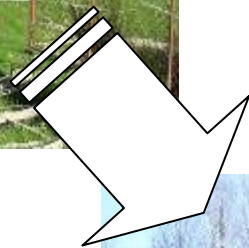


Project Report

SFF L06/008: Demonstrate the multiple benefits of establishing a natural water filtration system within a sheep & beef farming system



Clutha Agricultural
Development Board

July 2006 – June 2010

Contents

Page

3	Summary
4	Acknowledgements
5	Project objectives
6	Project design and approach - with Farm map and Bird's eye view of wetland
8	Project activity and results Site establishment
9	Stock activity and willow management
11	Animal health exercises
12	Water quality testing Turbidity
13	E. Coli
14	Total Phosphorus (TP)
14	Ammoniacal Nitrogen (NH ₄)
15	Nitrite-Nitrate Nitrogen (NNN)
17	Water testing and the wetland situation photos
18	Recommendations
Attached	Water testing 4 sites 2006-10 – the graphs of testing results Average Entry & Exit Results – tables of test results

Summary

SFF L06/008: Demonstrate the multiple benefits of establishing a natural water filtration system within a sheep & beef farming system

- ◆ A wetland as a natural water filtration system does have a variety of benefits.
- ◆ There is a certain amount of work in setting it all up, but it is valid development in a different way from the drain-and-pasture approach.
- ◆ This approach will add to biodiversity and bird life.
- ◆ It will be an idea pursued by farmers who want to monitor and minimise their nutrient losses to waterways. We believe sheep & beef farmers are becoming much more aware of their obligations to look after the water flowing through their land.
- ◆ In a wetland area which is fenced off and managed, there will be no stock losses by accidental bogging.
- ◆ The grazing of the wetland had its difficulties. For best regrowth and little damage to the bushes, hand cutting regrowth, carting and feeding to livestock would produce maximum regrowth. This is unlikely for most farmers, so the careful management of stock inside the wetland is essential to minimise direct nutrient deposits. Cattle are more likely to be used to control the willows and encourage coppicing. Stocking levels to ensure harvest is completed quickly over a few days appears best.
- ◆ Ewe fecundity after time on the willows in the wetland was examined in a very small demonstration. Despite the low quality grass on offer with few clovers and that the ewes on the willows lost weight, they scanned as high as the control mob of ewes on regular pasture.
- ◆ Water testing is a valid tool that will be used by farmers both to check that nutrients are not being wasted by flowing off the farm and to check on environmental considerations.
- ◆ The measurement of the water-borne nutrients in at three testing sites and nutrients out at the one exit site was a very useful way to get some readings of the five categories: Turbidity, E. Coli, Total Phosphorus, Ammoniacal Nitrogen(NH₄), Nitrite-Nitrate Nitrogen (NNN). These readings were carried out by the Otago Regional Council on six occasions.
- ◆ The variability of the results and the difficulty of identifying a direct cause for any particular reading is of some concern in the light of the attitude of some regulatory authorities' environmental monitoring activity. We believe the readings on this site show that any individual spot check will not necessarily show accurately the health of the catchment's water. Nor does a spot check approach show any understanding of the complex chemistry involved and the breadth of natural variables such as the soil and the weather.

- ◆ Despite some variable results, we believe we proved that there was value in slowing down the water and nutrients through the wetland. For the four categories apart from Ammoniacal Nitrogen over almost all the dates tested there was a clear trend that showed the wetland was reducing nutrient flow into the exit drain.
 - Exit turbidity readings improved an average 70% (over five of the six dates).
 - Exit levels for E. Coli improved 47% (over five of the six dates).
 - Exit levels for Total Phosphorus improved an average 45% over four dates (and was worse by 6% on the other two dates).
 - Two dates had extra-ordinarily high readings for Nitrite-Nitrate Nitrogen, but even so the average exit reading showed a 94% reduction on average input levels.

Acknowledgements

Thank you to the following for their contributions to this project:

- ❖ David & Alison Botting – for the use of the farm and enthusiasm for the project.
- ❖ Murray Harris, Land & Forest Consulting – at planting and for advice and reports.
- ❖ Otago Regional Council – Land Resources team, especially our initial contact Katrina Robertson, our more recent contact Alice Webster, water testing colleagues – for consistent support, and for Alice’s help at the Field Day.
- ❖ Clutha Agricultural Development Board Executive members & others who helped at planting time.
- ❖ Graeme Pringle, Clutha Agricultural Development Board – for advice and reports.

Report compiled with the help of the above

Malcolm Deverson
Projects Manager
Clutha Agricultural Development Board

31 August 2010

Project objectives

The general aim of the project was to give sheep & beef farmers an environmentally acceptable alternative to draining marginal wetland areas which also gave some economic benefit.

At the beginning of the project in 2006 we did not believe that sheep & beef farmers had taken up the challenge of managing water quality and nutrient use within and leaving their farms. We took the controlling of nutrient discharge into public waterways as one of the more pressing issues within sustainable farming practices and aimed in this project to give some workable ideas in a realistic on-farm situation.

