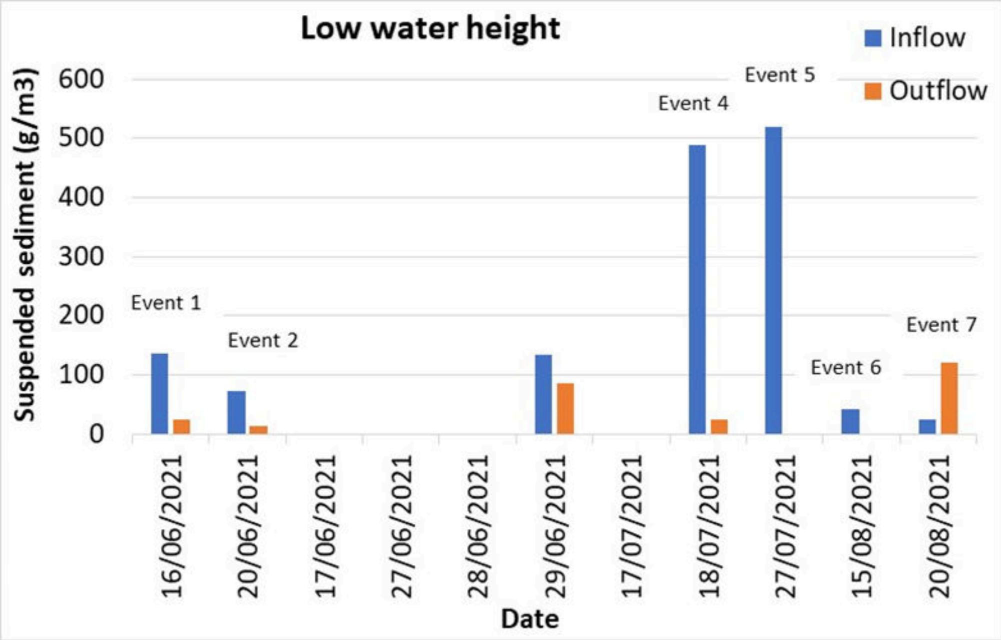

Figure 23: Foss site - low flow water sample results

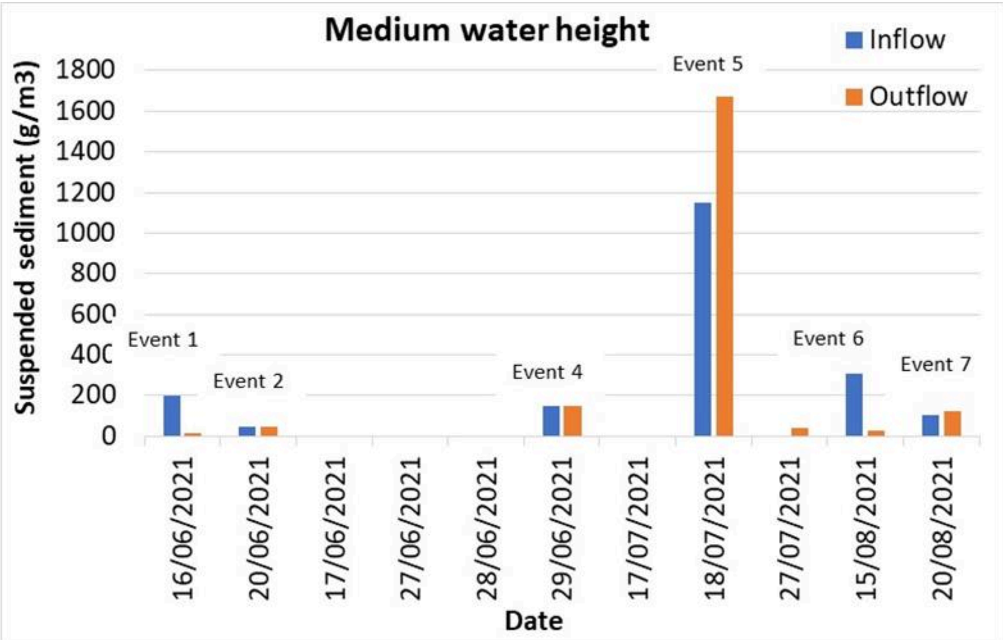

Figure 24: Foss site - medium flow water sample results

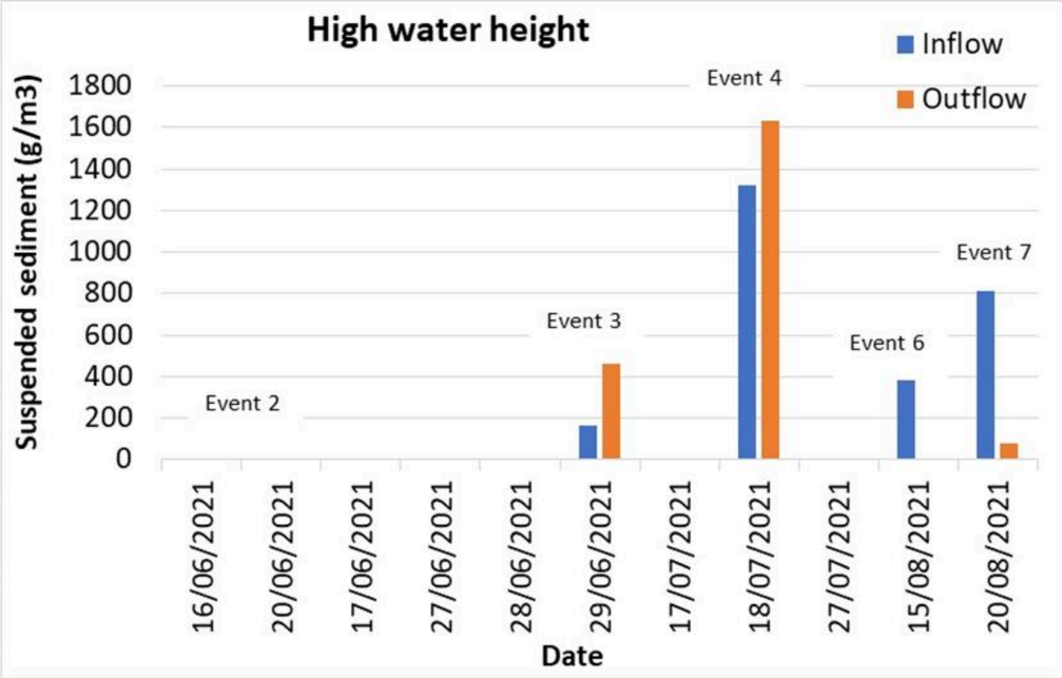

Figure 25: Foss site - high flow water sample results

5.6 **Proffit site**

5.6.1 This site had issues with collecting appropriate samples.

5.6.2 There were two events at medium flow that did create results as expected.

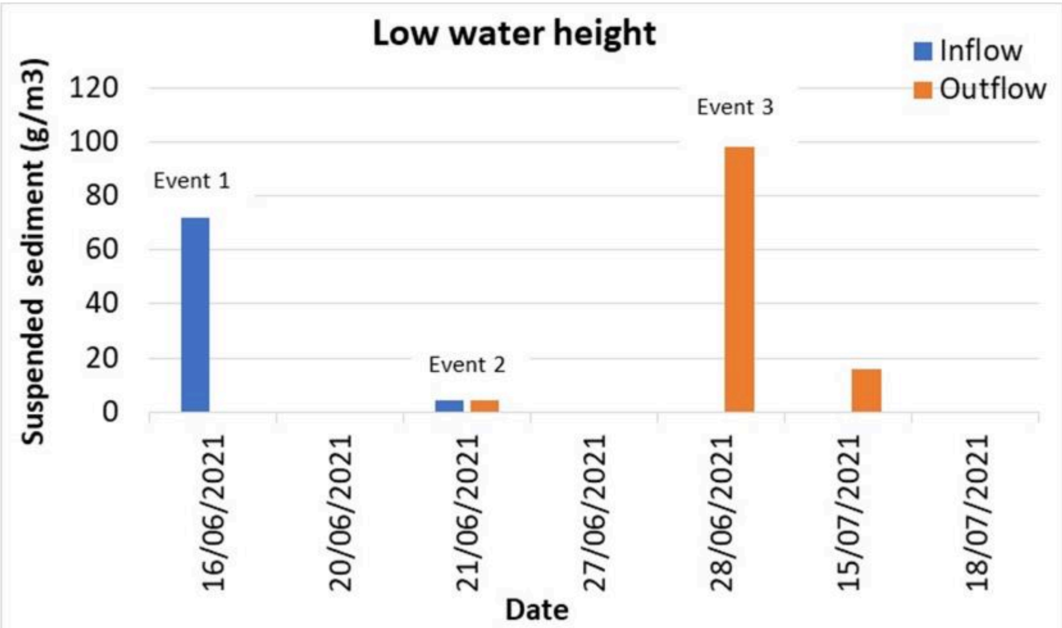

Figure 26: Proffit site - low flow water sample results

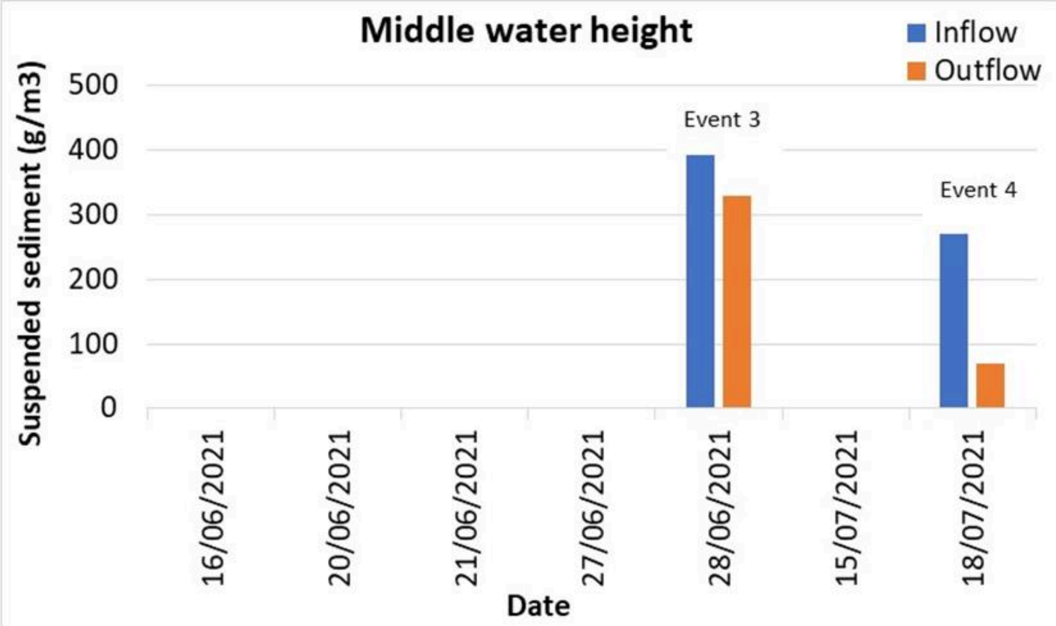

Figure 27: Proffit site - medium flow water sample results

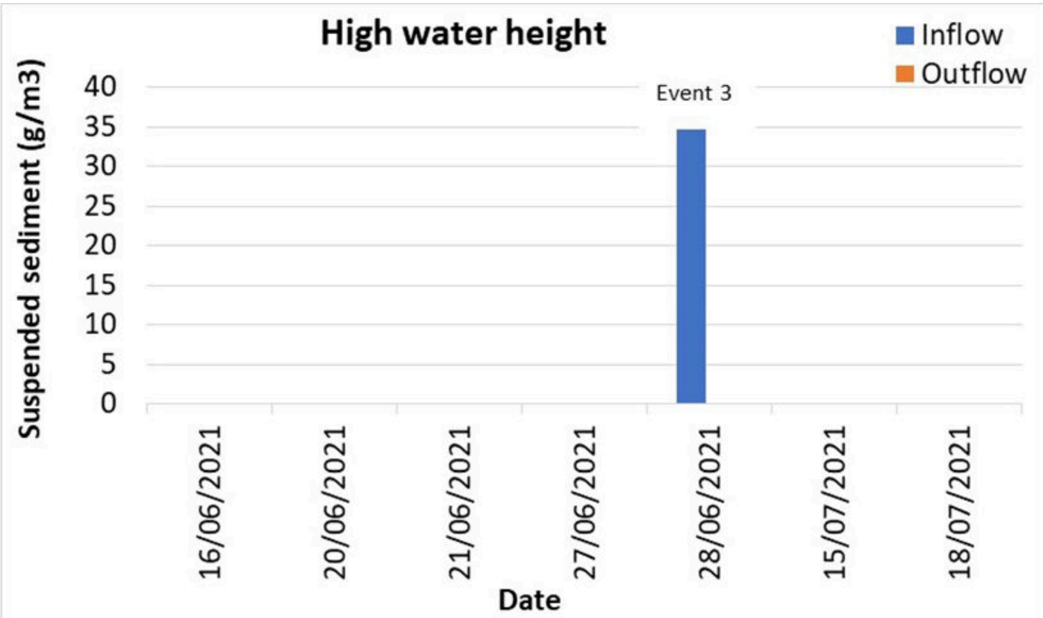

Figure 28: Proffit site - high flow water sample results

5.7 **Discussion**

5.7.1 The completed measurements did show that farmer-built sediment traps do trap sediment i.e., they work.

5.7.2 Other projects on this subject suggests that sediment trap size relative to the catchment area (and consequently volume of runoff), the shape of the sediment trap, and water inflow volumes, will influence the effectiveness of the sediment trap.

5.7.3 While this other work has suggested that 120 m^3/ha of catchment may be ideal in other locations with different soil types, this project has shown that smaller sediment traps can also remove sediment from surface runoff.

