Riparian Plan Gilead – rezoning phase

For Lendlease Communities

Prepared By Ecological Consultants Australia Pty Ltd

June 2022

About this document

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Statement of Authorship

This study and report was undertaken by Ecological Consultants Australia for the Client. The main author of the report is Geraldene Dalby-Ball who is a suitably Qualified Person as per the requirements of DPE.

With over 20 years' experience in this field (wetlands, waterways and ecological restoration in NSW) she is a recognised leader in waterways and wetland restoration including being a panel member of Sydney Olympic Parks WET committee (Wetland Education and Training) and a key trainer in WET workshops. Geraldene is an accredited BioBank Assessor BAAS19008.

Field work in 2017-2022 was conducted by Geraldene Dalby-Ball with ecologists including Anthea Whitlam. During the site inspection the vegetation within the subject site was ground-truthed and the plant species recorded. Detailed Ecological work has also been conducted on-site by EcoLogical, including early Biobank assessments. Geraldene wrote the initial riparian plans and these too inform this Riparian Plan.

Limitations Statement

Information presented in this report is based on an objective study undertaken in response to the brief provided by the client. Any opinions expressed in this report are the professional, objective opinions of the authors and are not intended to advocate any particular proposal or pre-determined position.

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Signed: Geraldene Dalby-Ball – Director of Ecological Consultants Australia

First Peoples and Land

We acknowledge the D'harawal People as the Traditional Custodians of this Land.

To the Elders past, present and emerging of the D'harawal Nation we pay our respects.

We acknowledge the waterways and riparian areas, the mossy rocks and deep pools, the over hangs and quite places, old trees and young native grasses are all part of Country, People, Place.

This Plan seeks to guide the retention and rehabilitation of waterways and the ecological communities alongside them. We seek to listen to the D'harawal People for guidance with the rehabilitation of this land and the return of many native species. Places of particular importance to First Peoples are within these lands and will be protected within the Riparian areas proposed.

Revision Control				
Version	**Date**	**Revision by**	**Approved**	**Revision made (brief)**
Draft 01	March 2022	GDB and MC	GDB	Riparian Plan updated from 2017 background. Review all comments from agencies. New data entered and background documents data added
Draft 02	14 April 2022	GDB and LJ	GDB	Updated development information, aerials and riparian information. Added in all sections of Riparian Plan
Draft 03	22 April 2022	GDB, LJ	GDB	Updates throughout draft maps
	10th May 2022	LJ	GDB	Update maps and areas and added for Stormwater Mgt
	4-12th June 2022	GDB, LJ	GDB	Updates throughout including Field work and legislation
Final Draft	19-21st June 2022	GDB	GDB	Included final versions of consultant's plans
Final	21st June 2022	WL, GDB	GDB	Final draft
	25th June 2022	GDB	GDB	Inclusion of Biobank/Conservation area overlap with Riparian Lands and future Mgt.

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Glossary

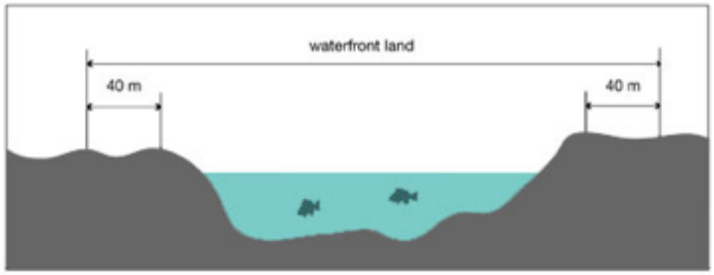
- **Biodiversity Conservation Trust** Guideline for Biodiversity Stewardship Sites
  Biodiversity Conservation Trust Guideline for Biodiversity Stewardship Sites August 2019

- **Biodiversity Stewardship Agreements:** Biodiversity Stewardship Agreements are in-perpetuity agreements registered on title. The land is protected and managed to achieve a gain in biodiversity values. This generates 'biodiversity credits' which can be used to offset the impacts of approved developments elsewhere.
- **Biobank Land:** land managed for conservation purposes as per an agreement with the •
  Biodiversity Conservation Trust (BCT).

- **Biodiversity Conservation Trust (BCT) Guidelines**: BCT guidelines for Biodiversity Stewardship Sites is limited to tracks, trails and other exclusions
  https://www.bct.nsw.gov.au/sites/default/files/2019-08/Guidelines%20for%20BSA%20Sites%20%28tracks%20and%20trails%29.pdf

  BC Act means the *Biodiversity Conservation Act 2016 (NSW).*

- **Controlled activity:** Controlled activities are certain types of activities which are
  i) carried out on waterfront land, and
  ii) defined as a controlled activity in the Water Management Act 2000.
  'Waterfront land' as per the Water Management Act definition means the bed of any river, lake or estuary, and the land within 40 metres of the river banks, lake shore or estuary mean high water mark.



Examples of controlled activities relevant to this VMP and Riparian Plan include:
i) modifications to a watercourse, such as erosion control works
ii) construction of stormwater management devices, outlets and spillways

- **Controlled activity approval**: A controlled activity approval confers a right on its holder to carry out a specified controlled activity at a specified location in, on or under waterfront land. Waterfront land as defined in the Water Management Act 2000. A controlled activity approval is as per Chapter 3, Part 3, Division 1, Section 91. There are two kinds of activity approvals, namely, controlled activity approvals (for works in 40m of a waterway) and aquifer interference approvals (not relevant here).
  https://www.dpie.nsw.gov.au/water/licensing-and-trade/approvals/controlled-activity-approvals/what/how-to-apply

- **Cycleways and paths:** Cycleways or paths no wider than four metres total disturbance footprint can be built in the outer 50 per cent of the VRZ. It is noted the cycleway proposed in the landscape plan that covers areas within this Riparian Plan are compliant providing off-setting of locations are as per the plan.

- **Detention basins:** Detention basins refers to the basins as per the drawings included in this Riparian Plan dated April 2022 (Enspire) fulfil the requirements of the guidelines.

As per the Guidelines detention basins can be built in the outer 50 per cent of the VRZ or online where indicated. Refer to the Office of Water's Controlled activities. Guidelines are that basins are to:

- be dry and vegetated
- be for temporary flood detention only with no permanent water holding
- have an equivalent VRZ for the corresponding watercourse order
- not be used for water quality treatment purposes.

DPE: NSW Dept of Planning and Environment –for Controlled Activity Approvals (work in waterfront land).

- **Guidelines for Riparian Corridors**
  https://www.industry.nsw.gov.au/__data/assets/pdf_file/0003/160464/licensing_approvals_controlled_activities_riparian_corridors.pdf

- **Guidelines for Vegetation Management Plans**
  https://www.industry.nsw.gov.au/__data/assets/pdf_file/0006/160467/licensing_approvals_controlled_activities_veg_mgt_plans.pdf

- **Guidelines for instream works on waterfront land**
  https://www.industry.nsw.gov.au/__data/assets/pdf_file/0018/160461/licensing_approvals_controlled_activities_instream_works.pdf

- **Guidelines for outlet structures on waterfront land**
  https://www.industry.nsw.gov.au/__data/assets/pdf_file/0020/160463/licensing_approvals_controlled_activities_outlet_structures.pdf

- **Guide to preparing a Vegetation Management Plan within the Campbelltown Local Government Area**
  file:///C:/Users/Kingfisher/Downloads/MRVegetationManagementPlan.pdf

- **Riparian:** terrestrial land alongside a waterway

- **Vegetation Management Plan:** A VMP is intended to assist land managers and/or owners in managing the impacts of development (planned, previous or existing), in order to protect existing bushland and habitat from disturbance and/or remediate impacts from development activities. A VMP outlines the objectives, techniques and actions specific to the management of vegetation on site.

- **Water Management Act 2000:** The name of the legislation (Act) governing water management in NSW with the current version being 1 November 2019.
  https://legislation.nsw.gov.au/#/view/act/2000/92

- **Stream order:** The watercourse order as classified under the Strahler System based on 1:25,000, 1:50,000 or 1:100,000 topographic maps whichever is the smallest scale available. See extract from the Water Management Act (2012) below.

Riparian corridor widths

The Officer of Water recommends a VRZ width based on watercourse order as classified under the Strahler System of ordering watercourses and using current 1:25 000 topographic maps (see Figure 2 and Table 1). The width of the VRZ should be measured from the top of the highest bank on both sides of the watercourse.

Figure 2. The Strahler System

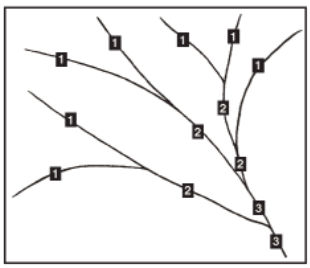


Table 1. Recommended riparian corridor (RC) widths

Watercourse type	VRZ width (each side of watercourse)	Total RC width
1st order	10 metres	20 m + channel width
2nd order	20 metres	40 m + channel width
3rd order	30 metres	60 m + channel width
4th order and greater (includes estuaries, wetlands and any parts of rivers influenced by tidal waters)	40 metres	80 m + channel width

- **Suitably Qualified person:** the definition from DPE and Campbelltown City Council are covered by the following minimum requirements: i) a tertiary degree in Natural Sciences and/or a Certificate IV in Conservation and Land Management ii) a minimum of 500 hours practical bushland regeneration. Brief CVs of authors are provided with this Plan.
- **Vegetated riparian zone (VRZ):** The required width of the VRZ measured from the top of the high bank on each side of the watercourse.
- **Riparian corridor (RC) off-setting for non-RC uses:** Non-riparian uses, such as Asset Protection Zones are allowed within the outer 50 per cent of the VRZ, so long as offsets are provided in accordance with the averaging rule as seen in Figure 2-7.
- **Subject site**: General term for the area of Gilead within which the riparian works will occur.
- **Stormwater outlet structures and essential services:** Stormwater outlets or essential services are allowed in the RC. Works for essential services on a fourth order or greater stream are to be undertaken by directional drilling or tied to existing crossings. Refer to the Office of Water's Controlled activities. *Guidelines for laying pipes and cables in watercourses* and *Controlled activities. Guidelines for outlet structures.*
- **Stream realignment:** Indicates that a watercourse may be realigned. Refer to the Office of Water's *Controlled activities. Guidelines for instream works.*
- **Road crossings:** Indicates permitted road crossing methods. Refer to the Office of Water's *Controlled activities. Guidelines for watercourse crossings* and NSW DPI policy and guidelines for fish friendly waterway crossings for Class 1 and 2 waterways

1 Introduction and Objectives

1.1 Riparian Vegetation Management Plan Preparation

This Riparian Plan (RP) applies to the area known as Gilead and more specifically the riparian zones in this stage.

This RP for Gilead Gilead and has been written to satisfy DPE (Office of Water) guidelines and also makes reference to Campbelltown City Council VMP requirements. It includes but is not limited to:

- Guidelines for Vegetation Management Plans on Waterfront Land – DPI Office of Water NSW (2012);
- Guidelines for Controlled Activities on Waterfront Land - DPI Office of Water NSW (2012);
- Vegetation Management Plan, Guide to preparing a Vegetation Management Plan within the Campbelltown Local Government Area. - Campbelltown City Council (2016).

A matrix demonstrating how the Riparian Plan satisfies the guidelines and requirements of the Riparian Plans of DPE (previously NRAR) and Campbelltown City Council provided below. It is noted that as this plan is for the rezoning stage there is additional detail in relation to detailed for implementation and cost and these will come in the follow stage of Riparian and Vegetation Management and Implementation Plan.

Table 1.1 Summary of requirements from DEP (NRAR) and Council's Riparian Plan guidelines.

No.	Requirement	Location in Plan
1	**Introduction and Objectives**	
1.1	Plan preparation	Section 1
2	**Site Assessment**	
2.1	General Details'	Section 2.2
2.2	'Site description'	Section 2.1
2.3	'Existing Infrastructure'	Section 2.1
2.4	'Site access'	Section
2.5	'Flora and Fauna'	Section 2.3
2.6	'APZ'	Section 2.4 and 4.5
2.7	'Site map' – **See Section 1**	
3	**Guiding principles and legislative requirements**	
3.1	Legislation and Policy	Section 3.2/ throughout
3.2	Aims and Objectives	Section 3.3

No.	Requirement	Location in Plan
3.3	Licenses	Section 3, 4.3.6/throughout
4	**Action Plan**	
4.1	Management Zones	Section 5
4.2	Site Preparations	Section 5.2
4.3	Site Management	Section 4
4.4	Weed Treatment	Section 4.3
4.5	Feral animal management	n/a
4.6	Stormwater, wastewater and hydrological function.	Section 4.4
4.7	Bushfire management	Section 4.5
4.8	Planting program	Section 5.5
4.9	Signage	Section 4.6
4.10	Fencing	n/a
4.11	Check list schedule of works with timeline or trigger points for works	Section 6
5	**Site Maintenance**	
5.1	Recommended Performance criteria	Section 10
5.2	Maintenance schedule implementation phase	Section 8
5.3	Maintenance schedule establishment phase	Section 8
5.4	Maintenance schedule on-going post establishment	Section 8
5.5	Threats to the VMP managed area and mitigation measures	Appendix B
5.6	Check list schedule of maintenance with timeline or trigger points for works	Section 6
6	**Monitoring, Evaluation and Reporting**	
6.1	What to monitoring and when. Routing and adhoc monitoring.	Section 9
6.2	Reporting evaluation requirements	Section 10

No.	Requirement	Location in Plan
6.3	Check list schedule of Monitoring and Reporting with timeline or trigger points action	
7	**Bill of Quantities**	To be completed
7.1	Summary of all actions	Section 5
7.2	Estimated cost range of proposed actions	Section 7
7.3	Estimated cost range of proposed monitoring and reporting annually	Section 8
7.4	Estimated cost range of proposed maintenance annually for each stage	Section 8

As per the requirements this plan addresses the following areas.

Requirements as per DPE and NSW Office of Water guidelines	*This Plan*
An appropriate width for the riparian corridor should be identified by consulting either the development consent, the relevant environmental planning instrument or the NSW Office of Water guidelines for riparian corridors. The VMP should consider the full width of the riparian corridor and its functions including accommodating fully structured native vegetation.	Riparian areas covered in this plan are 10 and 20m from top of bank based on 1st and 2nd order water ways
Maps or diagrams which clearly identify the riparian corridor; the existing vegetation; the vegetation to be retained; the vegetation to be cleared; the footprint of construction activities; and areas of proposed revegetation etc. should be prepared.	Included
The location of the bed and banks or foreshore of waterfront land and the footprint of the riparian corridor should be clearly identified. Vegetated riparian zones must be indicated.	Included
Photographs of the site should be supplied, and photo points should be identified. To assist with future monitoring and reporting requirements, the photo points should be identified by GPS coordinates or by survey. This is particularly important for large scale earthworks or extractive industries.	Will be refined and base-line photos will be provided pre works.
Measures for controlling long term access and encroachments (bollards, fences, etc.) into the riparian corridor should be identified.	Included
Vegetation species composition, planting layout and densities should be identified. The required mix of plant species relates to the actual community to be emulated and the size of the area or areas to be rehabilitated but mature vegetation communities are generally well structured, comprising trees, shrubs, and groundcovers species. Planting densities should achieve quick vegetative cover and root mass to maximise bed and bank stability along the subject watercourse.	Included
Costs associated with high density planting will be recovered through reduced maintenance costs for weeding or replacement planting in the maintenance period specified in the controlled activity approval (CAA).	Included
Seed or plant sources should be identified. Where possible, native plants and seed sources of local provenance should be used.	Included

Requirements as per DPE and NSW Office of Water guidelines	*This Plan*
Exotic vegetation should be avoided. The use of exotic species for temporary soil stabilisation is permitted provided they are sterile, non-invasive, and easily eradicated when permanent vegetation is established.	Corridors are predominantly locally native species. Landscape planning has a focus on native species.
Details of the planting program, rehabilitation methods and staging should be provided. Techniques such as hydro-seeding, direct seeding, brush matting or assisted natural regeneration may be considered.	Included
Maintenance requirements should extend for a minimum of two years after the completion of works or until such time as a minimum 80 per cent survival rate of each species planted and a maximum 5 per cent weed cover for the treated riparian corridor controlled activity is achieved.	Included
Project tasks should be defined and described, including a schedule detailing the sequence and duration of works necessary for the implementation of the VMP.	Included
Costings for the implementation of all components and stages of the work including materials, labour, watering, maintenance which includes plant replacement, monitoring and reporting should be prepared.	Included
Processes for monitoring and review, including a method of performance evaluation should be identified. This should include replacing plant losses, addressing deficiencies, problems, climatic conditions and successful completion of works.	Included
Regular reporting on the implementation and status of works covering progress, success or failures and completion should be provided. The number and duration of reporting periods will be identified in the CAA. Works as executed plans and reports detailing how the components of the VMP have been implemented will be required prior to the release of any security held by the NSW Office of Water.	Included
Security such as bank guarantees may be required before a controlled activity involving the implementation of a VMP is commenced. The amount of security is usually based on the costings provided.	NA Guarantees have been established with council (See VPA). As such no bond agreements are required for DPE

1.2 Background and General Introduction

Ecological Consultants Australia Pty Ltd (ECA) have prepared this Riparian Plan for Lendlease Gilead development (the 'project').

Greater Macarthur has been identified as Growth Area by the NSW Government and will provide for 15,000 new homes to the broader south Campbelltown region. Lendlease's landholding at Gilead has been identified as a Priority Precinct and will make the first contribution to housing supply in the region of approximately 3,300 new homes, retail centre and education facilities.

Importantly, it will secure key conservation outcomes including the establishment of linked Koala, and other fauna, corridors between the Georges River and Nepean River.

To facilitate both the housing and conservation outcomes for the site, a Planning Proposal is being prepared to rezone the site under the State Environmental Planning Policy (Precincts – Western Parkland City) 2021. The Planning Proposal will establish the Urban Development Zone for land capable of development and introduce a C2 Environmental Conservation zone for land containing key fauna habitat to be retained as well as land that native bushland is to be reconstructed. This report specifically addresses Riparian Zones and has been used to shape and inform the Planning Proposal and associated development outcomes.

Site

The Site consists of five properties including Lot 2 in DP 1218887, Lot 2 in DP 249393, Lot 1 DP603675, Lot 2 DP603674 and part of Lot 5 in DP 1240836 that have a combined area of 495ha.

The Site has been subject to significant clearing and used for cattle grazing. Intact stands of vegetation are generally contained within the creek lines that traverse the Site including the Menangle Creek, Nepean Creek, and Woodhouse Creek and along the Nepean River. Outside of these areas, vegetation consists of pastureland and scattered paddock trees.

Access to the Site is provided by a battle axe handle on the eastern side of Lot 2 in DP 1218887 that connects to Appin Road. Access to the Site is also provided via an easement over land to the east that will be formalised through public roads being delivered by Lendlease as part of their Figtree Hill development.

Rural properties boarder the southern boundary of the Site including Beulah Reserve which contains a State Heritage Item and a registered BioBank. The Nepean River forms the western boundary of the Site with Menangle Creek forming the majority of the northern boundary of the Site.

A minor portion of the Site (Lot 2 in DP 249393) has frontage to the Hume Highway and is accessed from Medhurst Road.

The Upper Canal is a State Heritage Item that traverses the Site from South to North and there are a series of electrical transmission line and gas pipeline easements that traverse the central park of the Site from North to South.

The Site sits to the south and west of the Mt Gilead Homestead complex that is a State Heritage Item and is contained within Lot 1 in DP 1218887.

The rezoning is limited to three categories (retained land – Mount Gilead Homestead, urban development zone – pink areas and open space, and conservation areas – dark green) these zones are shown in Figure 1-1. Riparian areas are wholly within the dark green areas.

Figure 1-1 Schematic showing layout of the area proposed for rezoning (Gilead) Source: Urbis 2022

1.3 Report Purpose

The development triggers a controlled activity approval under S.91 of the Water Management Act 2000 due to the proposed development including works on waterfront land.

