Lake Baroon Catchment Care Group

Working with our community...for our waterways

Projects 2023/24

Falls Creek

(Riparian fencing, revegetation, stream crossing & off stream water)

PROJECT PLAN

Riparian Condition Improvement & Agricultural Practice Improvement Programs

CBP2324-013

seqwater WATER FOR LIFE

Sunshine Coast COUNCIL

This Project Plan has been prepared by, and all enquiries to be directed to:

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Disclaimer

While every effort has been made to ensure the accuracy of this Project Plan, Lake Baroon Catchment Care Group makes no representations about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all liability for all expenses, losses, damages and costs which may be incurred as a result of the Plan being inaccurate or incomplete.

How to read this Plan

This Plan has been developed to provide a brief description of the project and includes summarised details of the stakeholders, budgets, outputs and outcomes. Appendices provide further useful information relating to budget, the Lake Baroon catchment and land use, and outlines various implementation activities of the project.

Confidentiality

Much of the information contained herein is confidential and must not be reproduced or passed on to any person outside Seqwater without prior written permission from Lake Baroon Catchment Care Group.

DOCUMENT VERSIONS & APPROVALS

Version	*Date*	*Version/Description*	*Result*
1.0	27 November 2023	Draft LBCCG Project proposal completed. Project emailed to LBCCG Committee for comments.	n/a
1.0	14 December 2023	Project proposal presented at LBCCG Management Committee meeting for approval.	Approved
1.0	15 December 2023	Project Proposal forwarded to Seqwater for approval (email)	Approved

AUTHORISATIONS

Name	*Signature*	*Date*
Prepared by: Mark Amos - Manager, LBCCG		
Approved by: LBCCG Management Committee (signed by Peter Stevens – President)		
Approved by (Seqwater): Julian O'Mara (Senior Planner – Source Protection		

Cover: Skene Creek (Falls Creek tributary) running through the property.

Contents

Introduction

Maintaining water quality is critical to providing safe bulk drinking water for the population of South east Queensland. All of the raw water storages managed by Seqwater are located in catchments which are developed to varying extents and support active and growing communities, including important industrial and rural economic activity. To provide a multi-barrier approach to the supply of drinking water, Seqwater must influence the management of land not owned by, but which exert an influence on Seqwater's core business.

The property lies in the mid to lower reaches of Falls Creek, a sub-catchment in the larger Lake Baroon catchment. Pre-dam, the creek was a relatively major tributary of Obi Obi Creek. Once dominated by dairying, the sub-catchment has transitioned largely into rural residential and lifestyle properties although the remaining larger properties continue to support relatively intensive beef, and to a lesser extent horse grazing. Seqwater owns a significant proportion of the sub-catchment in the lower reaches due to the purchase of the Eden Road and partial purchase of the Ferriday properties.

Landslips in the steeper, lower reaches of the sub-catchment are high risk to water quality and LBCCG has been active in the last decade addressing hillslope instability.

The property was ***not*** identified as a priority property in the 2021-26 Implementation Plan for the Lake Baroon catchment[1], due to its size (under 10 hectares) and assessment of livestock numbers (less than 10 head). This assessment was based on the previous owners who only ran several horses. The Humphreys purchased the property in 2019 and run 10 horses as well as regularly using neighbouring cattle to manage the western paddocks for pasture and weeds.

Background

The project lies in the Falls Creek tributary, Skene Creek. Previously most projects in the Falls/Skene Creek sub-catchment have focused on the Falls Creek waterway, taking advantage of significant momentum and landholder demand. With most of the main waterways fenced in Falls Creek, the attention has now turned to the Skene Creek sub-catchment with the project and the planned 2024/25 neighbouring project – *see Map1 on page 5.*

Strong engagement, high quality infrastructure and win/win outcomes continue to provide a blueprint for not only very successful projects, but the continued evolution of landholder acceptance and demand.

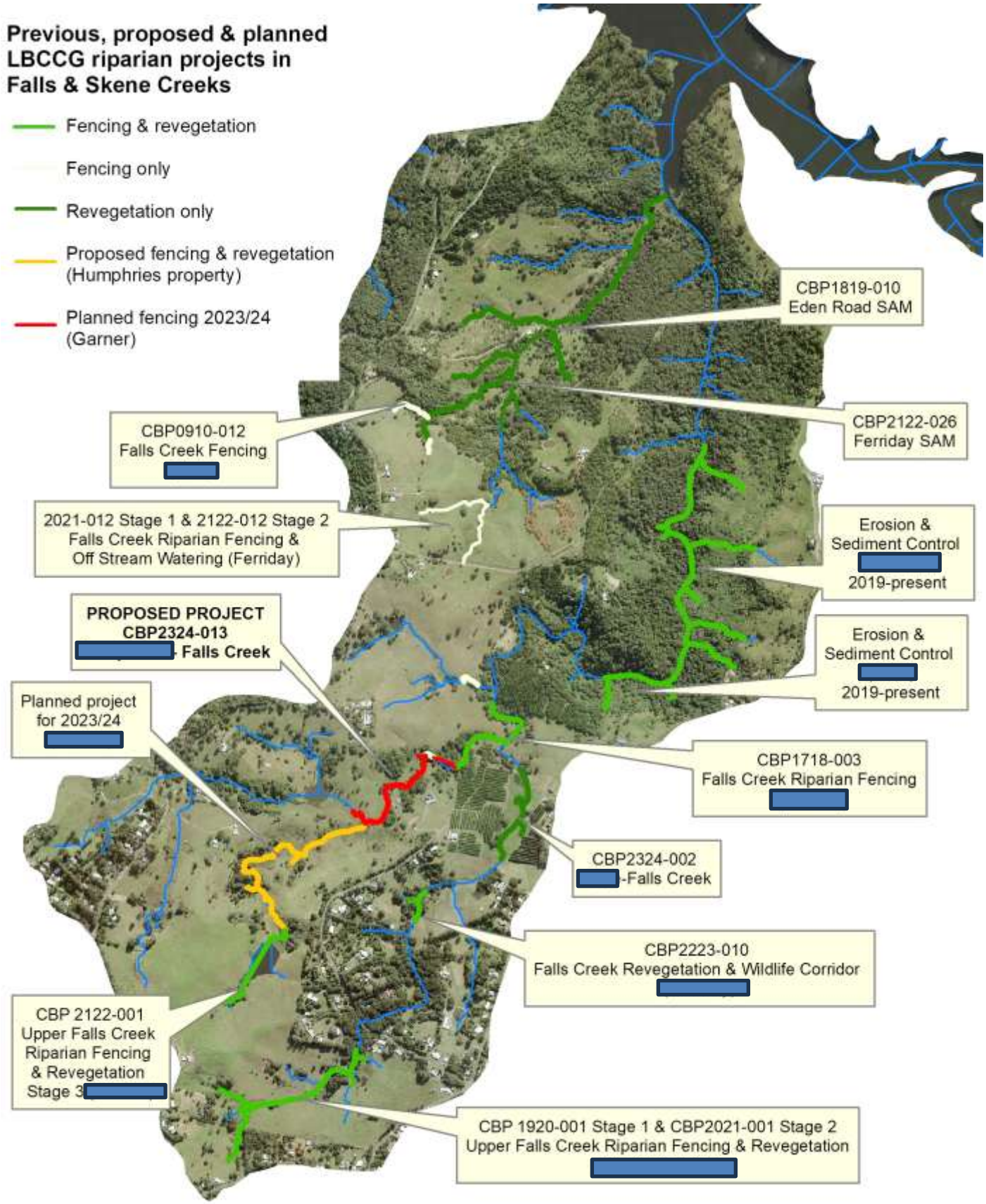
The property supports horses with occasional cattle grazing via the neighbouring property. Although the property is relatively small (under 10 hectares), it has a disproportionately long frontage to streams (700 metres). This combined with completed and planned projects occurring upstream and downstream significantly raised the priority for LBCCG to support riparian fencing and revegetation initiatives.