5.7.4 The actual specifications of the sediment trap will depend on the characteristics of the available sites within the individual catchments on the farm property concerned.

5.7.5 Completing accurate and scientifically comparable measurements with on-farm sediment traps proved to be difficult to achieve. Each catchment and sediment trap were different which made placing the sampling collecting devices difficult.

5.7.6 However, **at on-farm level there are key fundamentals of the process that should be considered:**

i. The catchment area should not be too large so the resulting sediment trap does not have to be too big to be effective at capturing sediment – the farmers involved in this project did not want to trigger resource or building consent requirements (i.e., the inadvertent creation of dams or disrupting permanent water courses) along with keeping the cost of individual on-farm projects low;

ii. The sediment trap surface area should be as large as possible with a shallow depth – but previous work suggests only up to 120 m^3 volume size per hectare of catchment.

iii. A riser pipe system that allows the sediment trap to be empty (within three days) in periods of no rainfall is recommended so a permanent water body is not created and vegetation (including pasture) can survive.

iv. The riser set up is an important influence on creating the buffering/sediment drop of the dam – pairs of 25 mm holes every 200 mm up the riser pipe worked well on the sites involved in this project.

v. The riser pipe system will handle different inflow rates. But always include a grassed overflow pathway out of the sediment trap to allow for the very heavy rainfall events.

vi. Planning the pond and riser pipe system should be completed in advance of construction so construction can take place promptly so a rainfall event does not occur before the pipes are fully in place – get the riser pipes in at the early stages of construction.

5.7.7 Remaining questions:

i. How can we calculate with more certainty the size and frequency of the small holes to be installed in the riser pipe to allow the sediment trap to be emptied within three days?

ii. The sampling bottle method of collecting sediment entry/exit sediment concentrations was problematic. How can we more easily measure the effectiveness of a sediment trap on-farm? What is wrong with collecting both an entry and exit water sample at the same time during a rainfall event?

iii. Can nova-coil drainpipe be used in the bottom of a sediment trap area instead of a riser pipe system?

iv. Is there an easy way to estimate the volume of water held in the sediment traps without needing expensive volume monitoring equipment?

5.7.8 **If we were doing this trial again, we also would include**:

i. Site specific rain gauges as there are localised rainfall events in rural areas.

ii. Have a formal sediment trap volume measurement process in place at both construction time and for when the traps are full of water.

iii. Design and include a farmer sample collection and measurement process to be implemented alongside the scientific method to assess any correlation of results.

6 The Farmer "Cheat Sheet"

Background

1. Sediment traps have a long history of being used in hill country to reduce sediment loss from tracks or eroding areas within a farm.

2. However, there is very little research regarding their effectiveness or optimal design.

3. Through the Our Land and Water National Science Challenge three farmers (Nelson, Foss, and Proffit) at Aria constructed a sediment trap on their respective hill country farms and in conjunction with Massey University measured the sediment that was captured. This sheet is a summary of the construction phase.

