Assessment of sites for on-farm pollution mitigation actions

Between the Domes Catchment Group

Prepared for Thriving Southland

July 2022

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Executive summary

Sites on seven farms were assessed to determine their potential to mitigate contaminants of diffuse origin. These assessments were carried out by NIWA for the Between the Domes Catchment Group (BDCG) in association with Thriving Southland. The assessment process included evaluating the candidate sites in terms of potential for constructing wetland and sediment ponds, restoration of existing natural wetlands, and riparian planting.

Relevant site characteristics were documented using information collected during site visits with clients on 7 April 2022. The most appropriate mitigation actions were identified and prioritised, considering factors such as feasibility, risk of adverse outcomes, water quality and biodiversity benefits, relative costs and site visibility.

The prioritisation process identified four candidate sites that we propose for further consideration by the BDCG. Two sites were "green field" (new development) sites suitable for constructed wetlands/ponds, and two sites were suitable for restoration of existing wetlands. It is anticipated that two sites will be selected by the group for further concept development.

1 Brief and introduction

Thriving Southland is a community-led group with a vision to create a prosperous Southland, healthy people, healthy environment from the mountains to the sea (Thriving Southland 2022). Much of their work to improve the environment is achieved through supporting and facilitating the work of local catchment groups. Thriving Southland Association Incorporated contracted NIWA to provide advice to the Between the Domes Catchment Group (BDCG) on the most appropriate and effective approaches for diffuse pollution mitigation that would lead to environmental gain in cost effective manner. This assessment would include relevant edge-of-field or sub-catchment scale mitigation options (i.e., consider use of multiple mitigation actions in a catchment), and provide high-level indicative costs for wetland or other mitigation options, to reduce contaminants of national concern such as suspended sediment, nutrients (particularly nitrogen and phosphorus) and faecal bacteria. Mitigation options are likely to include:

a. Restoration of existing wetlands.

b. Construction and use of sub-catchment scale wetlands (i.e., treating more than a single farm).

c. Establishment of new strategically located small to medium scale wetlands or other similar mitigations (e.g., 1-5 ha in size).

d. Small scale wetlands or edge-of-field mitigations (e.g., <1 ha in size) dealing with tile drainage and sediments arising from paddocks.

In this context, the National Policy Statement – Freshwater Management (NPS-FM, New Zealand Government 2020) provides guidance to regional councils and the general public on ensuring that natural and physical resources are managed to preserve the health and wellbeing of water bodies and freshwater ecosystems. Relevant excerpts from the NPS-FM are included in an appendix of this document. We note that trends in nutrient levels in the Oreti River (the major river in the BDCG catchment area) are considered very likely to be degrading (see Appendix A).

To facilitate this assessment and subsequent provision of advice, the Thriving Southland Catchment Coordinator, Poppy Hardie worked with the Catchment group to identify seven locations of interest within the catchment. This report provides details and assessment information for each site, along with conceptual designs or site modifications likely to enhance diffuse pollutant attenuation. This information will be used to prioritise a smaller number of sites (2-3) for which more detailed conceptual plans will be developed.

2 Methods

Identified sites at the farms visited are shown in Figure 2-1. These sites were visited by NIWA staff (James Sukias and Chris Tanner) on 7th April 2022, along with Keith Finlayson (Environment Southland) and various BDCG members. The Between the Domes Catchment area includes the upper reaches of the Oreti, Mataura and Aparima Rivers. The catchment area encompasses significant landmarks – East-, West- and Mid Dome.

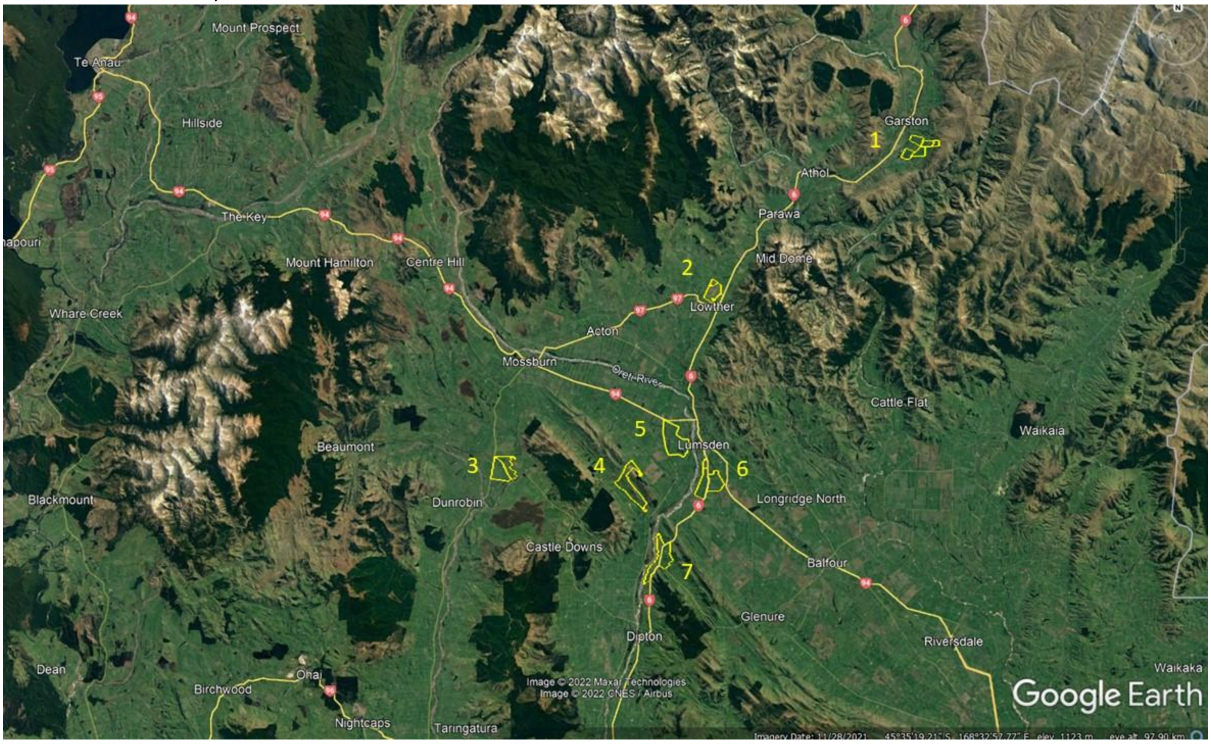


Figure 2-1: Farm sites map. Farms are numbered based on the order they were visited and assessed.

Each site was assessed for priority pollutants based on the authors scientific judgement, with input from the landowners and those members of the catchment group who were present. For instance, where runoff from the catchment was dominated by subsurface inputs, nitrogen and, to a lesser extent, phosphorus were considered priority pollutants, with sediments and faecal inputs largely unimportant. Conversely, in a catchment where inputs were dominated by surface flows in erodible soils, sediments were considered the priority pollutant. Secondary pollutants were included in brackets.

A decision matrix table is included at the end of this report. It was used to assist with prioritising sites for environmental enhancement. Ratings for different categories were assigned a score of 1-5, with higher being better, although it is worth stating that the ratings were largely subjective, based on the authors' experience and input from the group members who visited each site. Categories include the suitability of any remediation action proposed (clear path of action, feasibility and risk), and any potential water quality and biodiversity benefits. Site visibility (i.e., the site is able to be seen by the general public and demonstrate practical steps being undertaken by BDCG and the community to attenuate pollutants and enhance the environment) was identified by those attending the site evaluations as a consideration when selecting sites for upgrading. Likely relative costs for re-development of each site are also considered in the rating matrix. Sites requiring extensive earthworks and planting are likely to incur higher costs than sites requiring less extensive work.

The BDCG group was invited to undertake their own assessment for comparison/discussion of priority sites.