Waterways present include Woodhouse Creek, Menangle Creek (east-west) and Nepean Creek (north south) and the eastern bank of the Nepean River. Stream Orders for these are Woodhouse Creek (2nd), Menangle Creek (2nd) and Nepean Creek (2nd) and the eastern bank of the Nepean River (4th).

The Sydney Water 'upper canal' carries water however is not deemed a waterway in terms of full riparian revegetation as this is not possible with the current infrastructure requirements both of the canal and the high voltage power and other utilities in this immediate area. It will however be retained as open space and biodiversity values maximised through appropriate planting and habitat augmentation (eg for lizards, butterflies and a full range of pollinators).

This Riparian Plan has been prepared in accordance with General Terms of Approval issued by the NSW Natural Resources Access Regulator (IDAS1107446) and consistent with DPE approval requirements.

Activities covered in the Riparian Plan are the top of bank, with of riparian zone, assessment of current condition and possible impacts from proposed actions. It also has guidelines for the revegetation,

establishment and maintenance requirements of vegetated riparian areas, all of which will be in more detail in the riparian and VMP implementation plan.

This plan is crossed referenced with site specific plans in particular the First Peoples places, bush fire management, Koala corridors and water management. We will continue to work with the Landscape design, species and placement in the later stages of detailed plan for each riparian area so that biodiversity is maximised.

Maintenance is a consideration throughout the plan and details of outcomes have been included in this document. The specifications going for tendering the implementation of the riparian areas will include detail bill of quantities and involvement of the riparian species and ecologist.

Revegetation works are proposed to be conducted when the development has reached the appropriate stage (no later than 12 months after 80% of dwellings have been constructed within the contributing catchment). This will be detailed, as will the bond if needed, in the detailed Implementation Plan.

Clause 25.1 of the VPA requires that prior to the issuing of a Construction Certificate, Lendlease must provide security to Council totalling 110% of the agreed value of the works (the Contribution Value). The security will not be released by Council until the subject works are completed (clause 25.5 of the VPA).

1.3.1 Riparian Lands Plan Stages

The Riparian Lands Plan (RLP) is being presented in three stages.

The first stage report had input from (previous) NSW Office of Water (DPI Water) to consider the proposed riparian areas and what does / doesn't require offsetting. This in-principle approval has enabled the second, stage, of detailed development layout and riparian areas, to be completed and now brought back to DPE for assessment (this plan).

This Riparian Plan for the re-zoning summarises all reaches in Gilead.
It details all proposed incursions into the riparian areas. Shows where there is impact on the waterway or the inner or outer 50%. Shows proposed off-sets for these and provides information on any areas that do not comply with the NSW Waterway Guidelines.

It is noted that these are very few incursions and those proposed are associated with road crossings and minimal incursions from water management. The proposed offsets have been mapped and show fulfillment of off-set requirements.

Any non-compliance with the guidelines has been clearly stated including area (m^2) effected, and offsetting proposed. At this stage, there is no expectation of non-compliance with the guidelines with minor works in the inner 50% and adequate offsetting options for any compromising of the inner and outer 50%.

This report includes species lists, as well as information on vegetation community and composition which has been used in providing the estimate of works needed and associated implementation cost estimates.

Stage 3 is the detailed Riparian/Vegetation Implementation and Management Plans for riparian area. This stage will include the detailed civil drawings (road crossings and water management outlets). Each will have detailed bill of quantities, plant lists and associated specifications as well as bush regeneration needed in existed vegetated areas. The implementation plan will include detailed costing estimates for every section of proposed works along with maps showing what areas are to be rehabilitated and revegetated.

The final riparian and vegetation implementation and management plan will cover all areas of the riparian zones not already covered under conservation instruments such as Biodiversity Stewardship Agreements (BSAs). Given that the BAS provides detailed requirements on outcomes required, monitoring and reporting at a level that matches or exceeds the requirement so the Riparian Lands the final riparian lands implementation plans (Riparian and Vegetation MP) will exclude those area of riparian lands that are within conservation areas. The final stage Riparian and Vegetation Management Plans will be submitted to DPE Water and Council review.

1.3.2 Planning - summary

This report summarises the reaches proposed to have riparian zones and offsets areas.
Waterways present include Woodhouse Creek, Menangle Creek (east-west) and Nepean Creek (north south) and the eastern bank of the Nepean River.

Stream Orders for these are Menangle Creek (2nd and 3rd) and Nepean Creek (2nd), Woodhouse Creek (1st and 2nd) and the eastern bank of the Nepean River (4th).

The Sydney Water 'upper canal' carries water however is not deemed a waterway in terms of full riparian revegetation as this is not possible with the current infrastructure requirements both of the canal and the high voltage power and other utilities in this immediate area. It will however be retained as open space and biodiversity values maximised through appropriate planting and habitat augmentation (e.g. for lizards, butterflies and a full range of pollinators).

Figure 1.1 is the Hydro Line layer from NSW Water Managment (General) Regulation 2018. Waterways on the site with their full extent to enable assessment of Stream Order, where relevant. As can be seen the creeks vary in order along their length depending. For example Woodhouse is a first order for the initial 50% of its length then becomes a 2nd order where an unnamed waterway joins it.

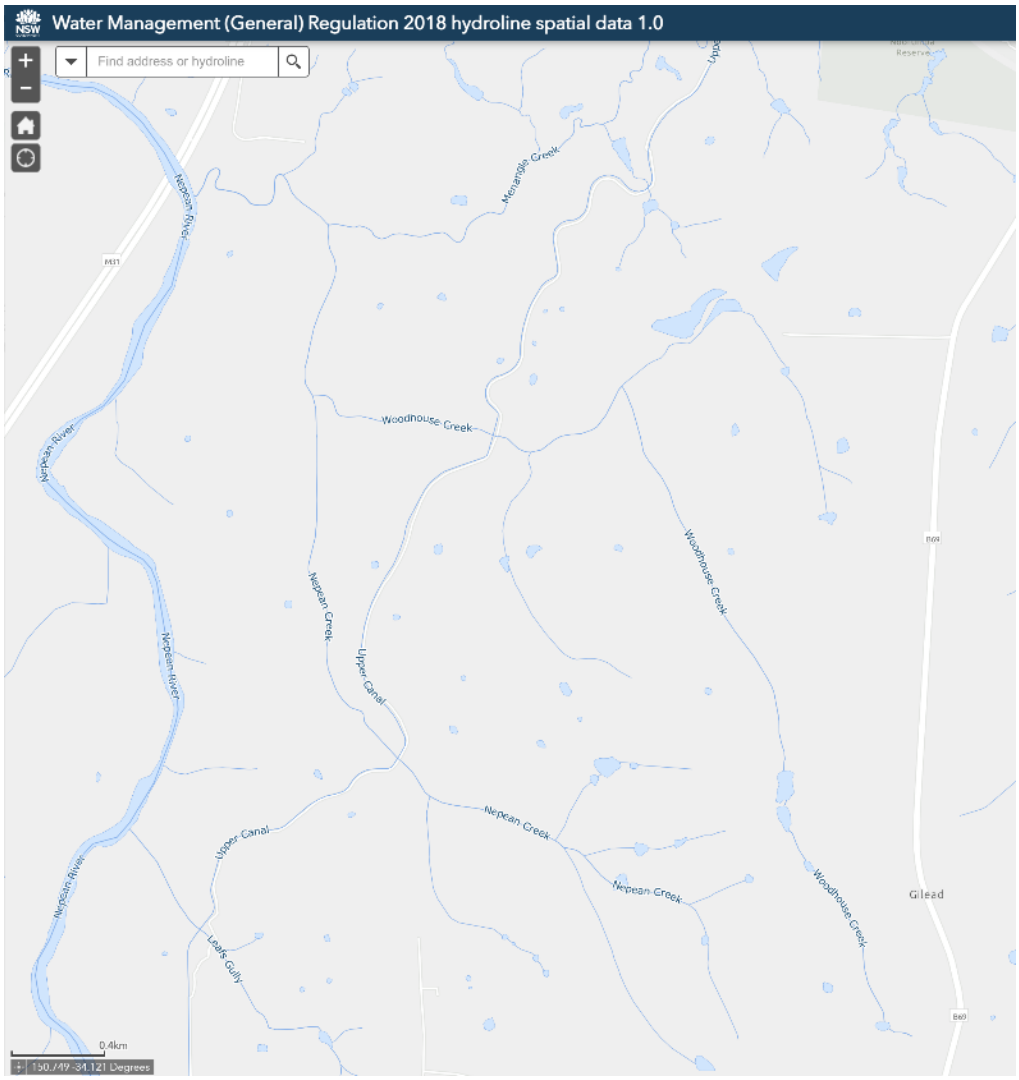


Figure 1-1 Hydroline Source: NSW Hydroline layer cited as 2018

Figure 1.2 shows the riparian corridor plan with riparian classification of stream order while Figure 1.3 shows the proposed riparian corridors. NB these are provided in detail later in the report for each reach and in CAD format. The riparian boundaries have been used as a guide for Bushfire planning as well as water management and landscaping. The Koala corridor can be seen in the Ecological reports and is not impacted by the riparian corridor. The Koala corridor includes a requirement to have canopy seperateion near the interface with urban areas to inhibit Kolas moving into urban areas. It is noted this can be achieved within a fully vegetated riparian area as the outer vegetation community is woodland and the tree spacing for the correct vegetation also complies with the Koala tree spacing requirements.

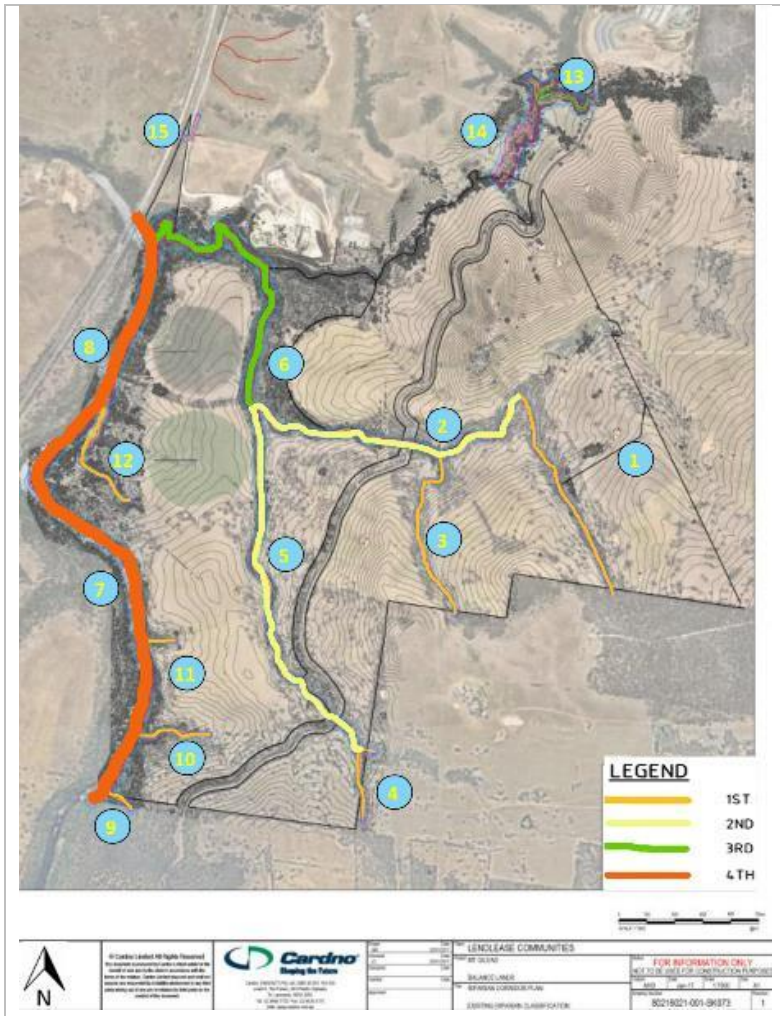


Figure 1-2 Waterway Stream Order. Source: Base map. Cardno 2017 and updated 2022

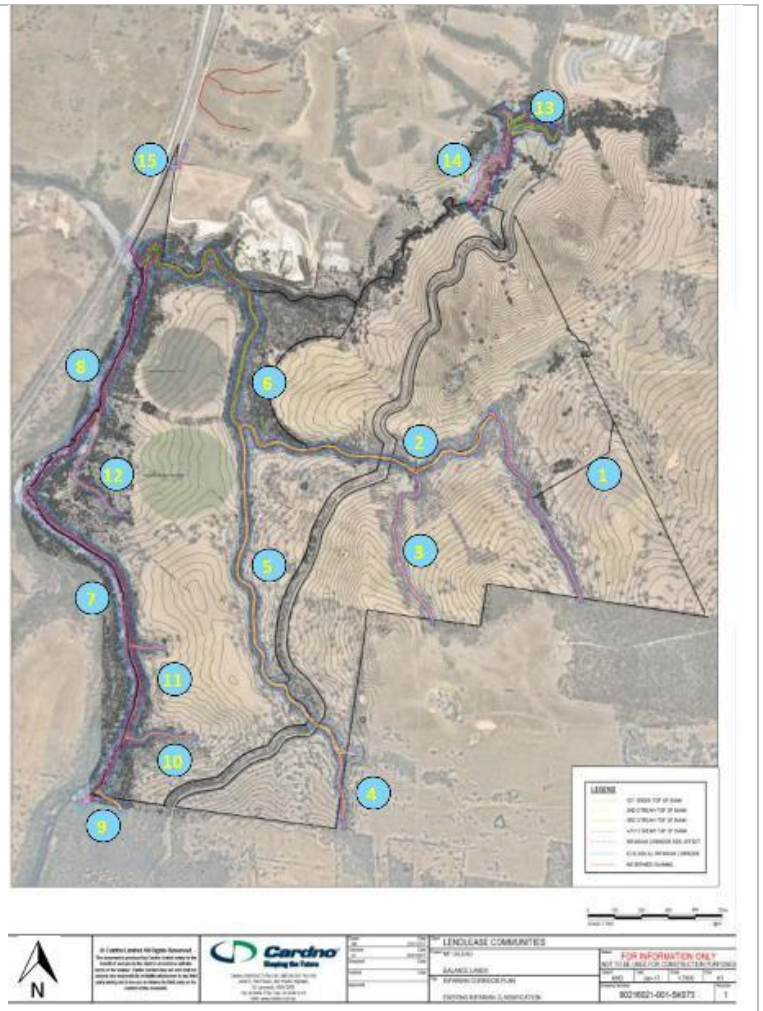


Figure 1-3 Riparian Corridor Plan with riparian classification of stream order. Source: Base-map Cardno 2017. NB provided at larger scale later

NB: close ups available for each reach and provided in CAD format. See also Appendix C for field results in photos form each reach.

1.3.3 Introduction to Waterway Variety in Gilead

Waterways in the Gilead vary from ephemeral to the substantial Nepean River. Pictorial examples of each of the three types are included below.

Shallow ephemeral, rocky drainage lines, occur on the west of the site. Some do not fulfill the definition of a waterway with no defined bed or bank and no vegetation indicating soil are inundated for any notable time (such as Reach 10) and are unnamed and typically lead to deeper sandstone gully waterways. Others have been classed as waterways as they do have a defined bed and or bank such as Reach 1 (unnamed waterway that flows to Woodhouse Creek). Existing vegetation consisting of native canopy and shrubs. Undergrowth and other shrubs are sparce due to past grazing.

Deeper sandstone gully waterways include parts of Menagle Creek, Nepean Creek and Woodhouse Creek. All vary from each other and along their reaches. In general, they have rocky beds (sandstone) that in places have continuous exposed sandstone. Long flows, with some pool and run formations are common. Reaches typically have shallow, narrow flows (1-2m wide) within defined banks. These usually flows are often within a narrow (~5-20m wide) gully that does, in storm events, provide carriage for additional water.

Often flow is discontinuous, unless in medium-high rain-fall conditions. Flows through these are known to be flashy with typical low flows replaced by fast deep water within the incised rocky gullies during high flow events. Heights are evidenced by the debris left in tall shrubs along the banks. High water drains quickly and waterways return to low intermittent flow conditions.

	
Reach 10 (not a waterway but numbered as a 1st order to influence order of the immediately receiving waterway).	Reach 1 classed as a 1st order waterway - it has a bed. Requires 10m riparian zone each side from top of bank

	
Reach 5 Nepean Creek is a 2nd order waterway requiring a riparian zone 20m each side from top of bank.	Reach 6 along Menangle creek is a 3rd order waterway requiring a riparian zone 30m each side from top of bank.

During extended low-flows fine-grained materials accumulate in pools. Instream bed and bank diversity resulting from the varied geology creates a diversity of in-stream habitats. While some locations are predictably a pool, run or riffle other locations are influenced more by sediment and debris deposition/accumulation resulting in greater variability through time. Bed adjustments are also dependent on material availability and the history of bedload transporting events (velocity and frequency). Waterways are confined to gully settings and have localised capacity for adjustment. Bedrock constrains lateral and vertical adjustment along significant parts of the reaches.

The Eastern bank of **Nepean River** boarders Gilead. Here the Nepean has a significant flow and is a 4th Order waterway.

	
Nepean River Reach 7 (4th Order Waterway). RHS looking down to the deeply incised river-bed from the ridge within Gilead. LHS: photo from the eastern bank looking west.	

2 Site Assessment

2.1 Site description

The Riparian Plan works area is within a site off Appin Road in Gilead, NSW 2560 (Figure 2-1).

Noorumba Reserve is to the north, beyond Noorumba Reserve is dense urban development. Heathcote National Park is located to the east. To the south and west there is currently rural development, this area is proposed to have additional urban development. West is the Nepean River with an existing riparian zone.

While most of the western boundary drops steeply to the Nepean River there is an area of lower gradient and here it is proposed that there be interaction with the river edge. Buildings do not currently exist within the area covered by this Riparian Plan. Biobank sites are proposed in this area, covered by Gilead, and complement the riparian zones.

Figure 2-1 shows yellow circle is the site and surrounds. Approximately 70% of the site has been cleared (for over 80 years) of native vegetation. Paddock trees are scattered in the Gilead area. Most vegetation will be retained with the conservation areas (riparian and other green spaces).

