Lake Baroon Catchment Care Group

Working with our community...for our waterways

Projects 2016-17

Clark Creek Off Stream Water Project (Thomas, Barlow & Macleod)

seqwater WATER FOR LIFE

Sunshine Coast. COUNCIL

PROJECT PLAN

Project No. 1617-008

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

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Disclaimer

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How to read this Plan

This Plan is split into three distinct sections.

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

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

The **Attachments** (pp. 17-41) provide 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

Lake Baroon and Baroon Pocket Dam are used interchangeably.

Confidentiality

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

DOCUMENT VERSIONS & APPROVALS

Version	*Date*	*Version/Description*	*Result*
1.0	7/4/2017	Draft LBCCG Project Proposal completed. Project emailed to LBCCG Committee for comments and in principle approval.	n/a
1.0	13/4/2017	Project Plan will be presented at April 2017 LBCCG Meeting for approval.	Approved (Minutes 97.7.7)
1.0	18/4/2017	Project Proposal forwarded to Seqwater for approval (email)	Approved 18/4/2017

AUTHORISATIONS

Name	*Signature*	*Date*
Prepared by: Mark Amos Project Manager, LBCCG		7/4/2017
Approved by (LBCCG): Peter Stevens President, LBCCG		13/4/2017
Endorsed by (Seqwater): Tim Packer Senior Planner, Source Protection Planning		18/4/2017
Approved by (Seqwater): Andrew Smolders Acting Principal Source Protection Planning		18/4/2017

Cover photo: *Headwaters of Clark Creek on the Thomas property.*

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PART A EXECUTIVE SUMMARY

PROJECT NUMBER & TITLE: **1617-008 Clark Creek Off Stream Water Project (Thomas, Barlow & Macleod)**

The Clark Creek Off Stream Water Project will be implemented in a high priority sub-catchment that delivers very high levels of nutrients and likely pathogens to Obi Obi Creek and ultimately Baroon Pocket Dam. LBCCG has been very active in the upper reaches of Obi Obi Creek for many years working with dairy farmers and large beef graziers rehabilitating laneways, installing stream crossings and off stream watering, fencing waterways, and other activities that reduce risks to water quality. The upper reaches of Obi Obi Creek support large agricultural properties that are suspected (and suggested by Seqwater water quality monitoring) of contributing high levels of contaminants to the system. The project will bring together three adjoining Landholders to fence riparian zones, install off stream watering systems and construct and repair stream crossings. This will address erosion caused by livestock, reduce the deposition of faecal material directly into waterways, improve buffers to watercourses and improve property management.

APPLICANT/LANDMANAGER DETAILS

Names	[redacted]
Postal Address	
Phone Number	
E-mail	

PROJECT / SITE LOCATION

Property Address	Reesville Rd, Reesville	Flesser Rd, Reesville, 4552	Aplin Road, Reesville
Latitude/longitude	-26.760960 152.797008	-26.766727 152.804390	-26.769581 152.810784
RP Numbers (Lot)	SP120424(1), MCH4176(277)	MCH164 (114)	SP156790 (6 & 7)
Property Size	80 ha	47 ha	54 ha
Land-use & stock carried	Beef (120)	Beef (60)	Beef (40), alpaca (20), horses (10), conservation
Sub-Catchment/MU	Obi Obi Creek OB1	Obi Obi Creek OB1	Obi Obi Creek OB3
M.U. Priority *(LBCCG IP)*	**Low**	**Low**	**Moderate**
M.U. Priority *(Pollution)*	**High**	**High**	**Moderate**
Water Quality *(ANZECC)*	**99% exceeded (1999-2005)**	**99% exceeded (1999-2005)**	**88% exceeded (1999-2005)**

PROJECT PARTNERS/STAKEHOLDERS & ROLES

Lake Baroon Catchment Care Group (Seqwater 2016-17 CORE Project Funding)	On ground project implementation (**$52,089**)
Lake Baroon Catchment Care Group (Seqwater 2016-17 CORE Administration Funding)	Project coordination, administration, reporting, monitoring & evaluation (**In kind $10,700**)
Landholders	Landowners, labour, cash and in-kind contributions (**$48,955** cash & in-kind)

PROJECT DETAILS

Start Date	Mar 2017	***Completion***	June 2017	**Duration** (implementation)	1 year
TOTAL OUTPUTS					
Fencing	1,545 metres	***Off stream watering***	2 systems (7 troughs)	***Stream crossings***	1 new 2 repaired
TOTAL OUTCOMES					
Length of watercourse fenced (stock managed)					730 metres
Area of land under improved management					181 hectares
Priority Landholder engagement					3 landholders

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

The Thomas, Barlow and Macleod properties lie in high priority Management Units in the Obi Obi Creek catchment – MU OB1 and OB3. These MUs lie in the upper reaches of Obi Obi Creek where agricultural properties still dominate land use. The Mus are characterised by moderately steep slopes and numerous watercourses, and have been identified as contributing significant inputs of nutrients (OB1 – 99% of samples between 1991 – 2005 exceeded ANZECC guideline levels; OB1 – 88% of samples between 1991 – 2005 exceeded ANZECC guideline levels). Although the middle and lower reaches of Obi Obi effectively 'clean' many of the contaminants that originate from the upper catchment before entering Baroon Pocket Dam, it is prudent to address issues at the source. =

The proposed project aims to complete six components:

Activity	Description	Property	Funded by
Permanent electric riparian fencing	1,420 metres	Thomas	LBCCG CORE funding
Permanent riparian fencing	125 metres	Macleod	LBCCG CORE funding
Extend off stream watering system	6 troughs	Thomas	LBCCG CORE funding
Extend off stream watering system	1 trough	Macleod	LBCCG CORE funding
Stream crossing	1 crossing	Barlow	LBCCG CORE funding
Rehabilitate stream crossing	2 crossings	Thomas	LBCCG CORE funding

Note: the project was identified as a <u>priority</u> in the LBCCG 2016-17 Annual Investment Strategy.

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 for 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).

The activities of LBCCG are supported by Seqwater as they align with Seqwater's commitment to the NHMRC Framework and to environmental stewardship by supporting catchment planning and targeted remediation for reduction of catchment based risks to water quality (Smolders 2011).

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 fence and revegetate riparian zones Including the remediation of landslips are considered sensible to support.

ii. BACKGROUND

The upper Obi Obi Creek catchment has been targeted for major on ground activities (projects) since 2009 as this sub-catchment is recognised as delivering very high volumes of nutrients and other contaminants (the sub-catchment is largely agricultural). Two different approaches have been used in this part of the catchment. Many works or activities have directly targeted the sources of point and diffuse pollution – stream crossings, riparian fencing and laneway rehabilitation for example. Further downstream where there are opportunities to fence and revegetate the Obi Obi Creek riparian zone (Farmhouse Macadamia, Kings Land Weir) large scale plantings have been implemented. These plantings are suspected of 'cleaning' flows as they pass through the system as water monitoring downstream indicate.

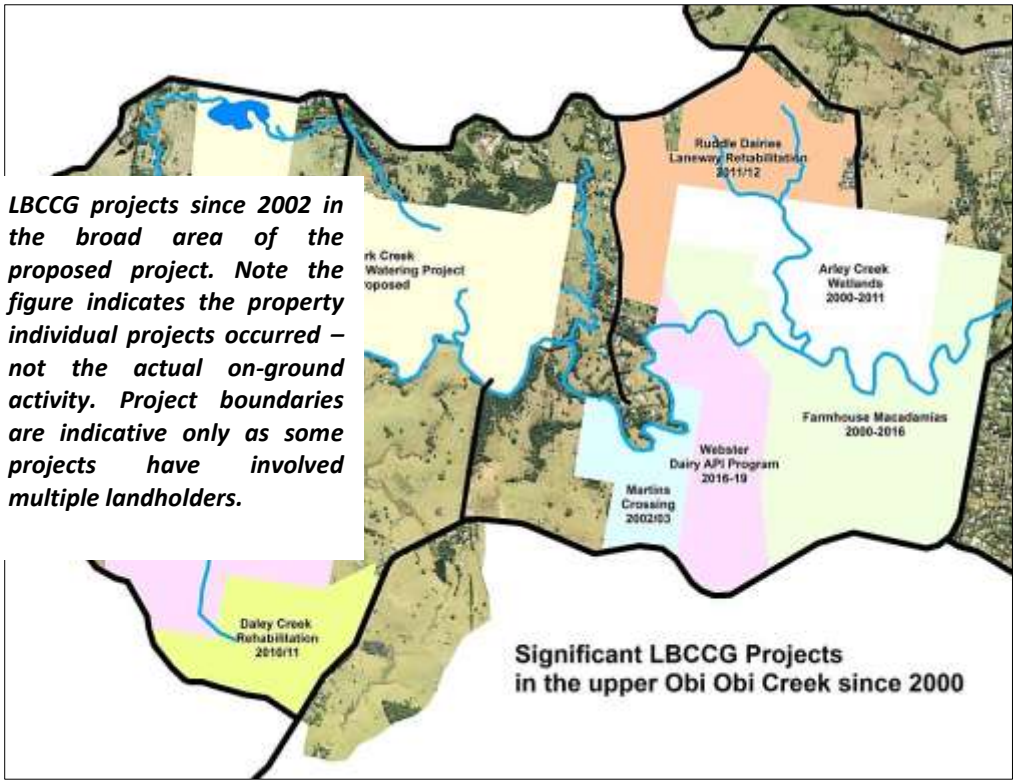
The Lake Baroon Implementation Plan (2007) considered this part of the catchment as low priority for works as it was deemed virtually beyond repair, or at least would cost significant levels of investment to make any difference. Certainly the lower reaches of this sub catchment (Management Unit) can be considered difficult to remediate however the upper reaches, as mentioned above, can be effectively and efficiently remediated. Recent (2009/10) changes to how catchments are assessed for priority, has resulted in a greater emphasis on areas that are identified as high contributors of contaminants. When this is taken into account the sub-catchment is considered High Priority (between 88% [OB3] and 99% [OB1] of samples exceeded ANZECC guideline levels 1991-2005 (Traill 2007).

iii. PREVIOUS PROJECTS IN AREA/CATCHMENT

Numerous large projects have occurred in the upper Obi Obi Creek catchment – where large agricultural properties still dominate. Since 2008 there has been a concerted effort made to engage the landholders in this area as the catchment provides high levels of nutrients (including faecal material, fertiliser run-off and other pollutants) and likely pathogens.

