THE MACKAY WHITSUNDAYS ISAAC RIPARIAN MANAGEMENT HANDBOOK

Australian Government

This Handbook has been developed by Reef Catchments and received grant funding from the Australian Government.

REEF CATCHMENTS

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TRADITIONAL ACKNOWLEDGMENT

We acknowledge the Traditional Owners past and present. We acknowledge their spiritual and cultural connection and their responsibility as Traditional Owners to maintain and care for Country.

ACKNOWLEDGEMENT

This Handbook was developed by the Reef Catchments Waterways Team: Liana Lillford, Emma Jones, Carla Lambropoulos, Brendan Smith, Emily Wilson, and Kelsey Marek. This book was developed as part of the *Nature-Based Solutions to Build Resilience Project.*

Many people have provided and assisted with the information contained within this handbook. Thanks to the many Mackay, Whitsunday and Isaac property owners who have worked with Reef Catchments over the past years to understand and implement land management strategies such as fencing, vegetation works, and streambank works to improve the quality and sustainability of local riparian land and waterways.

Special thanks to the local stakeholders who collaborated and provided valuable input in developing this book at the *Nature Based Solutions to Build Resilience Project - Stakeholder Collaboration Workshop.*

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Title page: photo credit: Reef Catchments

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RIPARIAN ZONES

Any land that adjoins, directly influences, or is influenced by a body of water is known as a riparian zone, and acts as a transition area between aquatic and terrestrial ecosystems. The body of water could be a creek or stream (even if it flows only occasionally), a river, a lake, or a wetland. Figure 1 provides examples of the types of riparian zones that landholders may have on their property.

Figure 1: *Photos of various local examples of riparian zones, from small streams with tropical ecosystems (top) to larger arterial river systems on flood plains (bottom) to mangroves.* ***Photo credit:*** *Reef Catchments*

PURPOSE

The purpose of the **Mackay Whitsunday Isaac Riparian Management Handbook (Handbook)** is to enhance community appreciation of the benefits of best practice riparian and waterway management and to inform landholders about the role healthy riparian land plays in mitigating the impact of climate-driven weather events throughout the Mackay Whitsunday Isaac (MWI) Region.

This document was funded by the Australian Government National Recovery and Resilience Agency through the Preparing Australian Communities (PAC) - Local Stream program. This program supports locally led projects aimed at improving community resilience against natural hazards. The Mackay and Whitsunday regions are categorised as being at a higher risk from natural hazards, specifically tropical cyclones and floods (Australian Government, 2022).

Severe Tropical Cyclone Debbie struck the Mackay Coast in 2017 as a Category 4 cyclone and was the costliest cyclone since Yasi in 2011. The Proserpine sugarcane industry lost 35% of its crop, valued at $50 million, while Bowen's horticultural sector lost 20% of its $100 million crop. Major flooding in several areas caused significant erosion and damage to infrastructure. Erosion was notably severe in regions lacking riparian buffer zones, such as Oakey Creek (see Figure 2), where the cyclone caused substantial land loss and jeopardised nearby power infrastructure.

Future climate outlooks for the MWI region predict an increased likelihood of heavy rainfall events and storms, as well as rising sea levels, storm surges, and extreme high tides (CSIRO, 2021). Tropical cyclones are expected to decrease in frequency across northern Australia, with a likelihood of increased average intensity (CSIRO, 2021). These climate-driven events are anticipated to significantly increase the flood risk in low-lying areas of the region (CSIRO, 2021). There is global acknowledgment of the need for nature-based solutions to address the climate crisis and help build community resilience to extreme weather events and climate change.

The PAC program seeks to strengthen Australian communities against natural disasters. The Reef Catchment's *Nature-Based Solutions to Build Resilience Project* has developed this resource to assist local landholders and industry professionals with riparian management in the region.

These extreme events also carry large quantities of suspended fine particulate solids into the Great Barrier Reef, causing imbalances and damage to its ecosystems. Figure 3 illustrates a flood plume from the Proserpine and O'Connell Rivers on January 28, 2005, impacting the Whitsunday Islands. Many waterways in these regions are adjacent to private land, highlighting the crucial role of landholders in understanding the value of riparian zones and their impact on climate-driven events.

Figure 2: *Photograph of damage on Oakey Creek from Severe Tropical Cyclone Debbie, causing threat to power infrastructure. The creek had little riparian vegetation along the banks.* ***Photo credit:*** *Alluvium Consulting*

Figure 3: *Satellite image (Landsat 5 TM) of the Whitsunday Islands showing a flood plume from the Proserpine and O'Connell Rivers, 28 January 2005.* ***Source:*** *Johnson & Martin (2011)*

CATCHMENTS

This document has been developed specifically to focus on riparian land within the MWI region, which comprises of four catchment basins, including:

- Proserpine Basin
- O'Connell Basin
- Pioneer Basin; and
- Plane Creek Basin

Relevant sub-catchment systems within each basin are illustrated in Figure 4.

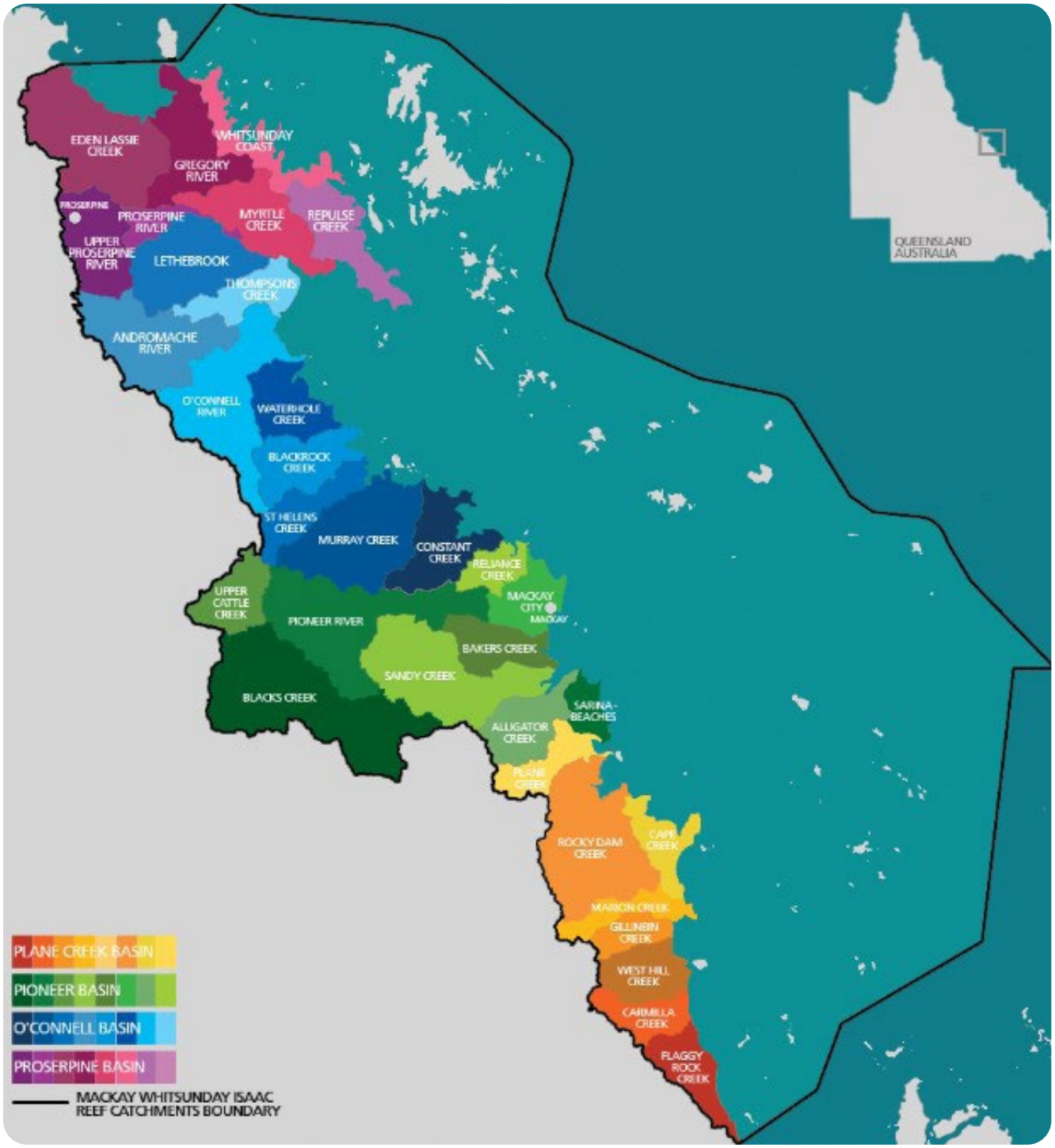


Figure 4: *MWI region Reef Catchments boundary indicating basin and sub-catchments within each basin.*
Source: *Reef Catchments 2024*

Figure 5: *Indigenous artwork of turtles.* ***Photo credit:*** *Reef Catchments*

VALUES OF RIPARIAN ZONES

Australian riparian landscapes hold profound intangible value for the community, encompassing cultural, spiritual, recreational, and aesthetic significance. The following sections explore how these landscapes are celebrated and deeply resonate with various members of the local community.

CULTURAL AND TRADITIONAL VALUES

Australian waterways hold significant cultural and spiritual importance, especially for Indigenous Australians. They are integral to life, and their protection and management are viewed as custodial and intergenerational responsibilities (Water Quality Australia, 2000). These values encompass spiritual connections, language, songlines, stories, sacred sites, customary uses, drinking water, and the flora and fauna within waterways and riparian zones. Riparian areas support many of these cultural activities and values. Native Title legislation, along with Commonwealth and State Cultural Heritage and water laws, acknowledge and address Indigenous interests in water (Water Quality Australia, 2000).

The MWI Region is home to seven tribal groups who are the traditional custodians of the land and seas within this area. Table 1 lists the MWI TOR Groups:

Table 1: *Traditional Owners and Representatives of the Seven Groups of Country bound by the MWI region*

Traditional Owner Representative Group	Location
Juru Country	Includes lands north of Bowen.
Gia Country	Includes the mainland adjacent to the Whitsunday Islands, north to Bowen, south to O'Connell River, and east to the Clarke Connor Ranges.
Ngaro Country	Includes the Whitsunday Islands and the mainland coastlines where they traded with the Gia people.
Yuwibara Country	The Yuwibara country boundary is north to Midge Point, south to Cape Palmerston, west to the Clarke Conner Range, and 10 nautical miles east of the coastline.
Koinmerburra Country	Includes Pine Mountain (Normanby Range) across to Styx River, north along the coast to Cape Palmerston and west to the Clarke Connor Range.
Barada Country	The Barada boundary is west of the Clarke Connor Ranges and south of Homevale National Park.
Wiri Country	Wiri boundary is west of the Clarke Connor Ranges and north of Homevale National Park.

Information around the role of Cultural Heritage bodies can be found in the Department of Treaty, Aboriginal and Torres Strait Islander Partnerships, Communities and the Arts (DSDSATSIP).

Planning riparian works should consider the impacts on a broad range of stakeholders, including traditional owners. Indigenous Australians have a profound relationship with, connection to, and responsibility for their local aquatic areas. Different groups may hold varying perspectives, beliefs, and approaches to managing waterways and riparian zones. Understanding the considerations surrounding traditional knowledge and the values of local Indigenous people is essential for achieving sustainable restoration outcomes that respect both Country and people.

As part of the landholder's Duty of Care, search the Cultural Heritage Database Register before completing works.

COMMUNITY VALUES

Riparian zones significantly enhance the aesthetics and recreational value of the local region. They support vital ecosystems that offer excellent recreational fishing opportunities and create scenic, peaceful areas ideal for picnics and relaxation.

Adjacent to waterways, riparian zones provide access to and protection for various local landmarks, such as waterholes and waterfalls, which are popular for swimming and fishing. Notable recreational spaces in the MWI region include Cedar Creek Falls and Finch Hatton Gorge. Maintaining the health of these areas is crucial for community enjoyment and connection with nature. Other locally enjoyed recreational activities include kayaking, hiking and fishing.

Figure 6: *Riparian zones in the MWI region offer some of the most beautiful natural spaces to explore.*
Photo credit: *Reef Catchments.*

Photo credit: *Reef Catchments*

BENEFITS OF HEALTHY RIPARIAN ZONES

Healthy riparian zones provide numerous benefits to our local landholders with great value in protecting, maintaining and reestablishing these areas. Within the agricultural sector, some key benefits of a healthy riparian area could include:

- Enhanced pollination of crops through the provision of habitat for pollinating insects.
- Pest control through biological control of pest species by birds and other animals.
- Shelter belts for stock and crops.
- Reduced mustering time if riparian zones are fenced off.
- Reduced flood or waterlogging damage.
- Reduced erosion into paddocks.
- Minimised runoff.

PROPERTY VALUE

Well-maintained, aesthetically pleasing rural land often commands higher market values and attracts buyers. This trend extends to riparian zones, where a well-managed riparian frontage can enhance property value while improving aesthetics and recreational appeal.

Studies abroad have shown that ecosystem services, such as wildlife habitats and scenic landscapes, increase agricultural land value. Similarly, river and forest assets boost rural property value through recreational and aesthetic benefits (Alluvium, 2023). Analysis in the MWI regions confirms this trend, revealing property values rise with the condition of riparian vegetation, applicable to both small farms (<100 ha) and larger properties (>400 ha) (Alluvium, 2023). Figure 7 illustrates an example of well-maintained riparian vegetation on a rural block.