Site location

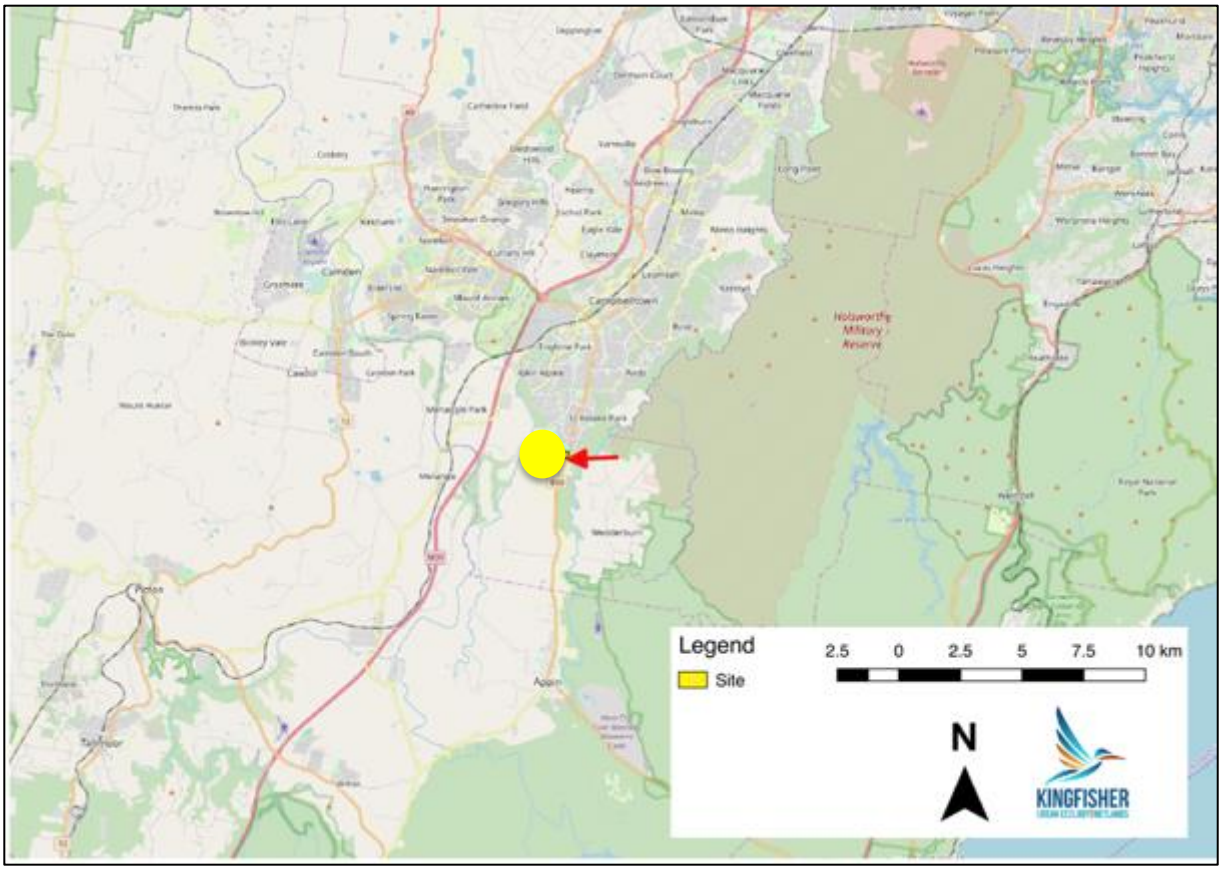


Figure 2-1 The vicinity of Gilead site and that contains the RP area in context to the surrounding area. Source: Open Street Map 2022

2.1.1 Geology and Soil Landscapes

Underlying shale caps overlay sandstone resulting in a transition between clay soils from the shale and sandy soils from sandstone. The boundaries are generally indistinct however are clear enough to indicate vegetation communities and thus the species selection for revegetation.

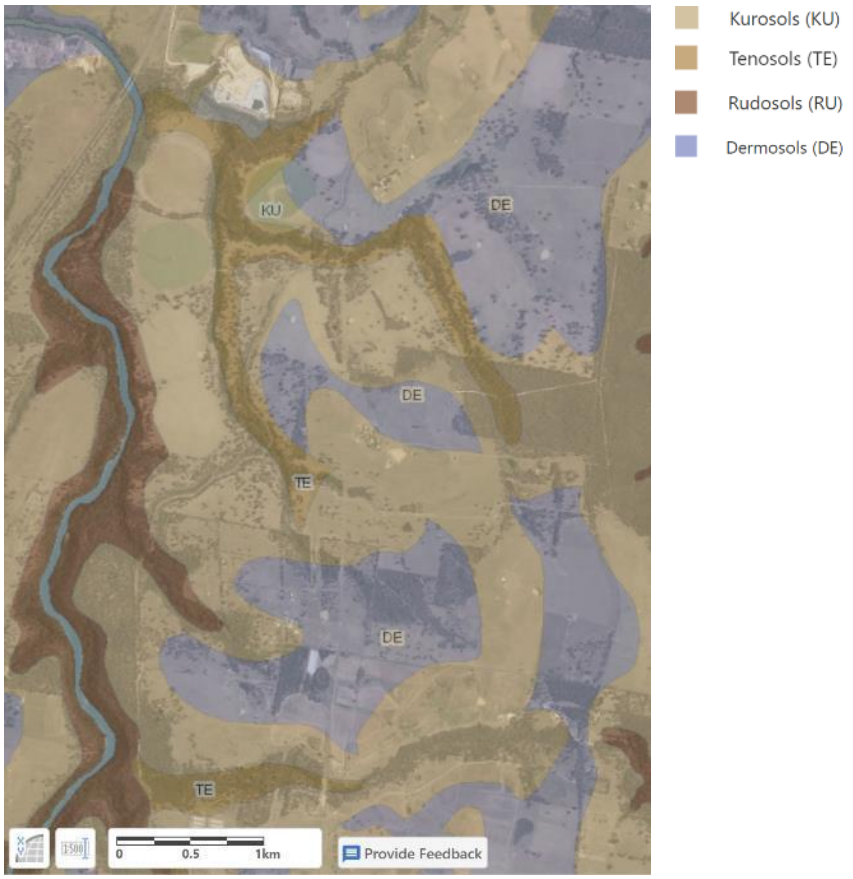


Figure 2-2 Soils Map. Source SEEDMaps Australian Soil Classification Type NSW

2.1.1 Vegetation – Plant Community Types

Most of the site has been previously cleared of native vegetation and replaced with pasture turf. The remaining ~10% contains a combination of native vegetation along the riparian zone and herbaceous exotic flora. Most of the remaining vegetation is along the waterways and will be retained within the riparian zones. Figure 2-3 and 2-4 shows maps of vegetation communities.

Native vegetation within the site has been identified using *Vegetation Map – Cumberland Plain West – VIS 4207* (via SEED mapping). Three Plant Community Types (PCT) are within site boundaries (Figure 2-3), PCTs are:

PCT_Code: 1395 *Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion* and
PCT_Code: 849 *Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion.*
PCT 835: Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion

PCTs 1395 and 849 are listed as Critically Endangered Ecological Communities under both the NSW Biodiversity Conservation Act 2016 (BC Act 2016) and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). See Figure 2-4

PCT = Plant Community Type

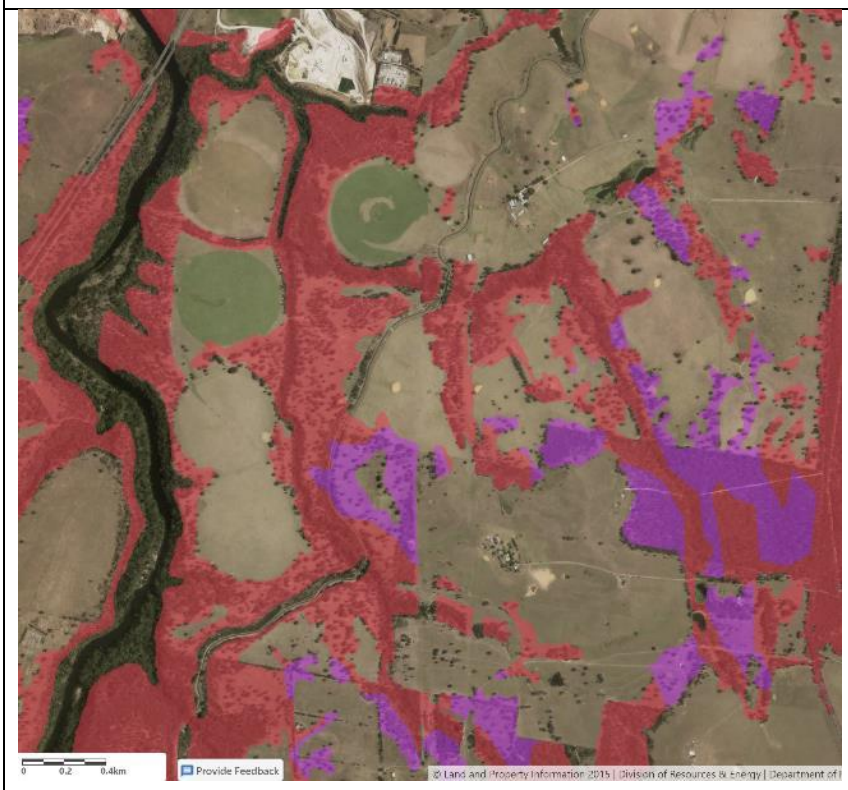
PCT 1395 (dark yellow): Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion

PCT 849: Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion

PCT 835: Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion

NB: colours from SEED portal and not altered

Figure 2-3. Map PCTs onsite. Source: SEED portal data June2022 .



Shale Sandstone Transition Forest in the Sydney Basin Bioregion

Cumberland Plain Woodland in the Sydney Basin Bioregion

Figure 2-4. Map Critically Endangered Ecological Communities onsite. Source: SEED portal data June 2022.

2.1.2 Corridors

Riparian zones contribute to the larger corridors matrix. Riparian areas on site contribute to the those of the *Cumberland Subregion BIO Map Biodiversity Corridors of Regional Significance* as see in Figure 2-5. This includes a Regional Corridor and Core Areas (along the Nepean River) and a regional corridor number 7 (through the site) and 60.75ha of bushland to the south of the site (outside the Gilead site boundaries). Riparian areas covered in this Plan include areas with existing vegetation and those that currently lack riparian vegetation and are in low condition. Planting and assisted regeneration will result in connected corridors.

Figure 2-5 Regional Corridors. Source SEED portal Cumberland Subregion BIO Map Biodiversity Corridors of Regional Significance. Yellow outline approximate boundary of Gilead.

Figure 2-6 shows the Masterplan area for Gilead here the riparian corridors are within the conservation zones and shown in Dark Green. Note the open space (bright green) areas are subject to change in location.

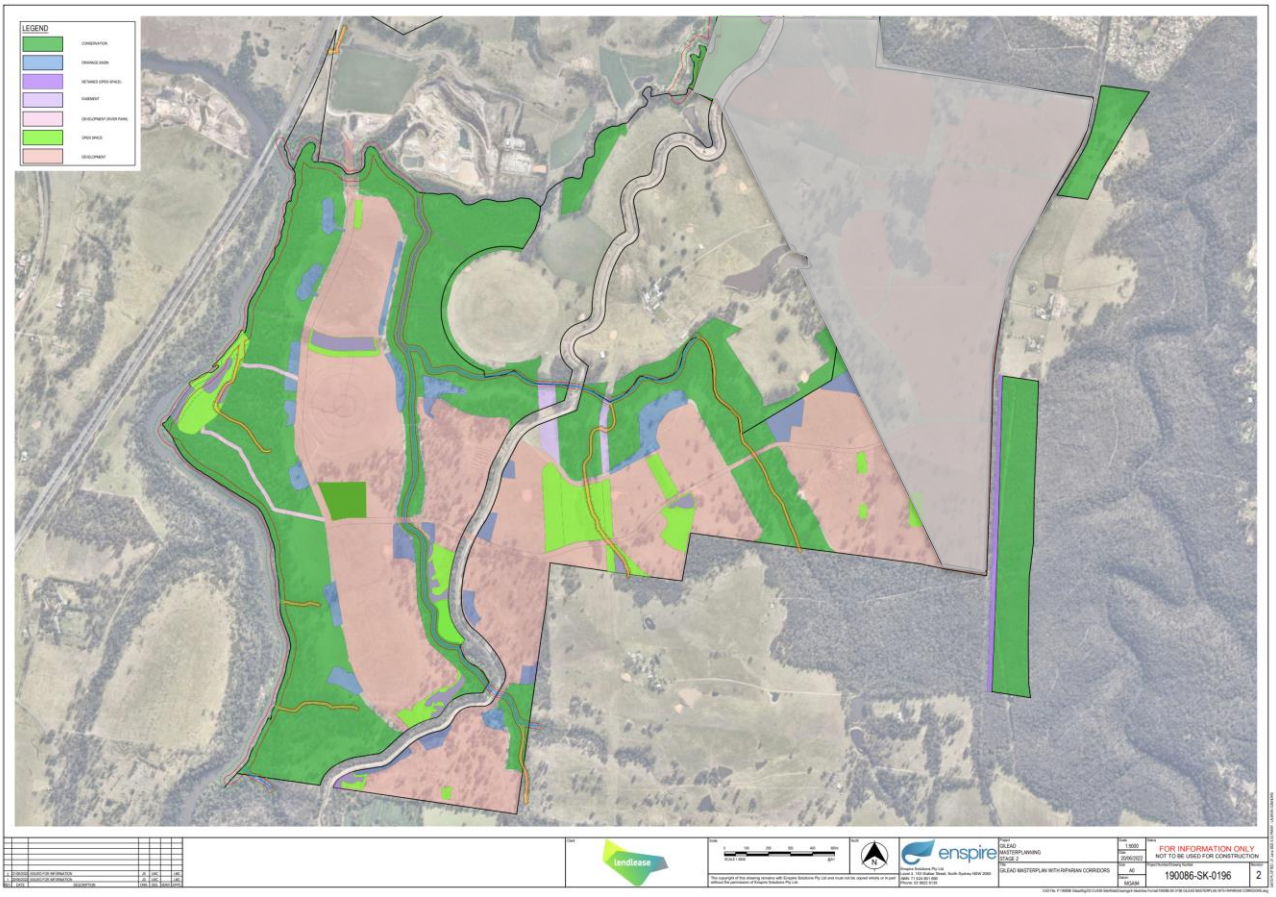


Figure 2-6 Masterplan Layout for Gilead. Source Enspire June 2022. Riparian corridors are within the dark green – conservation zones. Note the open space (bright green) areas are subject to changes in location.

2.2 Location of Riparian Zones

2.2.1 Catchment Context

The subject site is at the head of a catchment which drains west into the Nepean River. Woodhouse and Nepean Creeks both originate within, or close to within the site. Menangle Creek starts east of the site. This is a small, localised catchment and the waterways flow during localised rain. The Nepean River is large and has many points of inflow prior to forming the western boundary of the site.

2.2.2 Riparian Zones

This Riparian Plan applies to the riparian zone on each side of the waterways other conservations lands adjoining the riparian areas and these are not included in this Riparian Plan.

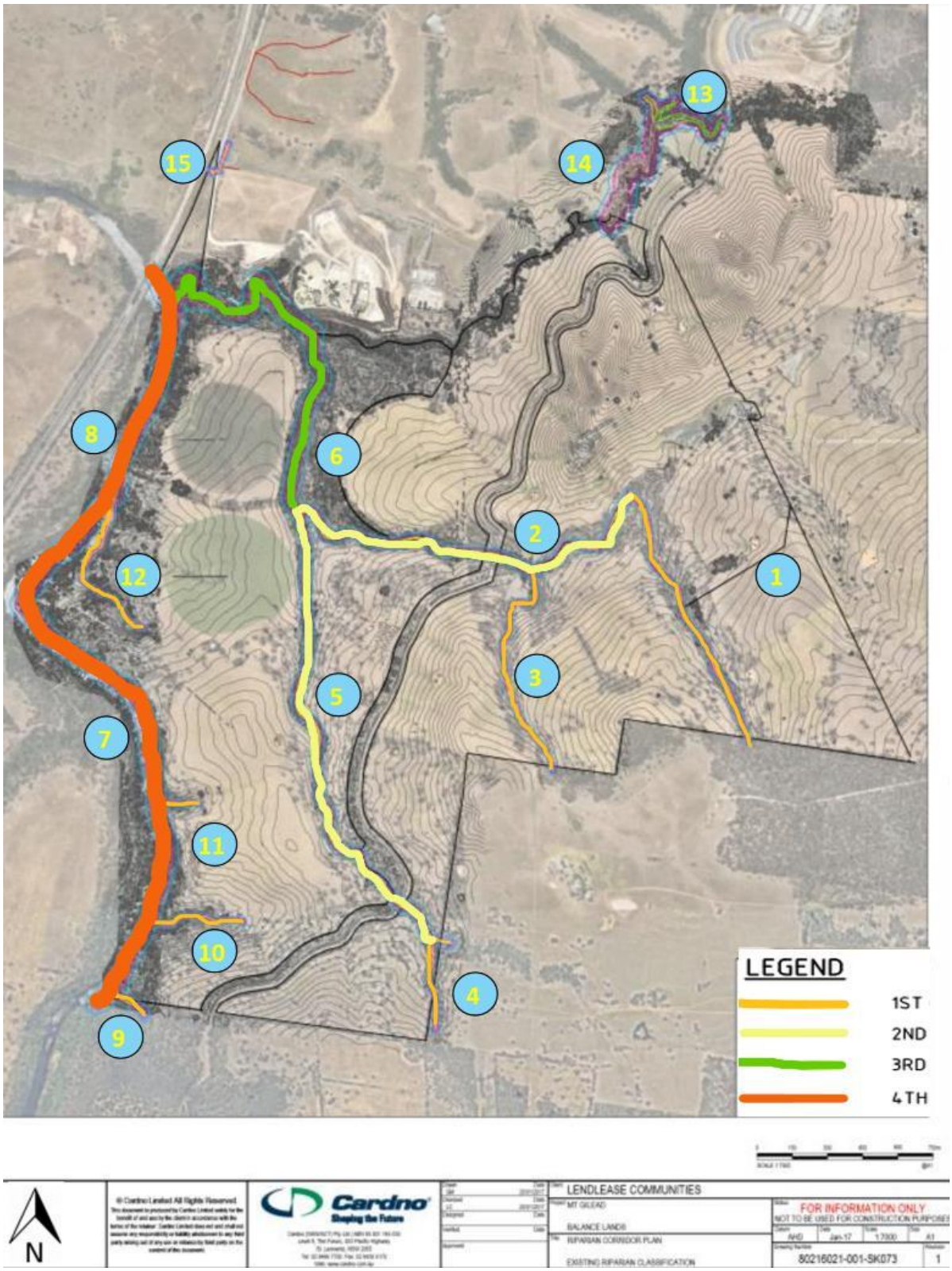


Figure 2-7 Waterway Stream Order. Source: Base map. Cardno 2017 and updated 2022

The riparian areas subject to this plan are shown in Figure 2-8 (excluding 13 and 14 as these are already covered in Stage 1).

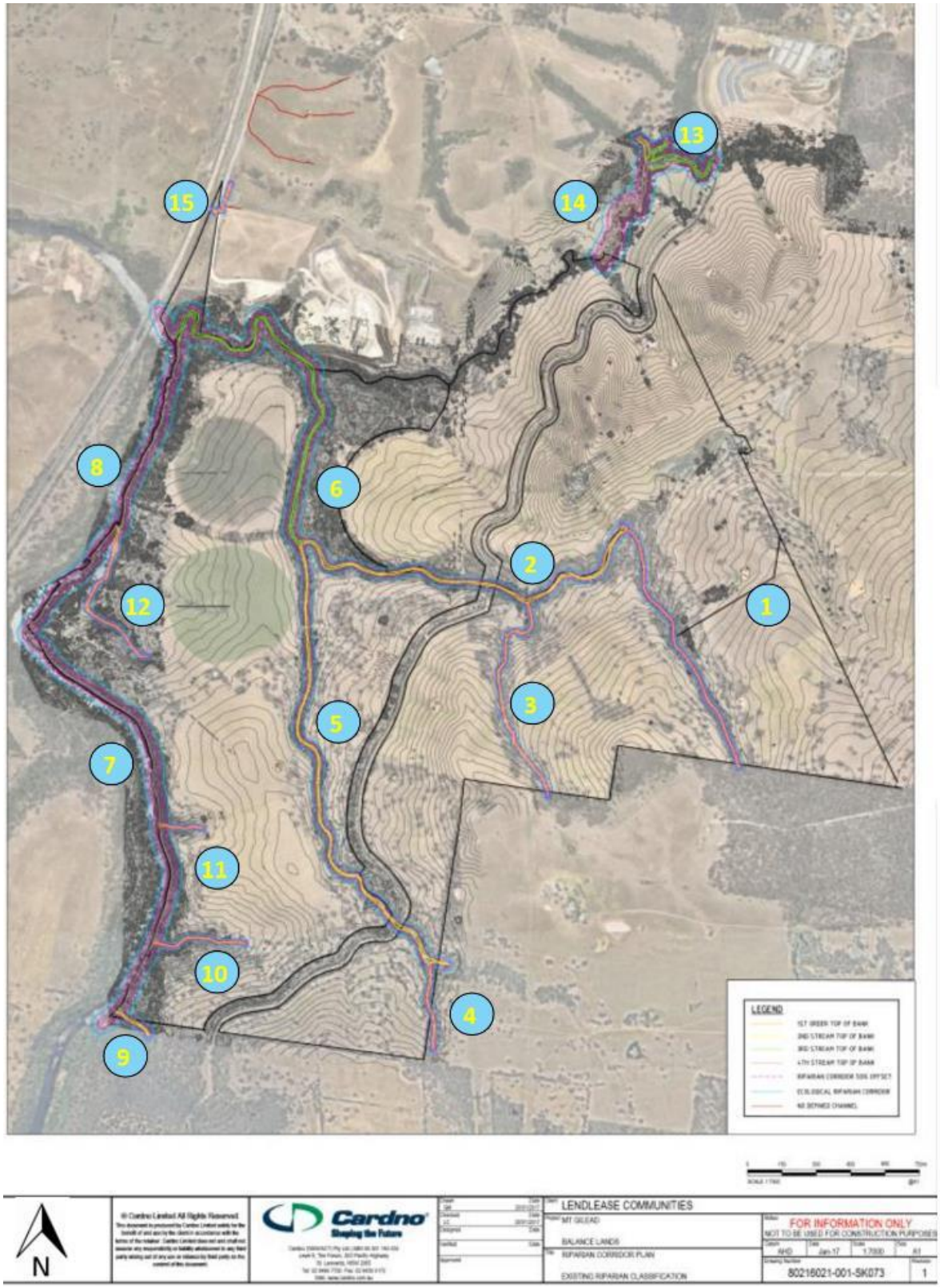


Figure 2-8 Riparian Corridor Plan with riparian classification of stream order. Source: Base-map Cardno 2017 NB: close ups available for each reach and provided in CAD format.

