Pondicherry Precinct Rezoning: Riparian Assessment

Department of Planning Industry and Environment

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Executive Summary

Eco Logical Australia Pty Ltd (ELA) was engaged by GDC 2 on behalf of DPIE to undertake a Riparian Assessment for the rezoning of the Pondicherry Precinct. The aim of this report is to identify key riparian constraints of the site and an assessment of the Indicative Layout Plan (ILP).

ELA field-validated the watercourses and riparian zones over multiple stages, most recently in July 2020. The majority of watercourses did not have defined bed or banks, and represent overland flow paths rather than 'rivers' as defined under the *Water Management Act 2000*. Three higher order streams had a distinctive channel bed, banks and aquatic habitat, with large online farm dams dominating the riverscape. The riparian vegetation varied in quality, with the majority of the site cleared and pastured. Habitat along the three higher order streams was classified as Cumberland riverflat forest (PCT 835), with a native canopy, weedy midstorey and sparse groundcover.

Two existing large online dams provide 46 ha of poor aquatic habitat on the site. The dams provided habitat in the form of with sparse macrophytes, degraded banks due to cattle trampling and turbid water. Previous consultation with the NSW Natural Resource Access Regulator (NRAR) revolved around a concept to retain large on-line waterbodies as a feature of the development. Extensive analysis of options was undertaken and presented to NRAR. The assessment presented to the NRAR concluded that the lake option is best placed to achieve the principles of ecological sustainable development and deliver the optimum social, economic and environmental outcome which is compliant with the Objects and Principles of the *Water Management Act 2000*. The ILP has adopted the preferred option of converting the existing farm dam to a lake precinct.

The ILP offers aquatic and riparian values across a mix of land use zones. The outcome of creating a lake and restoring other riparian corridors would ultimately improve the habitat values within the site and across the catchment.

1. Introduction

1.1 Description of Project

The NSW Department of Planning Industry and Environment (DPIE) has identified the Pondicherry Precinct and Oran Park Precinct as priority areas for development within the South West Growth Centre. Greenfields Development Company (GDC), on behalf of DPIE, engaged Eco Logical Australia Pty Ltd (ELA) to prepare a Riparian Assessment for the rezoning and precinct planning of Pondicherry. Specific objectives of this project are to:

- Undertake a Riparian Land Assessment to inform the rezoning and planning process and development of the Indicative Layout Plan.
- Work in collaboration with the water cycle management work, to map riparian corridors using the Strahler stream system and provide recommendations and planning controls for riparian lands.

ELA undertook mapping and preliminary assessments in 2017 and has since reassessed the site, providing updated top of bank mapping and riparian assessment to confirm the current condition of waterways within the precinct. Figure 1 illustrates the location of the study area. The lots that were accessed and validated were:

- Lot B, DP420694
- Lots 4 and 5 DP1223563
- Lot 50, DP1232523
- Lot C, DP391340
- Lot 11, DP1229416
- Lots 500, DP1225924
- Lot 2, DP1217189.

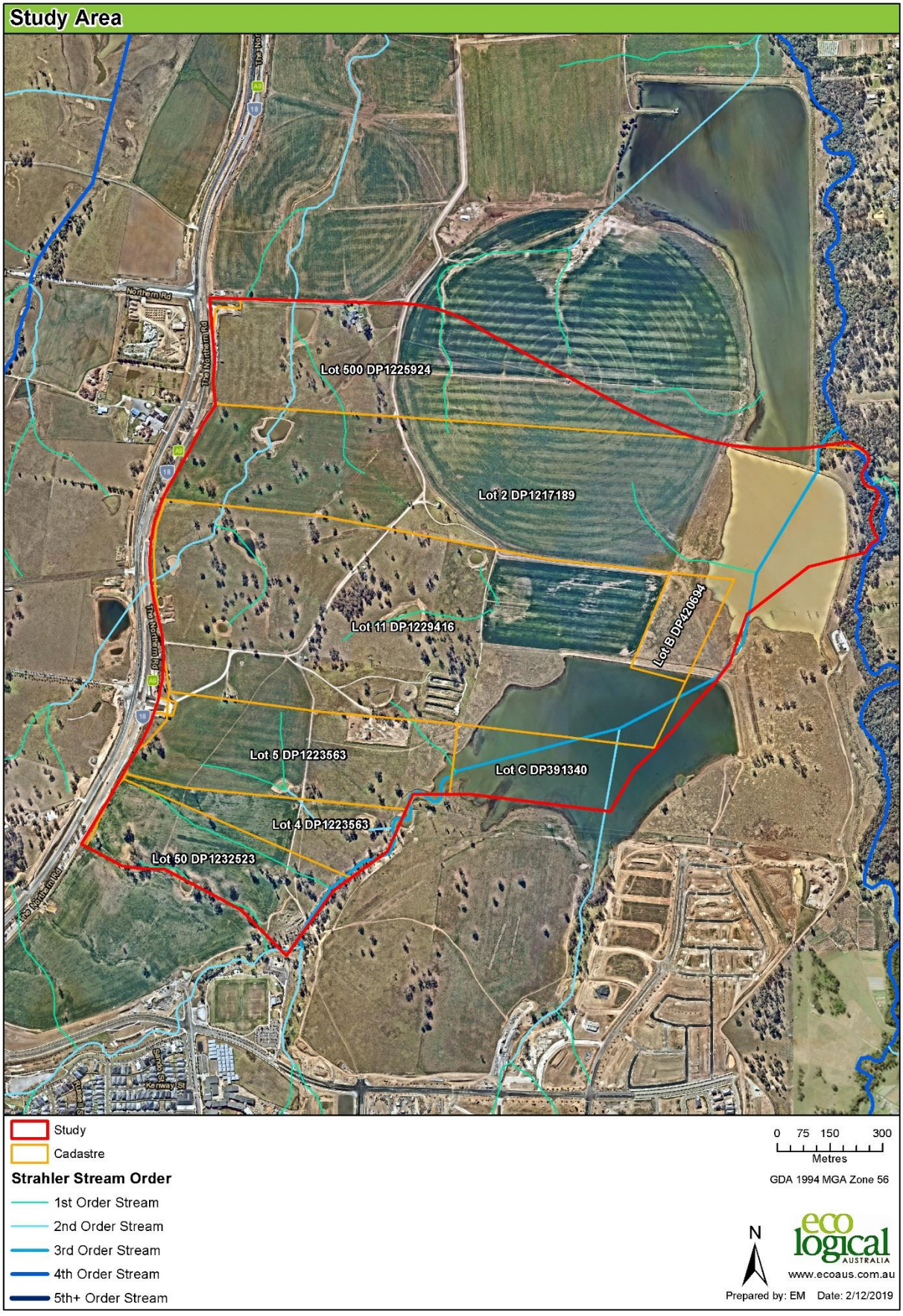

Figure 1: Riparian study area in Pondicherry

2. Statutory Framework

The specific riparian and aquatic regulatory requirements and policies were reviewed to determine their application to the Pondicherry Precinct. These included:

- NSW *Fisheries Management Act 1994* and Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (2013 update) (Fairfull, 2013)
- NSW *Water Management Act 2000* and Guidelines for controlled activities on waterfront land – Riparian corridors (NRAR, 2018)
- NSW Wetlands Management Policy 2010
- Oran Park and Turn Road Waterfront Land Strategy 2009
- Oran Park Precinct – Development Control Plan 2016
- Camden Local Environmental Plan – Local Environmental Plan 2020 (*under review*)
- Sydney Regional Environmental Plan No 20 – Hawkesbury Nepean River (No 2 – 1997)
- Previous relevant studies including
    - Pondicherry Water Cycle Concept – Ecological Considerations (ELA 2020).

2.1 Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) governs the management of fish and their habitat in NSW. The FM Act applies to fish and marine vegetation and requires a separate assessment from the NSW *Biodiversity Conservation Act 2016* (BC Act), which only relates to terrestrial animals and plants. Therefore, if the land is bio-certified under the BC Act, an assessment of fish habitat still needs to be undertaken. The objectives of the FM Act are to conserve fish stocks and key fish habitats, conserve threatened species, populations and ecological communities of fish and marine vegetation and to promote ecologically sustainable development. The FM Act also regulates activities involving dredging and/or reclamation of aquatic habitats, obstruction of fish passage, harming marine vegetation and use of explosives within a waterway.