Figure 7: *Local prime grazing land fully fencing healthy riparian vegetation.* ***Photo credit:*** *Reef Catchments*

Healthy riparian zones play a vital role in maintaining the ecological balance of our landscapes. These critical areas offer numerous benefits to landholders and the broader community, including improving water quality, preventing erosion, providing wildlife habitats, and offering recreational value.

Understanding riparian zones involves familiarising oneself with their key features, such as buffers, channels, and streambank elements like the bank crest and bank toe. These features are illustrated in Figure 8 and will be referenced throughout this Handbook.

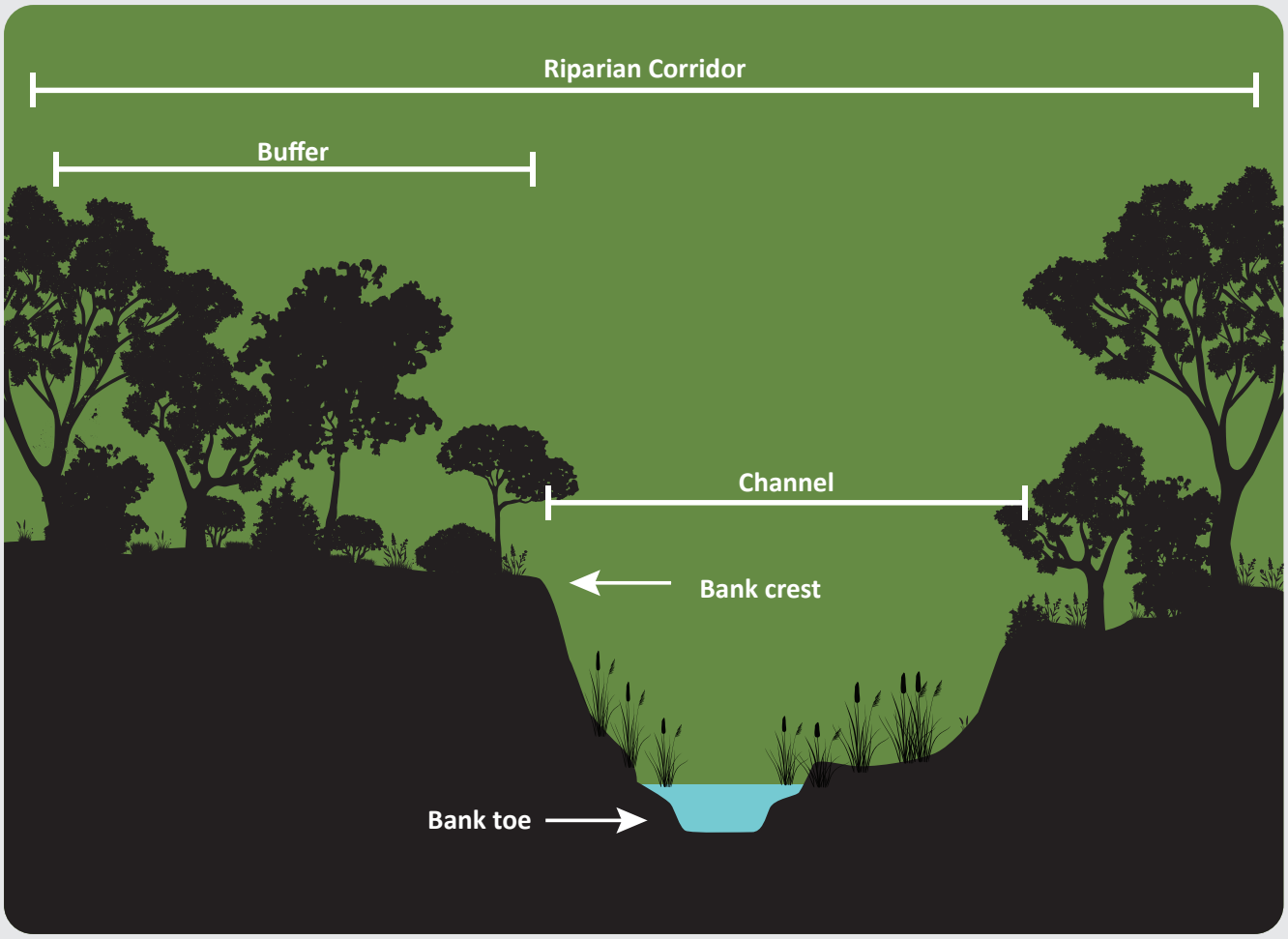


Figure 8: *Illustration of Riparian zone features including buffer zone, channel, bank crest and bank toe.*
Source: *Reef Catchment*

Within each unique feature of the riparian zone, a range of specific environmental processes and benefits occur. Figure 9 illustrates these processes in further detail.

In the riparian zone's channel and bank crest areas, structural components such as in-stream large woody debris and streamside vegetation contribute to channel complexity, provide habitat, and act as stabilising agents. Outside the channel, in the buffer section, key characteristics include deep-rooted vegetation and organic matter, which supply vital nutrients, habitat, and stability to the riparian zone. Figure 9 displays the functions and benefits of each structural component in greater detail.

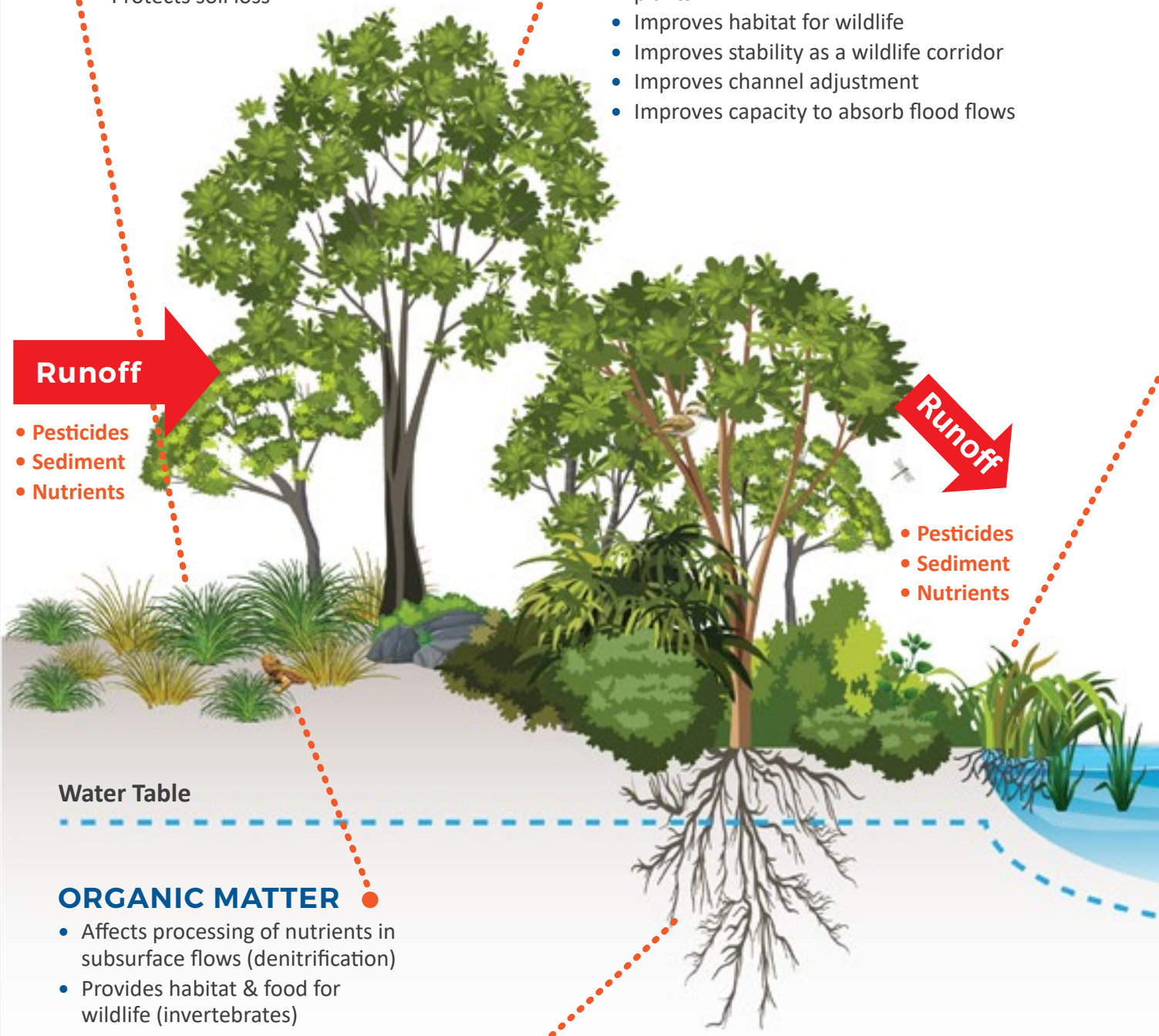
RIPARIAN FEATURES AND FUNCTIONS

FILTER STRIP

- Increases water penetration and infiltration
- Slows water
- Protects soil loss

VEGETATION

- Improves uptake and trapping of nutrient & sediment
- Improves capability to support riparian plants
- Improves habitat for wildlife
- Improves stability as a wildlife corridor
- Improves channel adjustment
- Improves capacity to absorb flood flows



ORGANIC MATTER

- Affects processing of nutrients in subsurface flows (denitrification)
- Provides habitat & food for wildlife (invertebrates)
- Filters pesticides

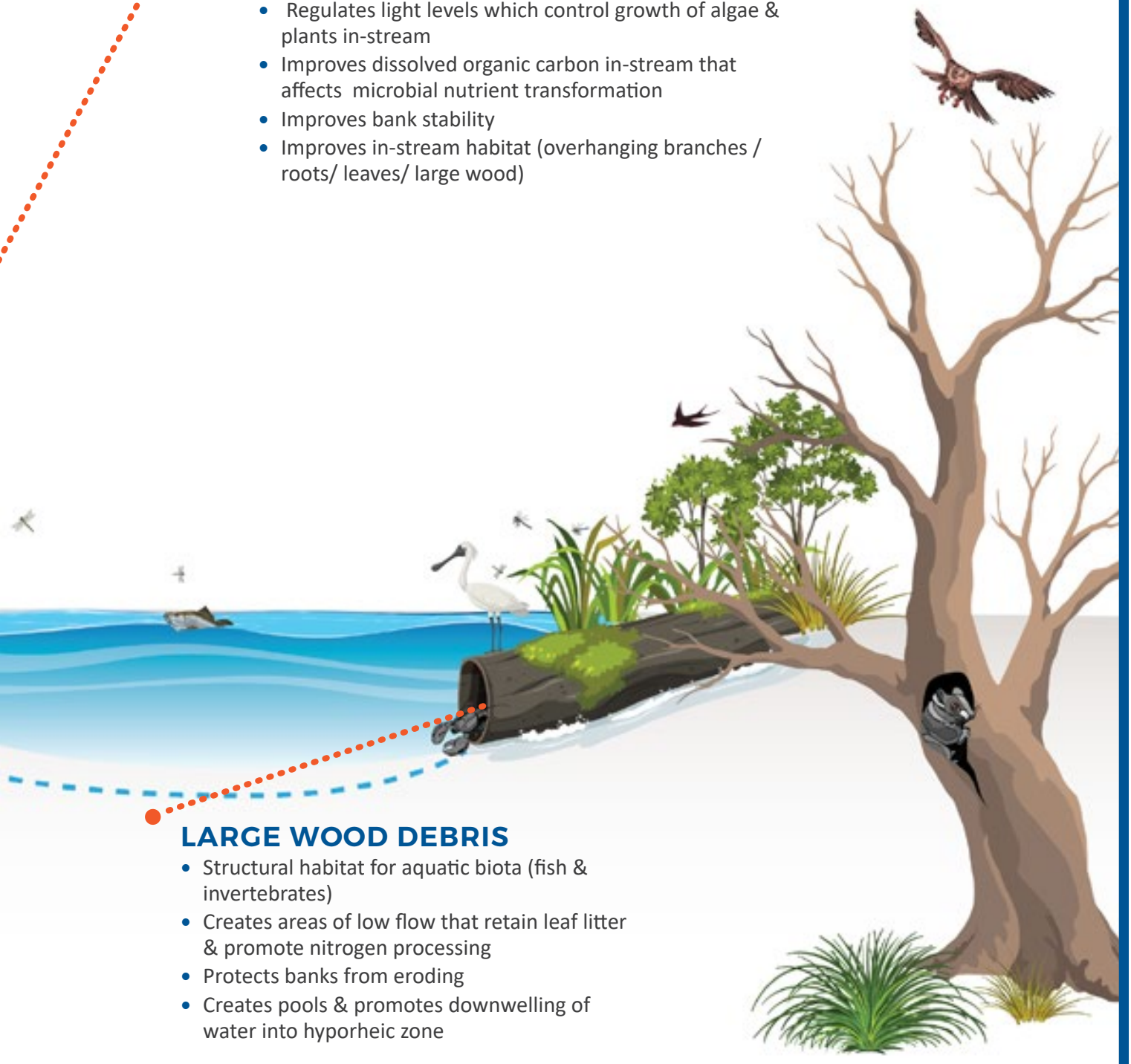
DEEP ROOT TREES

- Absorbs flood flows
- Provides habitat for riparian plants & wildlife
- Silt trapping

Figure 9: *Riparian attributes and aquatic and terrestrial ecological functions they support. Note: Some functions are influenced by multiple riparian attributes.* ***Source:*** *Adapted from Beesley et al. (2017)*

STREAM-SIDE VEGETATION

- Canopy cover captures rain & reduces splash erosion
- Shade to allow native vegetation to grow
- Roots reinforce soil
- Habitat for small fauna
- Regulates water temperature
- Regulates light levels which control growth of algae & plants in-stream
- Improves dissolved organic carbon in-stream that affects microbial nutrient transformation
- Improves bank stability
- Improves in-stream habitat (overhanging branches / roots/ leaves/ large wood)



LARGE WOOD DEBRIS

- Structural habitat for aquatic biota (fish & invertebrates)
- Creates areas of low flow that retain leaf litter & promote nitrogen processing
- Protects banks from eroding
- Creates pools & promotes downwelling of water into hyporheic zone

NATURAL RESILIENCE AND EXTREME EVENT MITIGATION

The climate outlook for the MWI regions suggests a rise in both the frequency of flooding and the severity of cyclonic events (DESI, 2019). As a result, riparian zones are becoming increasingly crucial for mitigating the impacts these events have on the surrounding areas. Well-vegetated riparian zones play a key role in reducing damage from wind and flooding. Mature vegetation serves as windbreaks, thereby safeguarding property assets (Alluvium, 2023). To be effective, riparian zones must incorporate a diverse array of overstorey, middle-story, groundcover, and aquatic plants. Each of these plant groups fulfill specific roles, and their collective presence stabilises streambanks and bolsters environmental resilience, as detailed in Table 2.