Table 2-1 summarises the characteristics for each Reach.

Table 2.1. Summary attributes of waterways within Gilead.

Reach Labels	Meets Creek definition	Stream Order	Name	Existing riparian vegetation %	Riparian proposed (each bank (m)	Comments
1	Yes	1st	Unnamed trib to Woodhouse	50	10	
2	Yes	2nd	Woodhouse	80	20	
3	Yes*	1st	Unnamed trib to Woodhouse	65	10	dam
4	Yes*	1st	Unnamed trib to Nepean Ck	65	10	
5	Yes	2nd	Nepean Ck	80	20	
6	Yes	3rd	Nepean Ck / Woodhouse	65	30	
7	Yes	4th	Nepean River	100	40	
8	Yes	4th	Nepean River (NR)	70	40	
9	No	1st	Trib to NR	60	Within conservation area at least 10m	
10	No	1st	Trib to NR	60	Within conservation area at least 10m	
11	No	1st	Trib to NR	80	Within conservation area at least 10m	
12	Yes	1st	Trib to NR	100	10	
15		1st				

3 and 4 are marginal (areas do not fit the definition) NB 13 and 14 covered in Figtree Hill

2.3 Flora and Fauna

2.3.1 Threatened Species and EECs

The Riparian Plan has been written to maximise long-term functionality of the riparian zone and the species and processes within them. Habitat for threatened species and Endangered Ecological Communities (EEC) have been identified within the site and are listed below and are detailed in the Ecological reporting by ELA June 2022.

The two CEECs have been used to direct the vegetation rehabilitation detailed in the actions section as have the habitat requirements of key species (listed below). Ecology details can be found in ELA's flora and fauna sections of the BCA (ecological July 2018 and subsequent updates May and June 2022)

Habitat requirements will be managed through the Riparian and Vegetation Implementation Plans. This Riparian Plan includes creating and enhancing habitat for threatened species and communities see Table 2-2 and other species such as Sugar Gliders and Microbats not listed as endangered. Table data is accurate as per listings June 2022

Table 2-2 Threated Species, Populations and Communities

	NSW	Commonwealth
Cumberland Plain Woodland in the Sydney Basin Bioregion	CEEC	CEEC
Shale Sandstone Transition Forest in the Sydney Basin Bioregion	CEEC	CEEC
Koalas	Vulnerable	Vulnerable
Cumberland Land Snail	Endangered	Not listed
Powerful Owl (*Ninox strenua*)	Vulnerable	Not listed
Microbats (including Threatened Species)	Depends on species - most Vulnerable	

2.4 Bushfire Protection and Asset Protection Zones

Bushfire reports have been written (McMonnies 2022). Reports have indicative Asset Protection Zones (APZ) and the development design has been influenced such that APZs are not required in the riparian zone. Design principles include perimeter roads as part of the set-back to riparian areas.

The APZ is shown on Figure 2-9in orange shows. The APZ is an inner protection zone (IPA).

For determining the APZs riparian areas have been assumed to be vegetated as 'forest' this means the fully strata of vegetation can be established in these areas and planting densities and species selected in this Riparian Plan have already been taken into account with APZ and bush fire management determinations.

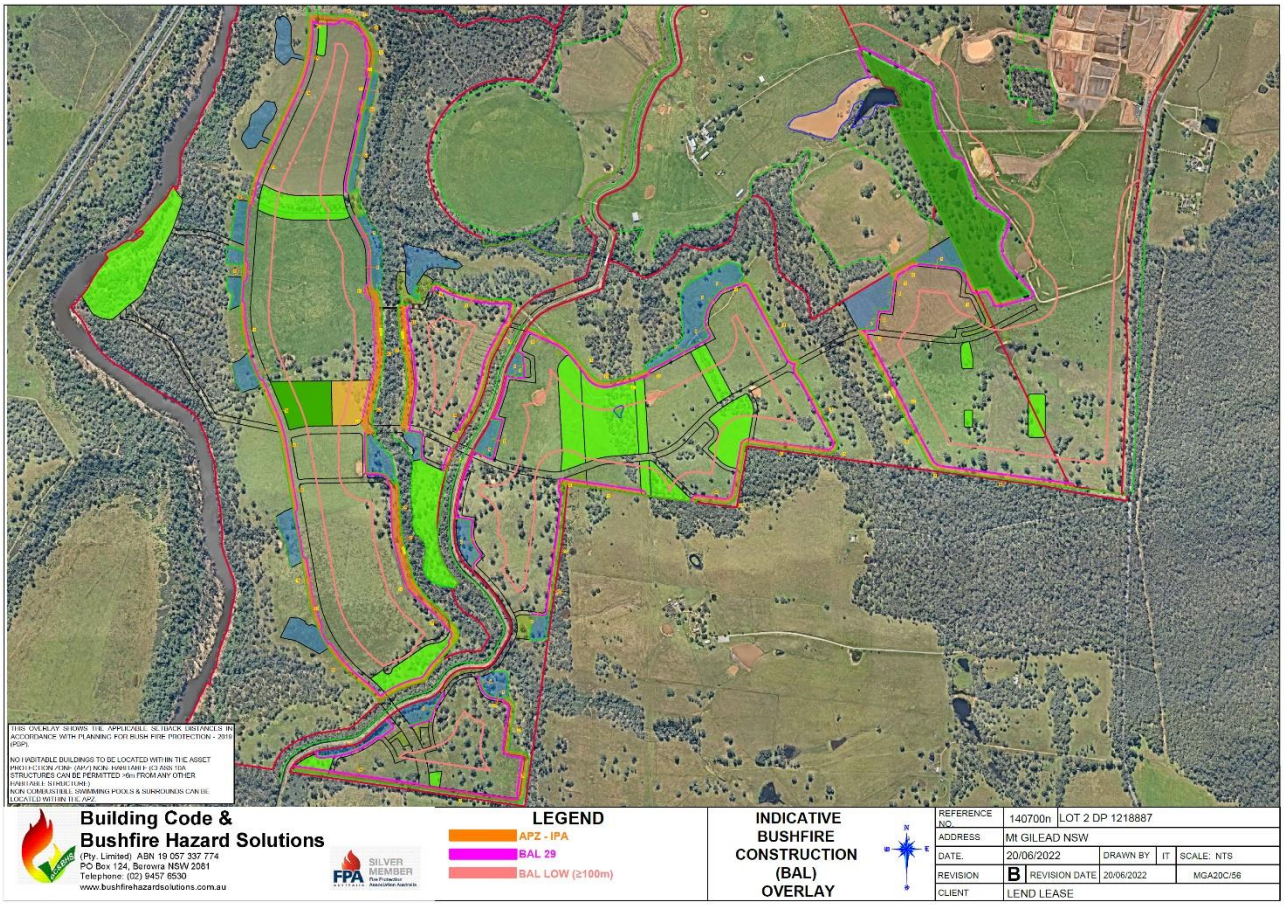


Figure 2-9 APZ zones. Source: McMonnies 2022

3 Guiding Principles and Legislative Requirements

3.1 Guiding documents

The Riparian Plan applies to land referred to as Gilead. While the rezoning doesn't result in works the subsequent requests for approval will result in creation of residential lots and associated civil works, including revegetation within conservation areas, the removal of some trees in paddocks, earthworks and the construction of roads and infrastructure. As some of this is within 40m of waterways the need for a Controlled Activity Approval has been triggered.

The following external approval and guideline documents have been reviewed and used to inform this Riparian Plan. Other legislative documents reviewed are included in Section 3.2 *Legislation.*

Development Conditions and requirements in Agreements as outlines in the following:

- Ecological Consultants Australia Pty Ltd, 'Riparian Plan – concept (2017 and 2019)

Guidelines for managing the riparian lands

- Guidelines for Vegetation Management Plans on waterfront land (DPI).
- Recovering Bushland on the Cumberland Plain: Best Practice Guidelines for the Management and Restoration of Bushland.
- Cumberland Plain Recovery Plan.

Development specific plans

Development specific plans will be detailed after this re-zoning stage. For now the road crossings have been set and the basin locations identified (see Figure 4-1). This is adequate to determine possibly interactions of infrastructure with the riparian zones. The masterplan by Urbis (Figure 1-1) is the key document on design for this rezoning stage.

The earlier Riparian Plans (ECA 2017 and 2019) informed the design concepts and aspects of the stormwater management as this current plan has inform the work of Civils, Water, Fire and Landscape plans.

3.2 Legislative context and statutory requirements

The Riparian Plan focus is the delivery of the on-ground work. Other documents show how the proposed areas for riparian zones are consistent with relevant legislation. The following legislation has been addressed in plans such as the ecological impact assessments (such as EcoLogical 2018 and updates including 2022) and the Riparian Plan (Dalby-Ball 2019). Legislation taken into consideration as part of this plan is included below.

Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) would become relevant if it was considered that an impact on a 'matter of National Environmental Significance (NES)' were likely, thus providing a trigger for referral of the proposal to the Department of Environment and Heritage.

Matters of national environmental significance identified in the Act include: nationally threatened species and communities. The Riparian Plan and ecological reports address matters relating to nationally threatened species and communities.

The focus of the Riparian Plan is the delivery of the on-ground work and its delivery will increase habitat for nationally threatened species and communities.

Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act 2016) is the key legislation that enables the conservation of biodiversity within the state of New South Wales. The BC Act 2016 facilitates the assessment and on-going protection of flora and fauna, including threatened species and ecological communities. The BC Act 2016 outlines assessment and offsetting requirements for activities with the potential to impact on threatened species and ecological communities in NSW, and the clearing of native vegetation which exceeds the threshold. This plan is consistent with the BC Act.

Water Management Act 2000

The objects of this Act are to provide for the sustainable and integrated management of the water sources of the State for the benefit of both present and future generations and, in particular:

- Ecologically sustainable development
- Protect, enhance and restore water recourses
- Recognise and foster social and economic benefits
- Recognise the role of the community
- Provide efficient and equitable sharing of water
- Management of water sources with other aspects of the environment including native vegetation and native fauna
- Encourage the sharing of responsibility and efficient use of water
- Encourage best practice management and use of water.

The proposed riparian areas are consistent with the Water Management Act as works are to improve waterways and link them with vegetated corridors. Details as per Riparian Plan (Dalby-Ball 2019).

State Environmental Planning Policy objectives have also influenced this plan including:

- State Environmental Planning Policy 19 – Urban bushland
- State Environmental Planning Policy 44 (Koala Habitat Protection) 2021
- State Environmental Planning Policy 55 – Remediation of land

3.3 Aims and Objectives

The aim of this Riparian Plan is to provide a stable watercourse and riparian corridor which will emulate local native vegetation communities. The broad objective is to protect, reinstate, maintain and enhance the native vegetation and habitat within the Riparian Plan scope area.

The aims and objectives will be achieved by:

- conserving and preserving the existing vegetation outside of development areas;
- undertake rehabilitation works in degraded native vegetation areas;
- undertake native vegetation protection measures;
- restore native vegetation to a level that reflects the cover, diversity and density of the indigenous vegetation; and
- provide educational material to promote responsible management of native vegetation areas.

This Riparian Plan direct outcomes so:

- the project retains and protects as much native vegetation as possible.
- the biodiversity of the site is enhanced through bush regeneration, habitat retention and habitat augmentation.
- biodiversity within the site is appropriately maintained and monitored during and post construction with reference to specific performance criteria and
- all tasks outlined in the Riparian Plan are performed by suitably qualified and experienced personnel.

Specific aims of the Riparian Plan include the establishment of suitable vegetation in riparian areas and the removal of weeds throughout the riparian zone and adjacent bushland.

4 Proposed Works

4.1 Activities

Proposed Riparian works have been guided by the Guidelines for Controlled Activities on Waterfront Land - DPI Office of Water NSW (2012 and subsequent updates).

Works within the riparian corridors include:

- Establishing, enhancing and maintaining riparian corridors through: bush-regeneration, planting, exclusion fencing, pest animal management.
- Water management infrastructure. While basins are outside of the riparian areas there are small incursions to enable treated water to reach waterways. Sizes and locations have been designed to minimise impact. Design details will be provided when finalised.
- Accessway crossings – roads and bridges are required, and all are in keeping with the guidelines of the Water Management Act.
- Sediment control
- Monitoring and reporting as part of on-going adaptive management.

Proposed works will be guided by Guidelines for riparian corridors on waterfront land (DPI Water). Key aspects of the guidelines being used to inform the detailed design stage are included below.

4.1.1 Objectives for riparian corridor management

The following section is an extract from the Guidelines that is being used to develop the detailed riparian plan. See also Table 4-1.

The overarching objective of the controlled activities provisions of the WM Act is to establish and preserve the integrity of riparian corridors.

Ideally the environmental functions of riparian corridors should be maintained or rehabilitated by applying the following principles:

- *Identify whether or not there is a watercourse present and determine its order in accordance with the Strahler System.*
- *If a watercourse is present, define the RC/VRZ on a map in accordance with Table 1.*
- *Seek to maintain or rehabilitate a RC/VRZ with fully structured native vegetation in accordance with Table 1.*
- *Seek to minimise disturbance and harm to the recommended RC/VRZ.*
- *Minimise the number of creek crossings and provide perimeter road separating development from the RC/VRZ.*
- *Locate services and infrastructure outside of the RC/VRZ. Within the RC/VRZ provide multiple service easements and/or utilise road crossings where possible.*
- *Treat stormwater run-off before discharging into the RC/VRZ.*

The Office of Water, does allow for a range of works and activities on waterfront land and in riparian corridors to better meet the needs of the community, so long as they cause minimal harm as outlined in the riparian corridor matrix below.

Riparian corridor matrix

The riparian corridor matrix enables applicants to identify certain works and activities that can occur on waterfront land and in riparian corridors. Applicants should note that the matrix relates to controlled

activity approvals under the WM Act only. They are still required to comply with other relevant government legislation, such as threatened species, flood planning levels and fisheries guidelines.

Table 4-1 Riparian corridor matrix. NSW Office of Water 2012.

Stream order	Vegetated Riparian Zone (VRZ)	RC off-setting for non RC uses	Cycleways and paths	Detention basins		Stormwater outlet structures and essential services	Stream realignment	Road crossings		
				Only within 50% outer VRZ	Online			Any	Culvert	Bridge
1st	10m	•	•	•	•	•	•	•		
2nd	20m	•	•	•	•	•		•		
3rd	30m	•	•	•		•			•	•
4th +	40m	•	•	•		•			•	•

Source: *Controlled activities on waterfront land - Guidelines for riparian corridors on waterfront land* NSW Office of Water, July 2012.

- **Stream order:** The watercourse order as classified under the Strahler System based on 1:25,000, 1:50,000 or 1:100,000 topographic maps whichever is the smallest scale available. A full list is provided at Part 2, Schedule 2 of the Water Management (General) Regulation 2011.
- **Vegetated riparian zone (VRZ):** The required width of the VRZ measured from the top of the high bank on each side of the watercourse.
- **Riparian corridor (RC) off-setting for non-RC uses:** Non-riparian uses, such as Asset Protection Zones are allowed within the outer 50 per cent of the VRZ, so long as offsets are provided in accordance with the averaging rule as seen in Figure 3.
- **Cycleways and paths:** Cycleways or paths no wider than four metres total disturbance footprint can be built in the outer 50 per cent of the VRZ.
- **Detention basins:** Detention basins can be built in the outer 50 per cent of the VRZ or online where indicated. Refer to the Office of Water's *Controlled activities. Guidelines for outlet structures* and *Controlled activities. Guidelines for instream works*. Online basins must:
    - be dry and vegetated
    - be for temporary flood detention only with no permanent water holding
    - have an equivalent VRZ for the corresponding watercourse order
    - not be used for water quality treatment purposes.
- **Stormwater outlet structures and essential services:** Stormwater outlets or essential services are allowed in the RC. Works for essential services on a fourth order or greater stream are to be undertaken by directional drilling or tied to existing crossings. Refer to the Office of Water's *Controlled activities.*
- *Guidelines for laying pipes and cables in watercourses* and *Controlled activities. Guidelines for outlet structures.*
- **Stream realignment:** Indicates that a watercourse may be realigned. Refer to the Office of Water's
- *Controlled activities. Guidelines for instream works.*

- **Road crossings:** Indicates permitted road crossing methods. Refer to the Office of Water's *Controlled activities. Guidelines for watercourse crossings* and NSW DPI policy and guidelines for fish friendly waterway crossings for Class 1 and 2 waterways.

4.1.2 Off-setting

Where a structure (as defined above) is proposed in the outer 50% the Gilead riparian plan will show where the offset will be located – as per Figure from the Guideline (DPI Water July 2012). It is noted that all proposed riparian zones in Gilead, all areas covered by this proposal, are dominated by cleared paddocks and exotic grasses with remnant native canopy trees. Exceptions to this do occur and can be seen on the aerial photography. Any averaging, if needed, will focus on consolidating areas of natural vegetation.

The averaging rule should generally be applied to cleared waterfront land. Development proposals involving waterfront lands that contain existing native vegetation should seek to preserve that riparian vegetation in accordance with the minimum riparian corridor requirements outlined in Table 1.

Figure 3. Averaging rule

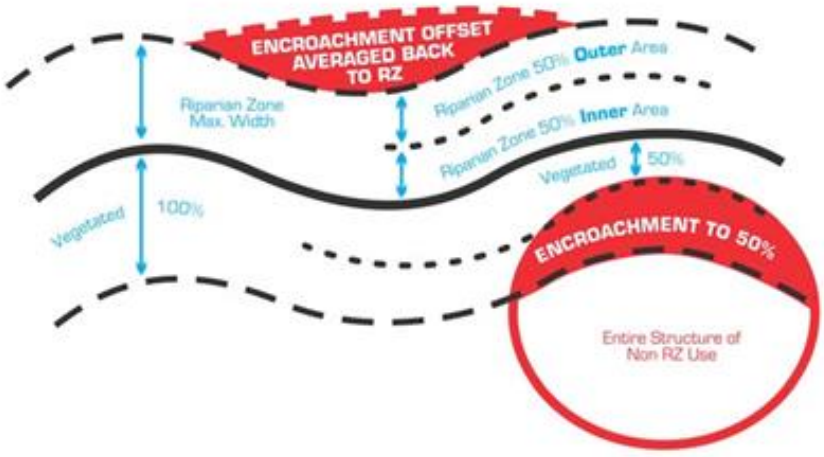


Figure 4-1. Offsetting proposal for Gilead Riparian Corridor Plan

4.1.3 Impact Areas

Water Management and road crossing will result in incursions into riparian areas. It is noted that the design for water management has it outside of the riparian corridors with the exception of a small areas for treated water to re-enter the waterways. These will be minor and examples of the types of inlet have been included in this report and will be detailed in the design-phase Riparian Plan.