To assess impacts to aquatic habitats, the regulatory framework of the FM Act and associated guidelines have been applied for this assessment. This allows consistent assessment of habitat presence and quality on site, whilst considering the broader catchment to determine the value of each creek.

A search of the Commonwealth Protected Matters Search tool, OEH BioNet database search and Fisheries Threatened Species distribution maps (Riches et al, 2016) identified three species of fish with the potential to be found within the study area (Table 1). However, there are no records within 5 km of the study area or in major creeks connected to the site (South Creek). As there is lack of suitable habitat and connectivity to other known occurrences of these species, it is unlikely that these species would be found within the study area.

Table 1: Likelihood of occurrence table for aquatic species

Species	FM Act	EPBC Act	Habitat Associations	Records within 5 km	Likelihood of occurrence
Archaeophya adamsi – Adam's Emerald Dragonfly	CE	-	Habitat is narrow, shaded riffle zones with abundant moss and riparian vegetation (often with a closed canopy). Benthic habitat is usually gravel or sand	0	No, no suitable habitat
Macquaria australasica - Macquarie Perch	E	E	Habitat for this species is bottom or mid-water in slow-flowing rivers with deep holes, typically in the upper reaches of forested catchments with intact riparian vegetation. Macquarie Perch also do well in some upper catchment lakes. In some parts of its range, the species is reduced to taking refuge in small pools which persist in midland–upland areas through the drier summer periods.	0	No, no suitable habitat. Nearest modelled occurrence is in Nepean River and Georges River (Riches et al 2016).
Prototroctes maraena - Australian Grayling	E	V	Historically, this species inhabited coastal streams from the Grose River southwards through NSW, VIC and TAS. On the mainland, this species has been recorded from rivers flowing east and south of the main dividing range. This species spends only part of its lifecycle in freshwater, mainly inhabiting clear, gravel-bottomed streams with alternating pools and riffles, and granite outcrops. Grayling migrate between freshwater streams and the ocean and as such, it is generally accepted to be a diadromous species (migratory between fresh and saltwaters).	0	No, no suitable habitat. Nearest modelled occurrence is in the Minnamurra River (Riches et al 2016).

2.2 Oran Park and Turner Road Waterfront Land Strategy 2009

This strategy applies to land identified as Riparian Protection Area (RPA) in the Oran Park and Turner Road Precincts, as defined in the Growth Centres SEPP. The strategy aims to set controls and outcomes for controlled activities on waterfront land in these Precincts. There is a Riparian Protection Area mapped along the southern boundary of the site (Figure 2).

Under clause 39A of the *Water Management (General) Regulation 2004*, development carried out in accordance with this strategy, on land to which this strategy applies, will be exempt from the requirement to obtain a Controlled Activity Approval (CAA) under the *Water Management Act 2000* (WM Act) (Section 2.3). Development in accordance with the strategy is as follows:

- Works within the Core Riparian Zone (CRZ) are limited to environmental protection works, drainage and crossings
- Works within the Vegetated Buffer (VB) are limited to environmental protection works, drainage, water quality features, service utilities, crossings, and passive recreation / open space (up to 40% of VB).

As the strategy is not within the site, the requirements are not strictly applicable to the Pondicherry Precinct but complimentary riparian corridors are proposed in the ILP upstream of the lakes and along South Creek. However, as the proposed lake and connecting residential interface now overlap the RPA in Oran Park, and the creek downstream of the lake is set up to 100 m further north of the RPA (Figure 2), Precinct Plan amendments may be required in the adjoining areas of Oran Park.

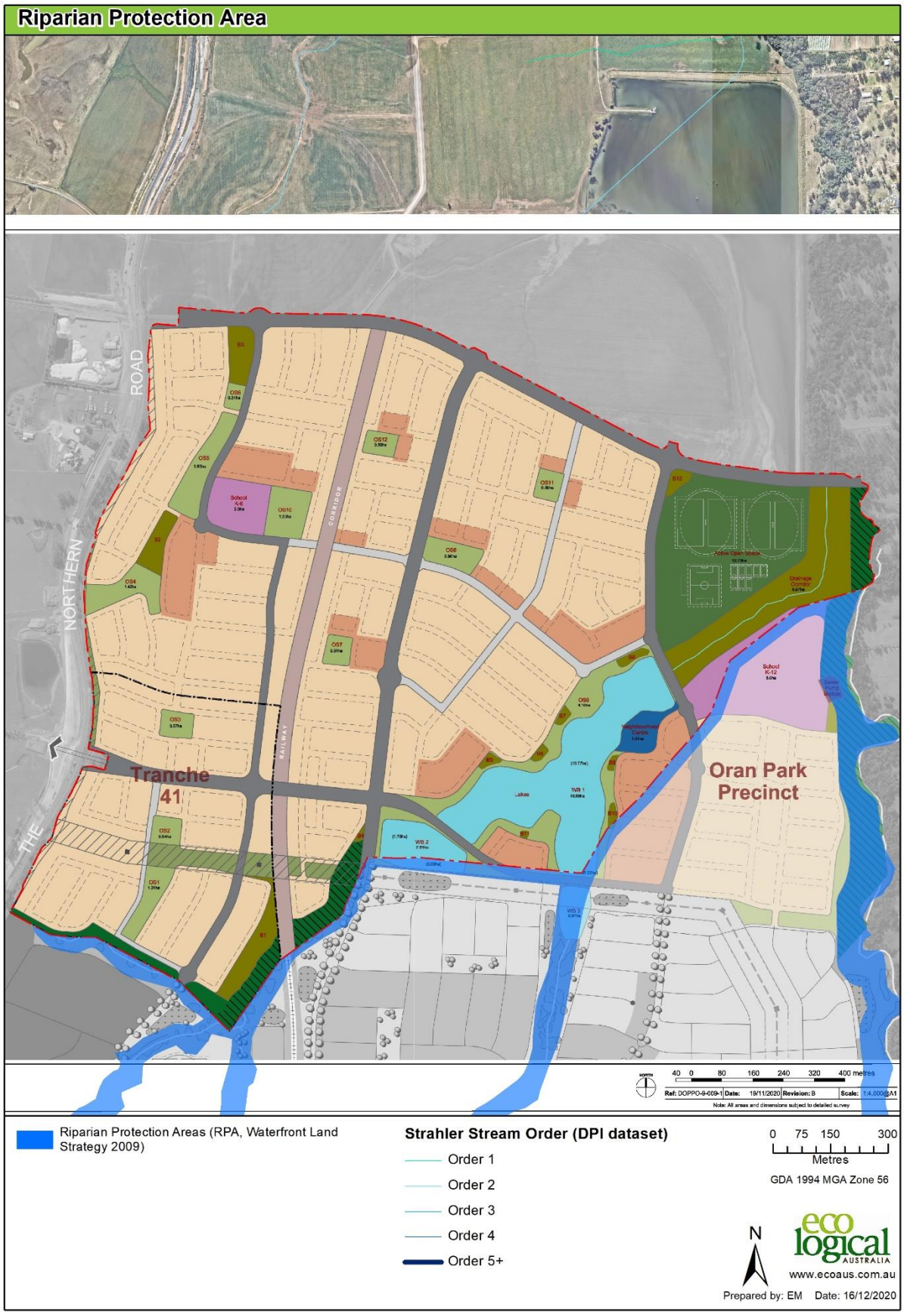

Figure 2: Riparian Protection Area mapped under the Oran Park and Turn Road Waterfront Land Strategy

2.3 Water Management Act 2000

The main objective of the WM Act is to manage NSW water in a sustainable and integrated manner that will benefit current generations without compromising future generations' ability to meet their needs. The WM Act is administered by NRAR and establishes an approval regime for activities within waterfront land, defined as the land 40 m from the highest bank of a river, lake or estuary.