We noted that farmers often see wetland areas and streams as unproductive. We aimed to show how such areas could be brought into the productive farming system without compromising water quality or natural water systems. The Japanese shrub willow *Kinuyanagi* and some native flaxes and grasses were suggested to enhance the areas and provide effluent filtration at key times, especially after winter strip grazing of catchment paddocks.

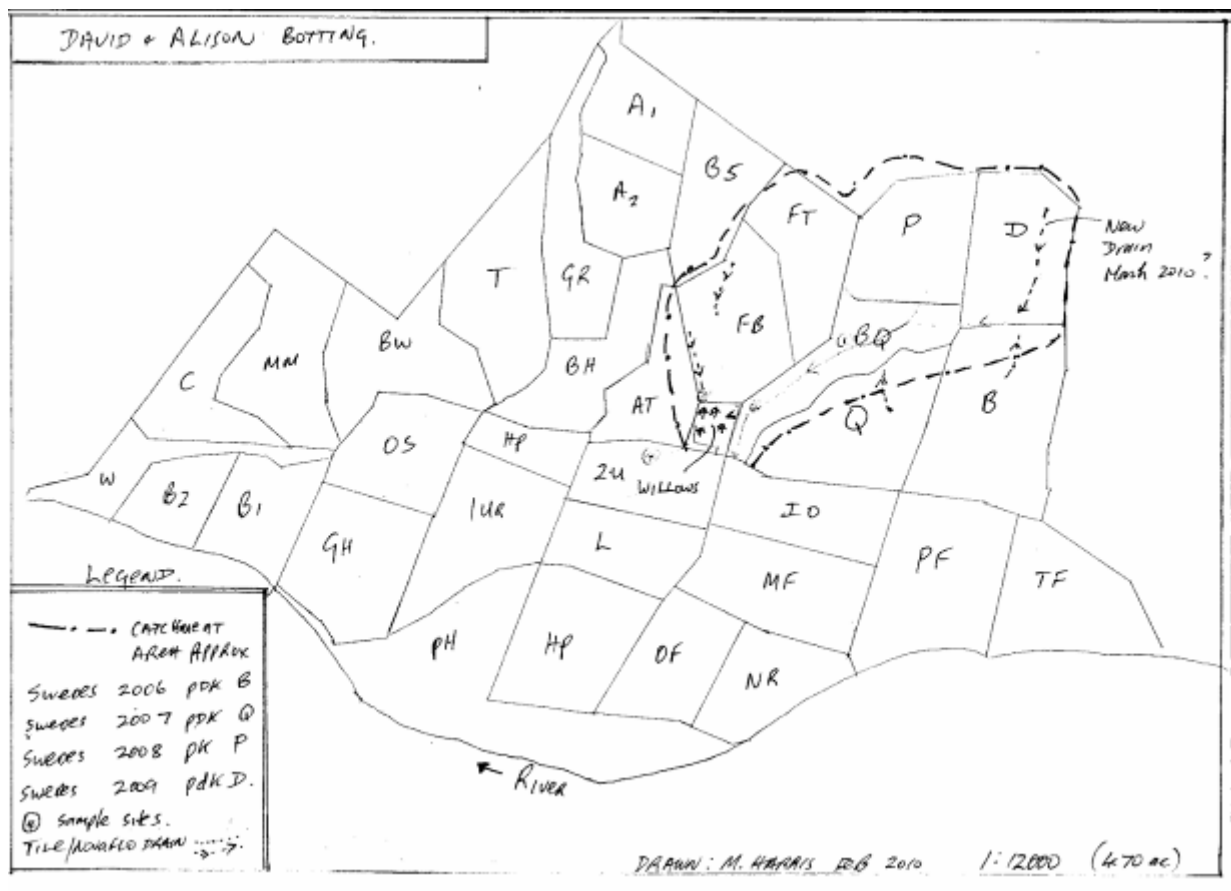
So, the project objectives included:

- ◆ To suggest an alternative to draining small areas at the bottom of gullies on rolling hill country.
- ◆ To consider the management of willows and natives as filtering plants in these areas.
- ◆ To test the water quality in and out of such a wetland-created area to check the effectiveness of these plantings as a filter.
- ◆ To bring sheep & beef farmers into the discussions about effluent and water quality.
- ◆ To consider any animal health benefits of pre-lambing grazing on *kinuyanagi* willows in a demonstrable context.
- ◆ To wrap all the successful ideas into a package of multiple benefits for farmers to consider.

These general objectives did not change throughout the project. However, this was a small-scale demonstration endeavour, and so some aspects became more important and more of a focus than others. The water quality issue became of prime concern, as general public and farmer awareness of the issue grew significantly during the four years of the project (2006-10). Also significant were the periods of drought within these four years and the disruption to both the water testing plans and also to the stock management that may have given us more data on animal health benefits.

Project design and approach

The project was a simple exercise to see what we could do on one site and property, that of David and Alison Botting at Te Houka, approx. 8 kms from Balclutha. The catchment site for the demonstration is a significant part of the farmer's property on undulating silt loam soils. The paddocks have tile drains running into several streams all of which run into a gully, down to a wetland on lower flats and then via a drain into the Clutha River. Initial drainage flows as we started had water and nutrients flowing quickly through this catchment and into the river. Traditional management might have involved draining and creating pasture from the wetland, clearing gullies and accentuating the flow through the property.