See Figure 4-1 for location of water management basins and associated infrastructure. Road crossing locations have been carefully chosen to minimise impact while working with the site grades and required access links. Six are proposed and can be seen on Figure 4-1. Table 4-2 summarises impact types and locations.

Bushfire mitigation work is not required in any riparian corridor.

All areas of incursion have been offset in the same waterway. Figure 4-2 shows incursions and offsets.

Table 4-2. Summary of works within the riparian zones or waterways within Gilead.

Reach Labels	Meets Creek definition	Stream Order	Waterway Name	Road Crossing	Water Management#	Impact Inner 50% m^2	Impact Outer 50% m^2	Off-set provided
1	Yes	1st	Unnamed trib to Woodhouse	1		TBA (~20m^2)	TBA (~20m^2)	yes
2	Yes	2nd	Woodhouse	0		0	0	na
3	Yes	1st	Unnamed trib to Woodhouse	2	Remove dam	TBA (~40m^2)	TBA (~40m^2)	yes
4	Yes	1st	Unnamed trib to Nepean Ck	0		0	0	na
5	Yes	2nd	Nepean Ck	1		TBA (~20m^2)	TBA (~20m^2)	yes
6	Yes	3rd	Nepean Ck / Woodhouse	0		0	0	na
7	Yes	4th	Nepean River	0		0	0	na
8	Yes	4th	Nepean River (NR)	0		0	0	na
9	No	1st	Trib to NR	0		0	0	na
10	No	1st	Trib to NR	0		0	0	na
11	No	1st	Trib to NR	0		0	0	na
12	Yes	1st	Trib to NR	0 – close to		0	0	na
15		1st				No	0	na

As there are no basins in the riparian areas the only incursions are the water outlets to creeks – these are not yet known. NB 13 and 14 covered in Fig tree Hill

4.1.4 Water Management Basins, Road Crossings and Associated Infrastructure

Water management basins (22 of them) are shown in dark blue on this plan. All are outside of the riparian zones. Details on each one will be provided with the full set of design documents. Road crossings are indicated with a yellow circle there are six proposed and all require bridging.

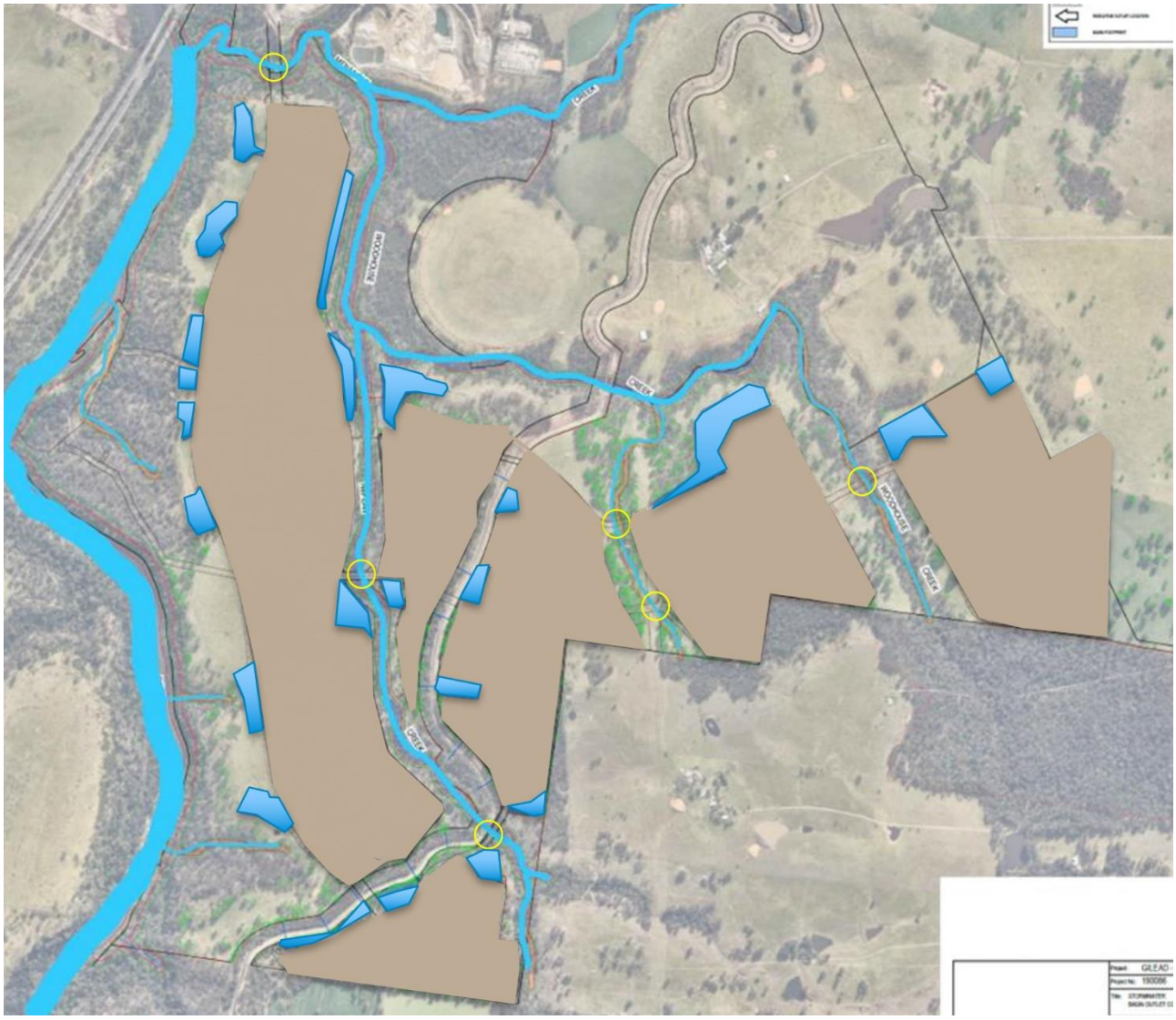


Figure 4-1 Water management basins (dark blue) and road crossings (yellow circles), grey (proposed development footprint). Source: Base map and basin locations (Enspire 2022).

4.1.5 Riparian Area

Riparian areas outside are shown in Figure 4-1. Riparian zones are required to meet the Riparian Guidelines and be fully vegetated, diverse and habitat supporting areas. The following works sections provide an overview of how riparian areas will be established and managed – these will be detailed after the re-zoning stage.

4.2 Establishing Riparian areas

A combination of fire, weed removal, regeneration of soils as well as planting will be used in the care and re-creation of riparian areas.

Existing vegetation, particularly canopy, is within areas marked to be riparian corridors and will be retained. In such areas supplementary planting may be required to assist in returning the mid and ground diversity that may have been lost due to past land management.

Working with the D'harawal People and DPE guidance could lead to small area burns, both hot and cold predevelopment. Burn areas can be managed to maximise the success of high diversity regeneration. Thermal treatment (with a thermal 'weeder' can also be used to bring fire to small areas.

Riparian areas and surrounding conservation areas will be within the Koala Corridors and some areas are subject to modification in relation to the Koala Plan of Management that aims to keep Koalas in the treed areas and out of urban areas. Reaches (e.g. 5 and 6 along Nepean Creek) have mature Grey Gums (Koala food trees) and these will be retained and others planted.

The following focus on requirements for areas proposed for planting.

4.2.1 Species confirmation, seed collection and plant propagation

While natural regeneration is expected in some areas once livestock is excluded, planting is required to achieve the required densities, particularly in riparian areas. Pre-works riparian area is compared to post works basin design in Figure 4-3.

Species required to be planted in the riparian zone are included in Table 4-4. The species list was selected based on previously collected data presented including in BioBank agreements. Planting density for the riparian area is displayed in Table 4-3. Note this table will be completed at the detail design phase.

Table 4-3 Planting areas and densities required.

Type	Area m^2	Required Density (plants/m^2)	Plants	Comment.
Canopy				
Riparian Zone	TBA m^2	0.1	TBA	
Shrubs				
Riparian Zone	TBA m^2	3	TBA	
Ground cover				
Riparian Zone	TBA m^2	3	TBA	
Total density calculation	TBA **m^2**			Average density = 6 plants/m^2

Overall density is 6 plants per m^2 made up of ground, shrub, and canopy species.
Canopy species average 1 per $10m^2$, shrubs average 3 per m^2 and ground average 3 plants per m^2.
Table 4-1b has species and recommended numbers to achieve the density and species diversity.

Table 4-4 Species list for planting. NB: details will be added at the detail design phase

Common Name	Species Name	*Total plants per species*
Canopy total		
Grey Gum	*Eucalyptus punctata*	*TBA*
Rough-barked Apple	*Angophora floribunda*	*TBA*
Grey Myrtle	*Backhousia myrtifolia*	*TBA*
Spotted Gum	*Corymbia maculata*	*TBA*
Cabbage Gum	*Eucalyptus amplifolia*	*TBA*
Small-leaved Ironbark	*Eucalyptus crebra*	*TBA*
Thin-leaved Stringybark	*Eucalyptus eugenioides*	*TBA*
Grey Box	*Eucalyptus moluccana*	*TBA*
Forest Red Gum	*Eucalyptus tereticornis*	*TBA*
	Melaleuca decora	*TBA*
Shrubs total		*TBA*
Sydney Green Wattle	*Acacia decurrens*	*TBA*
White Sally Wattle	*Acacia floribunda*	*TBA*
Hickory Wattle	*Acacia implexa*	*TBA*
Parramatta Green Wattle	*Acacia parramattensis*	*TBA*
	Bossiaea prostrata	*TBA*
Coffee Bush	*Breynia oblongifolia*	*TBA*
Blackthorn	*Bursaria spinosa*	*TBA*
Bitter Pea	*Daviesia ulicifolia*	*TBA*
Parrot Pea	*Dillwynia sieberi*	*TBA*
Hop Bush	*Dodonaea viscosa* subsp. *cuneata*	*TBA*
Australian Indigo	*Indigofera australis*	*TBA*
Tree Violet	*Melicytus dentata*	*TBA*
White Dogwood	*Ozothamnus diosmifolius*	*TBA*
Scrubby Spurge	*Phyllanthus gunnii*	*TBA*

Common Name	Species Name	*Total plants per species*
	Pultenaea microphylla	*TBA*
Native Raspberry	*Rubus parvifolius*	*TBA*
Forest Nightshade	*Solanum prinophyllum*	*TBA*
Groundcovers		*TBA*
Purple Wiregrass	*Aristida ramosa*	*TBA*
Threeawn Speargrass	*Aristida vagans*	*TBA*
Stout Bamboo Grass	*Austrostipa ramosissima*	*TBA*
Red Grass	*Bothriochloa macra*	*TBA*
Windmill Grass	*Chloris truncata*	*TBA*
Plump Windmill Grass	*Chloris ventricosa*	*TBA*
Barbed Wire Grass	*Cymbopogon refractus*	*TBA*
Queensland Bluegrass	*Dichanthium sericeum*	*TBA*
Shorthair Plumegrass	*Dichelachne micrantha*	*TBA*
Small-flowered Finger Grass	*Digitaria parviflora*	*TBA*
Bushy Hedgehog-grass	*Echinopogon caespitosus*	*TBA*
Forest Hedgehog-grass	*Echinopogon ovatus*	*TBA*
Bordered Panic	*Entolasia marginata*	*TBA*
Paddock Lovegrass	*Eragrostis leptostachya*	*TBA*
Weeping Grass	*Microlaena stipoides* var. *stipoides*	*TBA*
Australian Basket Grass	*Oplismenus aemulus*	*TBA*
	Paspalidium distans	*TBA*
Whitetop	*Rytidosperma caespitosum*	*TBA*
Wallaby Grass	*Rytidosperma racemosum* var. *racemosum*	*TBA*
Kangaroo Grass	*Themeda triandra*	*TBA*

4.2.2 Seed stock, collection and propagation

Plants are to be from local stock. Preference is to be given to seed collected on-site and the adjoining the reserve. If suitable seed is not obtainable from these areas, then it is to be from other areas within the Sydney Basin of the same vegetation communities. If stock is not available from those sources, then the following is to be applied. Collection can be over 50km if the pollinators or dispersal agents travel further than that typically. Seed collection must be undertaken in accordance with Florabank Guidelines by an

appropriately experienced bush regeneration contractor with appropriate licences and permits under the *National Parks and Wildlife Act 1974* to collect seed from protected flora.

Canopy: For canopy trees seed source can be within the range of south to Wollongong, West to the Blue Mountains and North to Newcastle as this is the usual distribution of the pollinators for the canopy species.

Shrubs and ground covers: Shrubs and ground covers are to be from the range that is the usual distribution of their pollinators / dispersal agents. Species are to be from within the Sydney Basin or south to Wollongong.

Plants may be propagated by a local nursery or the bush regeneration contractors if they have the appropriate facilities. 10-20% of planting stock may be expected to fail and subsequently, seeds must be stored to allow for propagation of replacement stock to allow for an 80% survival rate of each species following planting.

4.2.1 Soil amelioration and mulching

Soil

Have soil tested by project ecologist with input from soils expert. If existing soil is tested and found to not be adequate for native plant growth, then:

- rip soil pre planting (spray grass) and add required elements OR
- 50mm of clean topsoil, OR
- add and mix in 50-100mm of eucalypt leaf mulch.

Or implement other recommendations from soil expert/ecologist.

To be decided by project ecologist with input from soils expert in discussion with client.

Mulch

Add 100-150mm of leaf forest leaf material (preferable leaf material and not trunk mulch).

If mulch this ideally should be aged mulch (6+months), weed seed free, from local source.

NB: areas to be spray seeded may be sprayed with a mulch mix. Determine this prior to ordering mulch or whole site.

4.2.1 Planting

Plant as to specs to achieve the required density outcomes.

4.2.2 Irrigation

Irrigation is required for riparian plantings all plants are to be watered at time of planting and irrigated sufficiently throughout the establishment phase (18 months) to achieve the required final density of each vegetation strata and no gaps greater than $4m^2$.

4.2.3 Skills required

Creation and maintenance in the riparian areas is to be conducted by experienced bush regenerators with the supervisor to have at least 3 years' experience in bush regeneration, Cert III Conservation and Land Management, as well as training in the habitat requirements of threatened species.

4.2.4 Soil Stabilisation, Woody Debris and Mulching

Soil stabilisation will be required in some of the reaches as bank erosion is likely to be a risk particularly when weed vegetation is removed. Soil stabilisation may be required after primary weed removal works.

All trees, native vegetation, and plant litter to be removed for safety purposes, falling within construction footprints and those removed during asset protection zone creation may be used for Cumberland Land Snail habitat reinstatement or as mulch throughout all management zones. These activities must be performed at the discretion of the bush regeneration contractors in consultation with the project ecologist.

Cumberland Land Snail woody debris and plant litter habitat reinstatement must be given priority with remaining vegetation waste to be processed into mulch to aid in weed suppression throughout all management zones at discretion of the bush regeneration contractors. Mulch stockpiles must be kept under 1m in height, must be monitored for the presence of weeds and turned frequently to avoid spoilage. If the site does not contain enough mulch in situ, a native composition mulch may be imported to the site.

4.3 Weed Management

Retention of vegetation and native species as provided below. This information is relevant to all areas outside of approved construction zones.

4.3.1 Weed Control

4.3.1.1 Overview and experience required

Natural Area Specialists (NAS) with proven experience in large scale restoration of vegetation community in the Sydney Region are required to implement the initial planting and restoration works. People skilled in managing the Endangered Ecological Communities are required to conduct and/or direct works in the riparian areas. Additional people may be involved under the direction of a person experienced and qualified as a Natural Area Specialists (Cert II or III NAS).

4.3.1.2 Timing for Weed Management Outcomes

Required outcomes of weed control are provided in Table 4-4.

Table 4-4 Required outcomes of weed control in Riparian Areas

Stage	Riparian areas
Pre-Planting	Compete weed removal including all pasture grasses
During planting	As above
Post planting to 12 months	Keep weeds under 5%
To 2 years post planting	Keep weeds under 5%
2-5 years	Keep weeds under 5%
2-5 years	Keep weeds under 5%
5-10 years	Apply Best practice
10+	Apply Best practice

Table 4-6 will be altered close to the planting time and made specific to each waterway Reach.

Table 4-6- Weed Management Requirements

Management zone/s	Weeds	Method of monitoring	Dates required
All zone/s	Grass weeds (including Kikuyu, Panic Veldgrass, Paspalum, Pigeon Grass, and Brome)	1. Weeds reduced to maintenance levels over 90% of site. 2. Weeds reduced to less than 10% cover.	1. By end of Year 5. 2. By end of Year 9 and ongoing.
All zone/s	Herbaceous weeds (including: Cobbler's Peg, Thistle, Fleabane, Fireweed, Paddy's Lucerne and Purpletop)	1. Weeds reduced to maintenance levels over 90% of site. 2. Weeds reduced to less than 10% cover.	1. By end of Year 5. 2. By end of Year 9 and ongoing.
Other weed management activities (where required)			
Unless otherwise specified, all herbicide used should be a non-specific herbicide formulated for use around water.			
All plot markers are to be maintained in the same position if noted to have been damaged or disturbed during or by undertaking any weed management, they must be replaced.			

Weeds (listed above or any others) must be removed from the planted areas rapidly so that they do not set seed.

Weed removal is required at highest levels:

- pre planting
- in the first 12 months post planting

After the first 12 months it can be reduced through time depending on the success of weed suppression/eradication providing it meets the outcomes in Table 4-3.

The Biobank agreement in Section 2.1 requires that *the weed control plan must be reviewed each 4 years and no less than 6 years by an appropriately qualified person.* This applies to over 60% of the riparian area and the plan can be extended to all riparian lands in Gilead.

4.3.1.3 Key Weeds Present

Key weeds in the Biobank area and riparian zones are included in Table 4-7. Additional weeds are expected to germinate while native plants are establishing, and all require management with the aim of having weeds less than 5% and no weed species significantly impacting native diversity or habitat.