LBCCG projects in the upper Obi Obi Creek catchment include:

Project Name	*Years implemented*	*Project outputs*	*Total Project Value*
Martins Crossings (Martin)	2002/03	Stream crossings	$1,337
Daley Creek Rehabilitation (Woods)	2002/03 2010/11	Riparian fencing, stream crossing construction and repair	$36,420
Arley Creek Wetlands (Stevens) and other various projects	2002-2011	Riparian fencing, revegetation, stream crossings, off stream watering and weed management	$102,810
Obi Obi Partnership	2003-06	Riparian revegetation	$114,225
Kings Lane Weir	2005-10	Riparian fencing and revegetation	$21,331
Clark Creek Riparian (Barlow)	2009/10	Stream crossing, riparian fencing and revegetation	$13,197
Cork Dairies (Cork) (various projects)	2009-12	Stream crossings, laneway rehabilitation	$118,135
Farmhouse Macadamias (various projects)	2010-2016	Revegetation, stream crossings and weed management	$128,572
Ruddle Dairies Laneway Rehabilitation (Ruddle)	2011/12	Laneway rehabilitation	$60,729
Obi Obi Creek Fencing and Revegetation (Macleod)	2014/15	Riparian fencing, revegetation and alternative watering	$22,808
Webster Dairy API Program	2016/17	Off stream watering	$51,865



LBCCG projects since 2002 in the broad area of the proposed project. Note the figure indicates the property individual projects occurred – not the actual on-ground activity. Project boundaries are indicative only as some projects have involved multiple landholders.

1.0 WHAT

(What activities will be implemented)

The proposed project aims to complete/commence six activities before June 30, 2017 (weather dependent):

1. Install 1,420 metres riparian fencing on the Thomas property;
2. Install 125 metres riparian fencing on the Macleod property;
3. Extend Thomas off stream watering system and install six troughs;
4. Extend Macleod off stream watering system and install one trough;
5. Install stream crossing on Barlow property; *and*
6. Rehabilitate two stream crossings on Thomas property.

Obi Obi Creek at Aplin Lane.

2.0 WHERE

(Where in the catchment will the project occur)

The project will be implemented on the Thomas, Barlow and Macleod properties in the upper Obi Obi Creek catchment.

(a) Thomas property.
305 Reesville Rd, Reesville

Property is approximately 80 hectares – comprising the following:

- 72.5 ha of improved and unimproved pasture;
- 2 ha regrowth vegetation (including weeds); *and*
- 1.5 ha residential, old dairy, sheds and stock yards.

Additionally the property has:

- 2,160 metres of Clark Creek;
- 250 metres frontage to Obi Obi Creek; *and*
- Over 2,500 metres of minor watercourses (permanent and ephemeral).

(b) Barlow beef
89 Flesser Rd, Reesville

Property is approximately 47 hectares – comprising the following:

- 41.6 ha of improved and unimproved pasture;
- 2.4 ha remnant vegetation;
- 2.0 ha regrowth vegetation (including weeds); *and*
- 1 ha of residential including yards and sheds.

(c) Macleod beef, alpaca and horse property
75 Aplin Lane, Reesville

Property is approximately 54 hectares – comprising the following:

- 7.5 ha of unimproved pasture (including approximately 1.5 ha of potentially unstable slopes – ***see figure below***);
- 5 ha remnant vegetation;
- 7.5 ha regrowth vegetation (including weeds);
- 0.5 ha of residential (including access laneways).

3.0 WHY

(What benefits will the project provide)

Lake Baroon Catchment Care Group is focussed on improving raw water quality in the Lake Baroon catchment and achieves this by working with private landholders in the catchment. Supporting landholders to improve land management, in turn provides multiple beneficial outcomes; water quality and broader environmental benefits while providing 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 a range of other environmental outcomes which generates support from other funding providers (most notably Sunshine Coast Council).

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.

3.1 OBI OBI CREEK

The upper Obi Obi Creek catchment is predominantly cleared with gentle slopes on soils that suit agriculture – particularly grazing. The catchment is dominated by large properties that generate high pollution levels (nutrients).

The Obi Obi Creek is the most significant watercourse in the Lake Baroon catchment, consisting of 71 km of waterway in a sub catchment of 2,880 ha. A mere 18% of the sub catchment is covered in vegetation, with much of the area significantly disturbed, mostly supporting beef or dairy cattle; but also including urban Maleny (Dunstan 2007).

Obi Obi Creek has been divided into nine Management Units that reflect property boundaries, physiography, vegetation, land use, point and diffuse source impacts. This provides administrative convenience and the ability to prioritise stream zones more accurately according to various threats.

The project lies in Management Unit OB3.

3.2 RISKS TO WATER QUALITY

In excess, faecal material and associated nutrients (largely nitrogen and phosphorus) and pathogens are high risk to water quality. High levels of nutrients in surface water contribute to algae blooms that result in hypoxic or oxygen-deprived dead zones in water bodies (Baroon Pocket Dam). Throughout history, consumption of drinking water supplies of poor sanitary quality has been linked to illnesses in human populations. These illnesses most commonly present as gastrointestinal-related symptoms, such as diarrhea and nausea (Health Canada 2013).

Sampling for these pathogens is difficult and largely impractical due to the number of types and distribution variability of bacterial pathogens that can be present in animal and/or human wastes, and because detection requires significant resources. As a result, monitoring for a broad indicator of faecal contamination such as *Escherichia coli* is useful in verifying the microbiological quality and safety of the drinking water supply.

Although livestock in watercourses are an obvious risk, contamination can originate in many ways; failing or poorly performing wastewater systems, wildlife and birds, stormwater and so on.

Faecal material can also contain pharmaceuticals — anti-bacterials and hormones — given to some livestock to fight disease and promote growth. (Health Canada 2013).

3.3 WATER QUALITY MONITORING

Analysis of the raw water sampled from the Aplin Lane sampling site between 1991 – 2005 (Traill 2007) shows:

- Turbidity levels exceeded guideline levels only twice however it is unlikely the sampling program accurately captured the likely events (the topography of the catchment means flood waters rapidly disperse when rainfall ceases and it is unlikely sampling occurs in a timely manner;
- Nitrate levels exceeded the guideline value 59% of the time although this was falling as dairy farms converted to beef (less use of fertiliser);
- Ammonia levels exceeded the guideline value 76% of the time and varied throughout the sampling period making it difficult to pin point causes;
- Phosphate levels exceeded the guideline level 38% of the time although this is likely to be higher in reality, as phosphates attach to sediment and turbidity levels have already been identified as unusually low;
- Total phosphorus levels exceeded the guideline level 93% of the time; *and*
- Faecal coliforms exceeded the guideline level 70% of the time although declining during the sampling period.

3.4 OBJECTIVES

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

- reduce erosion of the bed and banks of Clark and Obi Obi Creeks and tributaries (riparian fencing and provision of alternative water supply) reducing turbidity and sedimentation;
- reduce direct faecal deposition (nutrients and pathogens) to watercourses and enhance buffers (riparian fencing and livestock do not spend as much time in watercourses where unfenced) to overland flows;
- improve livestock management (off stream watering and installing and repairing stream crossings) – important for gaining landholder support);
- build land manager engagement (previously unengaged landholder – Thomas); *and*
- enhance wildlife corridors and habitat (riparian fencing).

Baroon Pocket Dam in September 2013 (storage remained closed for almost 12 months). Cyanobacteria blooms disrupt recreational use of the storage and create difficulties in the production of potable water.

3.5 PRIORITY ACTIONS FOR OBI OBI CREEK (AquaGen 2004):

1. Maintain adequate riparian buffers and erect riparian fencing and exclude or actively manage stock access to waterways, including the provision for off stream watering and shade and hardened access points.
2. Actively promote the implementation of Industry relevant Environmental Codes of Practice.
3. Provide incentives, advice and encouragement for riparian landholders to retain and actively manage existing native vegetation within riparian buffers.
4. Encourage good farming practices, particularly on floodplains and steep slopes which reduces the rate of soil loss to below that of natural soil forming processes.

4.0 HOW

(How will the activities be implemented)

4.1 RIPARIAN FENCING - THOMAS

Livestock have uncontrolled access to a large four hectare farm dam and Clark Creek that flows into the neighbouring downstream property. The dam due to its size and construction (relatively shallow with a deep end near the wall provides a settling pond for agricultural contaminants and the impacts from several upstream rural residential properties (wastewater systems, grazing and so on).

