Lake Baroon Catchment Care Group

Working with our community...for our waterways

Projects 2013-14

Ling Landslip Remediation

Burnett Mary Regional Group

Sunshine Coast Council

seqwater WATER FOR LIFE

PROJECT PLAN

Project No. 1314-011

This Project Plan has been prepared by:

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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 in any way.

How to read this Plan

This Plan is split into three distinct sections:

The **Summary** (pp. 5-6) is a brief description of the project and includes broad details of stakeholders, budgets, outputs and outcomes.

The **Project Plan** (pp. 7-16) outlines the main details involved in implementing the project and in most cases should explain the project sufficiently.

The **Attachments** (pp. 17-48) provides additional information to support the Project Plan. The various numbered Contents in the Project Plan directly correspond with the numbered sections in the Attachments.

Terms used in this Plan

Landslide and land slip are used interchangeably throughout the document. Land slip is the more commonly used term in the Lake Baroon catchment while Seqwater documents use the term landslides.

Lake Baroon and Baroon Pocket Dam are used interchangeably, although *Lake Baroon* is usually used when referring to the catchment and *Baroon Pocket Dam* refers to the dam as commercial water storage.

PROJECT VERSIONS & APPROVALS

Date	***Version/Description***	***Result***
January 2014	Draft Project Plan	n/a
February 2014	Project Plan forwarded to BMRG for approval	
13/2/2014	Project presented to LBCCG Committee	Approved (Minutes)
	Project Proposal forwarded to Seqwater for approval (email)	
	Application to Sunshine Coast Council (LEG program)	

Cover photo: *The Ling property in 2008 following the reactivation of a large landslip.*

TABLE OF CONTENTS

PART A: EXECUTIVE SUMMARY

PART B: PROJECT PLAN

PART C: ATTACHMENTS

PART A EXECUTIVE SUMMARY

PROJECT NUMBER & TITLE: **1314-011 Ling Landslip Remediation**

Ling Landslip Remediation is a collaborative project between Lake Baroon Catchment Care Group, Burnett Mary Regional Group, Sunshine Coast Council, Seqwater and the landowner, Craig Ling. The project is designed to improve the stability of landslip prone areas, reducing sediment delivery to Baroon Pocket Dam, reduce livestock impacts on watercourses, establish a wildlife corridor and enhance knowledge of catchment processes and landslips. The reduction in risks to water quality are expected to be significant and an integral part of the broader aim of protecting the Lake Baroon resource, addressing the issues and risks associated with the production of a safe water supply to the Sunshine Coast and beyond.

LANDMANAGER DETAILS

Names	Craig Ling		
Phone Number	**0413 122 881**	***E-mail***	craig.ling@msgwa.com

PROJECT / SITE LOCATION

Property Address	18 Eden Road, Maleny, 4552	**Latitude/longitude**	-26.725080 / 152.872658
RP Number	RP895881 (Lot 5)	***Property Size***	17 ha
Existing Land-use	Mixed grazing/rural res.	***Stock Carried***	8 horses (current)
Sub-Catchment	Falls Creek	***LBCCG Management Unit***	FA3

PROJECT PARTNERS/STAKEHOLDERS & ROLES/CONTRIBUTIONS

Lake Baroon Catchment Care Group	Project coordination, administration, reporting, monitoring & evaluation (Cash $7,881 & administration in kind $8,924)
Burnett Mary Regional Group	Project funding ($7,500)
Sunshine Coast Council	Project funding ($5,000)
Seqwater (T. Odgers, J. Howlie)	Project support, technical advice, future funding
Craig Ling	Landowner, labour, funding ($2,640 cash & $2,614 in-kind)
QUT, Australian Rivers Institute	Research, remediation options, technical advice

PROJECT DETAILS

Project Start Date	Feb 2014	***Project Completion Date***	June 2014 (YEAR 1)
OUTPUTS (all first year only)			
Drainage	Improve drainage of 1 ha on Ferriday property; improve drainage on 4,000 m^2 on Ling property; overall improve stability of 7.5 ha of landslip prone area		
Fencing	500 metres		
Revegetation	1,120 plants		
Field Day	1 major event (25 attendees)		
OUTCOMES			
Hill slope stability	Improve landslip stability by 10% (first year)		
Reduced erosion	Reduce sediment delivery to watercourses (and BPD)by 10% through improved livestock management and improved ground cover (pasture and revegetation)		
Reduced pathogen risk	Reduce un-buffered inputs by 10% by removing livestock from 750 metres of watercourse riparian zone		
Wildlife corridor	Establish 300 metre wildlife corridor across property		
Landholder engagement	2 landowners		
Community engagement	1 x Field Day (25 attendees); other field walks as required		
Demonstration site	Accessible site for demonstration and research purposes.		

Maintaining water quality is critical to providing safe bulk drinking water to 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; 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 proposed project aims to complete five components in 2013-14:

1. Improve drainage of the area immediately above and adjacent to the landslips; redirect surface flows to a stable point(s) in the primary watercourse; profile slip areas so that surface water does not collect;
2. Install fencing to isolate the landslips from heavy grazing and protect riparian zones;
3. Revegetate either side of property road to a) protect the asset; *and*
   b) commence stabilisation of the landslips starting on the flanks;
4. Conduct Field Day onsite raising awareness of landslip management and to promote remediation;
5. Support research programs conducted by Queensland University of Technology and the Australian Rivers Institute into catchment erosion sources, budgets and remediation (funded by Seqwater).

The project will be implemented in the lower reaches of the Falls Creek catchment– a major tributary of Obi Obi Creek/Baroon Pocket Dam. The Ling property lies within Management Unit FA3 – a sub-catchment noted for its instability, and moderate contributions of contaminants (nitrogen, phosphorus) and likely pathogens due to intensive livestock grazing. The Lake Baroon Catchment Implementation Plan (2007) identified the sub-catchment as a Low priority for remediation due to its estimated high cost of remediation. When only water quality impacts are considered the sub-catchment rates a Very High priority – the second highest in the Lake Baroon catchment.

The project is expected to commence once LBCCG, Burnett Mary Regional Group and Seqwater approvals have been received and weather and site conditions permit (February – March 2014). Further approval by Sunshine Coast Council (Landholder Environment Grants) is expected in April-May 2014 but will not delay implementation.

Above: Sediment plume formed in Baroon Pocket Dam from landslips

PART B PROJECT PLAN

i. INTRODUCTION

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 efficiently producing high quality potable water for the Sunshine Coast (and greater South east Queensland) region.

Maintaining water quality is critical to providing safe bulk drinking water to the population of SEQ. All of the storages managed by Seqwater involve catchments which are developed (to varying extents) and support active and growing communities, along with important industrial and rural economic activity (SKM 2012). This is particularly true of the Lake Baroon catchment.

As this project is consistent with the LBCCG (and Seqwater) aim of reducing risks to water quality from erosion, nutrients and pathogens, the activities to stabilise landslips and associated activities are considered sensible to support.

In recent years Seqwater have taken a lead role in investigating sediment sources in the Lake Baroon catchment through the engagement of the Australian Rivers Institute with assistance and support provided by LBCCG. In association with this research, Business Cases have been developed and approved to a) conduct a Landslide Assessment and Preliminary Remediation Options Study; and b) commence a Landslide Remediation Program.

Landslides or landslips as they are more commonly known locally, present a high risk to water quality in Baroon Pocket Dam. LBCCG, with limited resources cannot effectively or confidently manage large-scale land slip remediation works but can provide support to the Seqwater Programs being implemented in the catchment. This not only provides landholders with confidence that activities will make a real difference, but also ensures efficient implementation.

ii. BACKGROUND

Landslides are common on the cleared slopes of the Maleny plateaux – particularly on the flanks that have formed by the deep cutting of watercourses and the edges of the lava (basalt) flows. The basalts are volcanic lavas that were poured out during the Tertiary period about 25 million years ago. They were originally much more extensive, but have been reduced in area by the gradual erosion of streams. Basalt forms a sensitive geological formation which is in a delicate balance under natural conditions. Clearing of the original forest has dramatically altered the balance resulting in the failure of the slopes (Willmott 1983).

Basalt is a rock which breaks down readily to deep fertile soils. On the Maleny plateaux these soils have combined with high rainfall to allow the growth of dense rainforest. In the early decades of this century, the fertile soils were cleared for dairying and intensive grazing. Unfortunately, the small size of the properties necessitated the clearing of even the steepest slopes with very little of the original forest remaining (Willmott 1983).

The basalt occurs as numerous individual lava flows that are roughly horizontal. While the thick, harder flows resist erosion and form scarps and cliff lines, the softer or more fractured lavas, or bands of sediments, form gently sloping benches or shelves on the flanks and valleys of the plateaux (Willmott 1983).

Following erosion of the edges of the plateaux over long periods of time, large volumes of rock and soil debris (colluvium) derived from disintegration of the scarps have accumulated as benches and extensive

aprons. Red Ferrosol soils are common on the plateaux surfaces, and dark grey to black, clayey prairie soils; chocolate soils and black earths are usual on their benched flanks. Such black soils are typical of areas mantled by colluvium. Many of these contain large quantities of swelling clay minerals (montmorillonite) which cause the soils to crack on drying and to swell on wetting. The swelling is accompanied by a marked decrease in strength. The presence of sodium cations in some of these clays tends to accentuate the loss of strength that accompanies the wetting (Willmott 1983).

The low permeability of this subsoil is evidently an important factor in promoting mass movement, causing water to flow laterally within the upper portions of the mantle and lubricate a slip surface. This, as is indicated by the sliding and flowing that occurs on the terraces with their low gradients, is evidently the chief reason for the greater incidence of landslides on the shallower, dark brown soil of the sides of the plateau than on the deep red soils at the top (Ellison & Coaldrake 1954).

Most of the landslides occur on slopes and benches on the flanks of the plateaux and ranges, and few occur on the actual flat surfaces of the plateaux.

Falls Creek (prior to the construction of Baroon Pocket Dam a tributary of Obi Obi Creek) is characterised by its steep slopes that despite having significant vegetation has been severely impacted by deforestation and degradation and is now seriously unstable. The soils of the catchment are predominantly black clays lacking the ability to absorb nutrients and rainfall, resulting in minimal filtering of run-off. Although there are significant areas of natural vegetation and many of the waterways have seemingly good riparian vegetation, the sub-catchment contributes significant volumes of sediments, nutrients and potentially pathogens to Baroon Pocket Dam (Dunstan 2007).

The Ling property is a relatively small property in the Falls Creek catchment but has quite poor soils and steep slopes, and consequently suffers from extensive land slips that are severely impacting on Baroon Pocket Dam.

LBCCG has been closely monitoring the property since 2008 but has been reluctant to invest in the property while it has been for sale and therefore no landowner commitment to implement and maintain remediation efforts. The property was sold in 2013 and since then LBCCG has developed a good working relationship with the new landowner.

Above: Abnormal rain events reactivate large landslips which deliver sediment directly to Baroon Pocket Dam and beyond.

1.0 WHAT

Above: The eastern landslip in June 2013 – shortly after purchase by Craig Ling. The primary watercourse on the property (Falls Creek tributary) can be seen in the background. Note the sandstone bedrock on the far bank of the creek.

The proposed project aims to complete five components before June 30, 2014:

1. Improve drainage of the area immediately above and adjacent to the landslips; redirect surface flows to a stable point in the primary watercourse; profile slip areas so that surface water does not collect;
2. Install fencing to isolate the landslips from grazing and protect riparian zones;
3. Revegetate either side of access road to a) protect the asset; *and* b) commence stabilisation of the landslips starting on the flanks;
4. Conduct Field Day onsite raising awareness of landslip management and to promote remediation;
5. Support 2013-14 Seqwater Landslide Assessment Study.

2.0 WHERE

Craig Ling rural property
18 Eden Road, North Maleny

Property is approximately 17 hectares – comprising the following:

- 4.7 ha of improved pasture and lightly vegetated areas including riparian zones;
- 3.7 ha of improved pasture considered to be within the landslip envelope;
- 5.3 ha of lightly to moderately vegetated areas degraded by weed species but accessible to, and grazed by livestock;
- 3.0 ha of remnant vegetation (Complex notophyll vine forest RE12.8.3 & Open forest complex RE12.9-10.17a);
- 0.3 ha of cottage, sheds etc

The primary watercourse running south to north through the land parcel cuts the property in two. A permanent creek, it has a relatively large catchment and flows virtually all year round. The creek is incised down to the underlying sandstone bedrock but as the watercourse continues to Baroon Pocket Dam, the banks become more gentle, vegetated and stable.

