



Guidelines to minimise mosquito and biting midge problems in new development areas



Queensland Government
Queensland Health

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Foreword

Many community areas are located close to major natural breeding sites of mosquitoes and biting midges. Inappropriate construction practices within community areas also have the capacity to create new breeding sites.

It is well documented that residents who live close to breeding sites of these insects may be subjected to intense problems from their bites. More importantly, some species of mosquitoes are vectors of mosquito-borne diseases including Ross River virus (RRV). Studies indicate that residents who live within three kilometres of major breeding sites of the mosquito vector of RRV have a higher risk of contracting the disease than those residing further away.

These guidelines provide advice on ways to prevent or minimise the impact of mosquitoes and biting midges in new development areas. Local government and developers should find these useful when developing and implementing development plans and insect mitigation programs.

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State Manager, Public Health Services
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Department of Local Government and Planning

Department of Primary Industries

Department of Natural Resources and Mines

Brisbane City Council

Caloundra City Council

Hervey Bay Town Council

Calliope Shire Council

Tweed Shire Council

Local Government Association of Queensland Inc.

Northern Territory Health Services.

Executive summary

Community areas, particularly residential developments, have been located in close proximity to major mosquito or biting midges major breeding sites. Some construction practices in development areas have also created new mosquito or biting midge breeding habitats.

These two factors have brought humans into closer contact with these biting insects leading to an increased incidence of Ross River virus diseases and other mosquito-borne diseases as well as intense pest problems.

These guidelines provide background information on the biology and public health importance of mosquitoes and biting midges.

The document outlines the consequences of locating residential areas at various distances from natural breeding sites of these insects.

Avoidance and mitigation measures, including practical information on the design of residential development areas and water impoundments within these sites, are detailed.

These measures should assist local government and developers in land use planning and development assessment.

Queensland Health has developed these preventative measures in consultation with other government departments and local government.

Contents

Foreword	1
Acknowledgements	2
Executive summary	3
Contents	4
1.0 Introduction	6
2.0 Aim of guidelines	6
3.0 Information about mosquitoes and biting midges	6
3.1 Common mosquito and biting midge species in Queensland	6
3.2 Factors contributing to the impact of mosquitoes and biting midges on the community	6
3.2.1 Meteorological conditions	7
3.2.2 Location of populated areas	7
3.2.3 Design of populated areas	7
3.2.4 Habits of mosquitoes and biting midges	7
4.0 Performance standard recommended for development of community areas to minimise arboviruses-related public health risks and problems from mosquitoes/biting midges	8
4.1 Seek information on local mosquitoes and biting midges	8
4.1.1 Local government	8
4.1.2 Monitoring program	8
4.2 Evaluate the significance of mosquito and biting midge breeding sites in the vicinity of proposed site	8
4.3 Develop a plan to minimise mosquito and biting midge problems	9
4.3.1 Avoidance through land use planning	9
4.3.2 Mitigation approach within proposed site	9
4.3.2.1 Residential area	9
4.3.2.2 Artificial wetlands/water impoundments	10
4.3.2.3 Drainage system	10
4.3.2.4 Construction effect	11
4.3.3 Breeding sites control programs	11

5.0 Possible consequences following inappropriate measures	12
5.1 Economic and social costs of mosquito-borne disease	12
5.2 Vector control cost, application, resistance and impacts	12
5.2.1 Larviciding	12
5.2.2 Habitat modification	13
5.3 Decrease in property value	13
6.0 Consultation authorities	13
6.1 Queensland Health	13
6.2 Local governments	13
6.3 Department of Primary Industries, Queensland Fisheries Service	14
6.4 Environmental Protection Agency	14
6.5 Department of Natural Resources and Mines	14
6.6 Department of Local Government and Planning	14
7.0 Glossary and abbreviations	15
8.0 References	16
9.0 Appendices	17
Appendix 1 Some mosquito species which are vectors or serious pests in Queensland (not including species which breed in containers)	17
Appendix 2 Some biting midge species which are serious pests in Queensland	20
Appendix 3 Distance from mosquito/biting midge breeding sites and its impact	22

Table

Table 1	Combined annual budget for aerial larviciding programs, 1993 to 1998	13
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1.0 Introduction

Mosquito-borne diseases, such as Malaria, Ross River, Barmah Forest, Dengue, Australian Encephalitis, Japanese Encephalitis, Kunjin, Kokobera and Stratford viruses, occur in Queensland. Among these, Ross River virus (RRV) is the most prevalent disease comprising 90 per cent of total notification of mosquito-borne diseases.

Many development applications are approved without taking into consideration the direct effects and public health implications of mosquitoes and biting midges

after development. Developments in close proximity to wetlands, particularly within the coastal zone, have brought humans into closer contact with these biting insects in their natural habitats. Some construction practices have created new mosquito or biting midge breeding sites. The increased incidence of Ross River virus and other arbovirus diseases can be attributed to such factors. To prevent this situation worsening, it is therefore necessary to establish and implement appropriate planning and mitigation measures.

2.0 Aim of guidelines

These guidelines provide advice on measures to prevent or minimise the impact on the community of mosquitoes and biting midges. They should assist town planners, developers and engineers, during the review of planning schemes and design of development proposals, to minimise the effects of mosquitoes and biting midges. The guidelines may also be used by local governments and other organisations that need to assess the impact of mosquitoes and biting midges, with regard to proposed development projects.

