



Shoreline

Biting Insect Management Plan

Prepared for:

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1 Introduction

1.1 Purpose of this Management Plan

This Biting Insect Management Plan has been developed to support the development of Shoreline, a new community at Redland Bay. The Plan informs the planning, design, construction and operational phases of the development, providing recommendations for the management of mosquito and biting midge breeding and roosting.

The Plan has been informed by the Biting Insect Management Strategy developed for Shoreline by Mosquito Consulting Services Pty Ltd (2014). The Strategy concluded that 'with implementation of (these) general control and design strategies the risks associated with biting insect can be suitably mitigated to a level suitable for urban development'.

1.2 Structure of this Management Plan

The Biting Insect Management Plan *per se* is presented in Section 7.

Sections 1 – 5 provide context to the Plan in respect of:

- the location of the site and regulatory framework (Section 1);
- the incidence of mosquitoes and biting midge (Section 2);
- the incidence of arboviruses (Section 3);
- the likely impact of development (Section 4) and the impact of mosquitoes and biting midge on residents and visitors (Section 5).

Section 6 provides a framework for management.

1.3 Shoreline, its Location and Context

Shoreline is a 310 ha development site located to the south of Redland Bay, straddling Serpentine Creek Road and with an extensive frontage to Moreton Bay (Figure 1). The line of Highest Astronomical Tide (HAT) separates the site from the Moreton Bay Marine Park. The site has been extensively cleared and is currently predominantly used for market gardening, horticulture and grazing.

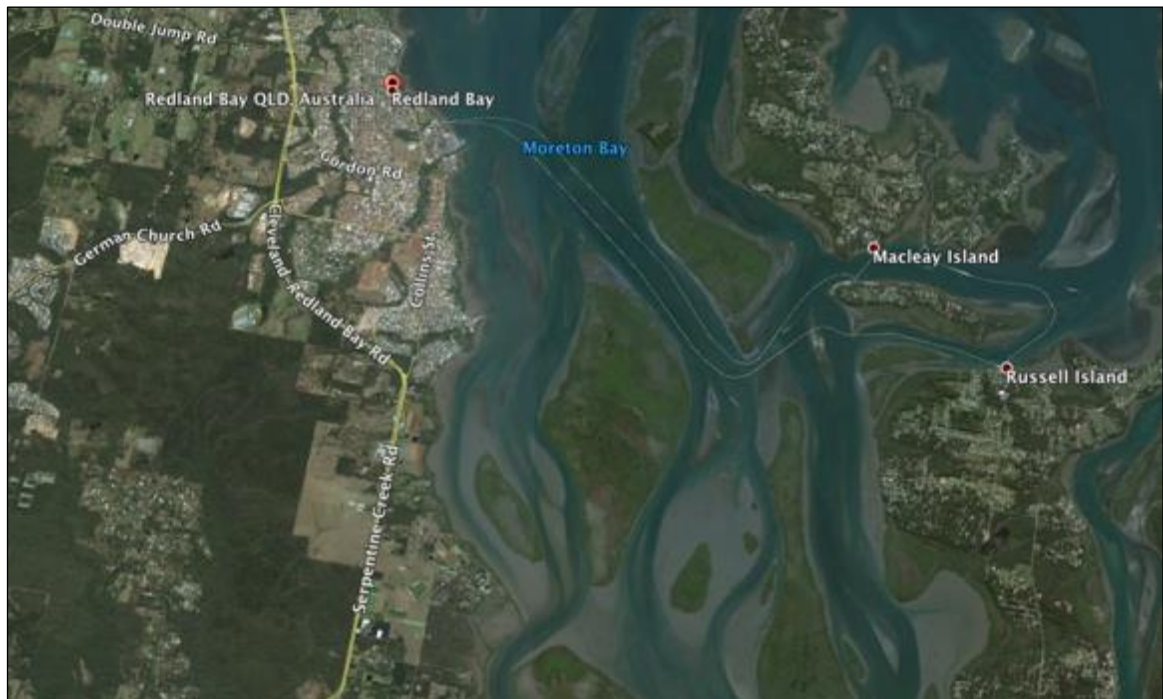


Figure 1.1 Shoreline, located to the south of Redland Bay (see also Figure 1.2).

The site rises steeply from the coast to an elevation of approximately 35 m, with a predominant north-south ridge contributing to minor catchments flowing east and west. The waterways are ephemeral, with small pools persisting after significant rainfall. A number of man-made dams serve the agricultural land use.



Figure 1.2 Contours across the Shoreline site (Shoreline 2014).

Extensive areas of mangrove, saltmarsh / claypan and unvegetated sediment characterise the intertidal flats adjoining the site. Shoreline recognises the conservation significance of these marine plant communities, providing a buffer of approximately 100 m width between proposed development and HAT.

Two isolated pockets of remnant vegetation occur on the foreshore and will be retained (Figure 1.3). Predominantly regrowth vegetation follows some of the more significant waterways, whilst to the west areas of Crown land support extensive bushland.

Shoreline seeks to re-introduce a traditional development pattern, structured around a series of well designed neighbourhoods serviced by a local village centre . This structure both fundamentally acknowledges the need for, and provides the basis for effective management of mosquito and biting midge. A population of approximately 10,000 is anticipated to develop by 2030.



Figure 1.3 Proposed land use, including areas for conservation of remnant vegetation and open space – as identified by BAAM (2014a).

1.4 Legislative and Regulatory Framework

The Strategy upon which this plan is based, provides a comprehensive discussion of relevant legislative and regulatory requirements for and of biting insect management in Queensland.

In summary, this Plan responds to all relevant requirements of the:

- Public Health Act 2005 and Public Health Regulation 2005
- Sustainable Planning Act 2009
- Environmental Protection Act 1994
- Nature Conservation Act 1992 and Nature Conservation (Wildlife Management) Regulation 2006
- Marine Parks Act 2004
- Fisheries Act 1994 and Regulation 2008
- Agricultural Chemicals Distribution Control Act 1966; and
- Chemical Usage (Agricultural and Veterinary) Control Act 1998.

This Plan is also consistent with, and has been informed by, the :

- Mosquito Management Code of Practice, 2012
- Guidelines to Minimise Mosquito and Biting Midge Problems in New Developments, 2002
- Australian Mosquito Control Manual, 1998 (revised 2009); and
- Redland City Council's
 - Mosquito Management Policy;
 - Mosquito Management Plan 2012 – 2017; and
 - Corporate Plan.

2 Incidence of Mosquitoes and Biting Midge

2.1 Approach

Integrated Mosquito Management relies on an understanding of the distribution and abundance of mosquitoes to support the development of suite of appropriate management responses. Often a site-based survey of adult and larval occurrence is required to achieve this. However, the location and characteristics of the Shoreline site are such that both the distribution and abundance of key pest species (mosquito and biting midge) may be readily and reliably inferred. Further, the high level of inter- and intra-annual variation (see Table 2.1) that characterises both larval and adult mosquito abundance and distribution significantly limit the usefulness of data collected from a single season.

Council's monitoring of adult mosquito distribution and abundance, and of larval abundance across key breeding sites serves to provide a robust basis for the assessment of risk. Whilst Queensland Health's monitoring of arbovirus incidence across the Redlands serves to illustrate the need for effective mosquito management.

This approach also recognises that the development of the site will significantly alter its characteristics, including the presence and relative proximities of existing on-site breeding and roosting habitat.

2.2 Breeding and Roosting Habitat, Dominant Species and Pest Range

Within the Redlands, a variety of species of mosquito and biting midge occur in association with marine, brackish and fresh waters. Marine and brackish water species are commonly associated with both a higher incidence of 'nuisance' complaints, and arbovirus infection, and consequently have been the primary focus for both research and control efforts throughout south-east Queensland.

Each of the individual species of mosquito and biting midge occurring within the region have specific breeding habitat requirements, dispersal capabilities, patterns of activity, and ability to act as vectors for diseases affecting humans and domestic animals.

Mosquitoes

The Shoreline site adjoins small pockets of saltmarsh breeding habit, and lies adjacent to low-lying, uninhabited islands that support extensive marine and brackish water breeding habitat. A number of ephemeral (fresh) waterways run through the site, characterised by

small residual pools. A number of freshwater dams have been constructed to support agriculture.

Within the Redlands, mosquito management focuses primarily on ‘saltmarsh’ mosquitoes common to the region (frc environmental, 2011; 2008; 1997). Analysis of adult mosquito distribution in the Redlands (based on the identification of over 500,000 mosquitoes collected over 1194 trap nights) shows that adult mosquito abundance varies significantly between years (for example mosquitoes were almost 7 times as abundant in 2001 than in 2000 (Ryan, Lyons, Alsemgeest, Thomas and Kay, 2004). *Aedes vigilax* is the dominant species, commonly representing over 40% of individuals collected in light traps, whilst *Culex annulirostris*, *Coquillettidia linealis*, *Coquillettidia xanthogaster*, *Culex sitiens*, *Aedes notoscriptus*, *Aedes procax*, *Aedes vittiger* and *Verrallina funerea* are also common (Peter Dobson, Team Leader, RCC Pest Management Unit pers. comm. 16th October 2014; Ryan, et al, 2004) (Table 2.1).

Table 2.1 Relative adult abundance (%) data from Redland City Council (light trap) monitoring of salt water breeding mosquitoes.

Species	2012	2013	2014
<i>Aedes alternans</i>	–	0.1	2.0
<i>Aedes vigilax</i>	10.0	39.6	41.1
<i>Aedes vittiger</i>	5.9	–	–
<i>Aedes kochi</i>	–	–	0.4
<i>Aedes multiplex</i>	–	0.2	–
<i>Aedes notoscriptus</i>	29.4	2.5	5.6
<i>Aedes procax</i>	3.9	–	–
<i>Anopheles annulipes</i>	3.9	0.5	–
<i>Culex sitiens</i>	10.0	56.0	46.6
<i>Culex orbostiensis</i>	–	–	3.4
<i>Coquillettidia xanthogaster</i>	17.6	0.8	–

(Peter Dobson, pers. comm. 16th October 2014)

The Redlands provides over 800 ha of salt marsh mosquito breeding habitat (Redland City Council, 2014), and there are a number of major salt marsh breeding sites within relatively close proximity to the proposed development (Mosquito Consulting Services Pty Ltd, 2014) (Figure 2.1). Marine and brackish water breeding sites also exist to the north, east and south of the Shoreline site.