3 Site assessments

Information on each site is presented in the order that they were visited. Farm boundaries and the location of the proposed remediation are shown in each instance. Priority pollutants were identified based on the characteristics of the site and contributing catchment. In some instances, other pollutants were also identified as being worthy of concern, but secondary to the prime pollutant sources. These have been included in brackets.

3.1 Site 1 – Sims Farm

Owner/Contact: Peter and Marie Sims

Address: Butson Road

Figure 3-1: Sims Farm boundary. Google Earth satellite image showing farm boundary (yellow outline). Arrow indicates site location (45°29'14.30" S 168°42'20.20" E).

Figure 3-2: Photo of the potential remediation site looking upstream.

Site current status: Undeveloped stream channel with riparian grass, weeds and occasional sedges. The channel is 0.5-2.0 m wide with perennial flow. The landowners note consistent stream flows of 1-2 L/s in summer, with up to 10 L/s baseflow in winter. Large events occur at a frequency of 5-10 years with much higher flows. Rain >100 mm noticeably increases flows. The contributing area comprises approximately 60-70 ha of hill country and 20 ha of toe-slope terrace (some of which is used for cropping), although most of the catchment has a low degree of pasture development, being scrubby with large areas of bare rock. Some areas of the stream are fully fenced.

Priority Pollutants: Fine silts (N and P).

The contributing catchment is steep and prone to erosion during high flow events. The area of cropping on a neighbouring property means nutrient losses from that property also need to be considered when selecting an appropriate remediation tool.

Potential site re-development: Multi-stage impoundments stepped down the valley in combination with riparian planting and fencing. Impoundment depths need to be sufficient to trap sediments, with riparian planting on their margins used to help stabilise trapped sediments and resist erosion within the broader channel margins. The stream channel is subject to flashy flood flows from upland hills. Structures constructed in the channel will be at risk of damage during high flows.

Preliminary remediation concept: Figure 3-3 shows a potential layout of off-line ponds or wetlands constructed on the edges of the main channel to capture sediment transported in flood flows.

A portion of the mainstream flow can be diverted into the ponds, although very high flows will continue down the existing channel. Offline wetlands/ponds greatly reduce the risk of bund collapse during high flows, do not interfere with fish passage, and in this landscape would be constructed in areas not considered existing wetlands. They are, however, likely to cost more than in-stream impoundments as they require full excavation, rather than modification of the existing flow way. The wetland/ponds with additional riparian planting would enhance habitat diversity, add shading and assist carbon sequestration.

Figure 3-3: Potential series of off-line sedimentation ponds/wetlands along stream channel.

Pros: The landowners are motivated to provide biodiversity benefits for the stream (e.g., for koura and native fish) as well as reduce sediment in the stream for the benefit of the community downstream of their property. Earlier, unpublished work involving connecting a disused gravel extraction pit to a highly channelised stream greatly increased the numbers of native fish. These measures are likely to generally trap sediment, reduce flow velocities and increase habitat diversity.

Cons: High flows during extreme events are likely to cause erosion in the stream channel and may affect plantings on the riparian margins, especially during establishment. Any structures on the main channel will need to be well-engineered and allow for fish passage. Off-line wetlands/ponds may be preferable.

Other notes[1]: The stream currently comprises an incised ditch winding its way down a small valley carved out by flood flows. The area is part of the Garston terrace and the main stream channel coming from the hills is approximately 200 m away. Flows enter the main stream from several gully systems, one of which is on a neighbour's property. Cropping was noted on the neighbouring property; thus N and P may potentially be additional priority pollutants. High flows will need to flow down the existing channel, bypassing the ponds, with low flows diverted into remediation systems. Fish passage will need to be maintained for any structures created. Potential exists to use logs from nearby trees destined for clearance as "mini-dams" to create a series of ponded areas down the valley.

[1] The "Other notes" section of this and following sections were provided to NIWA by BDCG and have largely been provided from the land-owners. Some additional notes are from NIWA or came as a result of on-site discussions. In some instances, these have been edited slightly or moved to above sections to add clarity to those sections of the report.

These will need to be well embedded into the stream base and banks. Earthworks in and along the stream channel are likely to trigger the need for resource consents. Based on our reading of the NPS-FM, the areas proposed for “off-line” constructed wetlands would not be considered inland natural wetlands requiring protection, due to the predominance of pasture grasses and associated exotic weeds in these areas. Thus we consider that this would not restrict modifications along the stream channel.

There are 2 culverts in the site area, and one tile drain running into the area, which flows for 7-10 months of the year depending on rainfall. The area under consideration is “wet land”, around a ditch that runs for another 1 km before its heads off the terrace and in this area the ditch goes dry for half of the year.

Native bullies and koura are reported as present in the terrace area of the stream.

The wetland/stream area being considered is long and narrow, involving approximately 0.6 ha under consideration for restoration. Restoration could be continued down the channel in the future.

A historic stone cottage by the stream has considerable heritage value, and any bunding should be designed to reduce the potential for flooding in this area. In addition, mature gums and an apple tree are associated with the cottage, which the owners were keen to preserve.

3.2 Site 2 – Drummond Farm

Owner/Contact: Greg Drummond

Address: Mossburn-Five Rivers Road

Figure 3-4: Drummond farm boundary. Google Earth satellite image showing farm boundary. Site is shown with yellow arrow (45°36'32.97" S 168°26'48.21" E).

Figure 3-5: Drummond Farm potential wetland location.

Site current status: The land available is a wet/boggy corner (particularly in winter) of a well-developed grain/cropping farm. The area is largely disconnected from the existing stream (by flood banks and a drainage system). It does not currently show significant wetland characteristics and has ground cover comprising more than 50% exotic pasture species, so would not require protection under the current proposed NPS-FM regulations. The landowners intend to convert upstream surface drains to subsurface drains.

Priority Pollutants: N & P

The contributing catchment area is flat and used for cropping, thus nutrients are likely to be the primary pollutant. The farm is not used for stock rearing so faecal contamination is minimal. By "undergrounding" the surface drain, sediment runoff is expected to be minimal.

Potential site re-development: The farmer is considering excavating a wetland/pond combination on this site, in part to compensate the environment for the "undergrounding" of upstream surface drains (converting to subsurface tile drains). Options to connect flows from a nearby surface drain about to be "undergrounded" to the proposed wetland/pond were discussed, and generally supported by the farmer. This would increase the quantity of contaminants intercepted by the wetland, improving the potential for water quality benefits. We suggest that the farmer investigate whether a consent is required for the drain modifications, if this has not already been explored.

Preliminary remediation concept: Figure 3-6 shows a possible option to utilise the area identified. The final design will need to consider existing land levels and the earthmoving and plantings required to develop the area.