These guidelines are relevant to development in the vicinity of wetland areas in coastal and inland regions. Also included are measures recommended for reducing the impacts of biting insect populations resulting from construction of recreational lakes, dams, stormwater drains, sewerage effluent and artificial wetlands for the treatment of sewage, and urban and rural stormwater run off.

Some recommendations stated in the guidelines, eg. the retention of some aquatic and riparian vegetation for water impoundments, differ from those recommended in conventional guidelines for mosquito control. These guidelines take environmental issues into consideration.

The guidelines contain:

- (a) avoidance measures for consideration by local governments in land-use planning and development assessment.
- (b) the mitigation approaches to be adopted on lands included in development proposals, where the development may expose significant numbers of people to insect vectors and pests.

Relevant proposals would include residential areas, tourist accommodation, recreational and commercial/ industrial developments.

3.0 Information about mosquitoes and biting midges

3.1 Common mosquito and biting midge species in Queensland

Information on the biology, distribution and public health importance of common mosquitoes and biting midges in Queensland is described by Marks and Reye (1982) and Reye (1992). Some mosquito and biting midge species, which are vectors or serious pests in Queensland, are listed in Appendices 1 and 2.

The lists provide examples of mosquito and midge species of likely public health significance, if a mitigation approach to alleviate the problems is not adopted for new development areas.

Newcomers to an area frequently have greater sensitivity to the bite of local pest species. Hence, a reduction of house value and the loss in tourist

business are known to occur in areas where residential and tourist developments are developed in close proximity to mosquito and biting midge breeding sites.

3.2 Factors contributing to the impact of mosquitoes and biting midges on the community

Some factors which influence the density and dispersal of mosquito and midge populations, and cause them to become a problem, are meteorological conditions, location of populated areas, availability of shelter and specific habits of mosquito and biting midge species.

3.2.1 Meteorological conditions

Wind

Strong wind reduces the flight activity of mosquitoes and biting midges and hence reduces the chance of being bitten. On the other hand, strong wind may carry large numbers of mosquitoes and midges away from their breeding sites to populated areas, which are normally out of pest range.

Humidity

High humidity enhances mosquito and biting midge survival but reduces their flight activities. Normally, flight activity will cease when the relative humidity is above 90 per cent.

Temperature

In sub-tropical areas, most mosquitoes stop feeding when the temperature falls below 10°C. Prolonged extreme temperatures of 10°C and 35°C will greatly reduce the survival rate of most adult mosquitoes and biting midges. However, high temperatures will warm the water or substrate in breeding sites, resulting in shorter development periods for eggs, larvae and pupae. Hence, pest problems always occur during warmer times of the year.

Rainfall

High rainfall helps to maintain permanent mosquito breeding sites, such as swamps and ponds, as well as creating extensive breeding sites in low lying grassy areas. Heavy rain can also flush mosquito larvae out of their breeding sites and drown pupae.

High tides and storm surge

Salt marsh mosquito numbers usually are abundant following normal high tides. In addition, cyclones and sub-tropical depressions can induce high tide and storm surge, which may trigger salt marsh mosquito breeding.

3.2.2 Location of populated areas

Direction

Populated areas, which are in the path of the dominant prevailing wind from mosquito and biting midge breeding sites, may be regularly affected by biting insects that are carried by wind.

Distance

The pest problem and risk from mosquito borne disease are reduced if community areas are not located within the pest range of mosquitoes and biting midges. The impact that mosquitoes and biting midges will have on the community at different distances is summarised in Appendix 3.

Topography

Hilltops overlooking mosquito and biting midge breeding areas appear to attract these biting insects from a considerable distance. Harbourage of biting insects on vegetated hilltops is common.

3.2.3 Design of populated areas

Landscape layout

The presence of vegetation corridors between community areas and mosquito/biting midge breeding sites provide a dispersal route for biting insects to community areas. Trees and shrubs with dense foliage, planted near dwellings, will provide harbourage sites for mosquitoes and biting midges.

Construction practice

Construction techniques and design of construction sites, such as the building of roads, drainage and canal developments, may create artificial breeding sites for mosquitoes and biting midges because of environmental modifications.

3.2.4 Habits of mosquitoes and biting midges

Mosquitoes and biting midges, which have a wide range of hosts or prefer to feed on vertebrates other than humans, will bite humans, less than species which feed solely on humans. Species that prefer to stay under the protection of vegetation in their breeding sites are less likely to become a pest problem. A medical entomologist can advise on the habits of mosquitoes/biting midges found locally.

4.0 Performance standard recommended for development of community areas to minimise arboviruses-related public health risks and problems from mosquitoes/ biting midges

4.1 Seek information on local mosquitoes and biting midges

Information covering biting insects existing in areas proposed for rezoning or development, location of their breeding sites and the distance from known breeding sites to proposed development sites, should be obtained prior to any development being undertaken or planned.

Usually, the problems associated with mosquitoes or biting midges depend on the distance between the proposed development site and significant mosquito or biting midge breeding sites, such as tidally influenced creeks, extensive mangrove areas, salt marshes, paperbark swamps or any large natural wetlands. However, the intensity of the problem is ruled by other factors, as described in section 3.2.

Hence, before beginning the planning stage of large scale residential developments in the vicinity of wetlands, developers should obtain information to determine significance of the wetlands as breeding sites for mosquitoes/biting midges as well as the abundance of these biting insects on proposed sites. The information can be attained from:

4.1.1 Local government

Check with local governments in the area to determine if they have up-to-date information concerning the significance of those wetlands as mosquito/biting midge breeding sites.