Currently the banks and bed of the dam and creek are degraded resulting in erosion and damage to wetland macrophyte vegetation that is essential for filtering polluted stormwater. The fencing of the watercourse will reduce damage to the bed and banks of the creek reducing erosion, nutrient and pathogen inputs and improve the watercourses ability to 'polish' pollution originating upstream.

Permanent electric cattle fencing will be installed (timber split posts at ten metre spacings, two plain wires and simple gates).

Large farm dam on Thomas property to be fully fenced, including downstream Clark Creek.

4.2 RIPARIAN FENCING - MACLEOD

Currently livestock in the western paddock access a short length of Obi Obi Creek for water. This creates management issues as following high flows the cattle can cross the creek and mix with the neighbours cattle. The livestock damage the bed and banks of the creek and can, in low flows, escape or lost from accidents. Standard cattle fencing will be utilised – timber split posts at four metres, four wires (mix of barb and plain) and steel gates.

Obi Obi Creek on Macleod property. The impacts of livestock watering here include damage to the bed and backs, erosion and turbidity and damage to native vegetation.

4.3 OFF STREAM WATERING - THOMAS

An existing off stream watering system will be reconfigured and extended. Currently two pumps are utilised for two separate farm water systems. A large irrigation pump in the front dam supplies water to the residence and historically to the dairy. A second system relies on two 'fire fighter' pumps in series in Clark Creek to pump to a header tank. This system is inefficient as it requires manual starting and stopping when the tank is full and the 'head' height means pumps require regular replacement.

By reconfiguring the three phase pump lines from the front dam the entire off stream watering system can become more efficient (the landholder will be responsible for modifications).

The system will then be extended to include six new troughs that will service the 'back' paddocks. Although the watercourses where livestock currently drink will not be fenced at this stage, cattle preferentially drink at

troughs over creeks so will spend less time in the watercourses.

As per LBCCG standard concrete troughs sourced from Toowoomba Tanks will be utilised.

4.4 OFF STREAM WATERING - MACLEOD

The Macleod property currently has a simple off stream watering system servicing a series of small troughs and paddocks in the centre of the property. With the fencing of the Obi Obi Creek a trough is required in the western paddock.

To increase the reliability and efficiency of the system a 5,000 gallon header tank will be installed into the system.

4.5 STREAM CROSSING - BARLOW

The Barlow property is dissected by several permanent watercourses with an existing crossing over Clark Creek severely degraded from livestock. A low level concrete crossing will reduce erosion and improve livestock management.

Stream crossing site on Barlow property. Livestock cross at this point on Clark Creek as most of the watercourse is steep or the channel is incised discouraging crossing.

4.6 CROSSING REHABILITATION - THOMAS

Two existing crossings on the Thomas property require rehabilitation or repair to ensure long term stability. The large pipe crossing immediately downstream of the farm dam has over time had its gravel surface washed away to the point where it is almost impossible to cross. The crossing requires the replacement of the gravel and road base along with sufficient compaction. Additionally a spillway will be excavated to the side of the crossing so that high flows are safely directed around the crossing rather than wash over it removing the gravel.

A second pipe and concrete crossing requires minor repair – filling of a narrow but deep channel being cut by high flows around the side.

Pipe crossing over Clark Creek on Thomas property. These types of crossings are no longer considered best practice and are not constructed. However this crossing remains in fair condition and can be rehabilitated relatively cheaply and easily.

4.7 FUTURE STAGES AND ACTIVITIES

The aim of the project is to reduce the reliance of livestock on natural watercourses for water. Even without riparian fencing livestock prefer trough water over creek water. Although coming from the same source, trough water is usually cleaner and located in a more convenient central location in the paddock. Furthermore livestock will have sure footing and drink at a height more comfortable.

Further stages on the Thomas property could involve riparian fencing although this requires detailed planning and consideration.

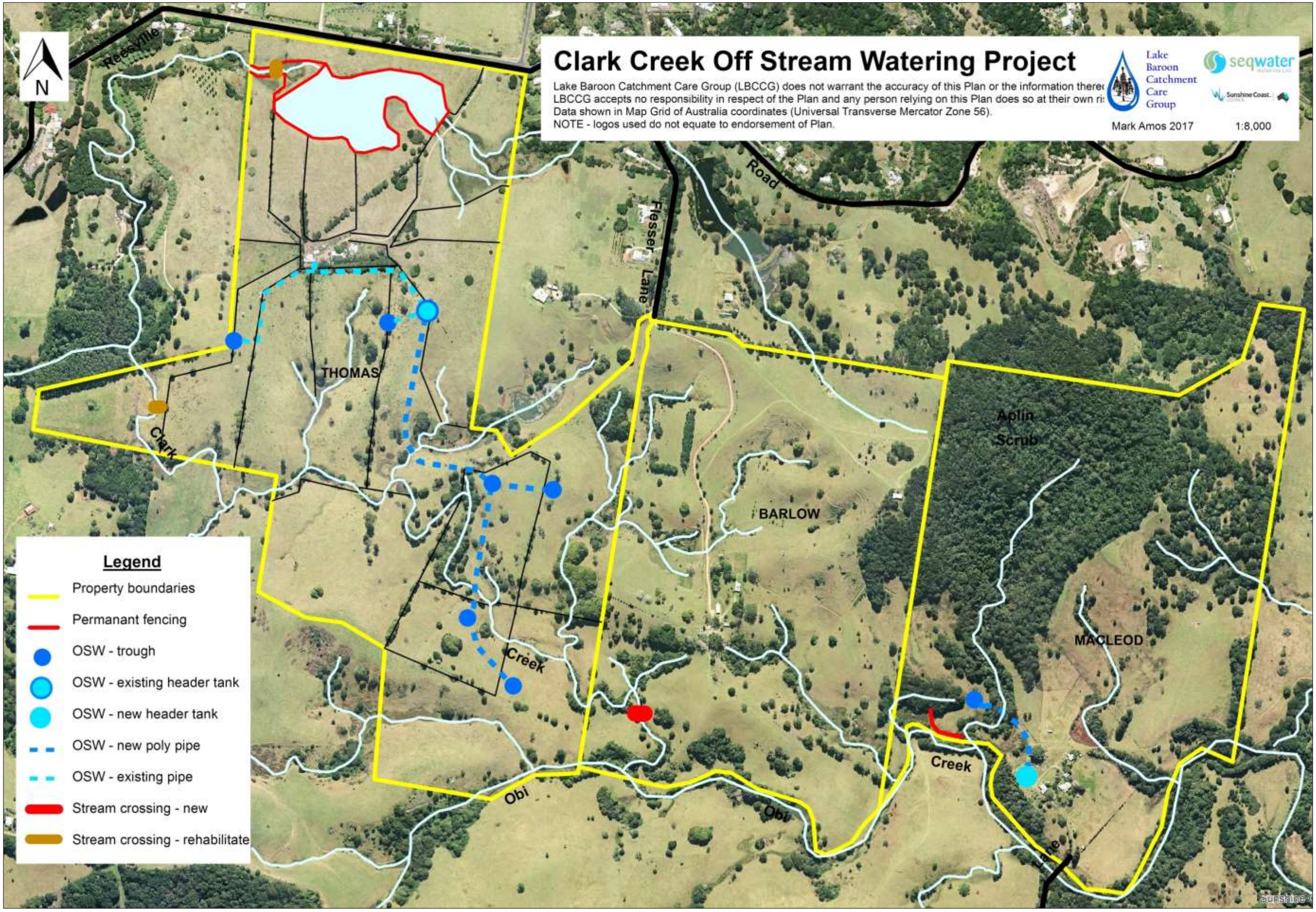
5.0 WHEN

(When will the activities be implemented)

The project is scheduled for completion by 30 June 2017 however due to the late start in the year some components may not be completed.

As per ALL LBCCG projects, completion of activities is weather dependent. We will not compromise the quality of the completed work by adhering to inflexible financial deadlines.

6.0 PROJECT MAP



7.0 BUDGET

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

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 and provide suitable 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. We cannot realistically completely restore cleared riparian zones to pre-European conditions, but we can improve the ability of the zone to maintain the quality of water delivered downstream.

Baroon Pocket Dam. Although the dam and most of the immediate surrounds are owned and managed by Seqwater, the vast majority of the catchment is privately owned. To influence land management that reduces the risk to water quality in the storage, Seqwater must engage the community. The most effective method to do this is work with existing community groups.

An estimated 80% of sediment and 35% of nitrogen in the waterways in south east Queensland comes from non-urban diffuse loads; sources such as unmanaged livestock grazing. Reduction of these loads clearly represents a major target for action if significant improvements in water quality are to be achieved in South East Queensland (DERM 2010).

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

The Lake Baroon Catchment Implementation Plan (2007) prioritisation of sub-catchments for works is effective and useful for rehabilitating waterways in the catchment through traditional fencing and revegetation but does not adequately reflect the nutrient and sediment inputs to the waterways through land use, particularly intensive dairy and beef grazing (Dunstan 2007). This method follows traditional 'bush restoration' techniques where sub catchments that are in the best condition that require minimal intervention to realise improvements. However an example of this theory and its application in the Lake Baroon catchment would result in the largely protected, Sunshine Coast Council managed and natural Mary Cairncross Park sub catchment receiving the highest priority for works.

1.2 GRAZING AND RIPARIAN ZONES

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

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

Cattle when drinking at streams and dams enter the water to reduce bending; resulting in the stirring up of suspended solids (turbidity), and riparian zones can be difficult places for livestock to access (steep, muddy or rocky banks) placing greater effort and stress on individual animals. Additionally when cattle enter a water source they tend to defecate directly into the water body (pers. comm. Colin Cork 2012).