The project was identified as a Preferred Project in the LBCCG 2023/23 Annual Work Plan[2].

[1] Lake Baroon Catchment Care Group, (2020), 2021-26 Implementation Plan for the Lake Baroon catchment, Maleny, Queensland

[2] Lake Baroon Catchment Care Group, (2023), 2023-24 Annual Work Plan – Source Protection, Maleny, Queensland

Map 1 Previous, proposed and planned projects in Falls and Skene Creeks



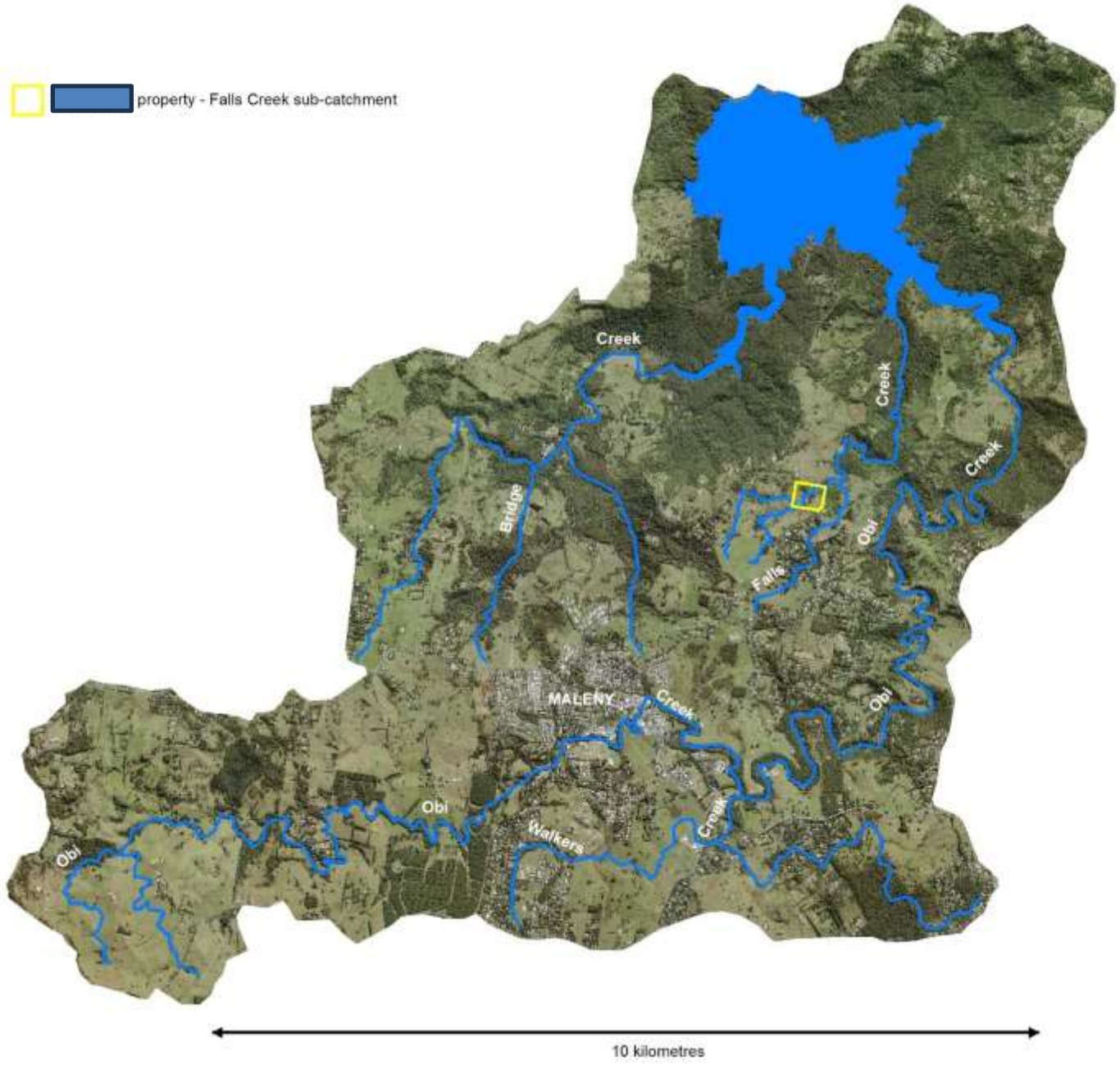
LBCCG has been very active in the Falls/Skene Creeks sub-catchments over the last several years addressing landslips and livestock access to natural waterways. This focus has led to high landholder demand and acceptance of LBCCG/Seqwater programs leading to a positive feedback loop.

Figure 1 Skene Creek in background; livestock have unrestricted access to riparian zones with a moderate coverage of native vegetation and woody weeds (devil's fig, lantana, wild tobacco and privet).