This map of the farm shows the catchment area and the small central wetland site.

Our project aimed to demonstrate the practical steps involved in establishing these kinds of areas as small wetlands with a variety of environmental and economic benefits. The emphasis was to be on the practical application of these benefits and their demonstration for farmers rather than instituting new research and new sets of figures.

We would fence off the area and plant largely the Japanese willow *Kinuyanagi* and some native flaxes and grasses in key areas on the site and then test the merits of this idea to reduce the flow of nutrients off the farm and allow only clean (N & P free) water to exit into the public waterway.

The water quality was tested and recorded by the Otago Regional Council through the life of the project at four key points: at the top of a gully with likely runoff from several paddocks (Site 1), at the point where this gully enters the wetland site (Site 2), at a second gully entry directly fed by a tile drain exit (Site 3) and importantly at the fenced off, never grazed exit point from the wetland to the open drain to the river (Site 4). The photo here show the undeveloped area – as at July 2006.



As well as this water quality benefit, we were hopeful of showing productive benefit through:

- adding to the options for the uses of waste ground – and pointing to the advantages of managing other riparian strips on the farm and planting Kinuyanagi willows where the ground and situation suited.
- improved animal health – we wanted to use the previous willow findings in SFF 04/089 to harvest as feed and see if we could detect any animal health advantages. A small lambing percentage ‘rough science’ trial was all that was able to be achieved for this aspect.

We envisaged two field days to show farmers this activity. As it turned out the “demonstration” of this site and its ideas was successfully achieved often informally by the farmer and the project team. There were small ‘discussion group’ visits, one Clutha Sheep Council visit, an educational visit by Telford Rural Polytechnic Diploma students, visits by MAF and Scion personnel and one major Field Day at the end of the project on 29 April 2010. There was little opportunity for ‘progress’ media interest (the slow gathering of some variable results initially meant we didn’t have much to say), but after the Field Day and now, on promotion of the Final Report, we expect further media interest. We have also had occasional discussions about the project on our Radio Clutha weekly spot.

Dairy based projects SFF 03/004 (Riparian strip photos), SFF 03/041 (Water aeration to improve DFE infiltration), and SFF 04/089 (Willows for environmental management and fodder) were being completed in the district in the early stages of this project. This new small demonstration area was to enable the district to maintain the momentum with clean water and willows for effluent management and fodder efforts. It was important for us to also extend the discussion into the sheep & beef area.

The farmer’s diary of activity, especially winter feed grazing was kept so that this could inform the results of water testing at the various sites. A photographic record of key progress points, especially with the establishment and management of the willows and other plantings, was also to be kept.

In summary, the project approach has been to establish a productive area on marginally useful land which is able to show multiple benefits for the environment and for the farmer. This has been largely achieved and the site will be available for some years to come as an example of what can be done in even a very small area.

Project activity and results

Site establishment

The development of the site into the demonstration area was begun in May – July 2006. It was fenced with a sheep mesh with an electrified top wire by the host farmer. This was to prevent ‘accidental’ grazing of the area by stock. Some digger work was also undertaken by the farmer to prevent drainage at the northern corner of the site and direct all drainage from the site through the eastern outlet to the drain out to the river. In this way, the wetland will contain all the water, have it run through the existing and new plantings, then also across the native area that is currently being worked on.



The trial site before fencing and planting – April 2006

In late July the area was sprayed with glyphosate in preparation for the planting. Rows were sprayed 1.5m apart in an approx. east-west direction. The planting took place on 8 September 2006 - approx 1175 *Kinuyanagi* willows which had previously been cut and stored from the Willows Project at Sharpins (SFF 04/089) were planted approx. 1m apart. They were well rooted and approx 30-40 cms in length. Many were planted in very swampy conditions but in the month after planting there were drying conditions. Survival was approx. 90% and most had grown to between 0.5m and 1.0m by February 2007.



Fencing and spray lines ready for planting

Further planting was undertaken in the following season to finalise the establishment phase. 50 *Salix Kinuyanagi* rooted small trees and approx 55 *Salix Kinuyanagi* cuttings were primarily used to blank up the gaps from 2006 and extended further towards the fence line on the eastern boundary. Planting was carried out on 11 and 27 September 2007 under warm conditions. The following natives were planted in the corner of water testing Site 4: 4 Pittosporum, 3 Broadleaf, 10 Toi Toi, 8 Cabbage trees and later on 8 October transplanted Pittosporums. This area was also fenced out as an isolated block within the wetland. It is to act as a final filter before

the water is released into the Clutha River-bound drain.

Stock activity and willow management

The management of the site through the four years of the project involved:

- Keeping the grass and willows in the wetland under control
- Giving the natives and grasses conditions in which they could thrive
- Managing stock which had temporary access to the site so that no damage was caused and any benefits could be identified
- Setting up the site for it to be used by stock in small animal health exercises
- Manage paddocks in the catchment above and feeding into this wetland to inform water test results downstream from particular paddock activity

The willows have been grazed in summer and/ or early autumn in each of the years since planting. In the first year approx. 600 hoggets grazed the block for approx 3 ½ hours in late February 2007 in dry conditions. They nibbled the willows as well as the pasture, especially the younger shoots and smaller plants. There was a further grazing by the hoggets in March, largely to clear the grass growth for the willows to progress, and by 40 heifers in April. The farmer has found during this project that while grazing sheep on the willows has some health benefits, beef cattle were preferable to tidy up the willows once established. Much of the growth in the willows, especially the most palatable tips, are beyond the reach of the sheep (some of this growth to 1.5m high).