Table 4-7 Key weeds in the riparian zone and / or immediately adjacent land including the Biobank area

Weed	Common name of target weed	Scientific name of target weed	Description of infestation (e.g. intensity (% cover) & location within zone
A	Amaranth	*Amaranthus* sp.	Sparse presence amongst mix of herbaceous and grass weeds
B	Moth Vine	*Araujia sericifera*	Sparse presence amongst mix of herbaceous and grass weeds
C	Bridal Creeper	*Asparagus aspara-goides*	Localised infestation
D	Daisy	*Asteraceae* weeds	Localised infestation
E	Cobbler's Pegs	*Bidens pilosa*	Sparse presence amongst mix of herbaceous and grass weeds
F		*Bromus* sp.	Localised infestation
G	Thistle	*Carthamus* sp.	Localised infestation
H	Nettle-leaf Goosefoot	*Chenopodium murale*	Localised infestation
I	Spear Thistle	*Cirsium vulgare*	Sparse presence amongst mix of herbaceous and grass weeds
J	Fleabane	*Conyza bonariensis*	Sparse presence amongst mix of herbaceous and grass weeds
K	Panic Veldtgrass	*Ehrharta erecta*	Sparse to heavy presence amongst mix of herbaceous and grass weeds
L	Catsear	*Hypochaeris radicata*	Sparse presence amongst mix of herbaceous and grass weeds
M		*Lepidium* sp.	Sparse presence amongst mix of herbaceous and grass weeds
N	Large-leaved Privet	*Ligustrum lucidium*	Localised infestation
O	Small-leaved privet	*Ligustrum*	Localised infestation
P	African Boxthorn	*Lycium ferociss-imum*	Localised infestation
Q	Red-flowered Mallow	*Modiola caroliniana*	Localised infestation
R	African Olive	*Olea europaea* subsp. *cuspidata*	Localised infestation
S		*Oxalis* sp.	Sparse presence amongst mix of herbaceous and grass weeds
T	Paspalum	*Paspalum dilatatum*	Sparse presence amongst mix of herbaceous and grass weeds

Weed	Common name of target weed	Scientific name of target weed	Description of infestation (e.g. intensity (% cover) & location within zone
U	Kikuyu	*Penniselum clandes-tinum*	Sparse presence amongst mix of herbaceous and grass weeds
V	Plantain	*Plantago lanceolota*	Sparse presence amongst mix of herbaceous and grass weeds
W		*Richardia* sp.	Sparse presence amongst mix of herbaceous and grass weeds
X	Blackberry	*Rubus fruticosus sp. aggregate*	Localised infestation
Y	Fireweed	*Senecio Madagascar-iensis*	Sparse presence amongst mix of herbaceous and grass weeds
Z		*Setaria parviflora*	Sparse presence amongst mix of herbaceous and grass weeds
AA	Paddy's Lucerne	*Sida rhombifolia*	Sparse presence amongst mix of herbaceous and grass weeds
AB	Blackberry Nightshade	*Solanum nigrum*	Sparse presence amongst mix of herbaceous and grass weeds
AC		*Solanum* sp.	Sparse presence amongst mix of herbaceous and grass weeds
AD		*Sonchus* sp.	Sparse presence amongst mix of herbaceous and grass weeds
AE	Chickweed	*Stellaria* sp.	Sparse presence amongst mix of herbaceous and grass weeds
AF	Unidentified exotic grass		Localised infestation
AG	Purpletop	*Verbena bonariensis*	Sparse presence amongst mix of herbaceous and grass weeds

4.3.1.4 Weed Control Methods

Weed control methods in Table 4-8 are guidelines and can be altered to attain the outcomes required if those conducting the works are experienced natural areas specialists (Bush regenerators).

Table 4-8 Guidelines Weed Control Methods

Weeds	Method of Weed Control	Frequency
Grass and herbaceous weeds in areas to be mass planted	**In areas with no regeneration potential and no existing native vegetation that are to be planted.** Primary Work in areas to be mass planted (e.g. riparian zones) In areas that are dominated by weed pasture grasses: scrape top 50+mm, burn (flame weed or broad-acre), or use herbicide to kill exotic grasses and weeds.	Once (3+ events) to get a pre planting or spray seed
	If existing soil is tested and found to *not be adequate* for native plant growth then: • rip soil pre planting and add required elements or • 50mm of clean topsoil (sandy loam organic mix), • And/or eucalypt leaf mulch (150mm). To be decided by project ecologist with input from soils expert.	Once post treatment of weeds
	Add 100-150mm of leaf forest leaf material (preferable leaf material and not trunk mulch). If mulch this ideally should be aged mulch (6+months), weed seed free, from local source (such as tree removals in the vicinity). NB: areas to be spray seeded may be sprayed with a mulch mix. Determine this prior to ordering mulch.	Once over soil and topped up as needed to get required cover pre planting.
	Plant or plant & spray native seed as per revegetation specs.	Once soil/mulch preparation complete and ideally post 2 weeks to allow any weed growth from / through mulch to be controlled pre planting / seed spraying.
	Maintenance Works – establishment period	At least fortnightly for the first 2 months (during and

Weeds	Method of Weed Control	Frequency
	Minimise herbicide use as far as possible. Hand removal, spot spray or thermal weed	post planting) then monthly for 18 months.
	Maintenance Works – post-establishment period (20 months to 2 yrs). Minimise herbicide use as far as possible. Hand removal, spot spray or thermal weed.	Minimum of 80hrs per ha per month (2 teams of 5 people working 8 hrs per month). Noting more may be required if hot wet weather or unplanned weed incursions occur.
	Maintenance Works on-going. Minimise herbicide use as far as possible. Hand removal, spot spray or thermal weed	Minimum of 56hrs per ha per month (7 people working 8hrs per month) Noting more may be required if hot wet weather or unplanned weed incursions occur.
Herbaceous and Grass weeds outside of areas to be mass planted.	Traditional bush regeneration techniques. In regeneration areas the preferable method is initially to treat with thermal weeder or managed broad-acre burn. If above not possible then traditional bush regeneration techniques. Also experiment with soil disturbance to initiate germination of some species. Minimise the use of herbicide.	Primary Works minimum of 52.5hrs per ha per month (7 people working one 7.5hr day per month). Maintenance works minimum of 37.5hrs per ha per month (5 people working one 7.5hr day per month).
Woody Weeds outside of areas to be mass planted	Stage one has small stands that can be treated by Tritter, mulcher, chainsaw or equivalent. Weeds to be cut and poisoned or completely removed. In areas with native regeneration potential and / or existing native plants near weeds then hand methods (chainsaw and forestry shredder) to be used.	Primary Work of 600hrs (team of 5 x 16 days) expected (5 people 10 days for primary and 6 days for follow up maintenance) during establish phase.

4.4 Works in the waterway

Works within the waterway in keeping with the DPE requirements. Areas proposed for off-setting encroachments in the vegetated riparian zone (VRZ) are included on maps in the Riparian Plan. Works are the retention of the watercourse including demarcation of banks and low-flow pathways, vegetation of banks. In accordance with original Office of Water Guidelines there are areas of stormwater management, crossings, and detention basins. In general, these are within the corridor of the existing waterway. Where they extend into the inner, or outer, riparian zone they have been off set with additional riparian zones.

Activities are in accordance with the DPI Office of Water guidelines, specifically; Riparian Corridor Matrix and *Guidelines for instream works on waterfront land.*

4.5 Bushfire Asset Protection Zones (APZs) and Ecological Burns

While no APZs are required in the riparian areas they will be created on land adjoining these areas. Edge markers will be required to protect the riparian areas from APZ encroachment. In most places the edge is formalised such as a road and no markers are required. Where landscaping or other soft edges interface with the riparian areas there must be permanent markers to denote the edge.

Training is required for on-site management personnel to educate about the riparian areas and edge management. The riparian areas are to be managed by appropriately skilled people (details provided later).

Riparian lands areas must be treated as an environmentally sensitive area to protect vegetation and sensitive fauna. Fencing requirements are in place for the Biobank land and is shown in Figure 4-6. Fencing is not required for the riparian area (providing all cattle have been removed from the area).

4.6 Fencing During works

Access to riparian zones to be limited with key personal such as construction contractors and bush regeneration contractors. The storage or stockpiling of tools or materials will not be permitted in these areas. Temporary fencing is recommended where direct works within 20m of the riparian zone. Fencing and signage is to protect the riparian zones and waterways.

4.7 Signage

Signage should be erected prior to the operational phase of the development to avoid unnecessary impacts on bushland. Signage positions have been suggested in the Biobank agreement. Suggested wording from the agreement:

"The vegetation within bushland is protected. Activities such as firewood collection, bushrock removal, picking of native flowers and dumping of garden waste harm the bushland and are not permitted"

4.8 Sediment Fencing

Sediment and erosion control measures must be compliant with the approved sediment and erosion control plans associated with the development works. Sediment and erosion control measures must ensure that no settlement of sediment or silt is to occur within areas of vegetation to be retained, or within the riparian zone. Detailed plans will form part of the construction documentation.

5 Proposed Revegetation Works

5.1 Location and Size of Planting Area

Riparian areas have a fully structured vegetation. Details will be provided in the Design Detail stage of planning and the updated Riparian Plan

5.2 Riparian Zone Species and Planting

Original vegetation communities of the riparian area and surrounds is detailed in the reports by ELA. Riparian planting will be from the species of the communities that are expected to have grown along the riparian areas. Seed stock is available for many species including from Noorumba Reserve. Table 4-1b provides the recommended species and numbers for planting (and is based on the Naroomba – Mt Gilead Biobank (ID 209).

A list of species that are appropriate for planting in the riparian areas are listed in this Riparian Plan. Minimum diversity of species required in each strata and limits on numbers of some of the more common species is also provided. Seed collection and ordering as soon as practical are the best ways to ensure appropriate locally native plants are available at the time of planting.

Photos below show examples of vegetated riparian corridors from the adjoining lands. Three dominant soil types occur on the site and species selection has been matched to soil types. The following images include existing riparian areas with examples from both soil types.

Figure 5-2 Existing riparian area within Nepean Creek.

5.2.1 Recommended species for revegetation

Species are provided in Section 4 (Table 4-1b planting list include the key species from PCT 1395). This vegetation community has a higher influence of sandy soil which overlaps the underlying shale derived clay. Many of these species have been included in the plant supply table.

The canopy layer is dominated by species including; Forest Red Gum (*Eucalyptus tereticornis),* Grey Gum *(E. punctata)* Ironbark (*E. fibrosa, E. crebra*) and Stringybark (*E. eugenioides E. globoidea*). The mid-storey primarily comprises of Blackthorn (*Bursaria spinosa subsp. Spinosa*) with a mix of Narrow-leaved geebung (*Persoonia linearis*) and White dogwood (*Ozothamnus diosmifolius*). Ground stratum is a mixture of native

grasses including; Kangaroo Grass (*T. triandra*) and Weeping Meadow Grass (*Microlaena stipoides var. stipoides).*

Suggested planting species for areas identified as PCT 849 are listed Table 4-1b planting list. Soils found in PCT849 are derived from underlying shale cap.

Canopy layer in PCT 849 is dominated by Grey Box (*Eucalyptus moluccana*) and Forest Red Gum (*E. tereticornis*) with the mid-storey dominated by Blackthorn (*Bursaria spinosa* subsp. *spinosa*). The ground layer comprises a mixture of native grasses including; Kangaroo Grass (*Triandra australis*) and Weeping Meadow Grass (*Microlaena stipoides* var. *stipoides*).

5.2.2 Natural regeneration, assisted regeneration and planting

Outcomes required are specified in this Riparian Plan while it seeks to retain flexibility with the method(s) chosen. Following are descriptions of the terms used in this part of the plan.

As most of the area is dominated by exotic grasses and has been grazed it is assumed that planting (possibly with direct seeding for grassy understory) will be required to establish the riparian vegetation areas.

Where possible revegetation works will include assisted natural regeneration (including using the thermal weeder to trigger natural regeneration) and then follow up planting, where needed, to achieve the desired density, diversity, and strata.

Natural regeneration

Natural regeneration **i**s possible in areas that adjoin Noorumba Reserve. The removal of African Olive may see the return of native species. Bursaria is likely to return rapidly. Natural regeneration is expected long-term with the established riparian corridors being self-sufficient in seed / propagule production. Additional species could be added to the corridors during the establishment phase. This includes some of the less common plants that could be added once ground weeds are well controlled. Species for planting in the 1st year of the establishment phase will be determined based upon plant / seed / propagule availability.

Assisted regeneration

Assisted regeneration includes the use of thermal weeders – as has been done in Noorumba Reserve and other locations in Western Sydney resulting in an increase in native species diversity and cover and reoccurrences of species that had not been observed for 15+ years.

Planting and direct seeding

Planting will occur in all riparian areas covered by this Riparian Plan.

Direct seeding of native Western Sydney grass and shrub species has been shown to be successful on other projects and it is recommended that it be an option for this project as well.

5.3 Staging - Mitigation and Rehabilitation

Pre-Construction/Pre-Clearing Checklist

Detailed design for the infrastructure and ancillary works associated with the project are yet complete, so information relating to the pre-construction and construction activities with regards to this Riparian Plan are based on advanced concept design information. The current proposal will require significant earthworks and development activities during the construction of the seniors living complex.

Activities to be implemented in the Pre-Construction/Pre-Clearing Phase are outlined in Table 5-1 below.

Table 5-1. Pre-Construction/Pre-Clearing Checklist

Management Measure	Details
1. **Soil and Water Management**	• Plans relating to the management of soil, sedimentation, erosion and water are to be written and implemented as part of the Construction Environment Management Plan associated with the project. • Stormwater detention basins must be planted with locally native, suitable species to prevent accidental spread of exotic species to the riparian zone and vegetated buffer area.
2. **Access Controls**	• Parking, access/egress routes, stockpiles and materials storage areas must be identified and mapped outside the protected vegetation areas.
3. **Biodiversity Protection**	• Areas of native vegetation planned for retention within proximity to works will require appropriate fencing or flagging to delineate from construction zones.
4. **Weed Control**	• Weeds must be managed, to a small degree in areas of earthworks, prior to commencement of works. Weed propagules must be disposed of within the site waste streams.

5.4 Construction/Clearing Phase

Ongoing mitigation measures are necessary throughout the construction phase to protect biodiversity within the site.

5.5 Primary Weed Removal

Low impact bushland regeneration methods will be utilised to meet weed control performance criteria in all areas of remnant native vegetation, to prevent unnecessary impacts to native vegetation and disturbance to soil. Low impact bush regeneration methods include the manual removal of herbaceous weeds and their propagules by hand and with hand tools. All bush regeneration activities requiring the use of chemicals must be performed in accordance with the NSW *Pesticides Act 1999.* Herbicides must not be applied whilst exotic plants are setting seeds. The weed removal program aims to be broad in approach and sustained in application to provide the best possible conditions for natural regeneration and to control

noxious weeds within the site. Weed removal will be performed until the site exhibits 2% or less noxious weed cover and 4% or less general weed cover within all management zones in accordance with the Department of Primary Industries (DPI) and Hills Shire guidelines for vegetation management plans.

No aquatic weeds have been identified on site. The application of herbicides in or near water is pollution as defined in the Clean Waters Act. Some local councils and other weed control operators can apply for annual or short-term pollution licences when required to use herbicides in or near water. Applying for a pollution licence will reduce the risk of incurring a penalty for polluting waters under the *Environmental Offences and Penalties Act 1989*. For further information, read the *Draft licensing guidelines on herbicide use in or near waters (1995)* which outlines the EPA's position on granting pollution control licences for using herbicides in or near waters.

Key Threatening Processes

Weed removal additionally aims to impede key threatening processes (KTP), to fulfil the requirements of the BC Act, the EPBC Act and DPI vegetation management plan guidelines. See Table 5-2 for a list of KTP associated with the proposed development.

Table 5-2 Key Threatening Processes

Key Threatening Process	Act	Details
Invasion and establishment of exotic vines and scramblers	BC	The site contains a diversity of exotic vines and scramblers with Bridal Creeper (*Asparagus asparagoides*) being most notable. Bush regeneration will aim to reduce impacts of exotic vines and scramblers upon native vegetation.
Invasion of native plant communities by exotic perennial grasses	BC	The site contains a diversity of exotic perennial grasses encroaching upon native vegetation. Bush regeneration will aim to reduce impacts of exotic grasses upon native vegetation.
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants	EPBC	*Asparagus* sp. and *Lingustrum* sp. are both examples of plants which were once garden plants that have become noxious weeds. These species were observed to be abundant within the site and significant management focus will be placed upon controlling them.

Although soil borne pathogens have not been identified as a KTP, accidental spread of pathogens can occur during pre-construction, construction and post-construction phase. To prevent the introduction of pathogens, Bushland Hygiene Protocols outlined in Appendix B must be followed. The hydrological conditions of the site may promote the spread of Phytophthora (a group of fungus-like diseases affecting plants) due to its moist soil and proximity to water. It is recommended that Bushland Hygiene Protocols be followed closely.

5.5.1 Weeds of National Significance

Non-native plants have been identified within the subject site that are listed under the Biosecurity Act 2015 and covered by the Biosecurity Regulation 2017. On the Biosecurity Act there are 32 species listed as Weeds of National Significance (WoNS) some species on site are WONS. Species are added from time to time so those managing the area should reference:
http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/index.html

Table 5-3 incudes WONS and some of the High Threat Environmental Weeds.

Table 5-3 Weeds listed on the Biosecurity Act

Scientific Name	Common Name	BS Act	Abundance and Link to more information
Olea europaea subsp. cuspidata	African Olive	WONS	Abundance of African Olive particularly in the Creek-line http://www.environment.gov.au/cgi-bin/biodiversity/invasive/weeds/weeddetails.pl?taxon_id=67712
Asparagus asparagoides Asparagus aethiopicus	Bridal Creeper and Ground Asparagus	WONS	http://www.environment.gov.au/cgi-bin/biodiversity/invasive/weeds/weeddetails.pl?taxon_id=62425 Low density scattered throughout site surveillance and eradication required.
Chrysanthemoides monilifera ssp. *monilifera*	Boneseed	WONS	http://www.environment.gov.au/biodiversity/invasive/weeds/publications/guidelines/wons/c-monilifera-monilifera.html 4 plants seen during the survey and all removed surveillance and eradication required.
Lantana camara	Lantana	WONS	http://www.environment.gov.au/cgi-bin/biodiversity/invasive/weeds/weeddetails.pl?taxon_id=10892 Low density - throughout surveillance and eradication required.
Opuntia sp.	Prickly Pear	WONS	http://www.environment.gov.au/cgi-bin/biodiversity/invasive/weeds/weeddetails.pl?taxon_id=85131 2 plants see – both removed – surveillance and eradication required.
Rubus fruticosus aggregate	Blackberry	WONS	http://www.environment.gov.au/cgi-bin/biodiversity/invasive/weeds/weeddetails.pl?taxon_id=68406 Small patches surveillance and eradication required.

Management of some of the WONS can be found at this link:
http://www.environment.gov.au/biodiversity/invasive/weeds/publications/index.html#wons

5.5.2 High Threat Weeds

High Threat Weeds are as listed in BAM (2017) and references J; Oliver, I; Wall, J *Consensus when experts disagree: A priority list of invasive alien plant species that reduce ecological restoration success Management of Biological Invasions*. The full list (currently 198 species) can be found at: https://www.lmbc.nsw.gov.au/bamcalc

Table 5-4 High Threat Weeds

Scientific Name	Common Name	BS Act	Abundance and Link to more information
Olea europaea subsp. cuspidata	African Olive		
Bryophyllum sp.	Mother of Millions	High Threat Env Weed	Surveillance and eradication required.
Ligustrum lucidum	Broad-leaf Privet	High Threat Env Weed	Plants on-site can be suppressed to no more than 10% over five years with a reduction of at least 20% per year for current levels. The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread.
Ligustrum sinense	Small-leaf Privet	High Threat Env Weed	Plants on-site can be suppressed to no more than 10% over five years with a reduction of at least 20% per year for current levels. The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread.
Senecio madagascariensis	Fireweed	High Threat Env Weed	The plant must not be sold, propagated or knowingly distributed. The 7 seen were pulled out Surveillance and suppression required.

5.5.3 Weed Removal Methods

As part of this Riparian Plan, weed removal methods have been provided tailored specifically to the site. Along with traditional bush regeneration techniques, flame (thermal) weeding has been recommended in controlling non-seeding annuals and grasses. Thermal weeding may stimulate natural regeneration and germinate of native species as well as achieving ecological burns. See Table 5-5 below.

Table 5-5 Weed Removal Methods

Weed type	Primary control treatment	Follow-up control	Maintenance weeding post-planting (revegetation)	Disposal
Woody weeds (e.g. shrubs and trees)	Cut/scrape and paint with herbicide for small shrubs[1]. Large trees greater than four metres high and diameter > 10 cm drill and inject with registered herbicide[2].	Retain dead trunks in or on ground has habitat. Continue to Cut/scrape and paint remaining weeds. Monitored monthly and controlled as required (and within a minimum of three months) and up until the date of final plantings.	Cut/scrape and paint germinating weeds. Monitored and carried out regularly for a period of five years from the date of final planting.	Raft and pile non-reproductive parts on site (for later pile burns or left as habitat) and bag flower heads, berries and seeds.
Climbing weeds (e.g. vines and scramblers)	Hand pull/ Dig juvenile growths and bag. Bag seeds, pods and flowers then skirt vines out of the canopy and Scrape and paint for established growths. Scrape from the base up the stem covering 1 m length. Large infestations foliar spray using registered herbicides.	Scrape and paint and bag reproductive parts. Monitored monthly and controlled as required (and within a minimum of three months) and up until the date of final plantings.	Scrape and paint and bag reproductive parts. Monitored and carried out regularly for a period of five years from the date of final planting.	Bag and remove from site.
Herbaceous weeds	Spraying using a combination of non-selective and selective herbicides where damage to adjoining native vegetation can be avoided. Spray herbicide close to	Spray or hand pull seedlings. Monitored monthly and controlled as required (and within a minimum of three months) and up until the date of final plantings.	Spray or hand pull seedlings. Monitored and carried out regularly for a period of five years from the date of final planting.	Bag and remove from site.