Table 2: *Vegetation Types and effect on flood waters in riparian zones.*

Function	Vegetation Type
Improve water infiltration.	The roots of shrubs, sedges and reeds stabilise and increase the porosity of the soil, increasing its ability to absorb water.
Increase surface 'Roughness' reducing flow rate going into the waterbody.	Reeds and sedges protect the soil from moving water and improve penetration and infiltration of water into the soil profile.
Strengthen and maintain bank stability.	Roots of larger trees strengthen the soil and streambanks (like steel in reinforced concrete).
Slow flow rate of water within the stream.	Logs from trees slow the water flow rate.

To illustrate the benefit of vegetation, moving a grain of sand from exposed ground surface requires only one unit of energy, while a fully vegetated ground surface demands 100 units of energy to move the same amount of sand (Misko & Hardie, 2022). Furthermore, vegetation can reduce floodwater speeds from 8 km/h to 2 km/h, decreasing the damage and spread of flood waters to surrounding property (Rutherford et al., 2006).

CHANNEL ADJUSTMENT

In nature, waterway channels adjust over time. However, events with high rainfall and higher-than-usual water flows exacerbate this rate. Vegetated riparian zones slow this process, particularly in high-flow events. Vegetated riparian zones limit channel adjustment in several ways:

- increasing hydraulic (frictional) resistance (Anderson and Rutherford, 2003)
- reduces in-channel stream power
- reduces near bank velocity; and
- structural protection of the stream bank provided by the vegetation (Alluvium, 2011).

A local example of farmland lost from channel adjustment from the 1970's to 2021 in Figure 10 below. Where there was little riparian vegetation on the banks, bank erosion was higher and the rate of change was more drastic than on the downstream bank, where vegetation was well established.

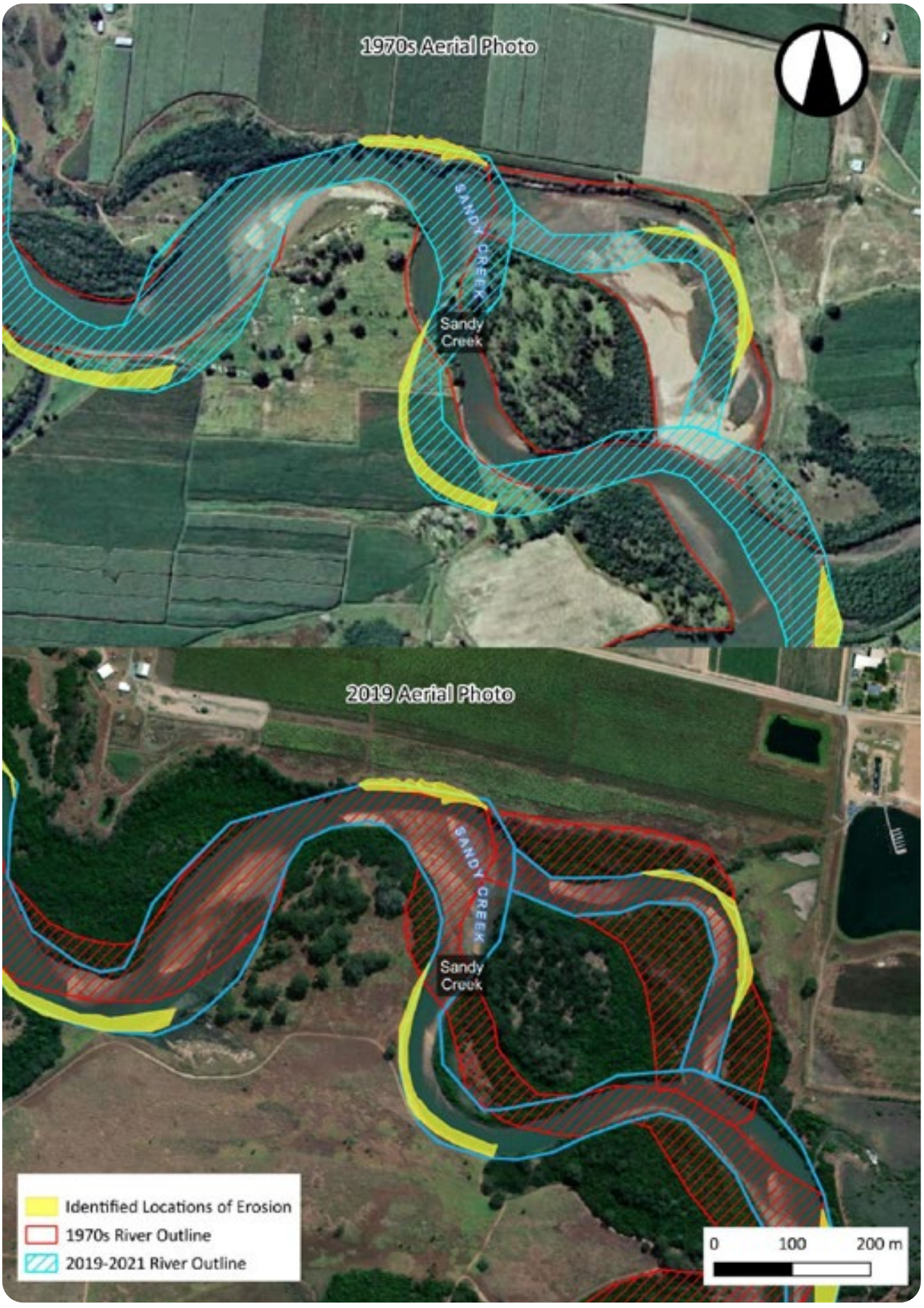


Figure 10: *Aerial Photograph (1970s) with cane adjacent to the waterway in 1970s in RED and waterway in 2019-21 outlined in BLUE. Note the lack of riparian zone along the waterway and land lost over time:* ***Source:*** *Neily Group, 2023.*

FLOODS

Research indicates that streambanks that have been cleared of native vegetation experience much greater erosion damage compared to those that have been revegetated over time (Alluvium, 2011). Furthermore, high-quality native vegetation established through revegetation programs can reduce erosion by 80-95% compared to unvegetated sites, as demonstrated in Figure 11.

Figure 11: *Photos comparing two streambanks, with no riparian vegetation (left) which experienced widespread erosion damage, while the revegetated site (right) in the paired study incurred mild erosion damage in the same flood event.* ***Photo credit:*** *Alluvium*

WATER QUALITY

Water quality entering catchments is crucial for downstream communities and the Great Barrier Reef. Healthy riparian zones function as natural filters, reducing nutrients and suspended sediments from overland flow into waterways (Alam, Rolfe & Windle, 2004).

Riparian vegetation limits nutrient runoff from both surface and groundwater flows and enhances nutrient retention through biological processes. By trapping sediment and its attached pollutants, riparian zones perform effective biofiltration. Grasses and understorey plants are particularly effective at creating buffer zones, especially in shallow, steady flows, while aquatic vegetation further purifies the water. Table 3 outlines the key processes by which riparian zones remove or transform runoff pollutants.

Table 3: *Key processes involved in the removal or transformation of runoff pollutants (Source: CRC 2015).*

Runoff pollutant	Key processes
Sediment	• Settlement during ponding • Physical filtration by vegetation and organic material
Nitrogen	• Nitrification (the conversion of ammonia to nitrate) • Denitrification (the conversion of nitrate to nitrogen gas) • Plant uptake • Biotic assimilation by microbes • Decomposition • Physical filtration of sediment-bound fraction • Adsorption
Phosphorus	• Physical filtration of sediment-bound fraction • Adsorption • Plant uptake • Biotic assimilation by microbes • Decomposition • Chemical bonding occurs when soils rich in iron, aluminium and organic matter attract phosphate ions (PO3-) trapping them in the soil matrix (Prosser et al. 1999).
Heavy metals	• Biotic assimilation by plants and microbes • Physical filtration of sediment-bound fraction • Oxidation/reduction reactions
Pathogens	• Adsorption-desorption • Physical filtration by media • Die-off (either natural or due to competition or predation)
Organic micropollutants (hydrocarbons, pesticides / herbicides)	• Adsorption • Biodegradation

Figure 12: *High shade cover from riparian trees.* ***Photo credit:*** *Reef Catchments*

LIGHT AND TEMPERATURE REGULATION

Riparian vegetation, particularly trees and shrubs, plays a key role in regulating the light and thermal regime of streams (Bayley & Williams, 1981; Rutherford et al., 2004). This regulation primarily occurs because canopy cover from the streamside zone absorbs incoming light (short-wave radiation), preventing it from reaching the stream (Rutherford et al., 2004).

Studies in Australia have shown that riparian vegetation can reduce maximum instream temperatures by 3–5 °C (Rutherford et al., 2004). This is particularly important for aquatic fauna that are sensitive to high water temperatures (Davies et al., 2004). Even partial shading created by riparian vegetation, as illustrated in Figure 12, can provide refuges of lower water temperatures for aquatic fauna during the summer.

ECOLOGICAL BENEFITS- CONNECTIVITY AND HABITAT

HABITAT CONNECTIVITY

Riparian zones are crucial for providing diverse habitats and supporting a wide range of species. Their vegetative diversity enhances species richness and abundance in both riparian and surrounding catchment areas. As transition zones between terrestrial and aquatic systems, riparian areas are biodiversity hotspots and vital corridors for animal movement and resource access (Wissmar & Swanson, 1990; Naiman & Decamps, 1997; Knopf & Samson, 1994).

An example of a riparian corridor is shown in Figure 13. Riparian plants have adapted to frequent disturbances such as flooding and drought, which makes them resilient and contributes to higher species diversity and abundance, particularly among birds and mammals (Martin et al., 2006).

Figure 13: *Healthy riparian corridor at the O'Connell River and Andromache River confluence.*
Photo credit: *Reef Catchments*

BIODIVERSITY

Riparian zones generally support a higher diversity of plants and animals compared to the surrounding landscapes. This is due to their wide range of habitats and food sources, proximity to water, milder microclimate and ability to provide refuge. Many native plants are found only, or primarily, in riparian areas, which are also essential for various animals throughout all or part of their lifecycle. Riparian zones offer a refuge for native plants and animals during times of stress, such as drought or fire. Examples of both native and endangered species in the local region are shown in Figure 14.

Figure 14: *Photos of local wildlife including the rose-crowned fruit dove (Ptilinopus regina) (top left)* ***Photo credit:*** *Barry Deacon, the endangered Red Goshawk (Erythotiorchis radiatus) (bottom left) and the endangered Northern Quoll (Dasyurus hallucatus).* ***Photo credit:*** *Reef Catchments.*

The role of riparian vegetation in supporting aquatic habitats is equally crucial. Woody debris, such as branches, large limbs, and trees, is an important natural component of the aquatic ecosystem, providing habitat for both aquatic and terrestrial organisms (DESI, 2013). This debris often serves as nurseries for juvenile angling species, such as Barramundi.

When an established canopy cover is present, riparian land becomes more effective in preventing the uptake of weed species. Increased native vegetation also encourages the return of native wildlife, which in turn acts as natural pest control. Pest-eating birds, owls, and insects can help protect pastures and crops from damage.

THREATS TO RIPARIAN ZONES

Waterways and riparian ecosystems face numerous threats, which are often intensified in modified landscapes with changes in land use and land cover. These impacts can extend to the broader ecosystem, affecting its function and resilience. For example, the loss of bird habitats and population declines can hinder their essential roles in pollination, seed dispersal and insect control. This chapter will discuss some of the more immediate and serious threats to riparian ecosystems in agricultural settings.

EXTREME CLIMATIC EVENTS

Extreme climatic events such as floods and cyclones are a major threat to our riparian zones that result in significant channel and streambank erosion such as the example provided in Figure 15. These events can trigger rapid change that can impact future stream stability. The MWI region has been impacted by 24 major cyclones since 1910 (Neilly Group 2023). Recent extreme events include:

- Severe Tropical Cyclone Debbie 2017
- Cyclones Ului (2010), Dylan (2014), Ita (2014)
- Monsoon Trough flooding event 2019

Figure 15: Bank erosion and loss of water monitoring infrastructure on the O'Connell River.
Photo credit: *Reef Catchments*

Figure 16: *Grass fire, if not managed carefully, has the risk of spreading into riparian zones.* ***Source:*** *Pixabay 2024*

FIRE

Uncontrolled use of fire in and adjacent to the riparian zone can have a detrimental effect on vegetation, resulting in loss of ground cover, reduced resistance to flow velocities, and increased risk of erosion and sedimentation. The November 2018 bushfires resulted in significant losses of riparian vegetation in parts of our region (e.g. Finch Hatton/Eungella), which exacerbated streambank erosion during subsequent high-flow events. Fire can also promote weed growth (e.g. Guinea Grass) and lead to an elevated fire risk due to increased fuel loads. Riparian vegetation is fire sensitive, and burning is not generally recommended (unless for a specific outcome such as initial weed control) (Reef Catchments Limited).