Aedes vigilax is the most common and wide-spread (Ryan, et al., 2004) mosquito encountered within the region close to the coast, breeding prolifically within pooled water of intertidal lands: *Aedes vigilax* is the predominant larvae recorded by Council from salt marsh breeding habitat within 5 km of Shoreline, from its long-term larval monitoring program (Peter Dobson, pers. comm. 16th October 2014). *Culex sitiens* and *Aedes alternans* also breed in temporary brackish pools and salt marshes filled by spring tides, and have been recorded from saltmarsh breeding habitat within a 5 km radius of Shoreline (Peter Dobson, pers. comm. 16th October 2014). The small pockets of brackish water breeding habitat adjoining the site are also likely to be used by these species. *Verrallina funerea*, which breeds in ponded areas under the cover of mangroves, melaleuca and emergent vegetation, is also likely to breed adjoining the site and on adjacent islands.

Council's long-term larval monitoring program shows significant inter-annual variation in average larval density: between 2001 and 2013, average *Aedes vigilax* larval density per standard dip ranged between approximately 12 and 20 (Peter Dobson, pers. comm. 16th October 2014).

These mosquito species have been widely implicated in the transmission of the debilitating disease Ross River virus (epidemic polyarthritis). *Aedes vigilax* is the most important vector of arboviruses in south east Queensland (Webb 2004), also being a suspected carrier of Barmah Forest virus and dog heart-worm. Laboratory trials indicate it may also be a carrier of Murray Valley encephalitis.

The adults of *Aedes vigilax* and *Culex sitiens* are capable of travelling over 30 km from breeding sites, often assisted by prevailing winds. Consequently, the entire Shoreline site is likely to be subject to these species from time to time.



Figure 2.1 Marine and brackish water breeding sites (yellow) adjacent to the Shoreline site (from Mosquito Consulting Services Pty Ltd, 2014).

Other common marine and brackish water breeders include: *Aedes alternans* (the Scotch grey), which breeds in both tidal pools and rain filled depressions; and *Anopheles annulipes*, which breeds in fresh or slightly brackish pools. Each of these species are also capable of travelling several kilometres from their breeding sites, and are potential vectors of Ross River virus.

Species that breed in freshwaters will use senescing pools and farm dams as well as rock pools, pot plant saucers, fallen palm fronds and discarded car tyres within domestic surroundings. *Aedes procax*, *Aedes notoscriptus*, *Aedes vittiger*, *Culex annulirostris*, *Coquilleltidia xanthogaster* and *Coquilleltidia linealis* are all commonly associated with freshwater breeding habitat in south-east Queensland. The distribution and abundance of these freshwater breeders are known to vary significantly between years (by a factor of at least 10), influenced by rainfall (Ryan, et al., 2004).

During breeding, the eggs are laid by the female of each species, in mud or on vegetation associated with pooled water, and hatch when water levels rise (with the incidence of tidal inundation or heavy rainfall). The larval and pupal stages together require approximately six days to develop in mid-summer (longer during cooler weather). The adults of each species rest amongst dense foliage, and bite (man, mammals and birds) during both the day and night: dawn and dusk are favoured by *Aedes vigilax*, whilst *Culex sitiens* and *Culex annulirostris* bite predominantly at night.

Biting Midge

At least five species of biting midge are considered common within the region and are likely to occur in proximity to the Shoreline site. (Table 2.2). No species of biting midge is currently considered a vector of human disease in Australia, although some have been linked to the transmission of veterinary arboviruses such as 'bluetongue' and 'akabane'.

Table 2.2 Characteristics of biting midge recorded in south east Queensland.

Biting Midge Species	Breeding Habitat	Distance Travelled
<i>Culicoides ornatus</i>	Within a narrow band surrounding MHWS where there is no strong wave or current action.	Up to 16 km.
<i>C. marmoratus</i>	Algal covered mud in saltmarshes or below mangroves. Breeding area must remain moist.	Peak emergence is up to 10 days prior to spring tides and the range of this species is believed to be in excess of 15 km.
<i>C. molestus</i>	Prefers relatively clean sand along open beaches or inlets (light mangrove cover tolerated), will also inhabit sandy canal developments. Lives between MHWS & ML.	Adults emerge around spring tides & will travel up to 1.5 km from large breeding grounds.
<i>C. subimmaculatus</i>	Breeds in estuarine sand to sandy mud between the MHWS & MHWN, sheltered from wave action with sparse vegetation or open forest.	May travel up to 500 m from breeding sites.
<i>Lasiohelea townsvillensis</i>	Decaying vegetation & moist conditions of rainforests preferred, but will happily inhabit well watered & mulched tropical gardens.	

MHWS Mean High Water Spring

MHWN Mean High Water Neaps

ML Mean Tide Level

(FRC Coastal Resource and Environmental 1997; Gold Coast City Council n.d.; Queensland Health 2002a, Watson and Watson, 1982).

Culicoides lay their eggs within well-aerated wet areas commonly associated with the upper half of the intertidal zone in either fresh or saline conditions, depending on the species. As breeding is commonly dependant upon monthly tidal inundation, the emergence of adults and the incidence of biting activity are commonly synchronous with

phases of the moon (Rust-PPK 1995). Apart from around the breeding site itself, *Culicoides* attack vertebrates (including man) primarily around sunset and sunrise, and infestations are usually the result of a number of species rather than an individual species (Marks & Reye 1982). *Culicoides ornatus* is a widespread species, commonly associated with significant pest problems along Queensland's east coast (Shivas & Whelan 2001, cited in Warchot 2004).

Lasiohelia townsvillensis breeds prolifically in leaf litter and well-watered urban gardens of the tropics and sub-tropics. It may be also be present (or become established post-development) at the Shoreline site following prolonged rain or excessive watering. This species is known to bite all day.

3 Incidence of Arboviruses

Two arboviral infections are commonly contracted within the Redlands: Barmah Forest virus and Ross River virus. *Aedes vigilax* and *Culex annulirostris* are considered to be the most significant vectors of these diseases in the Redlands, although *Coquillettidia linealis* may also be a significant vector associated with the bay islands (Ryan, et al., 2004).

Ross River virus (epidemic polyarthritis) is the most common human disease transmitted by mosquitoes in Queensland (Rust-PPK 1995). Symptoms of the disease include polyarthritis, muscle tenderness, lethargy and fatigue. The disease is not fatal, but has no cure. The length of incapacity varies from 1 to 24 weeks, and symptoms may persist for up to 40 weeks (Rust-PPK 1995). The disease usually occurs in seasonal outbreaks, due to increased mosquito breeding during periods of high rainfall or high tides (Queensland Health 2001). Therefore, the number of reported cases of Ross River virus varies widely from year to year, and probably from area to area (frc environmental, 2008).

Barmah Forest virus may have similar symptoms to Ross River virus, although they are believed to be of a shorter duration (Queensland Health 2002a). The incidence of this disease appears to have increased across the state since the 1990's. Whilst 2013 saw a spike in reported infections from the Redlands (positively correlated with above average rainfall), this increase was not considered significant. There is also a lack of evidence to correlate reported incidence of disease with the location at which the disease was contracted (Kerr, 2014).

Whilst both diseases are transmitted throughout the year, infection rates are highest between January and June, with a peak in March – April. Whilst reported cases of both Ross River Fever virus and Barmah Forest virus are likely to significantly under-estimate actual infection rates, as not all people that are infected show symptoms (Queensland Health 2001; 2002b), the incidence of Ross River virus and Barmah Forest virus in the Metro South region (that region of Queensland Health's arbovirus monitoring program encompassing the Redlands) is amongst the lowest in the state (Dr Brad McCall, quoted in the Redland City Bulletin, October 15th 2014).

Lower rates of Ross River virus are consistently lower in local government areas that implement mosquito control programs that pre-empt mosquito outbreaks using routine surveillance and then reduce mosquito abundance using mosquito control (Tomerini, 2007).

4 The Impact of Development

4.1 On Breeding Habitat

Development of the Shoreline site will alter the site's capacity to support mosquito and biting midge breeding and roosting, whilst having no impact on adjoining and adjacent marine and brackish water breeding habitat.

A reduction in the number of dams on site and the more deliberate management of those remaining (or that may be created) will likely result in a reduction in the extent of mosquito breeding habitat on site.

Engineering works required to profile and shape the site in preparation for residential subdivision, roadways, storm water works and open spaces will permanently diminish the current opportunity for ground pool breeding mosquitoes. Breeding habitat in the form of residual pools (vehicle ruts, etc.) will be reduced in extent. Stormwater drains and rainwater collected in man-made containers may provide breeding sites for a number of species of mosquito, notably *Culex anulirostris*. Seepage, surface runoff, and silt inputs from stormwater can all enhance or create breeding habitat (Rust - PPK 1995).

The biting midge *Lasiohelia townsvillensis*, which breeds prolifically in leaf litter and well-watered urban gardens of the tropics and sub-tropics, is likely to establish populations within some gardens over summer. The use of sub-surface watering and drip lines in the gardens (as opposed to using mists and sprinklers) is likely to reduce the presence of biting midges in these areas.

4.2 On Roosting Habitat

The site is currently subject to a range of agricultural landuses: market gardening, horticulture and grazing. A weed-infested patch of *Melaleuca quinquenervia*, *Lophostemon suaveolens* and sub-dominants (RE 12.3.6) is mapped in the centre of the site, whilst *Eucalyptus tereticornis* and *Melaleuca quinquenervia* with a weedy understory are mapped on the site's northern coast (BAAM, 2014b). These patches of remnant vegetation will be retained and enhanced. Management of the weedy understorey will reduce roosting habitat for both mosquitoes and biting midge.