The other watercourses on the property are largely ephemeral – including the gully that drains the western landslip.

3.0 WHY

The project is a collaboration of several organisations – all with slightly differing, but compatible motivations for involvement.

Lake Baroon Catchment Care Group is focussed on improving raw water quality in the Lake Baroon catchment and by definition achieves this by working with private landholders in the catchment. Supporting landholders to improve land management, which provides multiple outcomes; water quality and broader environmental benefits while providing essential productivity gains. 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 also provides broad environmental outcomes.

The Burnett Mary Regional Group has a whole catchment approach and activities implemented in the Baroon catchment benefit the Mary River as a whole; reduced turbidity downstream, reduced impact on Mary River Cod habitat directly downstream of the storage. Community engagement and establishment of erosion demonstration sites in the upper catchment are also important.

Sunshine Coast Council through its progressive environmental programs (Landholder Environment Grants program funded by an environmental levy) seek broad environmental benefits such as wildlife habitat and corridors, water quality improvements, weed management, endangered species protection and particularly community partnerships.

Seqwater have a clear core business of providing high quality water to the population of the Sunshine Coast Council and to the greater south east Queensland via the Northern Pipeline Interconnector. The project will support the 2013-14 Seqwater Project *"Baroon Pocket Dam – Landslide Remediation Program"* through the commencement of landslip stabilisation activities, which is likely to require significant commitment in the coming years. Additionally the project will support the 2013-14 Seqwater Project *"Baroon Pocket Dam – Landslide Assessment & Preliminary Remediation Options Study"* through the active engagement of a significant landholder in the Lake Baroon catchment and one of the identified key landslip properties.

The implementation of the planned activities will reduce threats to catchment water quality by:

- improve stability of land slip areas by improving upper-slope drainage;
- commence revegetation to provide stabilisation of landslips;
- reduce direct faecal deposition (nutrients and pathogens) to Baroon Pocket Dam;
- reduce erosion on the bed and banks of a Falls Creek tributary and reduce turbidity;
- improve livestock management on the Ling property (particularly in riparian zones);
- build community group and land manager capacity and skills;
- develop improved land manager engagement;
- provide demonstration site that has good access;
- provide ongoing access for Seqwater programs;
- facilitate further activities to be determined following detailed site investigations.

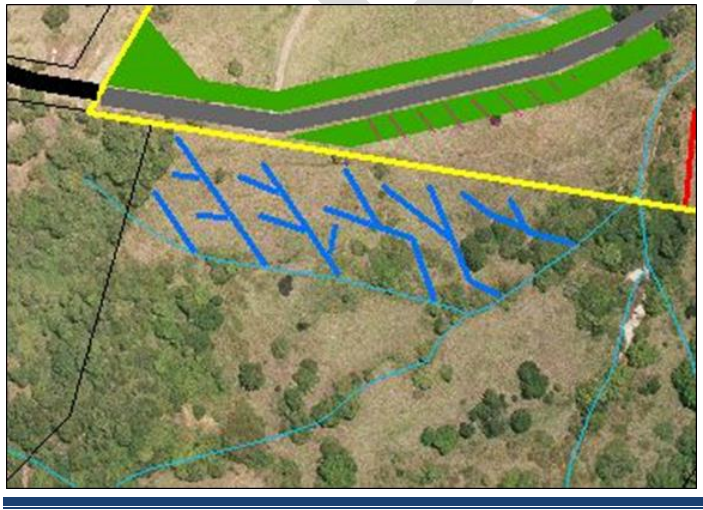
It is best practice to manage livestock in riparian zones to reduce pathogen, nutrient and sediment inputs into the waterway and ultimately Lake Baroon – the Sunshine Coast's most important water supply.

4.0 HOW

4.1 DRAINAGE AND PROFILING WORKS

Above: Poor drainage on the upper slopes and roadside contributes to 'bench' instability and resultant land slips.

Above: Google image from June 2007 clearly showing the drainage line from the Ferriday property into the Ling property and cutting down the eastern landslip.



Landslides occur when the strength of the material involved is reduced to below what is required to support its weight.

East (1978) suggests clearing therefore has:

- removed the mechanical support provided by a diversity of tree roots; *and*
- modified the hydrological balance in the soil profile leading to increased groundwater pressures.

Intensive livestock grazing combined with poor drainage and rotational landslips has resulted in water retention and formation of seasonal marshes behind slope benches. The retention of groundwater and surface water on slopes results in higher groundwater pressure and lubrication of the underlying surfaces that develop in the back-tilted benches. When abnormally high rainfall events are experienced (in excess of 100 mm per day or 300 mm over several days) land slips that are a feature of the property are reactivated.

Less than ideal attempts to drain Eden Road, the Ferriday property, Ling property road access and the incremental loss of vegetation have likely all contributed to the instability currently being experienced (although the site has been unstable for a long time).

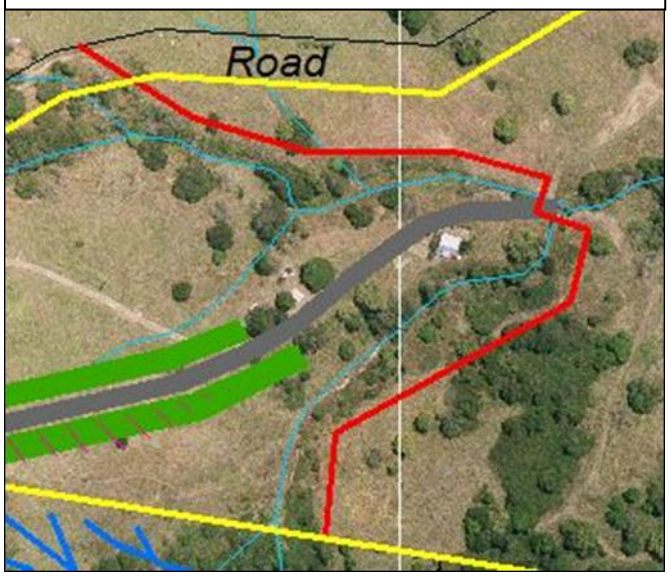
The identification and appropriate drainage of these areas and watercourses will minimise water retention on the upper slopes and contribute to the stabilisation of the land slips below through the reduction of peak groundwater pressure. This will benefit the revegetation of the landslips on the property by enhancing stability and improving the likelihood of establishing deep-rooted trees.

Left: Drainage works will channel surface water away from the Ling property and safely deliver it to existing natural waterways. Multiple drains will be required to drain a large unstable area. Further profiling on the south side of the Ling property road will assist revegetation.

4.2 FENCING

Above: Fencing will remove livestock from the unstable landslips, riparian zones and permit the commencement of revegetation.

Above: Standard cattle fencing will installed.



Left: The fencing will isolate approximately 750 metres of watercourse providing multiple benefits.

Livestock management on landslip susceptible areas is critical. Vegetation provides long term stability, and in the absence of deep rooted trees, cover pasture needs to be as robust as possible with Kikuyu and other 'running' species preferable. Kikuyu pasture is useful for binding surface soil as its matting ability holds together the profile and helps to contain the mobilised clay sediments (Ellison & Coaldrake 1954).

Springs, seasonal marshes and wet spots should not be trampled by stock as this can seal the soil and increase water pressures in the hillside behind. Livestock trampling on the slip itself can result in the retention of water on the unstable area through the formation of 'pugging'.

Fencing of the landslips and riparian zone will permit grazing of the stable areas of the property and reduce the risk of pathogen entry to the waterways.

Currently the property is only grazed by a small number of horses in an effort to improve and build ground cover. Horses however are selective grazers and are inclined to avoid many weed species whereas cattle are more likely to be less selective and consequently may be more useful to manage pasture areas.

It is likely in the future that cattle will be utilised on the property – therefore standard cattle fencing is considered appropriate.

4.3 REVEGETATION

Above: Landslips are difficult to revegetate, however the area to the right of the figure is stable and can be reliably planted to commence stabilisation.

Above: The extra cost of using guards is cost effective long term when maintenance is taken into consideration.

Left: Stage 1 of the landslip revegetation will commence with planting either side of the property road; protecting important infrastructure and establishing a cross property wildlife corridor. Further stages in the future will plant into the landslips.

Establishing trees on very unstable slips is exceptionally difficult. Constant movement disturbs root development limiting species that can be used. The highly disturbed nature of the soil and high clay content has limited fertility. Traversing the slopes are difficult with very uneven ground.

With this is mind it is appropriate to commence revegetation adjacent to the major slips which over time increases root stabilisation, above the slips to promote transpiration and the drying of the soil profile; and to assess the success of the drainage activities (may take several years to accurately assess).

Tree species selection is critical and species that *a)* can tolerate the poor soils (example *Acacia melanoxylon*); *b)* are fast growing (pioneer species); *c)* provide long term stability through deep taproots (*Araucaria*) and extensive root systems (*Ficus*) *and d)* high transpiration (*Eucalypts*). On the more stable areas consideration will be given to species that also provide wildlife benefits (given that part of the aim is to provide a wildlife corridor).

Specific tree species will be selected on availability at the time of planting and from specific input by knowledgeable specialists.

Plant Pink tree guards and weed mats, although initially expensive, reduce the level of maintenance required and extend maintenance timelines resulting in improved establishment.

Further revegetation will be required in future years to assist with stabilisation, moving from the landslip flanks and onto less stable (currently) areas.

4.4 FIELD DAY

Above: LBCCG field walk on the Ling property – August 2013.

A field walk was conducted in August 2013 by LBCCG shortly after the purchase of the property by Craig Ling. The walk was attended by the LBCCG Management Committee, Seqwater, Barung Landcare, Maroochy FarmFLOW, Hinterland Bush Links, Brush Turkey Enterprises and Green Hills; local community members who have experience and/or interest in landslips.

A Field Day will be held following the implementation of activities to showcase not only this on ground project but also highlight the current research being conducted by Queensland University of Technology and the Australian Rivers Institute.

4.5 MAINTENANCE AND FUTURE ACTIVITIES

LBCCG will assume responsibility in conjunction with the landholder, for all works at the completion of the project (June 30 2014) to ensure successful outcomes are achieved. Seqwater is expected to continue activities on the property in 2014-15 and beyond.

5.0 WHEN

Drainage works are ideally completed during the driest part of the year - the period between September and December. Soil moisture is at its lowest level although some moisture is required to be able to achieve sufficient compaction where required (diversion banks etc). Drainage works on seasonal soaks similarly need to be programmed during the driest period of the year to minimise the chances of bogging, and eliminating the risk of machinery/equipment accidents.

The 2013-14 summer at the time of this Project Plan (January 2014) has been exceptionally dry with the likelihood it will remain dry for some time. With this in mind it would be ideal if project approvals occur as quickly as possible and drainage activities can be commenced in late February.

If excessive rainfall interrupts activities, some drainage works can be completed – at least the redirecting of the main drain that is currently directing flows from Eden Road and the Ferriday property onto the eastern landslip. Follow up drainage activities can be completed when conditions permit. The landholder (Craig Ling) will pay for all drainage activities (contracting of earthmoving machinery).

Fencing will be installed as soon as possible although is weather dependent. Temporary electric fencing can be erected if permanent fencing is not possible to allow the revegetation to continue as planned.

Revegetation can usually be done at any time during the year although site preparation takes between 4 – 6 weeks. Ideally revegetation will occur in mid-March – mid April when soil moisture is high, soil temperature is still adequate but average atmospheric temperatures are beginning to fall which tends to reduce weed competition and reduces maintenance requirements.

The Field Day will be held when all on-ground activities have been completed – likely late April, or May.

6.0 BUDGET

All figures exclusive of GST.

