Environmental Management Plan

Pacific Pines, Lennox Head

Part 3A Approval MP_0026

quality solutions **sustainable** future

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Environmental Management Plan

Pacific Pines, Lennox Head

Part 3A Approval MP_0026

Prepared for: The Royal Bank of Scotland

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Version History			
UPR	***Description***	***Date Issued***	***Issued By***
1675881	Initial Draft	9/12/2011	DGH
1675087	Draft Rev 2	03/01/2012	DGH
1675273	Draft Rev 3	25/01/2012	DGH
1675258	Draft Rev 4	26/06/2012	DGH
1675546	Final Draft	20/07/2012	RVI
1675713	Final	13/08/2012	RVI
1675-1004	Updated final	05/09/2012	RVI
1675-2003	Update after agency review	30/11/2012	RVI

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1 Introduction

1.1 Background

On 12 November 2008, the New South Wales (NSW) Minister for Planning issued an approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (MP_0026) for the future subdivision of the Pacific Pines Estate, located at Lennox Head NSW.

MP_0026 includes Concept Approval for the whole of the development, and a Project Approval relating to Stages 1A and 1B.

The approvals have been modified, with the most recent modification (MOD 3) approved in September 2011. A further modification (MOD 4) is currently proposed, primarily to increase the area proposed on the site for ecological conservation.

This Environmental Management Plan (EMP) supports the proposed modification, addressing Condition B1 of the approval. Once the current modification proposal is determined, this EMP will provide a framework for the ongoing management of all areas of threatened species habitat and ecologically endangered communities on the land.

A separate Conservation Zone Management Plan (CZMP) addresses Condition B2 of the approval in relation to threatened species and EECs occurring within the designated Conservation Zone, including provision of a compensatory strategy to be developed to offset the loss of ecological values at the site. The CZMP is provided under separate cover and compliment this EMP.

The Concept Plan now proposed for the development is shown in **Illustration 1.1**.

1.2 Structure of the EMP

The requirements of Condition B1, as listed in the Minister's Approval for the Project, are reproduced below in **Table 1.1** as well as reference as to where these conditions are addressed in the EMP.

Table 1.1 Requirements of Condition B1 - Environmental Management Plan

Number	*Requirements for EMP*	*Location in Plan*
1	*A contemporaneous detailed plan specifying all areas of EECs and threatened species habitat to be retained and the areas to be revegetated.*	Section 3 and 4
2	*Details of the revegetation works proposed within the 100 m buffer to the SEPP 26 Littoral Rainforest to the north-west of the site.*	Section 6
3	*Details of the rehabilitation works within and revegetation works around the Littoral Rainforest EECs. The EMP shall include consideration of the ongoing recreational use of the land and how recreational activities will be managed to ensure that the ecological objectives of revegetation are achieved.*	Section 6
4	*The locations of any required Asset Protection Zones (APZ) and how the ongoing management of the APZs will be achieved.*	Section 5

Number	Requirements for EMP	Location in Plan
5	*An integrated weed management strategy.*	Appendix A
6	*Methods to be used be utilised to protect all threatened flora and fauna habitat and EECs on the site throughout the life of the project.*	Section 6, 7 and 8
7	*The manner in which public access will be managed throughout the life of the project.*	Section 6 and 7
8	*Details of interpretive signage to be installed.*	Section 7
9	*A comprehensive mosquito management plan.*	Appendix B
10	*Details of an overarching monitoring program of all EECs and threatened species that measures the ongoing viability of these species / communities on the site.*	Appendix C
11	*Procedures for the ongoing management of the entire site. Management actions are to commence upon construction and continue until five years after the release of the final subdivision certificate or as otherwise agreed by the department following consideration of the results of the monitoring required by this plan.*	Section 6, 7 and 8

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Drawn by: GJM Checked by: MVE Reviewed by: RVI Date: August 2012
Source of base data: Deicke Richards, Ballina Shire Council

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Concept Plan for the Proposal

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Site Details

2.1 Locality

The site is located in Lennox Head in northern NSW, which is situated within the Northern Rivers Catchment Management Authority (CMA), South Eastern Queensland Bioregion and Ballina Shire Local Government Area (LGA). The site is known as Lot 234 DP 1104071. The locality of the site is shown in **Illustration 2.1**.

2.2 Climate

The site, as part of north-eastern NSW experiences a warm temperate to subtropical climate due to its geographic location. Average rainfall for the Ballina area is approximately 1800 mm per year as shown in **Table 2.1**, with the highest falls in summer/ autumn (November to May) at which times the area can be subject to high intensity rain events and severe thunderstorms. The prevailing wind is typically from the south-east, however strong winds from the north are experienced in spring and summer (Anderson 1999).

Table 2.1 Indicative Climate Data for Ballina

Month	*Mean Daily Max Temp (˚C)*	*Mean Daily Min Temp (˚C)*	*Mean Monthly Rainfall (mm)*
January	28.2	19.6	170.7
February	28	19.4	225
March	26.9	18.1	254.4
April	24.9	15.2	203.4
May	22.4	12.1	192.2
June	20.2	9.7	159.7
July	19.9	8.5	97.9
August	21.2	8.7	70.4
September	23.5	11.5	60.8
October	24.8	14.0	112.7
November	26.1	16.4	128.9
December	27.4	18.2	157.9
Annual	**24.5**	**14.3**	**1838.4**

Source: BoM 2011. Rainfall Data: Meerschaum Vale (Barden) - 1959-current; Temperature Data: Ballina Airport - 1992-current

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Drawn by: RE Checked by: MVE Reviewed by: DGH Date: June 2012
Source of base data: Ballina Topographic Map 9640-3-N

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Site Locality Plan

GeoLINK environmental management and design

Environmental Management Plan: Pacific Pines
1675345

Illustration 2.1

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2.3 Geology

Geology occurring at the site is characterised by Morand (1994) as being a Bangalow soil landscape which is defined as low rolling hills on basalt with, moderately deep to deep (100->200 cm), well-drained kraznozems and brownish red kraznozems. These soils are described as being strongly acidic and moderately erodible.

2.3.1 Acid Sulphate Soils

Gilbert and Sutherland conducted an acid sulfate soils assessment for the site in March 2004. In summary, the report found that potential acid sulfate soils (PASS) were observed in soils between 0.75 m and 3 m below natural surface levels in the location of the water control ponds. These levels were not converted to AHD, however an indicative natural surface level of 1.2 m AHD is assumed based on the site survey information.

The report identifies three soil types found at the site that exhibited PASS. These include coarse sands, silty sands and silty clays in an increasing severity of PASS. A geotechnical investigation of the entire site has been undertaken by Ardill Payne and indicates that the occurrence of PASS is unlikely to occur above the 10 m AHD contour (limit of alluvial soils). This finding is consistent with Sheet 2 of Ballina LEP 1987, which indicates the extent of Class 2 and 5 acid sulfate soils approximately follows the 10 m AHD contour.

2.4 Topography

The site generally has a westerly aspect, with land occurring at elevations of around 50 m AHD in the southern, eastern and north-eastern sectors, around 20 m AHD in the far north-western corner and less than 5 m AHD in the central and north-western portions. Elevated areas of the site have a moderate slope of between 10-15%, while lower-lying sections of the site are generally flat.

The low-lying area in the central portion of the site supports a freshwater spring. There is also a large constructed water quality treatment pond along the south-western boundary of the site and a modified natural channel that traverses the north-western corner of the site. The modified natural channel and existing spring drain into the nearby North Creek and associated wetland to the south-west of the site.

2.5 Vegetation Communities

The majority of the site has been subject to extensive vegetation clearance and currently supports primarily cleared paddocks used for livestock grazing. There are a number of stands of remnant vegetation throughout the site comprising both native and exotic species. The following vegetation communities are represented at the site:

- Pastoral Land;
- Swamp Oak Forest;
- Swamp Sclerophyll Forest;
- Littoral Rainforest; and
- Freshwater Wetland.

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3

Significant Ecological Features

3.1 Background

A number of threatened flora species listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) have previously been detected at the site. Additionally, a number of native vegetation communities occurring at the site are indicative of Endangered Ecological Communities (EECs) listed under the TSC Act and/ or Threatened Ecological Communities (TECs) listed under the EPBC Act. Threatened flora species and EECs/ TECs occurring at the site are summarised in **Table 3.1**.

Table 3.1 Threatened Species and EECs Recorded at the Site

Scientific Name	*Common Name*	*TSC Listing*	*EPBC Listing*	*Habitat occurring on-site*
Archidendron hendersonii	White Laceflower	V	-	Littoral rainforest remnants
Arthraxon hispidus	Hairy Jointgrass	V	V	Damp areas of the site associated with seepages and wetland edges
Eleocharis tetraquetra	Square-stemmed Spike Rush	E	-	Sedgeland/ rushland
Macadamia tetraphylla	Rough-shelled Bush Nut	V	V	Littoral rainforest remnants
Syzygium hodgkinsoniae	Red Lilly Pilly	V	V	Littoral rainforest remnants
Tinospora tinosporoides	Arrow-head Vine	V	V	Littoral rainforest remnants
Freshwater Wetlands of the NSW North Coast, Sydney Basin and South-east corner Bioregions	-	EEC	-	Sedgeland/ rushland
Littoral Rainforest in the NSW North Coast, Sydney Basin and South-east corner Bioregions	-	EEC	CE	Littoral rainforest remnants within the site
Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-east corner Bioregions	-	EEC	-	Low-lying areas integrated with sedgeland/ rushland
Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South-east corner Bioregions	-	EEC	-	Low-lying areas integrated with sedgeland/ rushland

Notes: EEC – Endangered Ecological Community
CE – Critically Endangered
V – Vulnerable
TSC – Threatened Species Conservation Act 1995
EPBC – Environment Protection and Biodiversity Conservation Act 1999

3.2 Updated Mapping of Threatened Flora Species / EECs

Updated mapping of the distribution of threatened flora species / EECs occurring at the site was undertaken from 16 November to 23 November 2011. Updated mapping for subject species / EECs are discussed in the following sections.

3.2.1 Hairy Joint Grass (HJG)

Target surveys for HJG were undertaken within all areas of the site representing potential habitat for the species. At the time of survey, HJG at the site was between 7 cm and 30 cm in height and was highly visible due to the specific colour of its young foliage.

Surveys for this species involved walking transects throughout suitable habitat at the site, usually between 5 m and 10 m apart, and actively searching for this species. Transects were widened to approximately 15 m in areas where HJG was considered unlikely to occur due to unfavourable microclimates being present. Locations of the HJG were recorded using a Garmin etrex hand-held GPS unit. In areas of dense HJG, point data was collected approximately every 2 m apart to allow for the distribution of the species to be mapped. To improve the accuracy of data collection, known survey control points were also sampled prior to surveys to allow for later rectification of the data by Kennedy Surveyors. Point data information was used to develop updated distribution mapping for HJG, which is shown in **Illustration 3.1**.

A comparison with previous mapping of HJG at the site (Cardno 2010) is provided in **Table 3.2**. Differences in the mapped distribution of this species between surveys can partially be explained by the natural variations in populations, typical of this species.

3.2.2 Square-stemmed Spike Rush (SSSR)

Target surveys for SSSR were undertaken within all areas of the site representing potential habitat for the species namely, seepage areas and freshwater wetland occurring at the site. At the time of surveys, SSSR was highly detectable due to having distinctive reproductive material present.

Surveys for this species involved walking transects throughout suitable habitat at the site, usually between 5 m and 10 m apart. Locations of the species were recorded using a Garmin etrex hand-held GPS unit. In areas of dense SSSR, point data was collected approximately every 2 m apart to allow for the distribution of the species to be mapped. To improve the accuracy of data collection, known survey control points were also sampled prior to surveys to allow for later rectification of the data by Kennedy Surveyors. In areas with dense cover of this species, point data was collected every 1-2 m. Point data information was used to develop updated distribution mapping for SSSR, which is shown in **Illustration 3.2**.

A comparison with previous mapping of SSSR at the site (Cardno 2010) is provided in **Table 3.2**.

3.2.3 Freshwater Wetland EEC

The current boundary of the Freshwater Wetland EEC was surveyed during November 2011 and involved extensive ground-truthing of the boundary by an experienced ecologist (David Havilah). The limit of the Freshwater Wetland EEC boundary was derived with reference to the Scientific Determination for Freshwater Wetland EEC (2005). A second ground-truthing survey of the boundary was undertaken with the ecologist and Kennedy Surveyors to record detailed point locations for the boundary of the wetland. The location of Freshwater Wetland EEC at the site is shown in **Illustration 3.3**. A comparison with previous mapping of wetland at the site (Cardno 2010) is provided in **Table 3.2**.

Table 3.2 Comparisons of Threatened Species / EEC Mapping between Cardno 2010 and Current Mapping

Species/Community	*Area on site (Cardno mapping 2010)*	*Area on site (current GeoLINK mapping 2012)*	*Area to be removed*	
			Cardno 2010	Current 2011
Hairy Jointgrass	3.64	3.56	1.08	1.85
Square-stemmed Spike Rush	3.96	2.79	0.91	0.69
Freshwater Wetland EEC	4.12	5.17	0.54	0.77
Littoral Rainforest	-	3.87	-	0.00

3.2.4 White Laceflower, Rough-shelled Bush Nut, Red Lilly Pilly and Arrow-head Vine

The locations of these species were ground-truthed and found to be as previously recorded. The locations of these species are shown on **Illustration 3.4**.

3.2.5 Littoral Rainforest EEC and Swamp Sclerophyll Forest EEC

The locations of the littoral rainforest and Swamp Sclerophyll EECs were ground-truthed by an experienced ecologist. As the boundary of the littoral rainforest had potential to affect the site layout, a ground-truthing survey of the boundary of this community was undertaken with the ecologist and Kennedy Surveyors to record detailed point locations for the boundary of the wetland. Updated mapping of these EECs is shown in **Illustration 3.4**.

3.2.6 Retention and Protection of Threatened Species and EECs

The approved layout of the Pacific Pines development ensures the retention and ongoing protection of all threatened species and EECs at the site. The majority of species / communities are protected within the Conservation Zone. Where individuals or community remnants are located outside of the approved Conservation Zone, protection will be provided by way of specific restrictions placed on the title of lots. In those cases, detailed lot design will ensure that each lot contains ample space for the expected residential development in a manner that does not create pressure to remove vegetation.

Ongoing management of threatened species / EECs will be managed through the implementation of this Environmental Management Plan and the more detailed Conservation Zone Management Plan.

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Source of base data: Ballina Shire Council and Kennedy Surveying

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Distribution of Hairy Joint Grass at the Site

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1675-1016

Illustration 3.1

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Distribution of Square-stemmed Spike Rush at the Site

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Environmental Management Plan: Pacific Pines

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Illustration 3.2

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Distribution of Freshwater Wetland EEC at the Site

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1675-1018

Illustration 3.3

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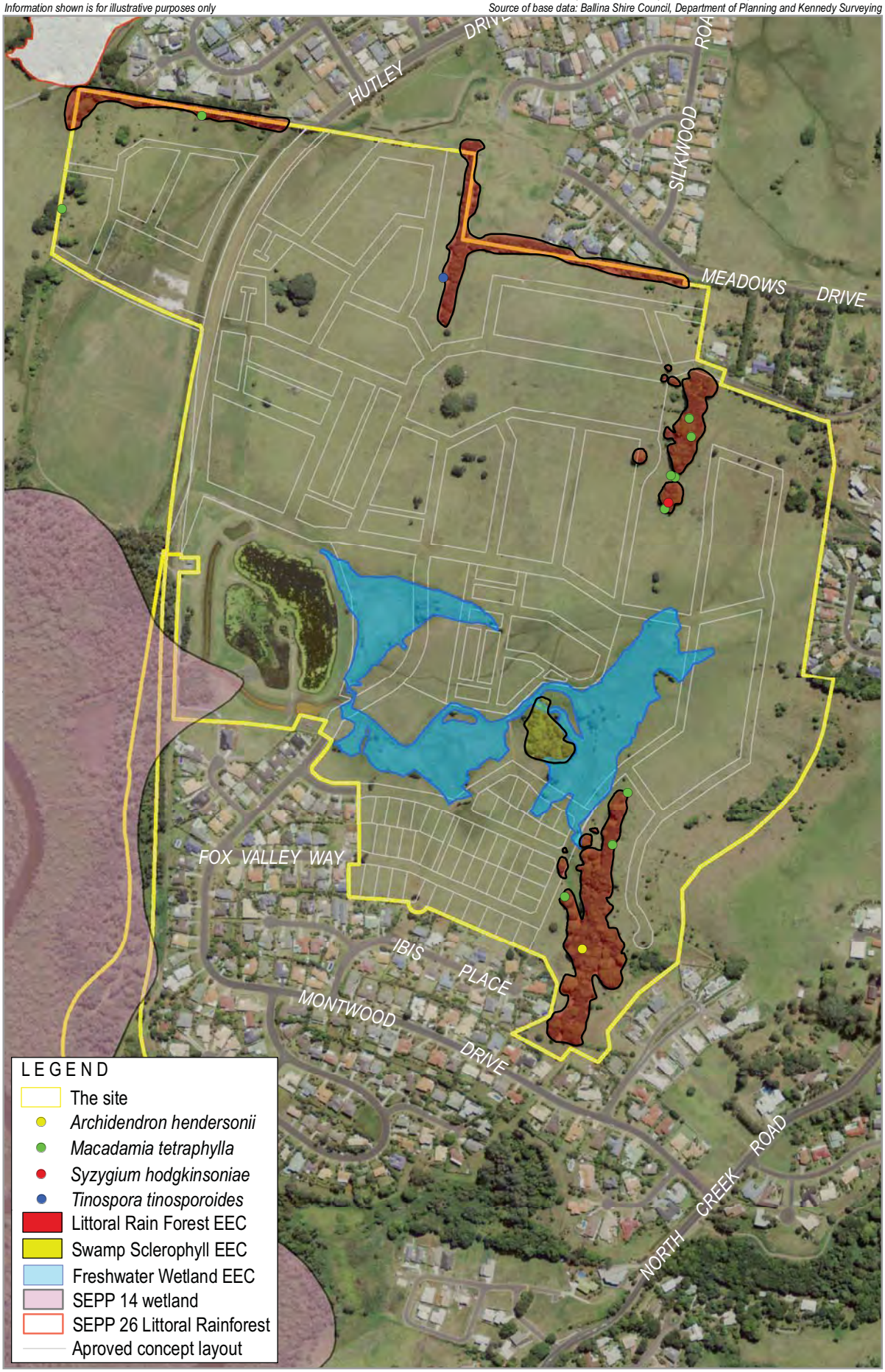

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Distribution of all EECs and Threatened Species (excluding HJG and SSSR) at the Site

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4.1 Management Zones

The Management Zones described below encompass all areas of native vegetation to be retained, rehabilitated and managed on the site.

4.1.1 Conservation Zone

The Concept Plan provides for a designated Conservation Zone of approximately 14.0 ha, which encompasses a significant proportion of habitat for Hairy Jointgrass, Square-stemmed Spike Rush, Freshwater Wetland, Swamp Sclerophyll EEC and Littoral rainforest EEC occurring within the site. The Conservation Zone will also provide an important wildlife corridor linkage between Ballina Nature Reserve in the west and other areas of retained vegetation occurring within the site.

Existing vegetation within the Conservation Zone comprises a range of wetland habitats including reedland, sedgeland and areas of dense Swamp Ricegrass (*Leersis hexandra*). An area of Swamp Sclerophyll forest, dominated by mature Broad-leaved Paperbarks (*Melaleuca quinkenervia*) and Swamp Oak (*Casuarina glauca*) occurs within the centre of the retained wetland area. A number of raised areas within and around the outer edge of the wetland area are representative of degraded pasture land.

The eastern end of this zone includes a relatively large area of littoral rainforest / Camphor Laurel forest, which is largely dominated by tall Guioa and Camphor Laurel trees. A number of threatened rainforest flora species are present within this remnant, including Rough-shelled Bush Nut, Arrow-head Vine and Red Lilly Pilly. Although native species are present in moderate abundance within the lower strata, vegetation in this area generally lacks the diversity of rainforest remnants occurring elsewhere on the site. A number of gaps, suitable for regeneration plantings are present towards the south of the zone.