LAND CLEARING AND LOSS OF RIPARIAN VEGETATION

Clearing or altering riparian vegetation poses significant threats to the function and resilience of these ecosystems. Healthy riparian vegetation serves as a buffer against bank erosion, weeds, pollutants, and fire. When riparian vegetation is cleared or fragmented, it disrupts the continuity and connectivity along watercourses, isolating remaining patches and impairing ecological processes. This disruption can degrade riparian habitats and the services they provide.

Additionally, the removal of vegetation accelerates water flow, leading to deeper river channels, steeper banks, and increased sediment transport. This results in larger-scale bank failures, channel widening, and reduced flood immunity. Eroded material can form sand slugs, which exacerbate erosion and disrupt the stream system.

Clearing vegetation also raises water tables, increasing the risk of land salinisation (build up of salt in the soil) and stressing or killing plants. The loss of mature trees removes essential canopy cover, shade, and leaf litter. Shade is crucial for controlling light and temperature, helping to prevent nuisance algae and supporting seedling growth in dry conditions. Leaf litter provides a protective microclimate for understorey plants in arid areas (Neilly Group, 2023; Lovett, 2001; Capon et al., 2017).

Logs are often removed from watercourses to reduce the risk of flooding or to facilitate boat passage (Abbe et al., 2003). However, the removal of large woody debris from channels can allow water to travel downstream at a faster rate, sometimes contributing to increased flooding and erosion of lowlands (Trotter, 1990). The accumulation of woody debris in large rivers increases channel complexity and promotes the formation of bars, pools, and side channels. These formations provide greater habitat options for flora and fauna. An example of the effect of large logs and root balls along the waterway can be seen in Figure 17.

Figure 17: *Fallen log along Juxat Creek offers as a refuge and habitat for small fish and invertebrates.* ***Photo credit:*** *Reef Catchments*

Figure 18: *Degradation of vegetation and bank stability from livestock accessing waterbody.*
Photo credit: *Reef Catchments*

UNCONTROLLED ACCESS BY GRAZING LIVESTOCK

Unrestricted, year-round stock access to riparian zones can damage stream bank vegetation, reduce ground cover, create cattle tracks, trample banks and reduce water quality. An example can be seen in Figure 18 below. This can result in significant erosion damage and often loss of productive land (Reef Catchments Limited 2022).

Stock walking up and down banks into creeks creates a stock pad that they use all the time. This creates a channel with no grass cover towards which overland flow will naturally gravitate. The water picks up the soil and transfers it to the creek. Over years of use, these will get deeper and deeper and become what is known as a 'nick point'. These often develop into head cuts (starting point for an erosion gully) that can travel into the paddock and get longer, wider and deeper. Additionally, this disturbance diminished the natural stability of the bank creating a higher risk for streambank erosion.

POLLUTION FROM RURAL, URBAN AND INDUSTRIAL ACTIVITIES

Pollution from rural, urban, and industrial activities can take the form of rubbish, excessive nutrients, sediment, and various pesticides. Inappropriate fertiliser application from adjacent activities can lead to invasive plant species dominating riparian areas, outcompeting native flora, and reducing biodiversity. Increased sediment and nutrients flowing into waterways can result in eutrophication (build up of phosphorus and nitrogen in the water) and acidification (a reduction in the pH of the water), negatively impacting macroinvertebrates and other wildlife that rely on riparian areas for drinking and breeding.

Pesticides, including herbicides, insecticides, fungicides, miticides, and rodenticides, are widely used in agriculture, parks, and domestic settings. Spray drift and runoff from cropping lands, corridors, parks, lawns, gardens, and grazing lands often enter riparian zones, causing significant impacts on native riparian vegetation and aquatic communities. In the MWI region, common agricultural chemicals include imidacloprid, a neonicotinoid insecticide known for its high mobility. If applied incorrectly or at high rates, imidacloprid can move into riparian zones and waterways, affecting the broader system. Imidacloprid has particularly disruptive and deadly effects on bees, which are key pollinators for riparian flora (Brandt et al., 2016).

URBAN AND RURAL DEVELOPMENT

Replacing natural riparian vegetation with engineered, hard, impervious surfaces (such as concrete and rock) increases water temperature and flow velocity, reduces the capacity to filter nutrients and sediment, and results in the loss of habitat (Beesley, 2017). Dams, weirs, and pumps alter water flow and levels, affecting riparian vegetation and in-stream plants and animals (Lovett, 2001). In-stream structures like dams and culverts may restrict fish passage, which is essential for the survival of many native species (DAF, 2021).

The removal of large woody debris (such as logs) from waterways leads to a loss of habitat. In some cases, removing this debris may accelerate erosion if it had previously been protecting the bank from scouring flow events. Roads that cross waterways create habitat fragmentation and remove corridors, isolating and restricting fauna movement while enabling weed growth (Beesley, 2017). Streambank erosion rates are also increased by disturbances such as sand and gravel extraction, alluvial mining, or channel diversions (Wilkinson et al., 2022).

RECREATIONAL ACTIVITIES

Overuse of riparian zones for recreational purposes can damage the locations we seek to enjoy. Concentrated foot and vehicle traffic in these areas can harm creek banks and vegetation, increasing the risk of erosion. Wash from boating activities can further erode streambanks. Other impacts include littering, increased fire risk, and habitat loss due to activities such as firewood collection. Riparian spaces are often popular camping spots, which can lead to cleared, compacted areas. These disturbances hinder natural vegetation growth, introduce weed species, and degrade bank stability and integrity.

INVASIVE SPECIES (PLANTS AND ANIMALS)

INVASIVE WEED SPECIES

Loss of native plants and disturbances to riparian land make them particularly vulnerable to invasion by exotic plants. Weeds in the riparian zone can increase fire loads, outcompete native vegetation communities, and reduce habitat for native species. Weeds often increase erosion risk due to poor ground cover. A local example is that of guinea grass (Megathyrsus maximus), as seen in Figure 19, often coming from agricultural areas colonising into disturbed sites to form dense clumps and may foster soil erosion in invaded areas. Establishments can occur rapidly and become so tall and dense that it becomes inaccessible to wildlife and native flora (DAF, 2024a).

Figure 19: *Guinea Grass and lantana cover most of the streambank at a site at Cattle Creek, inhibiting growth of native species.* ***Photo credit:*** *Reef Catchments*

Several weeds are often found in riparian zones in the MWI region which are regarded as Weeds of National Significance and declared as pests under Queensland legislation.

To view the list visit Weeds Australia: https://weeds.org.au/weeds-profiles/

Landowners have a general biosecurity obligation (GBO) to take all reasonable and practical measures to prevent or minimise the risk of spreading invasive plants, as outlined in the *Queensland Biosecurity Act 2014*. The GBO encourages landholders and other relevant parties to take a proactive role in preventing, managing, and addressing invasive species and risks that relate to them.

For assistance in weed identification the Mackay Regional Pest Group also offers the *Weeds of Mackay Whitsunday Region* which can be purchased here: Mackay Regional Pest Group – Pest management advisory group or through Reef Catchments.

INVASIVE ANIMAL SPECIES

Many pest animal species can often occur within riparian zones due to the water source and can often create significant damage to these areas if not controlled. Local Councils will have a list of key pest animals that impact the region the most. For the MWI region, feral pigs (*sus scrofa*) are identified as a key species of concern due to their impact on productive agricultural lands and the overall landscape, as seen in Figure 20.

Figure 20: *Feral piglets seeking water in the dry season.* ***Photo credit:*** *Reef Catchments*

Figure 21: *Damage from feral pigs disrupting revegetation plants and mulch layer at a restoration site at Murray Creek.* ***Photo credit:*** *Reef Catchments.*

The feral pig is a category 3, 4, and 6 restricted invasive animal under the *Biosecurity Act 2014*. Feral pig populations are prevalent throughout our region and can cause significant damage to the riparian zone. Their grazing, rooting, and wallowing activities damage stream banks and vegetation, exposing the land to erosion during rainfall and flow events. An example of their impact on a revegetation site along Murray Creek can be seen in Figure 21. Other pest animals, such as foxes and feral cats, prey on native fauna species within riparian habitats, impacting biodiversity values within these areas.

Local Councils aim to work collaboratively with landholders and stakeholders regarding pest management. Local Council Pest Management Officers are available to help and advise on best practice management options for weed and pest animal control. The Department of Agriculture and Fisheries also provides further guidance on pest identification and management options.

Figure 22: *Illegal dumping along St Helens Creek.* ***Photo credit:*** *Reef Catchments*

LITTER AND ILLEGAL DUMPING

Waste pollution of the riparian zones comes from a wide range of land uses. Sources may be very close or may have travelled down from upstream (DES 2023). Examples of items include car bodies, tyres, mattresses, plastic straws, cigarette butts, plastic containers and garden waste.

An example of illegal dumping is shown in Figure 22. Besides being unsightly and expensive to clean up, this also has an adverse effect on the riparian environment.

If you see illegal dumping, please report to your local Council.

BEST MANAGEMENT PRACTICE

Best management practice (BMP) in riparian zones refers to strategies and guidelines for sustainable agricultural activities near water bodies such as rivers, streams, and creeks. The primary goal of these practices is to minimise the environmental impact of activities while maintaining the health of riparian ecosystems.

Implementing proper grazing management adjacent to nearby riparian zones is crucial to protect water quality, prevent soil erosion, and preserve biodiversity.

The ABCD Land Condition Framework is a tool used in environmental and land management to assess and monitor the condition of natural landscapes in the context of rangeland and grazing management. This framework provides a systematic way to evaluate the health and ecological sustainability of land, with a focus on vegetation and soil condition. The term "ABCD" stands for four key land condition indicators through a progression of improvements to water quality, from D class ("Dated") management practices with the lowest corresponding water quality outcomes through C class ("Conventional" or "Common"), B class ("Best Practice") and finally to A class ("Aspirational") or yet unproven management practices (Folkers, et al., 2014).

For more information around agricultural Grazing Land Management, see this Fact Sheet:

https://www.hlw.org.au/resources/downloads/agriculture/56-agriculture-grazing-land-condition-factsheet/file#:~:text=The%20ABCD%20framework%20was%20developed,pasture%20condition%20and%20soil%20condition.

Below are links to BMP documents and Industry BMP programs relevant to the MWI regions.

SUGARCANE

The *Central Region sugarcane practice management ABCD Frameworks 2021-2022* can be found here: https://reefcatchments.com.au/files/2020/05/MWCaneABCD_2021-ART-1.pdf

Smartcane BMP: https://smartcane.com.au/

GRAZING

The *Mackay Whitsunday Isaac region- ABCD Management Practice Framework for Grazing 2022 Update* can be found here: https://reefcatchments.com.au/files/2021/11/2022-Update_ABCD-Management-Practice-Framework-for-Grazing_ART_no-bleed.pdf

HORTICULTURE

Hort360 BMP: https://www.growcom.com.au/hort360

Photo credit: *Reef Catchments*

REMEDIATION STRATEGIES

Any riparian rehabilitation work aims to develop a stable stream with well-vegetated banks. It is important to resolve any problems relating to stream stability before revegetating stream banks to increase the success of the restoration project.

Restoration of riparian zones requires planning and major works, and may require advice from local specialists. It is recommended that landholders seek support or engage with a professional for advice and help in determining remediation strategies.

The following will offer a starting point for planning the restoration of riparian zones.

FORWARD PLANNING

The key to any successful riparian restoration work is to set a clear plan that focuses on a set scope of works and investment, ensuring the long-term stability of that riparian zone. The steps detailed below describe the key activities to implement long-term success in a land management program.

STEPS TO IMPLEMENTING A SUCCESSFUL REMEDIATION STRATEGY FOR RIPARIAN ZONES.

The key steps to achieving a successful riparian restoration project are displayed in the diagram below. Steps can be seen as cyclical as they are often repeated as part of a longer-term plan in a land management program.