Development of the site will displace current market gardening and horticultural land uses, and remove much of the non-remnant regrowth and weed communities (including along the foreshore), whilst development of Foreshore Open Space and Open Space Corridors

will provide a mosaic of treed and mown grasslands (Figure 1.3) (BAAM, 2014a). Foreshore Open Space will provide a nominal 100 m wide sparsely vegetated buffer between the shore and residential and community precincts.

Each Open Space Corridor is comprised of a core of riparian vegetation flanked by margins that are 25 m wide of lightly treed low-maintenance grassland. A 20 m road reserve augmented by a 6 m building setback provides additional setback to properties. In aggregate, each Open Space Corridor will provide a 75 m setback between properties and freshwater mosquito breeding habitat, and a 50 m setback to roosting habitat (Figure 4.1).



Figure 4.1 Indicative schematic depicting vegetation management strategies for Open Space Corridors.

The additional Open Space Linkages (Figure 1.3) will neither support or are directly connected to mosquito (or biting midge) breeding habitat, and are characterized by lightly treed (managed) grassland providing minimal roosting habitat. All Open Space Linkages are set back several hundred meters from the foreshore (and potential marine / brackish breeding habitat).

Development of these environmental corridors, road reserves and set-backs will both reduce available roosting habitat on site, and increase the wind-assisted dispersal of biting insects from coastal breeding habitat to the more elevated bushland to the west of the site. Open eucalypt forests and banksia woodlands are poor habitats for mosquitoes and biting midges.

Rehabilitation of foreshore vegetation will reduce the density of existing understory (weed) vegetation. Retained and planted trees and shrubs within corridors will be well separated, with an understorey of maintained low grasses (BAAM, 2014b).

5 The Impact of Mosquitoes and Biting Midge on Residents and Visitors

5.1 Mosquitoes

Development on the coast inevitably brings humans into contact with mosquitoes and biting midges. A variety of species of mosquito may breed in freshwater habitats of the site, and may be carried to the site by prevailing winds, having bred within nearby estuarine wetlands.

Guidelines prepared by the Queensland Department of Health (Queensland Health 2002b) provide a quantitative (though imprecise) assessment of the likely impacts due to mosquitoes:

- 15 – 20 km from breeding sites. This distance is greater than the flight range of most species of mosquito, *Aedes vigilax* being a notable exception. Pest problems will be sporadic and not severe.
- 10 – 15 km from breeding sites. *Aedes vigilax* is likely to be the only species encountered in moderate number, causing some discomfort. Monitoring should be undertaken, and control measures may be required.
- 2 – 10 km from breeding sites. Pest impact from mosquitoes, particularly *Aedes vigilax*, *Verrallina funereus* and *Culex sitiens* will be noticeable, with the intensity and frequency of attacks increasing as distance from the breeding site decreases. Regular monitoring and control measures will be required.

Within the Redlands, the majority of mosquito-associated problems are related to 'saltmarsh' mosquitoes, that breed within the estuarine wetlands of Moreton. Shoreline's proximity to known breeding habitat infers that the entire site is likely to be subject to a noticeable presence of mosquitoes over the warmer months of the year. Regular monitoring and active management of particularly mosquito breeding on adjacent islands will be the cornerstone of any mosquito management program. Regular monitoring and active control of mosquito breeding on adjacent islands is currently undertaken by Council.

The limited extent of suitable on-site breeding habitat, and the incorporation of open-space buffers between these breeding areas and residential and community precincts, makes it unlikely that extensive on-site mosquito control will be required for the developed site

5.2 Biting Midge

The coastal nature of the Shoreline site is likely to result in the presence of a number of species of biting midge from time to time. *Culcoides* spp. may travel to the site from estuarine breeding areas under the right conditions (Queensland Health, 2002a). The biting midge *Lasiohelea townsvillensis* breeds in freshwater environments, and is likely to breed in well-watered landscaped areas on site.

Whilst midges in Australia are not vectors of human disease, their bites can irritate the skin. In abundance, midges can significantly reduce the amenity of outdoor areas.

6 Management of Mosquitoes and Biting Midge

Opportunities exist to minimise both the breeding of mosquitoes and biting midge on site, and the impact of mosquitoes and biting midges breeding on adjacent lands, through appropriate site planning, engineering design, building design and on-going site management.

Optimal management of biting insects at Shoreline will be achieved where proponent-initiated measures for on-site management support Council's off-site (local government area-wide) management of mosquitoes.

6.1 Current Monitoring of Mosquitoes and Biting Midge

Mosquitoes

Redland City Council's Pest Management Unit monitors the abundance of both larvae and adult mosquitoes throughout the city. This has provided a substantive understanding of the patterns of both larval and adult distribution and abundance (Ryan, et al., 2004). Larval populations are typically monitored using dip net samples, with the results of monitoring used to determine whether chemical treatment of a breeding site is necessary. Adults are monitored using CO²-baited light traps.

Midges

Redland City Council does not monitor the distribution or abundance of biting midge.

6.2 Current Control Measures within the Redlands

Mosquitoes

Council's Corporate Plan commits to the delivery of year-round mosquito management services to support strong, healthy communities, whilst its Mosquito Management Operational Plan 2012 – 2015 seeks to balance the cost of mosquito management against public health benefits and potential environmental harm. Council's Pest Management Unit operates as a member of a Contiguous Local Authority Group, recognising commonalities in both the distribution of pest species and required management methods.

Proximity of the Shoreline site to known and extensive marine and brackish water breeding habitat (on Crown land) underlines the importance of Council's aerial and ground-based mosquito control program. Council currently treats approximately 420 ha of salt marsh breeding habitat and a significantly lesser area of fresh water breeding habitat, within a 5 km radius of Shoreline. Treatment is by a combination of aerial and ground-based application.

Located to the immediate south of the township of Redland Bay, the Shoreline site likely benefits substantially from the Contiguous Local Authorities' (of which both Redland City Council and Gold Coast City Council are members) current mosquito control program.

Most (90+%) of Council's control efforts are focussed on saltmarsh mosquitoes, with only minor control activities undertaken in freshwater breeding habitat.

The mosquito control program uses two larvicides; s-methoprene as a growth hormone regulator and Bti (*Bacillus thuringiensis israelensis*) as a targeted biological control. These are distributed in spray or briquette form from helicopters after king tides or heavy rainfall. Peak breeding occurs between September and March, and ground investigations of larval abundance are conducted to determine when applications will have the greatest impact on larval mosquitoes. Adults can emerge in 4 – 5 days in warm climates (NSW Health 2004), so monitoring and treatment must occur within 2 – 3 days of high tides or significant rainfall events.

s-methoprene and Bti are also used to control freshwater mosquitoes, typically distributed by hand or by motorised backpack sprayers.

Midges

Redland City Council does not control biting midge (Redlands City Council, 2014a).

6.3 A Framework for Management

Whilst the Redlands Planning Scheme does not include a Biting Insect Code, a practical framework for mosquito and biting midge management at Shoreline is provided by the outcomes sought by the Biting Insect Code of the superseded Caloundra City Plan.

6.3.1 Siting and Design

Desired Outcome

Development is sited and designed to minimise the risk to public health from insect-borne arboviruses and nuisance caused by biting insects.

Considerations

Careful attention to elements of both conceptual and detailed design can significantly lessen the potential for mosquitoes and biting midges to breed and roost on site. The following guidelines have been adapted from: Queensland Health, 2002a; Easton, 1993; and Wheelan 1988, cited in Rust-PPK, 1995.

Siting of Sensitive Uses

Sensitive uses such as childcare and aged care facilities should be located distant from breeding and roosting sites.

Buffers

Dense vegetation corridors between mosquito / biting midge breeding sites and residential areas provide a dispersal conduit for the insects (Queensland Health 2002a). Dense vegetation adjoining known breeding sites, residential areas and public open space can provide roosting (resting) habitat for mosquitoes and biting midge. Consequently, the incidence of mosquitoes and biting midges within residential areas can be minimised by providing sparsely vegetated buffer zones between known breeding sites and residential areas. Choosing trees and shrubs with light foliage minimises the 'conduit' effect of vegetation corridors (Queensland Health 2002a). The duration of nuisance infestations will be lessened under conditions that cause the pest population to disperse widely: breezeways across known breeding sites and around residential areas should be incorporated *where practical*.

A significant reduction in the abundance of *Aedes vigilax* (the common salt marsh mosquito) and likely other species can be achieved with buffer distances ranging from 20 – 100 m (McGinn, 2014); whilst a buffer of 25 m may very significantly reduce the incidence of other common coastal species (McGinn, 2006).

Lower activity areas, daytime recreation areas and 'hi-rise' may be located closest to breeding sites, providing a buffer for residential and night time activity areas. Well-lit, sealed areas (such as roads and car parks) can also be used as buffers for activity areas, especially adjacent to biting midge breeding sites.

Engineering and Landscape Design

The extent of suitable breeding habitat can be minimised through landscaping and drainage that minimises ponding. This is particularly applicable to open grassed areas. All site drainage should be designed and installed such that sediment cannot accumulate and water cannot pond (Queensland Health 2002a). Elements of stormwater infrastructure, including sedimentation basins, bio-retention and detention basins, should be designed and managed to drain within 48 hours. Where possible, drains should discharge into a flowing waterway with healthy ecological processes that may assist to control mosquito numbers (Queensland Health 2002a).

Increase drainage and access for larvivorous fish to adjoining marine and brackish water breeding habitat may be achieved through runneling (permit required under the Fisheries Act 1994).

Re-profiling of the site should not impede the drainage of land up-slope, and vehicle access should be provided to potential breeding sites (eg. stormwater infrastructure).

Landscaping of public open space and residential gardens, that involves heavy mulching and watering, may encourage the breeding of the biting midge *Lasiohelea townsvillensis*. Heavy mulching and watering should be avoided to reduce this risk.