Plate 4.1 Littoral Rainforest / Camphor Forest at north-eastern end of Conservation Zone

Plate 4.2 General rubbish occurring within the Littoral Rainforest

Another area of littoral rainforest / Camphor-Laurel forest is located in the south-east corner of the Conservation Zone, occurring around a drainage line / ephemeral stream. Part of this drainage line, occurring along the southern portion of the zone, provides habitat for the endangered species, Square-stemmed Spike Rush. Areas surrounding the drainage line around the middle of the zone (refer to **Plate 4.3**) provide good locations for undertaking rehabilitation plantings to enhance vegetation within this zone. Native vegetation occurring within this zone is largely dominated by Tuckeroo and Guioa although there is a relatively diverse mixture of native species within the lower strata.

Numerous weed species are present within the area including Camphor Laurel saplings, Orange Jessamine (*Murraya paniculata*), Umbrella Tree and Tropical Soda Apple (*Solanum viarum*).

Plate 4.3 Drainage line running through the centre of southern Littoral rainforest area

Management actions aimed at conserving and enhancing native vegetation and, in particular, habitat for threatened flora species and EECs within the Conservation Zone, are included within a separate Conservation Zone Management Plan (CZMP) prepared for this area. Broad management strategies to protect and manage native vegetation within this area are provided in **Section 6.1.1**.

4.1.2 Management Zone 1

Zone 1 occurs in the far north-west corner of the site and is defined as a 100 m x 100 m designated buffer area to protect an area of SEPP 26 Littoral Rainforest, occurring to the north-west of the site. The area also includes a strip of vegetation extending along the northern boundary of the site from the designated 100 m x 100 m buffer area, east to the proposed alignment of Hutley Drive (refer to **Illustration 4.1**).

Existing native vegetation within Zone 1 includes a remnant of littoral rainforest / Camphor Laurel forest occurring in the far north-western corner of the site (refer to **Plate 4.4**). Numerous native saplings are present within the lower stratum of this area as well as a suite of weed species, including Lantana (*Lantana camara*), Camphor Laurel (*Cinnamomum camphora*), Asparagus Fern (*Asparagus densiflorus*) and Silver-leaved Desmodium (*Desmodium uncinatum*). There is a relatively high diversity of native species present within this area, which is a consequence of this area being contiguous with larger areas of littoral rainforest to the north. Similar littoral rainforest vegetation and weed species are present within vegetation extending along the northern boundary of the site (refer to **Plate 4.5**).

Larger areas of cleared pasture land are present throughout much of this area, providing habitat for the threatened species, Hairy Joint Grass, which occurs in isolated patches.

Plate 4.4 Littoral rainforest / Camphor Laurel forest remnant occurring in the north-west corner of the site

Plate 4.5 Remnant littoral rainforest vegetation extending along the northern boundary of the site

4.1.3 Management Zone 2

Zone 2 is a linear strip of vegetation on the northern boundary, approximately halfway across the site and extends south for approximately 220 m (refer to **Illustration 4.1**). The area encompassing this zone has been approved for subdivision with vegetation to be retained within individual lots. The width of existing vegetation within Zone 2 varies between 2 m and 10 m and comprises a mixture of littoral rainforest species and weeds, including a number of large, mature Tuckeroo (*Cupaniopsis anacardiodes*) (refer to **Plate 4.5**). Significant weed species present include African Olive (*Olea europaea* subsp. *cuspidate*), Asparagus Fern, Winter Senna (*Senna pendula* var. *glabrata*) and Governors Plum (*Flacourtia indica*).

Given the narrow width of existing vegetation within this zone, the area is prone to edge effects, such as from increased weed infestations and exposure to light / wind. General weed control measures are to be undertaken in accordance with the Weed Management Plan (WMP) for the site to minimise weed infiltration into this zone. Despite the narrow width of this remnant, high quality portions of littoral rainforest persist in areas that cattle have not accessed.

4.1.4 Management Zone 3

Zone 3 occurs approximately 150 m to the north-west of the proposed sports fields (refer to **Illustration 4.1**) and is dominated by a large, old growth Moreton Bay Fig (*Ficus macrophylla*), shown in **Plate 4.6**. A number of mature Guoia (*Guioa semiglauca*) are present around this fig. A suite of weed species are present beneath and adjacent to the canopy of the fig, including numerous small to medium Camphor Laurel, Tobacco Bush (*Solanum mauritianum*) and Fishbone Fern (*Nephrolepis cordifolia*). A large infestation of Duranta (*Duranta erecta*) is also present within this area and appears to be spreading (refer to **Plate 4.7**).

Plate 4.6 Old growth Moreton Bay Fig dominating Zone 3

Plate 4.7 Significant weed infestation of Duranta

4.1.5 Management Zone 4

Zone 4 occurs in a central portion of the site to the north of the designated Conservation Zone (refer to **Illustration 4.1**). Native vegetation within this area is limited to three mature Moreton Bay Figs as shown in **Plate 4.8**. Additionally, pasture grasses and a number of weed species including Lantana, Tobacco Bush and Camphor Laurel saplings are present within the zone. A number of fences and cattle handling yards are currently installed in this zone.

Plate 4.8 Mature Moreton Bay Figs within Zone 4

4.1.6 Management Zone 5

Zone 5 is located to the south-west of the site (refer to **Illustration 4.1**) and occurs as a portion of vegetation along the eastern boundary of the Ballina Nature Reserve. This area comprises largely intact Swamp Oak Forest indicative of Swamp Oak Forest EEC. Dense woody weed infestations are present within this area, including Lantana, Winter Senna and Groundsel Bush (*Baccharis halimifolia*), which form dense aggregations along the eastern edge of this zone. Vines comprising Silver–leaved Desmodium, Coastal Morning Glory (*Ipomoea cairica*) and Climbing Nightshade (*Solanum seaforthianum*) are present ascending into the canopy of Swamp Oaks. Additionally, a number of Camphor Laurel and Coral Trees occur within this zone. This zone is to be managed in accordance with the Ballina Nature Reserve Plan of Management.

Plate 4.9 **Eastern edge of Swamp Oak forest occurring with Zone 5**

Plate 4.10 **Dense weed infestations within Zone 5, including Coastal Morning Glory and Lantana**

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Source of base data: Ballina Shire Council

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Location of Management Zones

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Bushfire Asset Protection Zones

A bushfire assessment for the site has been undertaken in accordance with the procedures set out in Appendix 2 of Planning for Bushfire Protection 2006 (PBP) (RFS 2006) to determine Asset Protection Zones (APZs) for the proposed development. This section provides details of the APZs required at the site and requirements for the management of these areas.

5.1 Vegetation

For bushfire assessment purposes, the vegetation classification within the site is based on the conservation and management outcomes after rehabilitation and/or revegetation for all areas of vegetation retained on the site. Bushfire vegetation classification is shown in **Illustration 5.2** and consists of:

- freshwater wetland – located centrally within the Conservation Zone;
- forested wetland – located between the SEPP 14 Wetland and the existing water quality control pond;
- rainforest – comprising both littoral rainforest and small areas of swamp sclerophyll forest. (note that for the purposes of bushfire vegetation classification under PBP 2006, the swamp sclerophyll forest areas are classified as rainforest, as these areas are less than one ha and there is significant separation between individual areas); and
- grassland – located north-west of the stormwater ponds and adjoining the eastern site boundary.

5.2 Slope

The effective slope is defined by PBP as that part of the overall slope under the vegetation assessed as being a hazard that will have the greatest influence on bushfire behaviour in relation to the development. The effective slope categories for the Conservation Zone and Management Zones were identified using the slope categories on **Illustration 5.1**, and giving consideration to whether the hazard vegetation was upslope or downslope of proposed residential areas.

5.3 Fire (Weather Area)

Ballina Shire Council is located within the 'far north coast' fire area, with a Fire Danger Index (FDI) rating of 80.

5.4 Asset Protection Zones

Based on the effective slope, FDI rating and vegetation classification on the site, **Illustration 5.2** shows the required Asset Protection Zones (APZs) to achieve compliance with PBP 2006. Note that APZs are calculated based on a Bushfire Attack Level BAL 29 for a Building Code of Australia (BCA) building of Class 1 or 2.

APZs are recommended from the vegetation providing the hazard to the building line of the adjacent proposed lots (i.e. future houses). The APZs will be located outside of the Conservation Zone, except for in the southern-most edge of that zone, where it adjoins existing housing external to the site.

APZs of 10 m are required between:

- Management Zone 1 and residential areas;
- grassland adjacent to the eastern site boundary and residential areas; and
- community use lot and the Conservation Zone and residential areas.

APZs of 15 m are required between:

- the Conservation Zone and residential areas to the south;
- the southern-most extent of the conservation zone and proposed residential areas; and
- Management Zones 2 – 4 and residential areas

An APZ of 20 m is required between:

- existing residential lots and the southern-most extent of the conservation zone, and
- between forested wetland areas of the Conservation Zone and residential areas.

At the southern-most extent of the conservation zone, there is currently a 20 m wide strip of grassland immediately inside the property boundary, adjoining existing residential lots. Establishment of the required APZ, therefore, will not require any clearing within the Conservation Zone.

As shown in **Illustration 5.2**, a gravel access track will be constructed in this area to provide access for ongoing maintenance activities.

Super Lot 5 is located adjacent to the Conservation Zone. It is intended that this super lot will be developed in the future for retirement living (subject to a separate Development Application). Retirement living is considered to be a Special Fire Protection Purpose (SFPP). As such, APZs between the development within Super Lot 5 and the Conservation Zone will comprise:

- 35 m from areas identified as freshwater wetland; and
- 40 m from areas identified as rainforest.

5.5 Management of APZs

A large proportion of APZs identified within the site occur within road reserves. In these areas, no additional management is considered essential. The developer will be responsible for establishment and management of all APZs, upon commencing construction and continuing until hand-over of the various sites as public open space or conservation areas, or to residential allotment owners. Where APZs apply within proposed residential allotments, it will ultimately be the responsibility of the owner to ensure APZs are maintained.

All APZs are located outside of the Conservation Zone. Maintenance of APZs will all occur outside of the Conservation Zone and will therefore not directly impact on the conservation objectives (see safeguards outlined below).

5.6 APZ Maintenance and Establishment

APZs should consist of open areas with minimal fuel at ground level that could be set alight by bushfire. Some trees and shrubs are permissible within the APZ, provided crown separation can be achieved and vegetation does not overhang buildings. In addition, no combustible materials (e.g., wood piles, flammable building materials) should be stored in the APZ.

Within the APZs the following measures should be undertaken:

- plant trees and shrubs that are fire retardant and do not form a continuous canopy (crown separation of approximately 2 m);
- maintain the understorey in a mown state;

- trim dead branches from any existing trees and maintain the understorey with minimal leaf litter and combustible material; and
- trim limbs of trees and shrubs to ensure they do not touch or overhang buildings.

To enhance APZs, weed management activities should be undertaken regularly to control weeds. A monitoring program should be established to trigger the need to check fuel load build-up and program appropriate fuel reduction works in a timely manner. Please refer to the RFS document *Standards for Asset Protection Zones* (RFS 2005) for more details on the establishment and maintenance of APZs.

Where APZs are made up predominantly of road reserves, the monitoring program will not be required, as the bulk of the APZ will be public road, with Council maintaining the road verge. At the southern-most edge of the Conservation Zone, the APZ and associated access track will be maintained by the proponent until hand-over of the Conservation Zone to Ballina Shire Council.

For the APZs adjacent to Management Zone 2, the APZs will be monitored and maintained by private land owners, in accordance with a restriction on the title of these lots.

Where APZs are located adjacent to the Conservation Zone or management zone, management activities should be undertaken that will not have adverse impacts on potentially occurring adjacent threatened species. Safeguards that should be implemented to ensure risks are minimised include:

- chemical spraying in these APZs should be kept to a minimum;
- herbicides used should consist of relatively low-toxicity glyphosate-based herbicides, and consisting of brands such as Roundup Biactive® or Weedmaster Duo® where the APZ is near a wet areas such as drainage lines or wetlands;
- spraying of weeds should only be undertaken during appropriate weather conditions to minimise spray drift;
- slashing should not be undertaken during very wet periods when there is the potential for water quality and erosion issues that could impact on adjacent wetland areas.

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Information shown is for illustrative purposes only

Drawn by: TJP Checked by: DGH Reviewed by:RVI Date: December 2012
Source of base data: Ballina Shire Council

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North

Slope Categories for Asset Protection Zones

GeoLINK environmental management and design

Environmental Management Plan: Pacific Pines
1675-2021

Illustration 5.1

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Information shown is for illustrative purposes only

Source of base data: Ballina Shire Council

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North

Location of Asset Protection Zones

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6

Rehabilitation Plan

6.1 Rehabilitation Actions for Management Zones

This section provides actions and methods which are to be undertaken to rehabilitate and protect all areas of retained native vegetation occurring at the site as part of the designated Management Zones shown in **Illustration 4.1**.

6.1.1 Conservation Zone

As mentioned, a specific action plan aimed at conserving and enhancing vegetation occurring within the designated Conservation Zone is provided within a separate Conservation Zone Management Plan (CZMP). Broad measures proposed to manage vegetation and to be developed during the preparation of CZMP are summarised as follows:

- initial and ongoing weed control using methods developed to minimise impacts to threatened species and sensitive environments;
- replanting of designated parts of the Conservation Zone with endemic plant species;
- salvage translocation of affected areas of Hairy Joint Grass and Square-stemmed Spike Rush at the site into designated parts of the Conservation Zone to increase the local population of both species;
- annual slashing of areas (both naturally occurring and translocated) of Hairy Joint Grass (and possibly Square-stemmed Spike Rush), to be carried out in winter to reduce biomass and mimic the disturbance - regime necessary to establish and enhance these species;
- detailed measures to maintain the hydrology of the Conservation Zone, documented as part of a Water Management Plan, which will form part of the CZMP;
- provision of a 20 m buffer, to be applied to the retained areas of freshwater wetland within the Conservation Zone to buffer impacts from adjacent areas to be developed;
- retention and rehabilitation of remnant vegetation within the littoral rainforest areas;
- eradication and ongoing control of all mature Camphor Laurel, vine and understorey weeds; and
- enhancement of the littoral rainforest remnants by planting and maintenance of rainforest species around the periphery and within gaps beneath the canopy.

6.1.2 Management Zone 1

The primary objective for Management Zone 1 is to provide a buffer zone to areas of SEPP 26 Littoral Rainforest occurring directly to the north of the site. Additionally, this area would allow for retention and extension of areas of similar littoral rainforest and associated fauna habitats as those occurring to the north of the site. The isolated individual of the threatened species Rough-shelled Bush Nut (*Macadamia tetraphylla*) that occurs just south of Management Zone 1 (**Illustration 3.4**) would have ongoing protection through a restriction on the title of the relevant block.

The broad strategy to achieve these objectives is as follows:

- retention and rehabilitation of remnant vegetation occurring in the north-west corner of the site and along the northern boundary of Zone 1.
- removal and ongoing control of weed species.
- extension of retained vegetation by planting and maintenance of a dense, unfragmented 20 m band of littoral rainforest species.
- formalising opportunities for public access and visitation on the periphery of this zone and preventing access to ecologically sensitive areas within the buffer zone.

Specific actions developed to rehabilitate this zone are included in **Table 6.1**.

Table 6.1 Management Actions for Rehabilitation of Management Zone 1

Management Zone 1		
Issue / Impact	***Management Actions***	***Timing***
Livestock currently inhibiting the recruitment of native species.	▪ Remove livestock from the site. ▪ Ensure boundary fences are intact.	On adoption of this EMP and prior to any construction commencing.
Retention and conservation of existing native vegetation (including areas of HJG)	▪ All areas of native vegetation to be retained and conserved within the Management Zone. ▪ Temporary fencing (such as star pickets and parawebbing or the like) would be installed around this zone to protect native vegetation from inadvertent impacts during the construction process. Regular (fortnightly) checks of the no-go fencing are to be undertaken to ensure fencing is kept intact during construction. ▪ Ensure there is adequate signage on the fences to indicate that the area is not to be entered or disturbed.	Prior to Stage 1B construction.
Enhance / extend areas of native vegetation	▪ Establish planting areas as defined by a 20 m wide band around existing vegetation occurring in the north-west corner and along the northern boundary of the site. ▪ Spray out weeds and grass occurring within the proposed planting areas. ▪ Plant endemic species as listed in **Table 6.6** within the proposed planting areas. ▪ Install tree guards to minimise damage to plantings from Wallabies. ▪ Undertake maintenance of plantings as outlined in **Section 6.2** of this Plan to ensure the success of revegetation works including initial watering if insufficient rainfall occurs. ▪ Undertake ongoing monitoring of rehabilitation works / weeds as prescribed by the Monitoring Plan for the site to ensure the success of revegetation works and implement adaptive management actions where required.	To be undertaken during the first spring following the commencement of construction to maximise the success of plantings.
Weed infestations are present and are likely to proliferate within area after exclusion of cattle	General weed control measures are to be undertaken in accordance with WMP for the site. Specific actions to be undertaken within Zone 1 are as follows: ▪ Eradication of all exotic vine and understorey weeds associated with remnant vegetation in the north-west corner and along the northern boundary of Zone 1. Priority understorey weed species include Silver-leafed Desmodium, Asparagus Fern and Camphor Laurel saplings. ▪ Control of all Camphor Laurel and African Olive occurring within the zone by stem injection of herbicide. Once dead, trees are to be removed to avoid potentially safety issues.	On adoption of this EMP and prior to any construction commencing. Continuing until handover of management of this area to Council (refer to **Table 6.8**).

Management Zone 1		
Issue / Impact	***Management Actions***	***Timing***
	▪ Spot spraying or hand removal of all Lantana, in particular dense infestations occurring along the edge of remnant vegetation in the north-west corner and along the northern boundary of the zone. ▪ Undertake regular and ongoing weed control as prescribed by the WMP. Undertake routine weed surveys as part of the Monitoring Plan and based on the results, recommend priorities for future weed control.	
Public access / Landscaping	▪ Provide a formalised pathway around the periphery of the site to allow for formalised access and a visitation point at the site. The location of the pathway is to be prescribed by the landscaping masterplan for the site and is to be determined in consultation with an ecologist to ensure impacts to Hairy Joint Grass are avoided. ▪ Incorporate littoral rainforest landscaping plantings into areas along the edge of the pathway. ▪ Erect signage to exclude the public from ecologically sensitive parts of the Zone (i.e. areas of HJG and littoral rainforest habitat).	Pathway construction will be undertaken to coincide with civil construction of the adjacent residential area.
Environmental education	▪ Provide interpretive signage along the formalised peripheral pathway to educate the public of the ecological values associated with the local area and develop a sense of place.	Prior to the completion of civil construction for the adjoining residential area.

6.1.3 Management Zone 2

As the area encompassing Zone 2 has been approved for subdivision and would be retained as part of lots proposed for this area, the primary objective for vegetation occurring within this zone will be retention as well as initial eradication and ongoing control of weed species. It should be noted that although in **Illustration 3.4** Littoral Rainforest vegetation is mapped as occurring on the site in a linear strip east of Management Zone 2, on the ground it is apparent that it is only the tree crowns which extend across the fence.

Specific actions developed to rehabilitate this zone are provided in **Table 6.2**.

Table 6.2 Management Actions for Rehabilitation of Management Zone 2

Management Zone 2		
Issue / Impact	***Management Actions***	***Timing***
Livestock currently inhibiting the recruitment of native species.	▪ Remove livestock from the site. ▪ Ensure boundary fences are intact.	On adoption of this EMP and prior to any construction commencing.
Retention and conservation of existing native vegetation	▪ All areas of native vegetation to be retained and conserved within the Management Zone. ▪ Temporary fencing (such as star pickets and parawebbing or the like) would be installed to protect native vegetation within the zone from inadvertent impacts during the clearing process.	Prior to Stage 2 construction.