In the second year there was light grazing by 600 hoggets for 12 hours in early November 2007. This was necessary because the rank spring pasture and weed growth was competing with the willows and slowing down their dry matter production. This was a year of below average summer and autumn rainfall. While it was good for the willows that they did not have to contend with boggy conditions while establishing, it did mean less flexibility with what the farmer could do with his stock.



Hoggets graze the second year growth in November

The area was then grazed February – April 2008 to facilitate a small animal health trial as explained below. All stock clearly enjoyed the willows, even taking young shoots first when good clovers were available in the underpasture.

A mild winter in 2008 with minimal heavy frosts began year three of the project. However there were many rainy days July – September and 35% of the average annual rainfall for the farm fell in these

three months. There was a grazing by 35 cattle and their calves for a day and a half in drier conditions in mid November 2008. This trimmed the willows from an average 1.8m to approx. 0.5 – 0.75m.

These wet conditions caused an approx. 20% death rate of natives that were in low-lying areas of their corner. 28 more natives were planted in the corner section in October 2008. More water adaptive plants need to be considered in the future, e.g. sedges, *Juncus spp*, *Hoheria spp*, *Plagianthus betulinus* and Swamp Cypress. It would also be advantageous to keep an area around each plant free of grass to help establishment.

The willows were then left to grow though the summer for grazing in April 2009 in relation to a lambing percentage trial as below. Minimal maintenance occurred after this during the 2009 winter.

At the start of the year four extension to the project, in the spring 2009, it was decided to give the willows a chance to establish stronger root systems and leave stock out more than in previous years. 6 bulls grazed the block for 4 weeks from mid January. Further



Early spring conditions, September 2009

grazing also occurred around the time of the April Field Day. Then the willows were cut to coppicing height manually by a youth taskforce group in July 2010. At this time 400 cuttings were also taken to be used elsewhere on the farm with further plantings, some to help stabilise some riverbanks.



Summer growth before grazing, January 2010

In summary it has probably been a typical four years in trying to manage a wetland block as it is established. The site has been both saturated with rain at times, and also dealt with two dry summers in 2008 and 2009. 80% of plantings have survived. It has always required some thought to manage, but the farmer has found it useful for a variety of stock feed purposes (beyond the major aim to improve water quality out of the farm).

Animal health exercises

It was probably slightly disappointing that we were not able to do more to show the animal health benefits of even such a small block of these *Salix Kinuyanagi*. The scale and overall broad intentions of this project always meant that this aspect was going to be a sideline. Even so we did try two exercises to indicate animal health benefits that might be available to the farmer.

The first exercise was based around the idea (with the support of the science literature) that the tannins in the willows are good for ewes at flushing. 585 Two tooth ewes were put on the willows on 17 February 2008 for 24 hours. On 28 March 2008, 25 two tooth ewes were taken out of the main mob and put on a third break on the willows. 25 others were marked and left as a control mob with the main mob. They were all weighed and FEC tested (results were 30 eggs per gram on the whole mob) but unfortunately no follow up egg counts were done due to other farming activities taking precedence. This did not allow us to check on the anthelmintic effect on the lambs.

The willow grazing mob had 10-day shifts, then the ram was put out on 17 April 2008. They were taken off the willows on the 5 May 2008 and weighed empty.

	TEST MOB 25 (Red) i.e. grazing on willows	CONTROL MOB 25 (Blue) i.e. grazing only on pasture
Results on 28/3/08 Average Weight	62.2kg	60.9kg
Results on 5/5/08 Average weight	57.7kg	62.19kg
Scanning	4 singles 1 triplet 20 twins	3 singles nil triplets 22 twins

This is hardly conclusive. The willow-grazed mob appear to have lost weight but scanned as many lambs as the pasture mob. The scanning figures should also have been taken to lambing but the trial mobs were lost.

In the following year another scanning exercise was attempted by the farmer. On 1 April 2009 20 4 tooth ewes were put on the willows with orange tags and 20 others were randomly selected from the main mob on pasture as the control mob with blue tags. The ram was put in with the mobs from 7 April and taken out on 25 April 2009 after the block was eaten out.

The ewes were scanned on 14 July 2009 – the willows mob scanning 168% and the control mob 160%. No triplets were scanned for and the whole mob tailed at approx 130%. However, the farmer was sure that grazing ewes on the willows prior to putting the ram out did benefit the lambing percentage.

We stress that these were in no way scientifically validated trials. They were simply exercises by the farmer where he was very happy with the results. Perhaps there is enough here for other farmers to consider the opportunity. It is at least a potential added benefit to the others explored in this project.

Water quality testing

The work investigating the water flow through the established and new wetland plantings ended up being the main focus for the project. The support of the Otago Regional Council in undertaking the water tests and providing data and some analysis was much appreciated.