The relevant principles for this development and the scope of this study, as set out section 5 of the WM Act, are as follows.

Generally (1):

a. *water sources, floodplains and dependent ecosystems (including groundwater and wetlands) should be protected and restored and, where possible, land should not be degraded, and*
b. *habitats, animals and plants that benefit from water or are potentially affected by managed activities should be protected and (in the case of habitats) restored, and*
c. *the water quality of all water sources should be protected and, wherever possible, enhanced, and*
d. *the cumulative impacts of water management licences and approvals and other activities on water sources and their dependent ecosystems, should be considered and minimised, and*
e. *geographical and other features of Aboriginal significance should be protected, and*
f. *geographical and other features of major cultural, heritage or spiritual significance should be protected, and*
g. *the social and economic benefits to the community should be maximised, and*
h. *the principles of adaptive management should be applied, which should be responsive to monitoring and improvements in understanding of ecological water requirements.*

In relation to controlled activities (2):

a. *the carrying out of controlled activities must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and*
b. *the impacts of the carrying out of controlled activities on other water users must be avoided or minimised.*

The objects of the WM Act, outlined in section 3 of the Act, and listed below, 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:

a. *to apply the principles of ecologically sustainable development*
c. *to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality*
d. *to recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including:*
    i benefits to the environment
    ii benefits to urban communities, agriculture, fisheries, industry and recreation

iii benefits to culture and heritage

iv benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water

e. to recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources,

f. to provide for the orderly, efficient and equitable sharing of water from water sources,

g. to integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna,

h. to encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users,

i. to encourage best practice in the management and use of water.

Under WM Act framework, activities and works proposed on waterfront land are regulated. These activities include:

- the construction of buildings or carrying out of works
- the removal of material or vegetation from land by excavation or any other means
- the deposition of material on land by landfill or otherwise
- any activity that affects the quantity or flow of water in a water source.

NRAR's *Guidelines for Controlled Activities on waterfront land—Riparian corridors* (NRAR, 2018) outlines the need for a Vegetated Riparian Zone (VRZ) adjacent to the channel to provide a transition zone between the terrestrial environment and watercourse. This vegetated zone helps maintain and improve the ecological functions of a watercourse whilst providing habitat for terrestrial flora and fauna. The VRZ plus the channel (bed and banks of the watercourse to the highest bank) constitute the 'riparian corridor' (Figure 3). To be consistent with the guidelines, VRZ widths should be based on watercourse order as classified under the Strahler System of ordering watercourses and using Hydroline Spatial Data which is published on the department's website (Table 2).

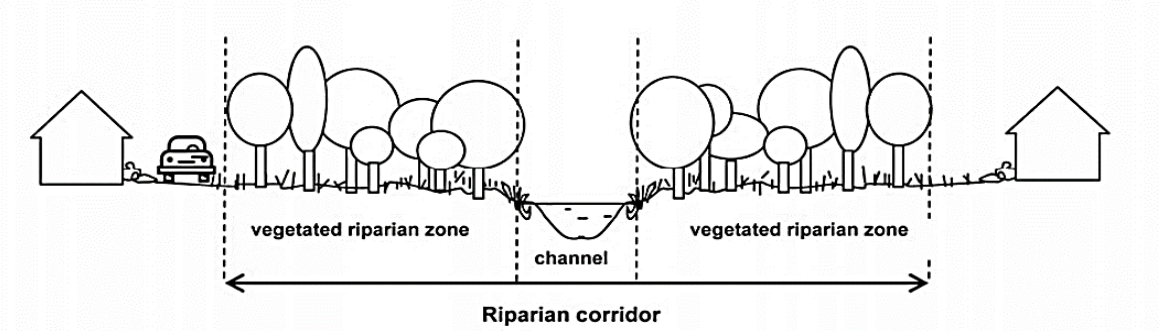

Figure 3: Vegetated Riparian Zone and watercourse channel comprising the riparian corridor (NRAR, 2018).

Table 2: Recommended riparian corridor widths relative to Strahler Order (NRAR, 2018).

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

Certain works are permissible within the riparian zone (Table 3). Non-riparian uses consistent with NRAR's guidelines in the outer 50% of the VRZ are permitted as long compensation (1:1 offset) is achieved within the site. The outer VRZ that is impacted must be offset elsewhere on site using the 'averaging rule' (Figure 4). Section 2.3 further outlines how the proposed rezoning relates to the WM Act objectives and guidelines.

Table 3: Riparian corridor (RC) matrix of permissible use (NRAR 2018).

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	•	•	•		•			•	•

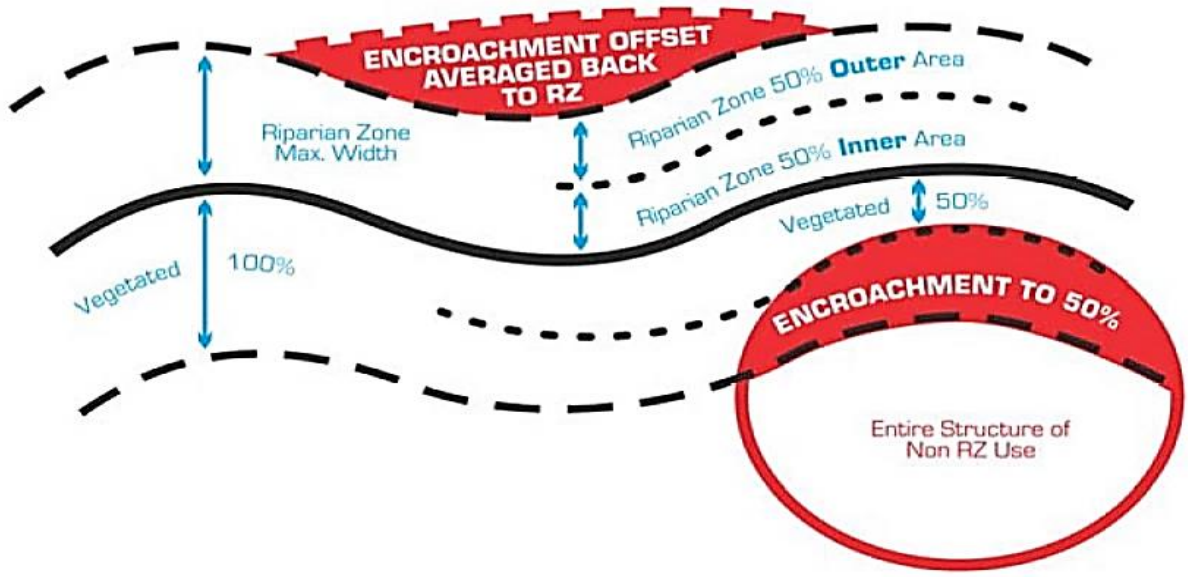

Figure 4: Riparian 'averaging rule' for offsetting encroachment into the outer 50% of the VRZ (NRAR 2018).

NRAR's *Guidelines for Controlled Activities on waterfront land—Riparian corridors* (NRAR, 2018) provides a fast-track assessment pathway for development that meets pre-determined criteria. The water cycle concepts discussed in this paper are acknowledged to be outside of the fast-track *Guidelines for Controlled Activities on waterfront land—Riparian corridors* and will, therefore, be subject to a merit-based assessment.

2.4 NSW Wetlands Management Policy 2010

The NSW Wetlands Management Policy (DECCW, 2010) aims to provide for the protection, ecologically sustainable use and management of NSW wetlands. Wetlands include lakes, lagoons, estuaries, rivers, floodplains, swamps, bogs, billabongs, marshes, coral reefs and seagrass beds. There are no wetlands on site.

2.5 Oran Park Precinct Development Control Plan (DCP)

The purpose of this DCP is to:

- Communicate the planning, design and environmental objectives and controls against which Camden Council will assess future Development Applications (DAs)
- Consolidate and simplify the planning controls in the Oran Park Precinct, Oran Park Precinct Growth Centres Precinct Development Control Plan 3
- Provide guidance on the orderly, efficient and environmentally sensitive development of the Oran Park Precinct as envisaged by the South West Sector Structure Plan as refined by the Oran Park Precinct Indicative Layout Plan
- Require the preparation of more detailed planning and design controls for important components of the Oran Park Precinct
- Promote high-quality urban design outcomes within the context of environmental, social and economic sustainability.