Weed type	Primary control treatment	Follow-up control	Maintenance weeding post-planting (revegetation)	Disposal
	and before flowering.			
Exotic grasses and broadleaf annuals around native grasses	Spray prep around natives. Low volume spot spraying of broadleaf selective and non-selective herbicides. Flame (thermal) weed in areas of large infestation of grasses and annuals.	Continue spray prep and spot spraying for re-established growths. Hand pull and bag weeds in amongst natives. Monitored monthly and controlled as required (and within a minimum of three months) and up until the date of final plantings.	Hand weed isolated patches. Monitored and carried out regularly for a period of five years from the date of final planting.	Bag and remove from site.
Weeds and seedlings in close proximity to protected native vegetation	Spray prep around natives and Spot spray. Hand weeding.	Spray prep around natives and Spot spray. Where possible hand weed. Monitored monthly and controlled as required (and within a minimum of three months) and up until the date of final plantings.	Monitored and carried out regularly for a period of five years from the date of final planting.	Bag and remove from site.
Bulbous and succulent weeds	Hand pull/dig, bagging all plant parts and removing from site[3].	Foliar spray and/or Cut and Paint.	Monitored and carried out regularly for a period of five years from the date of final planting.	Bag and remove from site.
Aquatic weeds	Hand dig/pull juvenile plants. Contact your local weed officer if you require a permit to spray near water.	Hand pull.	Monitored and carried out regularly for a period of five years from the date of final planting.	Bag and remove from site.

Note: [1]Some weeds will have different treatment requirements i.e. *Ochna serrulata* requires scrape and paint on one side with stem width less than 2 cm thick, scrape and paint both sides from root to 2/3 up the stem >2 cm thick. *Ligustrum s*pp. and Lantana are treated with cut and paint.

[2] After drill and inject treatment, the plant usually will drop its leaves within six weeks and dies within a few months. Monitor the plant and if it re-sprouts, the process will need to be repeated. Drill around the base of the tree and on exposed lignotubers less than 20mm apart and as deep as possible.

[3] If hand pulling/dig, ensure all reproductive parts of the plant e.g. corms, tubers and rhizomes are removed.

See Appendix A for more details on Bush Regeneration Techniques.

5.5.4 Construction/Clearing Checklist

Activities to be implemented in the Construction/Clearing Phase are outlined in Table 5-6 below.

Table 5-6 Construction/Clearing Checklist

Management Measure	Details
1. Soil and Water Management	• Plans relating to the management of soil, sedimentation, erosion and water are to be implemented as part of the Construction Environment Management Plan associated with the project. • Stormwater detention basins must be planted with locally native, suitable species to prevent accidental spread of exotic species to the riparian zone and vegetated buffer area.
2. Access Controls	• Parking, access/egress routes, stockpiles and materials storage areas must be identified and mapped outside of biodiversity protection exclusion zones.
3. Biodiversity Protection	• Exclusion zone fencing and signage must be maintained and kept in adequate, functional condition throughout the construction phase.
4. Property Boundary and Construction Zone Fencing	• Property boundary and construction zone fencing are to be erected where appropriate.
5. Cumberland Land Snail Habitat	• Large trees, bark and other woody debris removed during the construction phase are to be retained and relocated to appropriate areas of native vegetation (Zones 2,3 and 4), to supplement available habitat for the Cumberland Land Snail.

Management Measure	Details
	This should be performed at the discretion of the project bush regeneration contractors.
6. Clearing and Mulching	• Cleared native vegetation from the development zone or asset protection zones should be mulched and re-used within revegetation or management zones. Mulch may be stockpiled within the site until use, during which weed management and monitoring must occur. Mulch must be free of weeds prior to use. • Woody weeds may be mulched for use within the site if appropriate at the discretion of the project bush regeneration contractors.
7. Seed Collection	• Locally native seed to be collected and processed by experienced bush regeneration contractors in accordance with Florabank Guidelines. Seed collection must be sufficient to allow for a 10-20% replanting rate.
8. Plant Propagation	• Propagation of locally native seed as tubestock by an appropriately experienced horticulturalist in accordance with Florabank Guidelines.
9. Planting	• Planting is advisable in Autumn with Spring planting reserved as a backup. Water / irrigation is important here.
10. Bush regeneration	• Primary weeding is to commence throughout the site to facilitate rehabilitation of native vegetation.
11. Reporting	• Reporting is to occur yearly including the results of quarterly maintenance inspections and whether performance criteria are being met.

5.6 Post-Construction/Post-Clearing Phase

5.6.1 Secondary Weed Removal

Secondary weed removal will occur quarterly, considering the life cycles of targeted weed species, with greater effort required in the warmer months when weed growth will be greater. Secondary weed removal will follow the protocols outlined for primary weed removal (Section 10.2.1), with more of a focus on controlling new weed growth in their early stages to prevent future release of propagules. Secondary weed removal aims to maintain optimal conditions for the regeneration and growth of native plants by reducing

the competitive pressures. Exotic plants typically outcompete native species for soil nutrients and water and can shade out native plants, resulting in fatalities and decreased vigour.

5.6.2 Gross Pollutant Removal

Gross pollutants mat be expected to be transported during high flow rain events. Rubbish must be collected from this area on a quarterly basis, coordinated with bush regeneration activities and disposed of in an appropriate fashion.

5.6.3 Plant Establishment

Planting must be undertaken by an appropriately experienced bush regeneration contractor. Native vegetation plantings within management zone 1 must be performed post-construction once performance criteria are on their way to being met to ensure that plantings do not get outcompeted by exotic flora. Mulch will be required throughout all new planting areas throughout the development zone whilst mulch application in plantings within zone 1 may be left up the discretion of the bush regeneration contractors. Tree guards may be applied as required at the discretion of the bush regeneration contractors.

Plant Replacement

Any plants that fail are to be replaced by another individual of the same species, except for the case that an entire species displays low success rates. In this case, individuals from the same growth form may be substituted.

5.6.4 Watering

Within two hours of planting, each plant will require 10L of watering if the soil profile is moist and 20L of watering if the soil profile is dry. A temporary irrigation system (or watering) is to be established within each planting area for a minimum total duration of 13 weeks to ensure adequate watering of establishing plants and to reduce the risk of plant loss.

5.6.5 Maintenance Inspections

Management inspections will take place to gauge how all management zones are responding to rehabilitation works, and whether they are meeting performance criteria. Maintenance inspections will be performed by comparing the objectives of the project to the maintenance information recorded by the bush regeneration contractors. Maintenance inspections must be performed quarterly during the construction phase, reduced to bi-annually during the post-construction phase if performance criteria are being consistently met.

Quarterly or bi-annual maintenance inspections must include the following items:

- **Weeds:** Weeds must be assessed in terms of total weed cover per management zones with average densities of each species provided and updates to treatment recommendations.
- **Pests and disease:** Regenerating areas within all management zones must be monitored for herbivory by exotic and native fauna and the presence of any other disease or infection. The species being impacted must be recorded in addition to the type of pest or disease, proportion of total individuals being impacted and treatment recommendations.

- **Mulch:** Mulched areas should be maintained to a depth of 75mm. Alterations to mulching requirements may be made at the discretion of the bush regeneration contractors.
- **Sedimentation and Erosion:** Regenerating areas within all management zones must be monitored for erosion and sedimentation, particularly within the riparian zone with actions made if necessary.

5.6.6 Post-planting (6 month) Checklist

Activities to be implemented in the after 6 months are outlined in Table 5-7 below.

Table 5-7 Post-Construction/Post-Clearing Checklist

Management Measure	Details
12. Soil and Water Management	• Soil, sedimentation, erosion and water management strategies implemented in earlier phases are to be retained where appropriate to continue to protect native vegetation zones from additional minor works and impacts arising from site operation.
13. Access Controls	• Parking, access/egress routes, stockpiles and materials storage areas must be identified and mapped outside of biodiversity protection exclusion zones.
14. Biodiversity Protection	• Exclusion zone fencing must be maintained and kept in adequate, functional condition until site operation commences.
15. Boundary and Fencing	• Property boundary and construction zone fencing are to be monitored and maintained.
16. Bush regeneration	• Maintenance weeding is to commence throughout the site to facilitate rehabilitation of native vegetation in accordance with the frequencies defined in Table 2 and 9. • The soil seedbank is to be triggered to encourage natural regeneration in areas of medium to high resilience or where appropriate at the discretion of the bush regeneration contractors.
17. Planting	• Planting is to commence once performance criteria are on track to being met and there is little risk of plantings being outcompeted by exotics.
18. Reporting	• Reporting is to occur yearly including the results of quarterly maintenance inspections and whether performance criteria are being met. Reporting to continue as per the terms of the riparian zones (2yrs)

6 Timeframes

Relevant management and mitigation measures will be provided in the Riparian and Vegetation Implementation and Management Plan.

Parts of this Riparian Plan must be implemented *prior to commencement of any construction activities*.

Riparian Areas must be maintained and monitored for at least two years after *initial implementation of the Riparian Plan*.

Table 6-1 provides a summary of actions implemented with each year of operation of the Riparian Plan . Mitigation measures or other activities have been divided into three broad phases:

- Pre-construction/pre-clearing phase
- Construction phase (waterway in-stream works and surrounds)
- Post-construction phase

Table 6-1 Summary of Mitigation Activities associated with each year of operation of the Riparian Plan

Mitigation Measure	Timing			Frequency	Zone			Responsibility
	Pre-construction	Construction	Post-construction		Riparian zone	Basins	Development Zone	
Fencing of protected vegetation prior to commencement of earthworks, vegetation	✓			Prior to commencement of works and	✓	✓	✓	Construction contractors.

Mitigation Measure	Timing			Frequency	Zone			Responsibility
	Pre-construction	Construction	Post-construction		Riparian zone	Basins	Development Zone	
clearing or other construction activities.				continually maintained.				
Pre-clearing survey to be performed by a suitably qualified ecologist prior to removal of vegetation. Relocation of displaced fauna may be necessary, including that of the Cumberland Land Snail.	✓			Prior to clearing.	✓	✓	✓	Ecologist.
Relocation of fallen logs and bark litter removed during APZ creation to the vegetated buffer of the riparian zone to supplement Cumberland Land Snail habitat. This must be directed by a suitably qualified ecologist.		✓		During or post clearing.	✓	✓		Ecologist.

Mitigation Measure	Timing			Frequency	Zone			Responsibility
	Pre-construction	Construction	Post-construction		Riparian zone	Basins	Development Zone	
Microbats Searches and boxes if needed			✓	After 2 and 5 years	✓			Ecologist.
Surplus woody debris from clearing and asset protection zone activities to be mulched and reused within the site where appropriate.		✓		Throughout all clearing activities.	✓		✓	Bush regeneration contractors.
Protected Plant collection permit from DPE – Schedule 13 of the *National Parks and Wildlife Act 1974*		✓		Once	✓	✓	✓	Bush regeneration contractors.
Collection of native seeds.		✓		Once, at least 12 months prior to planting.	✓			Bush regeneration contractors.

Mitigation Measure	Timing			Frequency	Zone			Responsibility
	Pre-construction	Construction	Post-construction		Riparian zone	Basins	Development Zone	
Seed propagation.		✓		Once for initial planting and then as required for replacement plantings.				Bush regeneration contractors.
Triggering of soil seedbank to encourage natural regeneration in areas of medium to high resilience.		✓		Once, followed up by continual monitoring and weed control.	✓	✓		Bush regeneration contractors.
Collection of local seed 12-18 months prior to commencement of planting		✓	✓	Once	✓	✓		Bush regeneration contractors.
Seed propagation		✓	✓	Once for initial planting and for replacement planting as required		✓		Bush regeneration contractors.
Direct seeding and planting.			✓	Once for initial planting and then as required for	✓	✓	✓	Bush regeneration contractors.

Mitigation Measure	Timing			Frequency	Zone			Responsibility
	Pre-construction	Construction	Post-construction		Riparian zone	Basins	Development Zone	
				replacement plantings.				
Confirmation of the successful supply and installation of local provenance native seed.			✓		✓	✓	✓	Bush regeneration contractors.
Installation of a 75mm layer of mulch to planted areas and/or in cleared areas to suppress weeds.			✓		✓	✓	✓	Bush regeneration contractors.
Implementation of sediment, soil or water management plans as part of the broader Construction Environmental Management Plan.	✓	✓	✓	Applied continually and daily.	✓	✓	✓	Construction contractors.

Mitigation Measure	Timing			Frequency	Zone			Responsibility
	Pre-construction	Construction	Post-construction		Riparian zone	Basins	Development Zone	
Creation of the asset protection zone.		✓	✓	Once, prior to primary weeding	✓	✓	✓	Bush regeneration contractors.
Primary weeding.		✓	✓	Monthly.	✓	✓		Bush regeneration contractors.
Secondary Weeding.		✓	✓	Quarterly.	✓	✓		Bush regeneration contractors.
Weed inspections.		✓	✓	Quarterly.	✓	✓		Ecologist.
Pest and disease monitoring.			✓	Quarterly.	✓	✓		Bush regeneration contractors.
Maintenance weeding.			✓	Quarterly.	✓	✓		Bush regeneration contractors.

Mitigation Measure	Timing			Frequency	Zone			Responsibility
	Pre-construction	Construction	Post-construction		Riparian zone	Basins	Development Zone	
Maintenance watering.			✓	Initially after planting followed by quarterly deep watering.		✓		Bush regeneration contractors.
Replacement plantings.			✓	Approximately 6 months following initial planting	✓	✓	✓	Bush regeneration contractors.
Asset Protection Zone maintenance		✓	✓	Bi-annually. Once during spring and once at another time during the year at discretion of the bush regeneration contractors.	✓	✓	✓	Bush regeneration contractors.
Maintenance inspections.			✓	Quarterly.	✓	✓		Bush regeneration contractors.
Reporting		✓	✓	Yearly throughout the implementation of the VMP and then	✓	✓		Ecologist.

Mitigation Measure	Timing			Frequency	Zone			Responsibility
	Pre-construction	Construction	Post-construction		Riparian zone	Basins	Development Zone	
				every three years in perpetuity.				
Confirmation of completion of key performance indicators.			✓	Once all performance criteria have been met including: Reduction in noxious weed density to 2% or less in all management zones. Reduction in all other weed density to 4% or less in all management zones. Native vegetation displays a diversity of species resembling Coastal Enriched Sandstone Moist Forest with Shale influences.	✓			Ecologist.

Mitigation Measure	Timing			Frequency	Zone			Responsibility
	Pre-construction	Construction	Post-construction		Riparian zone	Basins	Development Zone	
				Evidence of gradual expansion of native plant cover. Appropriate erosion and sediment control throughout the project.				
Development of a bushland management plan as a continual management tool reflecting the aims and objectives of the Riparian Plan.			✓	Post-maintenance certification	✓	✓	✓	Ecologist

7 Costs

The following cost estimates have been based on actual costs of works by bush regeneration companies for areas of similar size. Cost here provide an indication of the costs associated with the bush regeneration aspects of the implementation of the Riparian Plan. This estimate of cost does not include construction related items such as fencing, signage, or the production of mulch in situ. Costs will be refined in the Riparian and VMP implementation Plan that will follow post approval of this document. Table 7-1 provides a detailed breakdown of estimated costs.

Table 7.1 Indicative Cost Estimate Breakdown

Item	Proposed Activity	Activity Details	Unit	Number of Units	$ per unit	$ sub-total excl. Gst
Pre-Planting Weed Removal						
1.	Riparian Planting Preparation: Primary bush regeneration weeding sweep through areas of high woody weed density and areas of herbaceous weeds. Price includes the supply and installation of 75mm layer of mulch to facilitate the establishment of plantings and to suppress weeds.	Cutting and painting of small to medium woody weeds, drilling and injecting large woody weeds. Scraping and painting of exotic climbing weeds. Hand weeding around native plants. The application of selective and non-selective herbicides to herbaceous weeds in areas where native plants will not be impacted.	m^2	xxx	2	Weeding = $xxx Mulch = $xxx
Planting and Assisted Regeneration						

Item	Proposed Activity	Activity Details	Unit	Number of Units	$ per unit	$ sub-total excl. Gst
2.	Riparian Planting - Collection and management of locally collected seed to produce 102,775 plants for use in revegetation and landscape planting.	Tube stock required for riparian zone revegetation. Planting densities within riparian areas are five plants per m^2.	Plant	xxx	0.10	$xxx
3.	Supply and installation of tubestock.	Cost per unit includes the supply, planting, Planting densities have been calculated at; six plants per m^2 in the riparian zones Establishment watering and supply of water retention crystals are not included but will need to be in final call for tender.	Tubestock	xxx	1.95	$xxx
4.	Supply, installation and decommissioning of temporary irrigation system post planting.	Temporary irrigation will be utilised for 26 weeks to maximise survival rates of plantings.	m^2	xxx	1.50	$xxx
Planting Maintenance						
5.	Replacement plantings lost during establishment period	Cost per unit includes the supply, planting and establishment watering.	Tubestock	xxx	1.95	xxx

Item	Proposed Activity	Activity Details	Unit	Number of Units	$ per unit	$ sub-total excl. Gst
	(expected to be up to 10% of total plants).					
Riparian Maintenance outside Biobank						
6.	Year one- Maintenance of riparian zones for a period of 24 months following the completion of primary weeding. Maintenance hours will increase throughout the warmer months.	This includes the maintenance of riparian zones areas = outside	m^2	xxx	3.1	$xxx per year = $xx24mths
7.	Year two- Maintenance of riparian zones for a period of 24 months following the completion Year one riparian maintenance. Maintenance hours will increase throughout the warmer months.	This includes the maintenance of riparian zones	m^2	xxx	2.2	$xx per year = $xxx mths
Subtotal of Two Years Riparian Maintenance						$xxx

Year 1 Maintenance and Reporting						
8.	Quarterly maintenance inspections	Inspections, monitoring and reporting.	hours	8	225	$1800
9.	Quarterly Reporting	Inspections, monitoring and reporting.	hours	8	225	$1800
Year 2 Maintenance and Reporting						
10.	Quarterly maintenance inspections	Inspections, monitoring and reporting.	hours	8	225	$1800
11.	Quarterly Reporting	Inspections, monitoring and reporting.	hours	8	225	$1800
Year 3 Maintenance and Reporting						
12.	Quarterly maintenance inspections	Inspections, monitoring and reporting.	hours	8	225	$1800
13.	Quarterly Reporting	Inspections, monitoring and reporting.	hours	8	225	$1800
Year 4 Maintenance and Reporting						
14.	Quarterly maintenance inspections	Inspections, monitoring and reporting.	hours	8	225	$1800
15.	Quarterly Reporting	Inspections, monitoring and reporting.	hours	8	225	$1800

Year 5 Maintenance and Reporting						
16.	Quarterly maintenance inspections.	Inspections, monitoring and reporting.	hours	8	225	$1800
17.	Quarterly Reporting	Inspections, monitoring and reporting.	hours	8	225	$1800
18.	Confirmation of completion of key performance indicators.	Inspections, monitoring and reporting.	hours	8	225	$1800

8 Maintenance

8.1 Annual Maintenance Schedule

As part of the final Riparian Plan, an annual maintenance schedule will be provided and tailored specifically to the site. See Table 8-1.