4.1.2 Monitoring program

If the information is not available, a consultant medical entomologist should be engaged to carry out a monitoring program, to interpret the data from trapping and to determine the significance of each breeding site. This involves a 12 month trapping program to monitor the species diversity and density of adult mosquitoes and biting midges near potential breeding sites, such as salt marshes, mangrove areas, creeks, paperbark swamps and freshwater swamps.

A 12 month study period is preferable to cover the seasonal diversity and population fluctuations of mosquitoes and biting midges. However, if it is not possible to monitor for 12 months, trapping should be carried out for a minimum of four months during periods of warm climate (December to March) when mosquitoes and biting midges are likely to be abundant.

4.2 Evaluate the significance of mosquito and biting midge breeding sites in the vicinity of proposed site

During the monitoring period, special light traps with carbon dioxide (dry ice) bait should be set fortnightly at various points. At the end of the monitoring period, the degree of importance of each potential breeding site can be ranked according to:

- the average number of mosquitoes and/or biting midges per trap per night
- the species which bite humans
- the species which are vectors of disease.

The breeding sites which are in the first rank (the most significant) are those near the trapping sites where the highest number of vector and/or pest species were collected, while the least significant breeding sites are those in which the lowest numbers of vector and/or pest species were caught.

Some salt marsh mosquitoes may be taken by the wind for up to 50 km from their breeding sites. The number of mosquitoes or biting midges that disperse usually declines significantly with increasing distance from the breeding site.

Information on some biting insect species commonly found in Queensland is contained in Appendices 1 and 2.

From the information provided in Section 3, it is inferred that problems from mosquitoes and biting midges are likely to occur if the areas to be developed for land use will involve a significant concentration of people and are within five kilometres of their significant breeding sites. Within this distance, appropriate measures may become necessary to ensure that public health risks are minimised. Therefore local governments and developers should recognise these risks and include adequate measures to minimise interaction between vector/pest species and residents. They should also be aware that control measures may not be permitted if mosquito/biting midge breeding sites are in areas containing sensitive flora and fauna.

4.3 Develop a plan to minimise mosquito and biting midge problems

4.3.1 Avoidance through land use planning

If it is possible, lands which may expose significant numbers of people to biting insects should not be developed.

Inappropriate land uses include residential areas, tourist accommodation, night time recreational developments and commercial/ industrial developments.

If these types of land are to be used for eco-tourism, where temporary accommodation such as camping is allowed, advice should be provided to visitors regarding the risk of mosquito-borne diseases and pest problems from the areas. Preventive measures, such as the use of protective clothing and insect repellents, should be promoted.

4.3.2 Mitigation approach within proposed site

Avoidance measures described above are the preferred choice. However, if it is impossible or impractical to exclude the proposed site from development, the development should incorporate a management plan to reduce the potential impact of mosquitoes and/or biting midges.

Local governments and developers should also be aware that mitigation measures are a priority because control measures may not be permitted if mosquito/biting midge breeding sites are in areas containing sensitive flora and fauna.

Proposals should incorporate the following measures to minimise the impact of existing biting insects on the community and to avoid creating new breeding sites.

4.3.2.1 Residential area

On-site design

Before planning for large scale residential developments, developers must check with the relevant authorities to determine the prevalence of mosquitoes and biting midges in the proposed site. If this information is not available, it is recommended that a consultant medical entomologist be engaged to monitor the biting insect population at the site, preferably over a 12 month period. However, if

this is not possible, regular on-going monitoring programs during the mosquito breeding season (December to March) are required to determine the level of public health risk from biting insects population and to devise appropriate alleviation measures to be included in planning stage.

Alleviation measures

Recommended measures to minimise the problems caused by mosquitoes or biting midges include:

- **Creating a barrier zone**

If the proposed site is found to be infested with mosquitoes or biting midges which are vectors or pests (see Appendices 1 and 2), a barrier zone should be created inside the proposed site to act as a buffer between the large breeding site and residential areas. The width of the barrier zone 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. This concept was devised and has been practised in the Northern Territory for different types of residential developments (Whelan, 1991).

The barrier zone created within the proposed site should be in an area exclusive of protected marine plants (eg. mangroves, saltwater couch), outside the boundaries of Fish Habitat Areas declared under the *Fisheries Act 1994* and not in areas where disturbance of natural vegetation is prohibited under *Environmental Protection Act (1994)*, *Nature Conservation Act, 1992*, *Nature Conservation (Wildlife) Regulation 1994* and *Land Act 1994*. Some of the dense vegetation in a barrier zone may have to be removed to ensure that there is no continuous line of dense vegetation connecting the breeding site and the community areas. This will interrupt the dispersal route of the biting insects from their breeding sites to residential area and reduce harbourage areas by removing the protection of vegetation for shelter. Hence, the impact of biting insects is reduced.

If the mosquitoes or biting midges that are prevalent in the proposed development site have a peak biting activity at dusk or dawn, daytime recreation areas such as golf courses, well maintained water impoundments, parking areas, parklands with small shrubs and flower beds, woodlands of tall trees with light foliage, or broad scale agricultural land can be used to

act as a barrier zone between breeding sites and residential areas.

In order to avoid any conflict of opinion among the different authorities, should these measures be adopted, it is essential that consultation among land developers, local government town planners, vector control officers, and other relevant authorities be carried out to decide on the appropriate design of barrier zones at the planning stage.