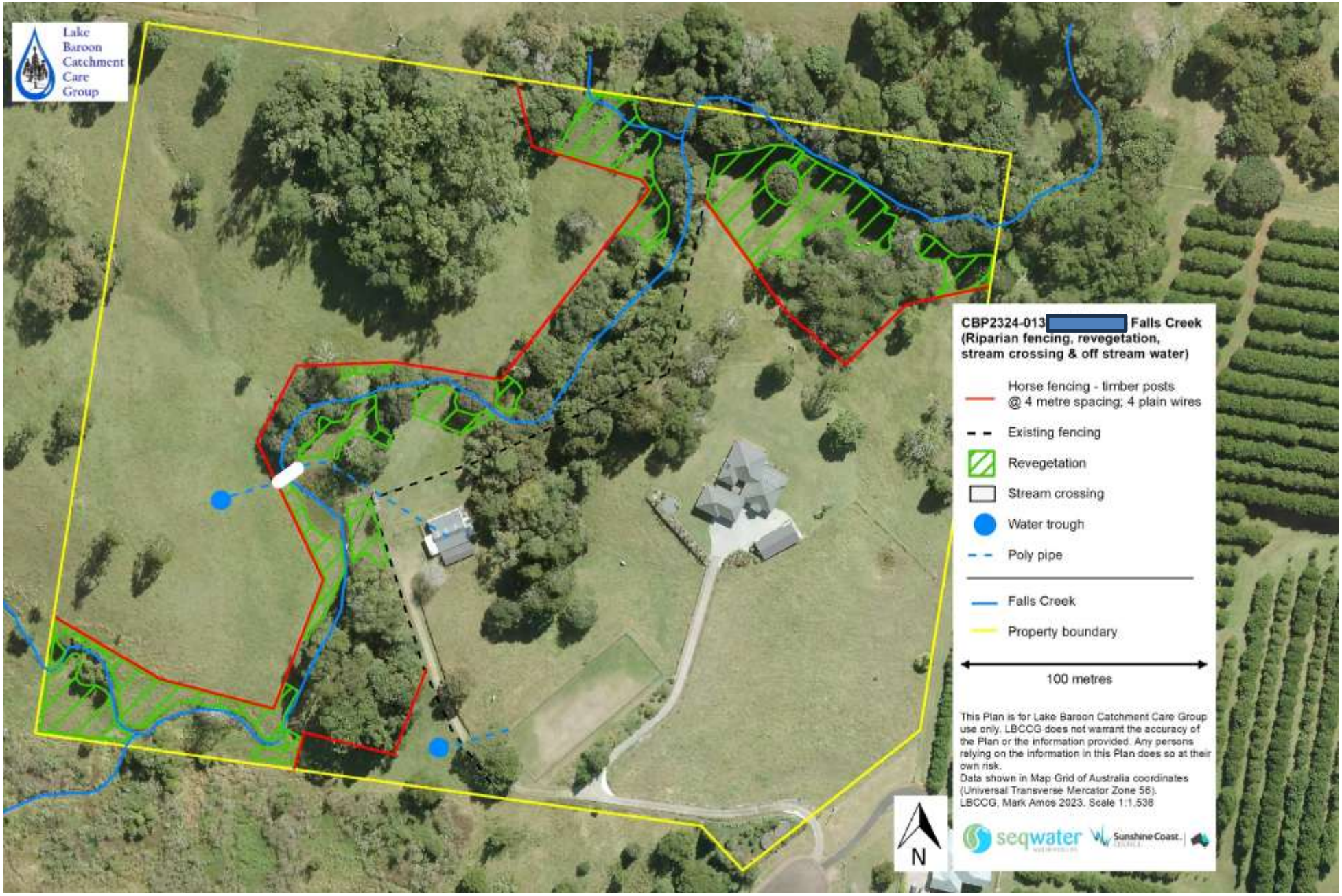
Figure 2 Stream crossing location (photographed when unusually dry). The stream has previously been unsuccessfully modified in an attempt to create a dry path across the waterway. Natural flow path will be reinstated and low-level crossing installed to minimise erosion (particularly post-fence installation) and provide reliable crossing.

Figure 3 A representative section of Skene Creek on the Humphreys property; gentle slopes, areas of remnant or regrowth vegetation, livestock access to the waterway, a moderate coverage of woody weeds and pasture to the stream edge.

Project location



Project map


Lake Baroon Catchment Care Group
CBP2324-013 [redacted] Falls Creek
(Riparian fencing, revegetation, stream crossing & off stream water)
Horse fencing - timber posts @ 4 metre spacing; 4 plain wires
Existing fencing
Revegetation
Stream crossing
Water trough
Poly pipe
Falls Creek
Property boundary
100 metres
This Plan is for Lake Baroon Catchment Care Group use only. LBCCG does not warrant the accuracy of the Plan or the information provided. Any persons relying on the information in this Plan does so at their own risk.
Data shown in Map Grid of Australia coordinates (Universal Transverse Mercator Zone 56).
LBCCG, Mark Amos 2023. Scale 1:1,536
N
seqwater
Sunshine Coast

Project plan

Project title	**Humphreys – Falls Creek (Riparian fencing, revegetation, stream crossing & off stream water)**	
Location	[redacted] Murer Drive, North Maleny, QLD, 4552	
Project Start Date	December 2023	
Project End Date	June 2024	
Landholder details	**Property owner / Manager**	[redacted]
	Contact details	
	Real Property description	Lot 6 RP889837
	Property size	8.1 hectares
	Land use	Horses/occasional beef grazing
	Livestock numbers	10/25
	Latitude/longitude	152.872 -26.738
	Water quality hazards present	1) Unmanaged livestock access to permanent waterway 2) Moderate condition riparian vegetation 3) Minor stream bank instability 4) Moderate weed coverage

Water Quality Risk (**re-assessed** according to *2021-26 Implementation Plan for the Lake Baroon catchment criteria)*		
Distance from Baroon Dam off take	High priority	Property is 3 km from off take
Prioritisation of land use	Medium to High	Grazing (moderate intensity)
Riparian condition	Moderate to High priority	No riparian fencing, most of stream has only one bank vegetated, moderate weeds, minor erosion
Landholder readiness & willingness	High Confidence	High confidence – landholder sought out engagement with LBCCG, significant cash contribution to project
Complimentary funding availability	Low Priority	Landholder has applied for 2023 Landholder Environment Grants (SCC) funding
Land management weightings	Moderate Priority	Priority land use, inadequate riparian buffers, low risk project
OVERALL PROJECT PRIORITY	**MODERATE TO HIGH PRIORITY**	

Cash & in-kind contributions		
Project funding	Seqwater 2023-24 Riparian Condition Improvement (Water Quality) - $14,897	$ 36,582
	Seqwater 2023-24 Agricultural Practice Improvement - $21,685	
Project management	Seqwater 2023-24 Project management (RCI & API)	$ 15,728
Landholder contribution	Cash & in-kind	$ 24,795
Other contributors	Sunshine Coast Council Landholder Environment Grant	$ 7,942
	LBCCG Management Committee in-kind	$ 1,516
TOTAL		**$ 86,563**

