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Mosquito Risk Assessment

Pacific Pines
Lennox Head

Mosquito Impact Assessment
May 2007

For

PETRAC
PO Box 3910
South Brisbane Qld 4101

Prepared by

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1.0 Introduction

Mosquito Consulting Services Pty Ltd was engaged by PETRAC in May 2007 to provide a mosquito impact assessment on its development Pacific Pines, Lennox Head, Ballina. This impact assessment addresses the Director General's Environmental Assessment Requirements for Mosquito Management item 6.7 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 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 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.

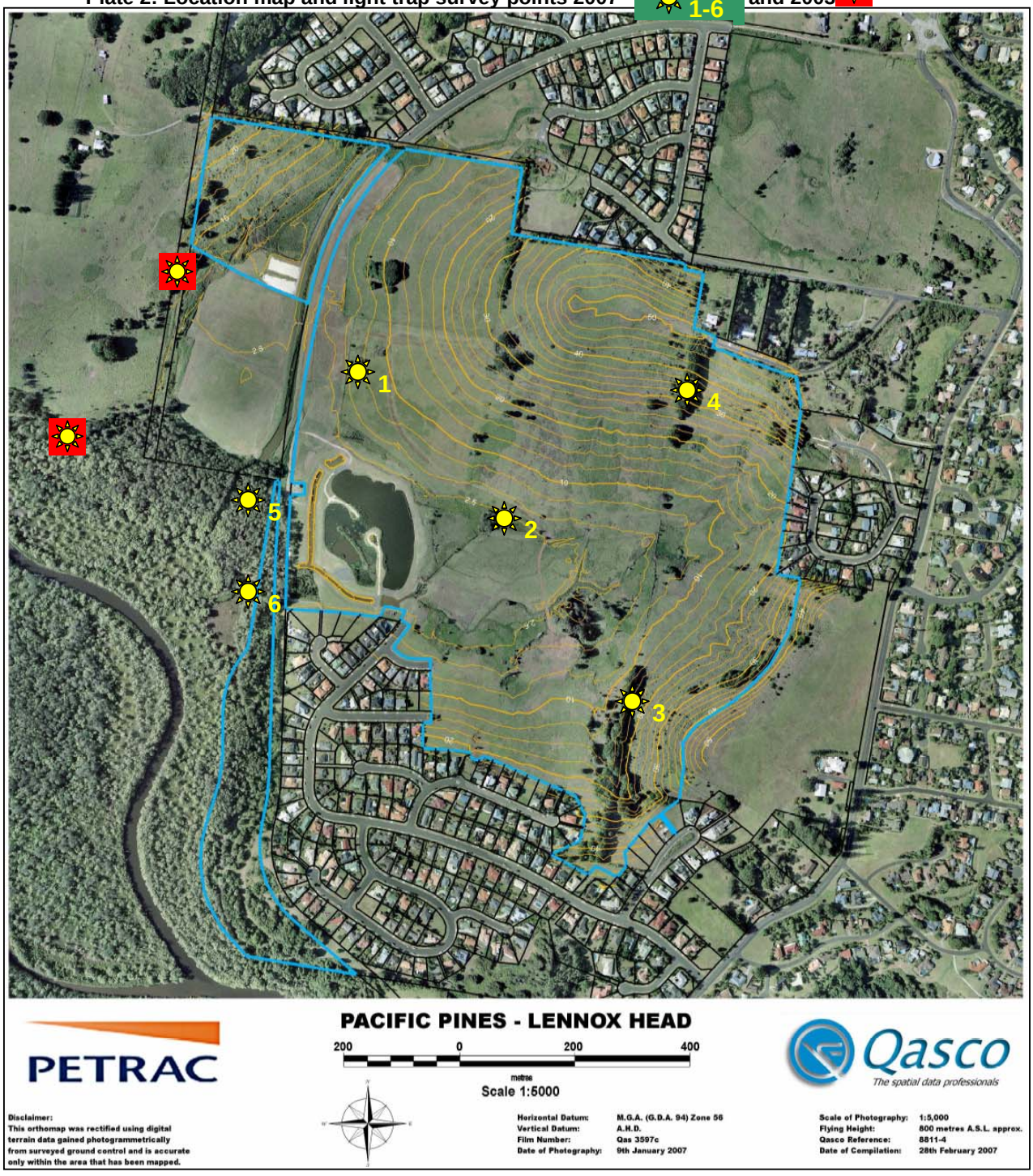
3.0 Investigation Methodology

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 1-6 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