- **Avoid creating new breeding sites and sheltered sites**

New breeding sites will contribute to the mosquito or biting midge populations while shelter sites will provide harbourage places close to human habitation. These can be prevented by avoiding the creation of:

- Continuous belts of dense foliage trees, as part of the landscape, or by choosing trees and shrubs with light foliage. Ensure that removal and replacement of vegetation conform to the policies set by various government departments (see 6.0, consultation authorities).
- Inter-tidal sandy beach habitats suitable to some species of biting midges in canal estates. Other designs, such as coarse pebble beaches or rock walls, should be considered. If a rock wall is constructed, care must be taken to prevent it becoming a shelter for rats and other vermin.

4.3.2.2 Artificial wetlands/water impoundments

Mosquito breeding in artificial wetlands/water impoundments, such as lakes, dams, canals and ponds, can be minimised in the following ways.

Location

Consider locating artificial wetlands/water impoundments at sites where the wind direction will enhance wave action. Wave action prevents larvae from breathing and female mosquitoes from laying eggs.

Depth

Artificial wetlands/water impoundments should be more than 60 centimetres (or at least 30 centimetres) deep so that they are not suitable for mosquito breeding. Increasing the water depth may achieve other benefits, such as having fish as predators. Choose a design

that does not support rapid, extensive growth of emergent aquatic plants or the formation of vegetation hummocks during periods of low water level.

Vegetation

Prevent the dense growth of emergent vegetation in artificial wetlands/water impoundments, as this will reduce mosquito breeding, allow predators to reach mosquito larvae and increase wave action. Consult with the relevant government departments to ensure that these practices do not disturb the environment.

Bank

Plant suitable vegetation on the walls and banks of water impoundments to prevent erosion and run-off of nutrients. Choose vegetation that does not vigorously invade the water body and support mosquito breeding. Choose wall or bank gradient that minimises vigorous growth of vegetation and requires less maintenance.

Mosquito control management

- provide vehicle access around the shoreline of the impoundment for inspection and maintenance
- introduce native fish into the water impoundment after liaison with Queensland Fisheries Service. A current list of native fish suitable for each area should be obtained from Queensland Fisheries Service (DPI)
- have a control plan to minimise mosquitoes in artificial wetlands/water impoundments in case preventative measures are not adequate to stop mosquito breeding. A mosquito control plan must be in line with the *Code of Practice for Mosquito Management*. This Code can be obtained from the Environmental Protection Agency.

4.3.2.3 Drainage system

Drainage systems for irrigation, sewerage effluent and stormwater channels should be designed to minimise mosquito breeding.

Stormwater retention basins should be designed to exclude mosquito production and include provision for ongoing maintenance.

As topography, soil type and other environmental factors vary from one location to another, the actual design of the above structures should be done in consultation with an engineer.

The following recommended design features minimise biting insect breeding:

Design of drains

- drains should be designed so that silt does not accumulate in the drain and water does not pond in the drain
- erosion of the drain batters should be controlled by using appropriate slope batters and planting vegetation type suitable to stabilise the slopes but not to invade the water bodies
- sizing of drains should be such that access by suitable machinery to carry out maintenance is achieved
- all maintenance should be carried out in accordance with procedures which ensure that further habitats for mosquitoes or midges are not created by wheel ruts
- consider concrete channel 'low flow' drains within large earthen drains.

Discharge point

- avoid discharging water into mangrove, tea tree and vegetated wetlands, as this can help maintain permanent breeding sites for mosquitoes or biting midges. Discharged water may be enriched with nutrients which assist the growth of some types of vegetation, resulting in the restriction of the water flow and preventing natural predators reaching mosquito larvae
- avoid discharging large volumes of water into one location, as it can cause soil erosion and kill vegetation at the discharge point
- discharge should be by sheetflow rather than point source to minimise erosion.

Where to discharge

- into regularly flushed tidal areas, preferably at high tide
- if water is discharged to artificial or natural wetlands resulting in these wetlands retaining water for a period of longer than six days, effort should be made to ensure that viable ecosystems with predators exist to deal with the mosquitoes
- discharge into settling ponds to remove silt and rubbish, then to suitable natural streams. Suitable natural streams are those which have good riparian vegetation, at least 30 metres wide with diverse structure, not choked by exotic species and a viable instream habitat exhibiting healthy stream processes.

4.3.2.4 Construction effect

Construction practice may create mosquito/biting midge breeding sites. In order to minimise the problem the following concepts should be practised:

- Design landscaping and drainage so that no stagnant ponding occurs during and after construction. Ensure that all stream crossings allow for unrestricted passage of fish to maintain populations of natural predators.
- Have an ongoing program to:
 - fill potential breeding sites such as depressions, pot holes, borrow pits and wheelruts in the development site during and after construction
 - prevent spoil materials, road embankments, access roads, or soil from blocking the flow of water and creating stagnant pools of water suitable for mosquito breeding

Note: Where potential breeding sites are in a tidal zone, a permit may be required from the Queensland Fisheries Service, DPI for disturbance of marine plants or for work to be performed in a declared Fish Habitat Area. For work in a national park, a permit may be required by the Beach Protection Authority, EPA prior to an alteration.

- If containment ponds are constructed during the construction stage to trap nutrient run off, check these ponds once a week for mosquito larvae. Apply larvicides if breeding is detected.

4.3.3 Breeding sites control programs

Control programs should be included in a development plan in case other mitigation measures fail to minimise mosquito/midge impact on residents.

