



Kingscliff Resort

Mosquito and Biting Midge Management Plan

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Table of Contents

1	Introduc	Introduction1		
2	Descript	ion of Site and Proposed Development	2	
	2.1	Site Description	2	
	2.2	Proposed Plan of Development	3	
3	Potentia	I Impacts of Mosquito and Biting Midge	4	
	3.1	Mosquitoes	5	
	3.2	Biting Midges	7	
4	Mosquite	o and Biting Midge Management Measures	9	
	4.1	Management Objective	9	
	4.2	Management Measures	9	
	4.2.1	Development Layout and Design	11	
	4.2.2	Engineering Design Plans and Stormwater Management	12	
	4.2.3	Barrier Treatments	13	
	4.2.4	Community Awareness, Personal and Building Protection	14	
5	Summar	у	16	
6	Informat	ion Sources	17	

List of Tables

Table 1	Distance from mosquito/biting midge breeding sites and its impact	6
Table 2	Summary of the results of some trials assessing the effectiveness of Bifenthrin	
	formulations in reducing levels of mosquito and/or biting midge14	4

Appendices

- APPENDIX A Figure 7 Existing Site Vegetation (Adapted from James Warren and Associates [March 2010])
- APPENDIX B Extract of Kingscliff Resort Precincts Key (adapted from LVO Architecture)
- APPENDIX C Operational Control Concept Plan (adapted from VDM Consulting [28 September 2010])
- APPENDIX D Figure 13 Biting Insect Control in Tweed (adapted from *Tweed Shire Development* Control Plan: Section A6 – Biting Midge and Mosquito Control Plan)



1 Introduction

This management plan has been prepared by Cardno (QLD) Pty Ltd ("Cardno") on behalf of Leighton Properties in response to the below request for further information made by the New South Wales Department of Planning in relation to the proposed development of the Kingscliff Resort on Crown Land, namely "Lot 490" which encompasses three adjoining parcels (Lot 490 on DP1095234, part of Lot 500 on DP727420 and part of Lot 489 on DP47021) on Casuarina Way between Cudgen Creek and the Pacific Ocean at South Kingscliff, New South Wales.

The Ecological Assessment exhibited with the EA states that although the biting midge may not present a problem of disease transmission, negative impacts generating complaints and medical conditions caused by allergic reactions and secondary infections may occur. Please advise of proposed mitigation measures to alleviate such impacts. In addition, according to the Ecological Report a report to the Lot 490 Steering Committee prepared by Clive Easton, identified mosquitoes as unlikely to be a problem on the subject site. Further assessment regarding potential problems associated with mosquitoes to the proposed tourist resort need to be investigated.

The above request has been made as part of the major project assessment system for the Kingscliff Resort site under Part 3A of the *Environmental Planning and Assessment Act 1979*. The purposes of this Mosquito and Biting Midge Management Plan ("MBMMP") are to:

- assess the level of potential health, social and economic effects of mosquitoes and biting midges to people that would temporarily reside and/or work within the proposed development; and
- provide details of the manner (during construction and occupation) by which it is intended to appropriately manage these potential effects.

This report provides:

- in Section 2, a description of the site and the proposed masterplan of development for the site;
- in Section 3, brief descriptions of the mosquito and biting midge species that have the potential to negatively impact upon people residing and/or working within the development and an assessment of the likely level of impact; and
- in Section 4, details of the management measures that would be implemented as part of the proposed development in order to minimise any potential negative impacts.

Preparation of this MBMMP addresses the guidelines for control of biting midge and mosquitoes as outlined in the *Tweed Shire Development Control Plan: Section A6 – Biting Midge and Mosquito Control Plan.*



2 Description of Site and Proposed Development

2.1 Site Description

The site encompasses an area of approximately 43.4 ha and is located between the urban centres of Kingscliff to the north and adjoins the residential and resort communities of Salt, Seaside City and Casuarina Beach to the south. Like these adjoining southern parcels of land, the site was sand mined until the early 1980s and as a result is extensively disturbed. The site is traversed by a sealed road in the form of Casuarina Way which extends from the north, through the site in an east-west direction before exiting the site along the central portions of its southern boundary. The site adjoins a tidally influenced section of Cudgen Creek along its north-western boundary and adjoins the open coast along its eastern boundary.

It is our understanding that Tweed Shire Council have not, historically, raised concerns in relation to the impact of either mosquitos or biting midges as part of the development of the tourist resort or residential developments located south of the site. Cardno has had long-standing involvement in the establishment of these adjoining developments.

Vegetation community mapping of the site has been completed by James Warren and Associates ("JWA") and is documented in their March 2010 report titled *Ecological Assessment Amended - Lot 490 DP1095234, Part Lot 500 DP1095235,Part Lot 489 DP47021 - Casuarina Way, Kingscliff.* The following summary of the vegetation communities present on the site has been adapted from the JWA (March 2010) report. Figure 7 of the JWA report, which illustrates the distribution of vegetation communities within the site is presented as Appendix A.

- Vegetation on the site is generally sparse and has been degraded by the invasion of numerous weed species.
- The majority of the site is characterised by Coast teatree (*Leptospermum laevigatum*) and Coast banksias (*Banksia integrifolia*) which were planted out on the site as part of post-mining rehabilitation. Similar plantings of Horse-tail she-oak (*Casuarina equisetifolia*) and Coastal wattle (*Acacia sophorae*) have also been undertaken on dune systems in the site's eastern extent.
- The site supports a Grey mangrove (Avicennia marina) community in its north-eastern corner and along parts of its north-western boundary where the site adjoins Cudgen Creek. These mangrove communities are bordered in part by patches of saltmarsh dominated by Saltwater couch (Sporobolus virginicus).
- The site supports in its western extent, discrete areas of open forest characterised by Macaranga (*Macaranga tanarius*) and Blackwood (*Acacia melanoxylon*); Swamp oak (*Casuarina glauca*); and Coastal banksia, and a low closed shrubland consisting of weed species such as Lantana (*Lantana camara*) and *Chrysanthemoides monilofera* subsp. *rotunda* along with scattered trees from other surrounding forest patches.
- A small wetland consisting of *Phragmites australis, Typha orientalis* and *Baumea articulata* occurs in the centre of the site to the south of Casuarina Way.