This DCP does not yet apply to the land within the Pondicherry Precinct. The DCP will be updated to reflect the Pondicherry Precinct Plan.

2.6 Policy and guidelines for fish habitat conservation and management

The *Policy and guidelines for fish habitat conservation and management* (Fairfull, 2013) (herein referred to as the 'Policy') is a supplementary document that outlines the requirements and obligations under the FM Act and the *Fisheries Management (General) Regulation 2010* and were developed to maintain and enhance fish habitat and assist in the protection of threatened species. The Policy provides a definition of key fish habitat and provides guidance for assigning a classification of waterways for fish passage, which informs the types of infrastructure suitable for the creekline (Table 4) and sensitivity of the key fish habitat present, which determines the potential disturbance and offsetting required for development (Table 5). South Creek, flowing along the eastern boundary of the site, is mapped as key fish habitat by NSW Fisheries. No other creeks within the site are considered key fish habitat, as they are not mapped by NSW Fisheries and do not provide habitat for threatened species. However, these guidelines should be referred to when designing infrastructure in or near watercourses.

Table 4: Classification of waterways for fish passage (Fairfull 2013)

Classification	Characteristics of waterway class
CLASS 1 **Major key fish habitat**	Marine or estuarine waterway or permanently flowing or flooded freshwater waterway (e.g. river or major creek), habitat of a threatened or protected fish species or 'critical habitat'.
CLASS 2 **Moderate key fish habitat**	Non-permanently flowing (intermittent) stream, creek or waterway (generally named) with clearly defined bed and banks with semi-permanent to permanent waters in pool or in connected wetland areas. Freshwater aquatic vegetation is present. TYPE 1 and 2 habitats present.
CLASS 3 **Minimal key fish habitat**	Named or unnamed waterway with intermittent flow and sporadic refuge, breeding or feeding areas for aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or other CLASS 1-3 fish habitats.
CLASS 4 **Unlikely key fish habitat**	Waterway (generally unnamed) with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or freestanding water or pools post rain events (e.g. dry gullies or shallow floodplain depressions with no aquatic flora present).

Table 5: Key Fish Habitat types (Fairfull, 2013)

Key fish habitat and associated sensitivity classification scheme (for assessing potential impacts of certain activities and developments on key fish habitat types)
TYPE 1 – Highly sensitive key fish habitat:
Posidonia australis (strapweed)
Zostera, Heterozostera, Halophila and *Ruppia* species of seagrass beds >5 m^2 in area
Coastal saltmarsh >5 m^2 in area
Coral communities
Coastal lakes and lagoons that have a natural opening and closing regime (i.e. are not permanently open or artificially opened or are subject to one off unauthorised openings)
Marine park, an aquatic reserve or intertidal protected area
SEPP 14 coastal wetlands, wetlands recognised under international agreements (e.g. Ramsar, JAMBA, CAMBA, ROKAMBA wetlands), wetlands listed in the Directory of Important Wetlands of Australia

Key fish habitat and associated sensitivity classification scheme (for assessing potential impacts of certain activities and developments on key fish habitat types)
Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 metres in length, or native aquatic plants
Any known or expected protected or threatened species habitat or area of declared 'critical habitat' under the FM Act
Mound springs
TYPE 2 – Moderately sensitive key fish habitat:
Zostera, Heterozostera, Halophila and *Ruppia* species of seagrass beds <5 m^2 in area
Mangroves
Coastal saltmarsh <5 m^2 in area
Marine macroalgae such as *Ecklonia* and *Sargassum* species
Estuarine and marine rocky reefs
Coastal lakes and lagoons that are permanently open or subject to artificial opening via agreed management arrangements (e.g. managed in line with an entrance management program)
Aquatic habitat within 100 m of a marine park, an aquatic reserve or intertidal protected area
Stable intertidal sand/mud flats, coastal and estuarine sandy beaches with large populations of in-fauna
Freshwater habitats and brackish wetlands, lakes and lagoons other than those defined in TYPE 1
Weir pools and dams up to full supply level where the weir or dam is across a natural waterway
TYPE 3 – Minimally sensitive key fish habitat may include:
Unstable or unvegetated sand or mud substrate, coastal and estuarine sandy beaches with minimal or no in-fauna
Coastal and freshwater habitats not included in TYPES 1 or 2
Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation

2.7 Sydney Regional Environmental Plan No 20 – Hawkesbury Nepean River (No 2 – 1997)

Camden LGA is subject to the Sydney Regional Environmental Plan No. 20 – Hawkesbury Nepean River (SREP 20). Part 3, Clause 11 of the SREP 20 lists development controls for land covered under this SREP. Sub-clause 15 relates to 'Land uses in or near the river' and outlines the following controls:

> *Definition:*
> *All uses in the river or a tributary of the river, or within 40 metres of the high-water mark of the river or a tributary of the river where it is tidal or within 40 metres of the bank where it is non-tidal. This includes clearing and the construction and use of piers, wharves, boat sheds or other structures which have direct structural connection to the bank or bed of the river or a tributary of the river.*
> *Consent required.*
>
> *Additional matters for consideration by the consent authority:*
>
> a. *The need to locate access points where riverbanks are stable, away from river shallows and major beds of attached aquatic plants, away from fishing grounds and fish breeding areas,*

where the proposed activities do not conflict with surrounding recreational activities, and where significant fauna and wetland habitats will not be adversely affected.

b. *The need to require remedial works, such as the re-establishment of flora and fauna habitats.*
c. *The potential for use of the land as a buffer to filter water entering the river.*
d. *The need for an Erosion and Sediment Control Plan.*
e. *The need for a Vegetation Management Plan.*

The SREP has been considered as part of the rezoning with riparian corridors and green space included as the proposed design in terms of rehabilitating flora and fauna habitats and the use of a riparian corridor as a buffer to filter runoff from residential zones. Following the proposed rezoning, residential development would commence having considered and incorporated the additional matters above.

3. Methods

3.1 Field survey methods

The Strahler stream order classification was extracted from the DPI Hydroline Spatial Data. Top of bank had previously been preliminarily assessed in the field by ELA in 2017 and validated by ELA in September 2019 by a Senior Aquatic Ecologist. A third survey was undertaken by an Aquatic Ecologist in July 2020 to ensure the results remained current and focus on recovery potential for riparian corridors.

1. Top of bank mapping – The geomorphic top of bank (ToB) for the creek was mapped using a GPS-enabled tablet and cross-checked with 0.5 m contours and high-resolution aerial imagery. The ToB identifies the geomorphologic extent of the watercourse and forms the basis for measuring any VRZ.

2. Riparian habitat assessment – An assessment of riparian condition and recovery potential was conducted for the creek. This assessment considered native vegetation cover, connectivity, quality, bed and bank stability and habitat diversity.

3. Aquatic habitat assessment – An assessment of the aquatic habitat within each reach was completed, which examined the general quality of aquatic habitats, including vegetation structure, regeneration and weed infestations.

4. Results

4.1 Reach descriptions

The Pondicherry precinct is highly modified, with land use primarily being cleared paddock/pasture. Reach descriptions have been fully detailed in Table 7 (Appendix A), using reach labels from Figure 5. Waterways ranged from undefined overland flows, to large online dams, to an incised channel with forested riparian land. Using the Strahler method of stream order, the DPI hydroline map shows eleven first-order, four second-order, one third-order, and one fourth-order stream within the site. Of these, only three of the higher order streams had a distinctive bed, bank and aquatic habitat. For each reach, a condition of good, moderate or poor was applied on the basis of:

- Stream shape and size
- Frequency of flow (ephemeral or perennial)
- Presence of aquatic habitat (pools, riffles, snags or macrophytes)
- Potential for threatened or protected fish
- Connection with other habitats.