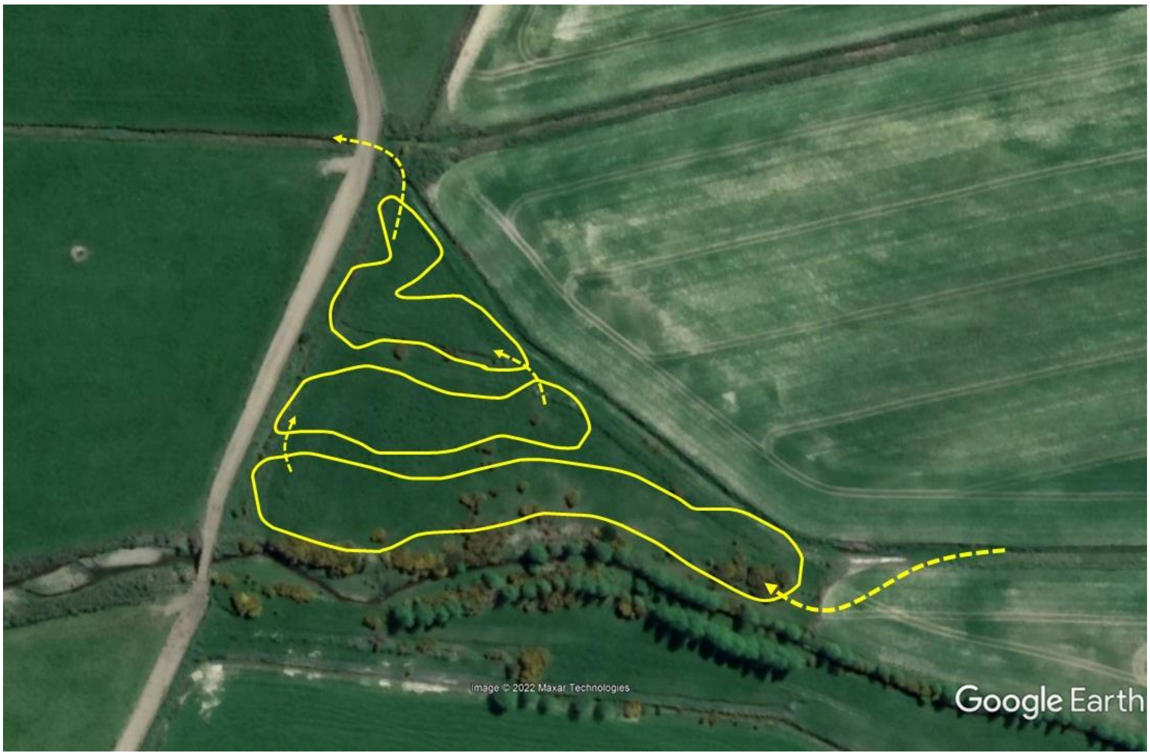


Figure 3-6: Concept drawing of potential constructed wetland intercepting tile drain flows. Actual wetlands may include different shapes, islands, and deep-water zones.

Pros: The land is somewhat flood-prone with low productivity. The owners want to use the land for water quality improvement and to benefit the environment. Routing drain flows through the area should improve water quality, and wetland creation would provide habitat for wildlife.

Cons: Location has low public visibility so lessens its value as a demonstration site.

Alternative concept: As the site is primarily to receive subsurface drainage, incoming nitrogen will primarily be as nitrate. This also lends itself to installation of a woodchip bioreactor system. This would comprise a lined bed filled with a porous organic carbon substrate such as wood-chips. The carbon acts as an energy source for bacterial denitrification, and may be more efficient (on a land/area basis) than a constructed wetland. It would however not provide biodiversity and aesthetic values, that were mentioned by the landowner as being important (i.e., giving back to nature).

Other notes: The area is a boggy spot which the owners are looking to dedicate to nature. The farmer is considering excavating a wetland/pond (~2000 m^2) combination on this site, in part to compensate the environment for "undergrounding" of large surface drains (converting these to subsurface tile drains). Options to connect flows from a nearby surface drain about to be "undergrounded" to the proposed wetland/pond were discussed. This would increase the quantity of contaminants intercepted by the wetland, potentially providing greater water quality benefits. The owners consider it unlikely to be flood prone. The amount of earthworks required for this proposal may trigger the requirement for a consent – we recommend that the regional council should be consulted before undertaking any earthworks.

3.3 Site 3 – Shirley Farm

Owner/Contact: Nathan Shirley

Address: Dipton-Mossburn Road

Figure 3-7: Shirley Farm boundary. Google Earth satellite image showing farm boundary. Arrow indicates site location (45°45'57.76" S 168°12'21.59" E).

Figure 3-8: Shirley Farm showing willow dominated natural wetland.

Figure 3-9: Potential site for wetland restoration and riparian planting. The area enclosed by the yellow polygon could be formed into a constructed wetland to treat the inflowing drain. The green polygon is around another input to the natural wetland that could be riparian planted. These areas are also shown in the same colours in Figure 3-10.

Priority Pollutants: N & P (suspended solids and faecal bacteria)

The farm is used as a dairy platform, thus fertilizer use (and consequently nutrient losses) is likely to be higher than for some other farming situations. Streams and surface drains are well fenced, minimising the potential for direct faecal contamination and streambank erosion. However intensive grazing and fodder cropping have the potential to mobilise suspended sediments and faecal bacteria, thus these have been included as potential secondary pollutants.

Site current status: Area where several surface drains converge in a willow-dominated natural wetland/stream complex.

Potential site re-development: The existing wetland area (defined by dashed in the preliminary remediation concept below) and the pond receiving drainage from the upper terrace (to left of photo above) will already be providing water quality and habitat benefits. Excavation within the existing wetland area is likely to be difficult due to the very soft soils, and it may not be permitted if the area meets the definition of a "natural wetland" under the proposed NPS-FM (New Zealand Government 2020) (e.g., proposed revisions to Section 3.21, "ground cover comprising more than 50% exotic pasture species". See Appendix B). Additional enhancement would accrue if the wetland were restored by controlling willow growths and replanting with native wetland species. The quality of water entering the wetland could be improved by constructing wetlands to intercept each of the two major drain inputs from the lower terrace area (Figure 3-9) before they enter the natural wetland area.

Preliminary remediation concept: The existing willow wetland area is outlined with a dashed yellow line (Figure 3-10). Associated wetland areas that could also be enhanced or developed are shown

with solid yellow lines.
The pond is outlined in blue, and an area which could be enhanced by riparian planting is outlined in green. We propose that riparian planting and wetland creation occur only along feeder drains to this area (e.g., green bounded area in Figure 2-10) because modification of the existing wetland area will be difficult.

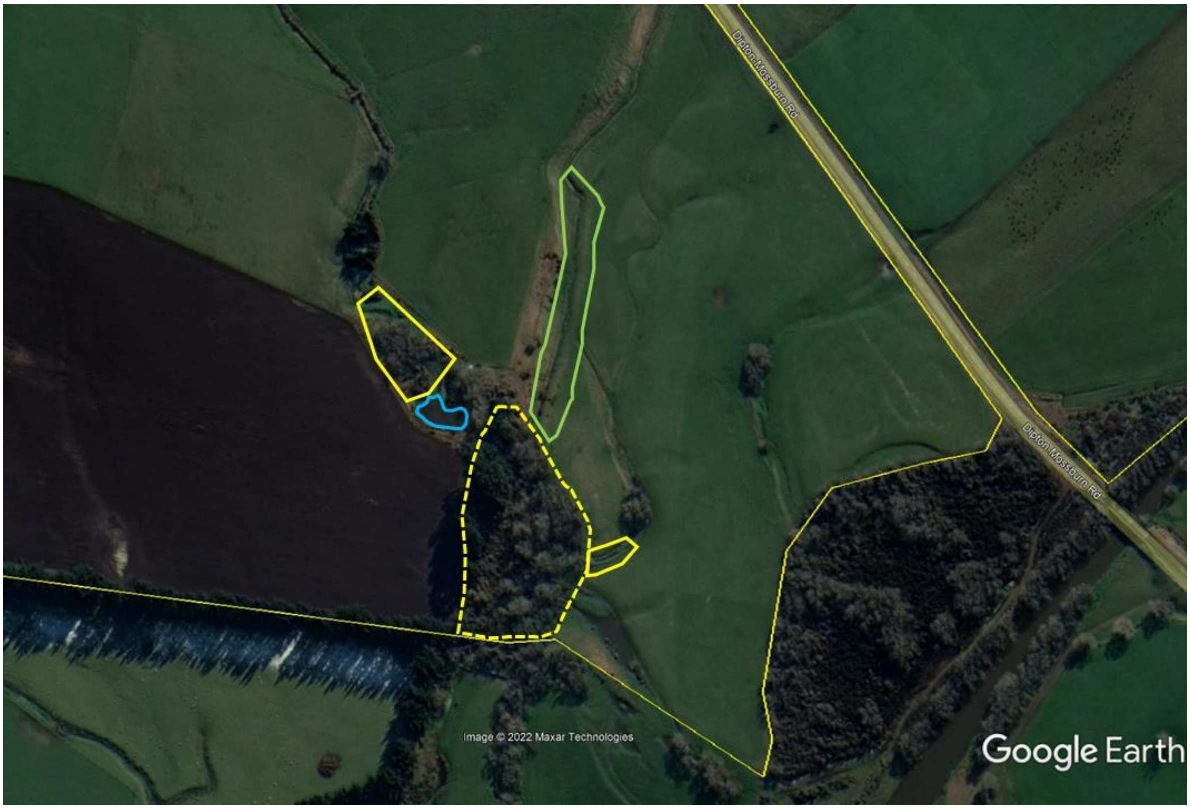


Figure 3-10: Overview of potential options for willow-dominated wetland area and surroundings areas. Potential wetland areas intercepting drain inflows are also shown in Figure 3-9.