Project Plan & Scope of Works			
Description of environmental hazards on site and how they are to be addressed	Livestock have unmanaged access to Skene Creek	Fence waterway to exclude livestock.	
	Fragmented vegetative buffer between Skene Creek and grazing	Revegetation with a diverse range of species along Skene Creek, linking existing regrowth and remnant vegetation. Link with previous projects downstream and planned project upstream (2024/25).	
	Moderate vegetation diversity in riparian zone – dominated by annual, perennial weeds, grasses and woody weeds		
	Minimal to moderate stream shading contributing to deoxygenation and other impacts		
	Lack of diverse native vegetation to provide complex root systems and mechanical bank stability benefits		
	Moderate to poor wildlife habitat / corridor		
Activities to be delivered as part of project & Schedule of works	1. Weed management	2 hectares	February 2024
	2. Fencing	760 metres	March 2024
	3. Revegetation	1,700 stems	March 2024
	4. Off stream water	1 system/2 troughs	May 2024
	5. Stream crossing	1 crossing	May 2024
Future maintenance requirements	Maintenance of revegetation will be required between 3 – 5 years. Likely $4.00 per stem in first year and reducing to $0 by year 5. Other on-going costs will be borne by the landholder.		

Project Outcomes		
Improve water quality *Improve water quality of:* *a. source water in Falls Creek; and* *b. raw water intake at Lake Baroon*	Improved riparian buffers in the Falls Creek Catchment	Revegetation of riparian zone improves ability of buffer to trap and/or process sediment, nutrients chemicals and pathogens.
	Reduced erosion of the bed and banks of Falls Creek reducing turbidity and sedimentation	
	Reduce pathogen delivery to waterways	
	Improved aquatic habitats	A reduction in turbidity, sediments, nutrients and pathogens will improve water quality and contribute to maintaining in-stream biodiversity.
	Improved land management	Protection of riparian zones, improved livestock management, improve livestock health.
	Increased awareness of water quality issues and causes	Utilise the Humphreys property as a demonstration site that displays the practical tools that landholders can incorporate on their land to help improve water quality.
Increase catchment biodiversity	Development of wildlife habitat corridors and sanctuary areas	Use revegetation plantings to provide wildlife corridors and habitat for native animals in the Falls Creek sub-catchment. Plantings to link remnant and growth areas.

Monitoring

Seqwater's new Monitoring, Evaluation and Reporting (MER) program will be used to monitor this project. Under this new, standardised program, a project asset register will be developed for each project using Field Maps. A Condition Assessment Survey will be developed using Survey 123 and a Performance Assessment Survey will be completed for each site. All projects will be reviewed using the MER program

Drone footage will be captured for the project site. A detailed map and photo monitoring points will be created for the site. The maps and photo monitoring points will be produced annually and will provide valuable evidence of works completion, a record of changes over time, and provide an important assessment tool to evaluate the project.

Whilst undertaking annual inspections after project completion, outputs such as riparian fencing, revegetation, stream crossings and off-stream watering will be monitored and assessed for condition and fit for purpose. Project updates will be provided at monthly LBCCG meetings. The Project will also be reported on in the LBCCG Annual Reports (LBCCG members and placed on LBCCG website).

Figures 4 & 5 Drone deploy software is utilised to monitor the project site providing repeatable imagery over time and establishing photo monitoring points. The example used is the 2023/24 project on the neighbouring Grice macadamia farm.

Future investment options

The proposed plan is a 'whole property' project addressing the priority water quality risks in a single works program. Other than ongoing revegetation maintenance and monitoring there are no plans to develop any new projects or works.

References

Barwick, M, Wassman, D & Pitman, K. 2009, *Maleny Community Precinct Environmental Management Scoping Document*, Australian Wetlands Pty Ltd, Caloundra, Qld

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Appendices

Appendix 1: Budget

LBCCG has a policy of keeping Project Budgets confidential as individual project costings vary and can give misleading information. Detailed Budgets can be supplied on request. Please contact the LBCCG Project Manager on info@lbccg.org.au for further information.

Appendix 2: Background information

Lake Baroon Catchment Care Group

Lake Baroon Catchment Care Group (LBCCG) is a not for profit community group focussed on reducing the risks to water quality in the Lake Baroon catchment - primarily through the implementation of on-ground remediation projects. This aim is consistent with Seqwater's objectives of producing high quality, competitively priced potable water for the Sunshine Coast (and greater South east Queensland) region.

LBCCG reduces risk to water quality by working with private landholders in the catchment; supporting landholders to improve land management provides multiple beneficial outcomes - water quality improvements and broader environmental benefits while enhancing property management and productivity. Catchment activities not only benefit the raw water flowing into one of south east Queensland's most important water storages (hence Seqwater's significant support) but by providing a range of other environmental outcomes generates support from other funding providers.

Reducing risk to water quality is critical to providing safe bulk drinking water for the population of south east Queensland. All of the storages managed by Seqwater involve catchments that are developed to varying extents and support active and growing communities, along with important industrial and rural economic activity.[3]

The activities of LBCCG are supported by Seqwater as they align with Seqwater's commitment to the NHMRC Framework and to environmental stewardship by supporting catchment planning and targeted remediation for reduction of catchment-based risks to water quality.[4]

Catchment land use and associated impacts

An estimated 80% of sediment and 35% of nitrogen in the waterways in south east Queensland comes from non-urban diffuse loads; sources such as unmanaged livestock grazing. Reduction of these loads clearly represents a major target for action if significant improvements in water quality are to be achieved in South East Queensland.[5]

Despite the extensive clearing, 22% of the Lake Baroon catchment is still moderately forested; a significant proportion in the immediate area around the dam, although much of this is degraded by environmental weeds. Today, the catchment is susceptible to impacts associated with an increasing diversity of land use.[6]

The area closest to the dam is popular with "tree changers" and has seen land use change from intensive grazing to increasingly smaller rural residential properties. This has resulted in the fragmentation of larger tracts of agricultural land into smaller parcels with a large increase in the number of on-site wastewater treatment systems in the catchment.[7]

[3] Murton, S. & Keys, S. 2012, Seqwater Natural Asset Management Plan – Lake Baroon, Sinclair Knight Merz, Brisbane
[4] Smolders, A. 2011, Project Briefing Note: Water Quality Project – Cork's Dairy Restoration, Seqwater
[5] Department of Environment and Resource Management, Development of a water quality metric for south east Queensland, 2010
[6] Keys, S., Murton, S., Costanzo, S. & Thompson, A. 2009, Catchment and In-Storage Risk Assessment for Water Quality – Baroon Pocket Dam, Sinclair Knight Merz, South Brisbane.
[7] ibid

Presently the catchment is susceptible to a number of land use impacts; [8] including:

- poorly managed dairying and cattle grazing;
- new developments and increased stormwater runoff;
- runoff from impervious surfaces of existing developed areas;
- irrigation of treated effluent associated with the Maleny Sewage Treatment plant;
- uncontrolled stock access to the lake and its tributaries;
- lack of riparian vegetation and integrity – a result of extensive vegetation clearing;
- abundance of weeds – shift in land ownership from land managers (e.g. farmers) to inexperienced residents has potentially led to the spread and proliferation of weeds (including emerging weeds); *and*
- varying pollution sources related to increased population.