Each condition was relative to other watercourses on site. Watercourses in good condition had clearly defined bed and banks with intermittent to semi-permanent water in pools with aquatic vegetation snags and fish habitat present. Watercourses in moderate condition had clearly defined bed and banks with ephemeral or intermittent water after a rain event. Aquatic vegetation may or may not be present, with less in-stream features such as snags. These creeks would provide fish passage during rain events and refuge for fauna such as turtles. Poor condition watercourses had poor or no defined bed and banks and were typically a dry gully or depression, lacking aquatic vegetation with no habitat for fish or other fauna.

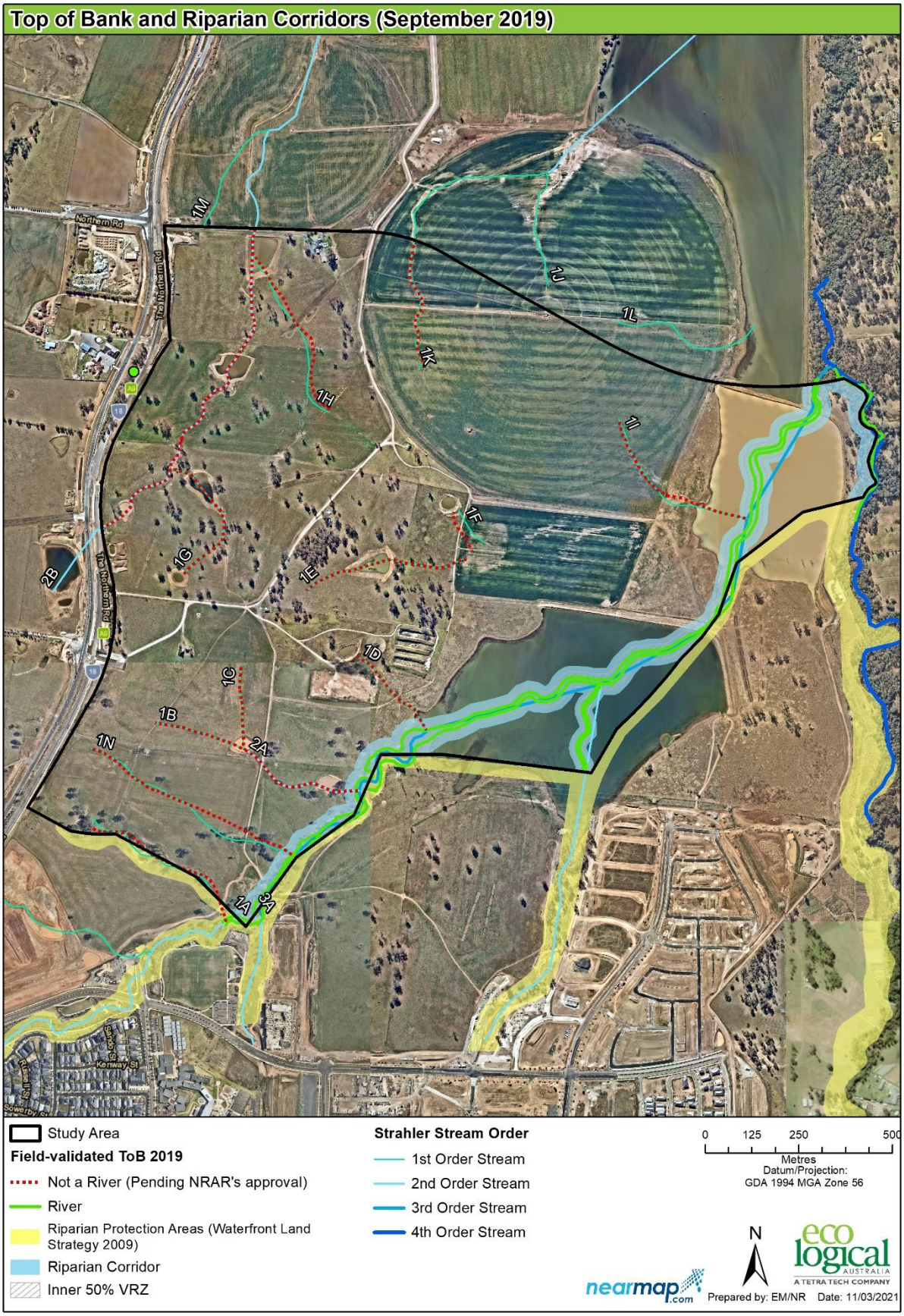

Figure 5: Top of bank (validated September 2019 and July 2020) with reach numbers and a hypothetical riparian corridor

4.2 Riparian habitat

The riparian habitat throughout the site varied in quality. The majority of the site was cleared or exotic vegetation with the exception of a few small patches (Figure 6). Habitat along 3A, upstream of the two dams, and South Creek (4A) was Cumberland riverflat forest (PCT 835), with a mature native canopy dominated by *Casuarina glauca* (She-oak), *Eucalyptus tereticornis* (Forest Red Gum) and *Eucalyptus molucanna* (Grey Box) (Figure 6). *Angophora subvelutina* (Broad-leaved Apple) and *Melaleuca decora* (Paperbark) were also present along South Creek, where the vegetation community was less disturbed. The midstorey was reasonably open, dominated by *Lycium ferocissimum* (African Boxthorn), with a groundcover of exotic grasses and forbs. Along 3A, the groundcover was approximately 50% density, with large bare patches of soil exposed throughout the riparian corridor. The overall condition of this vegetation was moderate along 3A and good along South Creek. Downstream of where 3A entered the dam systems, there was a lack of riparian habitat with pasture the only vegetation cover.

In the north-western extent, along the creek line 1G and 2B (Figure 5 and Figure 6), the vegetation community Cumberland shale plains woodland (PCT 849) was present in poor condition as scattered paddock trees, with no midstorey and a groundcover of exotic pasture (Figure 6).