Pros: Wetland creation could be undertaken in manageable steps. Significant improvement to the existing wetland may be possible by using aerial herbicide addition to kill willows (understory can be preserved if spraying is done appropriately followed by planting with natives). Multiple habitat types (stream, pond, wetland) currently occur at this site, providing wildlife habitat and potential for sediment and nutrient removal from drain flows and upwelling groundwater entering the area.

Cons: The existing willow-dominated area of wetland was very soft underfoot when we visited, with deep, low bulk density organic soils. Access of excavators would likely be difficult. The site is out of public view, limiting its value as a demonstration site.

Other notes: The site is complex. Various subsurface drains (Novaflow) route flows from a ~30 ha area into one of the surface drains entering the existing wetland area. An area of ~150 ha of farmland on the upper terrace to the northwest of the wetland site has permeable stoney soils. A drain at the base of the terrace face likely intercepts shallow groundwater flows, directing this drainage into this area. Mechanical removal of willows and/or construction of wetlands would likely be challenging and expensive and require ongoing management of invasive willows. Spraying of the willows may be possible followed by interplanting of natives (kahikatea, cabbage trees).

3.4 Site 4 – Saunders Farm

Owner/Contact: Simon Saunders

Address: Honeywood Road

Figure 3-11: Saunders Farm boundary. Google Earth satellite image showing farm boundary. Arrow indicates site location (45°47'12.98" S 168°21'50.73" E).

Figure 3-12: Natural wetland undergoing restoration.

Site current status: A natural wetland area (~3 ha) associated with an original meandering channel of Stagg Creek is being considered for rehabilitation. A stopbank between the current wetland area and Stagg Creek was probably created with spoil excavated when forming a linear channel for the creek. This wetland area receives flow from two surface drains and intercepts surface and subsurface run-off from upslope areas to the northwest of Stagg Creek, providing a relatively high wetland to catchment area ratio (>10%). The area remains wet for most of the year. There may also be potential for high-level flood-flows from the Creek to be reconnected into this area to increase natural water treatment.

Priority Pollutants: N & P (suspended solids and faecal bacteria).

The wetland is well fenced with large riparian margins. Nutrient inputs from contributing upper slopes are likely to be the prime pollutant to be addressed. Sediment and faecal bacteria inputs appeared to not be high, but should also be considered.

Potential site re-development: The current landowner(s) have impounded the outlet of this previously drained area, allowing reflooding and redevelopment of the wetland character of this site, including a large area of open water close to the outlet. They suggested creating a bund further up the catchment to create a 2 or 3 step wetland (Note: the Google Earth image to the left was from 2017; further drainage seems to have occurred after this, prior to current restoration efforts). The owners' vision for the site was well developed and appeared appropriate to the situation. Information on suitable plants likely to have been present in the original wetland/stream complex (e.g., flaxes, kahikatea, cabbage trees, tussocks, raupo, spike sedges, *Carex* species) would help to guide rehabilitation of this area. Herbicide pretreatment of the site (potentially twice) would assist with removal of extensive areas of broom and gorse and allow better establishment of wetland and riparian plantings.

Preliminary remediation concept: Figure 3-13 shows the approximate area proposed for wetland restoration by the current landowner. Creating some low earth bunds in strategic locations within the wetland may assist to maintain suitable water levels in the wetland to enhance contaminant removal. It will also help create a more diverse range of open water and shallow zones, increasing the range of wetland environments provided and resultant biodiversity in the area. Significant parts of the area would likely be considered natural wetlands under the RMA, and subject to the new wetland protection measures in the NPS-FM. Although the actions proposed are primarily aimed at restoration and rehabilitation of the wetland, the regional council will need to be contacted to determine consenting requirements, in particular for any earthworks involved.

Figure 3-13: Overview of wetland area currently undergoing restoration, parallel to Stag Creek. Flows from slopes to the northeast of the wetland (white-dashed arrows) are assumed to be intercepted in the wetland and then flow southeast through the wetland alongside the stream before discharging into the stream at the point indicated by the solid arrow.

Other notes: The owners are planning to develop a 3-ha wetland next summer on the edge of Stag Creek. The area is right at the bottom end of their farm. This block was purchased 2 years ago. The previous owner drained the pond and tried to redevelop the area by clearing the gorse and broom. The current owners have rebuilt the pond wall. The proposed wetland area sits beside Stag Creek, in what used to be the old meandering creek bed before it was straightened.