Management Zone 2		
Issue / Impact	***Management Actions***	***Timing***
	▪ Regular (fortnightly) checks of the no-go fencing are to be undertaken to ensure fencing is kept intact during construction. ▪ Ensure there is adequate signage on the fences to indicate that the area is not to be entered or disturbed. ▪ No-go fencing is to be set back 10 metres from the outer drip line of retained vegetation to prevent the impacts of construction on tree root zones.	
Weed infestations present and likely to proliferate	General weed control measures are to be undertaken in accordance with the WMP for the site. Specific actions to be undertaken within Zone 2 are as follows: ▪ Eradication of all exotic vine and understorey weeds within the zone. Priority weeds within this zone include Governors Plum, Asparagus Fern, Lantana and Winter Senna. ▪ Staged removal of Camphor Laurel and African Olive from the zone over three years to control potential increases in edge effects. Control is to be undertaken using stem injection of herbicide. ▪ Undertake regular and ongoing weed control as prescribed by the WMP. ▪ Undertake routine weed surveys as part of the Monitoring Plan and implement adaptive management of weeds when required at the site.	On adoption of this EMP and prior to any construction commencing. Continuing until handover of management of this area to Council (refer to **Table 6.8**).

6.1.4 Management Zone 3

The primary objective within Management Zone 3 is to conserve mature native trees and create a public use area featuring the existing old growth Moreton Bay Fig. Endemic littoral rainforest species are to be incorporated into the landscaping plan for this area. Rehabilitation of this zone will incorporate the following broad strategy:

- Retention of the Moreton Bay Fig and mature native trees.
- Eradication of all weed species.
- Additional littoral rainforest plantings to be incorporated into the landscaping plan.
- Landscaping plan to prescribe details of opportunities for public usage / recreation.

Specific actions developed to rehabilitate this zone are provided in **Table 6.3**.

Table 6.3 Management Actions for Rehabilitation of Management Zone 3

Management Zone 3		
Issue / Impact	***Management Actions***	***Timing***
Livestock currently inhibiting the recruitment of native species	▪ Remove livestock from the site. ▪ Ensure boundary fences are intact.	On adoption of this EMP and prior to any construction commencing.
Retention and conservation of native vegetation	▪ Retain Moreton Bay Fig and mature native trees occurring within the zone. ▪ No-go fencing is to be set back 10 metres from the outer drip line of retained vegetation to prevent the impacts of construction on tree root zones.	Prior to construction works commencing for development within Super Lot 8

Management Zone 3		
Issue / Impact	***Management Actions***	***Timing***
	▪ An ecologist or qualified bush regenerator is required to identify and mark mature native trees to be retained within the Zone prior to construction commencing in this area.Prior to construction commencing in this area, temporary No-go fencing (such as parawebbing and star pickets or the like) is to be erected around areas of native vegetation to be retained at the site.	[Note: subdivision in this super lot will require Development Consent].
Weed infestations present and likely to proliferate within area	General weed control measures are to be undertaken in accordance with the WMP for the site. Specific actions to be undertaken within Zone 3 are as follows: ▪ Control of all Camphor Laurel occurring within the zone by stem injection of herbicide. ▪ Spraying of the large infestation of Duranta ▪ Spot spraying of all exotic vine and understorey weeds. Priority weeds within this zone include Governors Plum, Lantana, Fishbone Fern and Tobacco Bush. ▪ Undertake regular and ongoing weed control as prescribed by the WMP. ▪ Undertake routine weed surveys as part of the Monitoring Plan and implement adaptive management of weeds when required at the site.	On adoption of this EMP and prior to any construction commencing. Continuing until handover of management of this area to Council (refer to **Table 6.8**).
Landscaping	▪ Incorporate the planting of additional littoral rainforest species into the landscaping plan for the zone (refer to **Table 6.6**). ▪ The Landscaping Plan for this zone could include opportunities for public recreation, including formalised access points and pathways. ▪ Any hard landscaping features should take into account appropriate Tree Protection Zones (TPZs) for retained trees, in accordance with the relevant Australian Standards.	During construction of the residential subdivision for Super Lot 8.
Education of public	▪ Provide interpretive signage at focal points within the zone to educate the public of the ecological values associated with the local area and cultivate a sense of place.	During construction of the residential subdivision for Super Lot 8.

6.1.5 Management Zone 4

The primary objective within Management Zone 4 is to create a public use area which features and protects the three mature Moreton Bay Figs and incorporates additional endemic littoral rainforest species. Rehabilitation of this zone will incorporate the following broad strategy:

- Retention of the three mature Moreton Bay Figs.
- Eradication of all weed species.
- Additional littoral rainforest plantings to be incorporated into the landscaping plan.
- Landscaping plan to prescribe details of opportunities for public usage / recreation.

Specific actions developed to rehabilitate this zone are included in **Table 6.4**.

Table 6.4 Management Actions for Rehabilitation of Management Zone 4

Management Zone 4		
Issue / Impact	***Management Actions***	***Timing***
Livestock currently inhibiting the recruitment of native species.	▪ Remove livestock from the site. ▪ Ensure boundary fences are intact.	Commencing immediately after adoption of plan
Retention and conservation of native vegetation	▪ Retain Moreton Bay Fig. ▪ Prior to construction commencing in this area, temporary No-go fencing (such as parawebbing and star pickets or the like) is to be erected around figs to be retained. ▪ No-go fencing is to be set back 10 metres from the outer drip line of retained vegetation to prevent the impacts of construction on tree root zones.	Prior to construction commencing for Stage 2.
Weed infestations present and likely to proliferate within area	General weed control measures are to be undertaken in accordance with the WMP for the site. Specific actions to be undertaken within Zone 4 are as follows: ▪ Spot spraying of all exotic vine and understorey weeds within the zone. Priority weeds within this zone include Lantana, Tobacco Bush and Camphor Laurel saplings. ▪ Undertake regular and ongoing weed control as prescribed by the WMP. ▪ Undertake routine weed surveys as part of the Monitoring Plan and implement adaptive management of weeds when required at the site.	On adoption of this EMP and prior to any construction commencing. Continuing until handover of management of this area to Council (refer to **Table 6.8**).
Landscaping	▪ Incorporate the planting of additional littoral rainforest species into the landscaping plan for the zone (refer to **Table 6.6**). ▪ The Landscaping Plan for this zone should include opportunities for public recreation, including formalised access points and pathways. ▪ Any hard landscaping features (including pathways) should take into account appropriate Tree Protection Zones (TPZs) for retained trees, in accordance with the relevant Australian Standards.	During works proposed for Stage 2.

6.1.6 Management Zone 5

The primary objective for Management Zone 5 is to enhance areas of vegetation and fauna habitats in accordance with the Ballina Nature Reserve Management Plan. Given that the main issue within this area is the presence of dense weed infestations, rehabilitation works will be focused on ongoing weed control works, which will allow for natural recolonisation of this area by endemic species.

Specific actions developed to rehabilitate this zone are included in **Table 6.5.**

Table 6.5 Management Actions for Rehabilitation of Management Zone 5

Management Zone 5		
Issue / Impact	***Management Actions***	***Timing***
Dense weed infestations present and inhibiting the recruitment of endemic species	General weed control measures are to be undertaken in accordance with the WMP for the site. Specific actions to be undertaken within Zone 5 are as follows: ▪ Eradication of exotic vine species, in particular Silver-leaved Desmodium, Climbing Nightshade and Coastal Morning Glory. ▪ Spraying of dense areas of Lantana occurring within the understorey. Control is to progressively penetrate further within this zone each control period. ▪ Cut and paint of Groundsel Bush occurring within this area. ▪ Selective spot spraying or hand removal of additional weed species within the area including Tobacco Bush, Winter Senna etc. ▪ Control of all mature Camphor Laurel and Coral Trees occurring within the zone by stem injection of herbicide. ▪ Undertake routine weed surveys as part of the Monitoring Plan and based on the results, recommend priorities for future weed control. Working with potentially high mosquito numbers in the zone would be addressed through appropriate WHS measures, such as timing works to coincide with relatively dry periods and ensuring contractors use suitable protective clothing and insect spray.	On adoption of this EMP and prior to any construction commencing. Continuing until handover of management of this area to Council (refer to **Table 6.8**).
Minimising weed encroachment into Management Zone 5 and Ballina Nature Reserve from the existing easement to the east of Management Zone 5	▪ Slashing/ mowing of the easement is to be undertaken, at least yearly, to minimise future weed incursions into Management Zone 5 and the Reserve. *Note that the easement is outside of the project site and that these actions would be undertaken by the relevant land manager (Ballina Shire Council).*	Ongoing (all management to be undertaken by Council)

6.2 Rehabilitation Methods

6.2.1 Planting

6.2.1.1 Replanting Areas

Outside of the Conservation Zone, Management Zone 1 is the only area proposed for replanting. Details of the replanting within the Conservation Zone will be outlined in the Conservation Zone Management Plan.

6.2.1.2 Species Selection

Existing vegetation in Management Zone 1 consists of Camphor Laurel regrowth/ Littoral Rainforest EEC. The species selected for the revegetation reflect this, consisting of a variety of hardy littoral rainforest species that will relatively quickly develop a canopy and limit weed infiltration into these areas. Many of the species selected produce fruit that will provide a food resource for native fauna. The fauna-assisted dispersal of these planted species will enhance the local regeneration and species diversity of rainforest areas on the Pacific Pines site.

Plants are to be sourced from local, licensed nurseries to avoid planting stock with inadequate genetic diversity. Plants will have local provenance from seed sourced from natural wild populations as close as possible to the site.

Species numbers are determined according to the suggested spacing of plants in the manual "*Subtropical Rainforest Restoration*" produced by the Big Scrub Rainforest Landcare Group [BSRLG] (2005). An average density for rainforest plantings of 2.5 m was selected, which is in the middle of the range of 1.5 – 4 m suggested in the BSRLG guidelines. This takes into account some loss of plantings through natural attrition and that most plantings to be undertaken are relatively dense buffer plantings, aimed at enhancing the edges of the remnants. Based on this, planting densities for Management Zones have been configured and are shown in **Table 6.6**.

6.2.1.3 Planting Implementation

The following measures (taken from Bush Regeneration – Recovering Australian Landscapes [Buchanan 1994]) are to be employed as a minimum to maximise the success of proposed replantings:

- a weed free area of 500 mm either side of each plant should be established prior to planting;
- the planting hole should be prepared by loosening the soil to at least twice the depth of the plant tube;
- 100-150 grams of slow-release fertiliser suitable for native plants with appropriate low phosphorus levels should be added to each planting hole to assist in plant establishment;
- at least 5 litres of water should be allowed per plant to settle soil and provide moisture for establishment;
- appropriate mulch is to be placed around all plantings; and
- Wallaby guards or appropriate fencing are to be installed around all plantings.

Table 6.6 Planting Schedule Zone 1

Common Name	***Scientific Name***	***Number of Plants***
Total Number Of Plants / Planting Area		**1080 (0.6 ha)**
Beach Acronychia	*Acronychia imperforata*	50
Beach Bird's Eye	*Alectryon coreaceus*	50
Black Wood	*Acacia melanoxylon*	40
Blue Lilly Pilly	*Syzygium oleosum*	50
Brown Kurrajong	*Commersonia bartramia*	80
Celery Wood	*Polyscias elegans*	50
Foambark	*Jagera pseudorhus*	50
Guioa	*Guioa semiglauca*	100
Hairy Walnut	*Endiandra pubens*	50
Large Mock Olive	*Notelaea longifolia*	50
Red Kamala	*Mallotus phillipensis*	80
Riberry	*Syzygium leuhmannii*	50
Scentless Rosewood	*Synoum glandulosum*	50
Three-Veined Cryptocarya	*Cryptocarya triplinervis* var. *triplinervis*	100
Tuckeroo	*Cupaniopsis anacardiodes*	100
Umbrella Cheese Tree	*Glochidion sumatranum*	80
White Bean	*Ailanthus triphysa*	50

6.2.1.4 Maintenance of Plantings

It is expected that plantings outlined above will require general maintenance over a five year period. Beyond this period they should become self-sustaining with the exception of some regular weed control.

The primary maintenance for plantings will involve weed management, which is addressed in a separate WMP (refer to **Appendix A**). The following additional maintenance tasks will be required as a minimum:

- Watering of plants (during the first few months if insufficient rain occurs after planting).
- Replacement of mulch.
- Repair and maintenance of tree guards.
- Replacement of plants which have died.

6.2.1.5 Timing for Rehabilitation Works

A schedule for the implementation of rehabilitation plantings and maintenance tasks is provided in **Table 6.7**.

Table 6.7 Timeline of Works, Maintenance and Monitoring

Component of Work	*Commencement*	*Repeat Dates to be Undertaken*	*Time of Completion*
Initial Works			
Revegetation planting (Zone 1)	At the commencement of works for Stage 1B	Plantings to be undertaken annually in spring to replace dead plants	When handover to Council occurs (refer to **Table 6.8**).
Mulching	Immediately after planting	Replenish mulch around plants annually in spring after replacement plantings	When handover to Council occurs (refer to **Table 6.8**).
Installation of tree guards	Immediately after planting	Install tree guards annually (as needed) around replacement plantings	Immediately after planting
Watering	Water plants during and after each planting event	Watch closely for early signs of wilting and rewater the trees at approximately weekly intervals until good rain has occurred	Watering should not be necessary after 2 months following planting and / or a reasonable wet season
Maintenance			
Weed Control	To commence immediately after adoption of the EMP	Twice a year as prescribed in the WMP	Handover of management of relevant areas to Council (refer to **Table 6.8**). .
Monitoring and reporting	Baseline data collection commence immediately after adoption of the EMP	Bi-annually for the first two years and then annually thereafter as prescribed in the Monitoring Plan	As above. A report would be provided to Council on handover.

6.2.2 Weed Control / Management

Details of the general weed management measures to be implemented at the site are provided in a separate, detailed WMP (refer to **Appendix A**). All weed control is to be undertaken by qualified local bush regenerators with a current 132 C license, as required by the Office of Environment and Heritage (OEH). The

key to effective weed control and success of the rehabilitation of Management Zones will be the regular and ongoing nature of weed control at the site.

6.3 Hand-Over of Management Zones

The proposed staging for hand-over of the management zones is outlined below in **Table 6.8**. The individual areas will be dedicated to Ballina Shire Council, generally as public open space. The rehabilitation and maintenance measures outlined in this section of the EMP shall be completed prior to the formal dedication of the sites to ensure that the condition of these areas has not deteriorated in relation to the baseline monitoring condition. It is expected that a standard 12-month maintenance period will be required as part of the dedication process.

Table 6.8 Proposed Hand-Over of Management Zones

Management Zone	*Stage of Hand-Over*
Conservation Zone	5 years after the release of the final subdivision certificate for the last stage of residential subdivision, as outlined in Condition B1.
Management Zone 1	Upon release of the final subdivision certificate for the future residential subdivision of Super Lot 7 [Note: separate development consent is required for future subdivision of Super Lot 7].
Management Zone 2	This will not be public land. Vegetation will remain in rear of future residential lots, protected by way of appropriate restrictions on the title of the lots.
Management Zone 3	Upon release of the final subdivision certificate for the future residential subdivision of Super Lot 8 [Note: separate development consent is required for future subdivision of Super Lot 8].
Management Zone 4	Upon release of the final subdivision certificate for the Stage 2 residential subdivision [Note: separate development consent is required for Stage 2 subdivision].
Management Zone 5	5 years after the release of the final subdivision certificate for the last stage of residential subdivision.

7

Site Management Plan

This section provides details of the general management actions proposed for the site during the construction and operational phases of the project to:

- protect retained areas of threatened flora / fauna habitat and EECs on the site throughout the life of the project;
- conserve and enhance biodiversity values at the site;
- manage public access at the site to protect sensitive ecological features at the site;
- educate the public of the ecological significance of the broader area and encourage a sense of place for local residents; and
- provide for the ongoing management of the entire site to conserve and enhance biodiversity values.

Key aspects of the management of the site are discussed in the sections below with a summary of specific management actions for the site during the Construction and Operational phases of the project provided in **Section 8**.

7.1 Weed Control

A critical component of the protection of retained vegetation at the site and connected will be ongoing and regular weed control. An integrated strategy for weed management at the site is included within the WMP for the site which is included as **Appendix A** of this report. The Plan prescribes regular and ongoing weed control to be undertaken at the site.

7.2 Management of Public Access

7.2.1 Designated Recreation Areas

As described above, Management Zones 3 and 4 would be provided as designated recreational areas. The landscaping plan for these areas should aim to address the following principles:

- retain and protect any native vegetation within these areas;
- enhance areas of native vegetation and recreate the original ecological character of these zones by incorporating the planting of endemic species into the landscaping plan for these areas; and
- provide opportunities for interaction with natural environments in these areas.

7.2.2 Formalised Access Areas

Public access is to be controlled within Management Zones to protect sensitive ecological areas from impacts associated with increased visitation. The primary method for controlling access would be the provision of pathways around the periphery of Management Zones to provide formalised access routes. These would be prescribed and developed as part of the Landscaping Plan for the site according to the following general principles:

- the locations of peripheral pathways are to be determined in consultation with an ecologist to minimise direct and indirect impacts to native vegetation and threatened flora habitat;
- no clearing of native vegetation is to be undertaken to accommodate pathways;
- pathways are to be designed to incorporate appropriate tree root protection zones in accordance with the relevant Australian Standards;

- dense planting of endemic littoral rainforest plantings are to be prescribed by the Landscaping Plan adjacent to pathways and along the edges of retained vegetation to deter human visitation; and
- peripheral paths would be considered around the edge of the Conservation Zone if suitable areas are identified around the retained wetland area and outside of known threatened species habitat. Alternatively the peripheral path would be located within the APZ surrounding the Conservation Zone.

7.2.3 Signage

Signage is to be installed along access areas associated with Management Zones to assist in deterring human visitation within areas of native vegetation. Signage should notify residents of potential negative impacts of walking off the pathway and assist in educating residents of the ecological values of the site.

7.3 Protection of Fauna

7.3.1 Construction Phase

Key management actions to prevent injury / mortality to fauna species during the construction phase of the development include:

- ecologist pre-clearing surveys of vegetation to be cleared, in particular mature Camphor Laurels along the western boundary of the site;
- should any threatened fauna species be detected during pre-clearing surveys, OEH should be notified and a strategy is to be developed by an ecologist, in consultation with OEH to ensure no such species are impacted by the works; and
- should any injured fauna species be detected at the site, local wildlife carers (WIRES Wildlife Rescue) would be contacted to rescue and rehabilitate such species.

7.3.2 Operational Phase

Three potential fauna crossing locations connecting green space areas / fauna habitats at the site have been configured and are shown in **Illustration 7.1**. These areas would be managed according to the following principles:

- lowered speed limits are to apply in the areas of potential fauna crossing. These may require traffic calming devices or constriction of the road to effectively slow traffic; and
- appropriate signage is to be installed to notify road users of the potential for wildlife crossing within these areas.

7.4 Interpretive Signage

Interpretive are to be installed at prominent positions within each Management Zones to educate the public of the ecological values associated with the site and broader area and further develop a sense of place for residents. Subject matter for interpretive signage is to be finalised during the development of the landscaping plan in consultation with an ecologist but is to include as a minimum:

- information on the littoral rainforest community (including description, significance and fauna habitats associated with this community);
- information on the freshwater wetland community including (including description, significance and fauna habitats associated with this community;
- information on threatened flora species at the site focusing on Hairy Jointgrass (HJG) and Square-stemmed Spike Rush (SSSR);
- details of research being undertaken into HJG and SSSR as part of the research strategy (currently being determined); and
- information on wetland conservation being undertaken within the North Creek catchment by Wetland Care Australia.

7.5 Monitoring

An overarching monitoring program (refer to **Appendix C**) has been developed to monitor the health and condition of significant ecological features at the site including rehabilitation areas, weeds, threatened flora species, translocated threatened flora and compensatory area.

In summary, a combination of transect, quadrat and photograph points will be surveyed regularly at fixed locations within the Management Zones to regularly record data related to the health and condition of vegetation. Data collected throughout the construction phase will be compared to baseline data to detect changes in vegetation condition / health and allow for adaptive management responses.

Annual monitoring reports will be prepared and submitted to BSC and OEH until handover of individual public areas to Ballina Shire Council.

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Drawn by: TJP Checked by: MVE Reviewed by: DGH Date: December 2012

Information shown is for illustrative purposes only

Source of base data: Ballina Shire Council

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North

Location of Potential Fauna Crossing Points

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8

Summary of Site Management Actions

8.1 Construction Phase

Potential issues / impacts associated with the construction phase of the project are listed in **Table 8.1** as well specific management actions developed to mitigate these impacts. For the purposes of this plan, the construction phase consists of construction activities, vegetation rehabilitation works, and flora and fauna management actions that are to occur until handover of all open space to Council.