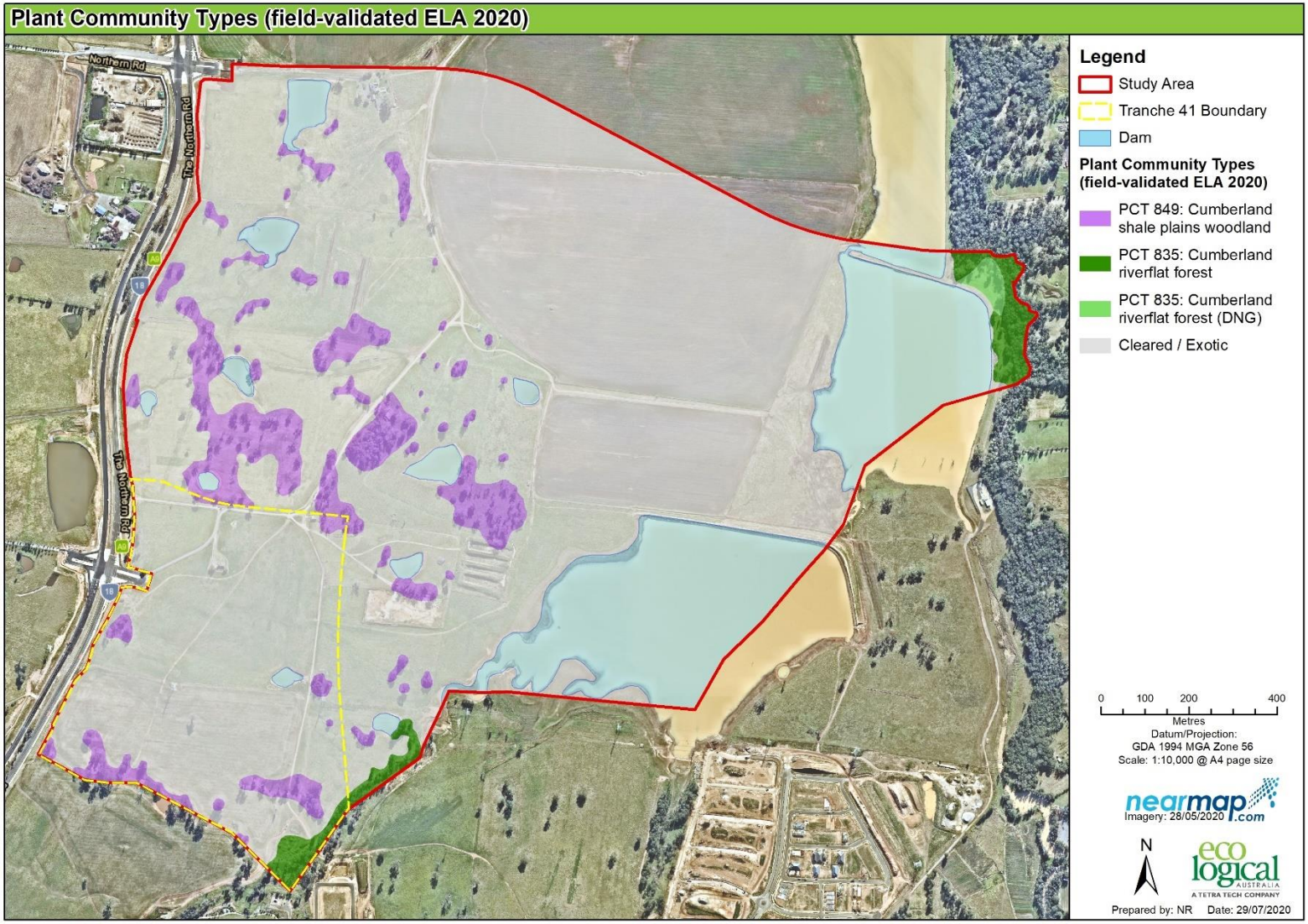

Figure 6: Validated vegetation communities (ELA 2020)

4.3 Dams

There are two large online dams on the third-order stream, plus numerous small online and offline dams scattered throughout the study area. The multiple small dams across the site all provided poor aquatic habitat with no or sparse macrophytes, trampling by livestock, turbid water and limited fringing vegetation. Pasture was the dominate riparian habitat for these smaller dams. The two large dams provide 46 ha of aquatic habitat and are supported by dam walls greater than 5 m high which have altered the creek's natural flow and obstruct fish passage in the catchment. The dams provided poor aquatic habitat with sparse macrophytes, degraded banks due to cattle trampling and turbid water. There was very little to no riparian vegetation present, with pasture dominating the riparian zone.

No fish, frogs or turtles were observed using the dams however, they are likely to be present where there is suitable habitat. Wetland birds were observed using all dams inspected. The most commonly observed species were:

- *Tachybaptus novaehollandiae* (Australasian Grebe)
- *Himantopus himantopus* (Black-winged Stilt)
- *Cygnus atratus* (Black Swan)
- *Anas gracilis* (Grey Teal)
- *Chenonetta jubata* (Australian Wood Duck)
- *Anas rhynchotis* (Australasian Shoveler)
- *Pelecanus conspicillatus* (Australian Pelican).

5. Indicative Layout Plan

5.1 Pondicherry Water Management Options

During the early stage of Precinct Planning it became evident that careful consideration would be required regarding the retention or removal of the large farm dams. In February 2020, Design & Planning, Calibre and ELA prepared an assessment of three options of the lake area and riparian treatment. The assessment was prepared in consultation with DPIE and Camden Council to provide a merit assessment of three options:

- retain and modify the lakes as on-line water features
- remove lakes and create on-line dry detention basins
- remove lakes and create off-line dry basins

The options were considered against the objects and principles of the *Water Management Act 2000* and were presented to NRAR. The assessment concluded that retention of the lake was the best option to achieve the principles of ecological sustainable development and deliver the optimum social, economic and environmental outcome. The ILP has adopted the preferred option of converting the existing farm dam to a lake precinct. Further discussion and justification is presented in chapter 4.2 of that report (Design and Planning 2020).

The appearance and treatment of the lake precinct is summarised in the conceptual graphic below (Figure 8). The ILP in Figure 7 has further developed this concept and closely follows the preferred design. Additional descriptions of potential habitat in and around the lake is discussed below in section 6.2.