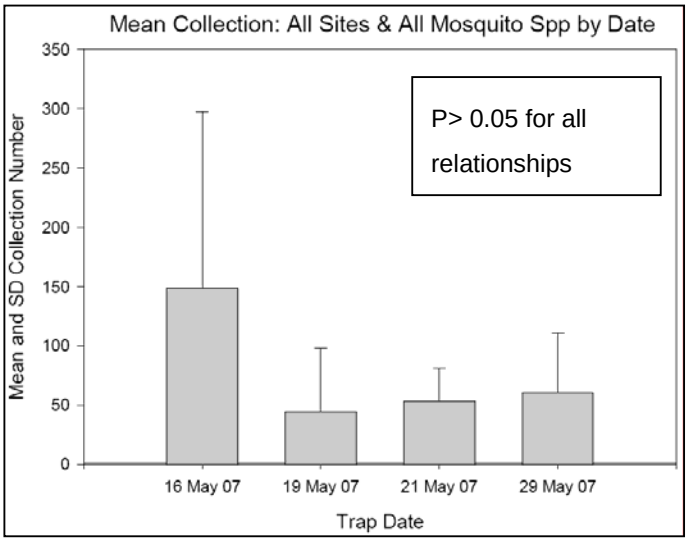
	16-17/05/07				19-20/06/07					21-22/05/07					28-29/05/07						
Species / Trap Site	No 1	No 2	No 3	Spp	No 1	No 2	No 3	No 4	Spp	No 1	No 2	No 3	No 4	Spp	No 3	No 4	No 5	No 6	Spp	TSpp	%
Ae ghanacola				0				T	0				1	1	2	2		1	5	6	0.6
Ae multiplex	10	8	28	46	1		14	R	15	7	8	18	26	59	4	8	12	18	42	162	15.7
Ae 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.

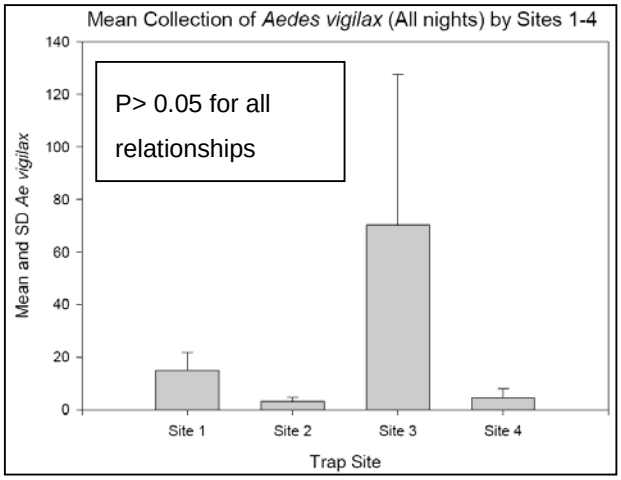
Statistical analysis of the 2007 Pacific Pines collections was undertaken to assess the consistency of data across the study. Graph 1 is the mean collections of all mosquito species for each trap date. Analysis by t-test produced P values greater than 0.05 for collections across all dates and shows there is no statistical difference between any of the collecting nights. This shows there was nothing acting to significantly suppress or amplify mosquito activity over the study period. This is generally also a reflection of the relatively 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.

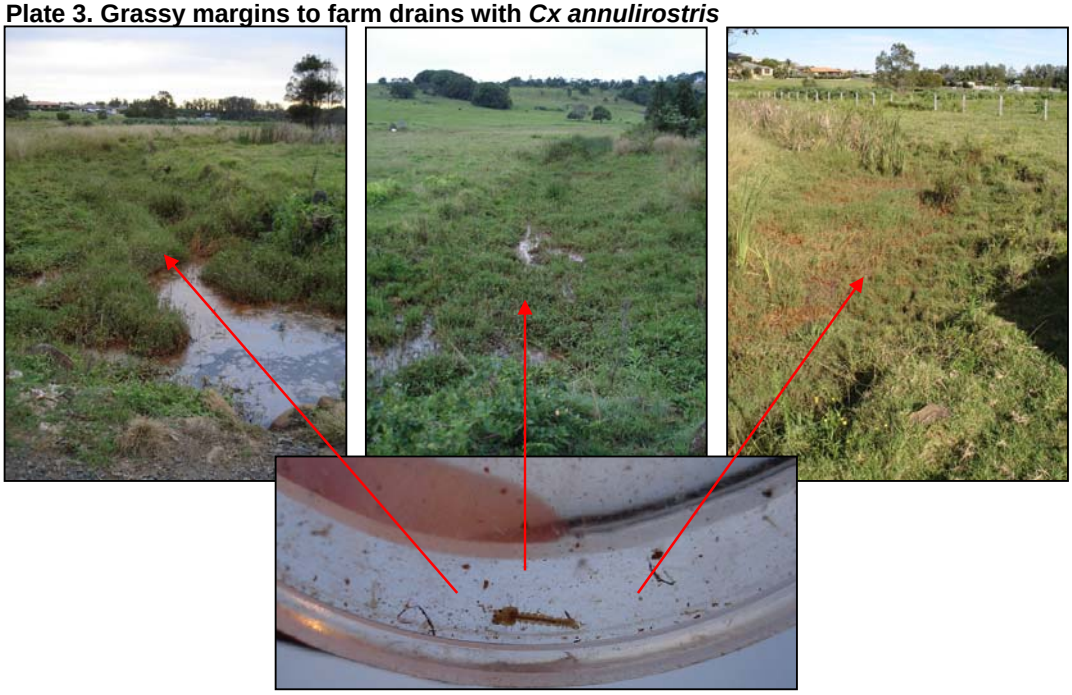
Graph 2:



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*

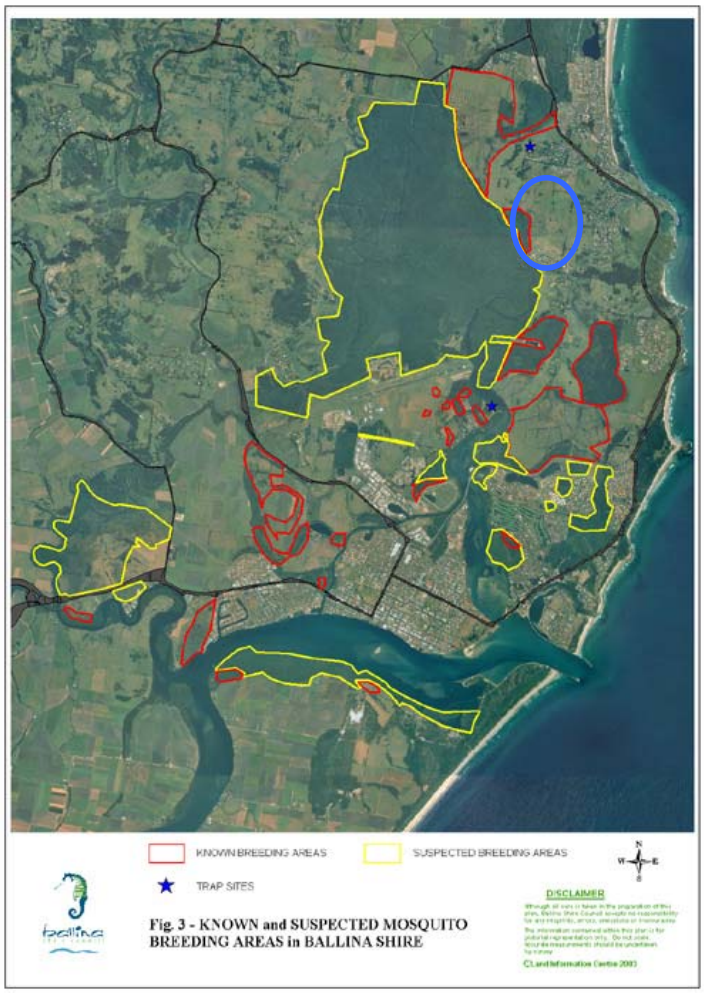
No *Verrallina funerea* breeding was found in this habitat during the study however the largest abundance adults of this species were collected in trap site 6 located at this site. This site is considered highly likely to produce *Verrallina funerea* from time to time. The habitat transitions into a 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).