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

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

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

The project will enhance vegetation buffers on the Walkers Creek. The effectiveness of a riparian buffer to provide multiple environmental and water quality benefits varies depending on several key factors, namely bank slope, vegetation species composition and age, and soil type. Slope gradient appears to be the most important variable in removal of sediment or particulate pollutants, whereas buffer width is most important for the effective removal of dissolved nutrients (Barwick et al 2009).

Riparian buffers comprising grassed buffer strips are effective at trapping sediments and nutrients adsorbed to sediments (such as phosphorus), but tend to be relatively poor at trapping dissolved nutrients, or for the provision of shade, food sources, in-stream structure or corridors for many species. Riparian buffers comprising taller, woody vegetation are typically good at providing shade, as a source of food and woody habitats, as a screen for light and noise, as corridors for terrestrial fauna (to a varying extent depending on species composition), and as a means for reducing soluble nutrient inputs. Designed riparian buffers usually incorporate multi-tiered systems of both native woody vegetation to enhance ecological function, and vegetated filter strips for the management of water quality. In essence, this approach seeks to mimic the complexity and effectiveness of a natural riparian buffer system, and often the best approach is to provide the required buffer width to enable a self-sustaining buffer of native vegetation (Barwick et al, 2009).

1.3 RIPARIAN FENCING

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The effectiveness of a riparian buffer to provide multiple environmental and water quality benefits

varies depending on several key factors, namely bank slope, vegetation species composition and age, and soil type. Slope gradient appears to be the most important variable in removal of sediment or particulate pollutants, whereas buffer width is most important for the effective removal of dissolved nutrients (Barwick et al 2009).

Riparian buffers comprising grassed buffer strips are effective at trapping sediments and nutrients adsorbed to sediments (such as phosphorus), but tend to be relatively poor at trapping dissolved nutrients, or for the provision of shade, food sources, in-stream structure or corridors for many species. Riparian buffers comprising taller, woody vegetation are typically good at providing shade, as a source of food and woody habitats, as a screen for light and noise, as corridors for terrestrial fauna (to a varying extent depending on species composition), and as a means for reducing soluble nutrient inputs. Designed riparian buffers usually incorporate multi-tiered systems of both native woody vegetation to enhance ecological function, and vegetated filter strips for the management of water quality. In essence, this approach seeks to mimic the complexity and effectiveness of a natural riparian buffer system, and often the best approach is to provide the required buffer width to enable a self-sustaining buffer of native vegetation (Barwick et al, 2009).

1.4 OFF STREAM WATERING

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

Even without exclusion fencing of riparian zones, off-stream water sources reduce the amount of time free ranging cattle spend in or immediately adjacent to watercourses. Cattle prefer to drink from a trough over other sources of water available to them, resulting in a significant reduction in time spent in the stream (watering) and adjacent stream side area (grazing and loafing). Studies in North America have shown that following the installation of the off-stream watering (OSW) infrastructure, stream bank erosion decreased by 77% and concentrations of total suspended solids, total nitrogen and total phosphorous decreased by 90, 54 and 81% respectively (Sheffield et al, in McIver 2004). More recent studies indicate that although the installation of OSW by itself is effective, providing livestock supplements and shade near troughs reduced riparian zone pressures even further (Ganskopp 2001, McInnis and McIver 2001, Porath et al. 2002 in McIver 2004). Porath et al. (2002) also found that the provision of supplements increased weight gain in cows and calves.

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

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

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

1.5 STREAM CROSSINGS

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

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

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

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

Low level concrete crossing construction

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

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

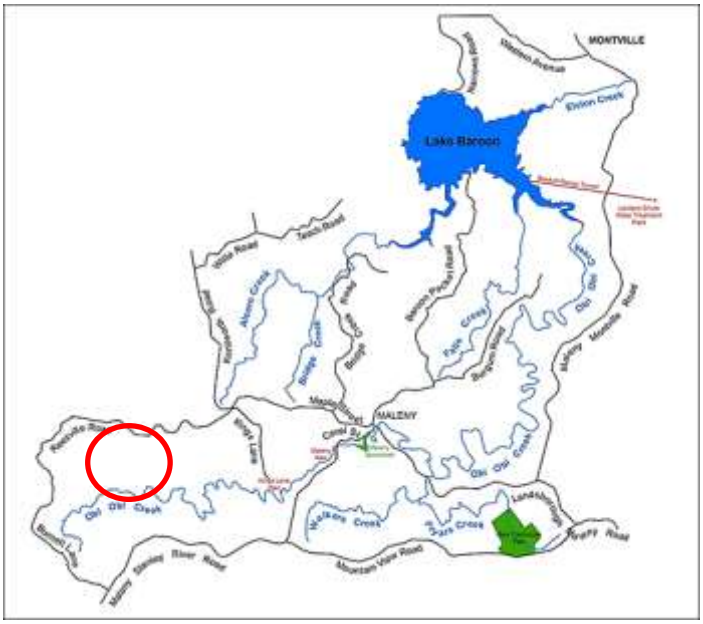
Other than providing access across a stream for people, vehicles and livestock, a well-designed crossing provides environmental benefits. Restricting crossings to one point will greatly reduce local erosion and protect riparian vegetation from stock; further stabilising stream banks, and can greatly assist in managing nutrient input to the stream system (Janicke & Murray 2008).

2.0 PROJECT LOCATION

2.1 BACKGROUND

Lake Baroon is situated on 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 constitute the remaining 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



The Thomas, Barlow and Macleod properties are located in LBCCG Management Units OB 1 and 3 which lie in the headwaters of Obi Obi Creek, including the major tributary Clark Creek. These MUs are major contributors of nutrients primarily due to historical and current land use.

2.3 THE OBI OBI CREEK CATCHMENT

The Obi Obi Creek is the most significant watercourse in the Lake Baroon catchment, consisting of 71 km of waterway in a sub catchment of 2,880 ha. A mere 18% of the sub catchment is covered in vegetation, with much of the area significantly disturbed, mostly supporting beef or dairy cattle; but also including urban Maleny (Dunstan 2007).

Dairy grazing (three farms) remains a significant land use although has been in decline since deregulation in 2000. Beef grazing has replaced dairying as the dominant land use.

Bridge Creek varies widely in topography, land use and threats to water quality. Upper reaches are largely grazed, mid reaches support a mix of natural bush and rural residential properties with some grazing again in the lower reaches.

The Aplin Road water quality sampling point in Management Unit OB3. The riparian zone has increasingly improved riparian vegetation cover.

2.4 CATCHMENT REVIEW

2.4.1 Background

Since the arrival of European Settlers, Lake Baroon and its catchment area have undergone significant change. Timber operators 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 beef and dairy cattle (1918) (Dunstan, 2007).

As a result riparian zones have been irreparably impacted such as:

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

2.4.2 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 (and where Baroon Pocket Dam wall was constructed).

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). 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 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 can be very prone to erosion. The Obi Obi, Bridge and Falls Creeks have gradually cut channels into the basalt plateau revealing the described layers underneath. The edges of the plateau have also eroded to form escarpments (Willmott 2007).

Soils on the site predominantly consist of heavy black clays. The bed of the watercourses on the site consists of thin, black alluvial soils that have been deposited by a combination of mass movement (landslips), hill slope (paddock) erosion and gullying. The velocity and volume of the local streams however limits sediment deposits forming.

However, clay soils erode easily and tend to reach their infiltration capacity faster than other soils, promoting overland flow. A potential consequence is that both bound and unbound nutrients will enter the watercourses via erosion and runoff (Lake Baroon Catchment Management Strategy & Caloundra City Council 2007).

Native vegetation is an indicator of soil types. The vegetation over the site therefore would have originally been a mix of rainforest (particularly in the gullies and wet and wet sclerophyll (eucalypt) forest.

2.4.3 Catchment 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 much of this is degraded by environmental weeds. Today, the catchment is susceptible to impacts associated with an increasing diversity of land use (Keys 2009).

The area closest to the lake 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:

- poorly managed dairying and cattle grazing;

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

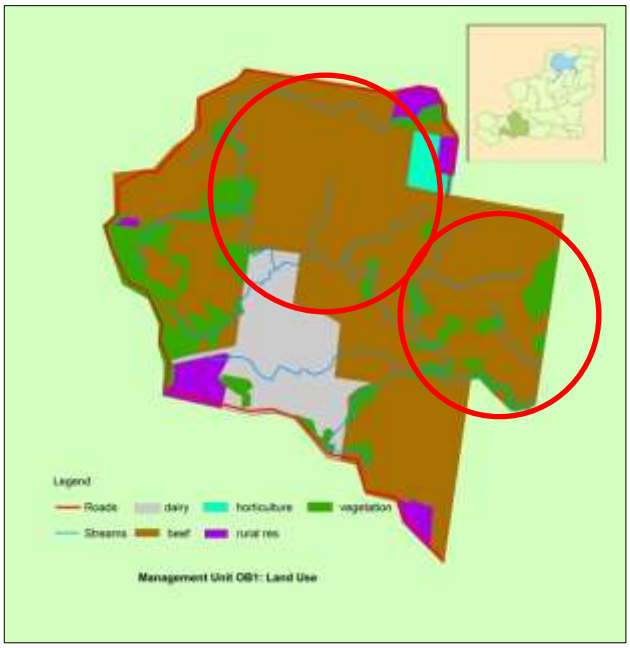
Obi Obi Creek has been divided into nine Management Units that reflect property boundaries, physiography, vegetation, land use, point and diffuse source impacts. This provides administrative convenience and the ability to prioritise stream zones more accurately according to various threats.

