



# Mosquito Management Strategy

February 2015

## TABLE OF CONTENTS

<b>1.</b>	<b>Introduction</b>	<b>1</b>
<b>2.</b>	<b>Goal</b>	<b>3</b>
<b>3.</b>	<b>Risk Assessment</b>	<b>3</b>
<b>4.</b>	<b>Strategic Implications</b>	<b>3</b>
<b>5.</b>	<b>Statutory Management</b>	<b>4</b>
5.1	Health Act 1911	4
5.2	Water Act 2007	4
5.3	Environmental Protection Act 1986	4
5.4	Shire of Broome Health Local Laws 2006	4
5.5	Occupational Health and Safety Act 1984	4
5.6	Health (Pesticides) Regulation 2011	4
5.7	Environment Protection and Biodiversity Conservation Act 1999	4
<b>6.</b>	<b>Mosquito Ecology</b>	<b>4</b>
<b>7.</b>	<b>Health Impacts of Mosquitoes in the Kimberley</b>	<b>5</b>
7.1	Ross River Virus	5
7.2	Barmah Forest Virus	5
7.3	Murray Valley Encephalitis	5
7.4	Kunjin Virus	6
7.5	Dengue	6
<b>8.</b>	<b>Mosquito Breeding Sites</b>	<b>7</b>
8.1	Wetland Areas	7
8.2	Tidal Mangroves	7
8.3	Recycled Water Reuse System	8
8.4	Broome Townsite	8
<b>9.</b>	<b>Mosquito Monitoring</b>	<b>9</b>
9.1	Adult Mosquito Trapping and Identification	9
9.2	Larval Surveillance	9
9.3	Sentinel Chicken Program	10
<b>10.</b>	<b>Mosquito Minimisation</b>	<b>10</b>
10.1	Cultural Control	10
10.2	Physical Control	11
10.3	Chemical Control	11
<b>11.</b>	<b>Resource Considerations</b>	<b>12</b>
11.1	Financial Resources	12
11.2	Human Resources	13
11.3	Equipment resources	14
<b>12.</b>	<b>Review of Plan</b>	<b>15</b>

<b>13.</b>	<b>Emergency Management</b>	<b>15</b>
<b>14.</b>	<b>Recommended Actions</b>	<b>16</b>
<b>15.</b>	<b>References</b>	<b>19</b>

Abbreviations;

BFV: Barmah Forest virus

BRAMS: Broome Regional Aboriginal Medical Service

CLAG: Contiguous Local Authorities Groups

DOH: Department of Health

EHO: Environmental Health Officer

EHO IC: Environmental Health Officer for Indigenous Communities

FIMMWA: Funding Initiative for Mosquito Management in Western Australia

KAMAC: Kimberley Aboriginal Medical Services Council

KUNV: Kunjin virus

LEMA: Local Emergency Management Arrangements

LG: Local Government

MMBOP: Mosquito Management Business operation Procedure

MoU: Memorandum of Understanding

MVE: Murray Valley Encephalitis

SoBMMS: Shire of Broome Mosquito Management Strategy

RAMSAR: Convention on Wetlands of International Importance especially as Waterfowl Habitat 1971

RRV: Ross River Virus

ULV: Ultra Light Vapour Mister

## 1. INTRODUCTION

The Shire of Broome Mosquito Management Strategy (SoBMMS) is an operational document providing guidance based on a continuous improvement model (figure 1) on the minimisation of mosquitoes within the Broome townsite and surrounds. It also forms part of an informing strategy under the Local Government Integrated Planning and Reporting framework as a form of measurement and reporting.

This document was prepared following significant seasonal rainfall and large tides that subsequently lead to an increase in the number of mosquito borne disease cases that occurred in Broome as reported during the 2010-2011 wet season (Table 1 refers to cases from 2006-14). The 2010-2011 environmental conditions highlighted the need for an integrated mosquito management strategy that will be used in the future to reduce the incidence of disease in the local population through improved control and management of mosquitoes.

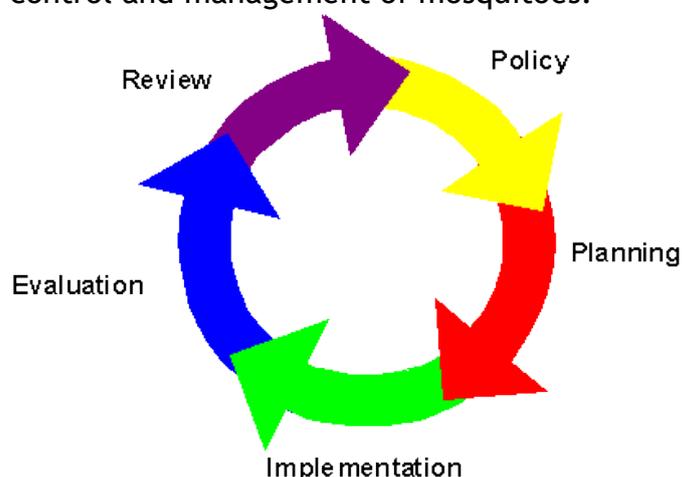


Figure 1 Continuous Improvement Model

During 2010/11 the Shire of Broome experienced elevated incidence of Mosquito Borne disease in comparison to other years. The number of reported cases of RRV, BFV and MVEV correlates with the rainfall received:

Table 1 Reported Cases of Mosquito Borne disease for Broome 2006 - 2015  
(Values from DOH reviewed in 2015)