Breaks in vegetation corridors should be provided between breeding sites and high activity areas. Minimising vegetation density near residential and evening activity areas will also reduce roosting of mosquitoes and midges near populated areas. Avoiding the use of heavy foliage plants and those that require frequent watering will also discourage mosquito and midge roosting and midge breeding. Trees with high canopies providing for good air circulation at ground level offer an obvious benefit.

Building Design

More open window area on the windward side of buildings, rather than the leeward, can be used to passively 'pressurise' the building, and reduce opportunities for biting insects to enter from the preferred leeward side. Furthermore, buildings should be fully screened to prevent insect entry. Ceiling fans and similar circulation devices can be incorporated to increase airflow.

Outdoor areas close to breeding grounds should incorporate screening.

Outdoor lighting directed towards the ground and the minimal use of lighting on balconies and near windows will likely minimise the attraction of a range of insects.

To minimise mosquito problems associated with rainwater tanks, WHO recommends that all tanks have screens or other devices to prevent adult mosquitoes from emerging (WHO 1997). All inlets, overflows and other openings should be covered with closely fitted, removable, mosquito-proof mesh to prevent access by adult mosquitoes, and if larvae are present, to prevent the escape of adult mosquitoes (Enhealth, 2004). Queensland Regulations (1996) specify that screens should be brass, copper, aluminium or stainless steel gauze with mesh not coarser than 1 mm. Rainwater should not be allowed to pond in containers or on surfaces below tank outlets or taps, as this can also provide a breeding site.

Shoreline's Response

Sensitive Uses

Shoreline will locate sensitive uses such as schools, childcare and aged care facilities remote from potential mosquito and biting midge breeding and roosting habitat.

Buffers

Integral to the urban design of Shoreline is the approximately 100 m wide cleared open-space foreshore buffer between the shore (HAT) and residential and community precincts (Figures 1.3 and 6.1). A 20 –100 m, open-space buffer has been reported to significantly reduce the abundance of both mosquitoes (and in particular *Aedes vigilax*) and biting midge (Mosquito Consulting Services, 2014).

The foreshore buffer is constrained at two locations towards the north of the site (Figure 6.1). Densely wooded Conservation Areas reduces the open-space buffer to approximately 10 m and 40 m wide. The establishment of Sub-area 1 in the Shoreline Plan of Development (Figure 6.2) will ensure that development within 100 m of potential roosting habitat must comply with the building design code attached at Appendix A.

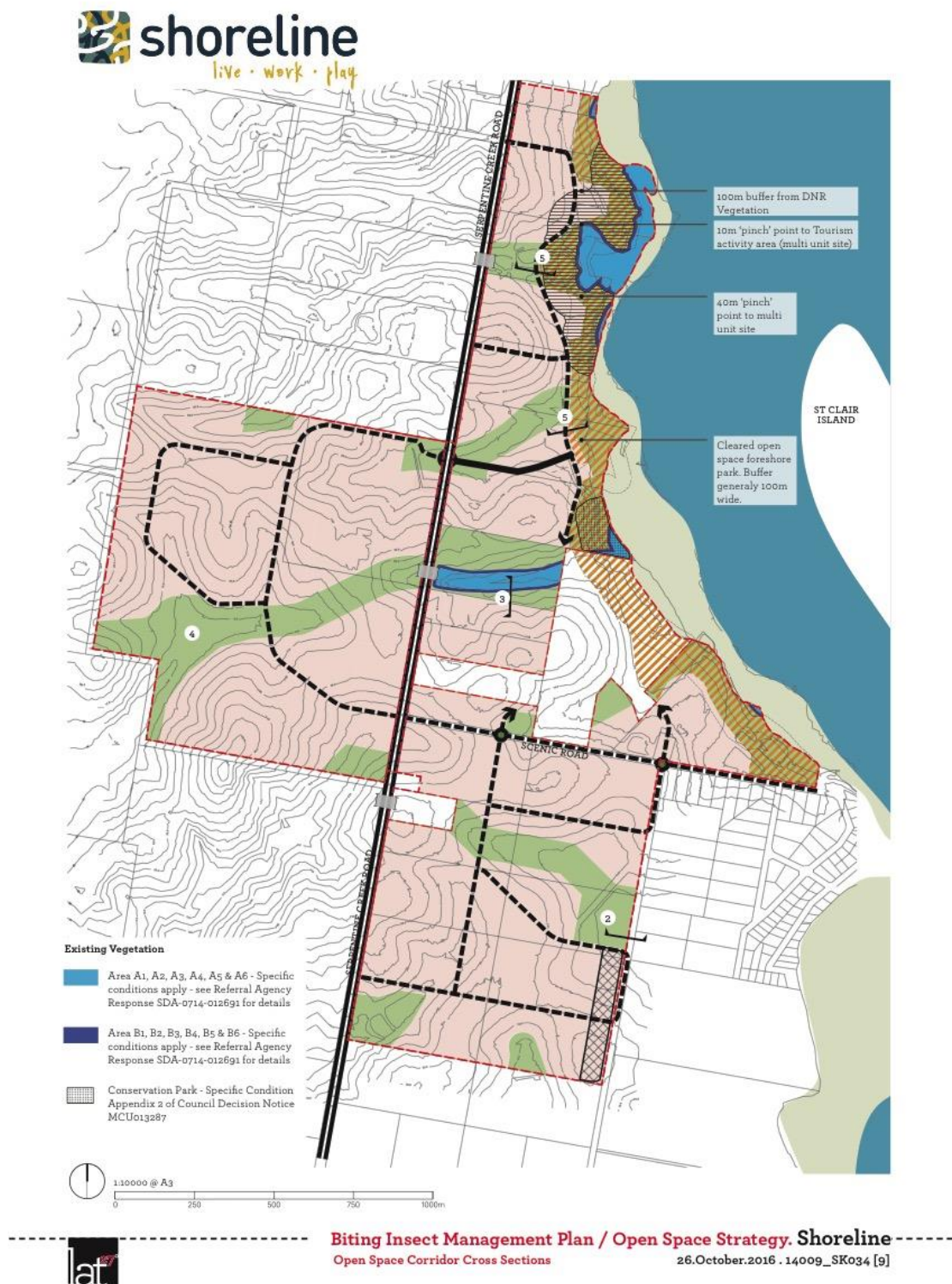


Figure 6.1 Proposed set-backs to mitigate the proximity to biting insect breeding and roosting habitat.

Open Space Corridors and Linkages will be no less than 100 m wide, comprised of a 50 m wide (or as otherwise agreed by Council) core of riparian vegetation and 25 m wide margins of lightly treed low-maintenance grassland, augmented by esplanade roads (road reserve 20 m wide) and building setbacks (6 m) (see Figures 4.1, 6.2 and 6.3).

In aggregate, each corridor and linkage will provide approximately a 75 m setback between freshwater mosquito breeding habitat and properties and 50 m from dense roosting habitat (sufficient to minimise the movement of mosquitoes such as *Aedes procax* and *Verrallina funereal*; McGinn (2013) recommends a 30 m wide buffer as sufficient to manage these species). These corridors will also serve as breezeways that discourage roosting of other species of mosquitoes and biting midge.

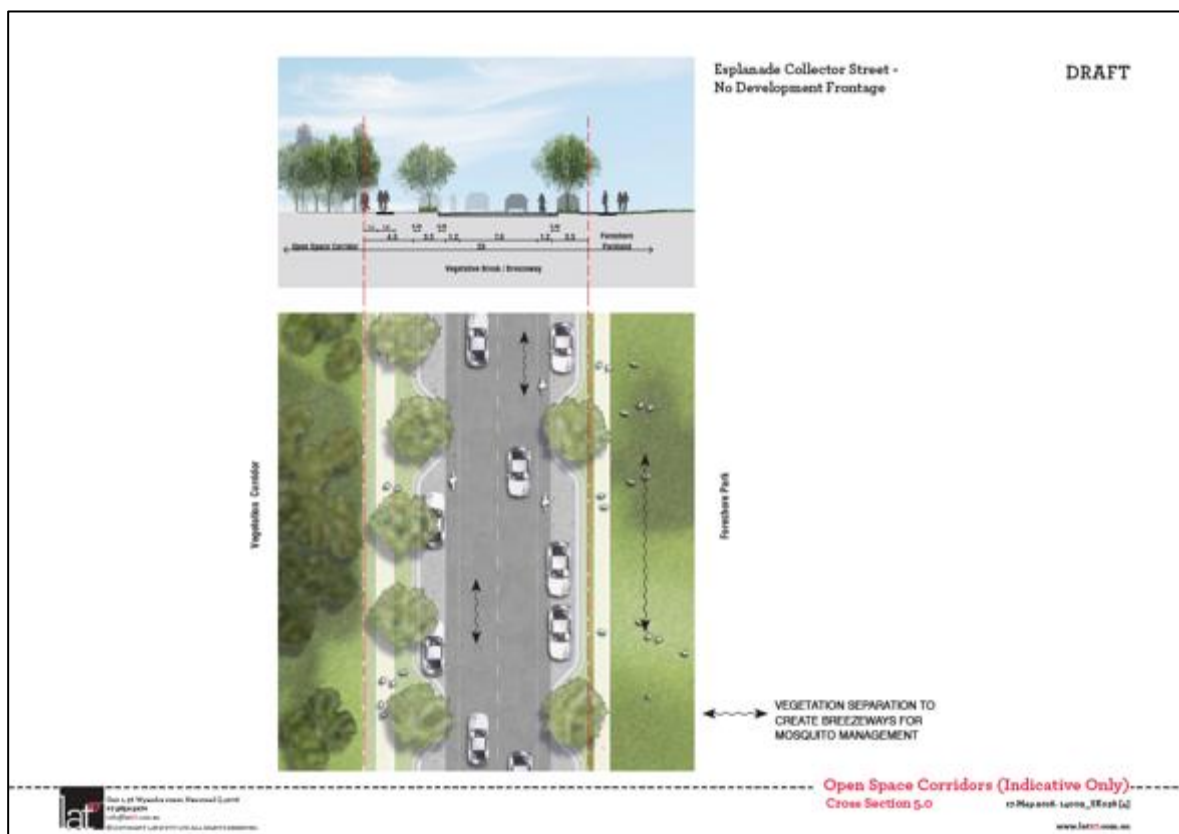


Figure 6.2 Proposed set-backs for Open Space Corridors.