Maintaining a healthy riparian system is essential for a productive landscape. When a riparian area is healthy it contains lush, thick vegetation, providing habitat for wildlife and aquatic species, maintains stream bank stability, influences morphology and provides shade which in turn lowers water temperatures and increases the oxygen carrying capacity of the stream. Additionally, riparian vegetation filters, utilizes and stores nutrients, thus preventing them from entering major watercourses. Weed invasion is an indicator that the riparian system is in decline and has the potential to alter the vegetation structure to such an extent that habitat and water quality outcomes are threatened.

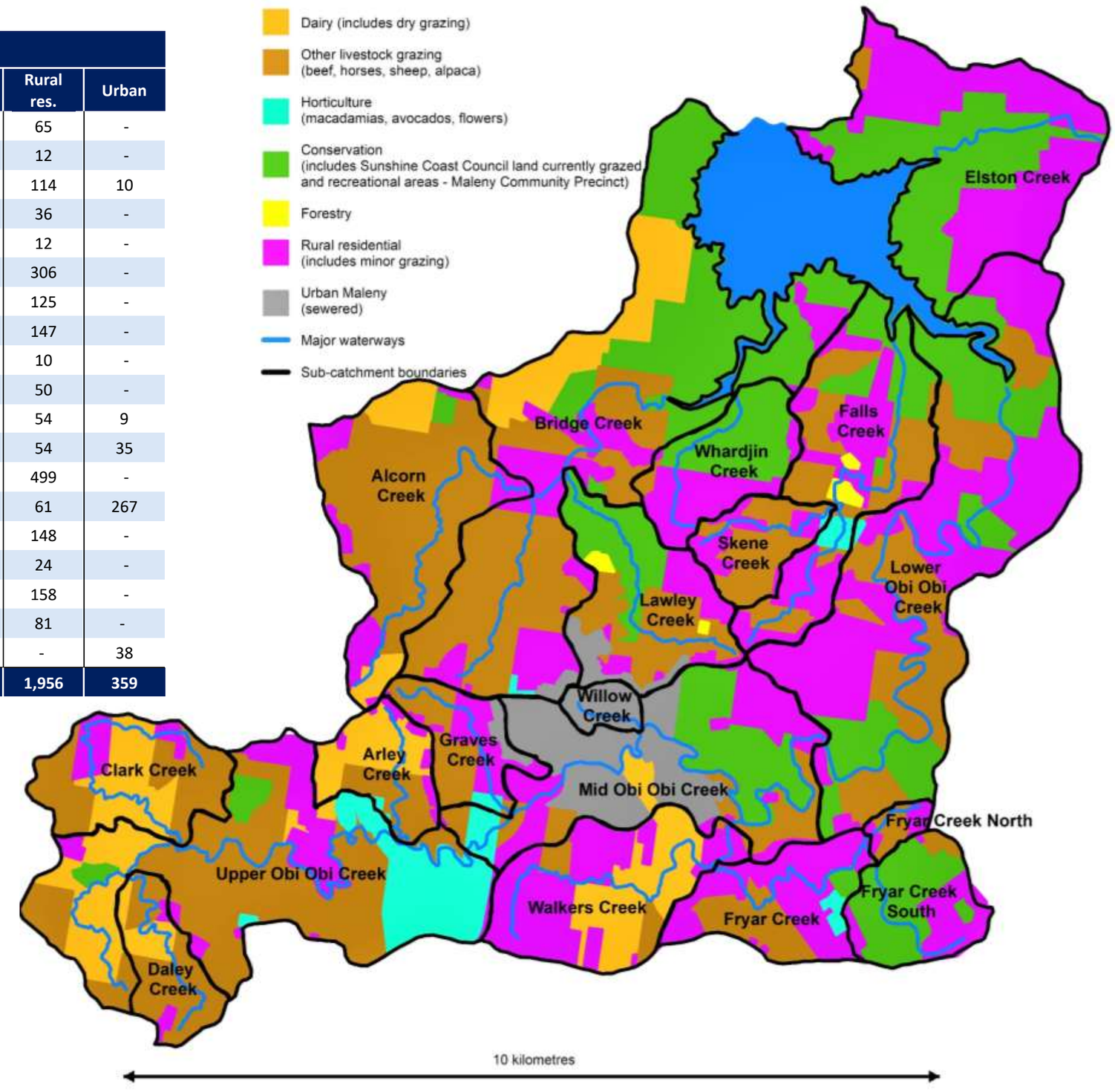
[8] Traill, C.B. 2007, State of the Lake Baroon Catchment, Volume 2: Appendices, AquaGen Water and Renewable Energy, Palmwoods

Table 1 - Lake Baroon sub-catchments and land use

Sub-catchment	Total hectares	Land use (hectares)						
		Dairy	Grazing	Horti-culture	Conser-vation	Forestry	Rural res.	Urban
Alcorn Creek	539	44	416	-	14	-	65	-
Arley Creek	135	72	49	2	-	-	12	-
Bridge Creek	1,250	166	476	-	484	-	114	10
Clark Creek	227	83	108	-	-	-	36	-
Daley Creek	127	28	87	-	-	-	12	-
Elston Creek	673	-	12	-	355	-	306	-
Falls Creek	391	-	154	12	89	11	125	-
Fryars Creek	200	-	47	6	-	-	147	-
Fryars Creek North	27	-	13	-	4	-	10	-
Fryars Creek South	164	-	8	2	104	-	50	-
Graves Creek	132	-	64	5	-	-	54	9
Lawley Creek	345	-	119	-	130	7	54	35
Lower Obi Obi Creek	935	-	296	-	140	-	499	-
Mid Obi Obi Creek	546	17	83	17	101	-	61	267
Upper Obi Obi Creek	740	95	344	124	29	-	148	-
Skene Creek	117	-	92	1	-	-	24	-
Walkers Creek	306	119	29	-	-	-	158	-
Whardjin Creek	228	-	14	-	133	-	81	-
Willow Creek	38	-	-	-	-	-	-	38
TOTAL	**7,120[1]**	**624**	**2,411**	**169**	**1,583**	**18**	**1,956**	**359**

[1] Does not include the Lake Baroon surface.