Table 8.1 Management Actions for the Construction Phase

Issue / Impact	*Management Actions*	*Timing*
Compaction to tree root zones from plant / equipment	A 10 m buffer zone is to be established from the outer edge of the drip line of any retained vegetation as a tree protection zone (TPZ) to prevent plant / equipment impacting tree root zones (see action 2 below for details of protective fencing to be erected around trees).	Prior to construction commencing
Impacts to flora / EECs from inadvertent clearing during the construction phase.	Erect temporary fencing (parawebbing and star pickets or similar) around management areas and the Conservation Zone. Fencing is to be supervised / checked by an ecologist as a hold-point prior to construction commencing to ensure that all retained areas are sufficiently protected.	Prior to construction commencing
	The location of significant vegetation / threatened species habitats to be retained on site is to be conveyed to construction personnel as part of a site induction.	Prior to construction commencing
Mortality / injury to fauna species during the clearing process.	A pre-clearing survey of any mature vegetation to be cleared is to be conducted immediately prior to clearing by an appropriately qualified ecologist (in particular mature Camphor Laurels occurring on the western boundary of the site, north of the sports fields). The aim of this survey will be to identify any fauna / nest sites within clearing areas and to relocate fauna where required. If threatened fauna species or active nest sites are located, an ecologist is to develop management strategies to ensure that such species/ active nests are not harmed during the works.	Prior to clearing of vegetation within each stage
	Should injured fauna be found on the site, local wildlife care groups and/or local veterinarians are to be contacted immediately and arrangements made for the immediate welfare of the animal. The phone number of the local WIRES group would be known to the project foremen (WIRES Northern Rivers: 66 281898). The contractor undertaking the work will be responsible for the financial cost of care / rehabilitation of any injured wildlife.	Throughout the entire construction phase
Spread and infestation of weed species (as taken from the WMP).	Priority control areas to be treated prior to works commencing with the exception of Camphor Laurels which are to be removed over a five year period.	ASAP
	All noxious weeds shall be managed in accordance with the relevant legal requirements for the far North Coast County Council area (refer to **Table 2.1**)	ASAP
	Regular control of weeds to be undertaken at the site as prescribed in Section 3.3 of the WMP.	At least every 6 months

Issue / Impact	*Management Actions*	*Timing*
	Sub-contractors to be used for weed control works are to be advised of all requirements stated within this weed management plan and ecological constraints associated with the site. These should be conveyed to the contractor by the developer as part of a toolbox induction.	Throughout the entire construction phase until handover
	Weeds species cleared would be disposed of at an appropriate green waste facility.	Throughout the entire construction phase until handover
	All vehicles / plant would be cleaned prior to working on site and before leaving site to minimise the spread of weeds.	Throughout the entire construction phase until handover
	Exposed areas of soil are to be seeded with sterile grass species to minimise weed infestations.	Throughout the entire construction phase until handover
	Regular control of weeds to be undertaken at the site as prescribed in Section 3.3 of the WMP. Control of all woody weeds by stem injection of herbicide. Once dead, trees are to be removed to avoid potentially safety issues	Every 6 months until handover
	Regular monitoring of weeds as per the Monitoring Plan for the site to be undertaken, with the results of weed monitoring to be incorporated into routine weed control activities.	Every 6 months in accordance with Monitoring Plan
	Appropriate instruction / signage is to be provided to educate residents of the need to dispose of garden waste at an approved waste transfer facility rather than within natural environments.	Prior to finishing construction of relevant stage.
	Lawn fertilisers are not be stockpiled / spread within 40 m of drainage lines to control the release of excess nutrients into natural environments.	Ongoing
Oxidation of Acid Sulfate Soils (ASS) and associated impacts to nearby waterways (e.g. reduced water pH, heavy metal toxicity, etc.).	If excavation is required below 10 m AHD, soil testing shall be undertaken to determine the presence of Acid Sulphate Soils.	Prior to construction commencing within each stage
	If Acid Sulphate Soils are detected within areas to be excavated, appropriate liming rates would be configured and treatment of soils would be undertaken in accordance with the Acid Sulfate Soils Management Plan approved for the project.	Throughout the construction phase
Potential spills / pollutants entering sensitive environments	Lawn fertilisers are not be stockpiled / spread within 40 m of drainage lines to control the release of excess nutrients into natural environments.	Ongoing
	A spill containment kit would be available at all times. All personnel would be made aware of the location of the kit and trained in its effective deployment.	Throughout the construction phase
	No dewatering is to be undertaken directly into waterways.	Throughout the construction phase

Issue / Impact	*Management Actions*	*Timing*
	Re-fuelling and handling of fuels/chemicals at the site is to be undertaken at least 50 m away from any waterway or the Conservation Zone to minimise the potential for spills and contaminants entering sensitive areas.	Throughout the construction phase
	Re-fuelling and handling of fuels is to be undertaken with a double-bunded area.	Throughout the construction phase
Impacts associated with air pollution	Vegetation or other materials are not to be burnt on site.	Ongoing
	Vehicles and equipment will be switched off when not operating.	Throughout the construction phase
Impacts associated with increased human visitation	Erect signage around management areas and the boundary of the Conservation Zone to deter people from entering these areas.	Prior to finishing construction of relevant stage.
Preventing inadvertent impacts to biodiversity from weed control works	Herbicide is not to be sprayed in windy conditions (>10 km/h) to prevent overspray entering waterways or sensitive ecological environments.	Throughout the entire construction phase
	Weedmaster Duo or Roundup Bioactive is to be used at areas in proximity to waterways / drainage lines to reduce toxicity on aquatic fauna and ecosystems.	Throughout the entire construction phase
	Weed control within the designated Conservation Zone and buffer is to be preferably undertaken using the cut/paint method or manual removal to avoid overspray affecting threatened flora species. If spraying is required within this area, works are to be undertaken during still weather with a knapsack sprayer or similar.	Throughout the entire construction phase
	Sub-contractors to be used for weed control works are to be advised of all requirements stated within this weed management plan and ecological constraints associated with the site. The management of sub-contractors will be the responsibility of the developer.	Throughout the entire construction phase
Rehabilitation and ensuring the survival of retained vegetation at the site	All measures prescribed within the VMP for the site to be undertaken.	Commencing upon approval of this plan
Minimising injury / mortality to fauna species at the site	Minimise traffic speeds within the designated fauna crossing points shown on **Illustration 7.1** by reduced speed limit signs or traffic calming devices.	Prior to finishing construction of relevant stage.
	Install wildlife crossing signs at the designated fauna crossing locations shown on **Illustration 7.1**.	Prior to finishing construction of relevant stage.
	Barbed wire fences to be avoided on the site. If required to exclude cattle, fences are to include plain top and bottom wires to minimise the potential for injury to fauna.	Ongoing.
Education and creating an appreciation of the site	Install interpretive signage as detailed in **Section 7**.	Prior to finishing construction of relevant stage

Issue / Impact	*Management Actions*	*Timing*
Maintaining the ecological character of the site	Incorporate endemic littoral rainforest plantings into the landscaping plan for areas of the site occurring off the floodplain.	Prior to finishing construction of relevant stage.
	Incorporate planting of species from forested EECs in more elevated parts of the Conservation Zone where there are no conflicts with threatened species.	Commencing upon approval of the CZMP
	Incorporate endemic wetland and floodplain species into the landscaping plan for areas of the site occurring on or near the floodplain, including within the area associated the water control ponds.	Commencing upon approval of the CZMP

Dr Tom Pollard
Ecologist
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Appendix A

Weed Management Plan

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Weed Management Plan

Pacific Pines, Lennox Head

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Version History				
UPR	***Description***	***Date Issued***	***Issued By***	***Reviewed By***
1675616	Initial Draft	9/12/2011	DGH	DSA
1675143	Draft V2	03/01/2012	DGH	RVI
1675278	Draft V3	26/06/2012	DGH	VJS
1675583	Draft V4	20/07/2012	SC	RVI
1675-1005	Final	06/09/2012	RVI	

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Introduction

1.1 Background

This Weed Management Plan (WMP) provides an integrated weed management strategy to be implemented at the Pacific Pines site, and forms part of the overarching Environmental Management Plan (EMP) and Conservation Zone Management Plan (CZMP) for the site.

1.2 Site Details

1.2.1 Vegetation Communities

The majority of the site has been subject to extensive vegetation clearance and currently supports primarily cleared paddocks used for livestock grazing. There are a number of stands of remnant vegetation throughout the site including both native and introduced species. The following vegetation communities are represented at the site:

- Pastoral Land.
- Swamp Oak Forest
- Swamp Sclerophyll Forest.
- Littoral Rainforest.
- Freshwater Wetland.

1.2.2 Significant Ecological Features

A number of threatened flora species listed under the NSW *Threatened Species Conservation Act 1996* (TSC Act) and the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) have previously been detected at the site. Additionally, vegetation communities occurring at the site are indicative of Endangered Ecological Communities (EECs) listed under the TSC Act and in some cases the EPBC Act. Threatened flora species and EECs occurring at the site are described in further detail within the overarching Environment Management Plan for the site.

1.3 Plan Aims and Objectives

1.3.1 Plan Aims

The general aim of this Weed Management Plan (WMP) is to provide an integrated weed management strategy to enable the ongoing control of all noxious, environmental and agricultural weeds at the site.

The plan aims to:

- list all weed species occurring at the site;
- map areas requiring priority weed control treatment within the site;
- outline weed control / management techniques to be implemented on the site;
- outline timeframes for weed control activities to be undertaken at the site; and
- describe a monitoring programme to detect future weed infestations at the site and a framework for prioritising control of such areas.

1.3.2 Plan Objectives

The specific objectives of works to be undertaken as part of this plan are to:

- decrease the abundance and diversity of weeds occurring within all management zones at the site; and
- prevent increased weed incursions within all areas of native vegetation to be retained at the site.

These objectives will be measured as part of the overarching monitoring program for the site to determine the success of weed control works at the site.

2

Weed Species Occurring at the Site

2.1 Introduction

As part of the preparation of this plan, a detailed weed survey was conducted at the site to locate all weed species occurring on the site and map priority areas for weed control.

Weeds are classed into broad groups depending on their characteristics and potential impacts. The main groups of weeds are:

- Noxious Weeds (as listed under the *Noxious Weeds Act 1993*);
- Weeds of National Significance (WoNS);
- National Environmental Alert List Weeds;
- Environmental Weeds; and
- Agricultural Weeds.

Thirty-seven weed species were detected at the site and are listed below in **Table 2.1**.

Table 2.1 Weeds Occurring at the Site

Family	*Scientific Name*	*Common Name*	*Listing*
Apocynaceae	*Gomphocarpus physocarpus*	Balloon Cotton Bush	
Araliaceae	*Schefflera actinophylla*	Umbrella Tree	
Asparagaceae	*Asparagus aethiopicus*	Asparagus Fern	
Asteraceae	*Ambrosia artemisiifolia*	Annual Ragweed	N5
Asteraceae	*Bidens pilosa*	Cobbler's Pegs	
Asteraceae	*Ageratina adenophora*	Crofton Weed	N4
Asteraceae	*Ageratum houstonianum*	Blue Billygoat Weed	
Asteraceae	*Ageratina riparia*	Mistflower	
Asteraceae	*Baccharis halimifolia*	Groundsel Bush	N3
Asteraceae	*Onopordum acanthium subsp. acanthium**	Scotch Thistle	
Asteraceae	*Xanthium occidentale*	Noogoora Bur	N4
Commelinaceae	*Commelina benghalensis*	Hairy Commelina	
Commelinaceae	*Tradescantia fluminensis (albiflora)*	Wandering Jew	
Davalliacea	*Nephrolepis cordifolia*	Fishbone Fern	
Dennstaedtiaceae	*Pteridium esculentum*	Bracken	
Fabaceae (Caesalpinioideae)	*Senna pendula var. glabrata*	Winter Senna	
Fabaceae	*Desmodium uncinatum*	Silver-leaved Desmodium	
Haloragaceae	*Myriophyllum aquaticum*	Parrots Feather	
Lauraceae	*Cinnamomum camphora*	Camphor Laurel	N4
Lythraceae	*Cuphea carthagenensis*	-	
Myrtaceae	*Psidium guajava*	Guava	

Family	Scientific Name	Common Name	Listing
Nymphaeaceae	*Nymphaea ceurulea*	Blue Egyptian Water Lily	
Oleaceae.	*Ligustrum lucidum*	Broad-leafed Privet	N4
Oleaceae.	*Ligustrum sinense*	Narrow-leafed Privet	N4
Oleaceae.	*Olea europaea subspecies cuspidata*	African Olive	
Ochnaceae	*Ochna serrulata*	Ochna	
Passifloraceae	*Passiflora subpeltata*	White Passionflower	
Poaceae	*Paspalum urvillei*	Vasey Grass	
Poaceae	*Setaria sphacelata*	South African Pigeon Grass	
Rutaceae	*Murraya paniculata*	Orange Jessamine	
Saliaceae	*Flacourtia indica*	Governors Plum	
Solanaceae	*Solanum mauritianum*	Wild Tobacco Bush	
Solanaceae	*Solanum linnaeanum*	Apple of Sodom	
Solanaceae	*Solanum viarum*	Tropical Soda Apple	N2
Verbenaceae	*Duranta sp*	Duranta	
Verbenaceae	*Verbena bonariensis*	Purpletop	
Verbenaceae	*Lantana camara*	Lantana	N4, WoNS
Convolvulaceae.	*Ipomoea cairica*	Coastal Morning Glory	

2.2 Listed Noxious Weed Species

Noxious weeds declared under the *Noxious Weeds Act, 1993* are required by law to be controlled by all landholders within a given control area. Nine listed 'noxious weed' species listed under the Ballina Control Area (NSW DPI, 2011) were detected at the site. One of these species, Lantana is also listed as a 'Weed of National Significance'.

No listed 'National Environmental Alert List Weeds' were detected at the site. Noxious Weeds / WoNS and relevant control requirements are listed in **Table 2.2**.

Table 2.2 Listed Noxious Weeds Occurring at the Site and Control Requirements

Scientific Name	Common Name	Listing	Extent / Location	Control Requirements
Ageratina adenophora	Crofton Weed	N4	Associated primarily with Littoral rainforest remnants and stand of Camphor Laurel. Occurring throughout the site.	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.
Ambrosia artemisifolia	Annual Ragweed	N5	Occurring throughout the site.	There are no requirements to control existing plants of Class N5 weeds. However, the weeds are "notifiable" and a range of restrictions on their sale and movement exists.

Scientific Name	Common Name	Listing	Extent / Location	Control Requirements
Baccharis halimifolia	Groundsel Bush	N3	Scattered occurrences throughout the site but some concentrations of the species in the north-western sector of the site.	The plant must be fully and continuously suppressed and destroyed.
Cinnamomum camphora	Camphor laurel	N4	Infestations primarily associated with littoral rainforest remnants occurring at the site.	As for other N4 weeds.
Lantana camara	Lantana	N4, WONS	Aggregations of Lantana occurring throughout the site but particularly concentrated in the north-western sector of the site.	As for other N4 weeds.
Ligustrum lucidum	Broad-leafed Privet	N4	Infestations primarily associated with littoral rainforest remnants occurring at the site.	As for other N4 weeds.
Ligustrum sinense	Narrow-leafed Privet	N4	Infestations primarily associated with littoral rainforest remnants occurring at the site.	As for other N4 weeds.
Solanum viarum	Tropical Soda Apple	N2	A number of juvenile plants within littoral rainforest remnant in the south-east corner of the site (conservation zone)	The plant must be eradicated from the land and the land must be kept free of the plant. The weeds are also "notifiable" and a range of restrictions on their sale and movement exist.
Xanthium spp	Noogoora Burr	N4	Small infestation located to the north of the site within pastoral land.	As for other N4 weeds.

2.3 Agricultural and Environmental Weeds

A variety of weed species that are not listed under the Noxious Weeds Act but are considered to be environmental or agricultural weeds were identified at the site. Occurrences of such species are summarised as follows:

- A number of infestations of Governors Plum (*Flacourtia indica*) are located in the lower stratum of littoral rainforest remnants occurring at the site. This species appears to proliferating at the site and should be a control priority.
- Occurrences of Asparagus Fern (*Asparagus aethiopicus*) and Silver-leaved Desmodium (*Desmodium uncinatum*) are present within the understorey of littoral rainforest remnants at the site. These species would be expected to proliferate after the exclusion of cattle from management zones.
- Infestations of Coastal Morning Glory (*Ipomoea cairica*) and Climbing Nightshade (*Solanum dulcamara*) are present within areas of Swamp Oak (*Casuarina glauca*) forest occurring along the south-western portion of the site, bordering Ballina Nature Reserve. Dense infestations of woody weeds including Lantana, Groundsel Bush, Wild Tobacco Bush (*Solanum mauritianum*) and Winter Senna (*Senna pendula var. glabrata*) are also present.

- Occurrences of Vasey Grass (*Paspalum urvillei*) and Pigeon Grass (*Setaria sphacelata*) are present around the fringes of the freshwater wetland on the site. These species would be expected to proliferate after the exclusion of cattle from the site and have the potential to out-compete the threatened species, Hairy Jointgrass (*Arthraxon hispidus*) and Square-stemmed Spike Rush (*Eleocharis tetraquetra*) which occur within the conservation zone.
- Occurrences of a number of pastoral weed including Balloon Cotton Bush (*Gomphocarpus physocarpus*), Cuphea (*Cuphea carthagensis*), Fireweed (*Senecio madagascariensis*) and Scotch Thistle (*Onopordum acanthium*) are widespread within areas of cleared grazing land at the site, but do not pose a major threat to rehabilitation of native vegetation.

2.4 Aquatic Weeds

A number of aquatic weeds were detected within drainage lines and the water control ponds at the site and would be likely to proliferate during favourable conditions. At the time of survey, these were dominated by Parrots Feather (*Myriophyllum aquaticum*) within drainage channels associated with the site and Cape Water Lily (*Nymphaea caurulea*) within the water control ponds.

The water control ponds at the site are known to have regular infestations of Cape Water Lily and Hairy Commelina (*Commelina benghalensisi*), which require removal to maintain the functioning of the ponds.

3

Impacts and Risk Assessment

3.1 Potential Impacts of the Proposal on Weeds

3.1.1 General Impacts

Environments subject to developments are prone to additional environmental pressures which can facilitate the proliferation of weed species. The principle mechanisms for weeds establishing in areas associated with developments include:

- elevated nutrients entering natural environments from stormwater run-off;
- physical disturbance to the soil from the general construction process;
- increased soil moisture from shading / reduced water infiltration;
- increased light at the margins of vegetation;
- disposal of garden waste into natural environments; and
- planting of invasive plants in new gardens.

Additionally, the removal of cattle from the site may favour the proliferation of certain weed species, particularly in areas of vegetation to be retained at the site and open areas, including the designated conservation zone.

3.1.2 Impacts During Construction

The construction phase of the project represents a high risk period for the spread and proliferation of weeds at the site. Key risks related to the spread of weeds during this stage of the project are:

- spread of weeds to / from the site or throughout the site by plant and machinery;
- weeds proliferating in exposed areas of soil after clearing or stripping of groundcovers; and
- inappropriate treatment / disposal of weeds.

3.1.3 Impacts within Areas of Retained Vegetation

The primary areas of risk for weed proliferation will be all areas of retained vegetation at the site, including the designated conservation zone. Areas of littoral rainforest and Camphor Laurel forest would be expected to experience an increase in lower storey and vine weeds, including Asparagus Fern, Silver-leaved Desmodium and Tradescantia. Additionally, shrubby weeds such as Privet, Lantana, Camphor Laurel and Governors Plum would be expected to spread if not controlled.

The spread of weeds within the conservation zone poses a particular risk due to the presence of habitat for the threatened species, Hairy Jointgrass (HJG) and Square-stemmed Spike Rush (SSSR). The removal of cattle will favour the spread of weeds, including Pigeon Grass and Vasey Grass.

Careful consideration of weed control within these areas has taken into account the need to minimise potential impacts on threatened species from the actual weed control works.

3.2 Risk Assessment for Weeds

A risk assessment, based on the Australian Standard (Risk Management - NSS4360: 1999) was prepared to determine the risk posed by weeds at the site. Each significant weed was given a risk level for the site, based on the likelihood and consequence of the spread and establishment of that weed at the site. The resultant assessment is shown in **Table 3.1**.