Control programs should be devised in consultation with the vector control section of the local government in the area responsible for the proposed development site or with a consultant medical entomologist. Control plans must conform to the *Code of Practice for Mosquito Management*.

The potential effects of large-scale mosquito control programs on the environment and wetland-dependant industries, such as fisheries, render this mitigation approach far less desirable than one based on avoidance through land use planning. Development proposals advocating breeding site control programs as a means of accommodating a project in a high risk area should therefore confront both the immediate and

wider community cost, monetary or otherwise, of implementing such programs.

Specific attention should be given to development proposals which may require breeding site control programs to be conducted on lands designated for environmental protection purposes, such as declared fish habitat areas (previously fish habitat reserves and wetland reserves), environmental parks, conservation parks or national parks. Recognition must be given to the fact that breeding site control programs may be totally inconsistent with the intent of existing land-use designations, such as those under the *Fisheries Act 1994* and *Nature Conservation Act 1992*, and may, therefore, not always be permissible.

Applications for permits from the relevant authorities (DPI, EPA and DNRM) are statutory requirements before undertaking control programs within such protected areas. When permitted, breeding site control programs within protected areas will be subject to conditions stipulated by the relevant local or state authority.

Even outside existing protected areas, large-scale breeding site control programs may also involve environmentally sensitive wetlands. These programs must therefore be designed in consultation with the EPA, DPI and DNRM.

5.0 Possible consequences following inappropriate measures

These guidelines contain measures to minimise mosquito and biting midge problems. Such problems have occurred in several residential and tourist developments in coastal Queensland as these developments are located within the flight ranges of mosquitoes and/or biting midges.

Successful prevention of the same problems in future urban subdivisions, particularly residential and tourist developments, relies on the co-operation of all relevant parties and their willingness to implement the avoidance and mitigation measures recommended. If this is not achieved, and populated areas are allowed to be developed near pre-existing or potential mosquito and biting midge breeding sites, the following consequences are likely to occur.

5.1 Economic and social costs of mosquito-borne disease

High numbers of mosquito vectors in a developmental site increase risk of the community contacting mosquito-borne diseases resulting in loss of productivity and high costs of treatment.

During epidemics of RRv in Queensland in 1992 and 1996, a total of 4154 and 4935 cases respectively were serologically confirmed (Communicable Disease Intelligence, 1993, 1997). Based on the cost (\$3 million) of the 1983-84 outbreak of RRv in New South Wales (Hawkes *et.al.*, 1985), it is estimated that the 1992 epidemic of RRv would have cost the Queensland economy approximately \$14 to 15 million. Costs include consultation fees for doctors, blood tests, drugs, absence from the workforce and domestic duties, and vector control (Dr J. Scott, unpublished data).

5.2 Vector control cost, application, resistance and impacts

Long term usage of control agents is expensive and can lead to chemical resistance in mosquitoes or biting midges.

Mosquito control must conform to the *Code of Practice for Mosquito Management*. The usual methods use for mosquito and/or biting midge control in Queensland are larviciding and habitat modification.

5.2.1 Larviciding

Temephos (Abate) is an organophosphorus larvicide which was previously used to control mosquito and biting midge larvae in Queensland before mosquito larvae in some locations developed resistance to this chemical. Currently, *Bacillus thuringiensis var. israelensis* (*B.t.i.*), a microbial insecticide and Methoprene, an insect growth regulator, are widely used to control mosquito larvae. The cost of these larvicides and application of them has been increasing every year. As a result, local governments along the Queensland coastline will have to cope with increasing expenses. This is evidenced by Table 1 which shows the five year cost of mosquito control from some local governments.

Table 1 Combined annual budget for aerial larviciding programs, 1993 to 1998

Local government group	Budget (\$)				
	(including the cost for treatment of private lands)				
	1993/94	1994/95	1995/96	1996/97	1997/98
North East Moreton Mosquito Organisation, comprising Brisbane City, Redcliffe City, Caboolture Shire and Pine River Shire Councils	583,937	646,192	747,700	892,500	1,085,000

Further, the use of larvicides may not be permitted in breeding sites which are in or near environmental sensitive areas, such as fish habitat areas, environmental parks, conservation parks or national parks. Community groups, as well as some government agencies, are likely to object to the chemical treatment of biting midge breeding sites because of the much higher dosage of, eg. up to 20 fold of temephos is needed for control of biting midge larvae when compared with that needed for mosquito larvae.

5.2.2 Habitat modification

Alteration of saltmarsh mosquito breeding areas using habitat modification (runnelling) has been implemented by a number of local governments with the approval of relevant government agencies. The implementation of

habitat modification techniques has an initial cost but this is considered less than ongoing costs of alternate controls such as larviciding. Habitat modification programs may not be suitable in all situations and are unlikely to be supported in areas where problems associated with disturbance of acid sulfate soil cannot be managed appropriately or if it is likely to have an adverse effect on flora or fauna in the area.

5.3 Decrease in property value

Once problem areas gain a reputation for mosquitoes and biting midges, property values and business opportunities may be reduced.

The intense attack by mosquito and biting midge pests can make life miserable for residents and tourists.

6.0 Consultation authorities

6.1 Queensland Health

Responsibility

- prevention and control of mosquito-borne diseases and enacting legislation aimed at controlling mosquitoes throughout Queensland
- general information on insects which are vectors of disease or pests, their breeding habitats, their biology and available control methods as well as any enquiries about the guidelines.