The majority of the site is zoned 2(f) Tourism under the *Tweed Local Environmental Plan* (LEP) 2000. Land fringing Cudgen Creek and that which incorporates the Grey mangrove community and immediate surrounds is zoned 7(a) Environmental Protection (Wetlands and Littoral Rainforest). The entirety of Lot 489 and the southern half of Lot 500 are zoned 7(f) – Environmental Protection (Coastal Lands). The northern half of Lot 500 is zoned 6(a) – Open Space.



2.2 Proposed Plan of Development

The proposed development is a resort that consists of:

- 180 accommodation units which would be contained within a lesser number of buildings such as units, bungalows and beachside bungalows;
- resort facilities such as a conference centre, reception, administration office, bar, amenities, pool, restaurant, retail outlet, kitchen and storage area;
- beachside public parking will be provided in Lot 500 along the eastern boundary of the resort;
- substantially rehabilitated and revegetated land to the west of Casuarina Way; and
- various infrastructure such as paths, a pontoon, tennis and basketball courts, and picnic shelters which will be located to the west of Casuarina Way.

An indicative masterplan of the proposed development is presented as Appendix B herein. The proposed development is situated within the portion of the site which has a 2(f) Tourism zoning.

A Stormwater Management Plan (28 September 2010) has been prepared for the development by VDM Consulting. The stormwater management concept that is proposed for the development involves directing stormwater run-off from roof and developed areas into a network of vegetated swales which will provide a treatment train for both stormwater treatment and conveyance. The swales have been designed to discharge into either bioretention basins or the existing wetland community in the centre of the site which is to be retained under the proposed plan of development. The bioretention systems will be used to remove a significant portion of sediments and nutrients from the post-development runoff (i.e. greater than 50% of suspended solids and 30% of nutrients). The existing wetland will not be utilised as part of the overall water quality treatment train (which will instead occur within the proposed swales and bioretention areas). Water freely drains from the wetland along existing contours and through culverts below Casuarina Way where it discharges into Cudgen Creek. This discharge point occurs 90m upstream of the Grey mangrove community and does not traverse or directly discharge into any mangrove or tea tree wetlands. The proposed stormwater concept does not propose any works be undertaken on the northern side of Casuarina Way. It is not anticipated that tidal influence will increase back along the current drainage path as a consequence of the proposed development. The Operational Control Concept Plan which outlines the above described stormwater management concept is presented as Appendix C.

Part of the proposed development involves the rehabilitation of the section of the site referred to as the "riparian zone" which occurs between Casuarina Way and Cudgen Creek. The extent of the rehabilitation is detailed in James Warren and Associates (6 September 2010) *Riparian Management Plan – Lot 490 Kingscliff* and will involve:

- removal and control of existing weed species; and
- enhancement plantings to promote natural regeneration of Swamp oak, Littoral rainforest, Banksia woodland and Coastal saltmarsh (although land forms would not be modified in order to enhance the extent of tidal influence to promote saltmarsh colonisation of areas additional to those already identified in Appendix A).



3 Potential Impacts of Mosquito and Biting Midge

Mosquitoes are native insects that breed in salt, brackish or fresh water whilst biting midges breed in substrate generally associated with wetlands such as intertidal areas and the sides of streams and rivers. Mosquitoes and biting midges have the potential to have adverse health and amenity effects upon humans that reside and/or work within localities where they are present.

In the coastal areas of Tweed Shire, mosquito nuisance is caused by several species of saltmarsh breeding mosquitoes, which breed in salt to slightly brackish water. Following heavy rainfall these mosquitoes may also be found in fresh water ground pools. Such mosquitoes can be vectors of viruses such as Ross River virus and Barmah Forest virus, which may cause disease in humans.

Biting midges are not known to transmit human disease in Australia, however, they do have a direct impact on human health that is caused through allergens in midge saliva. These allergens, depending on the sensitivity and immunity of the person in question, can produce a varying reaction in people with most finding the bites uncomfortable and distressing with the irritation leading to scratching and sometimes infected sores.

The estuarine and terrestrial environments within the Cudgen Creek locality support several species of biting midge and may support some mosquito species that affect existing residents of, and visitors to, the locality. Whilst the nature and magnitude of these effects are not acceptable to some individuals, many residents of and regular visitors to the Kingscliff locality are able to adequately manage their levels of exposure to mosquitoes and biting midges.

Mapping of the mosquito and biting midge habitat associated with Cudgen Creek and which occurs in the immediate vicinity of the site has been prepared by Tweed Shire Council as part of the *Tweed Shire Development Control Plan: Section A6 – Biting Midge and Mosquito Control Plan.* An extract of this Control Plan, namely Figure 13, identifies potential habitat for two species of biting midge (i.e. *Culicoides molestus* and *C. subimmaculatus*) associated with the Grey mangrove community in the site's north-east (located approximately 110m from accommodation units associated with the proposed development) and along the interface the site shares with Cudgen Creek (which is located approximately 140m from the proposed development). Additional habitat for *C. molestus* is identified on the northern side of Cudgen Creek (approximately 320m from the proposed development), and for *C. subimmaculatus* upstream of the site approximately 310m from the proposed development. A modified version of Figure 13 (which illustrates the approximate boundaries of the site) is presented as Appendix D.