The risk matrix assigns the following four different levels of risk, based on the likelihood of weeds spreading if not managed, and the anticipated environmental consequence of weeds spreasing:

- (1) Low Risk – not an important issue but requiring some attention and monitoring to avoid adverse impacts;
- (2) Moderate Risk – an issue that requires regular management, resources and monitoring;
- (3) High Risk – an important issue of high priority; and
- (4) Extreme Risk – an important issue with highest priority that requires immediate planning and action

Table 3.1 Risk Assessment Matrix for weeds Occurring at the Site

Scientific Name	*Common Name*	*Likelihood*	*Consequence*	*Risk Level*
Ageratina adenophora	Crofton Weed	B	B	2
Ageratina riparia	Mistflower	B	B	2
Ageratum houstonianum	Blue Billygoat Weed	A	C	1
Ambrosia artemisiifolia	Annual Ragweed	B	C	1
Asparagus aethiopicus	**Asparagus Fern**	B	A	3
Baccharis halimifolia	**Groundsel Bush**	B	A	3
Bidens pilosa	Cobbler's Pegs	A	C	1
Cinnamomum camphora	**Camphor Laurel**	A	B	3
Commelina benghalensis	**Hairy Commelina**	A	B	3
Cuphea carthagenensis	-	A	C	1
Desmodium uncinatum	**Silver-leaved Desmodium**	B	A	3
Flacourtia indica	**Governors Plum**	A	B	3
Gomphocarpus physocarpus	Balloon Cotton Bush	B	C	1
Ipomoea cairica	**Coastal Morning Glory**	A	B	3
Lantana camara	**Lantana**	A	A	3
Ligustrum lucidum	**Broad-leafed Privet**	B	A	3
Ligustrum sinense	**Narrow-leafed Privet**	B	A	3
Murraya paniculata	Orange Jessamine	B	B	2
Myriophyllum aquaticum*	**Parrots Feather**	A	B	3
Nephrolepis cordifolia	**Fishbone Fern**	B	A	3
Nymphaea ceurulea	**Cape Water Lily**	A	B	3
Ochna serrulata	Ochna	C	C	1
Olea europaea subspecies cuspidata	**African Olive**	A	B	3
Onopordum acanthium subsp. acanthium	Scotch Thistle	C	C	1
Paspalum urvillei	**Vasey Grass**	A	A	3 (within conservation zone)
Passiflora subpeltata	White Passionflower	B	B	2
Duranta sp	**Duranta**	A	B	3
Psidium guajava	Guava	B	B	2

Scientific Name	*Common Name*	*Likelihood*	*Consequence*	*Risk Level*
Pteridium esculentum	Bracken	B	C	1
Schefflera actinophylla	Umbrella Tree	B	B	2
Senna pendula var. glabrata	**Winter Senna**	A	B	3
Setaria sphacelata	**Pigeon Grass**	A	A	3 (within conservation zone)
Solanum linnaeanum	Apple of Sodom	B	C	1
Solanum mauritianum	Wild Tobacco Bush	B	B	2
Solanum viarum	**Tropical Soda Apple**	B	A	3
Tradescantia fluminensis (albiflora)	**Wandering Jew**	A	B	3
Verbena bonariensis	Purpletop	B	C	1
Xanthium occidentale	**Noogoora Bur**	B	A	3

Note: **Likelihood:** A – Almost certain, B – Likely to occur at some stage, C – Could occur at some time, D – Unlikely to occur
Consequence: A – Major, B – Moderate, C – Minor, D – Insignificant
Bold Font: denotes weed species with risk level of **3 – High** or greater.

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Weed Control

4.1 Weed Control Actions

Based on weed surveys undertaken for the preparation of this plan and the approved Concept Plan for the development, the nominated Weed Control Areas are the Management Zones identified in the EMP, as these areas represent the greatest risk for increased weed infestations at the site.

Detailed actions to be employed within each Management Zone are provided below in **Table 4.1**, with the general control methods for all weed species potentially occurring at the site are included in **Table 4.2**.

The timing of works required within priority areas is provided in **Section 4.2**.

Table 4.1 Priority Weed Control Actions

Management Zone	*Primary Target Species*	*Actions Required*
1	Lantana, Camphor Laurel, African Olive, Asparagus Fern, Silver-leafed Desmodium	▪ Eradication of all exotic vine and understorey weeds associated with remnant vegetation in the north-west corner and along the northern boundary of Zone 1. Priority understorey weed species include Silver-leafed Desmodium, Asparagus Fern and Camphor Laurel saplings. ▪ Control of all Camphor Laurel and African Olive occurring within the zone by stem injection of herbicide (no staging required). ▪ Spot spraying all Lantana, in particular dense infestations occurring along the edge of remnant vegetation in the north-west corner and along the northern boundary of the zone. Spraying is to be undertaken in winter to avoid impacts to Hairy Joint Grass.
2	Lantana, Governors Plum, Asparagus Fern, Winter Senna, Camphor Laurel, African Olive	▪ Eradication of all exotic vine and understorey weeds within the zone. Priority weeds within this zone include Governors Plum, Asparagus Fern, Lantana and Winter Senna. ▪ Staged removal of Camphor Laurel and African Olive from the zone over three years to control potential increases in edge effects. Control is to be undertaken using stem injection of herbicide.
3	Plumbago, Governors Plum, Lantana, Fishbone Fern, Tobacco Bush	▪ Control of all Camphor Laurel occurring within the zone by stem injection of herbicide. ▪ Spraying of the large infestation of Duranta at the site. ▪ Spot spraying of all exotic vine and understorey weeds within the zone. Priority weeds within this zone include Governors Plum, Lantana, Fishbone Fern and Tobacco Bush.
4	Lantana, Camphor Laurel, Tobacco Bush,	▪ Spot spraying of all exotic vine and understorey weeds within the zone. Priority weeds within this zone include Lantana, Tobacco Bush and Camphor Laurel saplings.
5	Lantana, Winter Senna, Groundsel Bush, Coastal Morning Glory	▪ Spot spray, cut and paint and hand-weed areas of Lantana, Winter Senna depending on size. ▪ Cut and paint occurrences of Groundsel Bush. ▪ Cut and paint and hand weed areas Coastal Morning Glory and other vine weed species.

Management Zone	*Primary Target Species*	*Actions Required*
Conservation Zone	Camphor Laurel , Pigeon Grass, Vasey Grass, Lantana, African Olive, Tobacco Bush, Governors Plum, Fishbone Fern, Asparagus Fern, Silver-leaved Desmodium, Crofton Weed, Mistflower, Tropical Soda Apple, Orange Jessamine, Winter Senna.	▪ Spray, cut and paint and hand weed species (including Lantana, Tobacco Bush etc) occurring within the zone during winter to avoid impacts to Hairy Jointgrass and Square-stemmed Spike Rush. ▪ Spot spraying of Lantana, Crofton Weed and Mistflower located around the periphery of remnant vegetation. ▪ Target spot spraying of Pigeon Grass and Vasey Grass during winter using a knapsack to avoid impacts to threatened species. ▪ Control of all Camphor Laure trees and Orange Jessamine within the conservation zone using stem injection of herbicide. ▪ Eradication of all exotic vine and understorey weeds occurring associated with remnant vegetation. Priority weed species include Tropical Soda Apple, Camphor Laurel saplings, Lantana, Governors Plum, Fishbone Fern, Winter Senna, Asparagus Fern and Silver-leafed Desmodium. ▪ Selective spot-spraying of weeds associated with the drainage line in suitable conditions to avoid spraying of threatened species. These works are to be supervised by an ecologist to ensure overspray is minimised. Some hand-weeding may also be required and would be specified by the ecologist. NB. Dead woody weed material is to be removed from the site to maximise areas for rehabilitation of Hairy Jointgrass and Square-stemmed Spike Rush.

Table 4.2 Summary of Weed Control Techniques

Weed Species		*Treatment*	*Notes*
Common Name	*Scientific Name*		
Asparagus Fern	*Asparigus africanus*	Crowning, cut stems at chest height, then at ground level, spray regrowth *glyphosate* 1:50 +Protec.	Best done summer / autumn
Balloon Vine	*Cardiospermum grandiflorum*	Hand-pull small seedlings or spray with 1:50 *glyphosate*. For larger plants scrape and apply 100% *glyphosate*.	Treat all year round.
Balloon Cotton Bush	*Gomphocarpus fruticosus*	Hand-pull or spray *glyphosate* 1:100+Protec.	
Camphor Laurel	*Camphora cinnamomum*	Stem inject 1:1.5 larger trees, cut scrape and paint 1:1.5 small plants. Spray seedlings *glyphosate* 1:50+Protec.	Larger plants may require several treatments. Best treated during growing periods
Castor Oil Plant	*Ricinus communis*	Hand pull seedlings, knock down larger plants with brush hook, spray regrowth *glyphosate* 1:100 or cut, scrape and paint larger stems 1:1.5.	Treat all year round.
Cats Claw	*Macfadyena unguis-cati*	Scrape and apply 1:1.5 *glyphosate*.	Best treated summer / autumn.

Weed Species		Treatment	Notes
Common Name	**Scientific Name**		
Coastal Morning Glory	*Ipomoea cairica*	Hand pull, cut scrape and paint 1:1.5 *glyphosate*. Roll up vines, spray	
Crofton Weed	*Ageratina adenophora*	Spray *glyphosate* 1:100+Protec. Alternatively hand pull and hang up.	Treat all year round.
Duranta	*Duranta sp*	Cut, scrape and paint (1:1.5) *glyphosate* or spray *glyphosate* 1:100	
Fishbone Fern	*Nephrolepis cordifolia*	Hand-pull plant; follow up required: spray with metsulfuron (1.5 g:10 ltrs)	
Groundsel Bush	*Baccharis halimifolia*	Cut and paint 1:1.5 *glyphosate.*	Best done before flowering in autumn
Lantana	*Lantana camara*	Lop and cut, scrape and paint base 1:1.5. Spray regrowth *glyphosate* 1:100+Protec.	Treat all year round.
Large-leaved Privet	*Ligustrum lucidum*	Stem inject 1:1.5 larger trees. Cut, scrape and paint 1:1.5 small plants. Spray seedlings *glyphosate* 1:50+Protec.	Best treated summer / autumn.
Madeira Vine	*Andredera cordifolia*	Scrape as much stem as possible (on one side) and paint with 100% *glyphosate*, tubers: scrape/gouge and paint (100%): spray ground infestation 1:50 +Protec. Bag tubers.	Do not cut the stem. Treat all year round.
Mist Weed	*Ageratina riparia*	Spray *glyphosate* 1:100+Protec. Hand pull and hang up.	Treat all year round.
Ochna	*Ochna serrulata*	Cut scrape and paint 1:1.5; small plants. Spray seedlings *glyphosate* 1:50+Protec. Paint stem on larger specimens with neat glyphosate to a height of 50 cm.	Treat all year round
Orange Jessamine	*Muraya paniculata*	Cut, scrape and paint (1:1.5) *glyphosate* or spray *glyphosate* 1:100	
Pigeon Grass	*Setaria sphacelata*	Hand pull or dig up. Spray *glyphosate* 1:100+Protec.	
Small-leaved Privet	*Ligustrum sinense*	Stem inject 1:1.5 larger trees. Cut, scrape and paint 1:1.5 small plants. Spray seedlings *glyphosate* 1:50+Protec.	Best treated summer / autumn.
Silver-leaved Desmodium	*Desmodium uncinatum*	Plants : hand pull or crown, cut, scrape and paint tuberous roots (G 1:1.5). Spray *glyphosate* 1:50+Protec.	

Weed Species		Treatment	Notes
Common Name	**Scientific Name**		
Tobacco Bush	*Solanum mauritianum*	Stem inject 1:1.5 larger trees. Cut scrape and paint 1:1.5. Spray seedlings *glyphosate* 1:100+Protec.	Treat all year round.
Vasey Grass	*Paspalum urvillei*	Hand pull or dig up. Spray *glyphosate* 1:100+Protec.	
Wandering Jew	*Tradescantia fluminensis*	Collect and bag or roll and rake carefully, then compost or place in bin, or spray *glyphosate* 1:100+Protec.	
White Passionfruit	*Passiflora subpeltata*	Hand pull smaller vines, cut, scrape and paint 1:1.5. Spray regrowth *glyphosate* 1:50 + Protec®	
Winter Senna	*Senna pendula*	Hand pull young plants or spray seedlings *glyphosate* 1:50+Protec. Cut, scrape and paint 1:1.5. Stem inject large specimens 1:1.5.	

4.2 Timing of Weed Control Works

Weed control works, as prescribed by this plan are to commence upon approval of the EMP for the site. At least two weed control sessions are to be conducted each year, one being in winter to allow for some limited weed control works within the conservation zone (during the dormancy period for HJG and SSSR).

Weed control at the site will continue until handover of the public areas, or as otherwise agreed by the Department, following consideration of the results of monitoring.

4.3 Weed Control Techniques

Recommended weed control techniques are included within **Table 4.2**. Some of the factors that have been taken into account in selecting weed control techniques include the following (Big Scrub Rainforest Landcare, 2005):

- the growth habit of the weed and its means of propagation;
- the size of the weed and the time in its lifecycle;
- predicted weather / climatic conditions;
- adjacent plants including threatened species / EECs;
- whether the use of herbicide is deemed appropriate; and
- the weeds habitat value for fauna.

4.4 Monitoring

Regular monitoring of weeds would be undertaken as per the Monitoring Plan for the site (Appendix D of the EMP). The results of monitoring sessions would generate recommendations for future weed control works which are to be actioned as part of ongoing weed management at the site. The developer is to be responsible for ensuring recommendations developed as part of weed monitoring are undertaken as part of weed control activities.

4.5 Personnel Responsible for Works

The developer will be responsible for ensuring that the measures contained within this weed management plan are undertaken in accordance with the timeframes proposed.

Given that primary weed control areas are located largely within areas of retained vegetation on the site, weed control works are to be undertaken by a qualified bush regenerator with a current Section 132 C license as required by the Office of Environment and Heritage (OEH) to ensure that appropriate techniques are utilised and works are taken out in accordance with this WMP and the associated VMP.

The selected sub-contractor is to be briefed on ecologically significant areas occurring at the site and the requirements of both the WMP and VMP.

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References

Big Scrub Rainforest Landcare Group, (2005). Subtropical Rainforest Restoration.

Buchanan, R.A. (1989). Bush Regeneration. Recovering Australian Landscapes. TAFE NSW.

Department of Sustainability and Environment (2006) *Native Vegetation Revegetation planting standards* – Guidelines *for establishing native vegetation for net gain accounting.* Victorian Government, Department of Sustainability and Environment, East Melbourne.

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Appendix B

Mosquito Management Plan

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Pacific Pines
Lennox Head

Mosquito Impact Assessment
And
Mosquito Management Plan
(as part of the Environment Management Plan)

21 November 2011

For
Petrac Lennox Head Pty Ltd (Receivers and Managers Appointed)
PO Box 235, Varsity Lakes Qld 4227

Prepared by

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1.0 Introduction

Mosquito Consulting Services Pty Ltd was engaged by Petrac Lennox Head Pty Ltd (Receivers and Managers Appointed) in October 2011 to address the relevant mosquito impact and management issues listed in the Concept and Project Approval Conditions for MP 07_0026 for Pacific Pines, Lennox Head, Ballina. The specific matters so listed are:

B1: Environmental Management Plan

12) A comprehensive mosquito management plan that addresses, but is not limited to:

- *a) Details of an ongoing monitoring program;*
- *b) Breeding patterns;*
- *c) Sources of control;*
- *d) Sources of mitigation; and*
- *e) Complaint management.*

C15: Mosquito Impact Assessment

Future applications for the development of the super lots shall include a mosquito impact assessment that addresses management measures to ensure that any mosquito nuisance is reduced. Particular consideration is to be given to any alfresco dining area or beer garden proposed as part of the tavern. These assessments shall be consistent with the Mosquito Management Plan required by condition B1(11) of this approval.

This document addresses the above conditions (B1 and C15) by reviewing and revising the Mosquito Impact Assessment that appears as Appendix L of Volume 2 of the Environmental Assessment Report dated March 2008 responding to the Director General's Environmental Assessment Requirements for Mosquito Management item 6.7 (dated 18 May 2007) to:

> *"Address the potential impacts of nearby known and suspected mosquito breeding areas for future residents of the development. Include consideration of Chapter 11 of Council's Combined DCP."*

Site investigation for the original Mosquito Impact Assessment was undertaken in May 2007.

1.1 Regulatory Context of the Mosquito Impact Assessment

Ballina Shire Council addresses the potential risk of mosquito related impacts of development through its Combined Development Control Plan, Chapter 11 – Mosquito Management. Through its DCP, the council seeks to have the issue of mosquitoes appropriately considered at all relevant stages of the planning process including rezoning and development application. This impact assessment has considered the DCP in formulating the risk assessment and recommendations for mosquito management on this site.

1.2 Mosquito Management Design Philosophy

The design philosophy relative to mosquito management is to demonstrate consistency with Councils Development Control Plan for mosquito management and optimise the amenity of the development for users and neighbours. Mosquito related risks are characterised in terms of likely exposure people may experience within the development. Mosquito populations fluctuate in their seasonal abundance. When considering this, the report aims to characterise likely exposure of people within the development under normal seasonal conditions.

Controls for mosquito risk management are based in Integrated Pest Management. This uses a number of strategies together including physical layout of developments, stormwater management, community information and natural biological controls to achieve control of risks. Maximum use of passive control and minimum use of active mosquito control has been adopted for risk minimisation within this report.

2.0 Scope and Limitations of Impact Assessment

The risk assessment and recommendations within this report address Ballina Shire Council's DCP Chapter 11 in the context of the nature of this development. The assessment is based on site data gathered via mosquito collections and characterisation of potentially relevant breeding sites. Mosquito populations respond rapidly to changes in weather conditions and can increase dramatically following periods of wet and warm weather. This assessment is intended to characterise mosquito related risk during typical weather conditions. From time to time mosquito populations within the region will increase to high numbers. During such times, residents within the region may experience higher exposure to mosquitoes also.

3.0 Investigation Methodology

3.1 Mosquito Adult Collections

Mosquitos were collected in May 2007 from the Pacific Pines site using light traps set over 6 locations (Plate 2). The traps (Plate 1) were baited with CO_2 (as dry ice) and the mosquito chemo-attractant, Octenol. On a given night, 4 light traps were operated between 4 pm to 8 am on 4 occasions between 16 May and 29 May 2007. Adult mosquitoes were identified to species by microscopy by the author.

Plate 1: Pacific Pines Light Trap Sites 3, 4 and 5.

Plate 2: Location map and light trap survey points 2007 and 2003

3.2 Mosquito Larvae Collections

The Pacific Pines development site contains a number of farm drains and remnant wetlands and a large Water Quality Improvement Pond. Significantly, the development site is situated adjacent to the Ballina Nature Reserve. The Reserve is considered a potentially large source of many species of mosquitoes. Breeding habitat around the boundary of the development and the Reserve were thoroughly surveyed to characterise the likely mosquito species involved and assess their risk to future residents in the context of the proposed development layout. The design of the Water Quality Improvement Pond system was reviewed by the author in December 2003. The design of the pond was endorsed at the time and recent inspection shows it to be constructed apparently per the reviewed plans. No further comments are provided on the design of the Water Quality Improvement Pond in this report.

Breeding habitat identified on the site was sampled in May 2007. Larvae of several mosquito species were collected. Existing mosquito breeding habitat on much of the site will be eliminated by the development. The potential habitat however was surveyed in order to assess the potential benefit by reduction of mosquito productivity in the general area of the development.

Mosquito breeding habitat designated by DCP Chap 11 and identified by the author during the study about the boundary of the site and the Ballina Nature Reserve was surveyed and portions that will be undisturbed by the development identified for inclusion in risk management considerations.

4.0 Mosquito Survey Results

4.1 Weather Conditions

Weather was monitored over the duration of the survey to characterise the suitability of conditions for mosquito activity. Weather data for Ballina Airport was sourced from the Bureau of Meteorology. The minimum temperature and relative humidity recorded between 16:00 hrs and 9:00 hrs each trap night are contained in Table 1 below. Rainfall was recorded as falls in the 24 hours to 9:00 hrs summarised in table 2 below.