Note – sub-catchments are based on named creeks in the catchment only and do not reflect land use, area or any other particular characteristic.



Falls & Skene Creek sub-catchments

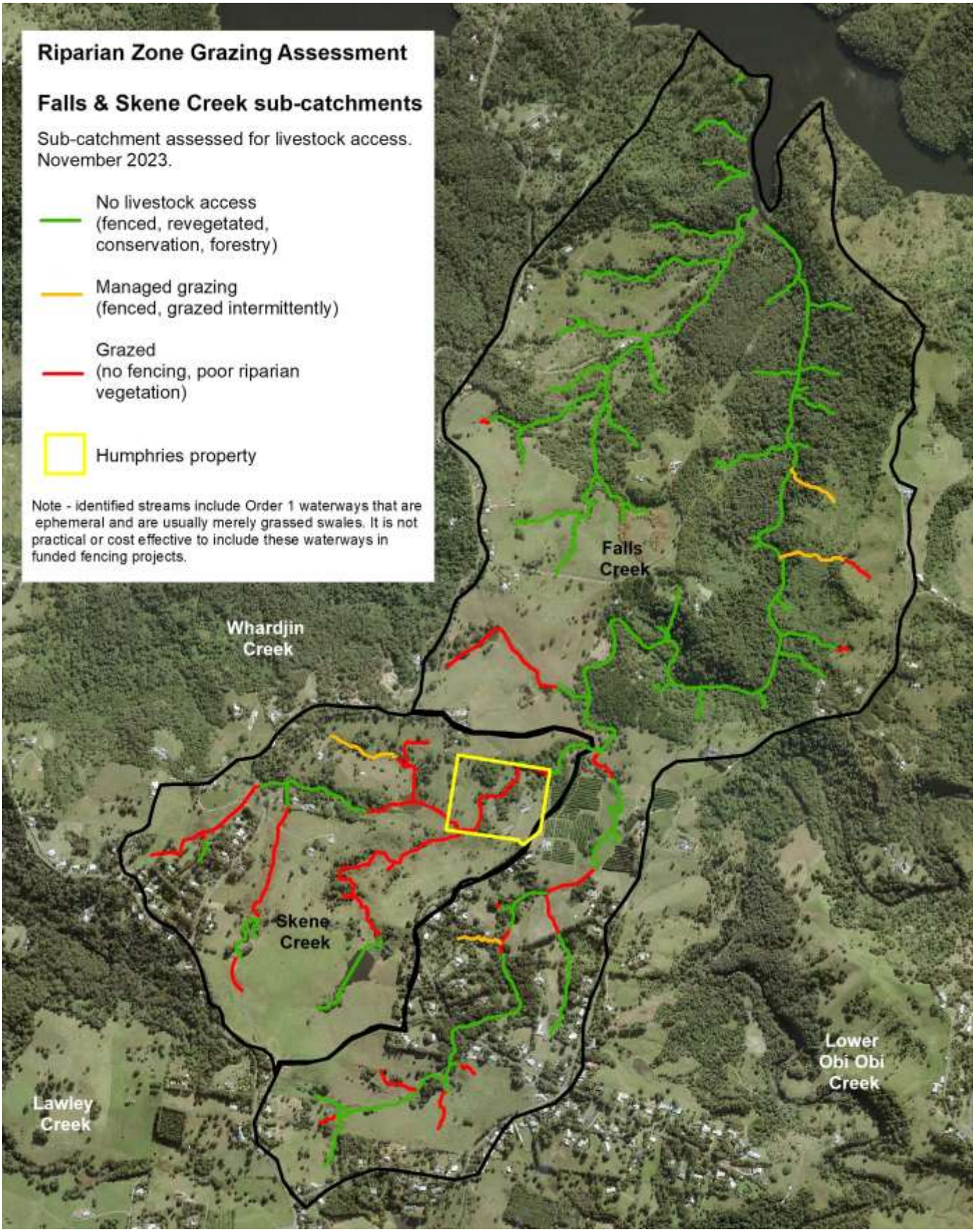
Falls and Skene Creeks are relatively small sub-catchments covering 508 hectares, representing approximately 7% of the Baroon Pocket Dam Catchment area. The sub-catchments are characterised by relatively un-intensive beef grazing (48%), considerable areas of rural residential (29%) and minimal vegetation, particularly along the watercourses.

Beef grazing has replaced dairying as the dominant land use (the last property ceased dairying around 2013). The gentle upper slopes are stable despite having little vegetation cover. The lower reaches however are steep with large areas uncleared or permitted to return to regrowth vegetation. The slopes closest to the Dam are generally very unstable with many large landslips which impact the water storage.

The Lake Baroon Implementation Plan (2020/21) considers this part of the catchment as a high priority property based on its distance to Baroon Pocket Dam off take tower, land use, riparian health, readiness to implement projects and the likelihood of gaining additional funding. Historically the upper Falls Creek catchment supported dairy grazing which, along with the rural residential, likely yielded poor water quality results - high levels of nutrients (and likely pathogens).

*Table 2 Riparian zone grazing assessment (as of March 2022; * indicates updated in November 2023)*

Sub-catchment	Total stream length	No livestock grazing	Managed livestock grazing	Unmanaged livestock grazing
Graves Creek	5,021 m	1,286 m (26%)	849 m (17%)	2,886 m (57%)
Arley Creek	5,857 m	482 m (8%)	1,583 m (27%)	3,792 m (65%)
Fryar Creek	8,746 m	5,523 m (63%)	0 m (0%)	3,223 m (37%)
Falls Creek*	***17,806 m***	***15,203 m (85%)***	***680 m (4%)***	***1,923 m (11%)***
Skene Creek*	***5,490 m***	***1,689 m (31%)***	***288 m (5%)***	***3,513 m (64%)***



Map 5 Much of Falls Creek has little to no riparian grazing, a significant proportion as a result of Seqwater funded projects led by LBCCG. The proposed project shifts focus onto the Falls Creek tributary, Skene Creek with the fencing and revegetation of riparian zones.