Departmental documents relating to vector/pest control

- *Health Act 1937*
- *Health Regulation 1996*

Contact unit

Communicable Diseases Unit
Queensland Health Building
GPO Box 48
Brisbane Q 4001
Ph (07) 3234 1155

6.2 Local governments

Responsibility

- determine development proposals
- information on mosquito and biting midge problems in the area.

Local government documents relating to vector/pest control

Depends upon the individual council.

Contact unit

- town planning
- health services.

6.3 Department of Primary Industries, Queensland Fisheries Service

Responsibility

- management of fisheries resources, protection of fish habitats and marine plants
- declaration and management of Fish Habitat Areas
- granting of approvals under fisheries legislation
- information on fish species suitable for mosquito control and stocking of waterways.

Departmental documents relating to vector/pest control

- *Fisheries Act 1994 (S 51, S122, S123)*
- *Fisheries Regulation 1995*

Contact unit

Fisheries and Aquaculture Development
GPO Box 46
Brisbane Q 4001
Ph 132 523

6.4 Environmental Protection Agency

Responsibility

- environmental planning
- assist local governments in checking submitted information, if required and ensure appropriate standards are met.

Departmental documents relating to vector/pest control

- *Environmental Protection Act 1994*
- *Nature Conservation Act 1992*
- *Nature Conservation (Wildlife) Regulation 1994*
- *Code of Practice for Mosquito Management*

Contact unit

EPA Advisory Service
GPO Box 155
Albert St, Brisbane Q 4002
Ph (07) 3227 7111

6.5 Department of Natural Resources and Mines

Responsibility

Administration and allocation of all non-freehold land in Queensland including land between LWM and HWM. This responsibility does not include matters of public health on such lands.

Departmental documents relating to vector/pest control

- *State Land Practice Manual*
- *Land Planning Guidelines*

Contact unit

Integrated Resource Management
GPO Box 456
Albert St, Brisbane Q 4002
Ph (07) 3896 3111

6.6 Department of Local Government and Planning

Responsibility

- review planning schemes and amendments submitted by local governments
- provide policy guidance to local governments.

Documents relating to vector/pest control

- *Mixed Used Development Act 1993*
- *Integrated Planning Act 1997*
- *Integrated Resort Development Act 1987*

Contact unit

Planning Services
GPO Box 31
Albert St, Brisbane Q 4002
Ph (07) 3227 7111

7.0 Glossary and abbreviations

Arbovirus Taskforce	A Taskforce established by Queensland Health in response to the 1992 epidemic of Ross River virus disease. The role of the Taskforce was to provide recommendations on how the risk and impact of future epidemics may be reduced.
Arboviruses	Viruses that are transmitted from animal to man or man to man by arthropods (eg. mosquitoes) and cause diseases, such as Dengue, Ross River and Barmah Forest.
Flight range	Distance where some adult female mosquitoes/biting midges can disperse from their breeding sites through their active flight or with the aid of wind.
Pest range	Distance from breeding sites which mosquitoes/biting midges regularly disperse from their breeding sites. The density of these biting insects within this distance are high and become intolerable to humans.
Pest species	Mosquito/biting midge species which do not transmit human diseases but their bites cause mild to severe skin reactions to humans.
Vector species	Mosquito/biting midge species which transmit disease(s) to humans/animals.

Organisations

DLGP	Department of Local Government and Planning
DNRM	Department of Natural Resources and Mines
DPI	Department of Primary Industries
EPA	Environmental Protection Agency
LGAQ	Local Government Association of Queensland Inc.
QH	Queensland Health

Diseases

AE	Australian Encephalitis
BF	Barmah Forest
DF	Dengue Fever
JE	Japanese Encephalitis
RRv	Ross River virus

Others

CDI	Communicable Diseases Intelligence
MHWS	Mean High Water Spring
MLW	Mean Low Water
MHWN	Mean High Water Neap