The mapping produced by Council does not identify any areas of known mosquito breeding habitat within the site or the upstream or downstream sections of Cudgen Creek. This is supported by:

- the vegetation community mapping prepared by JWA which identifies only small patches of saltmarsh vegetation (consisting predominantly of Saltwater couch) adjacent to the Grey mangrove community and along the interface with Cudgen Creek; and
- detailed vegetation community mapping contained within the Tweed Vegetation Management Strategy (2004) which does not identify any extensive areas of saltmarsh upstream or downstream of the site.

Given the above, it is expected that future visitors to the proposed Kingscliff Resort would be exposed to biting midge and low to negligible levels of mosquito incursion. The potential for adverse, and for some people unacceptable, impacts to occur as a result of such exposure is recognised as is the fact that this potential cannot be completely avoided nor mitigated given the location of the proposed development. Rather it is proposed that a combination of measures would be



implemented, as part of the proposed development, to maintain public exposure to biting midges at levels that are acceptable to the majority of people who choose to visit the locality.

Brief profiles of the main pest species of mosquitos and biting midge that occur in the Kingscliff locality are provided below.

3.1 Mosquitoes

Saltmarsh mosquitoes: are small generally black mosquitoes that breed in saltmarsh/mangrove areas associated with estuaries and tidal lakes. Breeding of saltmarsh mosquitoes generally occurs in the warmer months of the year following high tide events that flood low lying tidal flats and/or periods of extended rainfall that create ponding in saltmarsh areas. High tides cause inundation of low lying salt marsh areas where mosquito eggs may lay dormant. During such events dormant mosquito eggs are flooded, causing them to hatch and mature into adult mosquitoes in approximately seven to ten days (dependent largely upon temperature). The saltmarsh species which are occur in the coastal localities of the Tweed Shire are *Ochlerotatus vigilax, Culex sitiens* and *Verrallina funerea. Oc. vigilax* is the saltmarsh species with the greatest pest potential due to its propensity to be found extensive distances, in excess of 20 kilometres, from breeding habitats and its role as the primary vector of febrile diseases caused by viruses such as Ross River Virus and Barmah Forest Virus. Within the Tweed Shire, breeding areas for this species are found amongst poorly flushed mangroves surrounding Cobaki and Terranora Lakes, open tidal salt marshes around Cobaki Lake and on low lying agricultural pastures that receive occasional tidal flooding along the length of the Tweed River and parts of Cudgen Creek.

As outlined above, Tweed Shire have not identified the sections of Cudgen Creek which adjoin and occur within the nearby vicinity of the site as constituting areas of significant breeding habitat for saltmarsh species. In addition, past communications with Council's Entomological Control Officer (Clive Easton) has indicated that mosquitoes are unlikely to pose a problem to future visitors to the site. Nonetheless, it is recognised the Grey mangrove community in the north-eastern parts of the site and similar communities upstream would be inundated during spring tides or heavy rainfall events, and that such events create suitable breeding habitats for saltmarsh species. Given that saltmarsh species are known to commonly disperse up to 10 kilometres (and up to 40 km during strong and consistent wind events) from breeding sites it can be expected that mosquitoes which breed in this area have the potential to cause some degree of negative impact upon nearby tourist precincts. When consideration is given to the dispersal distances of these species, and the extent of mangrove vegetation within 10 km of Kingscliff, it is concurred that small Grey mangrove community does not represent a significant breeding habitat for saltmarsh species. The intensity of the mosquito impact is known to decrease with increasing distance from the breeding site. In this respect, Table 1 provides a description of the role of distance from breeding site in pest impact intensity as presented in the Queensland Health Guidelines.

Given the large dispersal distances of saltmarsh species, the significance of the relatively small areas of mosquito breeding habitat occurring within and adjacent to the site is reduced when considered as a component of the mangrove habitat which occurs upstream of the site as is inferred by Appendix D (which illustrates areas of biting midge habitat associated with mangrove communities).



Distance from breeding site	Risk of arbovirus diseases	Pest impact
Up to 1.5km	Very high	Intense from both mosquitoes and biting midges.
>1.5 to 5km (without continuous corridor of dense vegetation between breeding site and populated areas).	Significant, especially at the lower distance of this range.	 Unaffected from most biting midges Noticeable from species such as Ochlerotatus vigilax, Verrallina funerea, Culex, sitiens,
>5 to 10km	Moderate	 Unlikely by brackish mosquitoes and most biting midges Discomfort by a moderate number of <i>Oc. vigilax</i> adults.
>10 to 15km	Low	 Not severe and sporadic A small proportion of mosquitoes may be carried by wind into development areas.

Table 1	Distance from	mosquito/biting mid	dge breeding site	es and its impact
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Source: Appendix 3 - Queensland Health Guidelines to minimise mosquito and biting midge problems in new development areas.

As illustrated on Appendix D, there are no recognised areas of extensive breeding habitat for saltmarsh mosquito species within the surrounding locality and certainly none that occur within 1.5km of the site. As discussed above, the locality supports small patches of saltmarsh which would support the breeding cycle of the species discussed above. In this respect, however, it is recognised that the proposed development of the site would not result in people visiting, temporarily residing and/or working in an area at any higher risk from saltmarsh mosquito impacts than that posed at Kingscliff and the residential and tourist communities associated with Salt, Seaside City and Casuarina Beach.