Figure 29: Sediment trap for 3.6 ha catchment

4. The aim of the farmers involved in this project was to come up with a small and practical solution that other farmers could relatively easily implement to help improve water quality on-farm.

5. Some further related reading can be found at:

- https://www.dairynz.co.nz/media/254172/5-9_sediment_traps_2012.pdf
- https://nzarm.org.nz/vdb/document/23
- https://nzarm.org.nz/vdb/document/25
- http://www.wet.org.nz/wp-content/uploads/2012/03/COARSE_SED_TRAP.pdf
- https://doi.org/10.1002/hyp.14309
- https://atlas.boprc.govt.nz/api/v1/edms/document/A3262395/content

Choosing the site

6. The aim is to have several small sediment traps instead of 'one big one' – this is for effectiveness, aiming to stay within relevant council permitted activity rules, and cost considerations.

7. The ideal target is for your sediment trap to have 120 m^3 of storage per one hectare of catchment. However as can be seen in Table 3 this target was not the on-farm outcome achieved by our three farmers and sediment was still captured:

Table 3: The sediment trap capacity achieved by our three farmers

	Catchment area	Estimated size of sediment trap	Ratio – m^3/ha of catchment
Farmer 1	3.6 ha	390 m^3	108 m^3/ha
Farmer 2	20.3 ha	850 m^3	42 m^3/ha
Farmer 3	15.0 ha	1,300 m^3	87 m^3/ha

8. Identify as bigger flat an area high up the catchment as possible, so the catchment area does not get too big.
9. Be aware of your local government regulations so your sediment trap does not trigger a resource consent requirement.

Getting your pipes organised

10. The aim is for the sediment trap to empty within three days to allow pasture recovery, to be able to handle the next event, and to avoid creating a new permanent water body. The 'riser pipe' is the key tool in achieving this outcome.
11. Diagram of a riser pipe set up:

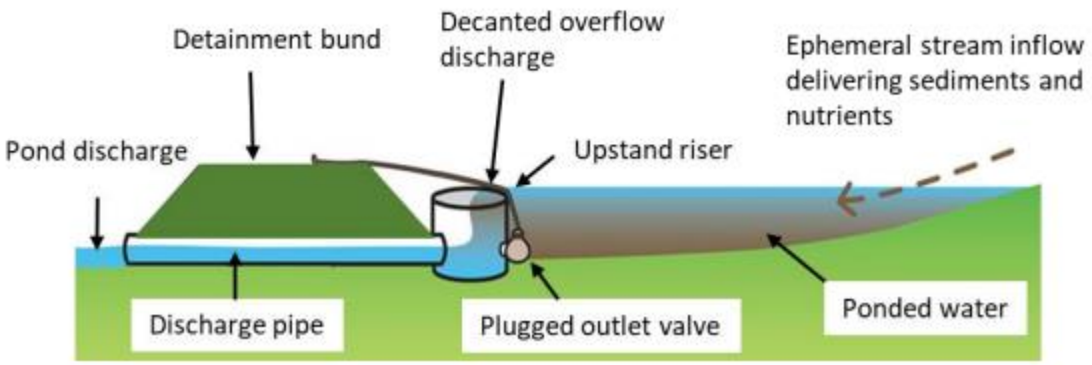

Figure 30: Diagram showing the stream inflow ponding behind an earthen wall or detainment bund used on good contoured land on pumice soil with a plug system in the riser pipe. Acknowledgement: John Paterson and Brian Levine.

12. Using a laser level like builders' use, makes getting the heights easier.
13. Get the outlet pipe and riser constructed in your sediment trap early in the process so if the rain comes you do not end up working in a 'pond'!
14. The outlet pipe size should increase as the catchment area increases (Figure 31).