The proposed project is located within Management Units OB1 and OB3.

2.4.4 Land-use in Management Unit OB1

OB1 covers an area of approximately 360 hectares with beef grazing (70%) as the dominant land use one dairy farm (20%) and minor rural residential (5%). Other land use such as horticulture and conservation are associated with rural residential.

A mere 10% of the catchment is vegetated with only 11% of waterways have riparian cover (Dunstan 2007).

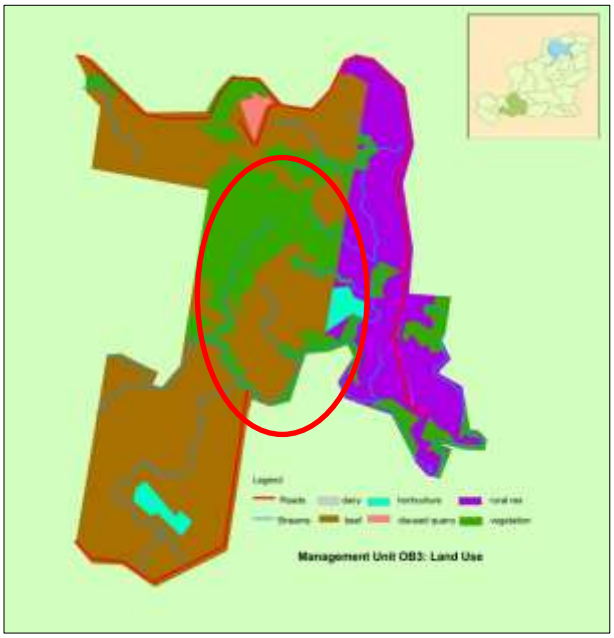


Land use in MU OB1 is predominantly beef grazing.

2.4.5 Land-use in Management Unit OB3

OB3 covers an area of approximately 295 hectares with beef grazing (50%) as the main land use however rural residential (Ruddle Drive) a significant land use (25%). Conservation covers around 15% of the management unit (Aplin Scrub on the Macleod property). Other very minor land use includes horticulture and the quarry (disused) on Howells Knob.

Approximately 20% of the catchment is vegetated while 21% of waterways have riparian cover (Dunstan 2007).



Land use in OB3 is dominated by beef grazing however the Ruddle Lane development

2.5 PROPERTY REVIEW – THOMAS

2.5.1 Land use and property management

The Thomas property is a large parcel of land with several unique features and issues. The property has numerous watercourses including a short length of Obi Obi Creek but also the equally significant Clark Creek – a tributary of the Obi once considered to be the true Obi Obi Creek.

The topography of the property (relatively steep) means there are numerous minor watercourses – some ephemeral but most permanently flowing due to springs and soaks. A dairy farm as recently as 2010, the property has been fenced into smaller paddocks arranged to take advantage of permanent water.

Although much of the fencing is degraded, reorganisation will be a complex and costly program. Any fencing of watercourses requires provision of alternative water – the primary aim of the proposed project.

An outstanding feature of the property is the very large (4 hectares) farm dam. The dam is utilised mainly for domestic and livestock water supply.

2.5.2 Hydrology

2.5.2.1 Drainage Lines, Watercourses & Wetlands

The numerous watercourses dissect the property effectively making it very difficult to exclude livestock from significant lengths. Short reaches of the watercourses support vegetation although predominantly this consists of woody weeds including camphor laurel, privet and blackberry.

The only constructed dam on the property is the large waterbody in the front paddock bordering Reesville Road. The sheer size of this dam and the aquatic vegetation it supports (predominantly native water lily) is considered important for aquatic wildlife and birds.

2.5.2.2 Flooding

Flooding is not considered a major issue as the properties placement high in the catchment means that high flows are generally brief although there is some wash damage to a stream crossing downstream from the constructed dam. Flooding is unlikely to damage any of the infrastructure installed as part of the proposed project.

2.5.3 Environmental Factors

2.5.3.1 Significant Vegetation & Ecosystems

There are no areas of remnant vegetation on the property although there are several individual remnant trees from which regrowth have spread.

2.5.3.2 Flora, Fauna & Corridors

There are currently no significant corridors on the property and at this stage there are no efforts to establish or enhance.

2.6 PROPERTY REVIEW – BARLOW

2.6.1 Land use and property management

The Barlow property is a moderately large beef farm located on Obi Obi Creek and the confluence of the Obi and Clark Creek. The property is relatively steep, with thin soils on the steeper areas supporting a mix of improved and unimproved pasture. The geology and soil qualities demand careful management to minimise erosion.

2.6.2 Hydrology

2.6.2.1 Drainage Lines, Watercourses & Wetlands

Obi Obi Creek forms the southern boundary of the property with Clark Creek splitting off in the south west corner. A large number of minor watercourses dissect the property – many of them permanent and like the Thomas property are relied upon for livestock watering.

There are several wetlands on the property formed from eroded soil collecting in flat watercourses. These are generally waterlogged mainly supporting native macrophytes and pasture grasses.

The properties watercourses have reasonably good vegetation coverage although this is predominantly woody weeds – privet, camphor laurel, blackberry, yellow berry and other weeds.

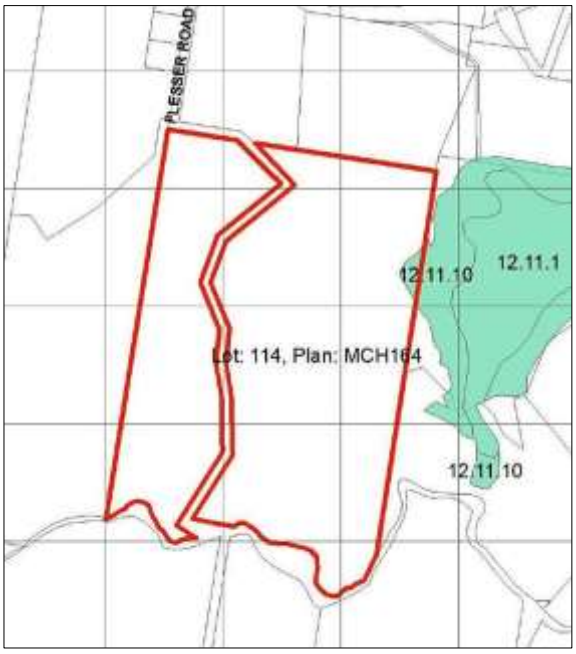
2.6.2.2 Flooding

Flooding affects the Obi Obi Creek and to a lesser extent Clark Creek and with the proposed new stream crossing to be constructed on Clark Creek implementation timing will need to be carefully scheduled.

2.6.3 Environmental Factors

2.6.3.1 Significant Vegetation & Ecosystems

The property supports a small area of remnant Notophyll vine forest which is part of the larger 'Aplin Scrub' – predominantly on the neighbouring Macleod property. Although this regional ecosystem is not considered a priority for State protection, the sheer size of the stand is considered very important locally. *See 2.7.3.1 for further information.*



The Barlow property supports a small stand of 12.11.10 Notophyll vine forest. This occurs on the highest slopes of the property and is significant in that it is part of the locally important 'Aplin Scrub'.

2.6.3.2 Flora, Fauna & Corridors

The project will not provide any corridor benefits.

2.7 PROPERTY REVIEW – MACLEOD

2.7.1 Land use and property management

The Macleod property is a moderately large parcel of mixed grazing land with improved and unimproved pasture supporting beef, alpaca and horse grazing. The Obi Obi Creek forms the southern boundary to the property with several tributaries splitting the property. The dominant feature of the property is the presence of 'Aplin Scrub', a large stand of remnant vegetation.

Previous projects have fenced and revegetated significant lengths of Obi Obi Creek and the installation of creek crossings and an alternative watering point).

2.7.2 Hydrology

2.7.2.1 Drainage Lines, Watercourses & Wetlands

Much of the Macleod property is gently sloping with the steep part supporting Aplin Scrub. The majority of the watercourses that drain the property have excellent vegetation cover and are mostly fenced to exclude livestock. The only points to permanent watercourses that still have livestock access are those required for livestock water. This project aims to further reduce stock access by installing riparian fencing and extending an off stream watering system.

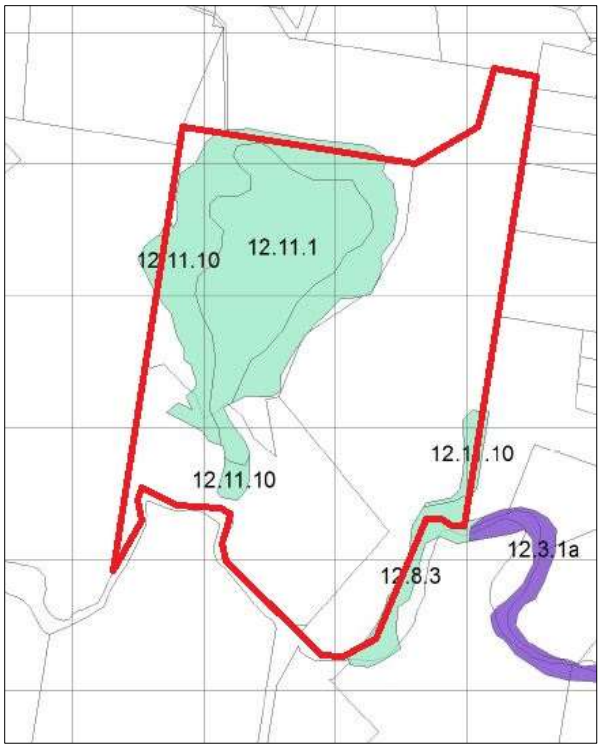
2.7.2.2 Flooding

The fencing of Obi Obi Creek will require careful consideration regarding alignment and timing of installation to ensure possible/likely flooding does not impact the works. Furthermore the installation of the poly pipe for the off stream watering trough must be trenched through a stream crossing so care will need to be taken to compact adequately.