Activity	*Description*	*LBCCG*	*LBCCG [1] Project Mgt*	*BMRG [2]*	*SCC [3]*	*Landholder Cash* & in-kind*	*Total $*
Drainage works	Machine hire 10 hours @$100/hour	-	-	-	-	1,000*	1,000
Fencing	500 metres @$14.00/metre	2,000	-	-	5,000	-	7,000
	3 gates @$380/each (includes labour to install)	-	-	-	-	1,140*	1,140
	Flood fence	-	-	-	-	500*	500
Revegetation	Site preparation – ring spray – 1,120 plants @$0.18/e	-	-	-	-	202	202
	Site preparation – brush cut/slash – 1,120 plants @$0.36/e	-	-	-	-	404	404
	Tubestock 1,000 @$1.50/e	84	-	1,416	-	-	1,500
	Tubestock 120 mega-tubes @$3.18/e	382	-	-	-	-	382
	Materials (guards, stakes & weed mats) 1,120 @$3.20/e	-	-	3,584	-	-	3,584
	Planting labour 1,120 @$4.50/e	5,040	-	-	-	-	5,040
	Maintenance - ring spray – 1,120 plants @$0.18/e x 2 visits	-	-	-	-	404	404
	Maintenance - brush cut/slash – 1,120 plants @$0.36/e	-	-	-	-	404	404
	In-kind (site clean-up, weed management, site marking, water supply, contractor supervision, monitoring etc) 40 hours @$30.00/hr	-	-	-	-	1,200	1,200
Field Day	Catering, vehicle hire, speaker engagement, preparation, handouts	-	-	2,500	-	-	2,500
Administration	Project development & Plan (15 days @$388.00/day)	-	5,820	-	-	-	-
	Monitoring, evaluation & reporting (5 days @$388.00/day)	-	1,940	-	-	-	-
	Contractor engagement including risk management (3 days @$388.00/day)	-	1,164	-	-	-	-
Sub-total		*7,506*					
Contingency (5% of LBCCG contribution)		375					375
Totals		**7,881**	**-**	**7,500**	**5,000**	**5,254**	**25,635**

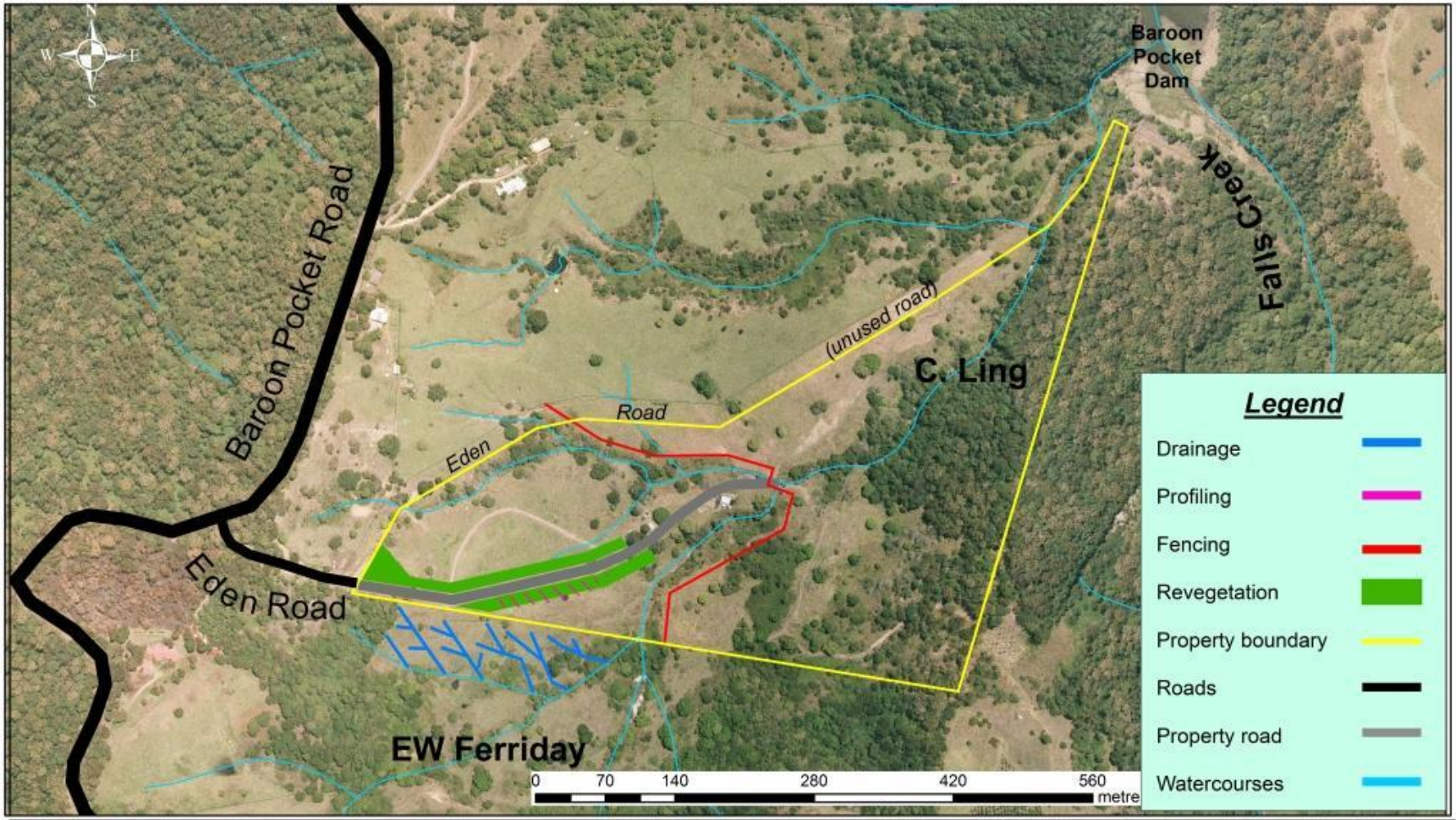
Notes

[1] LBCCG Project Manager is funded from a Seqwater Administration budget (separate to the Projects budget) and is included here for illustration purposes only (not included in Project totals).

[2] Burnett Mary Regional Group

[3] Sunshine Coast Council – funding is dependent on a successful application through the Landholder Environment Grants program

7.0 PROJECT MAP



Ling Landslip Remediation 2013-14

This plan has been generating using data supplied by The State of Queensland (Department of Natural Resources and Water),Maroochy Shire Council, Caloundra City Council and Lake Baroon Catchment Care Group. Digital Cadastre Database (DCDB) © The State of Queensland Department of Natural Resources and Water) [2006]. Maroochy Shire Council, Caloundra City Council, and Department of Natural Resources and Water (NRW), does not warrant the correctness of this plan or any information thereon. The Council's and NRW accepts no liability or responsibility in respect of the plan and any information or inaccuracies thereon. Any persons relying on this plan shall do so at their risk.

Data shown in Map Grid of Australia coordinates (Universal Transverse Mercator, Zone 56).

Burnett Mary Regional Group ...for Natural Resource Management Inc

Sunshine Coast Council

Lake Baroon Catchment Care Group

PART C:

ATTACHMENTS

1.0 PROJECT RATIONALE

1.1 INTRODUCTION

In an ideal world, all waterways in the Lake Baroon catchment would be rehabilitated to provide riparian buffers, lower in-stream temperatures and provide appropriate habitat for aquatic ecology. However the limited resources available means the catchment must be prioritised into areas where the greatest gains can be achieved through the smallest investment (Dunstan 2007).

The LBCIP prioritisation of sub-catchments for works is effective and useful for rehabilitating waterways in the catchment through fencing and revegetation but does not reflect the nutrient and sediment inputs to the waterways through land use, particularly intensive grazing (dairying and beef production). A modified Management Unit Prioritisation was developed by LBCCG that utilises MU stability; pollution and the degree of riparian vegetation present to determine the need for on-ground investment. In this context the proposed project rates VERY HIGH in priority.

1.2 LAND SLIP REMEDIATION

It is acknowledged that mass movement has been an important geomorphic process in the Sunshine Coast region and especially in the Lake Baroon catchment; however the modification of removing native vegetation and replacement with exotic pasture has undoubtedly greatly accelerated erosion rates (East 1978).

High rainfall does not necessarily trigger landslips but rather intense rainfall events (a good example is an ex-cyclone or deep east coast low) that deliver rain over an extended period (3 or more days). Most likely the first couple days of heavy rainfall completely saturate the soil profile and a subsequent heavy rainfall day will trigger the landslip (East 1978).

Landslides occur when the strength of the material involved is reduced to below what is required to support its weight. East suggests deforestation therefore has:

- Removed the mechanical support provided by a diversity of tree roots;
- Modified the hydrological balance in the soil profile leading to increased groundwater pressures.

Although fluctuating groundwater pressures have occurred periodically in wet seasons for tens of thousands of years, and are part of the natural balance, evidence suggests that groundwater levels and pressures rise significantly when the natural forest cover is removed. This is mainly due to the loss of transpiration of water by the trees. Such general background rises allow higher peak pressures to develop during intense rainfall events than was previously the case, and in susceptible locations cause a sufficient loss in strength to cause sliding. This effect is particularly important on the benched slopes, where groundwater is fed laterally outwards onto the hillside. On steep slopes and scarps the effect is combined with an increased rapidity of soil saturation following loss of the tree canopy, and a reduction of strength caused by loss of the tree root systems (Willmott 1983).

The geological sensitivity results from:

- the horizontal strata directing groundwater flows, through fractured or porous layer above tighter bands, laterally outwards onto the slopes;
- thick accumulations of unconsolidated colluvial debris on the slopes that can move relatively easily;
- the presence of swelling clays in the soil and colluvium which loses strength on saturation; *and*
- the presence in places, of beds of soft sediments in the basalt sequence which themselves may fail.

The combination of these factors has led to failures in susceptible locations when triggered by abnormal rainfall events.

Hoek and Bray (1981) suggest that it is not necessarily the amount of water that activates land slips but rather the pressure brought to bear by the water, and propose three principles need to be taken into account to improve the stability of circumspect hill slopes:

- Prevent water entering the hill slope through open cracks;
- Reducing water pressure in the vicinity of potential breakage surfaces through selective shallow and sub-shallow drainage; *and*
- Placing drainage in order to reduce water pressure in the immediate vicinity of the hillside.

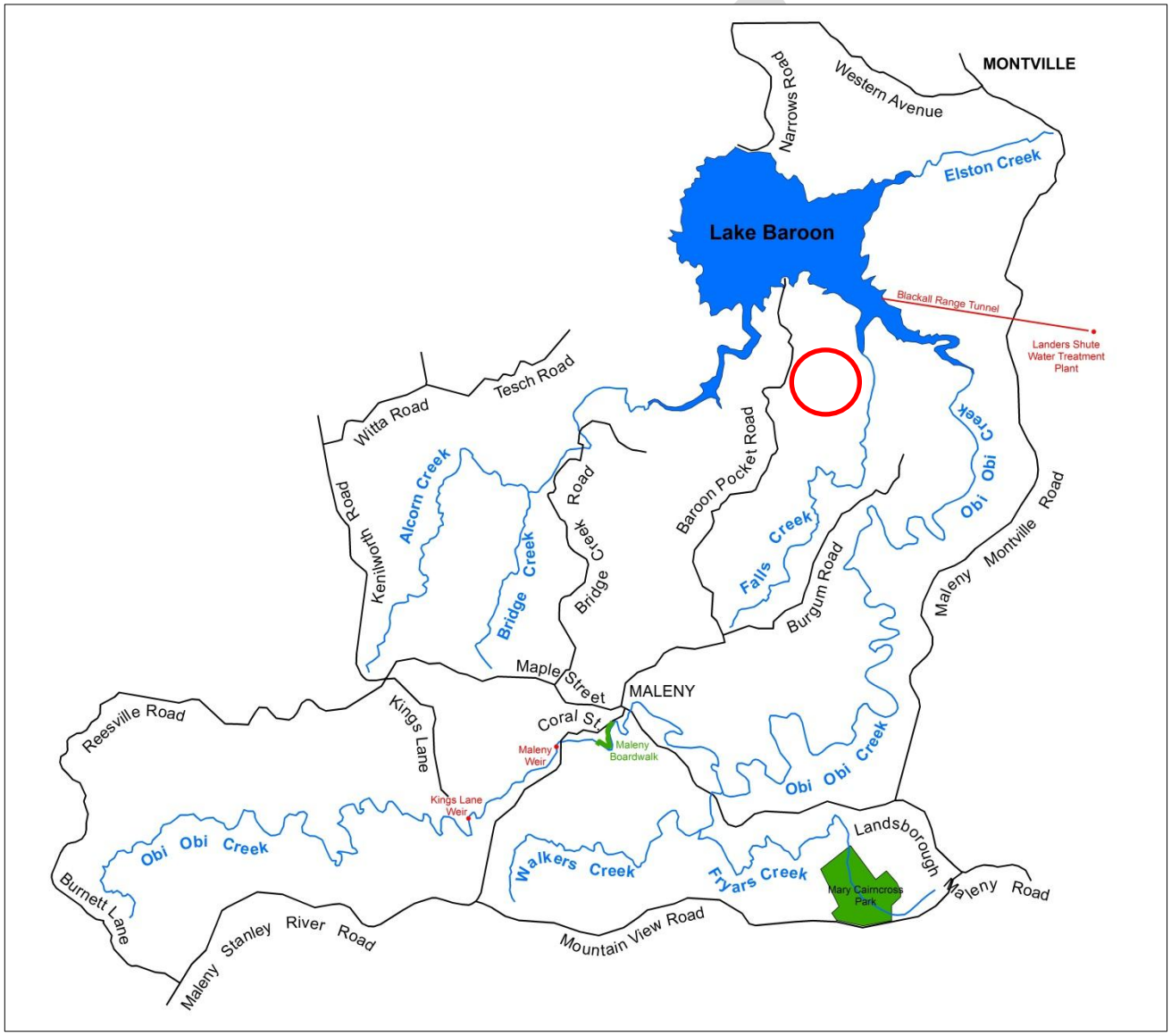
Drainage improvements may often be the most cost-effective means of reducing the likelihood of landslides. They may include simple measures such as inspecting and repairing existing drainage systems or directing runoff to safe areas. Drainage measures can also be more complex, requiring deep sub-surface drains, the drilling of wells and installation of pumps to lower groundwater levels (Dept of Ecology).