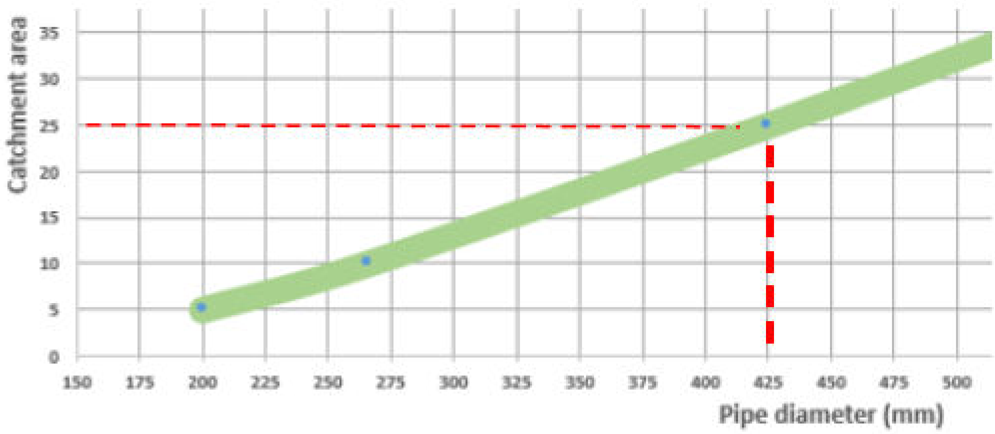

Figure 31: Suggested size of outlet pipe for different catchment area. Source Paterson et al. (2019)

15. For inlet holes, the farmers found two 25 mm holes every 200 mm of riser pipe height worked well.

16. For the outlet pipe it was easy to make a little hole bigger (with a sledgehammer)! But take your time and don't make the hole too big as we found the hardest thing was to seal up a big hole. Use concrete and wire for reinforcing or sandbags with cement mixed in.

Figure 32: Paired inlet holes every 200 mm are visible with exit pipe at the bottom of the riser pipe

17. See pages 23-25 and Appendices 1-4 in Levine (2020) for more information.

Site preparation

18. Do this in summer so you are not working in a flowing watercourse. This will allow more time for new grass to establish as exposed soil is not the desired outcome.

19. Make sure you have a firmly packed high rainfall event overflow.

20. You need to have the riser pipe close to your sediment trap wall as this makes access to clean and check it easier and safer.

Site maintenance

21. Remember if your sediment trap is built properly and working well you will have to remove some silt over time - as this will be accumulating and will reduce the dam's capacity.

22. You need to check and occasionally clean and unblock the little holes in riser pipe.

Health and Safety

23. Be very careful with young children.

24. Add the sediment trap to your farm hazard list and include a mitigation plan to make it as safe as possible.

25. Take care when doing site maintenance and communicate with someone prior to going to the sediment trap. Two people on site would be best practice.

26. The wall of your sediment trap needs to be fully compacted considering the soil type you are working with.

27. The top of the rise pipe should have a mesh cover to prevent debris and stock getting sucked in.

7 Project Success

7.1 In point 2.7 on page 10 the assessment criteria for the success of the project were detailed and Table 4 notes progress against these criteria.

Table 4: Progress against internal project criteria

Assessment Criteria	Progress
Successful installation of three simple sediment traps with siphon samplers and sediment plates to monitor sediment concentrations entering and leaving the trap during six rainfall events.	Completed.
Water samples collected from six runoff events by the farmers and analysed for suspended sediment by a commercial laboratory.	Completed.
Results are shared (using King Country River Care) and discussed with farmers in the Mokau river catchment area and they become engaged in a discussion and learn more about how sediment traps work and how to identify size and placement in hill country catchments.	Completed through on-farm field-day and King Country River Care communications but affected by various Covid-19 restrictions.
Farmers in the wider Mokau river catchment area will feel more confident to install sediment traps on their own farms.	Partially achieved as difficult to assess. Project farmers and field-day attendees certainly feel more confident.
If the measurements taken in this project show sediment traps can remove sediment from water runoff on farms, then sediment traps become a tool that can contribute to the long term reduction in sediment concentration within the Mokau catchment's waterways.	Achieved. Sediment traps were proven to be an available long-term tool to help reduce sediment concentration in the waterways of the Mokau catchment.

7.2 Based on the information in Table 4 it is concluded this project has been successful due to the on-farm results achieved and the feedback of those farmers who participated in the project and events associated with the project.

8 Acknowledgments

On behalf of farmers in the King Country region, Perrin Ag wishes to acknowledge and thank the following for their significant contribution to this study and trial:

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ii. Peter and Caroline Foss;
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iv. Bob Toes;
v. Dr Lucy Burkitt; and
vi. Professor Ian Fuller.

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