*Table 2 Riparian zone grazing assessment (as of March 2022; * indicates updated in November 2023)*

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Skene Creek*	***5,490 m***	***1,689 m (31%)***	***288 m (5%)***	***3,513 m (64%)***
Whardjin Creek	8,372 m	7,959 m (95%)	0 m (0%)	413 m (5%)
Alcorn Creek	20,641 m	8,296 m (40%)	3,520 m (17%)	8,825 m (43%)
Clark Creek	11,730 m	3,429 m (29%)	172 m (2%)	8,129 m (69%)
Daley Creek	5,338 m	0 (0%)	2,296 m (43%)	3,042 m (57%)
Walkers Creek	12,124 m	5,666 m (47%)	2,063 m (17%)	4,395 m (36%)
Elston Creek	24,447 m	24,257 m (99%)	0 m (0%)	190 m (1%)
North & South Fryar Creek	8,930 m	4,898 m (55%)	0 m (0%)	4,032 m (45%)
Willow Creek	913 m	913 m (100%)	0 m (0%)	0 m (0%)
Lawley Creek	12,287 m	10,672 m (87%)	152 m (1%)	1,463 m (12%)
Upper Obi Obi Creek	34,959 m	9,696 m (28%)	6,005 m (17%)	19,258 m (55%)
Lower Obi Obi Creek	45,888 m	33,496 m (73%)	1,466 m (3%)	10,926 m (24%)
Mid Obi Obi Creek	23,368 m	20,572 m (88%)	832 m (4%)	1,964 m (8%)
Bridge Creek	48,535 m	31,015 m (64%)	423 m (1%)	17,097 m (35%)
Totals	**300,452 m**	**185,052 m (62%)**	**20,329 m (7%)**	**95,071 m (32%)**

Livestock excluded from riparian zone

Riparian zone fenced but intermittent livestock grazing

No riparian fencing, livestock have unmanaged access

Note - it is unlikely 100% exclusion is possible as identified streams include Order 1 waterways that are ephemeral and are usually merely grassed swales. It is not practical or cost effective to include these waterways in funded fencing projects.

Appendix 3: Project works

Riparian fencing

Livestock grazing is a land use that has the potential to alter the condition of a stream and riparian area if not managed properly. Improper livestock use of riparian areas can negatively affect riparian areas by changing, reducing or eliminating the vegetation within them.

In the sub-tropics, the majority of overland flow events occur during the summer to early autumn period. Conversely during the winter and spring months, most faecal contamination in water channels occurs from an animal defecating directly into the water. Any practice that reduces the amount of time cattle spend in a stream will therefore reduce the manure loading and decrease the potential for adverse effects on water from grazing livestock.

The direct effects of improperly managed livestock grazing on riparian vegetation include:

- change, reduce, or eliminate vegetation;
- decrease the vigour, biomass and alter species composition and diversity;
- change the channel morphology by widening and shallowing of the streambed;
- alter the stream channel through trenching or braiding depending on soil and substrate composition;
- alter the water column by increasing water temperatures, nutrients, suspended sediments and bacterial counts;
- alter the timing and volume of water flow;
- cause bank sloughing leading to accelerated sedimentation and erosion; *and*
- decrease wildlife habitat and species.

However, when tightly controlled, fencing can be an invaluable, and sometimes essential tool to manage grazing in riparian zones whether permanent exclusion or managed grazed is performed.

This project will enhance vegetation buffers along Alcorn Creek. The effectiveness of a riparian buffer to provide multiple environmental and water quality benefits varies depending on several key factors, namely bank slope, vegetation species composition and age, and soil type. Slope gradient appears to be the most important variable in removal of sediment or particulate pollutants, whereas buffer width is most important for the effective removal of dissolved nutrients. [9]

Riparian revegetation

Riparian vegetation provides a buffer between water and agricultural activities. Buffers trap sediment, nutrients and faecal material before it reaches a flowing watercourse. Additionally, any contaminants that do reach the flowing water are more likely to be processed by in-stream vegetation if present. A combination of both native woody vegetation (trees) and grasses are ideal for buffers to utilise a wider range of nutrients so 'messy' riparian zones are likely more efficient despite possibly being viewed as 'ugly'.

Riparian zones due to their nature of being the most productive with good soils and moisture tend to grow thick stands of weeds (along with grass) and require either heavy management or require revegetation with native vegetation to

[9] Barwick, M, Wassman, D & Pitman, K. 2009, *Maleny Community Precinct Environmental Management Scoping Document*, Australian Wetlands Pty Ltd, Caloundra, Qld

out compete and shade most weed species. Revegetation therefore is a long-term management solution for fenced riparian zones.

Riparian buffers comprising grassed buffer strips are effective at trapping sediments and nutrients adsorbed to sediments (such as phosphorus), but tend to be relatively poor at trapping dissolved nutrients, or for the provision of shade, food sources, in-stream structure or corridors for many species. Riparian buffers comprising taller, woody vegetation are typically good at providing shade, as a source of food and woody habitats, as a screen for light and noise, as corridors for terrestrial fauna (to a varying extent depending on species composition), and as a means for reducing soluble nutrient inputs.

Designed riparian buffers usually incorporate multi-tiered systems of both native woody vegetation to enhance ecological function, and vegetated filter strips for the management of water quality. In essence, this approach seeks to mimic the complexity and effectiveness of a natural riparian buffer system, and often the best approach is to provide the required buffer width to enable a self-sustaining buffer of native vegetation.[10]

Weed management

Weed management is carried out for multiple reasons:

- clear weeds to replace with native vegetation;
- manage weeds to protect desirable vegetation;
- treat weeds that threaten remnant vegetation or riparian vegetation (vine weeds in particular); *and*
- manage agricultural weeds to prevent spread onto farmland.

Note however that weed management should only be implemented for targeted reasons and must require a long-term plan and funding source.

Major environmental weeds pose a serious and immediate threat to native vegetation and water quality due to their ability to alter the structure and composition of plant communities. Small leaf privet can thrive in low-light conditions and over time will dominate riparian zones, out-competing native species and effectively developing mono-culture systems. Similarly, lantana and blackberry form dense thickets. Natural regeneration is reduced below sustainable levels and only mature individual native flora species persist.

Vine weeds, although requiring high light levels (and therefore not usually a major threat to robust remnant vegetation) spread easily and can rapidly envelope all other vegetation, and in time can kill those plants simply through the elimination of light and smothering. Over time weedy vines and other pest species will degrade the edges of remnant vegetation and slowly but surely decrease the total area of remnant.