2.0 PROJECT LOCATION

2.1 BACKGROUND

Lake Baroon is situated on the edge of the Maleny Plateau in the headwaters of the Mary River, located inland from Sunshine Coast approximately 13 km south west of Nambour and 7 km north east of Maleny. Obi Obi Creek forms both the primary inflow and outflow of the dam. Walkers, Falls, Bridge, and Elston Creeks are significant creeks within the catchment providing water to Lake Baroon. The catchment encompasses an area of 74 km^2 (including the dam surface).

2.2 LOCATION MAP



Above: The Ling property is located in Management Unit FA3 which lies in the lower reaches of Falls Creek. This MU is a significant contributor of sediments and nutrients primarily due to the steep and unstable nature of the sub-catchment.

2.3 CATCHMENT REVIEW

2.3.1 Background

Since the arrival of European Settlers, Lake Baroon and its catchment have undergone significant change. Timber cutters first settled in the region in 1853 and selectively cleared the best timber from the area. Following the removal of the most valuable timber (1906), the majority of remaining vegetation was cleared for small crops, beef and dairy cattle (1918) (Dunstan, 2007).

As a result riparian zones have been substantially impacted through:

- vegetation fragmentation (as a result of clearing);
- increased erosion and sediment loads due to deforestation and intensive land use practices;
- changes to hydrology and water quality;
- altered natural processes such as grazing and urban development;
- the introduction of foreign fill materials; *and*
- the introduction of weeds, exotic plantings and exotic fauna.

2.3.2 Geology, soils & stability

The geology of the Maleny plateau is dominated by basalt lava flows occurring between 31 and 25 million years ago (MYA). However there are several other significant geological formations that influence the catchment – particularly soil type and consequently vegetation and stability.

The oldest rocks visible on the plateau are known as the North Arm Volcanics and originated somewhere in the North Arm region around 210 MYA. Multiple lava flows consisting of andesite and dacite to rhyolite form the northern bank of Lake Baroon and are visible in the lower reaches of Bridge Creek where erosion has exposed them. Rhyolite is very hard and resistant to erosion; evidenced by the Narrows where the Obi Obi Creek was forced to cut a narrow gorge through. The North Arm Volcanics underlay the entire Maleny plateau and extend as far south as the Glasshouse Mountains. Between 210 and 180 MYA the North Arm Volcanics 'sagged' into broad depressions that were subsequently filled with sediment, forming the deep Landsborough Sandstone formation (Willmott 2007). The Maleny volcanics lie on top of this sandstone.

Other geological formations in the catchment include small areas of Cedarton Volcanics – visible in the upper reaches of Obi Obi Creek; andesite rock that produces lighter coloured, moderately fertile soils; and an area of Amamoor Beds (315 MYA) - of hard meta-sediment rocks that were historically folded and steeply inclined and exposed at Howells Knob. Composed of quartzite, these rocks weather to variable cream or yellow soils. Maleny plateau basalts although outwardly appearing very hard have high concentrations of iron which promotes fracturing and therefore are usually very prone to erosion. The Obi Obi, Bridge and Falls Creeks have gradually cut channels into the basalt plateau revealing the above described layers underneath. The edges of the plateau have also retreated to form escarpments (Willmott 2007).

2.3.3 Land-use

Despite the extensive clearing, 17% of the Lake Baroon catchment is still heavily forested; a significant proportion in the immediate area around the dam (although a significant proportion was revegetation associated with the Dam's construction). Today, the catchment is susceptible to impacts associated with an increasing diversity of land use (Keys 2009).

The area closest to the lake (including Montville) is popular with "tree changers" and has seen land use change from intensive grazing to 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 (Keys 2009).

Presently the catchment is susceptible to a number of land use impacts (Traill, 2007; Dunstan, 2007) including:

- dairying and cattle grazing;
- new developments and increasing 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 a high percentage of catchment waterways;
- lack of riparian vegetation and integrity – a result of extensive deforestation;
- abundance of weeds – shift in land ownership from land managers (e.g. farmers) to inexperienced residents has potentially led to the spread of weeds; *and*
- varying pollution sources related to increased population.

2.4 THE FALLS CREEK CATCHMENT

Above: Lower Falls Creek has good riparian vegetation but is impacted by an unstable mid catchment and major erosion.

Above: The Ling property is typical of the FA3 sub-catchment with the tree-change lifestyle where livestock are used primarily for property management.

The Lake Baroon Catchment Implementation Plan (LBCIP) 2007 describes the Falls Creek catchment as small, but highly disturbed, dominated by dairying and non-dairy farming land uses. The sub-catchment covers an area of 508 hectares and has a total major stream length of 12 km (not including First Order streams).

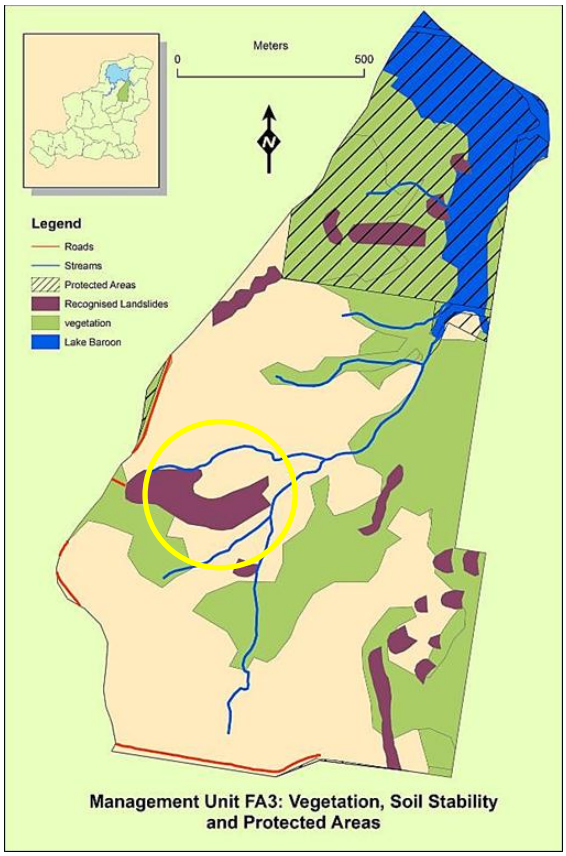
In the seven years since the LBCIP was produced there has been considerable land use change in the sub-catchment with a significant expansion of natural vegetation (although much of this is degraded by environmental weeds) with a sharp decline in grazing – particularly dairying (no dairies or dairy grazing remains in 2014).

The proposed project is located within Management Unit FA3. This MU is 183 ha in size and has only 3 km of significant waterways. Beef grazing is largely confined to a single property (Ferriday) with the remaining grazing small scale (largely for pasture management and not commercial production). Over 50% of the sub-catchment has vegetation cover although much of this has suffered disturbance and is degraded by environmental weeds (Dunstan 2007).

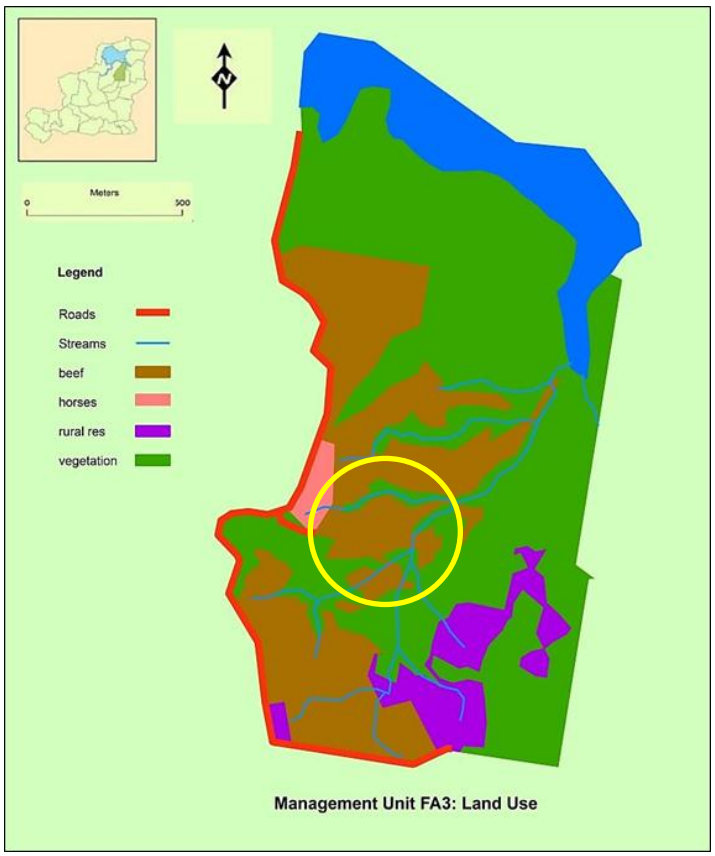
Similarly, riparian vegetation is present alongside 50% of the waterway length, although much of this is in a degraded condition from environmental weeds.

Falls Creek (prior to the construction of Baroon Pocket Dam a tributary of Obi Obi Creek) is characterised by its steep slopes and despite having significant vegetation has been severely impacted by deforestation and degradation and is now largely unstable. The soils of the catchment are predominantly black clays lacking the ability to absorb nutrients and rainfall, resulting in minimal filtering of run-off. Although there are significant areas of natural vegetation, and many of the waterways have good riparian vegetation, the sub-catchment contributes high volumes of sediments, moderate nutrients and potentially pathogens to Baroon Pocket Dam.

The headwaters of the catchment are generally more stable as the retreating escarpment has not removed the Red Ferrosol soils. The mid to lower reaches (where the Ling property lies) are steep with numerous and extensive areas of instability (landslips).



Above: A significant proportion of the property has been recognised as being particularly unstable and landslips are reactivated in years of abnormal or extended rainfall events.



Above: Management Unit FA3 with the Ling property circled.

2.4.1 Ling property geology, soils and stability

The Ling property ranges in elevation between 340 metres above sea level in the south east corner; 320 metres above sea level at the front gate; to 217 metres above sea level at the northern boundary (Baroon Pocket Dam). Where the Falls Creek tributary enters the property it is 270 metres above sea level – a 50 metre fall over the length of the watercourse (a distance of approximately 750 metres).

For comparison to where the property lies in the landscape, Lake Baroon is 217 metres above sea level, Howells Knob the highest point in the catchment is 560 metres above sea level, while Maleny is between 410 and 450 metres above sea level.

Soils are predominantly heavy black clays containing high levels of montmorillonite and sodium resulting from large scale historical erosion as the Falls Creek tributary has eroded down through the centre of the property. A bench of un-stabilised colluvium, reactivated during wet summers– particularly since 2009 appears as landslips.

Montmorillonite is characterised by a pronounced loss of strength on hydration and is found in large quantities in the basalt derived soils on the edges of the plateaux. On the other hand the underlying sandstone is virtually devoid of montmorillonite but high in the relatively stable clay mineral kaolinite In addition to the montmorillonite, Baroon Pocket soils also contain high concentrations (up to 2200 ppm) of exchangeable sodium ions. The ions have the effect of accentuating dispersion of the clay particles on hydration further reducing the strength of the montmorillonite clay soil (East 1978).