We managed to test the water at the four sites detailed above on six occasions. The water quality parameters that were measured in this study included Turbidity, E. Coli, Total Phosphorus (TP), Ammoniacal Nitrogen (NH₄), Nitrite-Nitrate Nitrogen (NNN). Other parameters such as temperature and conductivity were also monitored at all sites but are not discussed in these results.

It was not as easy as it sounded to arrange these tests at times when the effects of farming activity in the surrounding paddocks could be measured. Two very dry summers at the start of 2008 (also stretching into autumn) and 2009 and other occasional dry spells played havoc with our ordered intentions. As a consequence, we were not able to prove any causal link between specific farming practices and the runoff of monitored nutrients through the wetland. This would take a much more detailed and expensive project.

However, we were able to make some clear observations about the overall and very real effects of sheep & beef farming on water quality . This report will deal with the results with respect to each of parameters which are becoming standard measures of water quality and health. The comments relate to the full results which are in the tables which follow.

The guideline figures as stated are largely those agreed as trigger levels (a level above which some environmental action may need to be triggered) under an Australian and New Zealand Environmental Conservation Council (ANZECC) agreement in 1992 and at meetings in the early 2000s.

Turbidity

Turbidity is a measure of the clarity or cloudiness caused by fine particles or suspended solids in the water. A nephelometer measures scattered light in units – NTUs (Nephelometric Turbidity Units). The agreed trigger levels under ANZACC are 4.1 NTU for upland rivers and 5.6 NTU for lowland rivers. High levels are caused by soil run off and measurements can easily be affected by any disturbance of the water or stream bank.

The collected results for the four sites around the wetland over the six dates look very high in relation to the 5.6 NTU guideline. Some specific cases can be explained. On the initial 18 September 2006 testing there was pugging around Site 1 where cattle had inadvertently gained access, and at Sites 3 & 4 the testers had had to make small holes at the sites to get a hole big enough to get a bottle in to take the sample. The highest turbidity readings on 12 June 2007 were at Site 4 (not an ideal result if we are trying to show improvement through the wetland), but there was considerable disturbance and slumping around the culvert from the wetland area to the exit drain. The culvert was extended and the testing point moved slightly after this to avoid contamination from the track.

For each of these water quality parameters, we looked at the collected measures in two ways. Firstly we considered the raw figures over the four sites. In terms of turbidity it looks like it will be difficult to reach guideline figures within a farming system. Very high readings in the winter 3 June 2009 are likely to be caused by the stock grazing of winter feed crops as well as heavy prolonged grazing by the hoggets on the adjoining block (BQ on the farm map)) on the north side of the main creek.

However, what the trial is showing is that the turbidity is lowest on site 4 overall demonstrating that some sediments are being removed, trapped and deposited in the wetland vegetation area.

Perhaps the variability of these results is down to the variability of our so-called 'streams' being measured. Often they were no more than water running through a paddock and at several times in the project they were dry. The recommended levels may be more relevant to permanently running streams of some width and depth.

The second way that we considered the collected data was to compare an average input and exit figure. (These comments relate the tables entitled "Average Entry & Exit Results"). At five of the six testing dates the exit level (at Site 4) was an improvement on the average entry level (from Sites 1,2,3) by an average 70% (18% - 97% range). The outlier result on 12 June 2007 is explained by the culvert issue above.

Summary: all turbidity entry and exit readings were above ANZECC guidelines. Rainfall events (as these wash loose sediments etc into the waterway) and stocking conditions influenced this measure a great deal. The wetland plantings appeared to improve exit turbidity levels by an average 70%.

E. Coli

Escherichia Coli (E. Coli) are common bacteria that live in the intestines of warm-blooded animals and are excreted. Some strains of E. Coli can cause severe illness in humans. E. Coli is used as an indicator of how microbiologically safe the water is for drinking. It is measured as CFUs (Colony Forming Units) per 100mls of water. Safe levels under ANZECC are zero for drinking water, 260cfu/100mls for recreational contact, and 100cfu/100mls for stock grazing water. A high level of concentration on farm will be from animal excreta.

The collected results for E. Coli were largely within the recommended recreational parameters over the six test periods. The exceptions were the first readings on 18 September 2006 at Site 1 and the last readings on 12 January 2010 on Sites 1, 2, & 4. The higher 2006 reading can probably be explained by the inadvertent cattle grazing in the area as explained above.

The high readings in January 2010 were most likely due to a flushing of the paddocks above with nine consecutive days of rain after a prolonged dry period to 2 January. The stray bull in the wetland area also contributed to the higher readings. Sunlight is a key factor in destroying E. Coli over time and rank vegetation along the waterway and persistent dull weather may have meant that the sunlight was not penetrating and doing its work.

It is interesting from the table of results that there is no particular hiatus of E. Coli in winter or spring readings which are the times when stock is grazed on surrounding paddocks. It might be expected that these would be times of higher concentrations.

In this project, the levels of E. Coli measured at any given point can sometimes be traced to a particular event, but we suspect that in the normal course of farming the levels have a lot more to do with the climatic conditions and particular build-up situations. If this is the case, and some strict science would be required for this, there are serious implications for farmers. Beyond the obvious measures of keeping stock out of waterways and having adequate buffers which reduces cow pats being able to be washed away when it rains, farmers may be unable to control the latent potential for E. Coli release.