8.0 References

- Australian Mosquito Control Manual (1998) Published by Australian Mosquito Control Association of Australia.
- Black, R.H. (1972) Malaria in Australia: School of Public Health and Tropical Medicine, The University of Sydney Science Publication No 9, Australian Government Publishing Service.
- Communicable Diseases Intelligence Bulletin* (1993) 1992 Annual report of the national notifiable diseases.. Commonwealth Department of Health and Family Services.
- Communicable Diseases Intelligence Bulletin* (1997) 1996 Annual report of the national notifiable diseases, Commonwealth Department of Health and Family Services.
- Doherty, R.I. (1977) Arthropod borne viruses in Australia 1973-1976. *Australian Journal of Experimental Biology*, 55: Part 2: 103-130.
- Easton, C. (1993) Development control plan - biting midge and control in Tweed. The Tweed Council Development Control Plan No 25: 80-106.
- Hawkes, R. A., Boughton, C. R. and Naim, H. M. (1986) Epidemiological aspects and socio-economic effects of arboviruses infecting man in New South Wales. *Arbovirus Research in Australia* 4: 21-22.
- Linsay, M.D.A. Jasinska, E. M. and Oliveira, N.M. (1998). Implications of a new strain of Ross River virus in the Peel Region, southwestern Australia. Abstract from the 3rd National Conference of the Mosquito Control Association of Australia. Surfers Paradise, Gold Coast, Australia.
- Marks, E.N. and Reye, E.J. (1982) (revised edition) An atlas of common Queensland mosquitoes with a guide to common Queensland biting midges. Queensland Institute of Medical Research, Herston, 76 pp.
- Mosquito Management Code of Practice for Queensland (2001) Published by Environmental Protection Agency.
- Muhar, A., Dale, P.E.R., Thalib, L. and Arito, E. (2000) The spatial distribution of Ross River virus infections in Brisbane: significance of residential location and relationship with vegetation types. *Environmental Health Preview Medicine* 4: 184-189.
- Muhar, A. and Dale, P.E.R. (2000) Minimizing impacts of mosquito management in ecologically sensitive urban areas: a multi-scale approach. pp 448-455 in: Nature Conservation in Production Environments, J.L Craig, M. Mitchell and D.A. Saunders (eds), Surrey Beatty and Sons, Sydney.
- Reye, E.J. (1992) The Common Pest Species (of Biting Midges) *Bulletin of the Mosquito Control Association of Australia* 4 (3): 16- 24.
- Ritchie, S.A., Phillips, D., Brown, A., Mackenzie, J., Poidinger, M. and van den Hurk, A. (1997) Isolation of Japanese encephalitis virus from *Culex annulirostris* in Australia. *American Journal of Tropical Medicine and Hygiene* 56: 80-84.
- Russell, R.C. (2001) Constructed wetlands in Australia: Concerns and constraints, compromises and complements for effective mosquito management. *Arbovirus Research in Australia* 8: 314-323.
- Ryan, P. A. and Kay, B.H. (1996) Ross River virus ecology is complex. *Arbovirus Research in Australia* 7: 247-251.
- Whelan, P. I. (1986) Biting insects considerations for urban subdivision in the top end of the Northern Territory. Information sheet, Department of Health and Community Services, 2pp.
- Whelan, P. I. (1988) Construction practice near tidal areas in the Northern Territory- Guidelines to prevent mosquito breeding. A booklet produced for the Northern Territory Coastal Management Committee, 14 pp.
- Whelan, P. I. (1991) Murrumujuk Gunn Point Peninsula area biting insect investigation. Report, Department of Health and Community Services, Northern Territory, 36 pp.
- Whelan, P. I., Barker-Hudson, P., Morgan, B., Ebery, B. and Gee, K. (1989) Mosquito control measures in Darwin, Task Force Review. Northern Territory Department of Health and Community.
- Whelan, P., Merianos, A., Hayes, G. and Krause, V. (1997) Ross River virus transmission in Darwin, Northern Territory, Australia. *Arbovirus Research in Australia* 7:337-345.

9.0 Appendices

Appendix 1 Some mosquito species which are vectors or serious pests in Queensland (not including species which breed in containers)

Type	Species	Breeding site	Adult behaviour	Pest range	Public health importance
Salt water species	<i>Ochlerotatus vigilax</i>	<ul style="list-style-type: none"> temporary brackish pools and marshes which are flooded by the highest tides often associated with salt water couch grass (<i>Sporobolus</i>) and the succulent plants <i>Suaeda</i> and <i>Salicornia</i>. 	<ul style="list-style-type: none"> rest among mangroves and their pneumatophores or other trees with dense foliage may travel up to 50km from breeding site bite humans, mammals and birds, day and night. 	<ul style="list-style-type: none"> about 5km in conditions favourable for their dispersal, travelling up to 50km from the breeding site. 	Vector of Ross River virus (RRv), Barmah Forest virus (BF) and heart-worm of dogs.
Brackish water species	<i>Verrallina funerea</i>	<ul style="list-style-type: none"> slightly brackish-fresh water pools which are well shaded in swampy areas of teatree and sedges adjoining tidal areas. 	<ul style="list-style-type: none"> do not usually disperse far from their breeding site bite humans and mammals during the day in shaded areas and also at night their bites are painful. 	<ul style="list-style-type: none"> about 2km 	<ul style="list-style-type: none"> potential vector of RRv and BF adults are serious pests to residential areas close to mangrove, teatree or paperbark swamp.
	<i>Culex sitiens</i>	<ul style="list-style-type: none"> brackish pools left by high tides along the coast, occasionally in fresh water can also breed in irrigation areas containing salt heavy breeding commonly occurs in areas where the natural drainage and flow in tidal areas are blocked. 	Bite humans, other mammals and birds, mainly at night.	<ul style="list-style-type: none"> about 3km may travel long distance (up to 35km) from breeding places. 	<ul style="list-style-type: none"> shown to be a competent vector of RRv in the laboratory adults are serious pests to community in the residential areas close to breeding sites.

**Appendix 1 Some mosquito species which are vectors or serious pests in Queensland
(not including species which breed in containers)**

Type	Species	Breeding site	Adult behaviour	Pest range	Public health importance
Fresh water species	<i>Anopheles annulipes</i>	<ul style="list-style-type: none"> • all kinds of temporary and permanent ground pools, stream and swamp edges, and rock pools, usually sunlit or partly shaded • also breed in large open artificial containers, such as drums and troughs • may also be found in slightly brackish water. 	Bite humans, cattle and rabbits by night, particularly at dusk and dawn.	about 1.5km	Adults may be serious pests in areas close to extensive swamps and lagoons.
	<i>Culex annulirostris</i>	<ul style="list-style-type: none"> • fresh water swamps, pools, streams, usually with vegetation • large numbers of larvae may be found in low-lying grassy areas where water lies two to three weeks after heavy rain • heavy breeding is also associated with water from irrigation or organic effluent disposal • plague numbers of adults usually emerge from temporary breeding site where natural predators are not abundant. 	Bite humans, mammals and birds at night but can bite during the day if disturbed from their resting place.	about 5km	Vector of RRv, BF, Australian Encephalitis (AE), Japanese Encephalitis virus (JE) and heart-worm of dogs.