Details for each step are presented below in Figure 23:

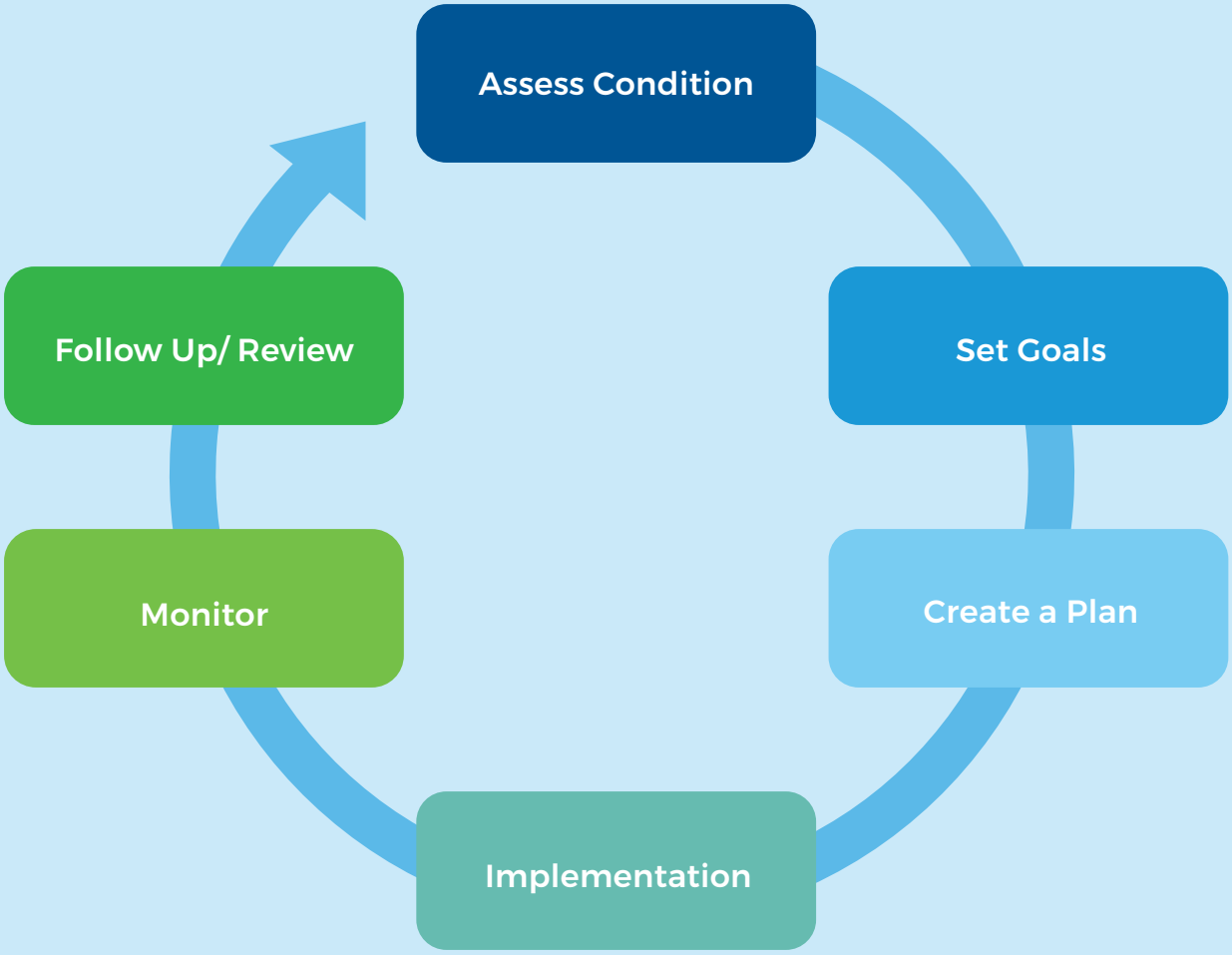


Figure 23: *Steps for undertaking work on riparian zones*

ASSESS CONDITION

As a starting point use the **Reef Catchments Riparian Scorecard** to assess the condition of the riparian site. You access this here:

Reef Catchments Riparian Scorecard:
https://reefcatchments.com.au/resources/pac-fact-sheet-riparian-scorecard/

SET GOALS

Following a condition assessment of the riparian site, set clear and targeted goals based on what key functions require improvement. Table 4 offers some general guidelines for achieving functional goals.

Table 4: *Riparian Ecosystem functional attributes and management guidelines.*

Function	Attribute	Guideline
Bank stabilisation	Buffer width	Minimum 10m
	Vegetation type	Natives, suited to the regional ecosystems. Different structures such as grasses, sedges and shrubs near bank toe and shrubs and trees nearing the bank crest.
	Livestock	Livestock exclusion fencing
Nutrient filtration	Vegetation type	Natives, suited to the regional ecosystems. Different structures such as grasses, sedges and shrubs near bank toe and shrubs and trees nearing the bank crest. Grass filter strip at outer edge of the vegetated zone.
	Buffer width	Minimum 10m
Aquatic Habitat	Vegetation Type	Native vegetation, specifically larger trees to offer woody debris and leaf litter as well as aquatic plants.
	Large Woody debris	Positioned approximately traverse to the channel into the water to enable pools and habitat
Terrestrial Habitat	Vegetation type	Natives, suited to the regional ecosystems. Different structures such as grasses, sedges and shrubs near bank toe and shrubs and trees nearing the bank crest.
	Vegetation Density	Highly dense - continuous ground cover and canopy cover
	Large Woody debris	Positioned approximately traverse to the channel on the bank and partly submerged into the water
	Weeds	Weed removal supports native growth. Livestock exclusion fencing.
Shading	Vegetation height	5-10m height
	Vegetation type	Natives, suited to the regional ecosystems. Different structures such as grasses, sedges, shrubs, trees.
	Vegetation Density	Highly dense - continuous ground cover and canopy cover
	Buffer width	Minimum 10m

FEATURES AND CONSIDERATIONS

During the early design steps, it is important to understand the key features of riparian zones and the social and physical aspects of the surrounding environment. The scope of desired outcomes should aim for both long-term and short-term goals. An example of this would be the consideration of sacrificing a small amount of cropping land to stabilise the bank to conserve adjacent prime agricultural land for a sustainable future, as seen in Figure 24. Another example may be the hydrological flow regime, where stream flow is intermittent, and earthworks may be best suited to be undertaken during the dry season to avoid delays and minimise disturbance.

Figure 24: *Aerial view of riparian restoration works involving converting sugarcane cropping land to stabilise the bank to mitigate ongoing intensive erosion of prime cropping land.* ***Photo credit:*** *Reef Catchments*

Key considerations and features that should be factored into creating goals and strategy activities are listed below.

Fresh water or Tidal	Legislative requirements Direction of flow
Flora & Fauna	Native vegetation Native wildlife (or evidence of) Weeds
Soils	Soil Type Soil structure Health
Other	Topography Aspect Wetlands/creeks/drainage
Issues	Erosion by wind Erosion by water Salinity
Infrastructure	Dams, Bores Buildings Powerlines
Access	Pedestrian Vehicles Machinery
Cultural/Historical	First Nations Historical
Management	Past / present land management practices Ownership, Planning controls, boundaries etc.

IMPLEMENTATION

Once goals and planning have been completed, the Implementation of riparian work can begin. See METHODS section of this Handbook for details on various remediation methods to achieve your desired outcome.

MONITOR

Monitoring can vary in duration based on objectives, such as a few months for weed control or several years for revegetation. Key metrics include ground coverage, plant survival rates, the ratio of weeds to natives, and site bank stability.

Permanent photo points are useful for tracking vegetation growth and bank stability over time. While professional monitoring often uses dedicated photo tags, any permanent feature or tree can serve as a reference for before-and-after comparisons. Figure 25 illustrates this approach with progress photos of a restoration site.

Figure 25: *Before/After photo of works using permanent photo points to monitor the progress of streambank revegetation program. This site illustrates a great example of growth and uniformity of vegetation to develop bank stability.*
Photo credit: *Reef Catchments*

REVIEW AND REFLECT

Once works have been completed and monitoring data collected, repeat the **Assess Condition** step and compare it with the original results. Reflect on what went well and what could have been done better next time. Tailor the plan forward with these learnings when approaching new sites or new activities on existing sites.

REMEDIATION METHODS

The type of stream and the erosion processes that are occurring need to be considered before planning any streambank project. The approach to stabilising a small creek will differ from that for a major river. Additionally, remediation strategies implemented in tidal zones may require a different approach due to estuarine conditions. Restoration methods for riparian zones can be regarded as either 'soft' or 'hard' approaches. 'Hard' approaches are considered to use structural features such as rock, wood, or concrete. Often engineers are required for advice or design and may need permits and approvals by relevant legislation. Hard approaches can be combined with vegetation to reinforce bank stabilisation.

Soft solutions (sometimes referred to as bioengineering) will use natural processes such as revegetation, weeding and mulching to safeguard streambanks. The aim is to encourage natural elements to self-rejuvenate the site back into a natural equilibrium. A soft approach may be more affordable and sustainable in the long term.

The following will explain various methods of each including:

- Soft Approaches
  - Establishing riparian buffer widths
  - Revegetation Principles:
    - Active revegetation
    - Passive revegetation
    - Direct seeding
  - Exclusion Fencing
  - Weed control
- Engineering or Hard work;
  - Bank battering
  - Timber pile fields
  - Log jams
  - Rock armouring; and/ or
  - Rock groynes

SOFT APPROACHES

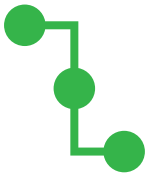
RIPARIAN BUFFER WIDTHS

An effective restoration project must first establish what a suitable riparian vegetation buffer width is to ensure bank stability and the effective functionality of ecological services. The width will be determined by the purpose of the riparian protection, types, stressors, physical attributes of a particular stream and position within the catchment (Balcombe, et al, 2020). Figure 26 demonstrates the progress of revegetation works program, where a landholder has relinquished cropping land to convert it back into a riparian buffer. A buffer width of greater than 10m was established to assist in bank stabilisation and mitigate further loss of cane cropping land. Factors which influenced the decision around buffer width included the dynamic nature of a tidal zone where the project site was located, the risk of further land loss and the value placed on the asset being protected by the landholder.

Figure 26: *Active revegetation before/after riparian works on the Murray Creek, utilising area from cane paddocks to revegetate and reinforce banks. The site plan included extending into adjacent natural areas for habitat continuity.*
Photo credit: *Reef Catchments*

REVEGETATION PRINCIPLES

In terms of revegetation methods, riparian zones and waterways often offer distinctive challenges and are worth considering the following before planning out (DPIENRP, 2020):

	Protect	**Protect** intact, remnant or established riparian vegetation by monitoring condition and taking action to prevent weed infestation or damage from grazing animals.
	Connect	**Connecting intact** riparian zones, rather than establishing a patchwork of isolated riparian zones.
	Encourage	**Encourage** natural regeneration where there are intact riparian areas and seed sources upstream.
	Revegetate	**Revegetate** when native vegetation is: • unlikely to recover naturally, specific plant species are required to achieve the rehabilitation objective, or • when erosion is relatively rapid and active revegetation is likely to have more immediate benefits.
	Start in the upper catchment	**Start in the upper catchment**, as the benefits of riparian rehabilitation accumulate in the downstream direction, unless there is a compelling case for intervention elsewhere. For example: • Address the point source of a problem (e.g. highly active bank erosion in lowland reaches) • Provide critical habitat needs for rare and threatened species. • Protect high value Aboriginal cultural sites or places
	Plant selection	**Select** plant species that are best suited to the site conditions. For example: • Species that previously grew in local riparian areas may become less resilient as the climate changes. • Many rivers today have different hydrology, substrate, microclimate, light, and nutrient conditions than under pre-development conditions. Some species that originally grew on these sites may no longer be suited to the current conditions. • Climate change and impacts on channels will likely cause major changes in flow regimes, flow conditions and the local climate at your site. Understanding these future changes is important to plan for in your project design and selection of species. • Local nurseries can be a good source of information to assist in species selection.

Department of Planning, Industry and Environmental (DPIE) and Natural Resources Commission (2020)

ACTIVE REVEGETATION

Active revegetation involves reintroducing and reestablishing vegetation at a site through various methods. These can include planting advanced tube stock propagated in nurseries, obtaining transplants from within or outside the rehabilitation site, direct seeding, or hydro mulching. Active revegetation is most suitable for sites where native vegetation has been removed and is not naturally recruiting. It's also ideal for sites where rapid vegetation cover is necessary to prevent soil erosion or where engineered solutions have disturbed the existing vegetation.

The first year is the hardest part of growing plants as they have a greater chance of going wrong than well-established ones. For these reasons, efforts should be made to "nurture them" throughout the establishment phase. This involves providing protection and support (watering, mulching, weeding, protection from pests) and gradually reducing the degree of support. A key to successful revegetation in North Queensland is the provision of irrigation during the dry establishment period (depending on location) and the provision of active maintenance.

Figure 27: *Active maintenance of tube stock at Murray Creek (top left) mulching plant species using local cane trash mulch (top right) and ongoing irrigation in the dry season to maximise plant survival rate (above).* ***Photo credit:*** *Reef Catchments*

PASSIVE REVEGETATION

Passive revegetation is a simple method that allows natural recruitment or succession to occur in an ecosystem after removing a source of disturbance or pressure. This allows the natural seed bank to establish and recover into equilibrium with limited intervention. This is a low-cost option but often can take longer to reach the restoration objective. The method assumes that there is a viable and diverse native seed bank available or that seeds from desirable species will be deposited on-site via birds, wind, wildlife, etc. It is important not to assume that the river or riparian will naturally return to its desired state, so regular monitoring is required for this approach to ensure change is occurring positively (DESI, 2022a).

DIRECT SEEDING

Direct seeding is a method that involves the sowing of treated seeds directly into prepared ground for germination and plant establishment. This can be undertaken either mechanically or by hand. Direct seeding can be a cost-effective option when planned and timed correctly.

Direct seeding requires a large amount of seed for the best chance of achieving site success. While the purchasing costs of seeds can seem high ($/kg), the overall cost per square meter is generally lower than tube stock plantings when factoring in the costs associated with tube stock plantings (trees, guards, and labour). A key disadvantage is that there is no guarantee that seeds will germinate and become established evenly. Seed dispersal and plant establishment may be patchy, which can lead to an insufficient groundcover for the site (Cotton Info, 2021). Another consideration is sourcing local seeds at the volume required. Local nurseries may or may not have seeds in stock, which can often be sourced from adjacent vegetation. Upon broadcasting, seeds will be exposed to the elements to break dormancy. This method will most likely work in the wet season.