2.7.3 Environmental Factors

2.7.3.1 Significant Vegetation & Ecosystems

The property has been partially cleared of vegetation to accommodate pastoral and agricultural activities. Remaining vegetation consists of substantial areas of remnant vegetation – most of which is unusual for the Maleny plateau. The grazed paddocks support scattered mature remnant trees and several wetlands, although degraded provide habitat diversity. Previous revegetation efforts have concentrated on the Obi Obi Creek riparian zone.



Remnant vegetation on the Macleod property.

RE12.8.3 – Complex notophyll vine forest

The majority of the Obi Obi Creek riparian zone and substantial areas of the lower slopes would historically have been covered by this Ecosystem. A degraded example of this vegetation can be seen in the riparian zone adjacent and downstream to the project on the neighbouring property. Although not considered a high priority in Queensland, there are few areas of this RE within the Lake Baroon catchment assessed as in good condition.

RE12.3.1 – Gallery rainforest on alluvial plains

This RE occurs almost exclusively in narrow linear corridors associated with major watercourses on the Maleny plateau. Due to its reliance on alluvial soils and subsequent narrowness this RE is difficult to map, suffers from degradation more readily than many other Ecosystems and usually intergrades with the similar 12.8.3 Complex notophyll vine forest. A narrow strip exists along the Obi Obi Creek downstream of the Macleod property. This ecosystem is endangered and therefore considered high priority for protection.

RE12.11.10 – Notophyll vine forest

A significant stand of this RE lies on the southern slopes of Howells Knob and a smaller (unverified) stand straddles the eastern property boundary on a gentle slope rising from Obi Obi Creek. This RE is not considered a priority for State protection.

RE12.11.1- Simple notophyll vine forest

Similar to RE12.11.10 a relatively large remnant lies on the southern slopes of Howells Knob. The RE is occupying the drier soils but is still largely made up of rainforest species (southerly aspect) with Lophostemon confertus probably a major species. This RE is not considered a priority for State protection.

2.7.3.2 Flora, Fauna & Corridors

The majority of permanent watercourse on the property are fenced and have excellent vegetation coverage, including extensive revegetation. The proposed project will further enhance these corridors and linkages by excluding livestock from the last reach of Obi Obi Creek.

3.0 PURPOSE, OBJECTIVES & OUTCOMES

3.1 BACKGROUND

A healthy aquatic ecosystem is stable and sustainable; maintaining its physical complexity, biodiversity and

resilience. It has the ability to provide ecosystem services that in turn contributes to good water quality, wildlife habitat and recreation.

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 contributes to their clearing) and are critical for biological diversity. The protection, enhancement and rehabilitation of riparian zones is essential for sustainable catchment management and reducing risks to water quality.

3.2 WATER QUALITY

The environmental health of the Lake Baroon catchment is considered generally poor, and in some respects declining (personal communications with Seqwater water quality staff). 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).

Pollutants entering Bridge Creek occur from three main sources:

- Diffuse run-off from traditional grazing practices provides nutrient inputs (animal manure and fertiliser application) and sediments from paddock erosion;
- Urban run-off carries nutrients derived from fertilisers, car washing, heavy metals and hydrocarbons from road run-off, litter and organic matter; *and*
- There is also the potential for sewer overflows (from the urban sewer system and individual wastewater treatment systems such as septic tanks) with high nitrogen, phosphorus and pathogens.

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

Less than 10% of the sub-catchment is vegetated; with minimal length of waterways supporting riparian cover of varying quality (mostly poor). The MU contributes a large nutrient load to Bridge Creek, with more than 98% of samples exceeding guideline levels (Dunstan 2007). This is most likely due to the number of rural residential properties combined with intensive grazing although the area utilised for dairying has dramatically reduced since 2007 (fall from 66% of the MU to less than 10%). Recent water quality sampling is not available but it is suspected there has been little improvement and most likely a deterioration as rural residential properties have increased and dairy grazing converting to beef grazing is high risk due to the sharp reduction in investment (pasture management, erosion etc). The MU is noted for its poor water quality but this is probably exacerbated by the fact there is insufficient riparian vegetation to filter nutrients originating in the catchment.

The Lake Baroon Catchment Implementation Plan (2007) rates BR1 a LOW priority for rehabilitation works. 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, BR1 rates as VERY HIGH; due to the contribution of nutrients and sediments to Bridge Creek.

3.2.1 Statistical Analysis of the Raw Water Quality Data Recorded from Aplin Road 1991-2005

Water quality monitoring and analysis sampled at Aplin Road between 1991-2005 by AquaGen shows, that despite a relatively dense coverage of vegetation, the catchment contributes significant nitrates, ammonia, phosphates, total phosphorus and faecal coliforms. The Aplin Road sampling site is primarily affected by agricultural impacts – intensive dairy grazing, dairy effluent, diffuse erosion, high fertiliser use, beef grazing, high chemical rates including veterinary and rural residential impacts (septic tanks etc. Most of the watercourses in the upper catchment are not fenced and are heavily impacted by cattle and grazing.

The routine sampling programs (CalAqua, AquaGen, Seqwater and others) are suspected of not adequately capturing the major pollution events that regularly occur in the catchment. Conducted either monthly (1991 – 1998) or bi-monthly (1999 – 2005), significant rainfall events in the catchment have probably been missed and the data collected may over-estimate the catchment's water quality (Traill, 2007).

Parameter	*pH*	*Turbidity*	*NOx (N)*	*NH3 (N)*	*PO4 (P)*	*Total P*	*Faecal Coliforms*
(units)	*(pH units)*	*(NTU)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(number/ 100 mL)*
Guideline Value	***6.5-8.2***	***<25.0***	***<0.040***	***<0.010***	***<0.030***	***<0.030***	***<100***
Max	7.7	39.5	1.100	0.550	0.617	0.219	26,000
Min	6.6	1.2	0.004	0.000	0.001	0.010	6
Mean	7.3	4.2	0.121	0.065	0.035	0.060	856
Median	7.3	2.5	0.061	0.032	0.019	0.052	180
Std Dev	0.2	5.4	0.166	0.083	0.062	0.032	2,679
20th Percentile	7.1	1.8	0.015	0.010	0.012	0.040	58
80th Percentile	7.5	4.2	0.190	0.110	0.045	0.071	598
Count above GV	0	2	78	99	50	117	93
Count	134	135	133	127	133	124	133
% above GV	**0.00**	**1.48**	**58.65**	**76.38**	**37.59**	**92.74**	**69.92**

The following data analysis has been sourced from Traill, 2007.

Turbidity does not appear in the data as a major concern. All sampling sites throughout the catchment have recorded low turbidity despite evidence to the contrary (sediment slugs and visibly extremely turbid water during rainfall events). Turbidity is a measure of the degree of scattering light, related to the amount of particulate matter suspended in water. Nutrients such as phosphorus adsorb onto soil particles suspended in the water column. Turbid waters can contain fine clay colloids that are difficult to remove from the water column. These clay colloids reduce light penetration into the water.

Nitrate levels are consistently high with inputs likely to be largely as a result of oxidation of ammonia nitrogen (faecal matter and ammonia based fertiliser). It would be expected with the dramatic decline in dairies within the catchment there should be a corresponding decline in nitrates detected. Nitrogen is essential for plant growth. However, increased levels of nitrogen can contribute to excessive algal growth (particularly in the Lake Baroon storage) and weeds.

Ammonia levels have remained consistently very high. Ammonia is the initial product of the decay of nitrogenous organic wastes - high concentrations of ammonia can be toxic to aquatic life. The likely cause of high ammonia levels is the loss of ammonia based fertilisers and direct access to watercourses by cattle.

Phosphate levels have remained high over the 1991-2005 period although appeared to decline significantly with the majority of guideline exceedances occurring pre 1996. This is probably likely due to a change in land use from dairying to beef grazing (and subsequent reduction in fertiliser use). However as phosphates are usually bound to sediment and with the low turbidity recorded it is possible the high phosphate loads have not been captured by the sampling program.

Total Phosphorus has remained generally excessive over the sampling period and can be attributed to a wide variety of sources including dairying, beef grazing, sewage sources, catchment erosion, fertiliser and stormwater. Generally expected in areas of intensive grazing, the high results could also be indicative of the density of rural residential properties and their associated wastewater treatment systems. Phosphorus is an essential plant and animal nutrient, however, increased levels of phosphorus can contribute to excessive algal growth (particularly in the Lake Baroon storage) and weeds.

Faecal coliforms have remained relatively high. There have been considerable changes in land use over the sampling period (and since) and a growth in rural residential properties. It appears that much of this can be attributed to organic sources (faecal matter) by the high total phosphorus results. Faecal coliforms are microorganisms found in animal and human excreta. Their measurement is used to indicate the potential presence of pathogens within water. Faecal coliform numbers are an important factor when determining the suitability of a water body for primary and secondary human contact. Faecal coliforms and the associated pathogens are high risk for water quality.

Livestock in waterways are high risk to water quality.