Figure 6.3a Proposed set-backs for Multipurpose Corridors.

(Note, the location of sports facilities does not form part of this approval.)

DRAFT



Figure 6.3b Proposed set-backs for Multipurpose Corridors.

(Note, the location of sports facilities does not form part of this approval).

Supplemental Open Space Linkages will have no direct connectivity with mosquito (or biting midge) breeding habitat and be characterized by lightly treed (managed) grassland providing minimal roosting habitat.

The south-east of the site (Lots 86 and 247 on S312432) will incorporate an 80 m development-free buffer, which with the 20 m wide road reserve (Orchard Road) will provide a 100 m clearance to development on lots 80 and 81 on S31102. These lots are densely vegetated and extend to saltmarsh habitat on the coastline, and as such have the potential to harbour pestiferous numbers of mosquitoes.

Development of these environmental corridors, road reserves and set-backs will both reduce available roosting habitat on site, and increase the wind-assisted funnelling of biting insects from coastal breeding habitat to the more elevated bushland to the west of the site.

Engineering and Landscape Design

The extent of breeding habitat will be minimised through landscaping and drainage that minimises ponding and opportunity for roosting. Re-profiling of the site will be designed and managed to not impede drainage. Stormwater infrastructure, including sedimentation basins, bio-retention and detention basins, will be designed to be free draining in accordance with the guidelines provided by Water by Design (2010). Where practical, drains will discharge into a flowing waterway.

Landscape planting will minimise the use of groundcovers, shrubs and small trees that may serve as roosting areas. Through careful selection of planting palettes, the use of organic mulch combined with the need for heavy watering will also be minimised to reduce breeding of biting midge.

Vegetation density near residential and evening activity areas will also be reduced to discourage roosting of mosquitoes and midges.

Vehicle access will be provided to potential breeding sites (e.g. stormwater infrastructure).

Building Design

Careful attention to elements of both conceptual and detailed design can significantly lessen the potential for mosquitoes (and biting midges) to enter buildings.

Outdoor entertaining areas are encouraged to be equipped with insect screens with a mesh aperture of not more than 1mm to minimise mosquito entry to the area.

Insect screens specifically designed to prevent the entry of smaller insects such as biting midge are recommended to be incorporated to minimise biting midge entry to the building.

Locate the majority of windows on the windward side of the building to pressurise the building and reduce opportunities for biting insects to enter the preferred leeward side of the building.

Ceiling fans and other air circulation devices are encouraged to increase airflow indoors and outdoors to minimise the ability for mosquitoes to travel inside the building.

Outdoor lighting is encouraged to be directed towards the ground to minimise the attraction of biting insects. Mosquitoes will travel significant distance towards lit up areas.

Elements of the the building design code dealing with biting insects, embedded within an extract of Shoreline's Plan of Development are presented at Appendix A.

6.3.2 On-site Works

Desired Outcome

Development does not intensify the presence of or expand breeding sites for mosquito larvae.

Considerations

Engineering works required to affect development of the site may permanently reduce the extent of breeding and roosting habitat on site.

Access roads should be fitted with culverts to prevent pooling of water.

Excavation, vehicle ruts, and temporary sediment control basins all have the potential to support mosquito breeding. Site-monitoring and prompt corrective action (such as filling ruts and draining or treating sediment control basins) should be undertaken as required. Application of larvicides should be undertaken only by a licenced pest controller.

Shoreline's Response

Engineering works required to affect development of the site will permanently reduce the extent of breeding and roosting habitat on site.

Access roads will be fitted with culverts to prevent pooling of water.

Excavation, vehicle ruts, and temporary sediment control basins will be monitored. Prompt corrective action (filling ruts and draining or treating sediment control basins, etc) will be undertaken as required. Application of larvicides will be undertaken only by a licenced pest controller.

6.3.3 Design and Use of Wetlands and Waterways

Desired Outcome

New waterbodies or stormwater treatment wetlands / detention basins are designed to minimise the potential breeding opportunities for biting insects.

Considerations

Wetland Design and Operation

Mosquito breeding within dams, retention basins and water features can be minimised by reducing the 'soft' edges around ponds, and by ensuring that the edges are steep and free of dense emergent vegetation (whether planted or invasive), which supports mosquito breeding (Queensland Health 2002a). Increased bed depth (>3 m) and 1:3 batters effectively restrict the distribution of most emergent reeds and rushes around dam margins, minimising mosquito breeding habitat. The use of concrete revetment would reduce opportunities for mosquitoes and biting midge to breed. The suitability of breeding habitat can also be reduced by preventing water from stagnating with adequate circulation and the use of fountains.

Fluctuating water levels may both directly and indirectly influence mosquito and midge breeding. Depending on timing and periodicity, fluctuating water levels may either create or destroy favourable breeding habitat for both mosquitoes and biting midges. For example, falling water levels may expose suitable moist substrate and leave shallow pools free from predators. Rising water levels may inundate drying substrate and both trigger hatching and provide habitat suitable for larval development. Fluctuating water levels commonly encourage the expansion of fringing macrophyte beds, indirectly providing increased habitat suitable for mosquito breeding. The use of concrete and rock revetments largely mitigates the effects of fluctuating water level.

Opportunities to increase the exposure lakes and wetlands to prevailing winds should be sought, as mosquito larvae require contact with a stable surface film for respiration.

Restricting aquatic macrophytes (either floating or emergent forms) to less than 60% of shallow waters (<500 mm), and clumping of plants with open space between will allow greater wind disturbance of the water surface.

While the initial design of water bodies may adhere to these requirements, the ongoing growth of vegetation, bank slumping, physical disturbance, accumulation of rubbish and debris, sedimentation, water quality deterioration, water management problems and general climatic conditions will all influence the production of mosquitoes (Webb and Russell, 2011; Russell, 2001).

Stormwater treatment wetlands by design will be shallow and densely planted. For these purpose-specific water bodies, a greater reliance must be placed on managing emerging larvae (see Native Fish as Control Agents below).

Shoreline's Response

Development of the site will retain a number of existing wetlands, dams and waterways. Shoreline's WSUD Strategy (2014) incorporates planted wetlands and bioretention basins. Whilst natural waterways will be unmodified, they will be set-back from residential and community precincts by a minimum of 20 – 30 m. Wetlands and dams will be designed / modified such that:

Wetland Design and Operation

For dams and lakes, breeding habitat will be minimised by the use of steep edges, maintaining water depths in excess of 600 mm, the judicious use of edge plantings and the orientation and exposure afforded all retained water bodies. Water quality, bank integrity and the distribution of aquatic plants will be managed to retain the integrity of the initial design(s).

Elements of Water Sensitive Urban Design including swales and bio-retention basins will be designed to minimise ponding (in accordance with Australian design guidelines), whilst planted wetlands will incorporate features to promote the effectiveness of larvivorous fish in controlling emerging larvae (Design Flow, 2104).

6.3.4 Biting Insect Control Measures

Considerations

Native Fish as Control Agents

Native larvivorous fish can be stocked in (fresh) waterbodies to contribute to mosquito control. The Queensland Department of Primary Industries & Fisheries list a number of species that are native to the region and likely to assist with mosquito control (DPI&F, 2006). Recent work by Hurst et al. (2004) has found that of the species recommended, the crimson-spotted rainbowfish (*Melanotaenia duboulayi*) and the firetail gudgeon (*Hypseleotris galii*) are likely to be the most effective at controlling mosquito populations in freshwater lakes. Studies have shown that these species also prey on tadpoles (Hurst, T. [Queensland Institute of Medical Research], pers. comm. 2004, 12 October; Hurst, Brown and Kay, 2004). These fish can be obtained from some aquariums and from registered fish hatcheries (DPI 2004); other species listed in Table 6.1 can also be stocked in the lake to enhance species diversity.

Native fish from commercial suppliers typically cost \$200 – \$400 per 100 fish (frc environmental 2002). Previous studies have suggested that fish stocking densities of around 1 fish per m² of potential breeding habitat (i.e. the approximately 2m of shallow habitat around the margin of the lake that may support aquatic macrophytes) should be sufficient to control mosquito populations (frc environmental 2002).

In order for stocked fishes to effectively control mosquito breeding, the fish must be allowed to develop sufficiently abundant populations, and must be able to get to locations used by mosquitoes for breeding. In effect, this requires permanent and relatively stable water (quality), and sufficient depth of water to allow the fish access to potential breeding habitats.

Table 6.1 Native freshwater fish species recommended by QDPI for stocking to assist with mosquito control.

Species	Com. Name	Status	Key Characteristics
Chandidae			
<i>Ambassi agassizi</i>	olive perchlet	LC	Often reaches 60 mm in length; inhabits flowing and still water bodies; eats microcrustaceans and insects (larvae and adult.)
Melanotaeniidae			
<i>Melanotaenia duboulayi</i>	Duboulay's rainbow fish	LC	Reaches 75 – 90 mm in length; inhabit ponds, streams and reservoirs, diet includes insects (adult and larvae), microcrustaceans and algae.
Eleotridae			
<i>Hypseleotris compressa</i>	empire gudgeon	LC	Reaches 100 mm in length; found in lower reaches of rivers; diet includes aquatic invertebrates – primarily cladocerans and insect larvae, algae and detritus.
<i>Hypseleotris galii</i>	firetail gudgeon	LC	Reaches 40 – 55 mm in length; occurs in coastal streams, rarely in lower reaches; feeds on aquatic invertebrates.
<i>Mogurnda adspersa</i>	southern purple – spotted gudgeon	LC	Commonly reaches 100 mm in length, inhabits clear and turbid environments; feeds on aquatic insects and crustaceans.