WEED CONTROL

Weeds are difficult to address in riparian zones and waterways due to the proximity to water and sensitive nature of aquatic plants and fauna from herbicides. There are various methods for weed control for riparian restoration, with the main methods including:

- Manual control using hands and hand tools.
- Mechanical control using various forms of machinery.
- Shading and other forms of exclusion, such as matting and mulching.
- Chemical control using a range of potential herbicide application methods such as injection or spraying.
- Biological control using plant pathogens or insects.

Given the impacts of herbicides on aquatic life, there should be restricted use of herbicides in riparian/waterway environments, with preference given to aquatic fauna ‘friendly’ products. Various factors come into play when determining which option to choose, such as the species, proximity to water, existing native vegetation, skills of the operator, weather and seasonal conditions, budget, accessibility of the site, and difficulty of the terrain. When selecting which technique to use, remember that a combination of weed control methods will generally be required to effectively treat the weeds in a site. In the MWI region, tropical grasses can easily outcompete and choke young native plants, particularly when the soil is exposed and in full sunlight. A common method for controlling grasses in revegetation sites in close proximity to water is to mulch as well as brush cutter snip around the native species during the establishment phase, or until canopy cover shades out areas from grass.

Figure 28: *Brushcut grasses as part of the maintenance plan for a revegetation site.* ***Photo credit:*** *Reef Catchments*

EXCLUSION FENCING

Restricting livestock access to riparian zones and waterways is a key land-based management action that can be implemented to protect waterways and riparian land. A range of fencing materials and methods (e.g. multi-strand, mesh, drop-down, electric, virtual) can be used, subject to the target animals for exclusion, the scale of the site, the adjoining land uses and the requirements of native animals to access the site (DESI, 2022b). Figure 29 shows a great example of stock fencing on a farm along Murray Creek. Controlling cattle access, especially through the wet season, can greatly reduce the impact on riparian areas. Off-stream watering points provide stock with a clean and reliable source of water that is easily accessible.

Figure 29: *Livestock fencing on local grazing properties allows native vegetation to develop undisturbed along waterways.* ***Photo credit:*** *Reef Catchments*

Fencing riparian land encourages the establishment of flora and fauna, improving vegetation structure and diversity, as well as improving streambank stability, as seen in Figure 30 below. When native vegetation establishes and creates a canopy cover it can become self-sufficient in managing weed incursions by shading out competition. The increase in native vegetation also encourages native wildlife to return to areas that can act as pest control for undesirable species.

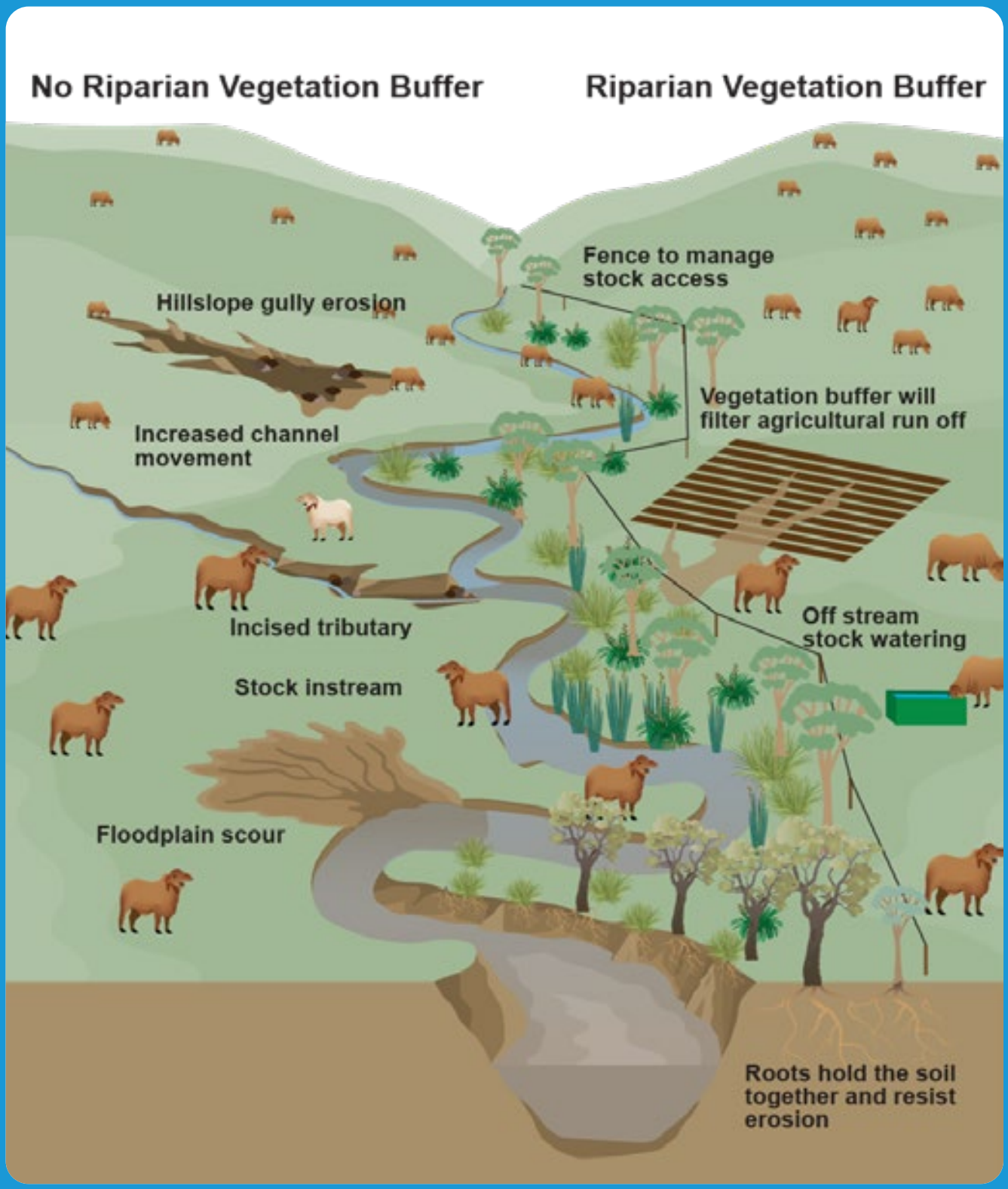


Figure 30: *Conceptual diagram illustrating the difference between grazing to the edge of a creek and farming with an adequate buffer, including fencing to exclude stock from the riparian zone.* ***Source:*** *,DESI c 2022*

ENGINEERING OR HARD APPROACHES

Engineering or 'hard approaches' are often adopted when significant stabilisation issues, such as where the bank needs stabilising, or there is a threat to infrastructure. The following methods are planned and designed by engineers to ensure the streambanks are sloped to a sustainable angle, and the designs are set to withstand the erosive forces associated with the situation.

BANK BATTERING

wBank battering is a method that involves excavation works to reduce bank slopes, as seen in Figure 31. This improves bank stability, allows vegetation to grow, and provides natural reinforcement. Bank battering requires a combined vegetation management and physical intervention approach and, in many instances, is limited to the upper bank profile (DESI, 2022c).

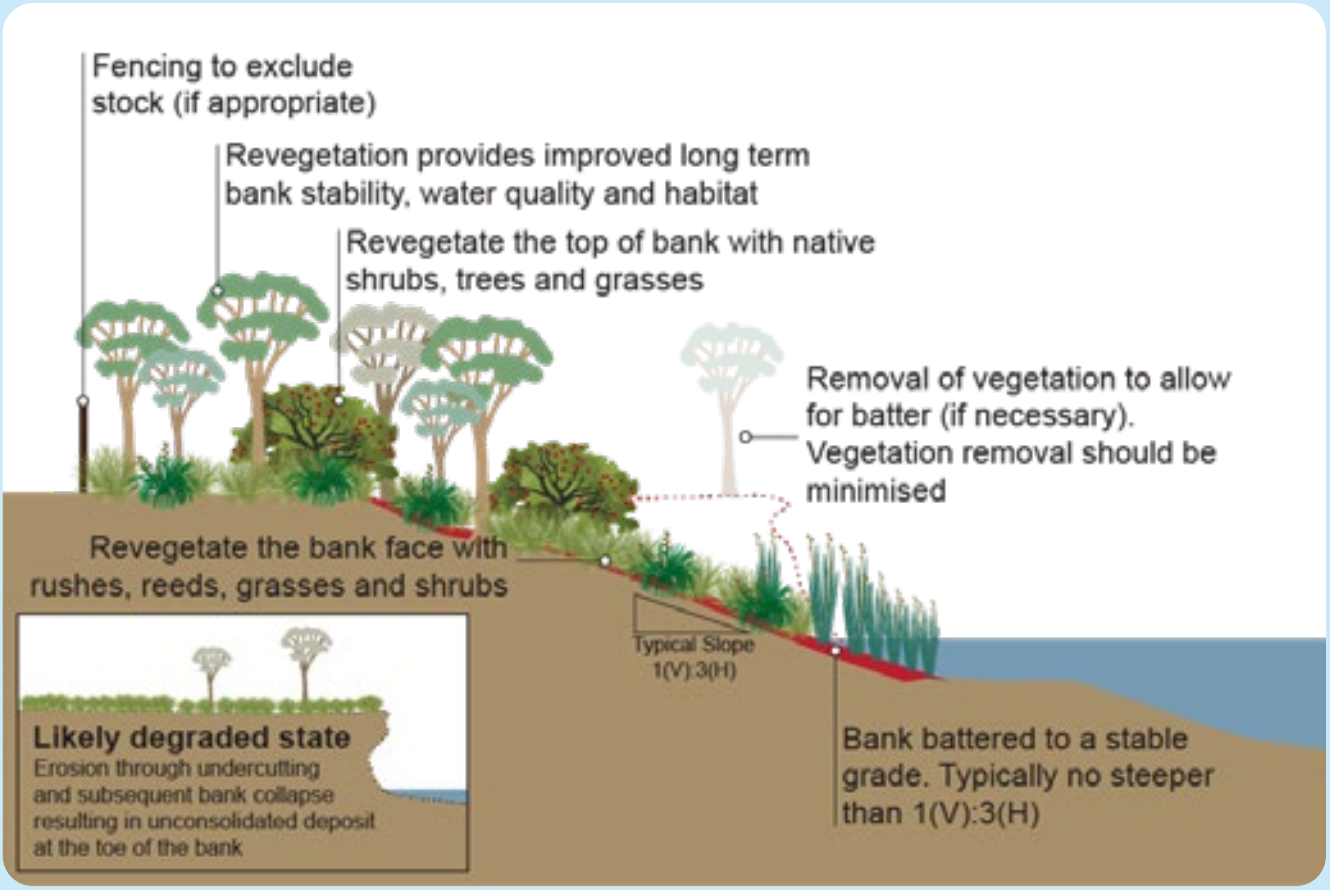


Figure 31: *Diagram of cross-section of battered bank for revegetation.* ***Source*** *Wetland Info, DESI 2022c*

Figure 32: *Photo of installation of timber pile fields on a property located in Mackay.* ***Photo credit:*** *Reef Catchments*

TIMBER PILE FIELDS

Timber pile fields are sets of vertical wooden structures buried into lines down the bank slope. The angle of the lines and the gaps between each log offer a permeable barrier to divert high-speed water flow away from the streambank. Figure 33 provides design details. This method aims to reduce riverbank erosion and promote sediment deposition at the bank toe. The approach is supported by revegetation efforts to ensure longevity and increase hydraulic roughness, further slowing down water speeds at the bank. The timber piles redirect fast-moving flows away from the bank providing an opportunity for vegetation establishment. It is noted that this method does not suit tidal waterways as the aligned barriers are effective for only one way.