Excessive erosion and nutrients delivered from the catchment contribute to cyanobacteria (blue green algae) blooms in Lake Baroon.

3.3 WATER SUPPLY CATCHMENT

The O'Brien, Keton and Malter properties is within the Lake Baroon Pocket Dam Catchment. Bridge Creek (2,134 hectares) comprises one of Lake Baroon's three major sub-catchments. Consequently it is the major 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 Landers Shute Treatment Plant (AOP 2013).

BPD, along with Image Flat (South Maroochy System) is the predominant source of water supply for northern South east Queensland with Ewan Maddock Dam (EMD), Lake McDonald and Mary Valley Water Supply Scheme considered additional intermittent sources (AOP 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 (AOP 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 (AOP 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 region.

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 ha
Gross yearly value of water sold by Seqwater (*Saxton et al, 2013*)	= $60,000,000
Value of water per hectare	= $8,108
Area of the Thomas, Barlow & Macleod properties	= 181 hectares
Gross value of raw water originating from the properties	**= $1,467548 annually**

Tourism has become the dominant economic driver in the catchment but relies on both the agricultural landscape (rolling green hills) and natural values equally. This is demonstrated by the popularity of Maleny Dairies milk processing plant and farm tours (in excess of 20,000 visitors per year; pers. comm. Keith Hopper) and the popularity of Mary Cairncross Park (200,000 visitors per year?).
Seqwater who receive the benefits of raw water flowing from the catchment into BPD, have an obligation to invest back into the catchment if water quality improvements are desired; into activities that reduce risks to water quality and its maintenance and protection, and broad environmental health.

The likely scenario under climate change modelling suggests more variable and possibly severe weather events; longer and more severe droughts (below average rainfall per month) and more intense rainfall events.

This will undoubtedly impact on both raw water quality entering BPD and on the storage itself. Between 2010 and 2014 unseasonal dry periods followed by intense high rainfall events have seen an increase in erosion (reactivation of land slips), turbidity and flood damage.

The community expects good water quality at their tap – free from discolouration, odours and the guarantee it will not impact their health, and increasingly demands the environment is protected as part of supply.

3.4 OBJECTIVES

Clark Creek Off Stream Water Project is designed to reduce the impacts of livestock access on watercourses and reduce the delivery of nutrients and pathogens to Obi Obi Creek Creek and Baroon Pocket Dam. The provision of off stream watering (even without fencing watercourses) will encourage livestock to spend less time in riparian zones as stock will preferentially drink from troughs over natural water sources. The project is directly addressing the issues and risks associated with the production of a safe water supply to the Sunshine Coast and beyond. However the project provides other broader environmental benefits that increasingly the community demands and expects.

The project aims to:

- implement an on-ground project that delivers water quality benefits;
- promote integrated catchment management in the Lake Baroon catchment;
- reduce nutrient delivery to waterways;
- reduce sediment delivery to waterways;
- protect and improve aquatic habitats;
- raise community awareness (including water quality issues);
- support and work cooperatively with like-minded community organisations;
- protect and enhance habitat;
- contribute to the conservation of threatened species;
- contribute to climate change adaptation; *and*
- demonstrate best management practice of riparian zones and property management.

Effective riparian areas can improve water quality by trapping sediment, reducing erosion, storing nutrients and filtering contaminants before they reach water storages (Lake Baroon). Riparian zone health is a key factor in a riparian area's ability to improve water quality.

3.5 OUTCOMES

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

Outcomes are the 'end product' of our activities – 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 ideally partnerships with universities and/or Seqwater to produce 'hard' data to prove the effectiveness of projects.

Our project will:

1. **Reduce pathogen delivery to waterways.**
   Managing livestock in riparian zones and rehabilitating livestock laneways reduces the volume of faecal material reaching waterways.

Managing livestock in the riparian zone reduces the opportunity for direct deposition of faecal material into the watercourses. Vegetative buffers intercept run-off contaminated with excessive nutrients from diffuse paddock sources.

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. Vegetative buffers intercept run-off contaminated with excessive nutrients from diffuse paddock sources.

3. **Reduce sediment delivery to waterways.**
   Soil from creek bank and bed erosion leads to high turbidity and is transported to Baroon Pocket Dam and beyond.

Improved livestock management reduces the loss of valuable top soil to catchment waterways. Improved management of livestock movement (fencing and stream crossings) maintain stability of riparian zones and managing livestock in the riparian zone reduces soil erosion from trampling.

4. **Improve aquatic habitat.**
   Improved management of sediments, nutrients and pathogens improves instream habitat.

A reduction in turbidity, sediments, nutrients and pathogens will improve water quality and contribute to maintaining in-stream biodiversity.

5. **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 and importance of effective livestock management. 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.

6. **Contribute to the viability and resilience of primary production in the Lake Baroon catchment.**
   Primary production has been in gradual decline since 2000 but dairying and beef production has experienced a recent upturn.

For long term water quality outcomes it is preferential to work with experienced landholders who understand the catchment and are skilled land managers. New landholders to the area are often ill equipped to manage land and are high risk to water quality.

For landholders to implement a water quality improvement project there needs to be a cost benefit rather than a burden on available resources. This project provides a win-win scenario where all stakeholders benefit.

6. **Provide terrestrial habitat.**
   Riparian vegetation provides important habitat for the adult stages of aquatic insects and amphibious organisms such as frogs and turtles.

The project will enhance riparian and associated vegetation improving, over time, valuable habitat for a variety of native fauna. The project will significantly reduce livestock access to a significant area of riparian and vegetation.

3.6 PRIORITY LANDHOLDERS/LAND IN THE LAKE BAROON CATCHMENT

Priority landholders were initially identified in 2007 (updated in 2014) 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.

All three of the project participants are Priority landholders.

3.6.1 Priority Landholder Project funding since 2000 - $ per hectare (CORE funding only)

There are 59 Priority landholder properties in the Lake Baroon catchment. LBCCG has endeavoured since 2007 to engage as many as possible and implement projects that deliver water quality benefits. Not all landholders will agree to be involved however currently LBCCG has worked with 29 of these properties with a further three receiving funding solely through the SCIP Programs in 2016/17 (Dairy, Landslides and Weeds). A further four landholders will be involved in the upcoming 2017-19 SCIP Programs. Several other landholders on the list have received minor, non-project assistance (less than $1,000).

A key aim for LBCCG is to spread the funding over as many properties as possible and therefore always prioritise previously un-funded projects/landholders over those that have received funding in the past. A simple table is reproduced below showing $ per hectare spent on Priority Landholder properties since 2000 which is useful for determining priority and 'fairness' when considering a new project.

Landholder/property	$ per ha
K. Watter	$ 1,907
Uniting Church of Aust (Erowal)	$ 1,341
R. McLauchlan	$ 1,129
K. Hopper	$ 984
C. Taylor/P. Stevens	$ 789
C. Waugh	$ 601
S. Marquardt	$ 600
M. Walker	$ 581
Farmhouse Macadamias	$ 552
G. Muller	$ 541
R. Thorne	$ 529
R. Donovan	$ 497
C. Cork (includes S. Cavanagh)	$ 489
C. Ling	$ 464
P. Ruddle	$ 461
N. Colley	$ 404
E. Lawley	$ 390
R. Cork	$ 350
F. Woods	$ 337
N. Macleod	***$ 285***
Sunshine Coast Council (MCP)	$ 140
S. Barlow	***$ 131***
R. Newsham	$ 75
D. Beacom	$ 74
C. Daley (R. Daley)	$ 35
G. Martin	$ 24
Maleny Cheese (Oehmichen) (1)	$

Cimesa & O'Connor [1]	$
K. Webster [1]	$
Nedgus Trustees	$ -
R. Sommers [2]	$ -
T. Porter	$ -
P. Mumford/C. Porter [2]	$ -
K. Thomas [3]	***$ -***
D. Barlow [2]	$ -
Gra. Newton	$ -
Unknown (ex O. Thomas)	$ -
R. Lee	$ -
B. McFarlane	$ -
E. Ferriday [4]	$ -
R. Tonkin	$ -
K. Trevor	$ -
Unknown (ex F. Woods)	$ -
Unknown (ex Courtice)	$ -
R. Newsham [2]	$ -
P. Howes & Co	$ -
CK. Denning [5]	$ -
M. Keleher	$ -
R. Hankinson [1]	$ -
J. Marsson	$ -
K. Garner	$ -
C. Taylor (ex J. King)	$ -
Wiston P/L	$ -
N. Forbes	$ -
J. Harwood	$ -
D. Boyd [2]	$ -
B.M. O'Rourke	$ -
Unknown (ex F. Woods)	$ -
I.L. Porter	$ -
G. Kruck	$ -
Average $ per hectare	**$ 527**

[1] SCIP Program funding (Dairy, Landslide, Weeds)
[2] Propose SCIP Program funding 2017-19
[3] 2016/17 CORE project currently proposed
[4] 2017/18 Core project
[5] Minor activities, non-project (<$1,000)

Annual raw water value per hectare = $8,108

As can be determined by the table above the Macleod and Barlow properties have currently received below the average funding for a property of that size ($404 per hectare). The Thomas property has never received any LBCCG funding.

3.7 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 assist in the management of risk is land use – essentially livestock grazing and the associated key issue of pathogens. A number of factors can contribute to pathogen contribution by livestock. A high likelihood ranking has been attributed by Keys 2009 to any site where the following conditions exist:

- direct animal access to waterways;
- intensive feed lots and dairies;
- heavy broad scale grazing; and
- animal deposition (including bio-solids piles) possible within 50 m of intermittent or permanent waterways.