The property has been historically as unstable – particularly the large area including the only access into the property. Erosion and slumping has interfered with drainage, with the formation of poorly drained areas that retain water and likely exacerbating the land slips further down slope. Compounding the drainage issues has been the deliberate cutting of drains from Eden Road and on the property immediately to the south, contributing to the destabilising of the eastern slip (*for diagrams of the slips please see Part C, Section 7.0 Mapping*).

The main laneway into the property was damaged beyond repair in 2008 from a major slip resulting in the realignment of the track. This may have altered drainage once again, as it appears the western landslip became somewhat more stable, and the eastern slip less stable. It is critical the current property access road is protected from further slippage as this is the only way onto the property.

2.4.2 Ling property land use and property management

Land use in Management Unit (FA3) is mostly vegetation (55% of the management unit) with the change from grazing to lifestyle properties, and only minor grazing. This is partially due to the poorer quality soils affecting pasture quality and the steepness of the catchment.

The Ling land parcel is a good example of the relatively rapid change from production to lifestyle properties associated with the construction of Baroon Pocket Dam. A significant proportion of the property is covered by vegetation – particularly the steeper areas that retain remnant vegetation, but is too small and the pasture too poor to run any more than a few head of livestock. Craig Ling purchased the property in 2013 as a weekend retreat and will merely run livestock as a pasture and weed management tool.

The north western part and south eastern slopes of the property are stable and capable of sustaining well managed grazing. This project plan proposes fencing the existing land slips to manage grazing.

2.4.3 Property history (landslips)

2001

The eastern landslip is quite visible and there is good vegetation on and adjacent to the western watercourse. There appears to be quite extensive stands of lantana over the property however this was probably assisting with stability.

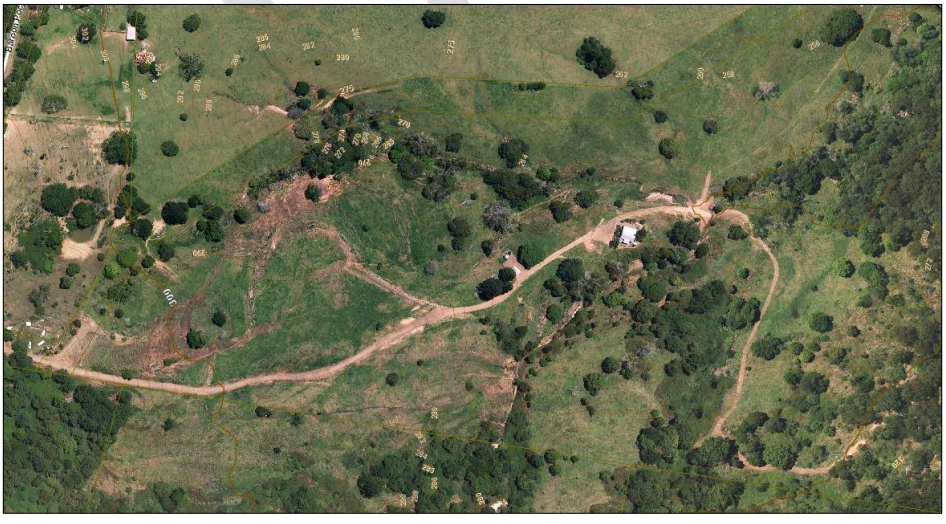
Significantly the property to the west has a good covering of vegetation.

2005

There appears to have been considerable effort controlling lantana and possibly other weeds (including Blackwood wattles). The eastern landslip is still quite obvious; western slip appears stable.

A visible drain from the Ferriday property directed onto the eastern slip is visible.

There has been some clearing occurring on the property to the west.



2008

Photo taken shortly after the major landslip in 2008. Note the destruction of the original access road; slip has been profiled and sown to pasture.

The eastern slip appears to have deteriorated.

Note the further loss of vegetation on the property to the west.

Western slip appears to be relatively stable (except for the leading edge which is continuing to deliver sediment into the adjacent gully) while the eastern slip has become increasingly active – likely from changes in drainage.

2011

2.5 ENVIRONMENTAL FACTORS

2.5.1 Significant Vegetation & Ecosystems

Like much of the Maleny region, the property has been substantially altered from its natural state and cleared for grazing; however there are significant remnants of the pre-clearing period. Primarily the steeper areas of the catchment were retained – mainly due to inaccessibility or limited value for grazing. The majority of the remaining vegetation is associated with the properties watercourses.

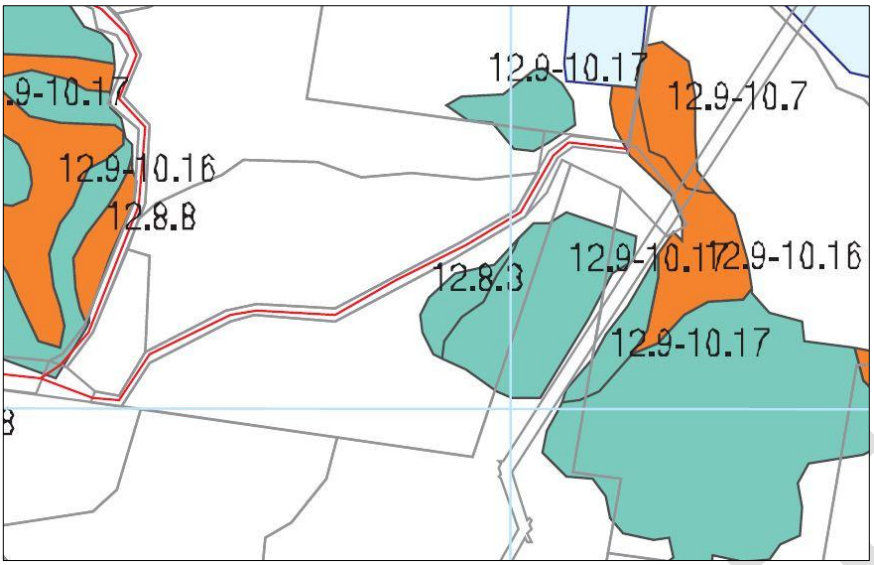
The identified Regional Ecosystem (RE) remnants are:

RE12.8.3 – Complex notophyll vine forest

The majority of the watercourses would historically have supported this Ecosystem. Although not considered a high priority for conservation in Queensland, there are few areas within the Lake Baroon catchment considered to be in good condition. This RE in the lower reaches of Falls Creek is relatively intact but is degraded by environmental weeds (lantana).

RE12.9-10.17/12.9-10.16 – Open forest complex/Araucarian microphyll to notophyll vine forest on sedimentary rocks

There has been no close investigation of the steep hill slopes to determine if the RE type is correct however it is clear from the distance that there is substantial stands of Brush Box (*Lophostemon confertus*) and mixed Eucalypt species (*E. microcorys* and possibly *E. tereticornis*). Therefore the assumption is made that the hill slope vegetation is likely RE12.9-10.17a. This will be confirmed by Sunshine Coast Council Community Partnerships officer Alan Wynn in the near future.



Left: Remnant vegetation on the Ling property; vine forest along the watercourse and open eucalypt forest on the hill slopes (on sedimentary rock).

2.5.2 Pest Species

The primary environmental weeds on the property appear to be lantana, camphor laurel, some blackberry and minor small leaf privet. Weed management is not a priority – particularly on the slip areas as any vegetation at this point in time is useful.

Wild dogs are a key threat to primary production in this area with numbers increasing in recent years. Besides primary production wild dog numbers are likely to severely impact on local koala populations which are under considerable pressure from habitat degradation and disease.

2.5.3 Fauna & Fauna Corridors

The presence of significant remnant vegetation (and the area of vegetation on the property) on either side of the property gives the property some importance as far as providing habitat and establishing wildlife corridors.

The remnant riparian vegetation along the banks of the main watercourse, and the creek itself, provide key habitat areas and corridors for both arboreal and ground dwelling animals and birds and aquatic species.

The project will provide a simple corridor linkage from vegetation at the front of the property to the main waterway while primarily focussing on the protection of the access track. There may be future opportunities to enhance and extend linkages however at this point in time prioritisation needs to focus on property stabilisation and improved livestock management (through fencing).

3.0 PROJECT PURPOSE & OBJECTIVES

3.1 BACKGROUND

A healthy aquatic ecosystem is one that is stable and sustainable; maintaining its physical complexity, biodiversity and resilience. It has the ability to provide ecosystem services that provide good water quality, wildlife habitat and recreation. This can include well managed grazing.

Riparian areas are the transition zones between land and water environments. They are generally more productive in terms of total biomass than the adjoining area (which contributed to their clearing and reluctance of some landholders to exclude from grazing) and are a critical source of biological diversity.

Landslips and the subsequent delivery of large volumes of sediment severely impact riparian zones. Turbidity and heavier particles smother habitat, affect desirable aquatic vegetation and reduces bed diversity; filling deeper holes and aquatic refuge areas. Sediment deposits can promote weed growth.

3.2 WATER QUALITY

The environmental health of the Lake Baroon catchment is considered generally poor, and in some respects declining. A State of the Rivers assessment (Johnson, 1996) indicated that significant sections of the waterways appear to be in moderately poor condition, with moderately to highly disturbed reach environs and considerable lengths of unstable banks and bed-streams. These were characterised by lack of native vegetation displaced by clearing, grass banks or exotic vegetation (Keys 2009).

Above: Consequences of climatic conditions and less than ideal catchment management: turbidity in Baroon Pocket Dam caused by excessive erosion (land slips).

Pollutants entering Falls Creek occur from three main sources. Diffuse run-off from traditional grazing practices provides nutrient and pathogen inputs (fertiliser application and animal manure), and sediments (from landslips, paddock erosion and bank erosion in watercourses from unmanaged livestock access). There is little urban influence in this part of the catchment however road run-off, litter and organic matter contamination remains a risk. Poorly performing rural residential wastewater treatment systems (such as septic tanks) with high nitrogen, phosphorus and pathogens are high risk (there are considerable rural residential areas in the upper catchment around the Burgum Road area) (Keys 2009).

The sheer volume of excrement produced by cattle, horses, and to a lesser extent other domestic animals, when in large herd sizes render them significant contributors within an open drinking water catchment. Reducing connectivity, through the management of riparian fencing and revegetation, would reduce the likelihood of pollution at almost all high risk locations in the catchment (pers. comm. A. Smolders 2012).

Over 50% of the sub-catchment is vegetated, and 40% of the waterways have riparian cover of varying quality. Despite the vegetation, the MU contributes a large nutrient load to Falls Creek, with more than 80% of samples exceeding guideline levels (Dunstan 2007). This is most likely due to the steep topography, unstable soils and traditionally heavy grazing practices. Land slips in the catchment likely contribute to the mobilisation of nutrients – particularly phosphorus. The riparian vegetation does not currently effectively buffer and filter nutrients originating in the catchment.

The Lake Baroon Catchment Implementation Plan (2007) rates FA3 a VERY LOW priority for rehabilitation works due to its very high cost to remediate (landslips, nutrients) despite a moderately good coverage of vegetation. When assessing the Management Unit using a modified version of the Prioritisation Process, which prioritises MU's on pollution input levels and land instability parameters, FA3 rates as HIGH; once again due to the severe land slips – including on the Ling property which contributes large volumes of sediments directly to Baroon Pocket Dam.

3.2.1 Raw water quality data

Above: Consequences of climatic conditions and less than ideal catchment management: cyanobacteria bloom stimulated by high nutrient inflows.

As Falls Creek is relatively inaccessible, a small catchment and flows directly into Baroon Pocket Dam there has been no water quality monitoring and analysis conducted on any scale that would provide useful data.

Since 2008 a sediment slug has been forming in Baroon Pocket Dam where Falls Creek and the Ling tributary enter the storage (*see 3.2.2 Impacts on Baroon Pocket Dam*). It is difficult to estimate volumes of sediment delivered as depending on Dam levels the sediment waxes and wanes in area and depth. However cursory estimations (by measuring width, length and depth) at a single point in time suggests annual deposition of many thousands of cubic metres. This merely estimates the larger particle size that drops out on entry to the storage and not the suspended sediment (turbidity) that hinders raw water off-take issues for Seqwater.

Current investigations by Griffith University and Queensland University of Technology are likely to shed further light on the impacts to Baroon Pocket Dam in the future.

3.2.2 Impacts on Baroon Pocket Dam

September 2008
Seqwater and LBCCG alerted to the landslip that had recently occurred on the Cayford & Craven (now Ling) property.