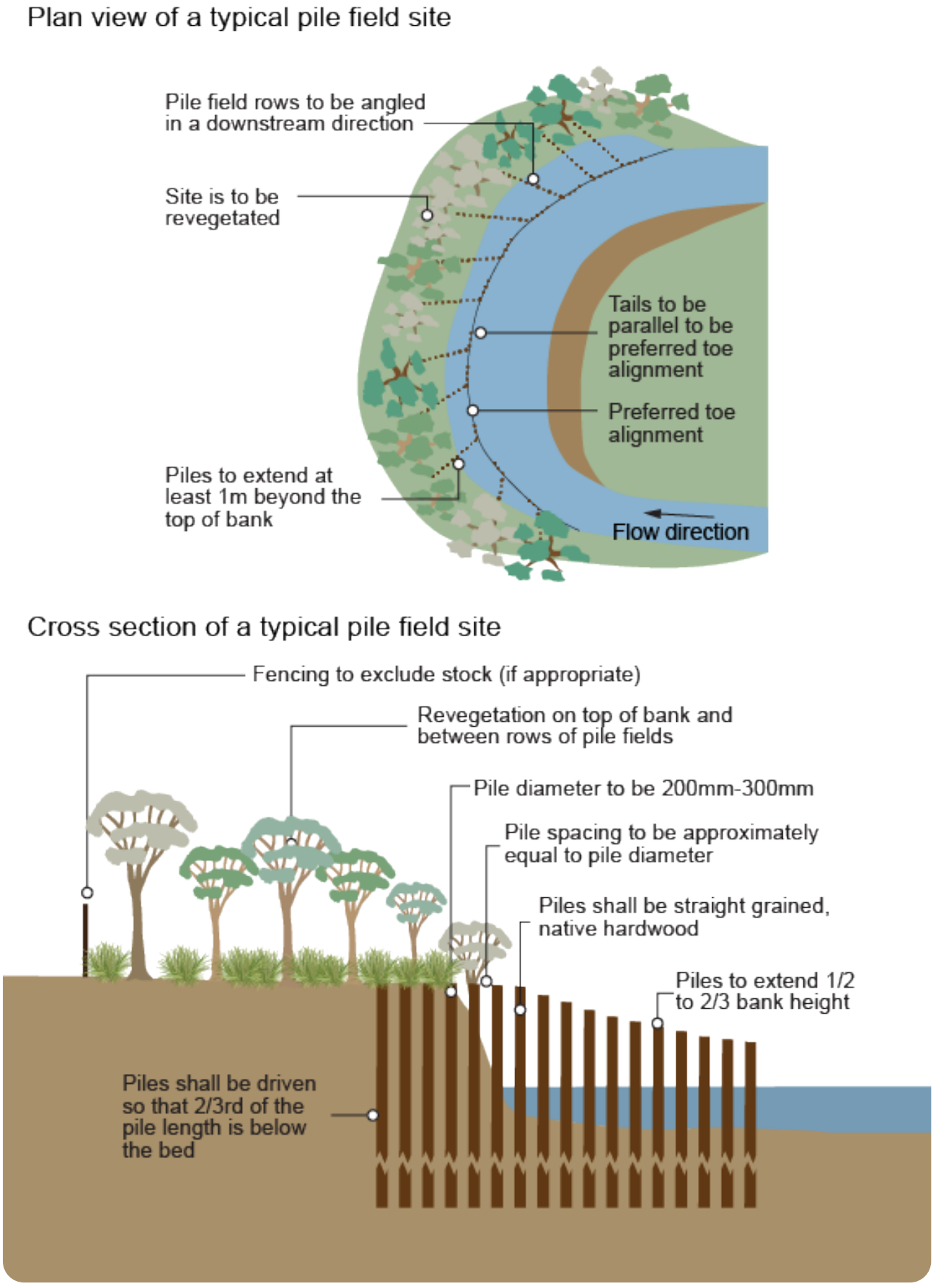


Figure 33: *Plan view and cross-sectional diagram of a typical pile field arrangement.* ***Source:*** *Wetland Info, 2022*

Figure 34 shows how revegetation is integrated into the pile fields to stabilise the bank and encourage sediment trapping.

LOG JAMS

This involves the placement of large native timber into a river, providing frictional resistance, which dissipates flow energy and reduces the near bank velocity and sheer stress. An example of a log jam system can be seen below in Figure 35.

Placing large wood can also cause local scour, enhance in-stream habitat, and accelerate the complexity of the channel, including pools, ruffles and runs. The specific arrangement and orientation of the placed large wood will depend on project objectives, river type, riverbed load, and river energy. Large wood arrangements can vary from single logs to entire trees or engineered timber structures. Construction requires large machinery to manipulate and place the structure.

Figure 34: *Timer pile fields and active revegetation as part of a streambank project on the O'Connell River.* ***Photo credit:*** *Reef Catchments*

Figure 35: *Photo of a log jam.* ***Photo credit:*** *Alluvium, 2024*

ROCK ARMOURING

Rock armouring is a method that involves the placement of quarried, angular rock against a riverbank to prevent further erosion of the bank, as displayed in Figure 36 (DESI, 2021). Rock armouring is a common method to protect infrastructure such as bridges and culverts. Hydraulic calculations are required to determine suitable rock size to prevent rocks from washing away.

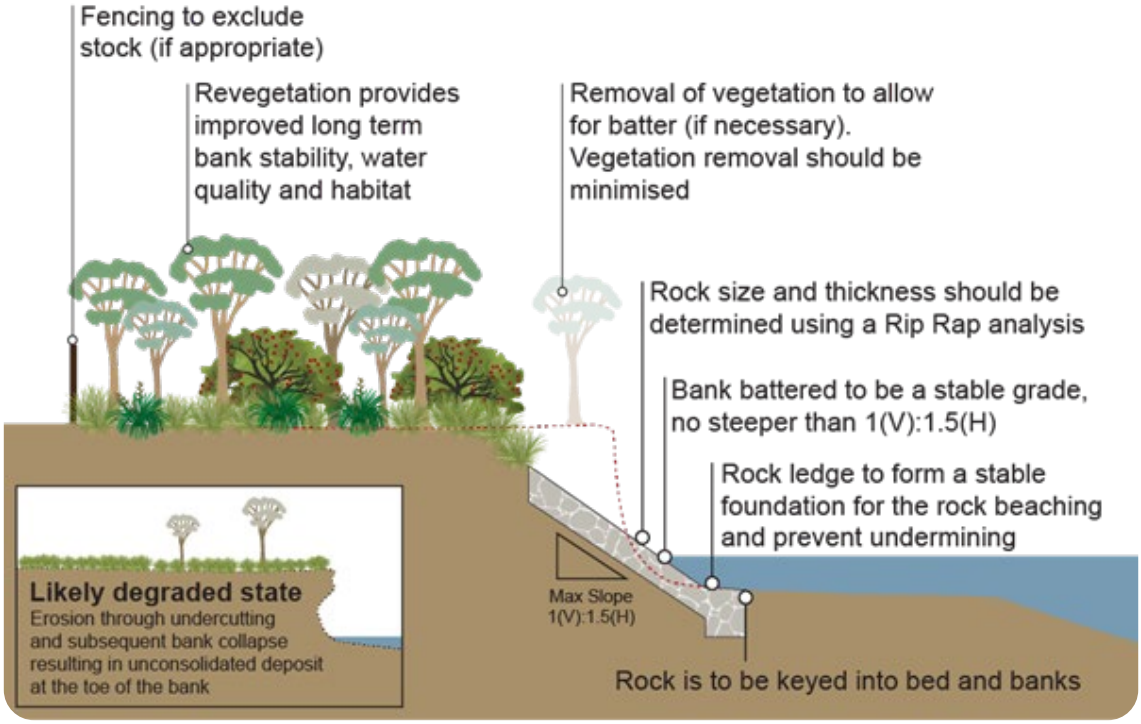


Figure 36: *Cross-sectional diagram of typical rock armouring bank works.* ***Source:*** *DESI, 2021*

Often rock armouring is integrated with vegetation establishment to stabilise the bank, eventually making the engineered structure redundant.

ROCK GROYNES

A rock groyne is a method to modify channel alignment and mitigate lateral erosion by placing rock walls that protrude from riverbanks and reduce flow velocity immediately adjacent to those banks. The rock structure is built perpendicular to the river and acts to reduce shear stress and trap sediments. A groyne field is a series of rock walls aligned together to protect a bank and promote in-stream complexity. The groynes are often aligned transverse to the stream channel, extending from the bank toe into the river channel. Angular rock is often used as a construction material as it is more durable and absorbs more force due to its permeable nature.

THE "DO NOTHING" APPROACH

It is important to understand that all waterways naturally adjust and move over the landscape over time. Erosion and deposition are natural processes that occur at natural rates. Often, streambank failure occurs as a means of self-healing, where filling from the collapse may create a more stable slope. "Do Nothing" may allow natural revegetation and rejuvenation to occur in its own time. Some banks may seem very steep and appear significant; however, their movement is naturally quite slow due to the bank's resistant parent rock material.

Waterways are responsive to events or changes made upstream and downstream, so it is important to assess the effect of the wider reach. Some mitigation methods may improve the site in question however the result may cause more harm down the reach of the waterway. In which case a "Do Nothing" approach may be the reasonable option to take.

In some circumstances, the "Do Nothing" may also be the best option when any other method may be too costly. The advantage is that there is no cost to the landholder. Disadvantages may incur that exotic plant species may invade the area. It can look weedy and still erode for several years until plants mature.

RIGHTS AND RESPONSIBILITIES OF RIPARIAN LANDHOLDERS

The following does not cover legal requirements related to animal welfare, workplace health and safety, or food safety. Although not exhaustive, key pieces of applicable Queensland legislation are listed at the end of this chapter.

Riparian landholders are those whose property includes an interface with water along gullies, creeks, streams, wetlands, and estuaries. It is essential for landholders to understand their rights and responsibilities when undertaking activities in riparian zones and around waterways.

Landowners are legally required to protect their land by taking reasonable steps to prevent environmental and cultural harm. This includes using natural resources sustainably, conserving biodiversity, and respecting Indigenous Cultural Heritage. These responsibilities are outlined in the Environmental Protection Act 1994, the Land Act 1994 (for State land occupiers), and various other statutory duties.

The purpose of this chapter is to inform landholders and stakeholders about the considerations and requirements that may be necessary when carrying out works in and around a watercourse. For additional information and resources, please refer to Table 4.

WHAT TYPES OF WATERWAYS DO I HAVE ON MY PROPERTY?

Identifying and distinguishing what type of waterway on your property may affect the repair work you can undertake.

To see the type of water features as defined by the *Water Act, 2000,* use Queensland Globe, which is a free online interactive mapping tool. Click the link below and zoom into the property.

Queensland Globe:
https://qldglobe.information.qld.gov.au/qldglobe/public/watercourse-identification-map-2

Another resource is the Queensland Government- Development Assessment Mapping System (DAMS) to see the SARA DA Mapping for Queensland waterways for water barrier works:

Development Assessment Mapping System (DAMS):
https://dams.dsdip.esriaustraliaonline.com.au/damappingsystem/

Is your watercourse unmapped?
Request can be made by enquiring with your Lot and Plan details in writing to the **Department of Regional Development, Manufacturing and Water:**

Website link: https://www.rdmw.qld.gov.au/about-us/contact
Email: WaterServicesNorth@rdmw.qld.gov.au
Address: PO Box 63, Mackay, QLD 4740

LOCAL COUNCIL: DO I NEED APPROVAL?

Depending on the scale and nature of the proposed work, you may be required to obtain a Development Permit from your local Council through the lodgement of a Development Application (DA) or Operational Works (OW) Application. Local Councils assess DAs per the *Planning Act 2016* to ensure that proposed works are undertaken lawfully. Local Council Planning Schemes will offer guidance in determining whether the proposal requires an application to proceed. If unsure whether an application is required to Council, lodge an enquiry with the relevant local government department.

As part of a DA or OW Application, the proposal may require referral to the State Assessment Referral Agency (SARA) under the *Planning Regulation 2017*. SARA is the prescribed decision maker for Development Applications requiring assessment by the State's technical agencies. The Development Assessment Mapping System and *Planning Regulation 2017* will aid in determining if a referral is required.

*Note: *If an application is not required to the Council for assessment, relevant State departments may still have an interest in the proposed works. Contact the Department of Environment, Science, and Innovation (DESI) or Department of State Development, Infrastructure, Local Government and Planning (DSDILGP) for advice in this instance.*

Contact the relevant local government or the State Assessment Referral Agency (SARA) for information around the current application process.

RIVERINE PROTECTION PERMIT

Any large-scale restoration work adjacent to a waterway must occur in compliance with Part 4 Riverine Protection of the *Water Act 2000. Riverine Protection Permits* are required if work involves destroying native vegetation, excavating or placing fill in a watercourse, lake, or spring under Section 218 of the Act.

Follow the link below to find out more about Riverine protection permits and how to apply:

Riverine Protection Permits: https://www.business.qld.gov.au/industries/mining-energy-water/water/authorisations/riverine-protection

FISH HABITAT AND BARRIERS

Any instream work that has the potential to affect fishery resources or fish habitat may be assessable by the Department of Agriculture and Fisheries. Under *The Fisheries Act 1994*, development approval is required for the construction or raising of waterway barrier works.

- What is a waterway barrier work can be found here: https://www.business.qld.gov.au/industries/farms-fishing-forestry/fisheries/development/waterways/barriers .

To determine if the working site is on a waterway that falls within this section, access the Development Assessment Mapping System (DAMS - under the SARA DA Mapping layer- 'Fish Habitat Areas'):

Development Assessment Mapping System (DAMS - under the SARA DA Mapping layer- 'Fish Habitat Areas https://dams.dsdip.esriaustraliaonline.com.au/damappingsystem/?accordions=SARA%20DA%20Mapping

RIPARIAN WORK AND VEGETATION

Protected vegetation cannot be cleared Under the Vegetation Management Act 1999. Request a Property Map of Assessable Vegetation (PMAV) or property map from the Department of Resources to determine whether a protected Regional Ecosystem on your property cannot be cleared as part of any erosion repair works.

A Property Map of Assessable Vegetation (PMAV) can be requested in the link below:

Request a vegetation map or property report | Queensland Government (resources.qld.gov.au)

If clearing vegetation interferes with 'endangered' or 'of concern' Regional Ecosystems, development approval is required under the *Planning Act 2016.* If the works interfere with areas defined as 'critical habitat' a permit is required under the *Nature Conservation Act, 1992.*

WEED MANAGEMENT

Under the *Biosecurity Act 2014,* everyone has a general biosecurity obligation (GBO) to prevent or minimise the risks of spreading invasive plants. More than 90 species of invasive plants have been recognised as prohibited or restricted invasive plants in Queensland under the *Biosecurity Act 2014.*

Further information can be found in the Prohibited

Invasive Plants of Queensland website: https://www.daf.qld.gov.au/__data/assets/pdf_file/0019/72253/prohibited-invasive-plants.pdf

When controlling weeds, there are restrictions when using agricultural chemicals in close proximity to waterways, which are listed in the *Chemical Usage (Agricultural and Veterinary) Control Regulation, 2017*, developed from the *Chemical Usage (Agricultural and Veterinary) Control Act 1988.*
Select the correct chemical product for the job and always carefully read the label.