The sheer volume of excrement produced by cattle, horses, and to a lesser extent other domestic animals, when in large herd sizes renders them significant contributors within an open drinking water catchment (Baker 2011).

With current control measures in place, water quality is still at high risk from risk sources dominated by land use activities and human access. Key issues in this section include hazards associated with the population growth in the area and the increasing rural lifestyle and urban and peri-urban land uses. Possible future

mitigation measures are dominated by improved land management practices, land acquisition (especially close to the dam's edge), reduced access to the dam wall, increased public education and enforcement, as well as monitoring and research (Keys 2009).

The project's objectives and outcomes are consistent with:

- 2015-16 LBCCG Annual Investment Strategy (Lake Baroon Catchment Care Group 2014)
- Lake Baroon Catchment Implementation Plan (AquaGen/LBCCG 2007)
- Lake Baroon Catchment Management Strategy (AquaGen/LBCCG 2004)
- Seqwater Natural Assets Management Plan – Lake Baroon Catchment (Seqwater 2012)
- Sanitary Survey of Baroon Pocket Catchment Report (Seqwater 2014)
- 2015-16 LBCCG Annual Investment Strategy (Lake Baroon Catchment Care Group 2014)
- Lake Baroon Catchment Implementation Plan (AquaGen/LBCCG 2007)
- Lake Baroon Catchment Management Strategy (AquaGen/LBCCG 2004)
- Seqwater Natural Assets Management Plan – Lake Baroon Catchment (Seqwater 2012)
- Sanitary Survey of Baroon Pocket Catchment Report (Seqwater 2014)
- Catchment and In-Storage Risk Assessment for Water Quality – Baroon Pocket Dam (Seqwater 2009)
- Sunshine Coast Council Waterways & Coastal Management Strategy 2011-12 (Sunshine Coast Council 2011)
- Mary River and Tributaries Rehabilitation Plan (Mary River Catchment Coordinating Committee 2001)

4.0 IMPLEMENTATION

4.1 RIPARIAN FENCING

All fencing to be completed by experienced Contractor (Thomas) or landholder (Macleod).

4.2 OFF STREAM WATERING

Off stream watering infrastructure will purchased from a specialist supplier and only quality products will be used. Installation will be completed by experienced Contractor and the landholder.

4.3 STREAM CROSSING CONSTRUCTION AND REPAIR

The stream crossings will be installed and repaired by experienced Contractor.

5.0 ACTION PLAN

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

1617-008 Clark Creek Off Stream Water Project (Thomas, Barlow & Macleod)

Action		*Responsibility*	*Start Date*	*Completion Date*	*Measurable Output*
LBCCG Project Plan		LBCCG Project Manager	Apr 17	Apr 17	Project Plan
Project presented to LBCCG Committee for in principle approval (emailed)		LBCCG Project Manager & Committee	Apr 17	Apr 17	Approved Plan
Project presented to LBCCG Committee for approval (Management Committee meeting)		LBCCG Project Manager & Committee	Apr 17	Apr 17	Approved Plan
Project Plan sent to Seqwater for final approval		LBCCG Project Manager	Apr 17	Apr 17	Approved Plan
Pre-works monitoring (including photo points)		LBCCG Project Manager	Mar 17	May 17	Photo & data set
IMPLEMEMNTATION	Riparian fencing	Contractor, landholder	Apr 17	May 17	1,545 metres
	Off stream watering	Contractor, landholder	May 17	Jun 17	2 systems/ 7 troughs
	Stream crossing construction & repair	Sunshine Coast Council, Contractor, landholder	Mar 17	Jun 17	1 new crossing/ 2 repaired crossings
Post-works monitoring		LBCCG Project Manager	Apr 17	Jun 17 ongoing	Photo & data sets
Progress Reports		LBCCG Project Manager	Apr 17	Jul 17	4 Reports
Final Report (LBCCG/Seqwater)		LBCCG Project Manager	Jul 17	Sep 17	Final Report
Ongoing monitoring & evaluation		LBCCG Project Manager, landholders, Sunshine Coast Council, Bridge Creek Bushcare	Jul 17	ongoing	TBD

Note – the Project Action Plan will be used as the basis for Monthly Reporting (LBCCG Management Committee meetings)

6.0 N/A

7.0 PROCUREMENT

7.1 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. Services and products will be sourced locally wherever possible and from not-for–profit community organisations if applicable.

Service/Product	***Supplier***	***Contact (if applicable)***
Fencing	Bald Knob Fencing	Tim Simpson
	Ferriday Fencing	Fred Ferriday
Off stream watering	P&K Nash Excavations	Phil Nash
	Bald Knob Fencing	Tim Simpson

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 trained and/or experienced.

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 hazard 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

Landholder to coordinate Contractors and liaise with LBCCG where required.

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

1. Fencing;
2. Off stream watering; *and*
3. Stream crossing construction.

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

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.

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 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 activities that could potentially unearth artefacts:

1. Fencing – holes up to one metre deep;
2. Off stream watering – trenching up to 600 mm deep, shallow excavation up to 300 mm deep; *and*
3. Stream crossing – shallow excavation up to 600 mm deep.

Visual inspections have not identified any artefacts. Most of the activity locations have been largely

disturbed since European settlement (deforestation) and have undergone significant movement of soil layers. Visual inspection of the sites during activities will be carried out and if artefacts or suspected features are unearthed activities 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.

10.2 MONITORING PROGRAM

Monitoring of rehabilitation activities, particularly the LBCCG funded component – fencing and off stream watering will be split into periodic and episodic monitoring. Monitoring of the components implemented by organisations other than LBCCG may be completed by others with reporting back to LBCCG.

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 the integrity of works (fencing and off stream watering). 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 REPORTING

Project updates will be provided at monthly LBCCG meetings.

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 the LBCCG newsletter.

Reporting will be ongoing until the monitoring phase of the project is complete (December 31, 2016). PowerPoint presentations presented at LBCCG Management Committee meetings will be converted to PDF and placed on the LBCCG website and forwarded to Seqwater.

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	tbc	LBCCG (Management Committee)
	tbc	
	tbc	
Technical advice	Tim Simpson	Contractor
	Sean Fitzgerald	The Pump House Beerwah
	Matt Bateman	LBCCG Project Officer
	Tim Odgers	Seqwater
	Phil Nash	Contractor

13.0 REFERENCES

Abal, E.G., Bunn, S.E & Denison, W.C. (Eds.) 2005, *Healthy Waterways Healthy Catchments: Making the connection in South-east Queensland, Australia*, Moreton Bay Waterways and Catchments Partnership, Brisbane.

Alt, S., Jenkins, A. & Lines-Kelly, R 2009, *Saving Soil – A landholder's guide to preventing and repairing soil erosion*, Northern Rivers Catchment Management Authority, NSW.

Australian Water & Wastewater Association, 1999, *National Water Quality management Strategy: Effluent Management Guidelines for Dairy Sheds in Australia*, Artarmon.

Baker, D. 2011, *Sanitary Survey of Somerset and Obi Obi Catchments*, ALS Water Resources Group, Penrith, NSW.

Biggs, A. & Harms, B, 2008, *Soil Science Field Trip Notes*

Department of Environment and Resource Management, *Development of a water quality metric for south east Queensland*, 2010

Dudgeon, S & Dunstan, M. 2007 *Large Scale Waterway Rehabilitation Business Case: Final Report*, Natural Solutions Environmental Consultants, Noosa Heads, Qld.

Dunstan, M 2007, *Lake Baroon Catchment Implementation Plan*, AquaGen Water & Renewable Energy, Palmwoods.

Keys, S., Murton, S., Costanzo, S. & Thompson, A. 2009, *Catchment and In-Storage Risk Assessment for Water Quality – Baroon Pocket Dam*, Sinclair Knight Merz, South Brisbane.

Health Canada (2013). Guidance on waterborne bacterial pathogens. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario (Catalogue No. H129-25/1-2014E-PDF).

Murton, S. & Keys, S. 2012, *Seqwater Natural Asset Management Plan – Lake Baroon*, Sinclair Knight Merz, Brisbane

Saxton, N., Olley, J., Burford, M., Ellison, T., Polson, Wallace, L. & Stewart, M., 2013, *Efficiency of Riparian Zones in Trapping Sediment and Nutrients*, Australian Rivers Institute Griffith University, Nathan.

Seqwater, 2013, *Annual Operations Plan May 2013*, Seqwater, Brisbane.

Smolders, A 2011 Project Briefing Note: Water Quality Project – Cork's Dairy Restoration, Seqwater

Stockwell, B., 2001, *Mary River and Tributaries Rehabilitation Plan – Implementation Edition*, Mary River Catchment Coordinating Committee, Gympie, Australia.

South East Queensland Healthy Waterways Partnership 2007, *South East Queensland Healthy Waterways Strategy 2007-2012*, South East Queensland Healthy Waterways, Brisbane.

South-east Queensland Regional Water Quality Management Strategy Team, 2001. *Discover the waterways of South-east Queensland: Waterways health and catchment management in South-east Queensland, Australia*, South East Queensland Healthy Waterways, Brisbane.

Sunshine Coast Council 2011, *Sunshine Coast Waterways and Coastal Management Strategy 2011-2021*, Sunshine Coast Council, Nambour, Qld.

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

Willmott, W., 2007, *Rocks and Landscapes of the Sunshine Coast Second Edition*, Geological Society of Australia, Brisbane.