3.5 Site 5 – Neilson Farm

Owner/Contact: Matt Neilson

Address: Frisco Road, Castlerock

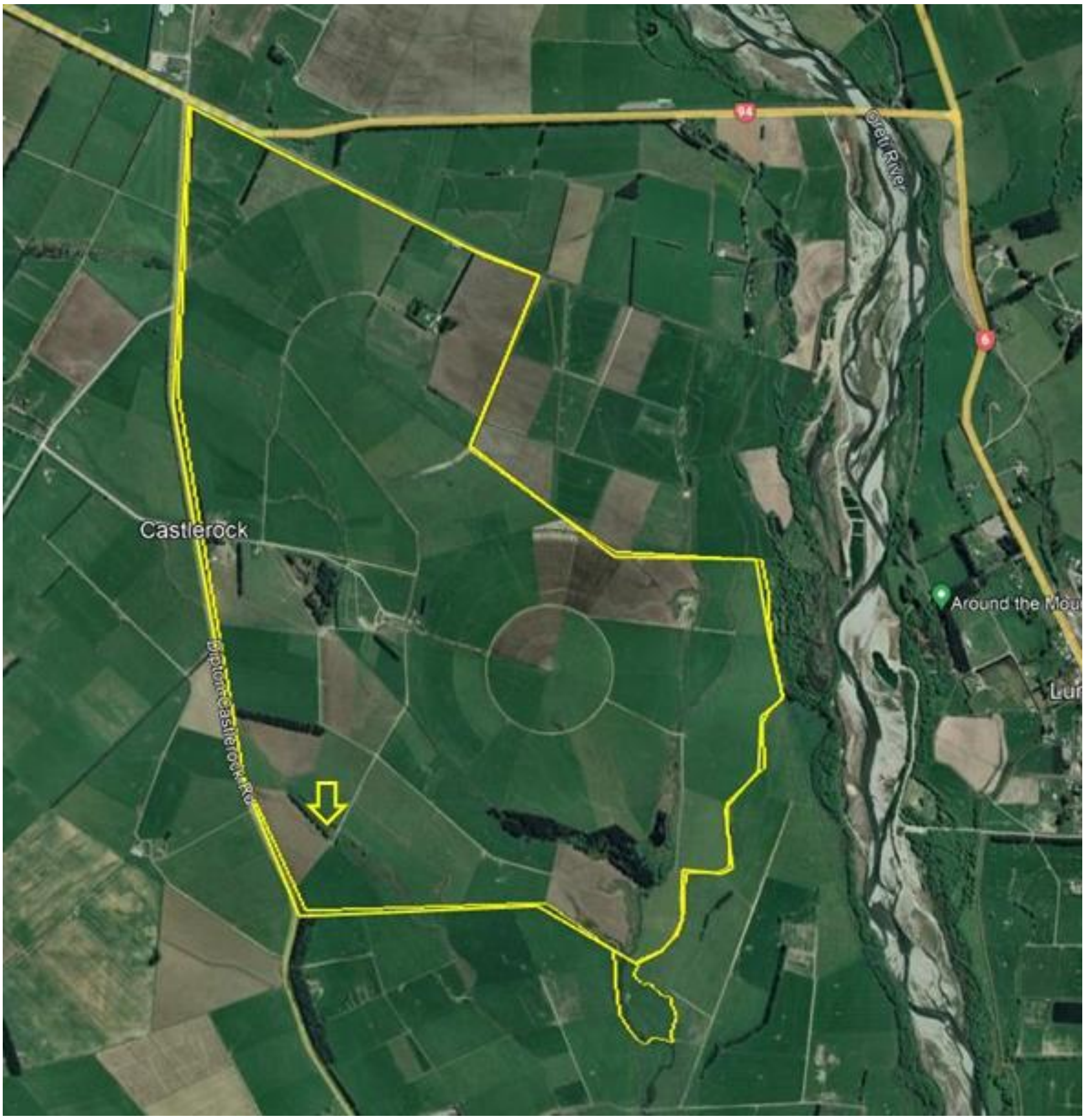


Figure 3-14: Neilson Farm boundary. Google Earth satellite image showing farm boundary. Arrow indicates site location (45°44'33.95" S 168°24'07.22" E).

Figure 3-15: Potential wetland site. The area has boggy soils and retains some wetland characteristics. This may trigger the NPS-FM status as a natural wetland. A large drain runs down the outside of the trees to the right (yellow dashed line). Dipton Castlerock Road location shown with blue dashed line.

Site current status: The site is a soft and boggy wetland swale, with a very shallow water table. Pasture grasses and some remnant rushes, *Carex* species and other wetland species, vegetate the site. Most flow either enters from the area to the left of the trees, or from the far end (close to the Dipton Castlerock Road). The current organic soils and wetland character will likely be providing significant treatment of any water entering the wetland swale.

Priority Pollutants: N & P

As a dairy platform, fertilizer use is expected to be higher than for some other land uses. Direct inputs of sediment and faecal contaminants were thought to be low due to the area being fenced, and with significant areas of pasture and wetland plants acting as a filter for sediments.

Potential site re-development: The low-lying nature of the surrounding farmland makes reflooding these areas difficult without detrimentally affecting drainage of adjacent pasture areas. The entire area could potentially be redeveloped into a wetland/pond complex with considerable amenity value, but this would require partial excavation of existing wetland areas and reconnection of drain-flows into the wetland, which may not be permitted if the area meets the NPS-FM definition of a 'natural wetland'. There was also concern that the soil was too soft/peaty for excavator operation and would require use of large mud mats or platforms. Planting of the area with harakeke (flax) and water-tolerant scrubs and trees would increase the ecological values of these areas and may help to improve water quality through nutrient uptake and provision of organic matter for denitrification.

To assess this option we have limited proposed action to weed control and planting of these wet swales with water-tolerant natives (e.g., harakeke/flax, pūrei/carex, tī kōuka/cabbage trees, kahikatea).

Other notes: A fenced off area of ~4.57 ha extent, split into two sections is available for wetland creation. It has farmland on either side of it and stays wet all year around. The catchment area is roughly 30 ha. Flow is predominantly year-round, but this year is an exception with relatively dry conditions prevailing. It also has wild deer and other animals in it from time to time.

3.6 Site 6 – Patterson Farm

Owner/Contact: Tony Patterson

Address: Timbertop Road, Lumsden

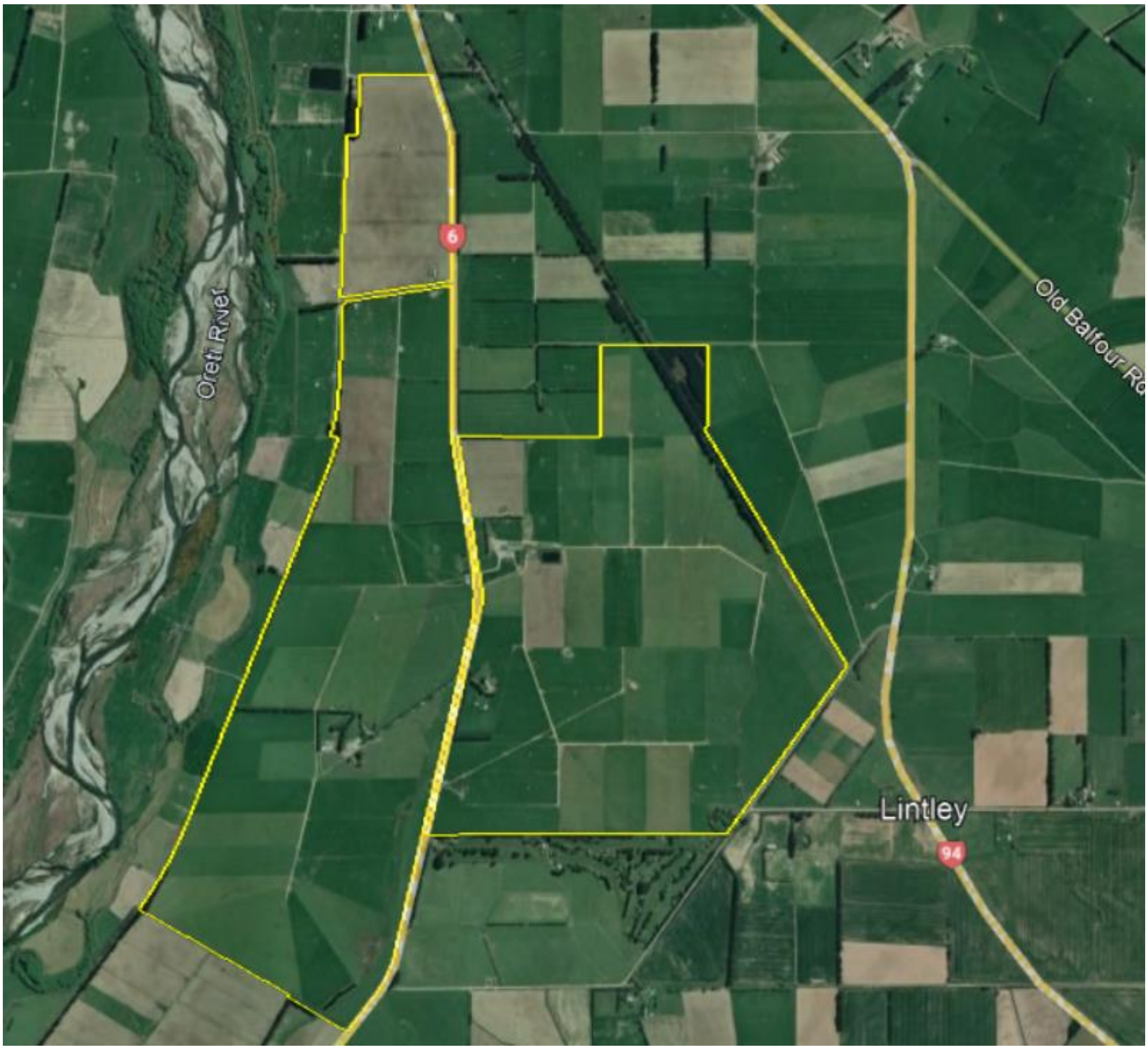


Figure 3-16: Patterson Farm boundary. Google Earth satellite image showing farm boundary.

Figure 3-17: Close up satellite image showing wetland swale and pond. The swale runs from north to south, with the deeper pond at the southernmost end. Site location ~45°46'49.82" S 168°26'34.92" E.

Figure 3-18: View looking north along the swale. Natural, but somewhat degraded, wetland vegetation is present in much of the area visible.