Table 1: Minimum temperature per trapping night between 16:00 and 9:00 hrs

Trap date	16-17/05	19-20/05	21-22/05	28-29/05
Temp ^{0}C range	22.7-13.3	20.6-10.9	18.5-12.4	20.1-12.2
RH % range	99-73	99-71	99-82	100-79

Table 2: Rainfall in the 24 hours to 9:00 hrs of the recorded date (Ballina AP).

Date	14/05	17/05	19/05	8/04	22/05	25/05	26/05	27/05	29/05
Rain mm	1.6	0.2	2.4	26.6	0.2	0.2	6.0	0.8	3.0

4.2 Adult Mosquito Collections

The mosquito species collected on each trapping night at each site location are presented in Table 3.

Table 3:

Pacific Pines Lennox Heads: Light Trap Collections 2007

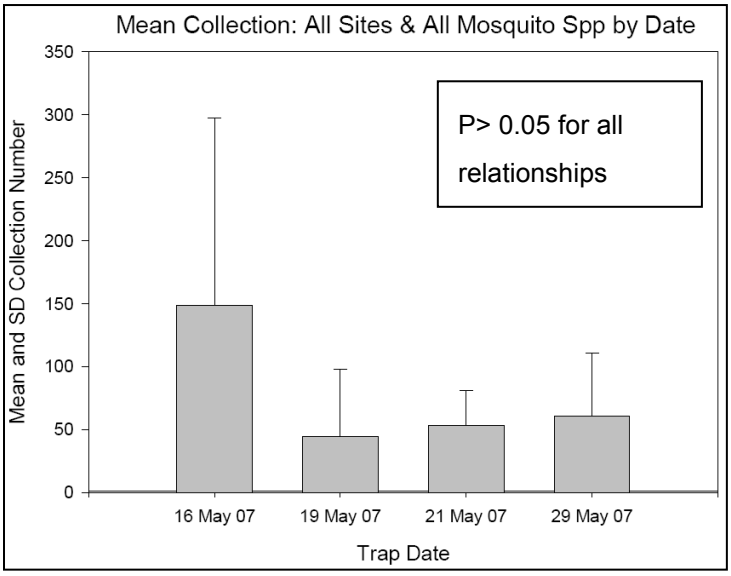
	16-17/05/07				19-20/06/07					21-22/05/07					28-29/05/07						
Species / Trap Site	No 1	No 2	No 3	Spp	No 1	No 2	No 3	No 4	Spp	No 1	No 2	No 3	No 4	Spp	No 3	No 4	No 5	No 6	Spp	TSpp	%
Ae ghanacola				0				T	0				1	1	2	2		1	5	6	0.6
Ae multiplex	10	8	28	46	1		14	R	15	7	8	18	26	59	4	8	12	18	42	162	15.7
Ae notoscriptus			14	14			5	A	5			1	6	7		9			9	35	3.4
Ae procax	1		27	28			8	P	8	1	1	4	3	9	1	1			2	47	4.6
Ae vigilax	10	5	136	151	13	2	44		59	23	2	31	7	63	3	2	1	8	14	287	27.8
An annulipies			2	2				F	0					0		1		1	2	4	0.4
Cq linealis			3	3			1	A	1		1	2		3					0	7	0.7
Cq xanthagaster				0				I	0		1			1	1				1	2	0.2
Cx annulirostris	5	3	23	31	1	2	8	L	11			3	3	6	7	5	1	8	21	69	6.7
Cx australicus		1		1				U	0	1				1					0	2	0.2
Cx edwardsi		17	24	41	2		22	R	24	5	3	22	15	45	5	1			6	116	11.2
Cx orbostiensis			6	6				E	0					0			6	6	12	18	1.7
Cx sitiens	6	3	26	35			3		3	1	4	4	2	11	3	3	3	34	43	92	8.9
Mi elegans				0					0			1		1					0	1	0.1
Ve funerea	41	15	31	87	4	2			6	5				5			27	58	85	183	17.7
Ve sp Marks 122	1			1					0					0					0	1	0.1
Trap Total	74	52	320	446	21	6	105	0	132	43	20	86	63	212	26	32	50	134	242	*1032*	*100.0*

In 14 trap-nights of collecting from Pacific Pines, a total of 1,032 mosquitoes from 6 genera and 16 species were collected across 6 locations in CO_2 and Octenol baited light traps. The four most abundant adult mosquitoes (accounting for 72.4% of the total) collected over the 14 trap-nights (by percentage and average per trap respectively) were *Aedes vigilax* (27.8% @ 21/trap), *Verrallina funerea* (17.7% @ 13/trap), *Aedes multiplex* (15.7% @ 12/trap) and *Culex edwardsi* (11.2% @ 8/trap).

A mosquito impact assessment undertaken on the adjacent site in September 2003 used three sites generally relevant to the Pacific Pines project in the context of also being on the interface with the Ballina Nature Reserve (see Plate 1 showing these trap locations in red). Data from each of these sites over 4 nights in September 2003 (using identical traps) showed they collected 400, 785 and 225 mosquitoes of all species respectively. The 4 most prevalent species from these traps were *Aedes multiplex* (49%), *Culex annulirostris* (19%), *Anopheles annulipies* (13%) and *Culex sitiens* (8.5%). The high risk mosquito *Aedes vigilax* represented only 1% of mosquitoes from these three traps.

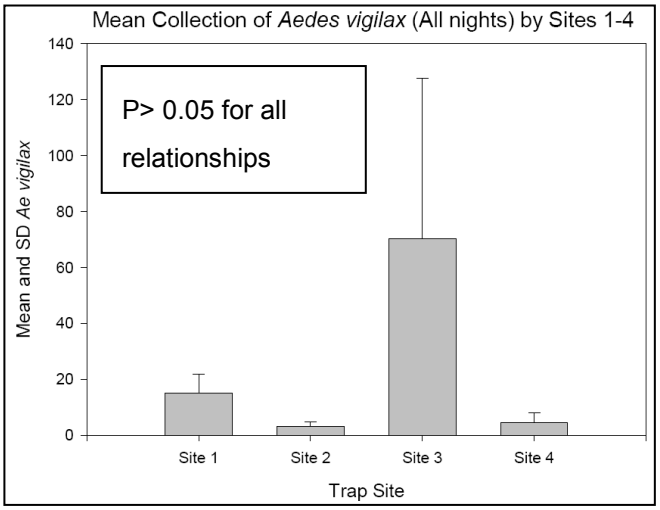
Statistical analysis of the 2007 Pacific Pines collections was undertaken to assess the consistency of data across the study. Graph 1 is the mean collections of all mosquito species for each trap date. Analysis by t-test produced P values greater than 0.05 for collections across all dates and shows there is no statistical difference in mosquito abundance between any of the collecting nights. This suggests there were no important weather differences acting to significantly suppress or amplify mosquito activity over the study period. This is consistent with the recorded similar temperature and relative humidity records for the collecting nights.

Graph 1:



Aedes vigilax is considered one of the high risk mosquito species along coastal Australia for both biting attack and disease transmission. This species was most highly represented in the study collections. This species however has a very wide distribution and its ability to disperse over many kilometres from its salt-marsh breeding habitat makes it a regional problem. The intensity of *Aedes vigilax* biting attack reduces somewhat as a function of distance from breeding habitat until a general background level of activity across a wider region is experienced. Analysis of *Aedes vigilax* collections across 4 sites on Pacific Pines was undertaken to assess if it was present in reducing intensity with increased distance from the Ballina Nature Reserve (a potential local source of breeding and harbourage) or if it was present more as generally uniform background activity. Graph 2 is the mean *Aedes vigilax* collections by trap location. Analysis by t-test showed there was no significant difference (P> 0.05) in its abundance across the 4 sites from which it is concluded to be representative of a more general background level of activity.

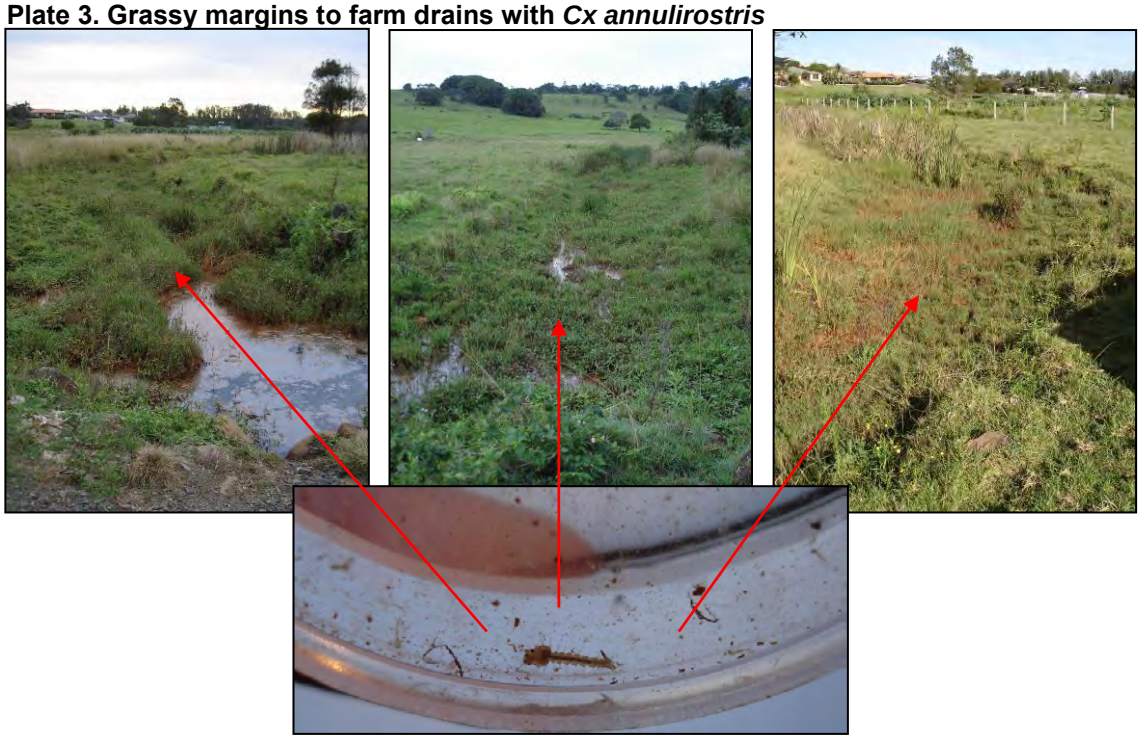
Graph 2:



4.3 Mosquito Larvae Collections

Existing on-site mosquito habitat was sampled for presence of breeding. Drains, remnant wetlands, the existing water course adjacent to proposed playing fields and the Ballina Nature Reserve boundary interface were inspected and sampled. Sampling showed that *Culex annulirostris* was breeding in grassy ground pools including the margins of portions of drains (Plate 3.)

Plate 3. Grassy margins to farm drains with *Cx annulirostris*



Remnant wetlands located around trap site 2 (Plate 2) provides potential habitat for a wide range of mosquitoes. Species from several genera including *Culex, Verrallina, Aedes,* and *Coquillettidia* were represented in trap 2. While trap 2 did not produce very large numbers of mosquitoes the potential of this habitat to produce pest numbers when flooded is regarded as high.

The boundary with the Ballina Nature Reserve contained areas of potential breeding for the important biting pest and disease vector *Verrallina funerea* (Plate 4).

Plate 4. Brackish habitat suitable for *Verrallina funerea*

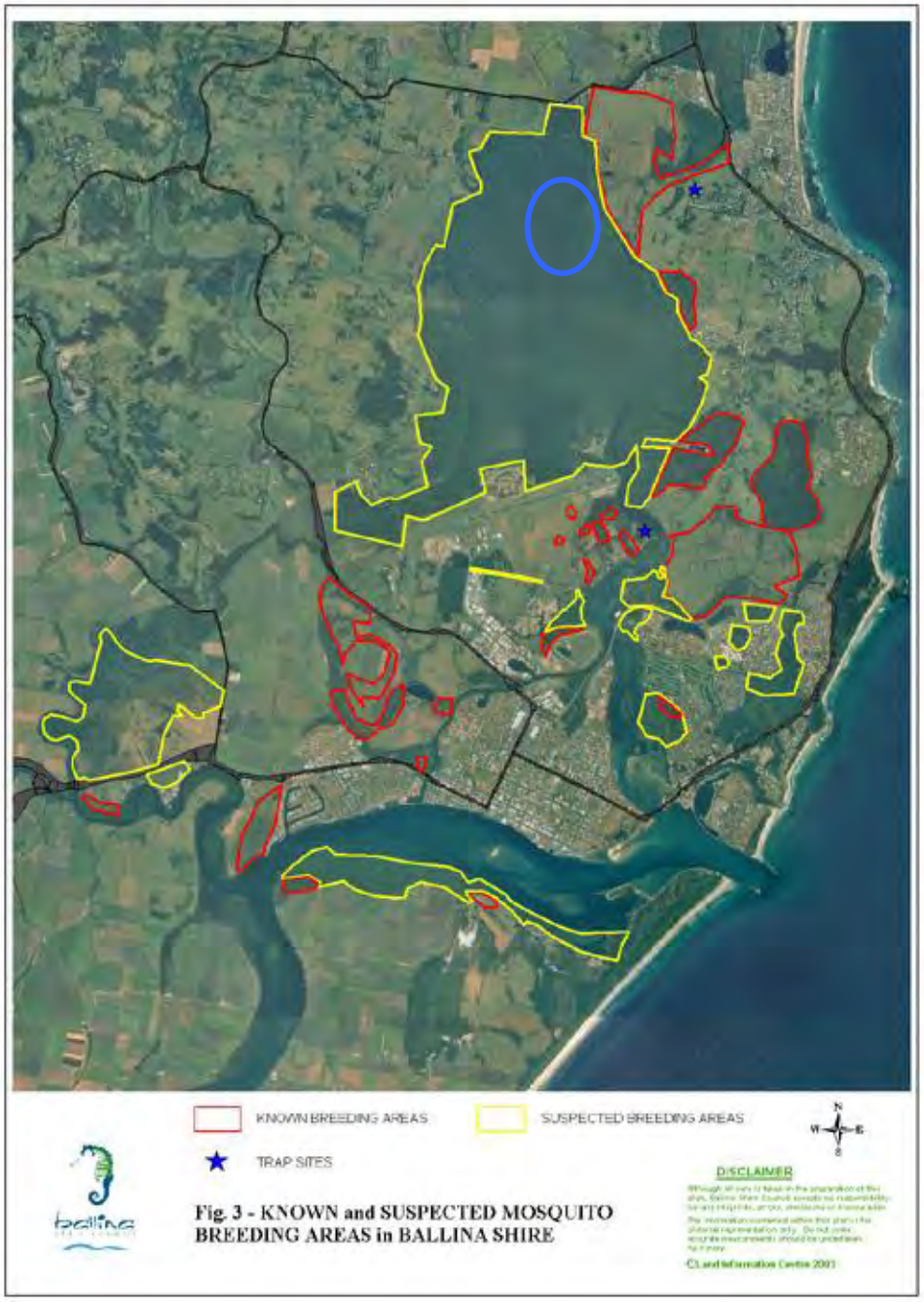
No *Verrallina funerea* breeding was found in this habitat during the study however the largest abundance adults of this species were collected in trap site 6 located at this site. This site is considered highly likely to produce *Verrallina funerea* from time to time. The habitat transitions into a small area of salt marsh. This area was considered for potential to produce *Aedes vigilax* but was assessed as very low grade habitat. Recent flooding from spring tides around 17 May 07 had flooded the site. No breeding of *Aedes vigilax* was detected. The relatively low numbers of this species recovered in traps 5 and 6 supports the conclusion that this habitat is of low productivity for *Aedes vigilax*.

A constructed watercourse east of the proposed playing fields (Plate 5) is currently ideal habitat for *Culex annulirostris*. Relatively shallow water provides opportunity for emergent grass and reeds to provide excellent breeding opportunity also for *Mansoina* and *Coquillettidia* species.

Plate 5. Existing watercourse provides excellent habitat for *Culex annulirostris*

Off site breeding locations have been identified by Ballina Shire Council in maps contained within DCP No 11 (Plate 6).

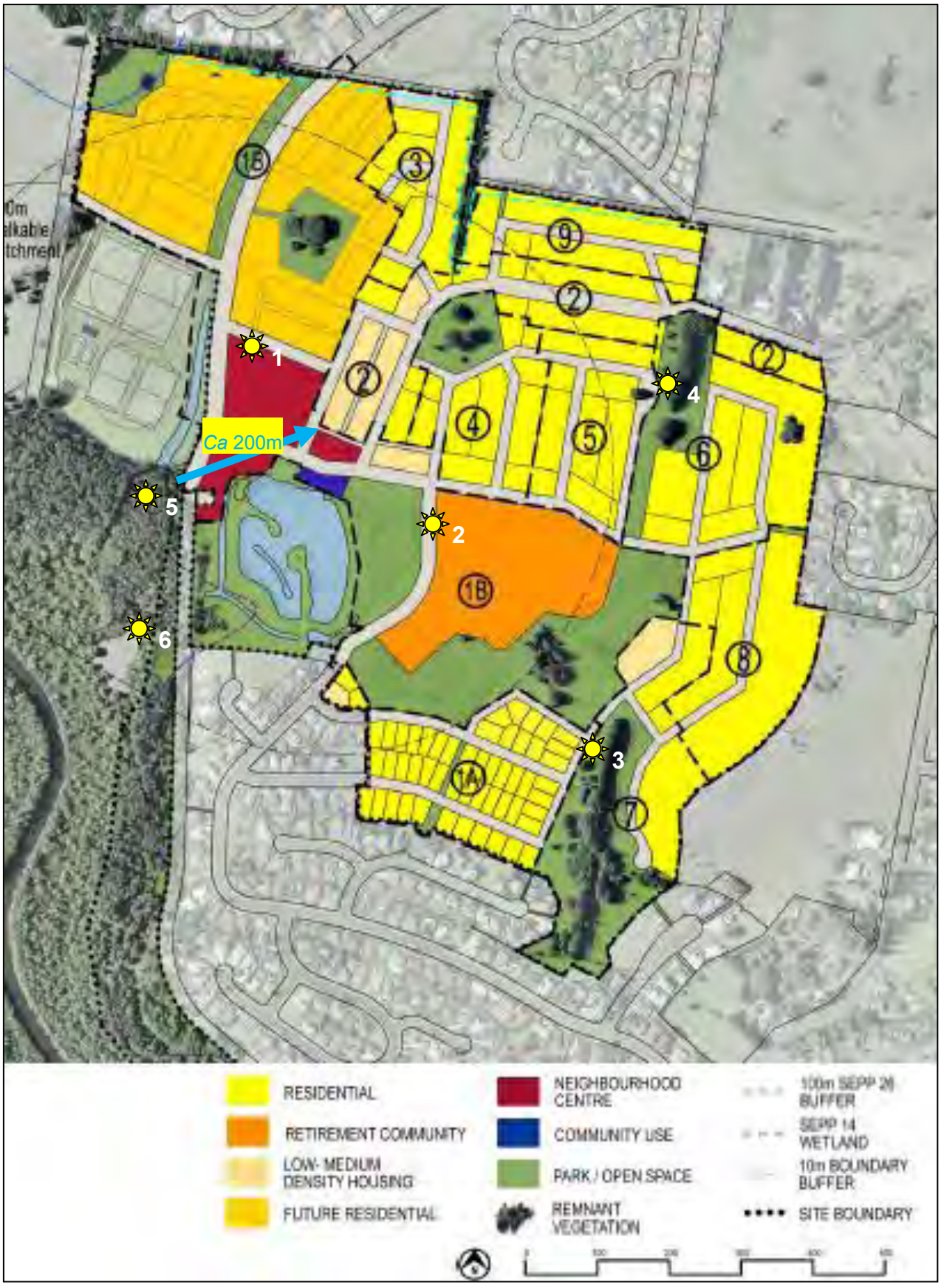
Plate 6. Ballina Shire Council DCP Chap – 11 designated breeding sites



The DCP Chap 11 identifies a known breeding site west of the development. This site was investigated and found to have greatest potential for production of *Verrallina funerea*. Relatively high numbers of *Aedes multiplex* trapped at the development site and previously on land adjoining the Ballina Nature Reserve suggest this designated site may also produce this species. There is a know association between these two species (Lee, 1984). The designated habitat does not appear suitable for significant production of *Aedes vigilax*. This conclusion is also supported by light trap from the development site and studies on adjoining land.