Sediment slug is primarily affecting the watercourse as it enters the storage. Difficult to determine extent of slug from photos – particularly when Dam is at full supply level.

September 2009
Sediment slug has encroached further into Dam – coarse sediments (sand) drop out as flows slow entering the storage.

February 2010
As the Dam levels drop, inflows cut through the deposited sediment slug.

January 2011

Sediment slug continues to spread into dam as each successive summer and abnormally high and intense rainfall events continually reactivate the landslips in the catchment.

March 2012

Full supply level and the sediment slug builds depth where the Falls Creek tributary enters the storage.

January 2014

With Dam levels below 75% the deposited sediment slug has been significantly eroded and the sand is delivered further into the storage. Clearly thousands of cubic metres of material has been delivered to the Dam, but does not accurately reflect the volume of suspended sediment (turbidity) that flows out of the Dam into sensitive habitats downstream, and hinders potable water production.

3.3 WATER SUPPLY CATCHMENT

The whole of the property is within the Baroon Pocket Dam catchment. Falls Creek is a major tributary (508 hectares and 12 kilometres major stream length) of the storage. Consequently it is a significant supplier of total water to the dam.

Baroon Pocket Dam (BPD) is a key source of water supply for Seqwater. Minimum flow volumes from BPD through the Northern Pipeline Interconnector (NPI) northwards are 7 ML/day (subject to availability if BPD falls below 60% capacity) to Noosa NTP; and 30 ML/day (20 ML/day if BPD falls below 70% capacity) southwards to Caboolture, Morayfield and Narangba. This indicates both surety of supply, location and cost effectiveness of the Landers Shute Treatment Plant (Seqwater Annual Operations Plan 2013).

BPD, along with Image Flat (South Maroochy System) is the predominant source of water supply for northern South east Queensland while Ewan Maddock Dam (EMD), Lake McDonald and Mary Valley Water Supply Scheme are considered additional intermittent sources (Seqwater Annual Operations Plan 2013).
EMD operates on an as needed basis, typically during high demand periods or when raw water quality in BPD is compromised by algal blooms (and possibly turbidity). EMD, relative to Landers Shute (LSTP) is more expensive to produce potable water (despite its recent construction), hence the reliance on BPD and LSTP (Seqwater Annual Operations Plan 2013).

It's important to note that the NPI (and all pipelines for that matter) require minimum transfer flows at all times to maintain operation and water quality. Typically this is a minimum of 5 ML/day (Seqwater Annual Operations Plan 2013).

BPD is a reliable source of raw water (volume) but is plagued by quality issues. These issues were somewhat expected when BPD was constructed and hence the design of LSTP, however demand for supply was never intended beyond the southern half of the Sunshine Coast local government area.

The value of the raw water that originates in the catchment as a whole greatly exceeds the value of primary production.

Lake Baroon catchment	*= 74 km^2 or 7,400 hectares*
Gross yearly value of water sold by Seqwater (Saxton et al, 2013)	*= $60,000,000*
Value of water per hectare	*= $8,108 per hectare*
Value of water originating from Ling property (17 ha)	***= $137,836 annually***

Tourism has become the dominant economic driver in the catchment but relies on both the agricultural landscape (rolling green hills) and the unique natural values equally. This is demonstrated by the popularity of Maleny Dairies milk processing plant and farm tours (in excess of 12,000 visitors per year) and the popularity of Mary Cairncross Park (500,000 visitors per year?).

Seqwater who receive the benefits of raw water flowing from the catchment into BPD, arguably have an obligation to invest back into the catchment, particularly if water quality improvements are desired; into activities that both reduces risks to water quality, and broader environmental outcomes.

The likely scenario under climate change modelling suggests more variable and possibly severe weather events; longer and more severe droughts and more intense rainfall events. This will undoubtedly impact on both raw water quality entering BPD and on the storage itself. Since 2009-10 unseasonal dry periods followed by intense summer high rainfall events have seen an increase in erosion (land slips), turbidity and flood damage.

Customers expect good water quality at their tap – free from discolouration and odours, and the assurance it will not impact their health, while increasingly demanding the source (the natural environment) is protected as part of supply.

3.4 OBJECTIVES

Ling Landslip Remediation is a project designed to reduce the impacts of major landslips, livestock access to riparian zones and to a lesser extent the reestablishment of wildlife corridors. Although a long term approach is required with the remediation of the landslips this project will provide immediate benefits of removing livestock access to 750 metres of watercourse (and 7.5 hectares of unstable areas), improve drainage of at least 1.4 hectares and establish a 300 metre wildlife corridor, while protecting important infrastructure. The water quality benefits are expected to be significant and an integral part of the larger aim of protecting the Lake Baroon resource, addressing the issues and risks associated with the production of a safe water supply to the Sunshine Coast and beyond. However the project provides far broader environmental benefits that increasingly the community demands and expects.

The project aims to:

- implement on-ground project that delivers water quality benefits;
- raise community awareness particularly of water quality issues;
- promote integrated catchment management in the Lake Baroon catchment;
- reduce sediment delivery to waterways and Baroon Pocket Dam;
- reduce nutrient delivery to waterways;
- reduce pathogen delivery to waterways;
- improve aquatic habitats;
- climate change adaptation; *and*
- demonstration of best practice.

3.5 TARGETS

- remove livestock access to 750 metres of waterway and 6.4 hectares;
- improve stability of landslips delivering large volumes of sediment to Baroon Pocket Dam;
- establish 300 metre wildlife corridor linking vegetation on either side of property;
- raise community awareness by implementing project in an accessible and convenient location;
- assist with Landslide Assessment study conducted by Queensland University of Technology;
- conduct a Field Day for 25 participants.

3.6 OUTCOMES

Healthy catchments lead to healthy waterways. By improving the health of riparian zones we ultimately aim to reduce the impacts that affect water quality. Seqwater provides generous funding and LBCCG offers appropriate incentives to landowners to implement activities that are designed to reduce the risk to water quality. Through the prioritisation and implementation of riparian protection and rehabilitation throughout rural catchments – particularly headwaters, we can provide multiple beneficial outcomes.

Outcomes are the ‘end product’ of the project – what we actually achieve. It can be very difficult to measure outcomes as they may take many years to be fully realised and can be enormously expensive to quantify – potentially far more than the actual implementation of the project. We must rely on best management practice, anecdotal evidence and if possible partnerships with universities and/or Seqwater to produce ‘hard’ data to the actual effectiveness of the project.

1. Reduce sediment delivery to waterways.

Soil from erosion leads to high turbidity and is transported to Baroon Pocket Dam and beyond.

Drainage activities improve the stability of landslips by removing excessive groundwater pressures which are the primary trigger of landslips. Revegetation provides long term stability of landslips with roots providing mechanical stabilisation and hydrological stability through transpiration. Managing livestock in the riparian zone reduces soil erosion from trampling and compaction in wet areas.

2. Reduce nutrient delivery to waterways.

Nutrient delivery to waterways is continuous and increases during episodic rain events.

Managing livestock in the riparian zone reduces the opportunity for direct deposition of faecal material into the watercourses.

3. Improve aquatic habitat.

Riparian vegetation plays a critical role in the creation and maintenance of aquatic habitats in freshwater ecosystems.

A reduction in turbidity will improve in-stream habitat and likely biodiversity.

4. Raise community awareness.

The majority of land in the Lake Baroon catchment is privately owned and without landholder and community support, activities improving catchment health and water quality is impossible.

The project will demonstrate the value of managing livestock in riparian zones and the addressing of landslips to reduce risks to water quality – both throughout the catchment and Lake Baroon. On-ground works provide the opportunity for land managers to apply their knowledge and experience at the local level whilst contributing to landscape scale outcomes, increasing the skills and capacity of the community.

5. Establish a healthy, diverse and resilient environment that addresses climate change variability.

Future climate change impacts may impact on the survival of threatened and vulnerable wildlife, increase the occurrence of significant storm events leading to the degradation and decline in the local environment and subsequently catchment water quality.

The project addresses key threats predicted by climate change - increasing the resilience of the catchment to extreme events (floods and drought).

6. Promote cooperation between various agencies and organisations.

To deliver significant outcomes requires buy-in from all stakeholders within the catchment.

The partnership between Lake Baroon Catchment Care Group, Burnett Mary Regional Group, Sunshine Coast Council, Seqwater and Queensland University of Technology fosters a collaborative approach to tackling catchment-wide issues.

3.7 PRIORITY LANDHOLDERS/LAND IN THE LAKE BAROON CATCHMENT

Priority landholders were identified in 2007 based on land-use, property size, and proximity to Seqwater infrastructure (Baroon Pocket Dam, Maleny Weir, and King's Lane Weir) and/or their potential to adversely impact on catchment water quality.

Although the Ling property was not identified as a Priority Landholder in 2007 the location in the catchment suggests it is a particularly high priority property for remediation activities (immediately upstream of Baroon Pocket Dam).

The Ling property is situated in a high priority Management Unit when pollution and land instability (according to broad water monitoring data) is considered (very high volumes of sediments and likely other contaminants). The land manager is extremely keen to implement activities that not only improve the management of the property but provide significant broader benefits – that is reducing the risk to the Sunshine Coast's most important water supply and the environmental outcomes that are realised.

3.8 ALIGNMENT WITH KEY PLANS & STRATEGIES

Reducing the risk to water quality is particularly critical for the supply of bulk drinking water to the population of south-east Queensland. All of the storages managed by Seqwater involve catchments which are developed (to varying extents) and support active and growing communities, along with important industrial and rural economic activity. If these catchments are not managed properly, the risk of exposure to water quality hazards is heightened as development continues and the population increases. As a pre-emptive measure, Seqwater is undertaking initiatives to minimise and manage the risks to water quality in its storages. Identifying and engaging stakeholders on water quality issues is critical to developing robust risk mitigation strategies and achieving good water quality outcomes in the broader catchment (Keys 2009).

The primary area LBCCG (and other community groups) can manage risk is in the area of land use – working with private landholders to minimise the impacts on water quality.

The project's outcomes are consistent with:

- Lake Baroon Catchment Implementation Plan (2007)
- Lake Baroon Catchment Management Strategy (2004)
- Seqwater Natural Assets Management Plan – Lake Baroon Catchment (2012)
- Catchment and In-Storage Risk Assessment for water Quality – Baroon Pocket Dam (2009)
- Sunshine Coast Council Waterways and Coastal Management Strategy 2011-2012 (2011)
- Mary River and Tributaries Rehabilitation Plan (2001)

3.8.1 Lake Baroon Catchment Implementation Plan (2007)

The LBCIP was developed in 2007 – a joint initiative of AquaGen (pre-Seqwater) and BMRG, and was delivered via LBCCG. The document aligns the summarised actions from the Lake Baroon Catchment Management Strategy (2004) with actions from the NRM Plan Country to Coast - a healthy sustainable future. Relevant actions include the development of on-ground works that address water quality, aquatic biodiversity, habitat recovery and particularly community involvement and engagement.

The project's outcomes are consistent with the Lake Baroon Catchment Implementation Plan (2007) which takes into account the Burnett Mary Regional Group Country to Coast: A Healthy Sustainable Future management actions.

Alignment of relevant summarised actions from the Lake Baroon Catchment Management strategy with actions from the NRM plan Country to Coast – a healthy sustainable future.

LBCIP Activity Theme		*Implementation Activity*	*BMRG Program*
On ground	OG1	Develop on ground works for water quality improvement and aquatic biodiversity maintenance & improvement	Water Quality & Equitable Use
			Biodiversity Conservation
On ground	OG2	Support and develop on ground works for habitat recovery	Biodiversity Conservation
On ground	OG3	Locate high value areas within catchment and target for protection and remediation	Biodiversity Conservation
Catchment management	CM1	Develop a program where by all landholders involved in on ground activities initiate PMP's as part of application process	Biodiversity Conservation
Catchment management	CM2	Property Management Planning Toolkit	Sustainable Use
Catchment management	CM4	Adoption of BMP for point and concentrated diffuse pollution	Community Capacity and Partnerships
Catchment management	CM6	Community involvement	Community Capacity and Partnerships
Catchment management	CM7	Stakeholder Survey	Community Capacity and Partnerships
Catchment management	CM8	Transition in NRM practice	Community Capacity and Partnerships
Catchment management	CM11	Industry involvement in NRM	Community Capacity and Partnerships
Catchment management	CM12	Training and skilling stakeholders in NRM	Community Capacity and Partnerships
Monitoring & research	MR1	Water quality hotspots	Water Quality & Equitable Use

3.8.2 Lake Baroon Catchment Management Strategy (2004)

An LBCMS was initially developed in 1997 by AquaGen and LBCCG in an attempt to identify the causes of poor water quality in Lake Baroon and consequently guide catchment investment. Updates have occurred in 2004 and 2007 although the most recent version remains in draft form. The 2004 LBCMS identifies priority management actions similar to the LBCIP – the active management of riparian lands throughout the catchment, reducing nutrient delivery to Lake Baroon, negating the impacts of development, addressing the loss of remnant vegetation, weed management and the engagement of the community – particularly large landholders.