Guidance on weed control can be sought through your local Council.
You can view further information and seek advice from Biosecurity Queensland: https://www.daf.qld.gov.au/business-priorities/biosecurity/invasive-plants-animals/plants-weeds

CULTURAL HERITAGE

There is an obligation for people to take all reasonable and practicable measures to ensure an activity they are undertaking does not harm Aboriginal or Torres Strait Islander cultural heritage under the *Aboriginal Cultural Heritage Act 2003* and the *Torres Strait Islander Cultural Heritage Act 2003*.

This 'duty of care' means land users must take all reasonable and practicable measures to ensure their activity does not harm Aboriginal or Torres Strait Islander cultural heritage, even on freehold land. Before commencing work, search the cultural heritage database and cultural heritage register here:

Cultural Heritage and Database Register:
https://www.qld.gov.au/firstnations/environment-land-use-native-title/cultural-heritage/cultural-heritage-database-and-register

WATERWAY WORKS ASSOCIATED WITH EMERGENCIES AND DISASTERS

Natural disasters, such as floods and tropical cyclones, can significantly impact watercourses and adjacent properties. Landholders can reduce these impacts by undertaking certain activities. You can access further information about the legal requirements for undertaking activities in a watercourse, before, during and after an emergency or disaster on the Queensland Government website: https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/disaster/flood/recovery/repairs-watercourses-infrastructure/watercourse-works

OTHER LEGISLATIVE CONSIDERATIONS

Some Federal, State and local government regulatory requirements that may be relevant to gully and stream bank remediation works in the MWI region are listed in Table 5.

Table 5: *Some Federal, State and local government regulatory requirements that may be relevant to gully and stream bank remediation works in the MWI region*

Matters	Legislation	Department	Contact and Information
Matters of National Environmental Significance including listed threatened species and ecological communities	Environment Protection and Biodiversity Conservation Act 1999 (Cth)	Australian Government Department of Climate Change, Energy, the Environment and Water	Ph: 1800 803 772 https://www.awe.gov.au
Vegetation clearing or removal	Vegetation Management Act 1999 (Qld)	Department of Natural Resources, Mines and Energy (Queensland Government)	Ph: 13 QGOV (13 74 68) https://www.resources.qld.Gov.au
Invasive weeds	Biosecurity Act, 2014	Biosecurity Queensland	Ph 13 25 23 www.biosecurity.qld.gov.au
Interference with overland flow Earthworks, significant disturbance	Water Act 2000 (Qld) Soil Conservation Act 1986 (Qld)	Department of Natural Resources, Mines and Energy (Queensland Government)	Ph: 13 QGOV (13 74 68) https://www.resources.qld.gov.au
Mining and environmentally relevant activities Infrastructure development (coastal) Heritage issues Protected plants and protected areas	Environmental Protection Act 1994 (Qld) Coastal Protection and Management Act 1995 (Qld) Queensland Heritage Act 1992 Nature Conservation Act 1992 (Qld)	Department of Environment and Science (Queensland Government)	Ph: 13 QGOV (13 74 68) https://www.des.qld.gov.au
Indigenous cultural heritage	Aboriginal Cultural Heritage Act 2003 (Qld) Aboriginal Cultural Heritage Act 2003 (Qld) Torres Strait Islander Cultural Heritage Act 2003 (Qld)	Department of Aboriginal and Torres Strait Islander Partnerships (Queensland Government)	Ph: 13 QGOV (13 74 68) https://www.dsdsatsip.qld.gov.au
Interference with fish passage in a watercourse, mangroves Forestry activities	Fisheries Act 1994 (Qld) Forestry Act 1959 (Qld)	Department of Agriculture and Fisheries (Queensland Government)	Ph: 13 QGOV (13 74 68) https://www.daf.qld.gov.au

Matters	Legislation	Department	Contact and Information
Road corridor permits	Transport Infrastructure Act 1994 (Qld)	Department of Transport and Main Roads (Queensland Government)	Ph: 13 QGOV (13 74 68) https:// www.tmr.qld.gov.au/
State government owners' consent for Crown land and road reserves	Planning Act 2016 (Qld)	Department of Natural Resources, Mines and Energy (Queensland Government), SLAM	Ph: 13 QGOV (13 74 68) https://www.resources.qld.gov.au
Pesticides and chemical usage (agricultural)	Chemical Usage (Agricultural and Veterinary) Control Act 1988 Chemical Usage (Agricultural and Veterinary) Control Regulation 2017 (Qld)	Australian Pesticides and Veterinary Medicines Authority	Ph: (02) 6770 2300 https://www.apvma.gov.au/
Local government requirements	Local Government Act 2009 (Qld) Planning Act 2016 (Qld)	Mackay- Mackay Regional Council	Mackay Regional Council: Ph:1300 622 529 https://www.mackay.qld.gov.au/ Whitsunday Regional Council: Ph: 1300 972 753 https://www.whitsundayrc.qld.gov.au/ Isaac Regional Council Ph: 1300 472 227 www.isaac.qld.gov.au
State government requirements		State Assessment Referral Agency (SARA)	State Assessment Referral Agency (SARA) PH: 07 4898 6888 https://www.statedevelopment.qld.gov.au/about-us/contact-us

CONCLUSION

Riparian zones are the crucial final barrier for maintaining water quality and managing water resources before they enter the aquatic environment. As the MWI community continues to develop and thrive, the demand for our local land and water services will only grow stronger.

Restoration activities require a carefully planned and systematic approach which aims to balance and maintain a variety of hydrological, ecological and management functions. Nature-based solutions will lead the landscape closer to a natural state of sustainability and equilibrium.

A call to action today and a commitment to ongoing adaptive and informed management is key to having lasting benefits to the environment for years to come. Sharing knowledge and developing a deep understanding of the dynamics of riparians in our waterways, must come from all levels of the community. The benefits will extend beyond individual landholders into the wider MWI Catchment area because robust riparian zones enable the community to be more resilient to the effects of climate change.

FURTHER ASSISTANCE

For further assistance or advice, you can contact your local government or Reef Catchments on

PH:	07 4968 4200
Address:	Suite 1/85 Gordon Street, Mackay, QLD 4740
Mail:	PO Box 815, Mackay, QLD 4740

Photo credit: *Reef Catchments*

USEFUL LINKS

Key resources for Tropical Cyclones, Bushfires or Floods information:

- Mackay Emergency Disaster Dashboard: https://disaster.mackay.qld.gov.au/
- Flood Check: https://floodcheck.information.qld.gov.au/
- Queensland Fire and Emergency Services- Current Bushfire warnings and incidents: https://floodcheck.information.qld.gov.au/
- Mackay Regional Council- Bushfire Factsheet: https://www.mackay.qld.gov.au/__data/assets/pdf_file/0010/261955/Bushfire.pdf
- Bushfire prone area- Mackay Whitsunday, Isaac: https://www.data.qld.gov.au/dataset/bushfire-prone-area-queensland-series/resource/c27945fb-1322-4a44-813c-34efe918e5b3
- Queensland Fire Danger Ratings: http://www.bom.gov.au/qld/forecasts/fire-danger-ratings.shtml
- Australian Government Bureau of Meteorology- Tropical Cyclone Forecast: http://www.bom.gov.au/cyclone/

Key resources for Cultural Heritage:

- A Landholder Guide for Aboriginal Cultural Heritage on Private Land: https://reefcatchments.com.au/files/2024/07/Cultural-Heritage-Web-Flyer-July2024.pdf
- Department of Treaty, Aboriginal and Tores Strait Islander Partnerships, Communities and the Arts (DSDSATSIP): https://www.qld.gov.au/firstnations/environment-land-use-native-title/cultural-heritage/cultural-heritage-bodies
- Local DSDSATSIP Regional Service Centre: https://www.dsdsatsip.qld.gov.au/contact-us/regional-service-centres#north-queensland-2
- Cultural Heritage Database Register: https://culturalheritage.datsip.qld.gov.au/achris/public/application-for-advice/enter

Key resources for Invasive species:

- Mackay Regional Council: Mackay Regional Council - Plants of the region
- Whitsunday Regional Council: Pest Management, Biosecurity and Wildlife – Whitsunday Regional Council (whitsundayrc.qld.gov.au)
- Isaac Regional Council: Managing weeds in the Isaac Region - Isaac Regional Council
- Department of Agriculture and Fisheries: https://www.daf.qld.gov.au/business-priorities/biosecurity/invasive-plants-animals
- DAF Invasive Plants and Animals: Invasive plants and animals | Department of Agriculture and Fisheries, Queensland (daf.qld.gov.au)
- Weeds of the Mackay Whitsunday Region, can be purchased online: Mackay Regional Pest Group – Pest management advisory group
- Lantana Fire Management Guidelines: Lantana Fire Management Guidelines - Reef Catchments
- Pig Exclusion Fencing in the Mackay Whitsunday Isaac NRM Region: Pig Exclusion Fencing in the Mackay Whitsunday Isaac NRM Region - Reef Catchments
- Wetlands Info- Stock feral animal access: https://wetlandinfo.des.qld.gov.au/wetlands/management/rehabilitation/rehab-process/step-4/intervention-options/stock-feral-animal-access-mod.html#prettyPhoto
- Queensland Government weed control factsheets and resources for herbicide applications.: https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/biosecurity/plants/invasive/manage/control

Key resources for Remediation Strategies:

- Reef Catchments- Riparian Revegetation Fact sheet: RiparianReveg_FactSheet_Final-1.pdf (reefcatchments.com.au)
- Reef Catchments- Riparian Connectivity and Buffering Capability Fact sheet: Riparian Connectivity and Buffering Capability - Reef Catchments
- Reef Catchments: Fencing Selection and Maintaining Integrity: Fencing selection and maintaining integrity - Reef Catchments
- Aquatic Ecosystem Rehabilitation Process: https://wetlandinfo.des.qld.gov.au/wetlands/management/rehabilitation/rehab-process/
- Queensland River Rehabilitation Management Guideline: https://wetlandinfo.des.qld.gov.au/wetlands/management/rehabilitation/guideline.html
- The Gully and Stream Bank Toolbox: https://www.dcceew.gov.au/sites/default/files/documents/reef-trust-toolbox-3rd-edition.pdf

Key resources for Best Practice Management:

- **Queensland Department of Environment and Science (DES):** This government agency provides a wealth of information on riparian management, including guidelines, best practices, and policies related to grazing near water bodies in Queensland. Their website offers fact sheets, publications, and resources on this topic.
- **Queensland Government - Agriculture and Fisheries (DAF):** The Queensland Government's Department of Agriculture and Fisheries provides resources and publications related to sustainable livestock management, including information on grazing practices in riparian zones.
- **Riparian Grazing Management Guidelines:** The Queensland Government has published specific guidelines for riparian grazing management. These guidelines offer practical advice on how to manage livestock near water bodies to protect water quality and ecosystems.
- **CSIRO Land and Water:** CSIRO, Australia's national science agency, conduct research on land and water management, including riparian zones and grazing practices. Their publications and reports often contain valuable insights into sustainable grazing in riparian zones.
- When using these resources, be sure to verify the most recent and region-specific information, as guidelines and recommendations may change over time or vary depending on the location within Queensland. Additionally, consult with local agricultural experts and organisations for on-the-ground advice and support tailored to your specific needs and circumstances.

DEFINITIONS

Bank Toe:	Lowest part of a streambank
Bank crest:	Highest part of the streambank.
Buffer:	Area of land extending from the streambank into the land area, vegetated to support streambank stability.
Channel:	Corridor carved by the water of the creek, stream or river which holds the moving water.
Erosion:	Wearing away of the land surface by water, wind, ice or other natural or anthropogenic agents that remove geologic material or soil from one point on the earth's surface and deposit it elsewhere (Carey et al., 2015).
Ecological Resilience:	The ability of an ecosystem to maintain its normal patterns of nutrient cycling and biomass production after being subjected to damage caused by disturbance (Britannica, 2023)
Groyne:	A linear artificial barrier built to reduce sheer stress on the bank. Groynes are aligned approximately traverse to the channel, extending from the lower bank or bank toe out into the water.
Natural hazard:	A natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.
Pile fields:	Rows of piles (wooden or concrete) driven into the stream bed. The piles are aligned approximately traverse to the channel to reduce flow sheer at the toe of the streambank.
Reach:	Stretch of a stream generally kilometres in length and having relatively uniform (natural or unnatural) form and boundary conditions that indicate itself as a unit.
Resilience:	The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner through the preservation and restoration of its essential basic structures and functions through risk management. As a concept, resilience is about the ability to adapt to changing conditions and withstand or rapidly recover from disruption, or potentially move to a new state or position. Resilience can sometimes be confused with preparedness. Preparedness is a state of readiness and is based on a specific event. For example, I have prepared my home in preparation for an impending hazard event or season. Resilience is separate from but complements preparedness programs by encouraging actions that promote strong community systems that address factors contributing to health and well-being.
Riparian:	(See definition in What is a Riparian Chapter). Can also be referred to a riparian zone or riparian land.
Rock Armouring:	Rocks positions to protect the toe and lower section of the streambanks.
Scour:	The eroding action of water flow removing sediment from a soil surface.
TOR:	Traditional Owner Representative
Watercourse:	(See definition in Legislation Chapter).

ACRONYMS

BMP:	Best Management Practice
DA:	Development Application
DAMS:	Development Assessment Mapping System
DESI:	Department of Environment, Science and Innovations
DSDILGP:	Department of State Development, Infrastructure, Local Government and Planning
GBR:	Great Barrier Reef
MWI:	Mackay Whitsunday Isaac
NRM:	Natural Resource Management
OW:	Operations Works
PAC:	Preparing Australian Communities
PMAV:	Property Map of Assessable Vegetation
SARA:	State Assessment Referral Agency

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NOTES

Australian Government

REEF CATCHMENTS

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