However, the “Average Entry & Exit Results” table shows that on five of the six dates (discounting the outlier results on 3 June 2009) exit levels for E. Coli were an average 47% down on entry levels.

Summary: E. Coli readings across the sites and dates were wildly variable. Some high readings could be explained but others were likely to be outside of the farmer’s direct control. Most results showed that the wetland allowed E. Coli readings to be reduced by an average 47% on exit.

Total Phosphorus (TP)

Phosphorus can originate from eroded soil, and also runoff of animal waste and fertiliser. It is a highly toxic chemical element and makes very strong bonds with other elements like soil particles. Farmers add phosphorus to aid plant growth as a matter of course. It is a problem in waterways as it aids the growth of nuisance plants and algae and kills fish and invertebrates.

Total phosphorus is a measure of all phosphorus, both available and unavailable to plants. The trigger level under ANZECC, and also the median level of the regional council and national network river sites, 2003–2007, (Ministry for the Environment) is 0.033 mg/L.

All the measures across all sites and dates during this project exceeded the recommended levels, at some times by a considerable amount. The catchment was topdressed with super phosphate in September 2008 (after the water test on the 4th). Average measures of TP after this event are higher at all sites than before, but this is largely due to the very high readings in January 2010. The readings from this particular date are likely to have been caused by direct soil erosion and runoff from paddocks either overgrazed or from bare paddocks or the remains of the swede paddock.

The “Average Entry & Exit Results” table shows that exit levels are variable over the six dates – one shows worse levels on exit, two show the same levels in and out, and three show some reduction in levels out. There is no trend of improved levels of TP in or out during the four years under review.

Summary: Total Phosphorus levels across the sites and dates are considerably above ANZECC trigger levels. There are a variety of likely explanations and more specific work would need to be done to identify particular causes for particular results. Are high phosphorus levels an inevitable consequence of NZ intensive farming?

Ammoniacal Nitrogen (NH4)

Ammoniacal nitrogen (ammonium) is a common nitrogenous pollutant that is toxic to many species, particularly fish and invertebrates, at elevated concentrations and under certain temperature and pH

conditions. If high levels of NH₄ are found in streams it is often due to a reasonably direct input, such as direct animal input, septic tanks and industrial discharges into the waterway. In the soil it breaks down reasonably quickly into NNN.

The trigger level for lowland streams and rivers is given on our test reports as 0.021 g/m³. The measurements are sometimes in g/m³ and at other times in mg/L – these have the same value. With respect to this element we found that different websites had different statements about the trigger level, but we have considered the 0.021 figure as our guideline.

Again the levels of NH₄ across all sites and dates in the project were largely above this suggested guideline. The highest levels at 12 June 2007 and 12 January 2010 can probably be explained by winter stock grazing on the catchment paddocks and inadvertent stock directly in the area, but the reason for the high values at Sites 3 & 4 at 31 May 2010 at the end of the project is a mystery. There is also no obvious pattern about which of the sites are showing higher ammonium values.

The “Average Entry & Exit Results” table shows the NH₄ readings to be the most disappointing of the five readings taken over these years. At only one of the six dates did the tests show a reduction at Site 4 from the average at Sites 1, 2, & 3. The 12 June 2007 reading showed an 80% reduction at Site 4, but only because Sites 1 & 2 readings were very high. In the other four dates to January 2010 there was an average increase at Site 4 of 23%.

Summary: Ammoniacal Nitrogen should be easier to control than NNN as it is commonly from a direct input and as it breaks down quickly, but we could not find the links between the farmer’s practice and the variable test results in this project. The plantings did not appear to reduce NH₄ levels. The farmer concerned believed that the reason for the presence of this element was not at all easy to pinpoint. This is all relevant if regulatory authorities are going to hold farmers accountable for their likely pollutant discharges.

Nitrite-Nitrate Nitrogen (NNN)

Nitrite and nitrate are sources of available nitrogen and are essential for all life on earth; specifically it is an important nutrient for all plants and algae. Nitrite is formed from the breakdown of NH₄ by bacterial action. This is then converted to the more stable, much less toxic nitrate through a process called "nitrification." Nitrate from nitrogenous fertilizers not taken up by crops or grass can enter water courses in runoff or leaching through the soil profile. Once in the water, nitrates can stimulate excessive plant and algae growth and then the decomposition of this material can deplete dissolved oxygen, adversely effecting fish and other aquatic life.

The trigger level under ANZECC for NNN is 0.444 g/m³. However, it was our advice later on in the project that for NNN the NZ Periphyton Guidelines rather than ANZECC should be used as these are more specific to NZ streams. The Guideline figure is 0.295 g/m³. This is a trigger level that if both NNN and Dissolved Reactive Phosphorus (DRP which makes up part of TP), are above the guidelines it is likely that periphyton (algae) will start to grow.

The first 18 September 2006 test was actually of “Total Nitrogen” which has a slightly higher value, but this has little relevance to our comments.

Before the most recent test results from 31 May 2010, consistently higher levels of NNN were found at Site 3. These results reflect the position of this testing site below a tile drain and perhaps are evidence of direct runoff effecting nitrite-nitrate levels.