3.8.3 Natural Assets Management Plan – Lake Baroon Catchment (Seqwater 2012)

The recent Seqwater NAMP (2012) reviewed the current and historical management plans for the Lake Baroon catchment and documented clear actions to reduce risks to water quality in Lake Baroon, particularly through the development and strengthening of partnerships. Relevant actions relating to the project include weeds, erosion, catchment management, livestock management, stakeholder partnerships, erosion and biodiversity.

3.8.4 Catchment and In-Storage Risk Assessment for Water Quality – Baroon Pocket Dam (2009)

Seqwater conducted an extensive review of the risks to water quality in Lake Baroon and associated catchment in 2009. The project addresses the following identified risks:

Risk No. 3.6.2. High Inflow Events

During and subsequent to a high rainfall event, the water quality of the lake is likely to be impacted due to an increase in nutrients, turbidity, colour, TOC, BOD, gross pollutants, pathogens, petroleum hydrocarbons and changes in temperature.

Risk No. 3.6.3. Steep and Unstable Slopes

The hazards to water quality due to steep and unstable slopes and associated landslips include high nutrient loads, increased turbidity and changes in water colour.

Risk No. 3.6.7. Livestock Management

Grazing management issues that may impact water quality include the use of pesticides and fertilisers, overgrazing of paddocks leading to accelerated erosion, livestock having direct access to streams, trampling of riparian vegetation, animal faecal contamination and animal carcasses.

Risk No. 3.6.14. Cyanobacterial Blooms

Cyanobacterial blooms (also referred to as blue-green algae) can produce extremely potent toxins that present a risk to potable water supply and direct contact recreation. Potential causes of cyanobacterial blooms include increased nutrient loads, temperature, drought, dam water turnover events and light.

Risk No. 3.6.15. Land Use Changes (intensification)

The Sunshine Coast and Maleny in particular is popular with tourists and new residents and is experiencing unprecedented levels of population growth and intensification of housing developments. Intensification of land use can have detrimental effects on water quality through increased erosion, increased stormwater runoff and increased pollutant loads.

3.8.5 Sunshine Coast Council Waterways and Coastal Management Strategy 2011-2021 (2011)

Sunshine Coast Council, particularly through the Rivers Initiative program, and various funding programs is committed to supporting community groups to improve the region's environment. The project addresses the following Strategy goals:

Natural waterways	***Goal: To provide a coordinated, integrated and informed approach to the protection, rehabilitation, sustainable use and enjoyment of natural waterways.***
NW3	Develop and sustain partnerships with government, industry, universities, regional natural resource management bodies and community groups.
NW8	Develop land management initiatives in partnership with the rural industry and state government to improve waterway health.
NW13	Undertake and support activities to improve the condition of riparian and in stream habitats.
NW16	Promote and inform the community about natural waterway values and management initiatives.

3.8.6 Mary River and Tributaries Rehabilitation Plan (2001)

The MRTRP is a Mary River wide rehabilitation plan. The Obi Obi Creek is a major tributary of the Mary River and therefore an integral part of Mary River planning and rehabilitation. The project addresses riparian vegetation management, the conservation of remnants, revegetation, erosion, enhancing habitat for vulnerable and threatened species and building the capacity of both landholders and community groups.

4.0 IMPLEMENTATION

4.1 Drainage & profiling

On cleared land the stabilisation of existing slides can be assisted through surface drainage of susceptible areas, thus helping reduce peak groundwater pressures that may develop during wet periods:

- springs, seeps and wet spots should not be trampled by stock as this can seal the soil and increase water pressures in the hillside behind.
- dams above, within and adjacent to landslips and susceptible locations must be removed;
- The temptation to use swamps and ponds (seasonal marshes) that develop in the back tilted upper sections on the benches for stock water must be avoided. Instead all means possible to drain such areas should be undertaken; *and*
- drains should remove the water to a safe location as directly as possible. Lateral drains may need to be sealed to avoid expanding the saturated area.

4.2 Fencing

Livestock management on landslip susceptible sites is critical. Vegetation on landslips provides some stability, and in the absence of tree cover pasture needs to be as robust as possible with Kikuyu and other 'running' species preferable. Kikuyu pasture is useful for binding an earthflow as its matting ability holds together the soil and helps to contain the mobilised clay soils (Ellison & Coaldrake 1974).

Springs, seeps and wet spots should not be trampled by stock as this can seal the soil and increase water pressures in the hillside behind. Livestock trampling on the slip itself can result in the retention of water on the unstable area through the formation of 'pugging'.

4.3 Revegetation

Rehabilitation of existing landslides or susceptible areas, particularly those on benches, primarily involves reducing groundwater pressures. Attention to surface drainage as described above helps but, as much of the water has a deep seated source (groundwater percolating through the rocks from the plateaux above), this alone is unlikely to be adequate.

A preferred option on deep, extensive landslips is a longer term approach is to combine drainage while promoting water uptake through transpiration of a replanted tree cover. There is increasing interest in this approach, as it has potential for restoring some form of productivity to the land (although long term), as well as controlling some of the main effects of landslides, such as soil erosion and noxious weeds. There is little information available at present as to what density of tree cover is required to achieve this satisfactorily. It is suspected that full forest cover will be necessary, as the residual strength of failed materials is commonly less than it was in the original state. Consequently, there is probably a need to reduce groundwater pressures to less than original levels if possible (Willmott 1987).

Reforestation on the basalt plateaux presents certain problems, and normal revegetation techniques are likely to be inadequate. The main problems are likely to be:

- choking effect of the dense kikuyu grass if reforestation areas are fenced off, the cost of chemicals and labour to control it, or the loss of seedlings to stock if the areas are not fenced;
- wet swampy areas in the centres of landslides or spring zones;
- possibility of further movement in landslides disrupting roots of growing trees; and
- species choice.

On the wettest and most mobile areas the priority should be to establish any form of tree cover that is possible, and thoughts of commercial return (either grazing or forestry) should be secondary. Tree species not normally used in revegetation may be necessary, and loss of trees through root disturbance in the early part of the programme will have to be accepted (and replaced).

As a rough guide Maleny has a very wet year (over 2,900 mm annual rainfall) approximately every 10 years, but this does not necessarily mean there were/are abnormal rain events likely to trigger landslips. On the other hand a drought year (less than 1,500 mm annual rainfall) occurs approximately every 5 years. Interestingly it appears that around every 25 years there is an exceptionally wet year.

Revegetation of landslips probably needs to occur during a prolonged series of dryer years (Reid & Page 2002 suggest a minimum of eight years is probably required before vegetation provides adequate stability on landslips). After three very wet years, is south east Queensland due for a prolonged run of below to average rainfall years?

4.4 Field Day

n/a

5.0 ACTION PLAN

Activity Start and Completion dates are indicative only and will be dependent on weather conditions.

Action		*Responsibility*	*Start Date*	*Completion Date*	*Measurable Output*
Project Plan		LBCCG Project Manager	Jan 14	Feb 14	Project Plan
Project Plan forwarded to BMRG for approval		LBCCG Project Manager	Feb 14	Feb 14	Approved Plan Funding granted
Project presented to LBCCG Committee for approval (includes Seqwater rep.)		LBCCG Project Manager & Committee	Feb 14	Feb 14	Approved Plan
Pre-works monitoring (including photo points)		LBCCG Project Manager	Sep 08	Mar 14	Photo & data set
Application to Sunshine Coast Council (LEG program)		LBCCG Project Manager, landholder	Feb 14	Mar 14	Approved Plan Funding granted
PROJECT IMPLEMENTATION	Drainage & profiling	Contractor, landholder	Feb 14	Mar 14	1 hectare drained; 0.3 profiled
	Fencing	Contractor, landholder	Feb 14	Mar 14	500 metres
	Revegetation	Landholder, contractor	Mar 14	May 14	1,120 plants
	Field Day	LBCCG Project Manager	Apr 14	May 14	25 attendees
Progress Report		LBCCG Project Manager	Mar 14	Apr 14	Progress Report
Final Report		LBCCG Project Manager	Jul 14	Aug 14	Final Report
Post-works monitoring.		LBCCG Project Manager	Mar 14	Jun 2014 ongoing	Photo & data sets
Maintenance & further activities		LBCCG & Seqwater	Aug 14	Jun 15 ongoing	TBD

Note – the Project Action Plan will be used as the basis for Quarterly Reporting

6.0 PROCUREMENT

6.1 SERVICES & PRODUCTS

The Project Manager will have the authority to engage and arrange payment for services and products for all activities once the Project Plan is approved. Any deviation over $300 from the approved Project Budget requires approval from the Project Committee (and in this case either/and Burnett Mary Regional Group and/or Sunshine Coast Council). Services and products will be sourced locally wherever possible and from not-for–profit community organisations if applicable.

Service/Product	*Supplier*	*Contact (if applicable)*
Drainage & profiling	Earthmoving Contractor: EW & CC Ferriday	Fred Ferriday
	Earthmoving Contractor: P & K Nash	Phil Nash
Fencing	Fencing Contractor: Bald Knob Fencing	Tim Simpson
	Fencing Contractor: Mark Franks	Mark Franks
Revegetation	Materials: Brush Turkey Enterprises	Spencer Shaw
	Revegetation: Barung Landcare	Matt Bateman
	Revegetation: Totem Fauna & Flora	Jason Flynn

Multiple service and product providers are listed to ensure timelines are met. In the event of a provider being unable to supply the requested service or product an alternative supplier will be selected from the list of preferred suppliers. All suppliers must demonstrate full insurance and liability requirements and that all staff or personnel on site are appropriately licenced and/or experienced.

6.2 COST ESTIMATION METHODOLOGY

6.2.1 Drainage & Profiling

Drainage works required is simply general machine work with no materials required. If materials are required that becomes the responsibility of the land manager.

Earthmoving hire rates have been estimated from similar activities conducted within the last twelve months.

EW & CC Ferriday and P & K Nash charge general earthmoving hourly rates of $100.00 per hour (GST exclusive) plus float hire if applicable.

6.2.2 Fencing

Fencing rates have been estimated from recent similar activities conducted by LBCCG.

Bald Knob Fencing charges an indicative rate of $14.00 per metre for standard cattle fencing (timber posts at 4 metre spacings; 4 barb wires; 12‘ steel gates) with gates at $350.00 each. This includes an extra strainer

post, gate, fittings and labour to install. These figures rely on long straight strains and little to no rock encountered.

Mark Franks fencing is generally more expensive and will only be engaged if Bald Knob Fencing is unavailable.

6.2.3 Revegetation

Revegetation figures are estimated from previous similar projects implemented by Barung Landcare and Totem Fauna & Flora.