Freshwater mosquitoes: Freshwater mosquitoes breed in any low-lying open or grassy areas that hold water after rain. Freshwater mosquitoes will breed in water of varying types (i.e. fresh to highly polluted) depending upon the species. In the site locality the freshwater breeding mosquitoes that are likely to be encountered are *Verrallina funerea* which also breeds in saline/brackish saltmarsh habitats. It is recognised that a small freshwater wetland area occurs within the centre of the site (south of Casuarina Way) and that this wetland area will be used to temporarily hold treated stormater runoff prior to it draining freely to Cudgen Creek. In this respect, the freshwater mosquito habitat within the site is not considered to represent a significant area of breeding habitat for freshwater mosquitoes. Freshwater breeding habitat in the site locality is likely to be limited to that provided by the existing small artificial waterbodies (i.e. road drains etc.) located within the residential precincts of Kingscliff, Salt, Seaside City and Casuarina Beach.

Container breeding mosquitoes: Many species of mosquitoes will breed in household containers that hold water such as plant pots, tyres, blocked guttering, wheelbarrows, children's wading pools and buckets. Most container breeding mosquitoes are potential vectors of disease and as such there is a need for households, both individually and collectively, to minimise the availability of habitat for container breeding mosquitoes. A container breeding mosquito species with a recognised pest potential that is known from the Tweed Shire is *Ochlerotatus notoscriptus* which has the capacity to transmit both the Ross River and Barmah Forest viruses.

The proposed development has the potential to increase the number of suitable breeding sites available for container breeding mosquitoes and may lead to an increase in the prevalence of such species in the locality. However this potential is not unique to the proposed development and can be effectively managed through an appropriately designed and implemented community awareness and property maintenance program.



3.2 Biting Midges

Biting midges are small mosquito like insects that breed within foreshore and estuarine sand and mud substrates. Biting midges can cause substantial annoyance and discomfort, particularly to people who have not developed some immunity to their bites, but are not a known transmitter of disease in humans. Whilst several species of biting midge occur in the Kingscliff locality, the main biting midge species identified by Council in the site locality are *Culicoides molestus* and *Culicoides subimmaculatus*. Brief profiles of these species, adapted from the *Tweed Shire Development Control Plan: Section A6 – Biting Midge and Mosquito Control Plan* are provided below

Culicoides molestus

This species is most commonly found breeding in clean flocculated sand, in the open or under light mangrove cover between mean tide level and mean high water spring tide level. *Culicoides molestus* has colonised the beaches of artificial canal developments on the Tweed River. They can also be found breeding on most sandy tidal river foreshores and suitable river sandbars.

Adult *Culicoides molestus* midge will travel at least 1km from the larger breeding areas. Residents living on hill tops overlooking these breeding areas are often affected more adversely by these midge than residents at lower elevations close to the breeding sites. *Culicoides molestus* bites most actively the week following full and new moon.

Culicoides subimmaculatus

This species, or more likely a complex of species yet to be determined, breeds in clean to muddy sand in the open or under light mangrove cover between mean high water neap tide level and mean high water spring tide level.

Culicoides subimmaculatus breeds along much of the Tweed River foreshore, particularly near stormwater outflows and along the fringe of mangrove growth on Tweed River islands. The species is also abundant along the middle reaches of Cudgen, Cudgera and Mooball creeks. *Culicoides subimmaculatus* adults are generally only a pest within 500m of their breeding areas. This range may double around extensive breeding areas such as the Ukerebagh passage area and the upper Terranora passage islands. This species bites most actively around the half moon period.

The periodic nuisance and annoyance caused by these species of biting midge is cyclic rather than constant in nature, with distinct seasonal, lunar and diurnal components. In this respect it is noted that:

- during the cooler period of the year (April to September) the level of nuisance caused by biting midge is reduced;
- during the warmer months the abundance of biting midge, and associated peaks in the level of annoyance they cause, generally occurs for a few days following a full or new moon; and
- during periods of high abundance, biting midge are most likely to cause nuisance early in the morning, late in the afternoon, or when conditions are still and overcast.

There is considerable variation in people's reactions to midge bites, with most people experiencing a slight redness of the skin that disappears within an hour or so. In general a person's immunity to biting midge increases over time with long term residents of areas where biting midge are common typically experiencing a much milder reaction to midge bites than first time visitors to the same area. However certain people, particularly young children, have a lower tolerance to midge bites and may experience a greater level of discomfort that may persist for a period of several hours or more. For



most people the effect of midge bites is short lived and no treatment is required. For people who experience a mild reaction measures such as taking a hot bath and/or applying a skin lotion or antiitching cream may provide sufficient relief. A small proportion of the population are hyper sensitive to midge bites and may experience severe and prolonged reactions that require a more intensive treatment and/or the instigation of measures to avoid repeat exposure to biting midges.



4 Mosquito and Biting Midge Management Measures

4.1 Management Objective

The objective of these mosquito and biting midge management measures is to inform the development process for the proposed Kingsliff Resort development in order to ensure that:

- a) the potential for any adverse social and economic effects to be experienced by future guests and employees of the resort are minimised; whilst
- b) enabling the social, economic and environmental benefits of the proposed development to be realised.

4.2 Management Measures

Tweed Shire Council has been actively involved in mosquito abatement since 1983 and has a formal agreement with Gold Coast City Council, Logan City Council and Redland City Council to cooperate in mosquito research and information exchange aimed at reducing mosquito nuisance and disease risks in South East Queensland and Northern New South Wales.

It is recognised that Council run an active program of mosquito management and control and that this program includes the following (which is adapted from http://www.tweed.nsw.gov.au/YourEnvironment/eh_1_mosquit.htm#what%20is%20tsc%20doing%2 Oddout%20rrv).