Site current status: The area is a natural wetland swale running through a paddock along the base of a short incline. The swale occupies an area of about 4 ha, is 1.8 km long and varies in width from 5 m to 30 m. At the outflow end, the area has been used as a gravel extraction pit which has now become a deep pond. The area has been fenced off from surrounding paddocks for c.14 years, but previously had been grazed by deer, resulting in loss of some wetland vegetation and ingress of wet-tolerant pasture species. The fence is set 2-3 m back from the water's edge around most of the swale area, giving potential for riparian planting, but it is much closer to the water's edge (c.1 m) around the pond/gravel extraction pit area.

The catchment area feeding the wetland is relatively small and localised. There are no tile or surface drains running into the swale. In some areas there may be surface run off from adjacent paddocks. The rocky/porous nature of the subsoil means that surface flow of water through neighbouring properties occurs only under very high rainfall events. A hard pan sits beneath the soil surface which may have maintained surface flows in the past, but installation of subsurface drains is considered to have broken the pan layer in those locations and lowered the water table. There is one spring that is located approximately 400 m upgradient to the pond. The owners have connected this spring, which flows year-round, to the swale via an open ditch. The paddocks are currently watered with a boom irrigator which also extends over the swale. The swale area continues downslope into neighbours' properties and then into the Oreti River. The swale area has a thick organic layer from wetland plant debris which should assist with nitrate removal through denitrification. The owners are motivated to use the area to benefit the environment and leave it "better for future generations". They would like to add native species such as kōura to the pond area.

Priority Pollutants: N & P (faecal bacteria)

As a dairy platform, fertilizer use is expected to be higher than some other land use scenarios, thus nutrients are identified as a prime pollutant. The wetland was fenced, although in some areas this was close to the edge of the wetland, thus runoff containing faecal bacteria is also worth considering. The land was not considered erosion prone, and the extensive existing area of wetland and riparian protection mean that sediments were not considered a priority pollutant.

Potential site re-development: The site is likely to be reasonably effective for removing contaminants from groundwater seepage and localised surface run-off in its current state. Intercepted water travelling down the length of the swale is likely to be well-treated, but water entering directly into the pond at the downstream end will have minimal opportunity for treatment. Further planting with native wetland species in the centre and riparian species (e.g., pūrei/carex and harakeke/flax) along the margins of the swale would improve the biodiversity and aesthetic values of the swale.

Past gravel extraction has created a pond area with relatively steep sides, which are currently not suitable for establishment of emergent wetland plants.

Preliminary remediation concept: Potential recontouring of the gravel extraction pond areas, if permissible, to incorporate shallow benched margins would allow planting with native emergent wetland species to enhance water quality in the pond and provide improved treatment of lateral inputs. Potential planting zones are shown in Figure 3-19. However, to assess this option we have limited our proposed action to weed control and planting of the wetland swale.

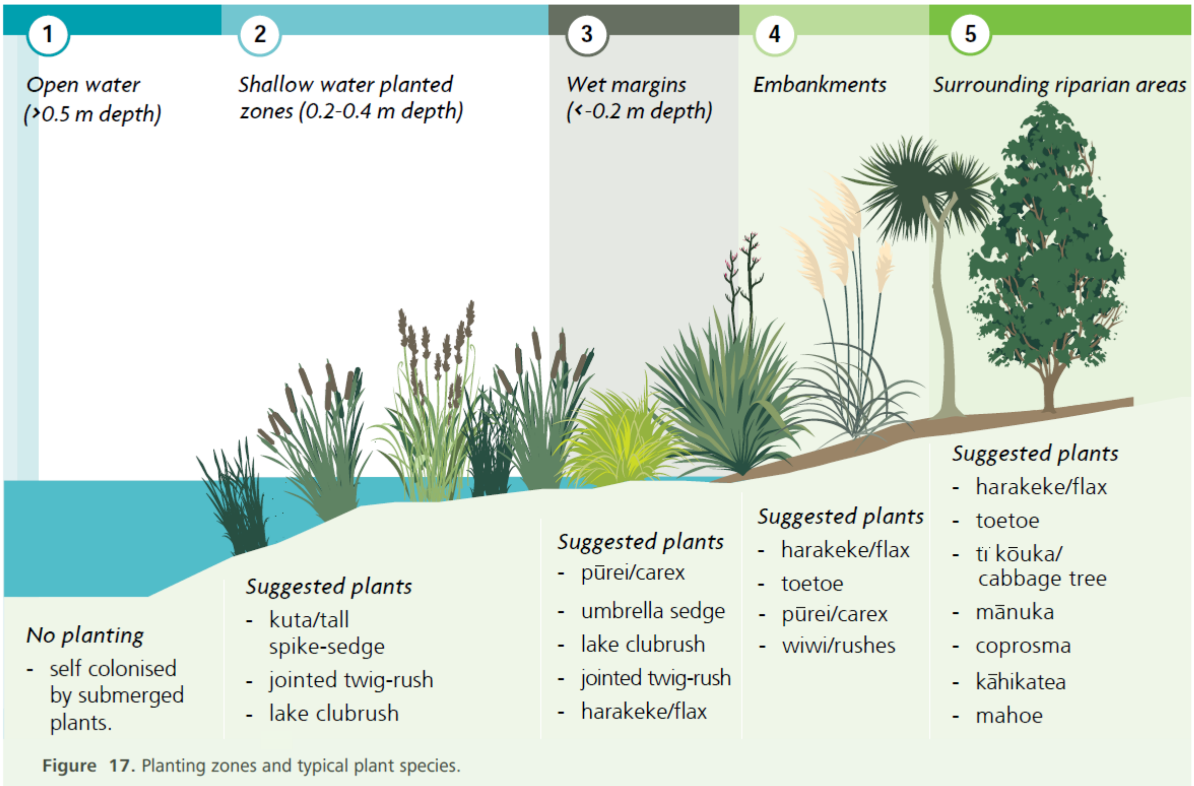


Figure 3-19: Example of marginal plantings possible if the banks of the flooded gravel pit are contoured to provide shallow-water platforms along the edges. Plant species characteristic of the locality should be used. From Tanner et al. (2022)[2].

Pros: The swale is large (1.8 km long and up to 30 m wide), retains considerable wetland characteristics (e.g., plants, organic soils), is already fenced, has a variety of habitats (pond area, permanently wet swales area, dry margins), and is highly visible to the public (adjacent to, and oriented along State Highway 6). Providing additional biodiversity/amenity values can be achieved relatively cheaply, as excavation is not required.

Cons: Existing wetland areas are likely to currently be providing a high degree of water quality benefits, so enhancement of the wetland via additional riparian planting may result in only limited additional water quality benefits. It may be difficult to manage/remove pasture species without harm to the existing wetland plant species.[3]

[2] Tanner, C.C.; Depree, C.V.; Sukias, J.P.S.; Wright-Stow, A. E.; Burger, D.F.; Goeller, B.C. (2022). Constructed Wetland Practitioners Guide: Wetland Design and Performance Estimates. DairyNZ/NIWA, Hamilton, New Zealand. https://niwa.co.nz/freshwater-and-estuaries/management-tools/restoration-tools/constructed-wetland-guidelines

[3] Pasture species can be shaded out by vigorous, tall growing wetland species. However established pasture species often outgrow wetland propagules, which may require handweeding of grasses until more desirable species reach maturity.

3.7 Site 7 – Andrews Farm

Owner/Contact: Jim Andrews

Address: Lumsden Dipton Highway

Figure 3-20: Andrews Farm boundary. Google Earth satellite image showing farm boundary. Arrow indicates site location (45°49'34.09" S 168°23'32.33" E).

Figure 3-21: Location of proposed wetland.

Figure 3-22: Farm view of proposed wetland site. The proposed wetland area is on the left side of the photo.

Site current status: The site is in a corner of a paddock which becomes difficult to manage during wet weather.

Priority Pollutants: N & P, faecal bacteria

As a dairy platform, nutrient and faecal bacteria are potential pollutants. The land was flat and not prone to erosion, so sediment inputs were considered to not be priority pollutants.

Potential site re-development: The landowner proposes to retire the area of the proposed wetland.