4.4 Proposed Urban Design

Plate 7. Development Staging Plan and Study Light Trap Locations

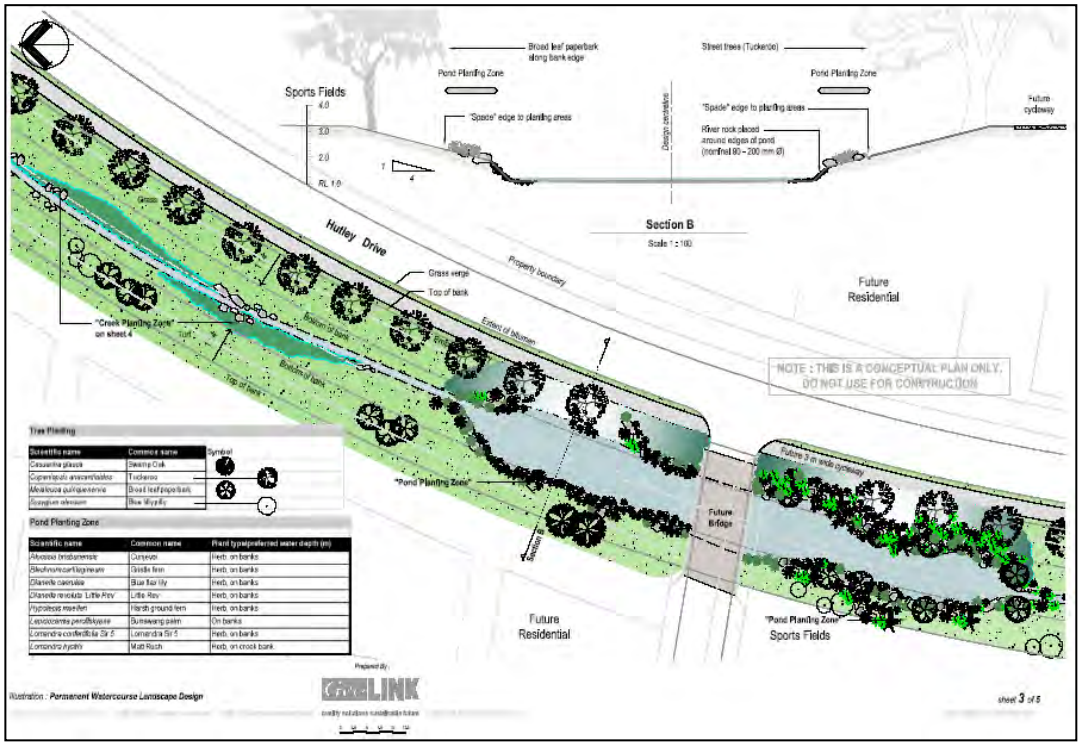


The proposed Development Staging Plan (Plate 7) has a number of features relevant to considering potential mosquito impacts to future residents. These features include:

- A 200m minimum (approx.) separation between the nearest residential allotments (Low-Medium Density Housing) and the Ballina Nature Reserve and DCP Chapter 11 designated mosquito breeding sites (see Plate 6).
- Mosquito habitat around trap 2 and existing farm drains identified as potential risk will be eliminated by the development.
- The proposed extension of Hutley Drive alignment between the Nature Reserve and Water Quality Improvement Pond increases mosquito buffering.
- A large clear space buffer will be created between residential allotments and the Nature Reserve by playing fields and the existing Water Quality Improvement Pond.
- Re-engineering of the water course per the existing DA: 2004/1113 and relative recommendations of this report will reduce mosquito breeding risk.

Plate 8 shows one of the approved conceptual views of the re-engineered watercourse.

Plate 8. Typical view of re-engineered watercourse



Much of the normal flow within the watercourse will be directed into a relatively narrow channel opening onto wider ponds. The concept plan shows no emergent vegetation and edge vegetation restricted to a narrow band. Rocks will line the narrow channel. Mosquito management is a serious concern in constructed watercourses if engineering criteria designed to

minimise mosquito breeding are not adopted. The NSW Department of Land and Water Conservation have produced The Constructed Wetlands Manual. Volume 1, Chapter 13 (pp 181-191) provides guidance for minimising mosquito breeding in such engineered watercourses. Recommendations relative to the proposed watercourse are presented in this report.

4.5 Results Discussion

Weather data recorded over the duration of the study shows that conditions were suitable for collecting adult mosquitoes with evening temperatures generally ranging in the teens and with high relative humidity. Of the known high risk mosquitoes likely to occur within Ballina Shire, only *Aedes vigilax* and *Verrallina funerea* were collected in significant numbers. Two species also in relative abundance were *Aedes multiplex* and *Culex edwardsi* but are considered of negligible risk.

High risk species that were not well represented in light trap collections but for which breeding habitat was identified on-site include *Culex annulirostris* and *Aedes procax*. Habitat for *Verrallina funerea* was identified on the site boundary with the Ballina Nature Reserve adjacent to the Water Quality Improvement Pond (Plate 4). No significant salt marsh habitat likely to produce *Aedes vigilax* was found in breeding sites designated by Ballina Shire Council's Combined DCP Chapter 11 and also adjacent to the development site. Light trap collections from the Pacific Pines site and adjacent Henderson Land (from study in 2003) shows a relatively low and more or less even distribution of *Aedes vigilax* that suggests the site is subject to typical background exposure to this very widely dispersing species from typical salt-marsh breeding sites located lower in the lower reaches of the Richmond River and North Creek.

Much of the grassy ground pool habitat identified on the site for the high risk species, *Culex annulirostris* and *Aedes procax* will be eliminated by earth works associated with the development. However habitat identified for *Verrallina funerea* adjacent to the Nature Reserve boundary will remain into the future and be preserved. Due to its presence as adults in relatively high numbers – particularly immediately adjacent to suitable breeding habitat on the Nature Reserve boundary, *Verrallina funerea* is considered likely to continue to be produced in relatively high abundance into the future. The existing watercourse adjacent to the playing fields is a source of *Culex annulirostris*. These two species are included in the assessment of future risk that will be managed by passive urban design.

6.0 Mosquito Risk Assessment

The Mosquito Risks Assessment methodology for this development was guided by the Australian and NZ standard for risk management AS/NZS 4360. It gives a framework to consider risk in a disciplined approach that can be repeated in the future to evaluate changes in risk and measure outcomes. The risk management framework follows the subsequent basic steps:

- **Identify the Hazard** (Mosquito borne disease, nuisance biting, public complaints)
- **In what Context** (The site's exposure to potential mosquito breeding, the design of the development)
- **Identify the Risks** (as a product of hazard and the likelihood of exposure)
- **Prioritise Risks** (What risks are important,)
- **Control the Important Risks**
- **Evaluate Control Effectiveness.**

6.1 Hazard Identification & Characterisation.

The identifiable hazards to the future residents of the development and the community at large include:

- Mosquito-borne disease including Ross River virus, Barmah Forest virus.
- Loss of amenity from mosquito biting activity.
- Potential future complaints to Ballina Shire Council.
- Sub-optimal economic return on property sales.

6.2 The Context of the Site Relative to the Hazards

The context of the site relative to mosquito hazards includes:

- The abundance of one important mosquito species, *Verrallina funerea* was moderate during the study but likely to become occasionally high due to good quality breeding habitat identified on the adjacent Ballina Nature Reserve boundary.
- The important species, *Aedes vigilax* was present in moderate abundance. Due to the uniform distribution across the site, it is characterised as being similar to the general seasonal background abundance for this species across the region.
- The abundance of other important mosquito species during the study was relatively low with *Aedes procax,* and *Culex annulirostris* present but not in significant numbers.
- Each of the above species is regarded as a public health risk as vectors of mosquito borne disease including Ross River virus.
- Development will eliminate most mosquito breeding habitat identified on-site.
- Placement of playing fields, the Water Quality Improvement Pond, roadways and other open space provides a minimum 200m clear buffer between the Ballina Nature Reserve and identified *Verrallina funerea* breeding habitat and the nearest residential allotments.
- *Verrallina funerea* dispersal is significantly attenuated by open space between breeding and harbourage habitat and sensitive receiving environment (residential allotments). Clear separations greater that 20 meters have been shown to significantly attenuate passage of this

species.

- Engineering specifications for the proposed watercourse should comply with DCP 11 and be subject to recommendations of this report.

6.3 Risk Assessment

The development site presents a moderate risk of exposure to a number of the important mosquito species. *Verrallina funerea* is considered the greater risk due to presence of suitable breeding habitat near to the development. Potential habitat for *Culex annulirostris* and *Aedes procax* present moderate exposure to risk also. Background abundance of *Aedes vigilax* presents a moderate risk also.

The proposed urban design of the development significantly reduces the identified risks associated with *Verrallina funerea*, *Culex annulirostris* and *Aedes procax* either due to physical separation of minimum 200m of clear open space between identified breeding habitat for the former species and residential allotments and/or elimination of breeding sites (of the former two species) within the development through urban engineering works.

The risk posed by the salt-marsh breeding *Aedes vigilax* is general and relatively common as with much of the coastal plane within Ballina Shire. Because of the long dispersal range (several kilometres) of this species, buffering of any practical dimension is of limited effectiveness. Minimisation of exposure to *Aedes vigilax* is desirable however due to its biting nuisance and disease vector status. Controls including minimising the mosquito attractiveness of street lighting, fitting insect screening to external windows and doors of dwellings and awareness of mosquito avoidance practices by residence will do much to manage this risk specifically and against all mosquitoes generally.

Mosquito production and hence the relative risk of exposure is sensitive to seasonal weather patterns. Prolonged wet weather in the warmer months can increase mosquito activity to extreme levels for periods extending from days to weeks. During such events, increased reliance on personal protection from biting mosquitoes will be necessary across the general public in the Ballina Shire region including residents of Pacific Pine.

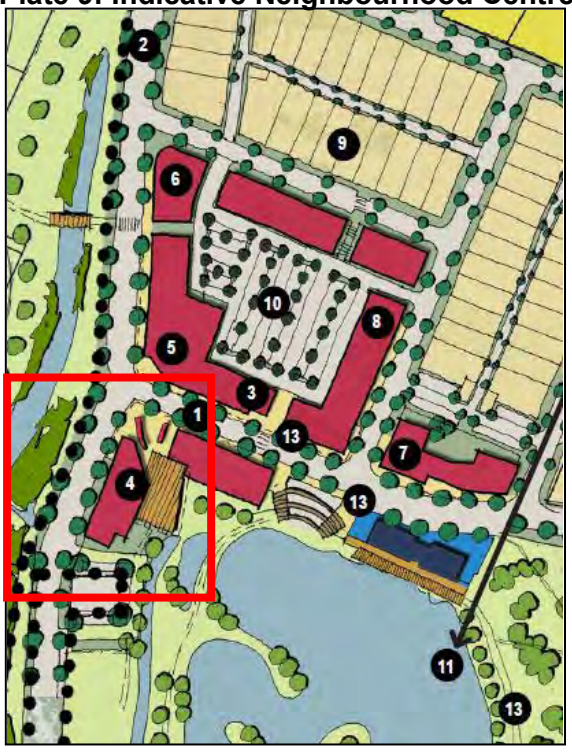
6.4 Risk Management Recommendations

- Exposure to *Verrallina funerea*, *Culex annulirostris* and *Aedes procax* will be effectively managed by development of the site eliminating ground pool breeding sites or interposing clear open space between breeding sites and residential allotments.
- Street lighting should be provided with shields or yellow filters to minimise artificial light attracting mosquitoes from the Ballina Nature Reserve into residential areas.
- Exposure to *Aedes vigilax* and mosquitoes in general will be effectively managed in residential allotments by standard type mosquito screening

fitted to residential dwelling windows and external doors to restrict entry of mosquitoes during occasional periods of high mosquito numbers.

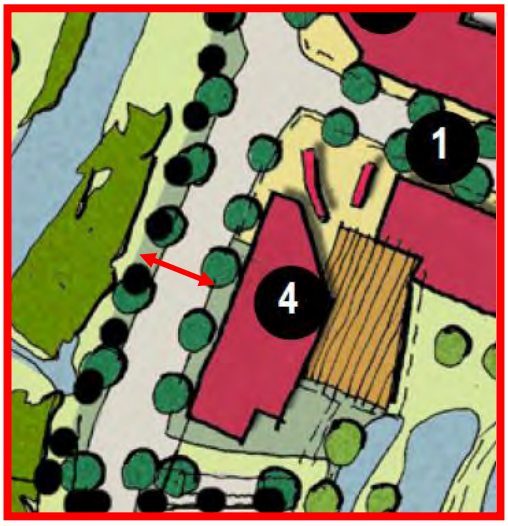
- Mosquito awareness materials should be made available to residents of Pacific Pines – as recommended generally within the Ballina coastal region.
- Rainwater tanks included (potentially) within the development should be protected by having mosquito proof screens fitted to openings including inspection openings and overflows. Such screens should be made of durable material such as stainless steel. The mesh size should not provide an aperture of more than 1mm.
- The proposed watercourse engineering specifications should include the following criteria within its design and also generally comply with The Constructed Wetland Manual Vol 1 Chap 13
    - The edge of the constructed watercourse should be as steep as practical (within the design standards for public safety) to minimise shallow water (< 500mm) suited to mosquito breeding.
    - Normal water levels within the watercourse ponds should maintain at a minimum of 500mm water depth except for the margins.
    - Open pond areas should be maintained free of emergent vegetation used by mosquito larvae as harbourage and protection from predator species such as fish.
    - Monitoring of mosquito production should be undertaken periodically to assess the performance of these mosquito management criteria.
- Mosquito management specific to the Indicative Neighbourhood Centre (Teven – alfresco dining and/or beer garden – per Plate 9) noted in Condition C15:

Plate 9: Indicative Neighbourhood Centre (Teven detail)



KEYNOTES

1. Main Street	8. Offices/service businesses
2. Hutley Drive	9. Home-based businesses
3. Retail Core	10. Rear parking
4. Tavern	11. Streets from Northern have clear view corridors to Pond
5. Medical centre	12. Public access around perimeter of Pond
6. Arts business centre	13. Indicative bus stop locations
7. Childcare centre	



- The identified risk species of mosquito relevant to this location is *Verrallina funerea*. The tavern will be generally separated from identified mosquito harbourage vegetation by the extension of Hutley Drive. The proposed 20m road reserve will serve as a buffer restricting dispersal of this species from harbourage into outdoor dining areas. The road reserve adjacent to the tavern will be vegetated only by closely mown grass and without street trees.

6.5 Responses to Condition B1 relating to Mosquito Management

Condition 12 a: Details of an ongoing monitoring program.

The risk posed by mosquitoes has been examined within the Mosquito Impact Assessment including detailed monitoring of important species and their abundance in studies conducted in 2003 and 2007. The conclusions of the assessment was that the risk of mosquito impacts was relatively low and passive control strategies as recommended by this report are reasonable to implement and control such risk under normal seasonal patterns of mosquito activity. There is no recommendation to implement an ongoing mosquito monitoring program as no active control process have been proposed that may require activation or deactivation due to changes mosquito activity.

Condition 12 b: Breeding Patterns

Detailed in Section 4.3 – Breeding Survey, and 4.5 - Results Discussion of this report.

Condition 12 c: Sources of Control

Detailed in Section 6.4 – Risk Management Recommendations of this report.

Condition 12 d: Sauces of mitigation

Detailed in Section 6.4 – Risk Management Recommendations of this report.

Condition 12 e: Complaint management

The risk posed by mosquitoes has been examined within the Mosquito Impact Assessment including detailed monitoring of important species and their abundance in studies conducted in 2003 and 2007. The conclusions of the assessment was that the risk of mosquito impacts was relatively low and passive control strategies as recommended by this report are reasonable to implement and control such risk under normal seasonal patterns of mosquito activity. There is no recommendation to implement a specific complaint management process.

7.0 Conclusions

The development of Pacific Pines provides an opportunity to eliminate a portion of the existing fresh water mosquito breeding from this land. Management of the remaining mosquito risks to the proposed development is through its design to provide open space buffers clear of any significant vegetation (apart from mown grass) by the use of playing fields, roadways and the Water Quality Improvement Pond and other open space between residential allotments and site boundary. The proposed engineered watercourse has potential to produce the important vector mosquito, *Culex annulirostris.* The recommendations for watercourse construction standards within this report, if implemented, should adequately manage this risk. Conventional use of screening on housing within the development should be a given and should be required by Council at the building application stage.

From time to time, Ballina in general experiences high numbers of mosquitoes – in particular, *Aedes vigilax* and *Culex annulirostris*. This site may also experience similar high numbers of these mosquitoes on occasions. However the evidence of mosquito collections and its location indicates the development site currently has moderate exposure reducing to relatively low exposure in its developed form. The author considers that within the limitations and savings of this report, and by following its recommendations the potential mosquito risk will be adequately managed to meet the intent of Ballina Shire Council's Combined DCP Chapter 11 and the Project MP 07-0026 Concept and Project Approval Conditions B 1 – (12) (a-e) and C15.

Darryl McGinn
Mosquito Consulting Services

References

Department of Land and Water Conservation New South Wales, 1998. The Constructed Wetlands Manual Volume 1, Chapter 13 pp 181-191.

Lee, D.J., Hicks, M.M., Griffiths, M., Russell, R.C., Marks, E.N. 1984. The Culicidae of the Australasian Region. Vol 3. pp 249-251. Aust Govt Pub Service, Canberra.

Appendix C

Monitoring Plan

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Monitoring Plan

Pacific Pines, Lennox Head

Prepared for: Royal Bank of Scotland

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Version History				
UPR	***Description***	***Date Issued***	***Issued By***	***Reviewed By***
1675618	Draft	09/12/2011	DGH	DSA
1675144	Draft V2	03/01/2012	DGH	RVI
1675447	Draft V3	26/06/2012	TJP	VJS
1675-1009	Final	06/09/2012	RVI	
1675-2004	Final v2	28/11/2012	TJP	

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1

Introduction

1.1 Background

This Monitoring Plan addresses a number of requirements within the Conditions of Approval (B1 and B2), which relate to the ongoing monitoring of ecological components of the Pacific Pines development. The plan forms part of an overarching Environmental Management Plan (EMP) for the site and also incorporates monitoring requirements for the Conservation Zone Management Plan (CZMP).

1.2 Objectives

The objectives of this monitoring plan are to:

- collect baseline data of the health and condition of the subject ecological components at the site;
- collect comparable monitoring data of the health and condition of subject ecological components of the site during and after the construction phase of the project;
- provide regular comparisons of baseline data and monitoring to identify positive or negative changes to the subject ecological components of the site;
- provide a system for the results of the monitoring plan to be incorporated into adaptive management actions, to enhance the management and conservation of ecological components of the site; and
- provide regular reporting of the results of the monitoring plan to the Office of Environment and Heritage (OEH) and Ballina Shire Council (BSC).

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2

Ecological Components Subject to Monitoring

2.1 Threatened Flora Species

A number of threatened flora species listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) occur at the site. These species are listed in **Table 2.1**.

The approved Concept Plan makes provision for the retention and protection, within designated management zones, of all areas currently occupied by four of the six threatened species. Additionally, a significant proportion of the habitat for Hairy Jointgrass [HJG] (*Arthraxon hispidus*) and Square-stemmed Spike Rush [SSSR] (*Eleocharis tetraquetra*) will be retained within the designated Conservation Zone as part of the proposal.

Further details of the location of threatened flora species at the site are provided in the overarching EMP for the site.

Table 2.1 Threatened Species Recorded at the Site

Scientific Name	*Common Name*	*TSC Act Listing*	*EPBC Act Listing*	*Habitat Occurring on-Site*
Archidendron hendersonii	White Laceflower	V	-	Littoral rainforest remnants within the site.
Arthraxon hispidus	Hairy Jointgrass	V	V	Damp areas of the site associated with seepages and wetland edges.
Eleocharis tetraquetra	Square-stemmed Spike Rush	E	-	Sedgeland / rushland.
Macadamia tetraphylla	Rough-shelled Bush Nut	V	V	Littoral rainforest remnants within the site.
Syzygium hodgkinsoniae	Red Lilly Pilly	V	V	Littoral rainforest remnants within the site.
Tinospora tinosporoides	Arrow-head Vine	V	V	Littoral rainforest remnants within the site.