- Cooperating with the NSW Department of Health by trapping adult mosquitoes weekly near major mosquito breeding areas at West Tweed Heads and Terranora. Trapped mosquitoes are chilled then sent live to Sydney's Westmead Hospital to be checked for viral incidence, to provide early warning of potential viral disease presence. Information gathered by this programme over many years helps us understand the factors influencing mosquito abundance and Ross River Virus prevalence.
- Undertaking innovative forms of habitat modification to reduce the breeding potential of mosquitoes in semi-tidal saltmarshes without reliance upon chemicals. Modifications such as runnels in saltmarsh, partial tidal impoundments, increased back water flushing, and reducing drain water acidity have reduced mosquito breeding by changing the environment to allow fish and other mosquito predators to more effectively predate on mosquito larvae or 'wrigglers'. The modifications have also reduced the sites' suitability as mosquito egg laying sites. The modifications work at their best when seasonal rain conditions are average to above average. During and following long droughts, small mosquito feeding fish numbers are often too low to effectively reduce mosquito numbers.
- Undertaking aerial larviciding following heavy rain or higher than usual spring tides to treat areas likely to support high incidences of mosquito hatching.
- Using a bacterial larvicide called Bti to spray mosquito breeding areas when warranted. This larvicide is specific to mosquitoes and several other closely related flies. Bti poses no harm to other aquatic non-target organisms. This chemical can be applied to breeding areas in sustained release formulations which inhibit mosquito wrigglers from turning into adult mosquitoes for up to six months in small infrequently flooded pools. Methoprene is also quite specific in its action, posing no risk to fish, crabs, amphibians and water birds.



Monitoring and controlling biting midge larval numbers at set points along canal estate beaches to time effective larvicide treatments and to judge the effectiveness of these treatments. Treatments are usually carried out in July and December. The July spray is timed to take out a maximum number of midge larvae before the big spring emergence of adult midge. This treatment leads to less early spring midge attack on residents and a delay to build up of midges over the early summer period. The next treatment is usually in December and is timed to reduce the impact of the second generation of summer midges. This gives relief from the very high midge populations which would normally emerge mid to late summer.

Vegetation which occurs within the site (and upstream of same) along the banks of Cudgen Creek has recognised environmental values, which are briefly outlined below.

- One (1) Threatened flora species was recorded Stinking laurel (*Cryptocarya foetida*), which is listed as Vulnerable under the NSW *Threatened Species Conservation Act* (*TSC Act 1995*) and the Commonwealth *Environmental Protection and Biodiversity Conservation Act* (*EPBC Act 1999*) within a closed forest community on the eastern side of the Grey mangrove community.
- Five regionally significant species (Sheringham & Westaway 1995) were recorded in vegetation north of Casuarina Way including:
 - Umbrella cheese tree (*Glochidion sumatranum*);
 - Grey ebony (*Diospyros fasciculosa*);
 - Thin-leaved coondoo (*Planchonella chartacea*);
 - o Red-fruited kurrajong (Sterculia quadrifida); and
 - Polyalthia (*Polyalthia nitidissima*).
- Three Endangered Ecological Communities (EECs) were recorded (NSW *TSC Act 1995*) to the north of Casuarina Way including:
 - Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions;
 - Littoral Rainforest on the NSW North Coast, Sydney Basin and South East Corner bioregions; and
 - Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions.

As such, the capacity for Leighton Properties and/or Council to further reduce the prevalence of saltmarsh mosquito and biting midge habitat via removal and treatment of larval habitats is limited. As such the management of mosquito and biting midge within the proposed development and wider locality is, and will in the future be, reliant on a combination of measures as described below.



4.2.1 Development Layout and Design

It is noted that the site does occur adjacent to a small but known area of biting midge breeding habitat and that this habitat is likely to also provide some suitable saltmarsh mosquito breeding habitat. In this respect, it is recognised that the potential exists for people visiting and/or working within the proposed resort to be subjected to some degree of incursion from biting midges and, to a lesser extent, saltmarsh mosquitoes.

In recognition of this potential, the design of the proposed plan of development has made provision for an open space buffer between tourist resort land uses and adjacent sectors of the Ross Creek marine areas. The *Tweed Shire Development Control Plan: Section A6 – Biting Midge and Mosquito Control Plan* generally recognises and promotes:

- the role of open space buffers established inside a proposed development site as a means of mitigating potential mosquito and biting midge impacts on residential areas; and
- that the width of the buffer is dependent on the species of biting insects, the prevailing wind, the existence of natural barrier zones, such as open grassland and woodland, and the design of development.

As discussed in Section 3 herein, the habitable components of the resort development would be located between 110-140m from identified biting midge breeding habitat, it is also recognised that, pursuant to the Riparian Management Plan prepared by JWA, that much of this buffer distance will be managed to promote natural regeneration of vegetation communities via weed removal and through enhancement plantings. It is also acknowledged that appropriate rehabilitation of this part of the site to enhance and expand the current distribution of the three EECs and habitat for the significant flora species was a likely requirement of the Department of Planning and/or the Department of Environment, Climate Change and Water.

In this regard, in the longer term the only "open" part of the buffer between the biting midge breeding habitat and the habitable parts of the development is that provided by Casuarina Way and car parks to the immediate south of this road. This will result, in the longer term, in a buffer of between approximately 40 to 70m between the rehabilitated zone to the north of Casuarina Way and habitable parts of the resort. It is considered that the current break of 110-140m and the projected future break of 40-70m between the vegetated corridor, that will ultimately be associated with land to the north of Casuarina Way, will discourage some movement of biting midges into the resort.