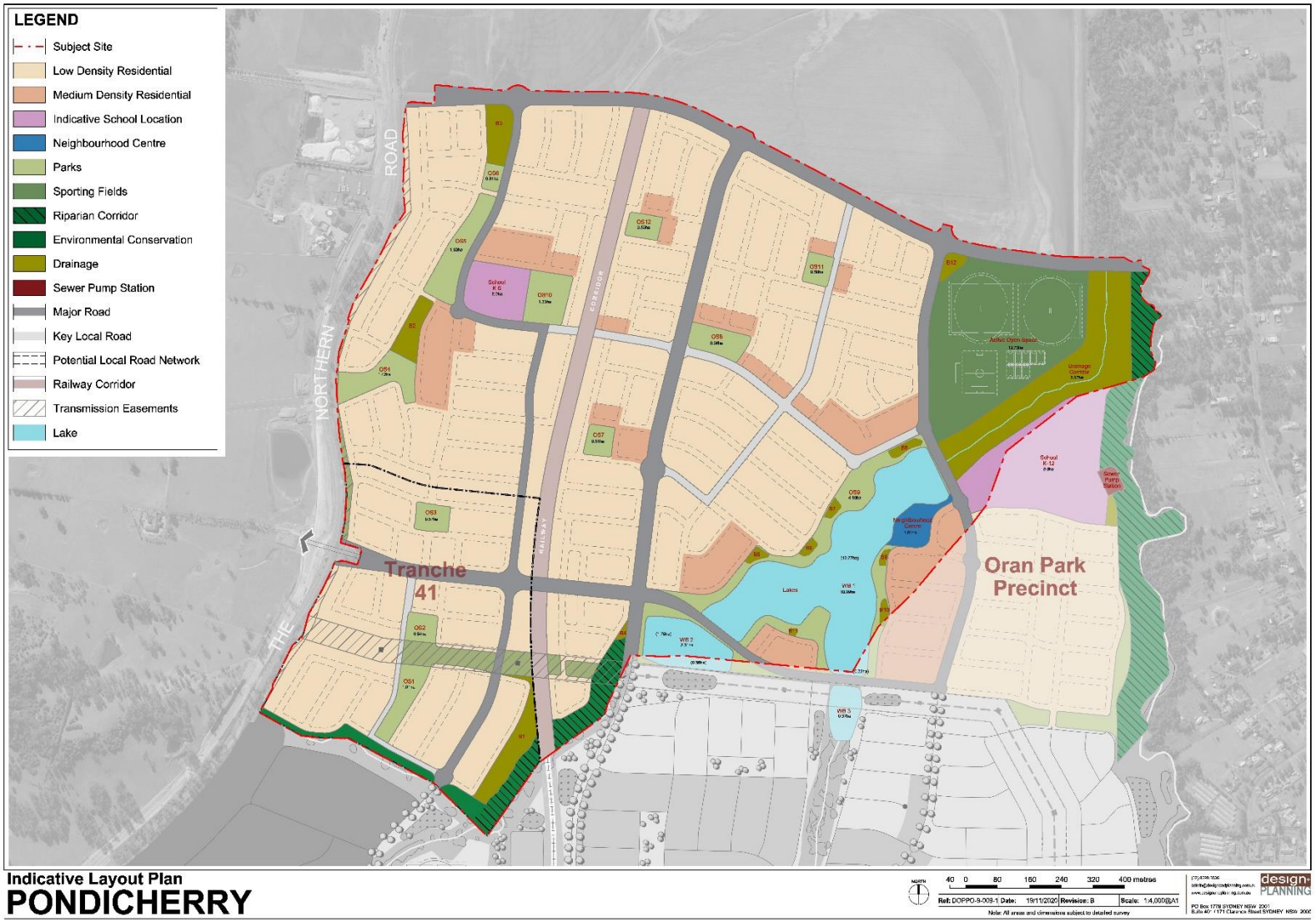

Figure 7: Pondicherry Indicative Layout Plan

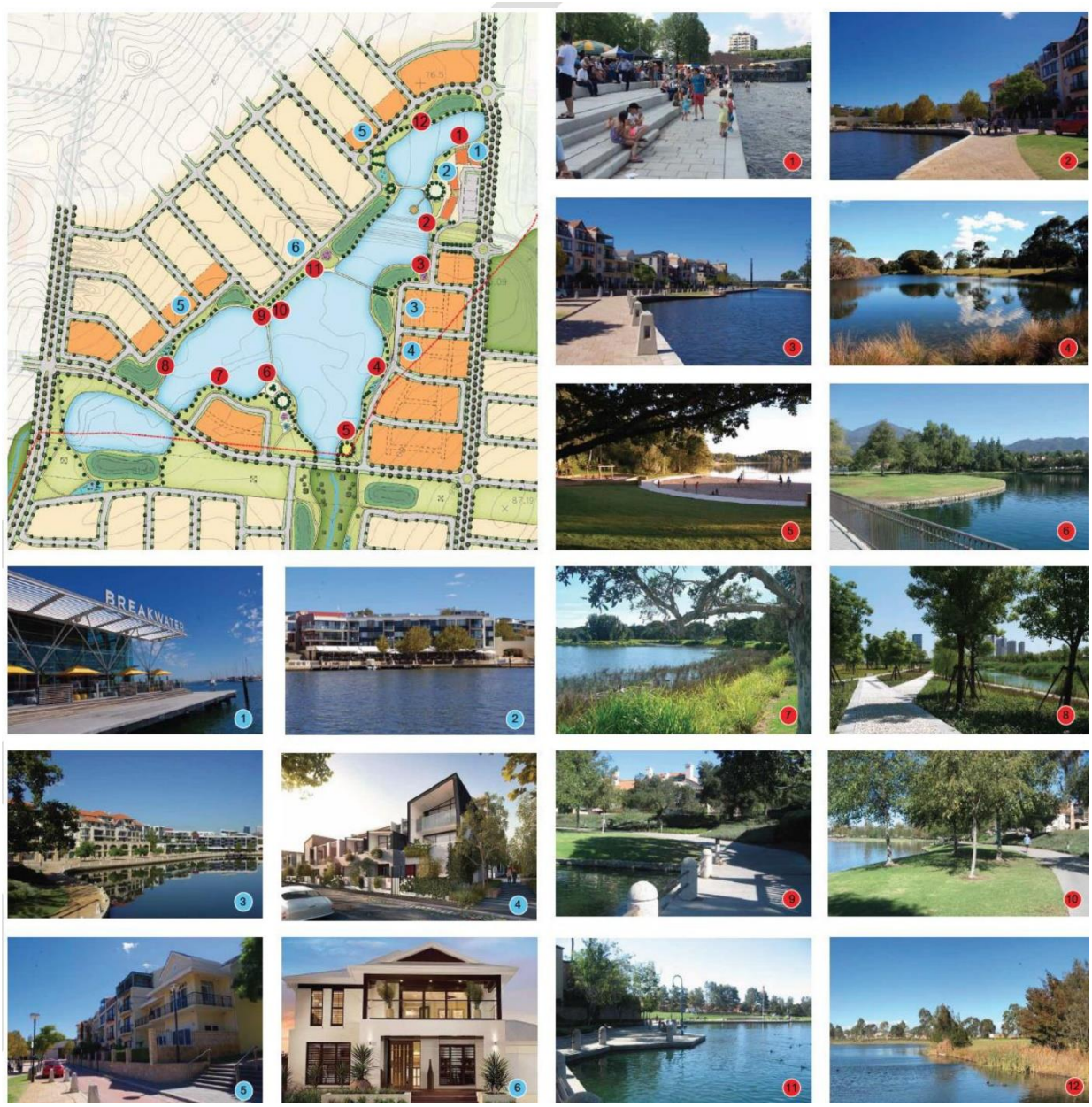

Figure 8: Preferred option of the lake precinct presented to the NRAR (Design and Planning 2020)

6. Assessment of the ILP

6.1 Riparian areas

Using the Strahler method of stream order, the DPI hydroline map shows eleven first-order, four second-order, one third-order, and one fourth-order stream within the site. Of these, only three of the higher order streams had a distinctive bed, bank and aquatic habitat. The ILP has five distinct riparian corridor types across several land uses (Figure 7). The ILP proposes to 'rationalise' the watercourse through the two large farm dams to form one large water body. The aim is to create a combination of a large open water body and riparian rehabilitation with small offline basins for water treatment. The lakes would be online and provide permanent bodies of water along the creek. The system would have the potential to contain fringing aquatic habitat and open water areas. Water would be fed into the system via the natural creek catchment and stormwater. The riparian land fringing the lakes would have a variety of treatments including commercial, recreational and environmental areas.

Downstream of the lake, the riparian rehabilitation area is proposed adjacent to South Creek and is likely to consist of a low flow channel, banks, some wetland areas and a structured woodland terrestrial ecosystem. This is in line with riparian corridors that are currently existing along South Creek and the tributaries upstream in the Oran Park and Turner Road Precinct.

The ILP offers aquatic and riparian values across a mix of land use zones (Figure 7 and Table 6). The outcome of creating a lake and restoring other riparian corridors would ultimately improve the habitat values within the site and across the catchment. The proposed ILP delivers a mix of aquatic and riparian habitat elements spread across a larger area as described in section 6.2.

Table 6: Area of aquatic and riparian zones in the ILP (Figure 7)

ILP zone	Code	Area (ha)
Riparian corridor		1.13
		1.67
		1.34
Lakes*	WB 1	10.99
	WB 2	2.31
Lakeside Open space**		4.10
Environmental conservation		0.91
		0.46
Drainage		6.97
Total		**29.88**

* includes some minor overlap into Oran Park Precinct

** mix of environmental restoration, open space and hardstand

6.2 Design and restoration principles

The ILP presents several land use zones that constitute riparian land (Figure 7 and Table 6). The following design and restoration principles for each land use type have been formulated to compliment concepts that were presented to NRAR for a preliminary merit assessment (Design and Planning 2020).

- **Riparian corridor** – this area would emulate a traditional riparian zone meeting NRAR's guidelines for controlled activities, including in-stream works, laying pipes and cables in watercourses, outlet structures, riparian corridors, vegetation management plans and watercourse crossings. A functional watercourse and riparian community would be reinstated in this area and managed under a VMP.
- **Lakes** – these open water bodies would benefit from having a mix of aquatic habitat elements, that when combined provide continuity and shelter for aquatic organisms and wetland birds. Example habitat elements suggested for the lake are:
    - A range of depths, with shallow submerged benches along the edge of the open space zone, and deeper water in the middle or where necessary for flow conveyance or for aesthetics at the Neighbourhood Centre.
    - Submerged and emergent macrophyte planting along portions of the shallow edge.
    - Dense rocky rubble substrate intermixed with sparse soft sediment in shallow areas where macrophyte planting does not occur.
    - Aeration device/s for enhancing dissolved oxygen, mixing water and prevention of algal blooms (e.g. fountains, jets or submerged aerators).
    - Overhanging canopy to shade the water and provide food for aquatic organisms, excluding the Neighbourhood centre, maintenance access, culverts, spillways, viewing platforms and other passive recreation nodes. Canopy spacing should ideally overlap, or be no more than one canopy-gap apart where constrained by other uses. Deciduous trees should not be planted within 40 m of the lake or other waterway unless excessive leaf drop can be captured and prevented from entering the lake.
- **Open space** (adjacent to the lake) – this constitutes a large area between residential development and the lake. Management of this areas should seek to blend riparian habitat with passive recreation use. At least two zones should be identified during the detailed design and VMP, including:
    - Fringing vegetation and habitat patches – including canopy overhanging the lake, understorey and groundcover planting beds to compliment the parkland and blend with the lake interface. The primary function of this vegetation would be to provide habitat continuity through the precinct, stabilise the banks, filter overland flows, shade the water, input organic material into the aquatic food web, and direct foot traffic to paths and other preferred nodes.
    - Parkland lawns with footpaths, picnic areas, feature trees and scattered planting beds.
- **Environmental conservation** – the strip of land along the southern boundary does not meet the definition of a 'river' under the WM Act, but is proposed to be zoned as Environmental Conservation. The land will be rehabilitated with native vegetation and will provide a vegetated corridor for wildlife.
- **Drainage** – this area would emulate a traditional riparian zone meeting NRAR's guidelines for controlled activities, including in-stream works, laying pipes and cables in watercourses, outlet

structures, riparian corridors, vegetation management plans and watercourse crossings. A functional watercourse and riparian community would be reinstated in this area and managed under a VMP.