2.2 Endangered Ecological Communities (EECs)

A number of Endangered Ecological Communities (EECs) listed under the TSC Act and EPBC Act occur at the site. These communities are listed in **Table 2.2**.

The approved Concept Plan makes provision for all areas of Littoral Rainforest EEC occurring at the site to be retained within management zones and within the Conservation Zone. The majority of Freshwater Wetland EEC, Swamp Sclerophyll EEC and Swamp Oak Floodplain EEC will also be retained within the designated Conservation Zone.

Table 2.2 Endangered Ecological Communities Occurring at the Site

EEC Name	*TSC Act Listing*	*EPBC Act Listing*	*Habitat Occurring on-Site*
Freshwater Wetlands of the NSW North Coast, Sydney Basin and South-east corner Bioregions	EEC	-	Sedgeland / rushland.
Littoral Rainforest in the NSW North Coast, Sydney Basin and South-east corner Bioregions	EEC	CEEC	Littoral rainforest remnants within the site.
Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-east corner Bioregions	EEC	-	Low-lying areas integrated with sedgeland / rushland.
Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South-east corner Bioregions	EEC	-	Low-lying areas integrated with sedgeland / rushland.

2.3 Weeds

A detailed Weed Management Plan (WMP) has been prepared as part of the overarching EMP. This plan details a number of noxious, environmental and agricultural weeds which occur or have potential to occur at the site. This monitoring plan provides details of the ongoing monitoring of weeds at the site and a strategy for incorporating the results of monitoring sessions into adaptive management strategies to inform future management actions for weeds.

2.4 Translocated Threatened Flora Species

As the proposal will require clearing of some areas of HJG and SSSR, a translocation project is to be implemented to assist in offsetting the loss of threatened species habitat. This project will aim to establish additional occurrences of HJG and SSSR within the designated Conservation Zone through a translocation program.

Although general details of translocation monitoring are provided in this monitoring plan, the detailed translocation methodology and monitoring protocols are detailed in the CZMP.

2.5 Rehabilitation Areas

The EMP and CZMP provide details of the actions to be undertaken for the rehabilitation and management of retained areas of native vegetation at the site. The specific objectives of works to be undertaken as part of this plan are to:

- decrease the abundance and diversity of weeds occurring within all management zones;
- increase the diversity of native flora species occurring within management zones;
- increase the cover of native vegetation within management zones; and
- maintain the health of retained threatened flora species within the management zones.

These objectives will be assessed through this monitoring plan to determine the success of the rehabilitation approach and to guide the future needs for effective management of native vegetation at the site.

3

Monitoring Methodology

3.1 Monitoring Plan Stages

The monitoring plan will comprise the following stages:

- **Pre-development**:
  - Baseline data will be collected prior to the commencement of any construction activities (with the exception of translocation areas – see below).
  - Baseline data for existing areas of HJG/SSSR will be collected during the peak growth period of these species in late Summer/Autumn (February-May).

Construction Phase:

- Monitoring events for translocated areas of HJG/SSSR will occur every two months for the first 2 years following establishment;
- Baseline data for translocated areas of HJG/SSSR will be collected at the end of the first growing season following translocation (February-May). This data will provide 'baseline / thresholds' to determine whether contingency measures will become applicable; and
- General monitoring events within the Conservation Zone will be undertaken every six months during the first 2 years of construction, and annually thereafter, until all major construction works are completed at the site.

Operational Phase:

- This monitoring phase will consist of annual monitoring for five years after the release of the final subdivision certificate or as otherwise agreed by the Department of Planning (DoP) following on from the results of the monitoring plan.

3.2 Baseline Data Collection and Monitoring Methods

The primary methods for baseline data collection and subsequent monitoring are quadrat sampling, mapping and photo point monitoring. These methods are site specific and have been designed to address the objectives outlined in **Section 1.2**. Monitoring methodology has used information from Benwell (2012), Barker (2001) and Price *et al.* (2007).

Suggested content of datasheet pro-formas to be used for quadrat monitoring are provided in **Attachment A**.

3.2.1 Quadrat Sampling in Forested Vegetation

Prior to construction commencing, a number of 10 m x 10 m quadrats will be established within representative areas of forested vegetation as shown in **Illustration 3.1**. These quadrats are identified in **Illustration 3.1** as either:

- EECs (excluding Freshwater Wetlands) quadrats;
- threatened rainforest flora quadrats; or
- combined EEC and threatened rainforest flora quadrats.

Where locating a 10 m x 10 m quadrat is not feasible due to the linear nature of an area, an elongated monitoring plot of equal area will suffice.

Prior to the collection of initial baseline data, a permanent marker, consisting of a steel star-post, will be established on the north-east corner of each quadrat and a metal tag attached indicating the quadrat number and size. This location will also be marked by GPS. The following data will be collected within each quadrat:

- flora species present (including weeds);
- life form of species (tree, tall shrub, low shrub, grass/ lily);
- average height of each strata present;
- percentage cover of all flora species, using a Braun Blanquet cover class rating, as shown in **Table 3.1**;
- the diameter at breast height (DBH) of all trees (woody plants with a DBH >10 cm);
- presence of dead plants (and identification of species if possible);
- signs of plant discoloration / disease;
- notes of any regeneration of native species occurring;
- degree of weed infestation; and
- general comments on the condition / health of vegetation community.

Table 3.1 Braun Blanquet Cover Classes

Braun Blanquet Score	*Cover Class*
1	<5%
2	5-25%
3	25-50%
4	50-75%
5	>75%

3.2.1.1 Quadrat Sampling for Threatened Rainforest Flora

White Laceflower, Rough-shelled Bush Nut, Red Lilly Pilly and Arrow-head Vine

A selection of subject threatened rainforest flora species will also be monitored by 10 m x 10 m quadrat surveys. A number of these threatened rainforest flora locations purposefully coincide with EEC monitoring locations to reduce the number of sampling locations (refer to **Illustration 3.1**).

In addition to the general data collected for 10 m x 10 m quadrats, the following data will be collected at these monitoring locations:

- confirmation of the presence of all threatened flora species. These will be numbered and marked (with metal tags) during baseline surveys to allow for comparisons of survey results;
- an assessment of foliage vigour for threatened flora species within the quadrat using the following scoring method (*1-dead, 2-poor condition / discoloured, 3-minor discoloration, 4-good condition, 5-excellent condition*);
- degree of weed infestation; and
- photographs of all threatened flora individuals within the quadrat to allow for comparisons of health / condition over time.

A summary of the timing for data collection in quadrat sampling in forested quadrats is:

- baseline data will be collected prior to construction;
- ongoing monitoring will occur every six months during the first 2 years of construction, and annually thereafter, until all major construction works are completed at the site; and
- monitoring phase will consist of annual monitoring for five years after the release of the final subdivision certificate or as otherwise agreed by the Department of Planning (DoP) following on from the results of the monitoring plan.

3.2.2 Quadrat Sampling in Treeless Vegetation

The purpose of the monitoring within these areas is to provide data on:

- the distribution, cover and health of existing occurrences of HJG and SSSR;

- the cover and health of translocated HJG and SSSR; and
- the floristics, distribution, cover and health of Freshwater Wetlands EEC;

3.2.2.1 Existing occurrences of HJG and SSSR within Freshwater Wetlands EEC

A number of 1 m x 1 m quadrats will be established in areas supporting HJG and/or SSSR within treeless communities (consisting of the Freshwater Wetland EEC and adjacent grassland community). The approximate locations of these monitoring sites are shown in **Illustration 3.1**. In addition to providing specific data on HJG and SSSR these quadrats will also provide data more broadly on the health and changes within the Freshwater Wetlands EEC.

These quadrats will be established along belt transects to assist in accurate relocation of the monitoring points. Belt transects of 10 x 2 m will be established randomly within representative areas. Each belt transect will consisting of twenty 1 m x 1 m quadrats laid out contiguously, with10 quadrats on either side of a centre line.

To assist in future location of these belt transects, prior to the collection of initial baseline data, permanent markers, consisting of steel star-posts, will be established at both the north-east and south-west corner of each of the belt transects, and a metal tag attached to the north-east post indicating the belt transect number and the size of both the quadrats and transect. The following data will be collected within each quadrat:

- flora species present (including weeds);
- life form of species (tree, tall shrub, low shrub, grass/ lily);
- average height of each strata present;
- percentage cover of all flora species estimated to the nearest 5%;
- the diameter at breast height (DBH) of all trees (woody plants with a DBH >10 cm) if present;
- presence of dead plants (and identification of species if possible);
- signs of plant discoloration / disease;
- notes of any regeneration of native species occurring; and
- general comments on the condition / health of vegetation community.

In addition to this data, the following specific data will be collected on HJG and SSSR (when present) consisting of:

- an assessment of foliage vigour for HJG and SSSR within the quadrat using the following scoring method (*1-dead, 2-poor condition / discoloured, 3-minor discoloration, 4-good condition, 5-excellent condition*); and
- photographs of example HJG and SSSR individuals within the quadrat.

3.2.2.2 HJG and SSSR translocation quadrats

Detailed methodology for monitoring the success of the translocation of HJG and SSSR will be prepared as part of the CZMP. Translocation monitoring will be quadrat-based (1 m x 1m) at approximate locations as shown in **Illustration 3.1**.

Quadrat sampling in treeless vegetation:
All quadrats except for translocation quadrats

- baseline data will be collected prior to construction during the peak growing season for HJG/SSSR [Feb-May] (except for translocation quadrats – see below);
- ongoing monitoring will occur every six months during the first 2 years of construction, and annually thereafter, until all major construction works are completed at the site; and
- monitoring phase will consist of annual monitoring for five years after the release of the final subdivision certificate or as otherwise agreed by the Department of Planning (DoP) following on from the results of the monitoring plan.

Translocation quadrats

- baseline data for HJG/SSSR translocation will be recorded during the peak growing season (Feb-May) in the subsequent year following translocation;
- Monitoring events for translocated areas of HJG/SSSR will occur every two months for the first 2 years following establishment;
- Baseline data for translocated areas of HJG/SSSR will be collected at the end of the first growing season following translocation (February-May). This data will provide 'baseline / thresholds' to determine whether contingency measures will become applicable;
- ongoing monitoring will occur annually thereafter, until all major construction works are completed at the site; and
- monitoring phase will consist of annual monitoring for five years after the release of the final subdivision certificate or as otherwise agreed by the Department of Planning (DoP) following on from the results of the monitoring plan.

3.2.3 Mapping

3.2.3.1 HJG and SSSR distribution

A target survey and mapping of HJG and SSSR will be undertaken within the Conservation Zone to coincide with the growing / seeding period for both species (February-April). Survey methods for both species will replicate the methodology used previously at this site by GeoLINK (2012). A summary of these methods is provided below.

Line transects 5 m apart will be walked within the Conservation Zone, with all locations of SSSR and HJG marked with a hand-held GPS. Where larger areas of HJG and SSSR are encountered GPS points will be taken every 2-3 m to allow for the distribution of occurrences to be identified. A GIS map layer of the distribution of threatened species within the Conservation Zone will be generated and overlayed on previous year's distributions to detect changes over time.

3.2.3.2 Freshwater Wetlands EEC Boundary

Mapping of the boundary of the Freshwater Wetlands EEC within the Conservation Zone will be undertaken annually and compared to previous baseline mapping conducted in 2011-2012 by GeoLINK. This community will be mapped on the ground by tracking the location of the boundary with a GPS. This will be supplemented by aerial photograph interpretation of the area, which will assist in validating the results.

3.2.4 Photo Point Monitoring

Photo point monitoring will be undertaken to assist in the determination of vegetation condition change. During each monitoring survey, photos will be taken at the north-east corner of each 10 x 10 m quadrat (facing south-west) and at both ends of all transects.

All photos will be taken from approximately 1.6 m above the ground and effectively display the nature of the vegetation within the quadrat or transect.

3.3 Weeds

The density of weeds within monitoring quadrats/ transects will be collected during each monitoring session. Any opportunistic observations of weeds that are located outside of specific quadrat/ transects will be recorded to inform the 'priority weed map'. The extent of these weed infestations will be recorded with a hand-held GPS unit.

A simple map showing the locations of priority weeds will be prepared for each monitoring report. This map will be provided to weed control contractors to inform future weed control works.

3.4 Translocation of Threatened Species

The detailed translocation methodology and monitoring protocols are detailed in the Pacific Pines CZMP. Methods will be quadrat-based, and will aim to provide cover data to measure the degree of success of the threatened species translocation for HJG and SSSR.

3.5 Revegetation Areas

Monitoring data will be broadly collected on the state of the revegetation areas. This information will provide information on the success or otherwise of these revegetation plantings. No set monitoring quadrats will be established for revegetation area, and instead information collected will be qualitative and consist of information such as the health of plants, evidence or damage or death of plants, the need to replace tree-guards or mulch, and the degree of weed infestation. This data will feed into maintenance requirements for the revegetation areas, including weed control and replacement plantings.

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Information shown is for illustrative purposes only

Drawn by: TJP Checked by: MVE Reviewed by: RVI Date: December 2012
Source of base data: Ballina Shire Council

0 150

North

Proposed Monitoring Locations

GeoLINK environmental management and design

Monitoring Plan: Pacific Pines
1675-2009

Illustration 3.1

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4

Data Analysis, Reporting and Adaptive Management

4.1 Data Analysis

Data collected during the construction and operational phases will be directly compared to baseline data to detect changes in the health / condition of vegetation. Key indicators of change are:

- changes in native vegetation species numbers and structure;
- changes in exotic species numbers, cover and structure;
- changes in species assemblage;
- changes in EEC boundaries;
- a substantial change in the number of dead plants (not attributable to seasonal die-off); and
- signs of discolouring or poor health in plants.

After the initial baseline monitoring data collection, the ecologist / botanist will be required to compare monitoring results to baseline data to determine:

- if any the above changes are occurring;
- if the change is positive or negative in terms of biodiversity values; and
- if required, to identify necessary management actions to mitigate against negative impacts on biodiversity values. Any required additions or modifications to the monitoring plan should also be stated.

When changes in vegetation condition have been identified through monitoring, it is important to remember that ecosystems are dynamic and ecological changes occur in response to natural process (e.g. drought, HJG dies off over winter). Therefore natural variations in vegetation will be considered during data analysis.

4.2 Reporting

The results of monitoring events will be incorporated into reports to be provided to OEH and BSC no later than two months after monitoring sessions are undertaken. These reports will be prepared bi-annually for the first two years and annually thereafter.

Monitoring reports will include but not be limited to the following key sections:

- **Monitoring Results** – including(but not limited to) summary of findings, raw data, and sample comparisons of photo monitoring points;
- **Analysis** - including (but not limited to) a direct comparison of previous monitoring results, with a particular focus on the indicators of change identified in **Section 4.1**. Analysis will also include identification of any changes to subject components of the site and a discussion of the likely causes of such changes; and
- **Recommendations** - including (but not limited to) management actions required to be implemented to ameliorate any potential negative impacts that are identified as part of monitoring, including the provision of a simple priority weed map to be provided to weed control contractors.

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5

Monitoring Timing and Project Responsibility

5.1 Timing

5.1.1 Quadrat sampling in forested quadrats

- baseline data will be collected prior to construction;
- ongoing monitoring will occur every six months during the first 2 years of construction, and annually thereafter, until all major construction works are completed at the site; and
- monitoring phase will consist of annual monitoring for five years after the release of the final subdivision certificate or as otherwise agreed by the Department of Planning (DoP) following on from the results of the monitoring plan.

5.1.2 Quadrat sampling in treeless quadrats

All quadrats except for translocation quadrats

- baseline data will be collected prior to construction during the peak growing season for HJG/SSSR [Feb-May] (except for translocation quadrats – see below);
- ongoing monitoring will occur every six months during the first 2 years of construction, and annually thereafter, until all major construction works are completed at the site; and
- monitoring phase will consist of annual monitoring for five years after the release of the final subdivision certificate or as otherwise agreed by the Department of Planning (DoP) following on from the results of the monitoring plan.

Translocation quadrats

- baseline data for HJG/SSSR translocation will be recorded during the peak growing season (Feb-May) in the subsequent year following translocation;
- Monitoring events for translocated areas of HJG/SSSR will occur every two months for the first 2 years following establishment;
- Baseline data for translocated areas of HJG/SSSR will be collected at the end of the first growing season following translocation (February-May). This data will provide 'baseline / thresholds' to determine whether contingency measures will become applicable;
- ongoing monitoring will occur annually thereafter, until all major construction works are completed at the site; and
- monitoring phase will consist of annual monitoring for five years after the release of the final subdivision certificate or as otherwise agreed by the Department of Planning (DoP) following on from the results of the monitoring plan.

5.1.3 Mapping

HJG and SSSR distribution mapping and mapping of the boundary of the Freshwater Wetlands EEC is to occur annually (during the peak growing season of HJG/SSSR in Feb-May).

5.2 Project Responsibility

5.2.1 The Developer

The developer will be responsible for funding and managing the monitoring program. They will be responsible for engaging a suitably qualified ecologist or botanist to undertake the monitoring work and ensure that regular reports are submitted to OEH and BSC within two months of completing each monitoring event.

5.2.2 Ecological/ Botanical Consultant

Any ecological/ botanical consultant contracted to undertake the monitoring work will be responsible for ensuring consistency with the monitoring methodology as detailed in this monitoring plan. This is important to ensure that data derived from the monitoring program is accurate and comparable and can readily detect changes in vegetation condition of the site.

References

Barker, P. (2001). *A Technical Manual for Vegetation Monitoring*. Resource Management and Conservation, Department of Primary Industries, Water and Environment, Hobart.

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Attachment A

Datasheets / Proformas

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Table A.1 Quadrat Monitoring Field Data Sheet (10 m x 10 m quadrats)

Date:	Person/s undertaking monitoring:	Quadrat Number:	Easting and northing of north-eastern corner (GDA 94):		
Vegetation Community:					
General comments on degree of weed infestation, health of vegetation etc:					
Photo point details:					
Canopy					
Species	^Cover Class (Braun-Blanquet)	*Life-form	Average Height (m)	Diameter at Breast Height (DBH) (cm)	Comments
Mid-Stratum					
Species	^Cover Class (Braun-Blanquet)	*Life-form	Average Height (m)	Diameter at Breast Height (DBH) (cm)	Comments

Ground Cover					
Species	^Cover Class (Braun-Blanquet)	*Life-form	Average height (m)	n/a	Comments
Threatened Species					
Species	Code/Number	Height (m)	Diameter at Breast Height (DBH) (cm)	#Foliage Vigour (1-5)	Evidence of Recruitment / Reproduction

Foliage Vigour (1-dead, 2-poor condition / discoloured, 3-minor discoloration, 4-good condition, 5-excellent condition).
^ Braun Blanquet Cover Classes (1 - <5%, 2 – 5-<25%, 3 – 25-<50%, 4 – 50-75%, 5 - >75%)
* Life-forms (tree - >10 cm DBH and >5 m height; tall shrub - 1-5 m height; small shrub - <1 m height; grass/lily – low-growing monocots)

Table A.2 Quadrat Monitoring Field Data Sheet (1 m x 1 m quadrats)

Date:	Person/s undertaking monitoring:	Quadrat or Belt Transect Number:	Easting and northing of north-eastern corner (GDA 94):		
Vegetation Community:					
General comments on degree of weed infestation, health of vegetation etc:					
Photo point details:					
Trees (if present)					
Species	Cover (to nearest 5%)	*Life-form	Average Height (m)	Diameter at Breast Height (DBH) (cm)	Comments
Mid-Stratum (if present)					
Species	Cover (to nearest 5%)	*Life-form	Average Height (m)	Diameter at Breast Height (DBH) (cm)	Comments
Ground Cover					
Species	Cover (to nearest 5%)	*Life-form	Average height (m)	n/a	Comments

Threatened Species (HJG or SSSR)					
Species	Code/Number	Height (m)	#Foliage Vigour (1-5)	Evidence of Recruitment / Reproduction	Comments

Foliage Vigour (1-dead, 2-poor condition / discoloured, 3-minor discoloration, 4-good condition, 5-excellent condition).
* Life-forms (tree - >10 cm DBH and >5 m height; tall shrub - 1-5 m height; small shrub - <1 m height; grass/lily – low-growing monocots)