**Appendix 1 Some mosquito species which are vectors or serious pests in Queensland
(not including species which breed in containers)**

Type	Species	Breeding site	Adult behaviour	Pest range	Public health importance
Fresh water species (continued)	<i>Culex quinquefasciatus</i>	<ul style="list-style-type: none"> • polluted water close to human habitation • also found in less polluted water in vases, tins and tyres • prolific breeding can occur in creeks or dams if polluted by sewage or other organic effluents. 	Bite humans and birds at night.	about 1km	Vector of heart-worm of dogs.
	<i>Coquillettidia xanthogaster</i>	Permanent and semi-water permanent swamps and water holes in association with aquatic plan (water hyacinth, grasses, sedges, etc.) where larvae attached to roots of stem to obtain oxygen.	Bite humans, domestic animals and birds at night or during the day in shade.	1.5km	Adults may be serious pests in areas close to extensive swamps and lagoons.
	<i>Mansonia uniformis</i>	Same type of habitats described for <i>Cq. xanthogaster</i> .	Similar to <i>Cq. xanthogaster</i> .	about 1.5km	Adults have been infected with RRv and AE in laboratory studies.

Type	Species	Breeding site	Adult behaviour	Pest range	Public health importance
Rocky substrates species	<i>Culicoides immaculatus</i>	Boulder covered foreshores where the boulders lie on a mud-sand-shell base and wave action is moderate, in a band near high tide level.	Bite from dusk to early daylight.	about 400m	<ul style="list-style-type: none"> biting midges are not vectors of human disease in Australia can be a very severe pest if adults are abundant their bites can cause intense itching and skin reaction from their saliva in sensitive people, blister and weep serum may occur from the site of the bite.
Sandy substrate species	<i>Styloconops australiensis</i>	Clean sandy shores subject to moderate wave action such as in bays and estuaries, where beaches are protected from oceanic waves by offshore reefs or extensive shoals.	Bite from dawn to dusk.	about 50m	
	<i>Culicoides molestus</i>	<ul style="list-style-type: none"> natural breeding sites are clean sand and on open beaches, around creek or streamlet mouths, and on sand banks and beaches within larger streams the sand substrate is between MHWS and MLW sandy shores in canal estate developments (artificial breeding sites). 	<ul style="list-style-type: none"> bite at dawn and dusk on overcast humid days, biting occurs all day and night. 	<ul style="list-style-type: none"> about 400m from small natural breeding sites up to 1.5km from large, natural or artificial breeding habitats. 	

Type	Species	Breeding site	Adult behaviour	Pest range	Public health importance
Sandy substrate species (continued)	<i>Culicoides sp near subimmaculatus</i>	<ul style="list-style-type: none"> • in the surface feeding tunnels of the crab Mictyris livingstonei • in tunnels which are above MHWN • in artificial habitats created by sand pumping fill, by ditching in soils with sand underlay and by clearing mangroves so that the silt layer is eroded off. 	<ul style="list-style-type: none"> • bite throughout the day in or close to their breeding site • at locations away from larval habitat will bite only at dusk • will enter houses. 	about 400 metres	<ul style="list-style-type: none"> • biting midges are not vectors of human disease in Australia • can be a very severe pest if adults are abundant • their bites can cause intense itching and skin reaction from their saliva • in sensitive people, blister and weep serum may occur from the site of the bite.
Species which breed in mud substrate	<i>Culicoides ornatus</i>	<ul style="list-style-type: none"> • subterranean tunnels (some 15cm below the surface) of small crab, which inhabits the muddy area of River Mangrove (<i>Aegiceras corniculatum</i>) • typical breeding habitat is within a narrow band about MHWN in areas where there is no strong wave or current action, such as creeklets, dead ends of creeks or in cut-off meanders. 	<ul style="list-style-type: none"> • bite at dusk and dawn • can be very severe pests both indoors and outdoors. 	about 1.6km	
	<i>Culicoides marmoratus</i>	Muddy sand to pure mud in areas above MHWS to just below MHWN.	<ul style="list-style-type: none"> • feed readily on native marsupial, livestock and humans • can be a serious pests to humans. 	up to 16km	

Appendix 3 Distance from mosquito/biting midge breeding sites and its impact

Distance from breeding site	Risk from arbovirus diseases	Pest impact	Control measures needed
up to 1.5km	very high	Intense from both mosquitoes and biting midges.	Regular monitoring and control measures for mosquitoes and biting midges at breeding sites and development sites.
>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	<ul style="list-style-type: none"> • unaffected from most biting midges • noticeable from mosquito species such as <i>Ochlerotatus vigilax</i>, <i>Verrallina funerea</i>, <i>Culex sitiens</i>, <i>Cx annulirostris</i>, <i>Coquillettidia spp</i> and <i>Mansonia spp</i>. 	Regular mosquito monitoring and control at breeding sites and development sites.
> 5 - 10km	moderate	<ul style="list-style-type: none"> • unlikely by brackish and fresh water mosquitoes and most biting midges • discomfort by a moderate numbers of <i>Oc. vigilax</i> adults. 	<ul style="list-style-type: none"> • monitoring of mosquito population • control may be required to minimise the risk of mosquito-borne disease.
> 10 - 15km	low	<ul style="list-style-type: none"> • not severe and sporadic • a small proportion of mosquitoes may be carried by wind into development sites. 	Unlikely to be needed.