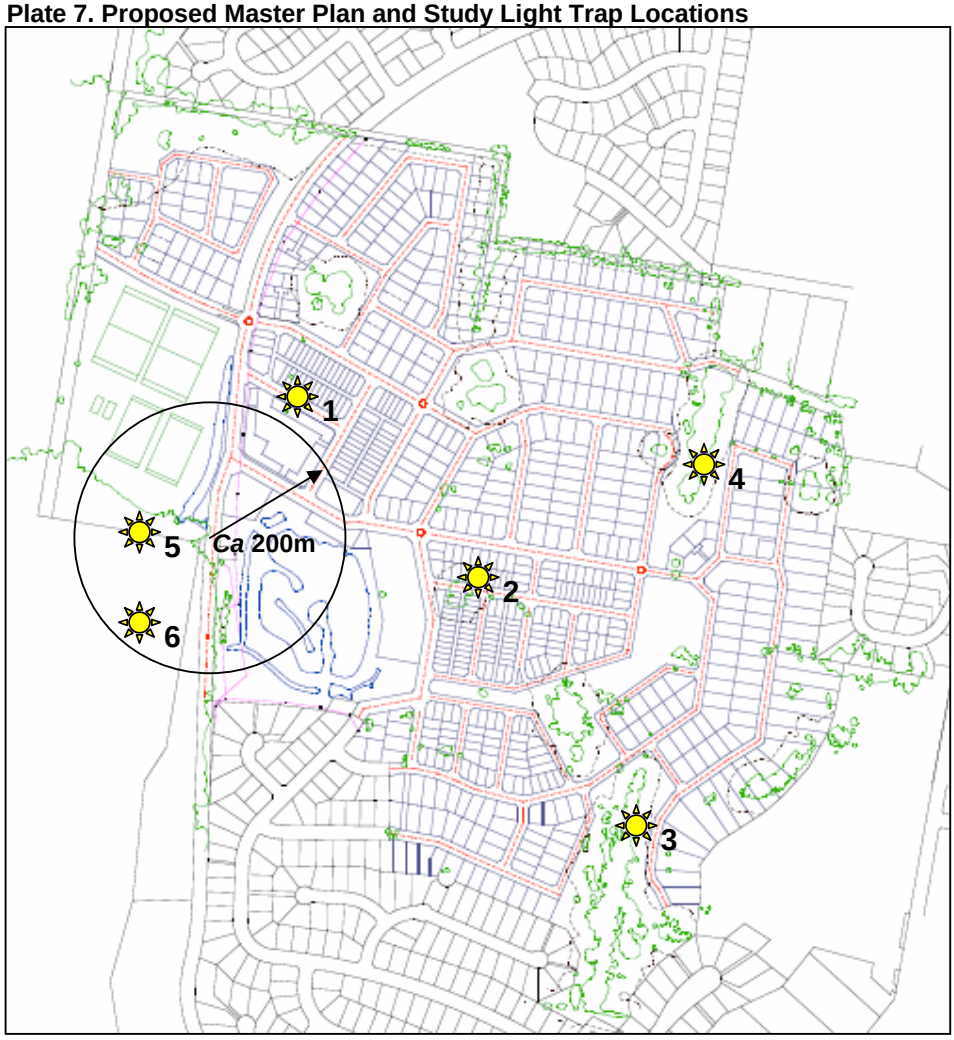
Plate 6. Ballina Shire Council DCP Chap – 11 designated breeding sites



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. Proposed Master Plan and Study Light Trap Locations



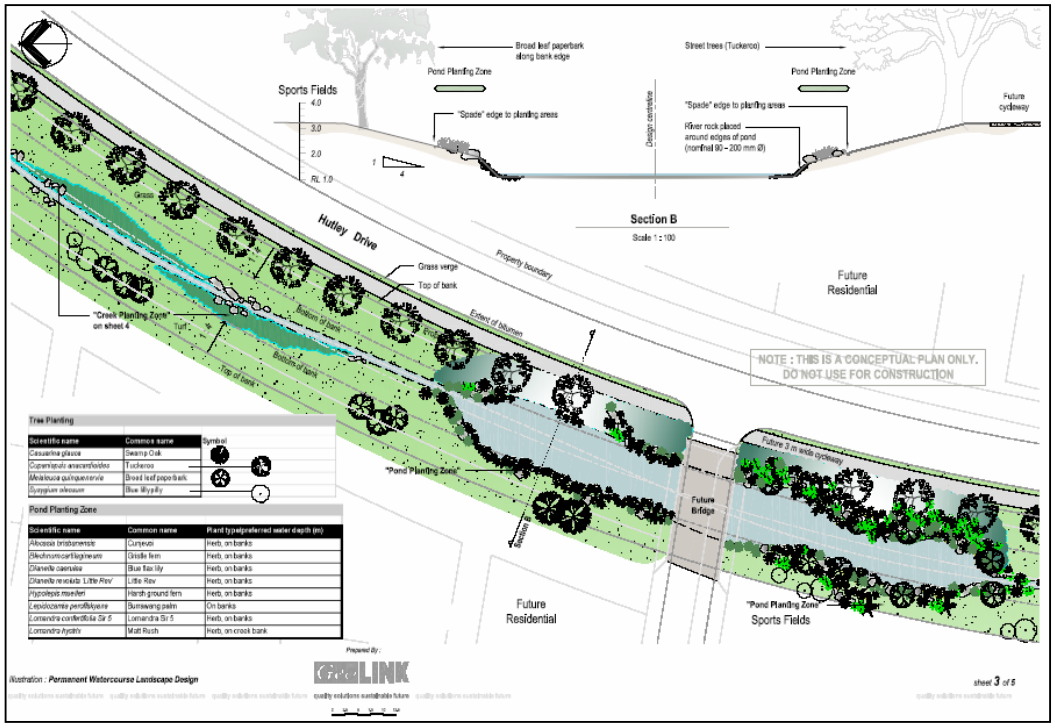
The proposed master plan (Plate 7) has a number of features relevant to considering potential mosquito impacts to future residents. These features include:

- A 200m minimum (approx) separation between residential allotments 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) provide 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 being 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 apparently 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 but with good quality breeding habitat identified on the adjacent Ballina Nature Reserve boundary.
- The important species, *Aedes vigilax* was present in moderate abundance but characterised as similar to the general background regional abundance.
- 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 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 allotment.
- *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.
- 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.

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 extremes 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.

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