The likely effectiveness of this buffer is to an extent influenced by the position of the resort relative to the direction of prevailing winds during the periods when biting midge are most likely to be encountered (Spring and Summer). In this respect the resort is positioned to the south and east of the biting midge habitats associated with Cudgen Creek whilst the prevailing wind directions at this location in spring and summer are generally from the south-west in the early morning and from the east in the evenings.

In accordance with sub-section 3.2.2 of the *Tweed Shire Development Control Plan: Section A6* – *Biting Midge and Mosquito Control Plan* and with reference to Appendix B, the development proposes recreation areas (i.e. tennis courts and basketball courts), roadways, Asset Protection Zones ("APZ") for bushfire management purposes and car parks between accommodation areas and the known areas of biting insect breeding habitat and future vegetated corridors that will be provided by the rehabilitation zone.



4.2.2 Engineering Design Plans and Stormwater Management

The potential for additional mosquito and biting midge breeding habitats to be created by the proposed development is recognised and all elements of the proposed stormwater drainage and treatment train would be designed to avoid the creation of additional mosquito and biting midge breeding habitat. In this respect, the stormwater drainage system should be designed to have the following characteristics as recommended in sub-section 3.2.1 of the *Tweed Shire Development Control Plan: Section A6 – Biting Midge and Mosquito Control Plan:*

- drains would be designed so that silt does not accumulate in the drain and water does not pond in the drain;
- stormwater run-off would be treated to ensure that nutrient enrichment of the receiving environment, which can increase the productivity of associated mosquito and biting midge habitats, does not occur; and
- stormwater detention and bio-retention basins would be designed to be free draining following the cessation of rainfall to prevent mosquito breeding.

As described in Section 2.2, a Stormwater Management Plan (28 September 2010) has been prepared for the development by VDM Consulting. The stormwater management plan for the site:

- avoids the creation of drains that will accumulate silt, rather it proposes free draining vegetated swales that will convey stormwater runoff to biorention systems and ultimately a free draining wetland prior to its discharge to Cudgen Creek;
- provides for the appropriate treatment of nutrient loads within the runoff to avoid organically enriched waters entering Cudgen Creek and modifying the local environment to promote the growth of aquatic and semi aquatic vegetation species that restrict drainage flow and create potential and additional breeding habitats for mosquitoes and biting midge;
- has an ultimate discharge point into Cudgen Creek along existing contours and is not directed at mangrove or tea tree wetlands;
- does not require earthworks or land form modification at or close to the discharge point which would increase the likelihood of tidal influence backing up into a drain or feature, thereby promoting colonization by saltmarsh species and providing additional breeding habitat for saltmarsh mosquitoes; and
- avoids construction of permanent waterbodies or other forms of permanent water detention.

In addition, the proposed development, for the most part, does not involve any filling to elevate parts of the site above flood height. As outlined in VDM Consulting's (28 September 2010) *Ecotourism Development Flood Assessment Report Issue 3* which has been prepared for the site, the portion of the proposed development that is to be located within the Defined Flood Level will be of pier and beam construction with any habitable areas located above the defined flood level. This construction technique minimises the need for filling within the flood plain and thereby minimises any obstructions to regional flood conveyance and impedence of surrounding drainage systems, which could promote biting insect breeding activity through creating additional breeding habitat.

The proposed development will involve some filling below the defined flood level to establish internal roads and to provide emergency access/egress routes. Stormwater runoff from the embankments associated with these roads will be conveyed via the network of vegetated swales through to the bioretention systems or existing free draining freshwater wetland and is not expected to significantly promote the extent of potential mosquito breeding areas on the site or within the site locality.



As part of the process of securing requisite approvals to construct the proposed resort development, detailed engineering design information for the stormwater management system would be provided which, at a minimum, includes:

- a. construction details and location of water sensitive urban design devices, infiltration trenches, swales, bioretention systems and other water retention devices to eliminate any potential for the structure to become, or likely to become, a breeding ground biting insects;
- b. maximum water retention periods for biorention systems and how these will be designed to avoid becoming a breeding ground for biting insects;
- c. details on the monitoring, management, maintenance and responsibility for bioretention devices, prior, during and post development to ensure their continual function and their prevention from being a breeding ground for biting insects; and
- d. if required, detail design of all biorention devices demonstrating compliance with *AS/NZS* 3500.3:2003 *Plumbing and Drainage Stormwater Drainage*.

4.2.3 Barrier Treatments

In recent years there has been considerable effort put into the development and registration of an effective insecticide that can be used to form a chemical barrier designed to interfere with the dispersal of mosquito and/or biting midge from breeding habitats into adjacent residential and commercial areas. Formulations that have now been demonstrated to be effective as a chemical barrier treatment for mosquito and/or biting midge contain the active chemical *Bifenthrin*. Through a biting midge committee with scientific, community and elected representation a product, later registered as Bistar®, was identified and tested giving 90 per cent control against biting midge (and mosquitoes) for a period of up to three months and was subsequently given United Nations recognition as good practice in improving the living environment (Fanning, Undated).

Table 2 provides a summary of the results of some trials of the effectiveness of *Bifenthrin* formulations in reducing levels of mosquito and/or biting midge exposure, as reported in the proceedings of a Biting Midge Forum held at Hervey Bay in August 2004.