6.3 LEP and DCP Provisions

Land identified in the ILP as Riparian Corridor and Environmental Conservation should be zoned *E2 Environmental Conservation* under the Growth Centres SEPP as this provides clear objectives for the protection and management of the riparian corridor. The permissible uses within the Environmental Conservation zones are shown below.

Zone	Permitted without consent	Permitted with consent	Prohibited
Environmental Conservation	Nil	Drainage; Earthworks; Environmental facilities; Environmental protection works; Flood mitigation works; Information and education facilities; Kiosks; Recreation areas; Roads; Signage; Waterbodies (artificial)	Business premises; Hotel or motel accommodation; Industries; Multi dwelling housing; Recreation facilities (major); Residential flat buildings; Restricted premises; Retail premises; Seniors housing; Service stations; Warehouse or distribution centres; Any development not specified in item 2 or 3

The E2 lands should be subject to the Camden City Council Growth Centres Precincts DCP clauses that relate to Water Cycle Management (2.3.2) and Native Vegetation and Ecology (2.3.5). The clauses are triggered by including the riparian areas on the Growth Centres SEPP Riparian Protection Area map. The DCP (section 2.3.5) has controls specifically for the Riparian Protection Areas which should apply to the Pondicherry precinct:

- *Within land that is in a Riparian Protection Area, native vegetation is to be conserved and managed in accordance with the Guidelines for riparian corridors on waterfront land prepared by the NSW Office of Water*.

The conservation and management regime for the vegetation should be described in a Vegetation Management Plan that has been prepared to be consistent with the zone objectives and riparian guidelines.

Where multiple land uses are proposed, for example the Open Space along the lakes, other land use zones may be appropriate such as *RE1 Public Recreation*. Detailed landscape design of these areas will be required at the masterplan or DA stage. Where public access for recreation is proposed, public ownership of riparian lands is likely to be the best solution. Discussion with local government regarding the infrastructure and vegetation management in the riparian zone is recommended.

7. References

Design and Planning 2020. Pondicherry Lake Precinct Water Management Act Assessment, February 2020. Prepared for NSW Department of Planning, Industry and Environment.

Appendix A Reach descriptions and condition

Table 7: Reach and condition description

Reach name	Strahler stream order	Status and proposed action	Condition	Typical features	Representative photos
1A	1st	Not a 'river'. Rehabilitate and establish a functioning creek line with riparian corridor to align with the Waterfront Land Strategy in the adjacent Oran Park.	Poor	No defined bed or bank, wide grassy depression only that facilitates overland flows. One small online dam.	

Reach name	Strahler stream order	Status and proposed action	Condition	Typical features	Representative photos
1B	1st	Not a 'river'. Remove as constraint (pending NRAR approval)	Poor	No defined bed or bank (overland flows only). One small online dam.	
1C	1st	Not a 'river'. Remove as constraint (pending NRAR approval)	Poor	No defined bed or bank (overland flows only). One small online dam.	

Reach name	Strahler stream order	Status and proposed action	Condition	Typical features	Representative photos
1D	1st	Not a 'river'. Remove as constraint (pending NRAR approval)	Poor	No defined bed or bank (overland flows only). One small online dam.	
1E	1st	Not a 'river'. Remove as constraint (pending NRAR approval)	Poor	No defined bed or bank (overland flows only). One small online dam.	

Reach name	Strahler stream order	Status and proposed action	Condition	Typical features	Representative photos
1F	1st	Not a 'river'. Remove as constraint (pending NRAR approval)	Poor	No defined bed or bank (overland flows only). One small online dam.	
1G	1st	Not a 'river'. Remove as constraint (pending NRAR approval)	Poor	No defined bed or bank, wide grassy depression only that facilitates overland flows. One small online dam.	

Reach name	Strahler stream order	Status and proposed action	Condition	Typical features	Representative photos
1H	1st	Not a 'river'. Remove as constraint (pending NRAR approval)	Poor	No defined bed or bank (overland flows only).	
1I	1st	Not a 'river'. Remove as constraint (pending NRAR approval)	Poor	No defined bed or bank (overland flows only).	

Reach name	Strahler stream order	Status and proposed action	Condition	Typical features	Representative photos
1J	1st	Off site	-	-	Off site, no photo
1K	1st	Not a 'river'. Remove as constraint (pending NRAR approval)	Poor	No defined bed or bank (overland flows only).	
1L	1st	Off site	-	-	Off site, no photo
1M	1st	Off site	-	-	Off site, no photo

Reach name	Strahler stream order	Status and proposed action	Condition	Typical features	Representative photos
1N	1st	Not a 'river'. Remove as constraint (pending NRAR approval)	Poor	No defined bed or bank (overland flows only).	
2A	2nd	Not a 'river'. Remove as constraint (pending NRAR approval)	Poor	No defined bed or bank (overland flows only). One small online dam. Minor gully depressions but filled with pasture species.	

Reach name	Strahler stream order	Status and proposed action	Condition	Typical features	Representative photos
					
2B	2nd	Not a 'river'. Remove as constraint (pending NRAR approval) and establish open space and basins to promote green space and reduce the urban heat effect	Poor	No defined bed or bank (overland flows only). Three small online dams. Minor gully depressions occur but are filled with pasture species and associated with dams.	

Reach name	Strahler stream order	Status and proposed action	Condition	Typical features	Representative photos
					 

Reach name	Strahler stream order	Status and proposed action	Condition	Typical features	Representative photos
2C	2nd	River	Moderate	Online dam within the site. Channel upstream of dam is off site and not assessed.	Upstream section off site, no photo
2D	2nd	River	Moderate	Defined channel with shallow pooled water and dense macrophytes. Cattle fenced off from riparian vegetation. Steep banks and scattered trees with the study area, dominated by herbaceous groundcovers. Creek flows from upstream development that has protected and restored a 40 - 50 m wide riparian corridor. Reach cuts southern tip of study area, then joins with Reach 3A offsite.	

Reach name	Strahler stream order	Status and proposed action	Condition	Typical features	Representative photos
3A	3rd	River	Good / Moderate	The reach length consists of about 1/3 defined channel and 2/3 large online dams. The channel area was highly impacted from unfenced cattle, with steep eroded banks, compacted and trampled bed, incised channel, sedimentation of bed, turbid water, and a thin row of riparian trees with limited recruitment. Channel habitat for macroinvertebrates and amphibians was very poor. There were patches of Typha and *Eleocharis* sp. present throughout the defined channel. Fish passage along the creeks was severely obstructed by several dam walls, each >5 m high. Very sparse Typha was present along the eastern side of the second dam, with no other macrophytes observed. The lower dam spills into a large and narrow third dam off site and also a secondary overflow channel into South Creek. Numerous large invasive Carp were observed in third dam. The dam water was turbid and green with filamentous algae. Several species of common wetland birds were observed using the dams. Overall, there was a poor cover of aquatic macrophytes in the dams and channel, and limited aquatic value.	 

Reach name	Strahler stream order	Status and proposed action	Condition	Typical features	Representative photos
					
4A	4th	River (South Creek)		This reach forms the eastern perimeter of the study area. Cattle exclusion fencing has protected trampling of riparian land and banks, but severe weed infestations dominant the mid-storey vegetation. African Olive, Lantana and Blackberry are invasive species that compete with native plants and recue the long-term survival of the endemic community. The channel was dry, with a meandering deep and narrow form through the forest. Large amounts of woody debris instream would help slow flows and trap plant propagules. Large amounts of rubbish had also been trapped instream.	

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