Table 8-1 Annual Maintenance Schedule

Maintenance Task	Frequency	Responsibility
1. Secondary Weed Control	Quarterly, performed with respect to weed life cycles.	Bush Regeneration Contractor
2. Weed Inspections	Quarterly	Ecologist
3. Riparian Zone Rubbish Removal	Quarterly	Bush Regeneration Contractor
4. Condition and Adequacy Assessment of Erosion and Sediment controls	Quarterly, or after extremely heavy rain	Bush Regeneration Contractor
5.		
6.		

8.2 Weed Management

Methods of weed control are summarised in Table 8-2.

Table 8-2 Methods of weed control

Management zone/s	Weeds	Method of weed control	Frequency
Revegetation zone	Grass weeds	Primary treatment: Spot-spray with a non-selective herbicide and hand removal. Maintenance: Spot-spray and hand removal as required.	Years 1-5: Throughout the year, but work, especially spraying, should be focused between September and February. Years 6-9: Minimum of two treatments, October and February. Additionally, treatment of small areas can take place throughout the year to coincide with planting events specified in Item 6. Years 10 and beyond: Throughout the year. Spraying during growing season, approximately September to February.
Revegetation zone	Herb-aceous weeds	Primary treatment: Spot-spray with a non-selective herbicide and hand removal. Secondary treatment: Spot-spray as required. Maintenance: Spot-spray and hand removal as required.	Years 1-5: Throughout the year, but work, especially spraying, should be focused between September and February. Years 6-9: Throughout the year. Additionally, treatment of small areas can take place throughout the year to coincide with planting events specified in Item 6. Years 10 and beyond: Throughout the year. Spraying during growing season, approximately September to February.
Revegetation zone	Woody weeds	Primary treatment: cut and paint. Secondary treatment: cut and paint, spot spray, as required. Maintenance: Spot-spray and hand removal, as required.	Years 1-5: Throughout the year, but work, especially spraying, should be focused between September and February. Years 6-9: Throughout the year. Additionally, treatment of small areas can take place throughout the year to coincide with planting events specified in Item 6. Years 10 and beyond: Throughout the year. Spraying during growing season, approximately September to February.

9 Monitoring

Table 9-1 Monitoring and inspections of existing and new weeds

Management zone/s	Weeds	Method of monitoring	Dates required
Revegetation zone	Grass weeds (including: Kikuyu, Panic Veldgrass, Paspalum, Pigeon Grass, and Brome)	Weeds reduced to maintenance levels over 90% of site. Weeds reduced to less than 10% cover.	By end of Year 5. By end of Year 9 and ongoing.
Revegetation zone	Herbaceous weeds (including: Cobbler's Peg, Thistle, Fleabane, Fireweed, Paddy's Lucerne and Purpletop)	Weeds reduced to maintenance levels over 90% of site. Weeds reduced to less than 10% cover.	By end of Year 5. By end of Year 9 and ongoing.
Other weed management activities (where required)			
Unless otherwise specified, all herbicide used should be a non-specific herbicide formulated for use around water (e.g. Roundup Biactive®).			
All plot markers are to be maintained in the same position if noted to have been damaged or disturbed during or by undertaking any weed management, they must be replaced.			

10 Reporting

Monitoring must be performed by a suitably experienced ecologist on an annual basis, in consultation and collaboration with the project bush regeneration contractor. Reporting must be performed in association with maintenance inspections to form the primary source of information for monitoring and review reports. Monitoring must occur quarterly during the construction phase and bi-annually in the post-construction phase if adequate progress towards performance criteria is achieved. A primary goal of monitoring and reporting will be to provide recommendations to improve compliance with performance criteria to be incorporated into forthcoming management strategies.

10.1 Performance Criteria

The following performance criteria must be met to affirm the successful implementation of the Riparian Plan:

- For any replanting activities, plant stock must be certified to have been collected from local provenance sources.
- Noxious weed density must be reduced to 10% or less across the total area of each management zone.
- Non-noxious weed density must be reduced gradually to 4% or less across the total area of each management zone.
- The native plant diversity of remnant vegetation must resemble the PCTs.
- Bush regeneration activities must facilitate the natural regeneration and gradual extension of native plant cover throughout each management zone containing native vegetation.
- Appropriate management of erosion and sedimentation within construction areas such that native biodiversity is protected.

Table 10-1 monitoring template based on photo monitoring points.

Monitoring Points	Date	Observations and assessment of monitoring This table must include the information for each point (or groups of zones) which is described in the table titled 'monitoring and inspections of existing and new weeds'.

Photo monitoring

Photographs will be taken at photo-points at each of the locations and in the direction identified in the table below titled 'Location of photo points' within 2 months of the commencement date and then at least every 6 months thereafter.

The photo points are to be established prior to the implementation of the Riparian Plan. The purpose of the photographs is to show changes over time. Photographs should be taken at approximately the same direction, location, height and time of day (during daylight hours) in each reporting period and retained for

the life of this agreement. All photographs must be dated, stating the direction in which they were taken and identified with their location.

Photo monitoring must occur throughout the riparian area to provide evidence of compliance (or non-compliance) with the supplied performance criteria. Preliminary photo points have not been included, however, final photo points may be altered closer to the date of commencement of works.

Table 10-2 location of PMP - template

Projected coordinate system: GDA94 MGA Zone 56			
Photo point reference	East	Northing	Direction of photo (magnetic degrees)

Table 10-3 Photo Monitoring Assessment Sheet

Point	**Management Zone**	**GPS Coordinates (x, y)**	**Picture**
1	1		

Figure 5. Preliminary Photo Monitoring Points

This Figure will be created in the next and final stage of the implementation plan.

10.1.1 Measurables

- Weed cover at the end of 5 years is to be <5% within the forested area (place with canopy cover and no weeds listed on the Biosecurity Act as High Threat Weeds.
- Company Contracted to provide a plan to show how this will be achieved.
- APZ is to have a cover of native plants in all stratum at levels in compliance with APZ requirements.
- Cumberland Land Snail habitat to be retained and improved.

10.2 Long-term Bushland Management Plan

The maintenance period will be concluded once at least five years of maintenance has occurred in which time all performance criteria have been met. At this time, a long-term bushland management plan must be developed to manage all areas of vegetation within the site in accordance with the aims and objectives of this Riparian Plan. The long-term management plan must be developed by an appropriately qualified and experienced ecologist

11 Roles and Responsibilities

Due to the highly technical nature of restoration works, on-ground works and reporting must be performed by contractors and/or consultants external to the proponent and construction contractors. The broader management and implementation of the Riparian Plan must be performed by an appropriately experienced and qualified ecologist reporting the project managers of the works. On-ground restoration works must be performed by an appropriately experienced and qualified Bush Regeneration contractor with sufficient capacity to undertake the works (see Table 11-1 below).

Table 11-1 Roles and Responsibilities

Role	Responsibility
Lendlease	• Integration of Riparian Plan conditions relating to construction and clearing activities with the broad goal of ensuring that native biodiversity is protected and enhanced throughout the various phases of the project and during the post-maintenance period.
Construction Contractor	• Compliance with the conditions described in the Riparian Plan.
Bush Regeneration Contractor	• Performance of the on-ground works described in the Riparian Plan. • Confirmation of supply and installation of local provenance native seed. • Maintenance inspections in collaboration with the project Ecologist. • Achieving performance criteria outlined in the Riparian Plan. • Management of pests and disease, potentially in collaboration with pest management contractors if required. • Providing technical advice and recommendations to improve compliance with performance criteria to be incorporated into forthcoming management strategies.
Ecologist	• Managing the implementation of the broad aspects of the Riparian Plan. • Maintenance inspections in collaboration with the bush regeneration contractors. • Production of reports following monitoring inspections. • Providing technical advice and recommendations to improve compliance with performance criteria to be incorporated into forthcoming management strategies. • Confirmation of completion of the maintenance period of the project once all performance criteria have been met.

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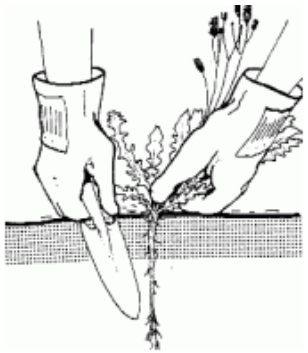
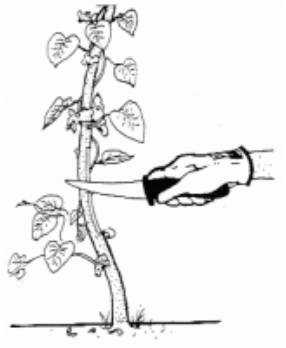
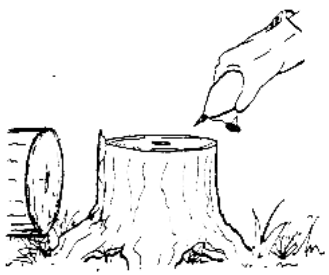
12 Appendices

APPENDIX A

Bush Regeneration Techniques

Item	Method	Technique	Equipment
1	**Hand Removal** 	Seedlings and smaller weed species where appropriate will be pulled out by hand, without risk of injury to workers. The size that this can occur varies throughout the treatment area. Generally, it ranges from post seed to approximately 300mm in height. Rolling and raking is suitable for larger infestations of Wandering Jew. The weed can be raked and stems and plants parts rolled. The clump of weed material can then be bagged and removed from site.	Tools: Gloves, Rakes, Knife and Weed Bags
2	**Crowning** 	Plants that possess rhizomes or bulbs might not respond to various removal techniques and may need to be treated with crowning. A knife, mattock or trowel is to be driven into the soil surrounding the bulb or rhizome at an angle of approximately 45 degrees with surrounding soil, so as to cut any roots that may be running off. This is occur in 360 degrees around the bulb/rhizome. The rhizome or bulb is to be bagged and removed from the site and disposed of at an appropriate waste recycling facility Soil disturbance is to be kept to a minimum when using this technique.	Tools: Knife, mattock, trowel, impervious gloves, and all other required P.P.E.
3	**Cut and Paint Stems**	Weed species deemed unsuitable for hand removal shall be cut. Those that have persistent of vigorous growth will be cut and painted with Roundup® Biactive Herbicide or equivalent.	Tools: loppers, secateurs, pruning saw, herbicide applicator/sprayer, impervious

		Juvenile and smaller weed species will be cut with secateurs at base of plant, and herbicide applied via applicator bottle. Stem to be cut horizontally as close to the ground as possible, using secateurs, loppers or a pruning saw. Horizontal cuts to be made on top of stem to prevent the herbicide running off the stump. Apply herbicide to the cut stem immediately, within 10-20 seconds, before the plant cells close and the translocation of the herbicide is limited. Herbicide is not to reach sediment, or surrounding non-targeting plants.	gloves, Roundup® Biactive Herbicide and all other required P.P.E.
4	**Scrape and Painting** 	More resilient weed species, where other techniques are less reliable are to be scraped with a knife or chisel and poisoned with appropriate Herbicide. Works to be carried out by a contractor with a current herbicide license. Weed species will be scraped with a knife or chisel up the length of the trunk, and herbicide applied via applicator bottle. Scrape the trunk from as close to the ground as possible to approximately ¾ of the plants height. Where trunk diameters exceed approximately 5 cm a second scrape shall be made on the other side of the trunk. Apply undiluted herbicide to the cut trunk immediately, within 10-20 seconds, before the plant cells close and the translocation of the herbicide is limited. All care must be taken by the contractor not to spill herbicide onto sediment, or surrounding non-targeting plants. Follow up treatment may be required. If plants re-sprout, scrape and paint the shoots using the same method after sufficient regrowth has occurred.	Tools: knife, chisel, protective clothing, safety glasses herbicide applicator/sprayer, impervious gloves, Roundup® Biactive Herbicide, and all other required P.P.E.
5	**Cut with a Chainsaw and Paint** 	Larger size weed species, too large for cutting with hand tools, shall be cut with a chainsaw and painted with undiluted with appropriate Herbicide. Works to be carried out by a contractor with a current chainsaw and herbicide license. Larger weed species will be cut with a chainsaw at base of plant, and herbicide applied via applicator bottle. Cut the stem horizontally as close to the ground as possible, using the chainsaw. Remove upper branches to reduce bulk of plant. If cutting at the base is impractical, cut higher to get rid of the bulk of the weed, then cut again at the base and apply herbicide. Make cuts horizontal to prevent the herbicide running off the stump. Apply	Tools: chainsaw, ear muffs, protective clothing, safety glasses herbicide applicator/sprayer, impervious gloves, Roundup® Biactive Herbicide, and all other required P.P.E.

		undiluted herbicide to the cut trunk immediately, within 10-20 seconds, before the plant cells close and the translocation of the herbicide is limited. Ensure there is no runoff of poison. All care must be taken by the contractor not to spill herbicide into water, onto sediment, or surrounding non-targeting plants. Follow up treatment will be required. If plants resprout, cut and paint the shoots using the same method after sufficient regrowth has occurred.	
6	**Spot Spraying** 	Spot spraying involves spraying non-seeding annuals and grasses, and for regrowth of weeds once an area has been cleared or brushcut. Works to be carried out by a contractor with a current herbicide license. Herbicide will be mixed up according to the manufacturer's directions for the particular weed species being targeted. Mixed herbicide shall be applied to the targeted weed species with a backpack sprayer. All care must be taken by the contractor not to spill herbicide onto sediment, or surrounding non-targeting plants.	Tools: protective clothing, safety glasses, herbicide sprayer, impervious gloves, Herbicide, and all other required P.P.E.
7	**Flame (Thermal) Weeding** 	Flame weeding involves burning non-seeding annual and grasses, and for regrowth of weeds once an area has been cleared or brushcut. Works to be carried out by a contractor. The contractor must contact the local fire burgage before commencement of flame weeding. Needs a minimum of three people. One person using the flame thrower, and two people with backpack sprayers with water (10L). Weeds that have been successfully controlled using this technique include Bidens, Mother of Millions, and aquatic weeds such as Alligator weed.	Tools: protective clothing, safety glasses, flame thrower, heat tolerant gloves, gas bottle, backpack sprayer full of water and all other required P.P.E.

APPENDIX B

Bushland Hygiene Protocols for Phytophthora

- Always assume that the area you are about to work in is free of the disease and therefore needs to be protected against infection.
- Always assume that the activity you are about to undertake has the potential to introduce the disease.
- Arrive at site with clean shoes, i.e.: no dirt encrusted on them.
- If you arrive with shoes that are encrusted with dirt, they will have to be completely soaked in metho or disinfectant and allow a few minutes to completely soak in. NEVER scrape untreated dirt off your shoes onto the ground.
- Before you move onto the site spray the bottom of your shoes with 70 % metho. Bleach solution (1% strength) or household/commercial disinfectant (as per label) are also suitable.
- Check all tools and equipment that comes in contact with soil are clean before entering the area (they should have been cleaned on site at the end of the previous work session). If there is any dirt on them, spray them with 70% metho.
- Clean all tools at the end of each work session while still on site ensuring this is done away from drainage lines and adjacent work areas. Knock or brush off encrusted dirt and completely spray with 70 % metho. Replace in storage/transport containers.
- Preferably compost all weed material on site.
- Never drag vegetation with exposed roots and soil through bushland.
- When removing weeds from site, remove as much soil as possible from them in the immediate work area and carefully place vegetative material into plastic bags.
- Try not to get the bag itself dirty; don’t put it on/in a muddy area.
- Always work from the lower part of a slope to the upper part.
- Always work in areas known to be free of the pathogen before working in infected areas.
- Minimise activities wherever possible when the soil is very wet.
- Vehicles should not be driven off track or into reserves (unless vehicle decontamination is carried out before and after entering a single work site).
- Only accredited supplies of plants/mulch to be used.
- Kit should contain: 1 bucket, 1 scrubbing brush, 1 spray bottle (metho 70% solution), 1 bottle tap water, 1 bottle methylated spirits.

Facts about Phytophthora

Phytophthora cinnamomi (Phytophthora) is a microscopic, soil borne, water-mould that has been implicated in the death of remnant trees and other plants in Australian bushland. Phytophthora is not native to Australia. It is believed to have been introduced sometime after European settlement. Phytophthora is a national problem and is listed as a key threatening process under the Commonwealth's Environmental Protection and Biodiversity Conservation Act 1999.

Symptoms including Dieback

"Dieback" simply means dying or dead plants. There are many causes of dieback; Phytophthora is just one of them. Often dieback is the result of a combination of factors such as; changed drainage patterns and nutrient loads (e.g.: increased stormwater run-off) or changed soil conditions (e.g.: dumped fill or excavation of/near root zone). Plants that are stressed are more vulnerable to Phytophthora. Initial symptoms of Phytophthora include; wilting, yellowing and retention of dried foliage, loss of canopy and dieback. Infected roots blacken and rot and are therefore unable to take-up water and nutrients. Severely infected plants will eventually die. Symptoms can be more obvious in summer when plants may be stressed by drought. If you suspect that Phytophthora is on your site, please contact the Bushcare team to collect a soil sample to be lab tested. This is usually done in the warmer months where conditions are optimum for the disease.

Infection

There is no way of visually telling if Phytophthora is present in the soil as its structures and spores are microscopic (invisible to the naked eye). Phytophthora requires moist soil conditions and warm temperatures for infection, growth and reproduction. Spores travel through moist soil and attach to plant roots. Once Phytophthora has infected a host plant it can grow inside plant root tissue independent of external soil moisture conditions. After infection, Phytophthora grows through the root destroying the tissue which is then unable to absorb water and nutrients.

Author

With over 25 years wetland and urban ecology, experience, a great passion for what she does, and extensive technical and on-ground knowledge make Geraldene a valuable contribution to any project.

Geraldene has over 8 years local government experience as manager of environment and education for Pittwater Council. Geraldene presented papers on the topic at the NSW Coastal Conference, Sydney CMA and Hawkesbury Nepean forums. Geraldene is a Technical Advisor Sydney Olympic Park Wetland Education and Training (WET) panel.

Geraldene has up to date knowledge of environmental policies and frequently provides input to such works. Geraldene was a key contributor to the recent set of Guidelines commissioned by South East Queensland Healthy Waterways Water Sensitive Urban Design Guidelines. Geraldene's role included significant contributions and review of the Guideline for Maintaining WSUD Assets and the Guideline for Rectifying WSUD Assets.

Geraldene is a frequent contributor to many community and professional workshops on ecological matters particularly relating to environmental management. She is an excellent Project Manager.

Geraldene is a joint author on the popular book Burnum Burnum's Wildthings published by Sainty and Associates. Author of the Saltmarsh Restoration Chapter Estuary Plants of East Coast Australia published by Sainty and Associates (2013). Geraldene's early work included 5 years with Wetland Expert Geoff Sainty of Sainty and Associates. Geraldene is an expert in creating and enhancing urban biodiversity habitat and linking People with Place.

Geraldene Dalby-Ball
DIRECTOR

SPECIALISATIONS

- Urban Ecology – and habitat rehabilitation and re-creation.
- Urban waterway management – assessing, designing and supervising rehabilitation works
- Saltmarsh and Wetland re-creation and restoration – assessment, design and monitoring
- Engaging others in the area of environmental care and connection
- Technical Advisor – environmental design, guidelines and policies
- Sound knowledge and practical application of experimental design and statistics
- Project management and supervision
- Grant writing and grant assessment
- Budget estimates and tender selection
- Expert witness in the Land and Environment Court

CAREER SUMMARY

- **Director and Ecologist**, Ecological Consultants Australia. 2014-*present*
- **Director and Ecologist**, Dragonfly Environmental. 1998-*present*
- **Manager** Natural Resources and Education, Pittwater Council 2002-2010
- **Wetland Ecologist** Sainty and Associates 1995-2002

QUALIFICATIONS AND MEMBERSHIPS

- **Bachelor of Science with 1st Class Honors**, Sydney University
- WorkCover WHS General Induction of Construction Industry NSW White Card.
- Senior First Aid Certificate.
- **Practicing member** Ecological Consultants Association of NSW
- **Accredited Biobank Assessor**