In summary, the chemical barrier treatment involves the periodic application of the chemical treatment, using conventional spraying equipment, to either plane surfaces (i.e. fences or walls) or multi-plane surfaces (i.e. shrubs, grasses of hedges). The effectiveness of the chemical barrier treatment diminishes over time and repeat applications are usually required throughout the biting midge and mosquito season. The effectiveness of the treatment is also influenced by the attractiveness of the treated surfaces to mosquito and/or biting midge, as the chemical agent acts when physical contact is made between the treated surface and mosquito or biting midge. As such the barrier treatment relies upon the establishment and treatment of surfaces (e.g. fences, walls, shrubs or hedges) that provide an attractive shelter to mosquito and biting midge that are moving through open areas from breeding habitats into urban areas. This form of treatment takes advantage of the fact that mosquito and biting midge are small insects which are easily swept away by light to moderate breezes if they move away from the shelter of structures, ground layer or forest vegetation.



Table 2Summary of the results of some trials assessing the effectiveness of Bifenthrin
formulations in reducing levels of mosquito and/or biting midge

Trial Description	Results Summary		
Hervey Bay (Urangan) Field Trial - Bistar 80SC Barrier	Biting Midge - a 91% mean reduction in biting midges (<i>C. ornatus</i> and <i>C. subimmaculatus</i>) in levels over a 7 week period.		
	Mosquito – a 88% mean reduction in mosquito numbers over a 7 week period.		
River Heads, Hervey Bay – Bistar 80SC Barrier	Biting Midge - a 65% mean reduction in biting midges (<i>Culicoides</i> spp) over a 6 week period.		
	Mosquito – a 94% mean reduction in mosquito numbers over a 6 week period.		
Newport Waterways Canal Estate, Redcliffe City – Bistar 80SC Barrier.	Biting Midge - a 73% mean reduction in biting midges (<i>Culicoides</i> spp) over a 6 week period.		
	Mosquito – not assessed/reported.		

This form of treatment is significantly different from the use of chemical "fogs", which have a longer history of use in the management of mosquitoes and biting midges. Chemical fog treatments are designed to be dispersed over large areas in fine mist-like droplets drifting on the breeze to knockdown flying mosquitoes and/or midges. Fog treatments are non-residual and non-selective with little control over where the insecticide is carried and no way to contain its effect within a defined area. In comparison, chemical barrier treatments use a residual insecticide placed strategically and precisely on surfaces used by dispersing mosquitoes or midges as harbourage either within or adjacent to residential areas.

In respect of the Kingscliff Resort, it is **<u>not</u>** recommended that a barrier treatment be established with emphasis placed, instead, on the other biting insect management measures outlined herein. It is recognised that sufficient area would be available on the southern side of Casuarina Way (between this carriageway and the proposed car parks) to establish such a barrier if required in the future.

4.2.4 Community Awareness, Personal and Building Protection

Community awareness of the important role that personal and building protection measures play in the management of exposure to mosquitoes and biting midges is an integral component of any effective mosquito and biting midge management plan. Such measures could, where practicable, include the following.

- Keeping low vegetation surrounding the habitable buildings to a minimum. This reduces insect harbouring areas and increases air flow surrounding the building. Landscaping with tallish vegetation with an upper tree canopy is preferable to low, dense vegetation in biting midge prone areas as it allows a much better airflow near ground level. It is recognised that other necessary design requirements will prevent such a measure being adopted at the Resort. These requirements include the need for landscaping
 - o achieve and promote an appropriate and required standard of visual amenity;
 - o incorporate native plant species; and

around Resort buildings to:

• mitigate the potential for bushfire spread.

As such, this management measure is not deemed suitable or appropriate for the Resort.

- Reducing the number of mosquitoes within the resort by:
 - o removing outside containers that hold water (i.e. tyres, tins, jars, etc.);
 - o changing water in any bird baths frequently;
 - cleaning roof gutters on a regular basis;
 - avoiding the use of bromeliads (and similar plants) as part of the landscaping or else regularly flushing the mosquito larvae from the plants using a high pressure hose;

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- o emptying any pot plant saucers every week or filling them with sand;
 - keeping swimming pools clean and chlorinated;
- o keeping ornamental ponds and fountains stocked with fish; and
- keeping grass regularly mowed.
- Screening of dwelling and workplace windows and doors using smaller mesh sizes such as those found in products like Solar mesh® to stop entry of both mosquitoes and biting midges. Screens can also be sprayed with low toxic surface sprays containing synthetic pyrethroids to deter midges entering.
- Installation of ceiling fans (or other air circulation devices) to circulate air, thereby removing the stagnant environments that mosquitoes and biting midge prefer.
- Ensuring that any water storage facilities (i.e. water tanks etc.) are fitted with fine stainless steel intake screens.
- Avoiding activities like vehicle washing and gardening during the early morning and late afternoon when mosquitoes and midge are most active.
- As biting midges are biologically linked with the lunar cycle, taking note of the lunar period when midges are most active. Residents, staff and visitors are most likely be affected by *C. molestus* for a period of a few days following a full moon and affected by *C. subimmaculatus* around the half moon period.
- For staff (particularly ground staff) that predominantly work outdoors wearing light long sleeve clothing when outdoors to minimise exposure to mosquitoes and biting midges with personal insect repellents applied as directed to provide several hours protection.
- Biting midges are also known to have a histamine like substance in their saliva which can cause intense itching in sensitive individuals. Most people develop a personal immunity with a regular exposure to low numbers of midge bites (not occasional heavy exposure). To prevent acute allergic reaction and allow the body to develop its own immunity to midge bites the use of vitamin B1 (thiamine), which has an anti-histamine type action, has been recommended by biting midge expert, Dr. Eric Reye. Persons who have a more acute reaction to midge bites may require anti-histamine drugs at times.

It is important that guests to and staff of the resort are made aware of the presence of biting midges and the potential for mosquitoes in the locality and as well as potential health and amenity impacts that can occur at certain times of the year. Such awareness could involve promoting understanding during staff inductions (i.e. similar to promoting awareness of the need for sun protection) and providing informative literature (i.e. in the form of a brochure) in guest's rooms (as part of an information package which also includes other information about the resort) or at the check in desk.