The high level at Site 4 on 12 June 2007 may be explained – it is understood that the reading may have been taken from the other side of the track culvert hence the high figures are due to runoff from the track.

We suspect that the high levels at all sites on 31 May 2010 (collectively 1100% higher than the average of all previous results) are showing something that it would be difficult for this small project to justify. There was no recent fertilizer application by the farmer that would explain the results. The suspicion of the practical members of the project team is that there is a build up of NNN in the catchment, especially during sustained dry spells; then when we have tested in wet periods soon after, we have detected a ‘flushing’ of these nutrients through the whole area.

We hope this contention is worth further debate and perhaps study.

Despite the results for the two tests with high outlier results, the “Average Entry & Exit Results” table shows that the wetland filter area was, in fact, successful in reducing NNN at the Site 4 exit on the latest four dates by an average 77%. Apart from the strange June 2007 and May 2010 results, the readings at Site 4 are all well under the 0.444 ANZECC trigger level, and around or under the NZ Periphyton Guidelines.

Summary: this wetland appears to be acting as a useful nitrite-nitrate filter generally. However, NNN concentrations in the catchment also appear to flow quickly through the area in certain circumstances, and perhaps this is worth further study.

Water testing photos – SFF 06-008 Water filtration project CADB



Water testing at Site 1



Water testing at Site 4



Discussion of preliminary results at the April 2010 Field day



Surrounding paddocks to show likely runoff situation



Winter scene from the head of Site 1 gully, looking down towards the wetland



Winter feeding on surrounding paddocks will have caused some of the runoff

Recommendations

- ✦ The project team will meet in the months after the project has finished to do a final summary of results (the April Field Day only had five of the six results and not so much analysis was completed by this time) and plan any further action.
- ✦ Consideration should be given as to how to continue the momentum achieved and to demonstrate to more people what can be done with natural wetland sites such as this.
- ✦ It would be useful to continue on with the water testing on a more systematic plan to coincide with grazing or other farm practices (this would need further ORC support).
- ✦ The 2009 swede paddock (D on the farm map) has had excavator work and the installation of a novaflo drain system in the gully which will drain directly into the water way that has been monitored (just above Site 1). It would be interesting then to note any changes in the samples at Site 1 and other sites following this work.
- ✦ The site is ideally set up to look at manipulating some farm management practices, e.g. the time of fertiliser application or the period or intensity of grazing, and then looking at water test results as a consequence. This might be seen as the next step to confirm links that largely are only suspicions or suggestions from this project about what causes high or low results.
- ✦ Work probably needs to be done within the wetland to make sure there is a delayed flow through and around the wetland, rather than a situation where the water is able to rush across to Site 4 and exit. Much of the value of a wetland area is to encourage denitrification and for this the wetland must all remain wet and the water needs to circulate for approx 5 days. (Rutherford & Nguyen, Dairy Exporter, June 2001). If the wetland dries out the denitrifying microbes die out and the water must also be in contact with the soils long enough for the microbes to remove nitrate.
- ✦ The farmer is giving consideration to doing something similar in other gullies or riparian strips. There could be some consideration given to establishing a 'control' site where nutrients are flowing freely off this type of rolling hill country. Although it is accepted that this project has shown that it would be difficult to find such a thing as a 'typical' site. Water quality readings appear to be very dependent on both farmer-induced and natural variables.

Malcolm Deverson
Projects Manager
Clutha Agricultural Development Board
31 August 2010

Attached: Water testing results graphs 4 sites – 2006-10
Average Entry & Exit Results - tables

Water Quality Monitoring over time at trial wetland

Turbidity	2006	2007	2008	2009	2010	2010
Site	18-Sep	12-Jun	4-Sep	3-Jun	12-Jan	31-May
1	28	12.6	2.35	178	63	9.67
2	8.1	11.5	24.6	406	45.2	4.92
3	118	8.75	70.5	392	163	163
4	20.4	83.7	26.6	10.8	9.67	7.66
Guidelines	<5.6NTU	<5.6NTU	<5.6NTU	<5.6NTU	<5.6NTU	<5.6NTU
T 1,2,3	154.1	32.85	97.45	976	271.2	177.59
Ave	51.4	11.0	32.5	325.3	90.4	59.2
Decrease	31.0	-72.8	5.9	314.5	80.7	51.5
%	60	-664	18	97	89	87

Average Entry and Exit Results

Sheep & beef water filtration project

Farmer: David Botting, Te Houka

SFF Project L06-008

Clutha Agricultural Development Board

Entry (sites 1-3 averaged) and exit from wetland analysed

Water Quality Monitoring over time at trial wetland

T Phosph	2006	2007	2008	2009	2010	2010
Site	18-Sep	12-Jun	4-Sep	3-Jun	12-Jan	31-May
1	0.18	0.23	0.08	0.192	0.564	0.095
2	0.15	0.13	0.08	0.451	1.29	0.076
3	0.05	0.13	0.48	0.075	0.266	0.232
4	0.120	0.050	0.220	0.106	0.369	0.147
Guidelines	<.033g/m ³	<.033g/m ³	<.033g/m ³	<.033g/m ³	<.033g/m ³	<.033g/m ³
T 1,2,3	0.38	0.49	0.64	0.718	2.12	0.40
Ave	0.127	0.16	0.21	0.239	0.707	0.134
Decrease	0.007	0.11	-0.01	0.133	0.338	-0.013
%	5	69	-3	56	48	-9