Species	Com. Name	Status	Key Characteristics
Atherinidae			
<i>Craterocephalus</i> <i>stercusmuscarum fulvus</i>	fly-specked hardyhead	LC	Reaches 100 mm in length; found in still or slow flowing water; diet includes mosquito larvae, aquatic insects and crustaceans.
Pseudomugilidae			
<i>Pseudomugil signifer</i>	Pacific eye	blue LC	Reaches 62 – 88 mm in length; widespread in fresh and brackish coastal waters; diet includes mosquito larvae and other insects.

LC – Declared as 'Least Concern' wildlife under the Queensland Nature Conservation (Wildlife) Regulation 2006.

(DPI 2004; 2006; Merrick & Schmida 1984; McDowall 1996)

Shoreline's Response

Shoreline will stock retained water-bodies with native larvivorous fishes in accordance with Fisheries Queensland guidelines.

7 Biting Insect Management Plan

7.1 Objective

This Biting Insect Management Plan has been developed to support the development of Shoreline, located on the shores of Moreton Bay and consequently subject to mosquito and biting midge incidence, in a manner that balances the health and amenity of residents, visitors and neighbours, with cost and environmental harm.

Its purpose at each stage of development is summarised in Table 7.1

Table 7.1 Purpose of this plan, for each stage of development.

Stage	Purpose
Pre-Development	Inform the refinement of site layout, engineering and landscape design, and of water-body and building design.
Development	Inform the planning and conduct of on-site works; and of the monitoring and management of on-site mosquito breeding.
Operational	Inform on-going monitoring and management of mosquitoes both on- and off-site.

7.2 Goals

This Biting Insect Management Plan is designed to:

- support the development of the site in a manner that does not increase the abundance of mosquitoes and biting midge, or the extent of breeding habitat;
- support the development of the site such that residents and visitors alike can enjoy the amenity of the site and not be unduly subjected to arboviruses;
- describe the responsibilities of the Proponent;
- identify appropriate on-site monitoring procedures, triggers for treatment and environmental safeguards;
- comply with the Mosquito Management Code of Practice; and
- support compliance with legislative and regulatory requirements.

7.3 Performance Indicators

The effectiveness of this Biting Insect Management Plan will ultimately be assessed against:

- the frequency of residents' complaints;
- the incidence of mosquito borne disease; and
- environmental harm.

Larval and adult abundance may also be used to provide a measure of the success of this management plan.

7.4 Responsibilities

The Proponent is responsible for developing site layout, and for engineering, landscape and water-body design. The Proponent may be responsible for the design of some buildings.

In general terms, the Proponent will be responsible for the management of mosquitoes and biting midge on land it owns.

7.5 Design Refinement

Site layout, engineering, landscape and water body design will be refined in accordance with Section 6 of this Plan, as summarised in Table 7.2.

Table 7.2 Summary of factors influencing design refinement.

Issue	Key considerations to minimise the prevalence of mosquitoes and biting midge
Siting and Engineering, Landscape and Building Design	Open-space buffers to separate off-site and on-site breeding habitat from residential and community precincts. Landscaping and drainage to minimise on-site breeding and roosting habitat. Building design to exclude biting insects.
Waterways and Wetlands	Open-space buffers to separate breeding habitat from residential and community precincts. Orientation to encourage wind exposure. Breeding habitat minimised through minimum depths, edge treatments and plantings.

7.6 During Development of the Site

The site will be progressively developed. Monitoring and management of mosquito and biting midge on site will be the responsibility of the Proponent's Site Development Manager. It will be the Site Development Manager's responsibility to:

- ensure all employees, contractors and sub-contractors are aware of their responsibilities regarding mosquito and biting midge management;
- implement routine monitoring of the site generally (pot holes, wheel ruts, temporary water storages and erosion control measures), and of temporary and permanent water bodies in particular. Monitoring of mosquito and biting midge breeding will be undertaken at least weekly over the period September – April. Records will be maintained digitally.
- implement and document corrective actions;
- recommend improvements to the Biting Insect Management Plan based on acquired experience and evolving best practice.

On-site Monitoring

Monitoring of adult mosquito incidence within the development footprint (recognising the site will be developed in stages) will be undertaken following significant rainfall events likely to lead to senescing waters.

On-site larval monitoring (of waterways and dams), will be conducted where the results of adult monitoring indicate that freshwater species are a significant component of the mosquitoes recorded on-site.

The objectives of monitoring are to:

- determine the incidence of freshwater-breeding mosquitoes, to trigger (and assess the effectiveness of) treatment (or other management response) of on-site waterbodies; and
- provide an indication of the effectiveness of both on- and off-site (brackish water) larval management programs.

Larval monitoring will be conducted where it is assessed that freshwater species are a significant component of the adult mosquitoes caught by the light traps. Where larval monitoring triggers on-site treatment by the Proponent, monitoring will be continued to confirm the effectiveness of treatment. Treatment will be designed and effected by a licenced pest controller. A treatment register will be maintained and include:

- areas treated;
- date and time of treatment;
- treatment used (inc. dose, batch number, etc); and
- results of follow-up monitoring.

Table 7.3 Summary of On-site Mosquito Management during Development.

Issue	KPIs	Routine Responsibilities	Responsible Entity	Required Outcomes	Corrective Actions
On-site breeding and roosting habitat (and breeding) is not increased	Extent of breeding habitat. Larval density.	Use of culverts to avoid pooling of water. Maintenance of the site, including: · regular mowing of grassed areas · monthly maintenance of gross pollution traps · weekly surveillance of the site (may include larval monitoring).	The Proponent	The timely remediation of breeding habitat and prevention of adult emergence.	Filling of ruts, draining of detention basins, etc as appropriate to reduce breeding habitat and prevent emergence of adults. Treatment of breeding habitat that is unable to be remediated. Improved site management.
Education and Awareness	Published material Site induction manual	Broad-based community awareness. Site-based awareness and education.	Qld Health currently performs this role The Proponent	Broad-based community awareness. Awareness of staff and contractors.	 Improvement of induction manual / process.
Record Keeping, Reporting and Review	Records and Reports	Maintenance of records (site maintenance, breeding habitat surveillance, larval monitoring and corrective actions).	The Proponent	Demonstrated diligence.	

7.7 Of the Developed Site

The Proponent will undertake mosquito monitoring and management appropriate to infrastructure within its ownership and control (as per Table 7.1).

Where practical, on-site mosquito management will be co-ordinated with Council's off-site program.

7.8 Training and Awareness

The Proponent will provide appropriate training to its staff, contractors and sub-contractors such that they are aware of the risks to human health posed by mosquitoes and biting midge, what constitutes suitable breeding and roosting habitat, and as required by their individual responsibilities, how they are expected to contribute to on-site mosquito and biting midge management. Environmental and health risks associated with mosquito and biting midge control will be highlighted. A register of training will be maintained.

Council, together with Queensland Health currently develop, publish and promulgate material that serves to educate the community (and particularly those moving to the Redlands) as to the need for individuals to manage their exposure to mosquitoes and biting midge (see: Redland City Council 2014, 2014a, 2014b, 2014c).

7.9 Record Keeping and Continual Improvement

This Biting Insect Management Plan will be reviewed annually from the commencement of development of the site for the duration of development. Amendments will be made to reflect best practice. Where the Proponent retains elements of the site post-development, element-specific management plans will take on any required residual responsibility for biting insect management.

All Proponent-initiated activities will be documented, with records maintained by the Proponent. During the development phase, an annual summary of mosquito and biting midge management will be prepared by the Proponent and made available to relevant stakeholders.

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**Appendix A Building Design to Reduce Exposure to Mosquitoes
- extract from Shoreline's Plan of Development
(pp116-117)**

Code	Outcome/Solution	Variation/Addition
		a. For residential configuration, a maximum of two lots are served by a pipe system that discharges roof water run off to the nearest downhill road reserve or lawful point of discharge; or; b. For other reconfiguration, an inter lot drainage system discharges roof and surface runoff to the nearest available downhill road reserve or lawful point of discharge; c. Avoids the risk of flooding by ensuring that uses and other development are undertaken on land above the 1% AEP flood and storm tide level (2.4 meters AHD).

An additional code has been added:

8.3 BUILDING DESIGN CODE TO REDUCE THE INCIDENCE OF BITING INSECTS

8.3.1 Application

This code applies to self-assessable and assessable development identified as required by the tables of assessment in **Part 3 (Tables of assessment)**.

8.3.2 Purpose and overall outcomes

- (1) The purpose of this code is to ensure development minimises:-
- (a) the exposure of people to health risks associated with arboviruses;
 - (b) the adverse impacts on an amenable lifestyle and the public's wellbeing from exposure to biting midges and mosquitoes; and
 - (c) the adverse impacts of biting midges and mosquitoes on human health, and long-term management costs to Council.
- (2) The purpose of the code will be achieved through the following overall outcomes:-
- (i) In sub-area 1 or within the Open Space Precinct
 - a) Development and other uses must ensure all external windows and doors are equipped with insect screens with a mesh aperture of not more than 1mm; and
 - b) Where a Child Care Centre must ensure outdoor play / entertainment areas are equipped with insect screens with a mesh aperture of not more than 1mm.
 - (ii) Where an Aged Person and Special Needs Housing or Child Care Centre use in any location, development ensures all external windows and doors are equipped with insect screens with a mesh aperture of not more than 1mm.