The Tweed Shire Council website provides a highly informative webpage that outlines general mosquito and biting midge advice and specific advice relating to the management of mosquitoes and biting midges in the coastal localities of the shire. As such, it is proposed that, in addition to the awareness measures outlined above, visitors and staff are directed to the Tweed Shire Council webpage should they require information relating to the management of mosquitoes and biting midges. In addition, fact sheets designed to incorporate the information prepared by Tweed Shire Council could be kept at the resort's administration office for issue to any visitors or staff which request information or advice on biting insect management.



5 Summary

This MBMMP has been prepared in response to the below request for further information made by the New South Wales Department of Planning in relation to the proposed development of the Kingscliff Resort. Specifically this report provides details of the mosquito and biting midge management measures that have been and would be incorporated into the design of the proposed development.

In summary:

- 1. the proposed resort development will result in an increase in the number of people visiting and/or working within a coastal locality adjacent to a known breeding (larval) habitat for biting midge which also provides potential breeding habitat for saltmarsh mosquitoes;
- 2. future staff and visitors of the proposed resort development would be periodically exposed to biting midges and possibly mosquitoes as are some existing residents of and visitors to the southern Kingscliff township;
- the frequency and severity of exposure to mosquito and biting midges is not likely to be any greater than that currently experienced by existing residents of and visitors to the southern Kingscliff;
- 4. the construction of permanent waterbodies or other forms of permanent water detention is not proposed as part of the proposed resort development;
- 5. staff and visitors to the proposed resort development would be educated about, and encouraged to use, an array of personal and property protection measures to manage their levels of exposure to mosquitoes and biting midges; and
- 6. the proposed resort development would be carried out in accordance with the management measures outlined in Section 4.2 of this Mosquito and Biting Midge Management Plan, which is designed to ensure that the proposed resort development occurs in a manner that:
 - a. minimises the potential for adverse social and economic effects to be experienced by staff of, and visitors to, the resort; and
 - b. enables the social, economic and environmental benefits of the proposed development to be realised.

In conclusion, it is considered that approval of the proposed plan of development would not create a situation whereby the health or amenity of existing or future residents of the locality would be placed at an unacceptable risk.



6 Information Sources

VDM Consulting (28 September 2010) Proposed Tourist Resort Lot 490 on DP1095234, Part of Lot 489 on DP47021 Part of Lot 500 on DP1095235 Casuarina Way, Kingscliff Stormwater Management Plan. Prepared for Leighton Properties.

VDM Consulting (28 September 2010) *Ecotourism Development Flood Assessment Report Issue 3 - Lot 490 on DP1095234, Part of Lot 489 on DP47021 Part of Lot 500 on DP1095235 Casuarina Way, Kingscliff.* Prepared for Leighton Properties.

Fanning I D (undated). *Engaging the Community to Defeat Biting Midge*. Hervey Bay City Council, Urangan, Queensland, Australia.

Hervey Bay City Council (2004). Biting Midge Forum Proceedings.

James Warren and Associates (March 2010) *Ecological Assessment Amended - Lot 490 DP1095234, Part Lot 500 DP1095235, Part Lot 489 DP47021 - Casuarina Way, Kingscliff.* Prepared for Leighton Properties.

James Warren and Associates (6 September 2010) *Riparian Management Plan – Lot 490 Kingscliff.* Prepared for Leighton Properties.

Kingston, M.B., Turnbull, J.W. and P.W. Hall (2004) *Tweed Vegetation Management Strategy 2004 Volume 3 of 3 – Appendices.* A report prepared for Tweed Shire Council by Ecograph: Ecological and Geographical Information Systems Consultants – Limpinwood, NSW

Marks, E. and Reye, E. (1982). An Atlas of Common Queensland Mosquitoes with a Guide to Common Queensland Biting Midges. Qld. Inst. Med. Res.

Mosquito Consulting Services Pty Ltd (2006). *Mosquito Impact Assessment, April 2004 – October 2006 And Mosquito Buffer Effectiveness Study: Dr Stewart's Land, Lennox Head October 2006.*

Mosquitoes & Biting Midges(Sandflies) in the Tweed Shire Updated 19/12/05 http://www.tweed.nsw.gov.au/YourEnvironment/eh_1_mosquit.htm#what%20is%20tsc%20doing%2 0about%20rrv

Queensland Department of Primary Industries and Fisheries (2008). *Infosheet – Mosquito management in tidal wetlands*.

Queensland Health (2002). Guidelines to minimise mosquito and biting midge problems in new development areas.

Reye, E. (1991). *A General Introduction to Biting Midges*. Bulletin of the Mosquito Control association of Australia. Vol 3(3):15-19.

Reye, E. (1993). *Collecting Midges Biting*. Bulletin of the Mosquito Control association of Australia. Vol 5(2):4-9.

Shivas MA and Whelan P (2001a). *The biting midge research project: March 1999-March 2001.* Report of a joint Medical Entomology Branch, Territory Health Services and Northern Territory Department of Lands, Planning and Environment research project.



Shivas MA and Whelan P (2001b). *The dispersal biology of the biting midge Culicoides ornatus (Diptera: Ceratopogonidae) near Darwin, NT, Australia.* Arbovirus Research in Australia, 8:293.

South Australian Department of Health (2006). South Australian integrated mosquito management resource package 2006: an informative guide for mosquito management practitioners.

Tweed Shire Development Control Plan: Section A6 – Biting Midge and Mosquito Control Plan.