As the site is usually above the existing water table, maintaining a wetland character year-round at this site will require excavation of the site down to the water table. Surface or subsurface drains could be used to route overland flow from most of the paddock into the proposed wetland area. The owner proposes to create a complex of deeper areas and shallow areas in the wetland, and using some of the excavated material to create islands for biodiversity and amenity value.

Preliminary remediation concept: The area that could be converted into a wetland with appropriate excavation and planting is shown in Figure 3-23. An alternative concept could include a series of cells rather than a single cell. We have assumed that this site would need significant excavation to connect it to receive flows from existing tile and open-drain flows from the catchment, so as to provide treatment of this drainage water.

Figure 3-23: Possible wetland area in the low corner of the paddock. Arrows show hypothetical flow paths entering the wetland.

Pros: The site is adjacent to the Lumsden/Dipton Highway (State Highway 6), so it has high visibility and potential as a demonstration site. The owner is highly motivated to utilise the area for water quality and biodiversity benefits. As a “green field” (i.e., undeveloped) site, the owner is able to create whatever wetland/pond complex he thinks will be most suitable.

Cons: Considerable excavation is likely to be required.

Costs: The owner thinks excavation costs may be around $5K, with an additional $2-3K for fencing. Suitable plants and planting costs may be subsidised.

Other notes: The catchment area is approximately 10 ha of gently sloping pasture. The area available for a wetland is around 1 ha. The area is reported to have 400 m of tile drain and 150 m of nova flow drain. There is water flowing over the surface after rain events. The area has previously been used for gravel excavation and is underlain with “rotten” rock and a hard pan. The pan is considered to be contributing to the ponding of this area during wet periods.

The paddock has tile drains which empty into open (surface) drains. The owner is considering retiring an area of around 1 ha, which would give a high wetland area to catchment area ratio (10%), which would be anticipated to provide high levels of treatment for nutrients, and trap sediment.

4 Recommendations

All of the sites visited were good prospects for remedial action. We used a qualitative assessment matrix (Table 4-1) encompassing feasibility, risk, water quality and biodiversity benefits, relative costs and visibility as a demonstration project to prioritise sites for more detailed assessment going forward. Based on this assessment, we recommend that sites 2, 4, 6 and 7 be considered by the group as potential demonstration project candidate sites.

These sites (in the order they were visited) were:

- Site 2 – Drummond farm. The proposed area would receive groundwater from "undergrounded surface drains" exiting from cropping areas on the farm. Diverting this water into a waste area, and developing it into a "natural" wetland, achieves the expressed wish of the farmer to "give back to nature".
- Site 4 – Saunders farm. An existing wetland which had undergone extensive drainage was being restored by the landowners.
- Site 6 – Patterson farm. A long natural swale/wetland received drainage water. The site is mostly fenced, and is likely to be reasonably effective in treating the drainage water it is receiving. However the site is highly visible, and further enhancement of the wetland by marginal planting with wetland trees, weed management within the wetland, and replanting with native sedges, rushes and other wetland plants which may have been removed by past cattle grazing would substantially enhance the biodiversity and aesthetic potential of this site. Some reconfiguring of the subsurface profile in the gravel extraction area which is now a pond, would also improve habitat biodiversity.
- Site 7 – Andrews farm. A problematic wet corner of a roadside paddock was suggested by the landowner as a potential site for a constructed wetland. The site has high public visibility and is a "green fields" development (no existing wetland or other infrastructure to constrain design), thus any wetland proposed could be sized and shaped to meet the landowners' vision for the site.

Applying equal weighting to all criteria, the four candidate sites proposed had similar overall scores. They include two green field (new development) sites where wetland and pond construction were recommended (Sites 2 and 7). Excavation requirements and associated construction costs are likely to be higher for these sites, especially if construction activities require a resource consent. Use of sites 4 and 6 would require restoration of pre-existing wetland areas which retain varying amounts of wetland vegetation. Construction costs are likely to be much lower for these two sites, although weed management will likely need to be undertaken for some time to ensure re-planting is successful.

We recognise that BDCG may apply additional criteria and may weight criteria differently when choosing sites for mitigation works. Once BDCG has determined the sites they want to focus attention on, we will develop specific concept plans for their implementation.

Table 4-1: NIWA site assessment matrix, scores and prioritised ranking.

Site	Farmer(s)	Main action proposed	Clear path of action	Feasibility	Risk	Water quality benefits	Biodiversity benefits	Relative cost	Visibility as demonstration site	Overall score	Rank
			(1-5) higher score is better	(1-5) higher score is better	(1-5) higher score is better-i.e. risk is less	(1-5) higher score is better	(1-5) higher score is better	(1-5) higher score is better i.e. relative cost is less	(1-5) higher score is better		
1	Peter & Mary Sims	Pond/wetland creation and riparian planting	3	2	2	3.5	4	2	2	18.5	7
2	Greg Drummond	Constructed wetland linked to tile drains	5	5	5	4	3.5	2	2	26.5	3=
3	Nathan Shirley	Riparian planting and wetlands on incoming drains	3	4	4	3	2.5	3	2	21.5	5
4	Simon Saunders	Wetland planting and minor earthworks	5	5	4	3	4	4	2	27	2
5	Matt Neilson	Wetland planting	4	3.5	2.5	1	4	4	2	21	6
6	Tony Patterson	Wetland planting	5	5	5	2.5	3.5	4	5	30	1
7	Jim Andrews	Constructed wetland	5	4	3	3.5	4	2	5	26.5	3=

5 Acknowledgements

The authors thank Poppy Hardie (Catchment Group Co-ordinator, Thriving Southland) and Jim Andrew (Catchment Group Co-chair) for arranging an excellent programme of field visits encompassing a diverse range of farming situations “Between the Domes”. Keith Finlayson, Senior Land Sustainability Officer at Environment Southland, provided farm maps and invaluable local knowledge on land and water in the region. Landowners were generous with their time and provided helpful information on their farms and prospective mitigation plans.

6 References

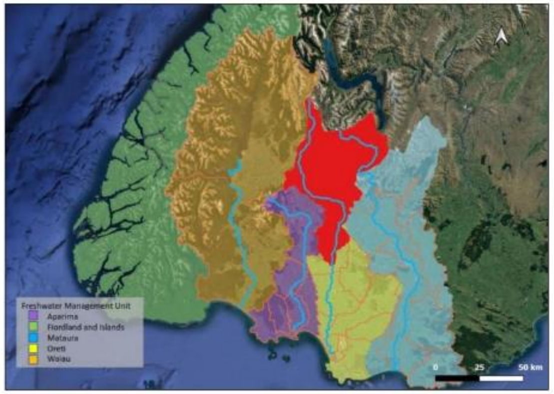
Landpro (2020) Southland Freshwater Quality, Implictions for rural communities: 179. https://issuu.com/thrivingsouthland/docs/thriving_southland_-_science_report

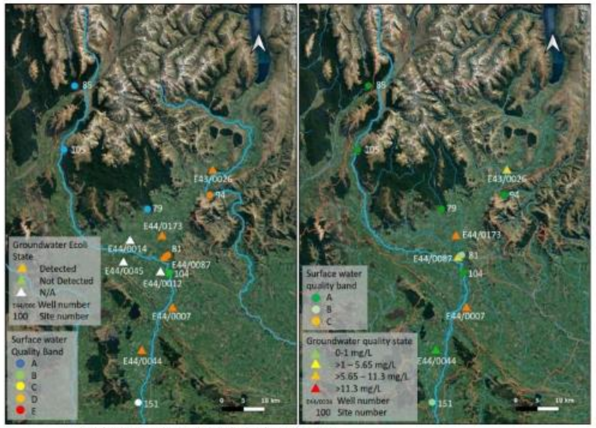
New Zealand Government (2020) National Policy Statement for Freshwater Management 2020. In: Ministry for the Environment (Ed), Wellington: 70. https://environment.govt.nz/acts-and-regulations/national-policy-statements/national-policy-statement-freshwater-management/

Thriving Southland (2022) Thriving Southland Webpage. https://www.thrivingsouthland.co.nz/

Appendix A Extract from Southland Science Report.