Editor's Note - Building Design Advice

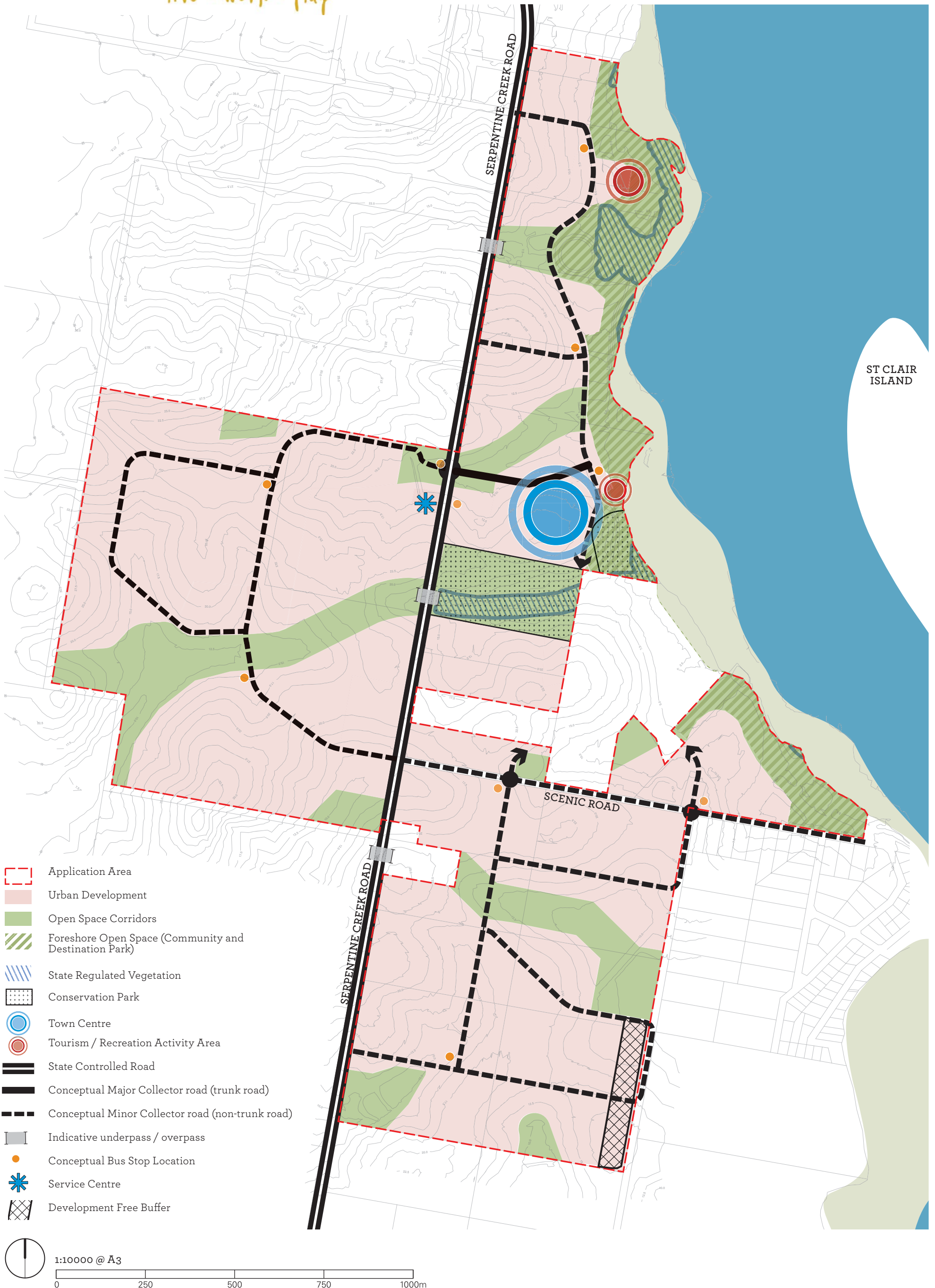
Careful attention to elements of both conceptual and detailed design can significantly lessen the potential for mosquitoes (and biting midges) to enter buildings.

- Outdoor entertaining areas are encouraged to be equipped with insect screens with a mesh aperture of not more than 1mm to minimise mosquito entry to the area.
- Insect screens specifically designed to prevent the entry of smaller insects such as biting midge are recommended to be incorporated to minimise biting midge entry to the building.
- Locate the majority of windows on the windward side of the building to pressurise the building and reduce opportunities for biting insects to enter the preferred leeward side of the building.
- Ceiling fans and other air circulation devices are encouraged to increase airflow indoors and outdoors to minimise the ability for mosquitoes to travel inside the building.
- Outdoor lighting is encouraged to be directed towards the ground to minimise the attraction of biting insects. Mosquitoes will travel significant distance towards lit up areas.

8.3.3 Specific Outcome and Probable Solutions applicable to Assessable Development

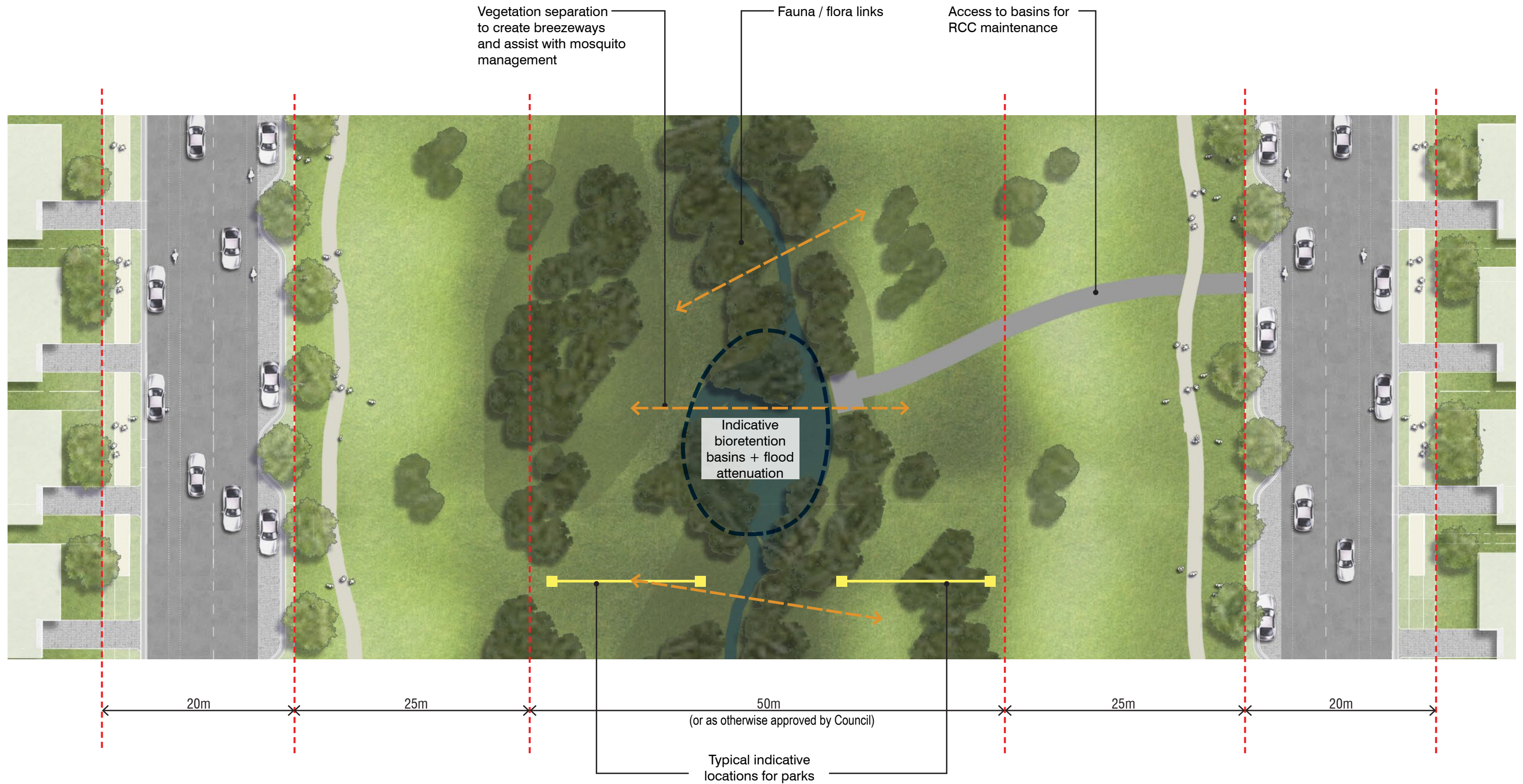
Specific Outcomes		Probable Solutions	
S1.1	(1) In sub-area 1 and the Open Space Precinct - a) Development and other uses must ensure all external windows and doors are equipped with insect screens with a mesh aperture of not more than 1mm; and b) Where a Child Care Centre, must ensure outdoor play/entertainment areas are equipped with insect screens with a mesh aperture of not more than 1mm. (2) Where an Aged Person and Special Needs Housing or Child Care Centre use in any location, development ensures all external windows and doors are equipped with insect screens with a mesh aperture of not more than 1mm.	P1.1	(1) No probable solution identified. (2) No probable solution identified.