Activity	***Description***	***Cost $ (GST exclusive)***
Site Preparation	Ring spraying per plant	0.18
	Brush cutting per plant	0.36
Planting	Cost per plant	3.64
	Place weed mat and guard	0.91
Revegetation Materials*	Think Pink 500 mm x 250 mm x 250 mm guard & hardwood 900 mm x 23 mm x 13 mm stake	2.50
	370 mm x 370 mm weed mat	0.70
	Tube-stock (native tube)	1.50
	Tube-stock (mega tube)	3.18
Maintenance	Ring spraying per plant (includes hand weed inside guard where necessary)	0.18
	Brush cutting per plant	0.36

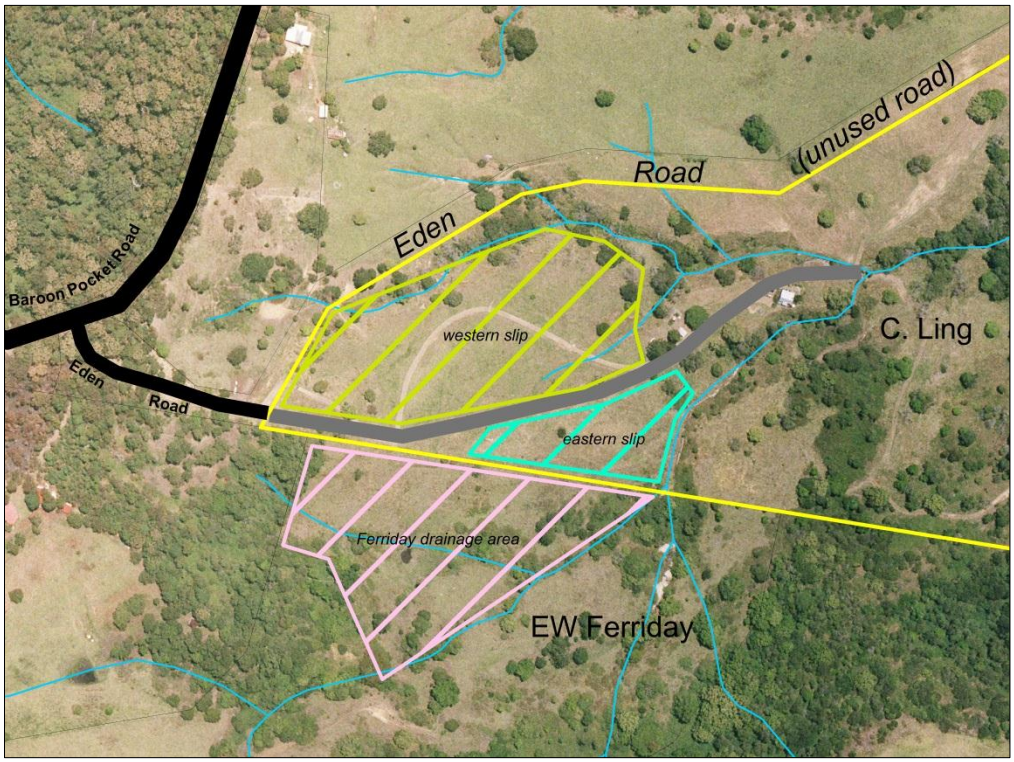
* Revegetation materials price lists can be found here:

http://www.brushturkey.com.au/wp-content/uploads/2013/08/BTE-July-Price-List.pdf

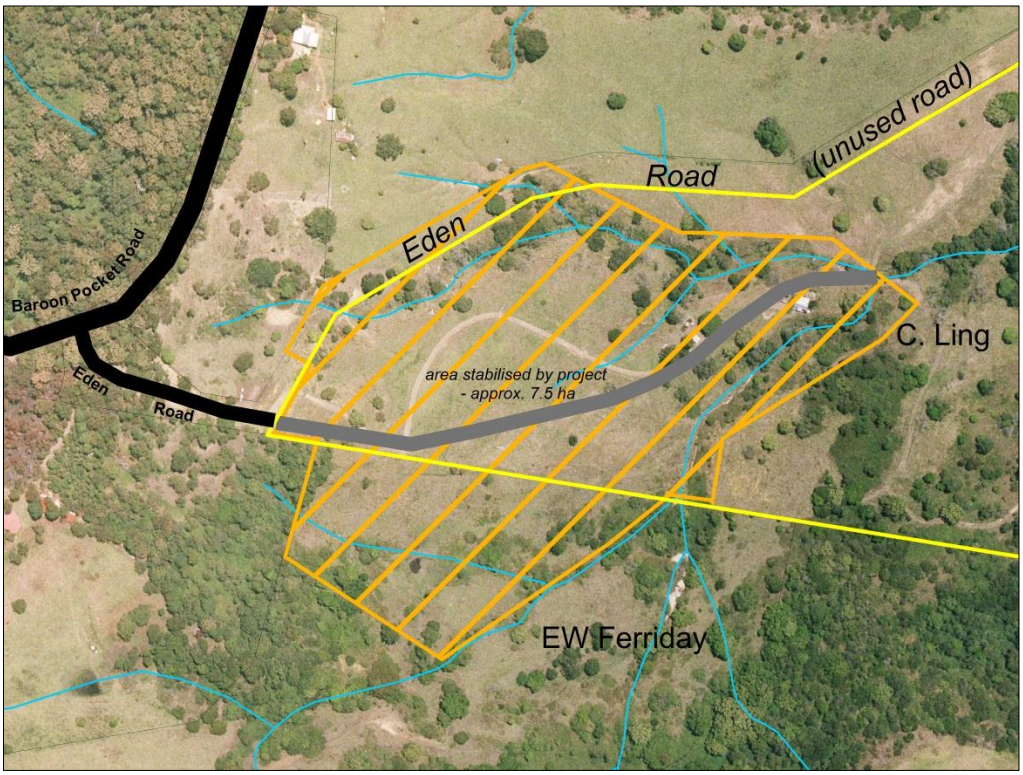
6.2.4 Field Day

To be determined.

7.0 MAPS



Above: Project map showing the location of the various individual sites described in the Plan.



Above: The area to be stabilised; initially through drainage works and over time revegetation.

8.0 HAZARD & RISK ASSESSMENT (HRA)

LBCCG has a comprehensive Safety Management System that clearly directs all aspects of Projects; Project selection (on the basis of safety), Project development, Contractor and/or volunteer engagement, Landholder expectations and requirements, Project implementation and ongoing Project monitoring and evaluation.

LBCCG adheres to the relevant legislation, policy and standard requirements:

- **AS/NZS Risk Management Standard 4360:1999**
  Establishes and implement a risk management process that involves the identification, analysis, evaluation, treatment and ongoing monitoring of risks.
- **AS/NZS 4084:2001 Occupational Health and Safety Management Systems – General Guidelines on Principles, Systems and Supporting Techniques**
  Provides guidance on the development and implementation of occupational health and safety management systems (OHSMS) and principles, and their integration with other management systems.
- ***Workplace Health and Safety Act 2011*** **(Qld)**
  To prevent a person's death, injury or illness being caused by a workplace, by a relevant workplace area, by work activities, or by plant or substances for use at a workplace.

8.1 ASSUMPTIONS AND LIMITATIONS

Assessment of hazards and risks associated with the project was undertaken as part of the project development process. As a result, the risks and hazards identified are based on existing information about the project at the time of writing, and proposed construction and operational features. Further risks and hazards may be identified in future stages or identified risks could be downgraded or upgraded in terms of the level of risk they pose. Additional mitigation measures as required will be developed and documented in the Implementation Risk Management Plans for the project which will need to remain live documents throughout the relevant project phases. The consideration of natural hazards is based on existing information about the project area including overlay mapping from the former Caloundra and Maroochy Shire Councils (now Sunshine Coast Council). This enables a high level assessment to be made of the risk of natural hazards in the project area, however, detailed modelling or prediction of natural hazards has not been undertaken.

8.2 IDENTIFICATION OF RISKS

Hazards (and related risks) have been identified relating to the four on-ground phases of the project:

1. Drainage works (earthmoving);
2. Fencing;
3. Revegetation; *and*
4. Field Day.

The project is believed to be both a safe and efficient landslip remediation activity. All activities and phases present some level of risk however, which will be identified through a HRA so that appropriate management measures can be implemented to reduce or remove those risks.

All site visitors will be provided with a site specific induction. Contractors engaged complete, with the LBCCG Project Manager, a *Contractor Field Safety Induction Form* (LBCCG Form No. 007) providing current Insurances, accreditations and acknowledgement of Contractor responsibilities.

9.0 CULTURAL HERITAGE

The Native Title Determination in November 2012 awarded the Jinibara People non-exclusive title of the Maleny area including Baroon Pocket (Baroon Pocket Dam).

The paramount legislation in Queensland, with regard to Aboriginal cultural heritage issues, is the *Aboriginal Cultural Heritage Act 2003*, which states that a person who carries out an activity must take all reasonable and practicable measures to ensure the activity does not harm Aboriginal cultural heritage (the 'cultural heritage duty of care') (Section 23[1]). The Act defines cultural heritage as (S8):

- a significant Aboriginal area or Aboriginal object
- evidence, of archaeological or historic significance, of Aboriginal occupation of an area.

A significant Aboriginal area is 'an area of particular significance to Aboriginal people' because of either or both of the following:

- Aboriginal tradition
- the history, including contemporary history, of any Aboriginal party for the area (S9).

The Act states that it is an offence for a person to harm, remove or possess cultural heritage if the person 'knows or ought reasonably to know that the object is Aboriginal cultural heritage' (S26).

The Maleny area and particularly the Baroon Pocket area have had significant cultural heritage values for a long period of time. Items of cultural heritage significance can be discovered anywhere in the catchment however riparian zones are a likely location.

The project will involve three phases that could potentially unearth artefacts:

1. Earthmoving activities – digging of drains near watercourses, profiling edge of landslip (levelling);
2. Fencing – shallow scraping to clear alignment, boring of moderately deep holes for posts; all within or adjacent to the riparian zone; *and*
3. Revegetation activities – digging shallow holes.

All activity locations have been largely disturbed since European settlement (deforestation) and have undergone significant movement of soil layers – particularly the areas to involve earthmoving activities. Visual inspection of the sites before and during activities will be carried out and if artefacts or suspected features are unearthed, activities will be immediately suspended and the relevant representative contacted (Ken Murphy, Jinibara Elder).

10.0 MONITORING AND EVALUATION

10.1 INTRODUCTION

Monitoring and evaluation strategies are essential components of any environmental rehabilitation project. Evaluation is the best way to improve our knowledge about what works, what doesn't and how we can best direct our rehabilitation efforts. Monitoring strategies are key components of the overall evaluation process that allows you and others to learn from the project and assess whether rehabilitation aims have been met.

Furthermore, monitoring results and information will be used to:

1. Raise awareness and encourage further remediation works with priority landholders (primary producers and large landholders in the Lake Baroon catchment).
2. Promote cooperative projects between Lake Baroon Catchment Care Group, Seqwater, Sunshine Coast Council and other Natural Resource Management organisations.
3. Critically examine techniques and methods used throughout the project to continually improve the service to landholders conducting on-ground works in the catchment and improve best practice management.
4. Develop cost-effective strategies and techniques to perform on-ground activities.
5. Continue to develop monitoring and evaluation program that meets the requirements of funding bodies, but also provides the relevant information and feedback to the LBCCG and Seqwater to improve project delivery.

It can be very difficult to measure outcomes as they may take many years to occur or reach the final result and can be enormously expensive to quantify – potentially far more than the actual implementation of the project. We must rely on best management practice, anecdotal evidence and sometimes partnerships with universities and/or Seqwater to produce 'hard' data to the actual effectiveness of the project.

We will rely on the both the Australian Rivers Institute and Queensland University of Technology to assist us to measure (or accurately estimate the project's outcomes).

10.2 MONITORING PROGRAM

Monitoring of rehabilitation activities – the drainage works, fencing and revegetation will be split into periodic and episodic monitoring.

Periodic monitoring is important to measure the effectiveness of the activities over time and will occur on a biannual basis by LBCCG.

Episodic monitoring will occur following significant storm/rainfall events (or extended dry periods) and will check all the fencing integrity. This may, depending on the severity of the event, be achieved by a phone call to the landholders.

Photo point monitoring will provide valuable evidence of works completion, a record of changes over time, and provide an important assessment tool to evaluate the project.

11.0 COMMUNICATIONS

Project Progress Reports will be provided at monthly LBCCG meetings which are open to all stakeholders. A Final Report (for BMRG funding) will be produced once all on-ground activities and initial monitoring and evaluation is completed (June 30 2014). Sunshine Coast Council Final Report will be produced as required but will likely be in May 2015.

A modified version of the Project Plan (specific financial details and landholder contact details deleted) will be placed on the LBCCG website: www.lbccg.org.au.

The project will also be included in LBCCG newsletters.

12.0 REPONSIBILITIES & ROLES

The Project Manager will be responsible for project implementation, management, reporting, evaluation and general management of the project. Other contributions will be on an as-needed basis and the following register of roles will ensure the project is implemented efficiently, effectively and follow best practice.

Role	***Individual***	***Organisation***
Project Manager	Mark Amos	LBCCG
Project Owner	Peter Stevens	LBCCG (President)
Project Committee	TBD	LBCCG (Management Committee)
	TBD	
	TBD	
Technical advice	John Day, Kay Enkelmann, Emily Maher	Burnett Mary Regional Group
	John Howlie, Tim Odgers	Seqwater
	Will Stearman, Jess Trofimovs	Queensland University of Technology
	Luke Shoo	University of Queensland
	Matt Bateman	Barung Landcare
	Jason Flynn	Totem Fauna & Flora
	Alan Wynn	Sunshine Coast Council

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