Between the Domes Catchment Group





Left: *E. coli* surface and groundwater monitoring sites current state
Right: TON (surface water) and NO3-N (groundwater) monitoring sites current state
Site key: Groundwater △ as labelled
Surface water ○ refer to Appendix B for site names

Surface Water Quality State and Trends

Summary of *E. Coli* state and trends in surface water

E. Coli	State*	Trend		
Monitoring sites in catchment	**NOF band**	**5-year**	**10-year**	**15-year**
Cromel Stream at Selbie Rd	A	Likely improving	Not assessed	Not assessed
Irthing Stream at Ellis Rd	D	Likely improving	Indeterminate	Very likely improving
Oreti River at Lumsden Bridge	B	Very likely improving	Likely improving	Indeterminate
Oreti River at Three Kings	A	Likely improving	Likely improving	Not assessed
Dipton Stream at South Hillend-Dipton Rd	N/A	Very likely improving	Not assessed	Not assessed
Mataura River at Parawa	D	Very likely improving	Likely degrading	Likely degrading

* 2014-2018 LAWA median graded as per NPS-FM 2020

Summary of Total Oxidised Nitrogen (TON) state and trends in surface water

Total Oxidised Nitrogen (TON)^	State*	Trend		
Monitoring sites in catchment	**NOF band**	**5-year**	**10-year**	**15-year**
Cromel Stream at Selbie Rd	A	Likely degrading	Very likely degrading	Not assessed
Irthing Stream at Ellis Rd	B	Very likely degrading	Very likely degrading	Not assessed
Oreti River at Lumsden Bridge	A	Very likely degrading	Not assessed	Not assessed
Oreti River at Three Kings	A	Likely improving	Very likely improving	Not assessed
Dipton Stream at South Hillend-Dipton Rd	B	Very likely degrading	Not assessed	Not assessed
Mataura River at Parawa	A	Very likely degrading	Not assessed	Not assessed

^ Total Oxidized Nitrogen (TON) is the sum of nitrate and nitrite. Nitrite is generally a very small fraction of the TON concentration in rivers, TON is taken to be equivalent to the nitrate concentration
* 2014-2018 LAWA median graded per NPS-FM 2020 using TON as surrogate for NO_3-N

Groundwater Quality State and Trends

Summary of *E. Coli* state and trends in groundwater

E. Coli	Statistics NZ comparison to DWSNZ* and/or LAWA data	
Monitoring sites in catchment	**State (2014-18)**	**Exceedance category^**
E44/0173	Detected	0-10%
E44/0044	Detected	0-10%
E44/0007	Detected	0-10%
E43/0026	Detected	10-25%
E44/0087	Detected	10-25%

* https://www.stats.govt.nz/indicators/groundwater-quality
^ Grades categorised as per Stats NZ (2014-2018)

Summary of Nitrate-Nitrogen state and trends in groundwater

	Statistics NZ comparison to DWSNZ* and/or LAWA data	
Monitoring sites in catchment	**State (2014-18), NO_3-N mg/L**	**Exceedance category^**
E44/0173	7.20	0%
E44/0044	0.02	0%
E44/0007	7.30	0%
E43/0026	4.20	0%
E44/0087	1.35	0%

* https://www.stats.govt.nz/indicators/groundwater-quality
^ Grades categorised as per Stats NZ (2014-2018)

Figure 6-1: Catchment issues for Between the Domes Catchment Group. (Landpro 2020).

Appendix B Excerpts from National Policy Statement-Freshwater Management

Key principles from the NPS are included below. A short set of definitions of abbreviations used in the NPS is included below. Sections numbers are those from the NPS-FM for reference purposes.

3.7 NOF process

(3) The NOF also requires that regional councils: (a) monitor water bodies and freshwater ecosystems (clauses 3.18 and 3.19); and (b) take action if degradation is detected (clause 3.20).

3.8 Identifying FMUs and special sites and features

(1) Every regional council must identify FMUs for its region. (2) Every water body in the region must be located within at least one FMU. (3) Every regional council must also identify the following (if present) within each FMU: (a) sites to be used for monitoring (b) primary contact sites (c) the location of habitats of threatened species (d) outstanding water bodies (e) natural inland wetlands.

3.21 Definitions relating to wetlands and river

natural wetland means a wetland (as defined in the Act) that is not: (a) a wetland constructed by artificial means (unless it was constructed to offset impacts on, or restore, an existing or former natural wetland); or (b) a geothermal wetland; or (c) any area of improved pasture that, at the commencement date, is dominated by (that is more than 50% of) exotic pasture species and is subject to temporary rain-derived water pooling

natural inland wetland means a natural wetland that is not in the coastal marine area

restoration, in relation to a natural inland wetland, means active intervention and management, appropriate to the type and location of the wetland, aimed at restoring its ecosystem health, indigenous biodiversity, or hydrological functioning.

aquatic offset means a measurable conservation outcome resulting from actions that are intended to: 24 National Policy Statement for Freshwater Management 2020 (a) redress any more than minor residual adverse effects on a wetland or river after all appropriate avoidance, minimisation, and remediation, measures have been sequentially applied; and (b) achieve no net loss, and preferably a net gain, in the extent and values of the wetland or river, where: (i) no net loss means that the measurable positive effects of actions match any loss of extent or values over space and time, taking into account the type and location of the wetland or river; and (ii) net gain means that the measurable positive effects of actions exceed the point of no net loss

3.22 Natural inland wetlands

(1) Every regional council must include the following policy (or words to the same effect) in its regional plan(s): “The loss of extent of natural inland wetlands is avoided, their values are protected, and their restoration is promoted, except where: (a) the loss of extent or values arises from any of the following: (i) the customary harvest of food or resources undertaken in accordance with tikanga Māori (ii) restoration activities (iii) scientific research (iv) the sustainable harvest of sphagnum moss (v) the construction or maintenance of wetland utility structures (as defined in the Resource

Management (National Environmental Standards for Freshwater) Regulations 2020) (vi) the maintenance or operation of specified infrastructure, or other infrastructure (as defined in the Resource Management (National Environmental Standards for Freshwater) Regulations 2020 (vii) natural hazard works (as defined in the Resource Management (National Environmental Standards for Freshwater) Regulations 2020); or (b) the regional council is satisfied that: (i) the activity is necessary for the construction or upgrade of specified infrastructure; and (ii) the specified infrastructure will provide significant national or regional benefits; and (iii) there is a functional need for the specified infrastructure in that location; and (iv) the effects of the activity are managed through applying the effects management hierarchy."

(2) Subclause (3) applies to an application for a consent for an activity: (a) that falls within any exception referred to in paragraph (a)(ii) to (vii) or (b) of the policy in subclause (1); and (b) would result (directly or indirectly) in the loss of extent or values of a natural inland wetland. (3) Every regional council must make or change its regional plan(s) to ensure that an application referred to in subclause (2) is not granted unless: National Policy Statement for Freshwater Management 2020 25 (a) the council is satisfied that the applicant has demonstrated how each step of the effects management hierarchy will be applied to any loss of extent or values of the wetland (including cumulative effects and loss of potential value), particularly (without limitation) in relation to the values of: ecosystem health, indigenous biodiversity, hydrological functioning, Māori freshwater values, and amenity value; and (b) any consent is granted subject to: (i) conditions that apply the effects management hierarchy; and (ii) a condition requiring monitoring of the wetland at a scale commensurate with the risk of the loss of extent or values of the wetland. (4) Every regional council must make or change its regional plan(s) to include objectives, policies, and methods that provide for and promote the restoration of natural inland wetlands in its region, with a particular focus on restoring the values of ecosystem health, indigenous biodiversity, hydrological functioning, Māori freshwater values, and amenity value.

NOF	National Objectives Framework
NPS-FM	National Policy Statement – Freshwater Management