Appendix B Shoreline Plans, current March 2017



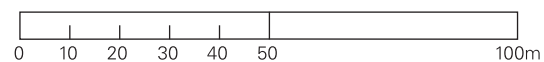
ST CLAIR
ISLAND

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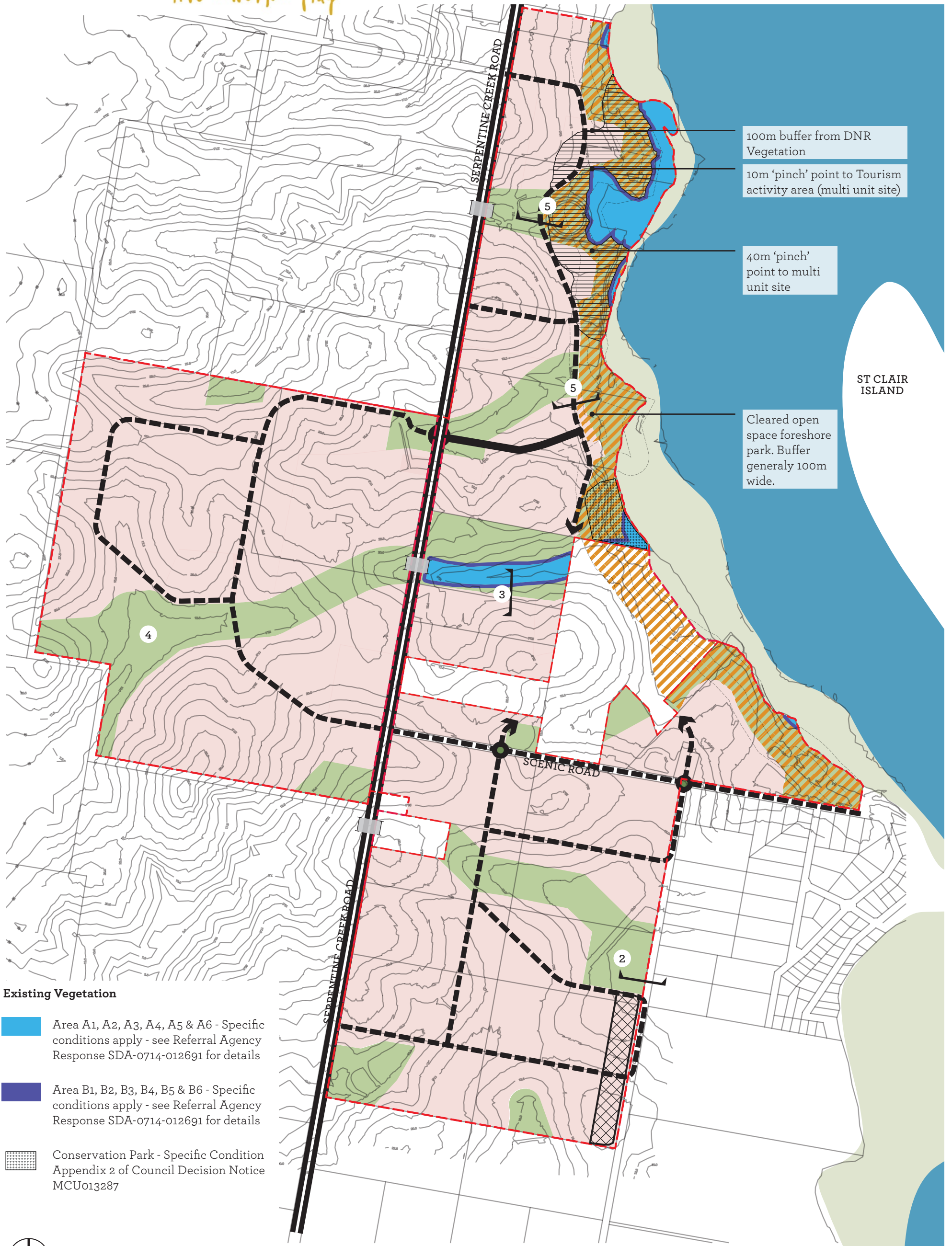
Open Space Corridors With Parks (Indicative Only). Shoreline

DRAFT



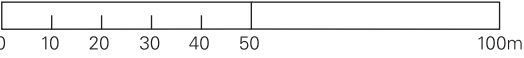
NOTE: The location of the sports facilities does not form part of this approval.

VEGETATION SEPARATION TO CREATE BREEZEWAYS FOR MOSQUITO MANAGEMENT





NOTE: The location of the sports facilities does not form part of this approval.

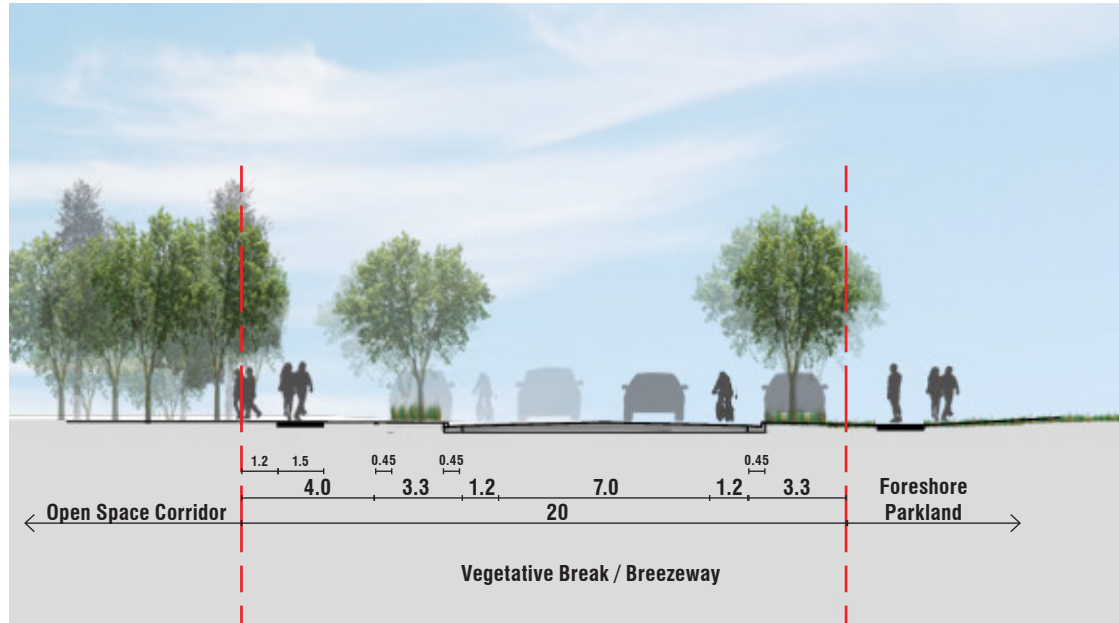


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Open Space Multipurpose Corridor (Indicative Only).
Cross Section 2

26.October.2016 . 14009.01. Sk036 [5]

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Esplanade Collector Street -
No Development Frontage

DRAFT

Vegetation Corridor
(30m Nominal)



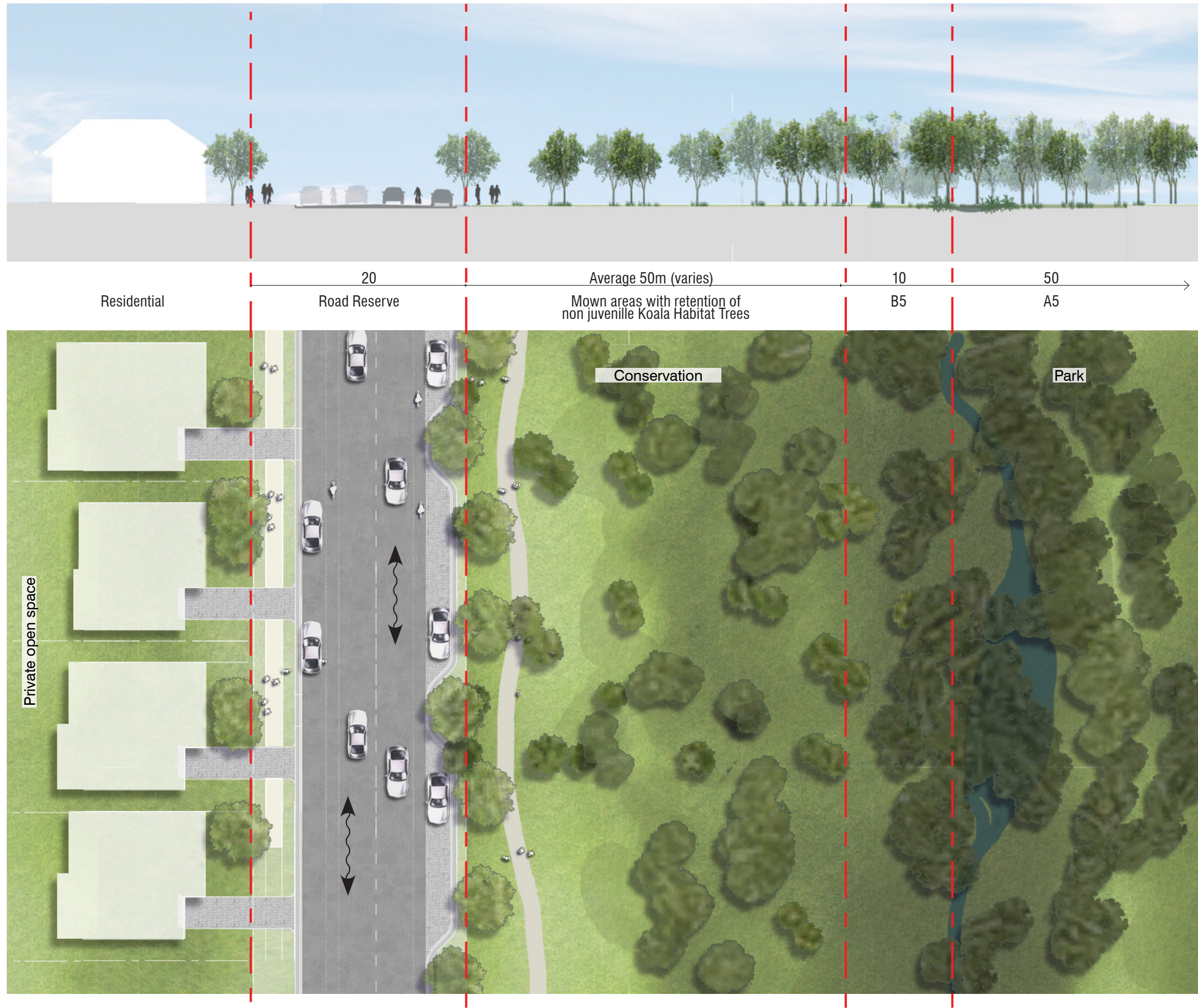
Foreshore Park

VEGETATION SEPARATION TO
CREATE BREEZEWAYS FOR
MOSQUITO MANAGEMENT

Open Space Corridors (Indicative Only)
Cross Section 5.0

12.June.2015 . 14009_SK038 [3]

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VEGETATION SEPARATION TO CREATE BREEZEWAYS FOR MOSQUITO MANAGEMENT

Development Adjacent to Conservation Park (Indicative Only)
Cross Section 3.0