Water Quality Monitoring over time at trial wetland

E.Coli	2006	2007	2008	2009	2010	2010
Site	18-Sep	12-Jun	4-Sep	3-Jun	12-Jan	31-May
1	1200	100	140	280	4000	520
2	200	90	160	88	1900	400
3	120	8	400	96	160	250
4	90	14	200	740	1800	200
Guidelines	<260cfu/100ml	<260cfu/100ml	<260cfu/100ml	<260cfu/100ml	<260cfu/100ml	<260cfu/100ml
T 1,2,3	1520	198	700	464	6060	1170
Ave	507	66	233	155	2020	390
Decrease	417	52	33	-585	220	190
%	82	79	14	-378	11	49

Water Quality Monitoring over time at trial wetland

NNN	2006	2007	2008	2009	2010	2010
Site	18-Sep	12-Jun	4-Sep	3-Jun	12-Jan	31-May
1	0.22	0.29	0.27	0.283	0.098	6.55
2	0.13	0.29	0.1	0.131	0.004	4.17
3	0.15	0.64	0.81	0.583	0.258	3.09
4	0.020	2.200	0.030	0.028	0.040	2.910
Guidelines	<0.614g/m ³ TN	<0.444g/m ³ N	<0.444g/m ³ N	<0.444g/m ³ N	<0.444g/m ³ N	<0.444g/m ³ N
T 1,2,3	0.500	1.220	1.180	0.997	0.360	13.810
Ave	0.167	0.407	0.393	0.332	0.120	4.603
Decrease	0.147	-1.793	0.363	0.304	0.080	1.693
%	88	-441	92	92	67	37

Water Quality Monitoring over time at trial wetland

NH4	2006	2007	2008	2009	2010	2010
Site	18-Sep	12-Jun	4-Sep	3-Jun	12-Jan	31-May
1	0.04	0.16	0.02	0.03	0.05	0.02
2	0.03	0.12	0.01	0.01	0.01	0.02
3	0.04	0.03	0.02	0.01	0.14	0.02
4	0.04	0.02	0.02	0.02	0.12	0.23
Guidelines	<0.02g/m ³	<0.02g/m ³	<0.02g/m ³	<0.02g/m ³	<0.02g/m ³	<0.02g/m ³
T 1,2,3	0.11	0.31	0.05	0.05	0.20	0.06
Ave	0.037	0.103	0.017	0.017	0.067	0.020
Decrease	-0.003	0.083	-0.003	-0.003	-0.053	-0.210
%	-9	81	-20	-20	-80	-1050

- Blue Exit data above trigger value guidelines
- Yellow Exit data below trigger value guidelines
- Green % improvement at Site 4 exit
- Pink % worsening at Site 4 exit

SFF Project 06/008 Water testing results from ORC

Test result data September 2006 - May 2010																														
Site	Turbidity					E. Coli					Ammoniacal Nitrogen (NH4)					Total Phosphorous (TP)					Nitrite-Nitrate Nitrogen (NNN)									
	18 Sep. 06	12 Jun. 07	4 Sep. 08	3 Jun. 09	12 Jan. 10	31 May. 10	18 Sep. 06	12 Jun. 07	4 Sep. 08	3 Jun. 09	12 Jan. 10	31 May. 10	18 Sep. 06	12 Jun. 07	4 Sep. 08	3 Jun. 09	12 Jan. 10	31 May. 10	18 Sep. 06	12 Jun. 07	4 Sep. 08	3 Jun. 09	12 Jan. 10	31 May. 10	18 Sep. 06	12 Jun. 07	4 Sep. 08	3 Jun. 09	12 Jan. 10	31 May. 10
1	28	12.6	2.35	178	63	9.67	1200	100	140	280	4000	520	0.04	0.16	0.02	0.03	0.05	0.02	0.18	0.23	0.08	0.192	0.564	0.095	0.22	0.29	0.27	0.283	0.098	6.55
2	8.1	11.5	24.6	406	45.2	4.92	200	90	160	88	1900	400	0.03	0.12	0.01	0.01	0.01	0.02	0.15	0.13	0.08	0.451	1.29	0.076	0.13	0.29	0.1	0.131	0.004	4.17
3	118	8.75	70.5	392	163	163	120	8	400	96	160	250	0.04	0.03	0.02	0.01	0.14	0.02	0.05	0.13	0.48	0.075	0.266	0.232	0.15	0.64	0.81	0.583	0.258	3.09
4	20.4	83.7	26.6	10.8	9.67	7.66	90	14	200	740	1800	200	0.04	0.02	0.02	0.02	0.12	0.23	0.12	0.05	0.22	0.106	0.369	0.147	0.02	2.2	0.03	0.028	0.04	2.91
Guidelines for lowland streams and rivers	<5.6 NTU					<260 cfu/100ml					<0.9 g/m³-N					<0.033 g/m³-P					0.444 g/m³-N									