Many weed species due to their ability to out compete native species and form monocultures affect overland water flow and run off, and may not filter sediments and nutrients as effectively as diverse native vegetation

Weed management almost always requires a combination of control methods for long term success:

- mechanical clearing by machine mounted mulchers or slashers, brush cutting or mowing (always requires herbicide follow up);
- herbicide spraying;

[10] ibid

- biological control; *and*
- hand management (hand weeding, cut & swab, targeted spraying, stem injection, stem scrape & poison, ring barking etc).

Off stream water

Even without fencing of riparian zones, off-stream water sources reduce the amount of time free ranging livestock spend in or immediately adjacent to watercourses. Livestock prefer to drink from a trough over other sources of water available to them, resulting in a significant reduction in time spent in the stream (watering) and adjacent stream side area (grazing and loafing). Studies in North America have shown that following the installation of the off-stream watering infrastructure, stream bank erosion decreased by 77% and concentrations of total suspended solids, total nitrogen and total phosphorous decreased by 90, 54 and 81% respectively (McIver 2004[11]). More recent studies indicate that although the installation of OSW by itself is effective, providing livestock supplements and shade near troughs reduced riparian zone pressures even further (McIver 2004). Porath et al.[12] (2002) also found that the provision of supplements in association with alternative watering points increased weight gain in cows and calves.

Livestock when drinking at streams and dams enter the water to reduce bending; resulting in the stirring up of suspended solids (turbidity), and riparian zones can be difficult places for livestock to access (steep, muddy or rocky banks) placing greater effort and stress on animals. Additionally, when cattle enter a water source they tend to defecate directly into the water body (pers. comm. Colin Cork). Troughs provide a level, relatively dry watering point where the animal does not have to bend excessively, reducing stress by providing improved footing, increased visibility and reduced physical effort. This is likely to lead to healthier animals with less risk of injury.

Livestock use riparian areas for resources other than water - crossing points, forage, shade, grooming sites (scratching posts) and general loafing. A well-designed OSW system needs to consider all these factors. Research by Gillen (1984)[13] (in McIver 2004) shows that cattle prefer to graze within 200 metres of water. Therefore, to optimise uniform grazing and water efficiencies, livestock should not have to walk more than 300 metres to water.

Season and time of day also have an effect on the effectiveness of an off-stream water source in reducing degradation to riparian areas. In the warmer months, riparian areas give shade and protection from the heat and the coolness of the water often draws the animals to the water's edge. It is essential to ensure that alternative shade is provided within the paddock – preferably near the OSW trough and ideally on a high point exposed to cooling breezes.

[11] McIver, S., 2004, Using Off-Stream Water Sources as a Beneficial Management Practice in Riparian Areas – A literature review. Agriculture and Agri-Food Canada, Canada.
[12] Porath, M., Momont, P., DelCurto, T., Rimbey, N., Tanaka, J., McInnis,M., 2002. Offstream water and trace mineral salt as management strategies for improved cattle distribution. Oregon State University, LaGrande.
[13] Gillen, R.L. , Krueger, W.C. , and Miller, R.F. . 1984. Cattle distribution on mountain rangeland in northeastern Oregon. J. Range Manage. 37: 549–553.

Stream crossings

Formalised crossings protect livestock and the river from the problems associated with unrestricted access. The benefits include (Water and Rivers Commission 2000):

- improved water quality by limiting sedimentation and nutrient enrichment;
- enhanced livestock health through access to cleaner water;
- reduced loss of productive land and livestock deaths;
- potentially the provision of a relatively cheap option for providing livestock watering;
- maintaining river pools to provide a water source that is available for longer periods of year;
- stabilisation of the river banks and bed; *and*
- improved riparian vegetation and riverine habitats.

Crossings can be designed to provide many other ecological benefits such as (Water and Rivers Commission 2000):

- having a riffling effect which aerates the water and provides a variety of riverine micro-habitats;
- allowing for fish passage;
- maintaining river pools that are important in providing summer refuges and breeding areas for certain aquatic animal species, such as crayfish; *and*
- contributing to channel stability by controlling the velocity of flow and reducing the downstream movement of sediments into the river.

Installation of a stream crossing will improve water quality, reducing nutrient, sediment, pathogen, and organic matter loads to streams. A formal crossing will also reduce streambank and streambed erosion. Stream crossings can provide cattle with improved access to pastures thereby improving grazing distribution while reducing the likelihood that cattle will be injured. Stream crossings also improve vehicle access for weed management, pasture improvement, erosion management and other activities that influence the quality of water flowing off properties. Stable stream crossings can help prevent farm equipment damage by providing a smooth entrance and exit.

A good crossing is one that serves the purpose for a long time and requires minimal maintenance. The design must allow for a range of flow conditions and sustain as little damage as possible when flooding occurs. It is also essential to ensure that the crossing will have negligible environmental impacts.

Other than providing access across a stream for people, vehicles and livestock, a well-designed crossing provides environmental benefits. Restricting crossings to one point will greatly reduce local erosion and protect riparian vegetation from stock; further stabilising stream banks, and can greatly assist in managing nutrient input to the stream system. The overall benefits include reduced sedimentation, improved water quality, creation of shelter belts for stock and habitat for native wildlife.[14]

[14] Janicke, S. & Murray, K. (2008) Crossing Creeks – Stream crossings on farms, Department of Water, Government of Western Australia, Perth

Revegetation maintenance

Maintenance is critical for the long-term success of large revegetation projects (Bridge Creek Rehabilitation). Good maintenance is an extremely important component of re-establishing vegetation particularly within the first 3 years of planting. Weed growth is very rapid on the Maleny plateau – particularly over the summer months where maintenance must be performed every six weeks. Failure to do so can result in plant mortality, weed infestation and frustrating labour – all of which results in excessive costs to 're-capture' the site.

It is desirable, if not essential, to employ specialists who have the equipment, skills and knowledge to successfully manage revegetation sites and ultimately establish a functioning buffer. Landholders are rarely capable of managing all the maintenance required on large revegetation sites (more than 500 plants) and therefore in an effort to ensure success, LBCCG provides the bulk of support for maintenance. Contractors are selected on their experience, value for money, landholder engagement skills and landholder preferences.

Grass is maintained between the rows of revegetation to reduce erosion and to act as a filter – trapping sediments and nutrients during high rainfall events. Glyphosate herbicide is sprayed immediately around the 'Plant-Pink' guards reducing competition whilst weed mats placed under the guards minimises weed growth inside the guard. The grass between the rows is occasionally slashed so that access is maintained and the site does not become over-grown.

Appendix 4: 2023/24 RCI & API projects

Estimated budgets v actual budgets & approvals