Year (July - June)	Total Rainfall (July - June)	Ross River Virus	Barmah Forest Virus	Murray Valley Encephalitis
2014/2015	710	21	4	-
2013/2014	962.6	56	4	-
2102/2013	688.1	40	0	-
2011/2012	611.4	28	4	-
2010/2011	1098.8	107	10	-
2009/2010	503.2	14	3	-
2008/2009	636.4	41	9	1
2007/2008	486.2	23	5	-
2006/2007	821.4	55	8	1

The Shire of Broome receives significant rainfall during the wet season and combined with heat and humidity, usually experiences an increase in mosquito numbers until naturally occurring pooling water has evaporated from the environment. There is a reoccurrence of seasonal pooling in the wetland area behind the Broome Waste Management Facility/Lullfitz Drive including the intertidal dune area from Cable Beach up to Coconut Well as well as the Roebuck

Plains wetland area on Roebuck Plains Station (Refer to BOP for map of Locations). The Kimberley region experiences large tides especially during autumn and spring. Inundation of tidal salt mangroves also contributes to an increase in mosquito breeding. The area is also affected by tropical lows and cyclones and localised flooding events that will provide for an increase in mosquito breeding as was evident throughout the Kimberley in early 2011.

Some species of mosquitoes common to the Broome area are only nuisance mosquitoes, whereas others are known vectors of disease including Ross River Virus, Barmah Forest Virus, Murray Valley Encephalitis and Kunjin virus. Elevated incidence of these diseases has the potential to impact community health, amenity, tourism and local business.

The SoBMMS will focus on the Broome townsite and the surrounding environment as this is the main population centre for the Shire. Environmental health services to indigenous communities are currently carried out by the Environmental Health Officer for Indigenous Communities (EHO IC) hosted by Nirrumbuk Aboriginal Corporation. The Shire of Broome will liaise with the EHO IC during times of increased mosquito breeding and elevated numbers of mosquito borne illness to ensure common and consistent information is provided to the wider community.

Success has been evident in minimising incidence of disease in surrounding local government authorities who have implemented integrated mosquito control programs. Given a combination of environmental conditions in Broome, it is inappropriate to compare statistical data for local government authorities in the Region. It is important to note the SoBMMS may assist in reducing the number of disease cases however there may be times when local environmental conditions will overwhelm the program and a number of cases may still be reported.

The development of an effective SoBMMS requires an integrated approach, which identifies funding opportunities and staff resources. It is important to note two very important components to the plan:

- No minimisation program will kill all mosquitoes. As such this document is considered a 'management program' and not a control program. This plan is not a definitive answer and significant work will need to be completed to achieve desired results.
- The program will only be as effective as the resources it receives.

Consideration needs to be given to what is involved in committing to the plan, the extent of the Shire's current staff and financial resources, our ability to cope with a mosquito event, current practises/procedures and what results do we expect to achieve by implementing a program. It is also important to consider the relative cost of implementing this strategy versus the cost to the community and local

business of an occurrence of disease cases such as widespread Ross River Virus cases or Murray Valley Encephalitis.

**2. GOAL**

Assist in the protection of Broome’s community health, lifestyle, economy and amenity for the permanent population and visitors from infectious disease by safely minimising the number of mosquitoes, specifically those that are vectors of disease, in the Broome environment.

**3. RISK ASSESSMENT**

In accordance with the Shire of Broome’s risk identification planning, the impact of mosquitoes on the health of the community has been identified as a High risk (major consequences and possible likelihood of occurrence). This identified high risk requires urgent management attention and necessitates an action plan.

**Figure 2**

		A	B	C	D	E
		Negligible	Minor	Moderate	Significant	Severe
E	Very Likely	Low Med	Medium	Med Hi	High	High
D	Likely	Low	Low Med	Medium	Med Hi	High
C	Possible	Low	Low Med	Medium	Med Hi	Med Hi
B	Unlikely	Low	Low Med	Low Med	Medium	Med Hi
A	Very Unlikely	Low	Low	Low Med	Medium	Medium

**4. STRATEGIC IMPLICATIONS**

In accordance with the Shire of Broome Strategic Plan, this Mosquito Management Strategy addresses the Shire’s strategic directions of:

*People*

*Our People Goal Foster a community environment that is accessible, affordable, inclusive, healthy and safe*

**Place**

*Our Place Goal Help to protect the natural and built environment and cultural heritage of Broome whilst recognising the unique sense of the place.*

**Prosperity**

*Our Prosperity Goal Create the means to enable local jobs creation and lifestyle affordability for the current and future population.*

## 5. STATUTORY MANAGEMENT

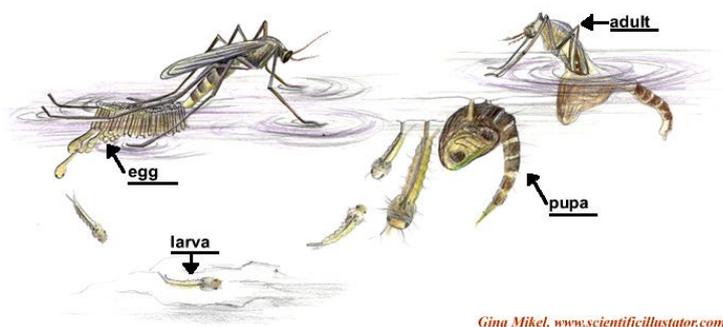
The following legislation is applicable to the management of mosquitoes:

- 5.1 Health Act 1911
- 5.2 Water Act 2007
- 5.3 Environmental Protection Act 1986
- 5.4 Shire of Broome Health Local Laws 2006
- 5.5 Occupational Health and Safety Act 1984
- 5.6 Health (Pesticides) Regulation 2011
- 5.7 Environment Protection and Biodiversity Conservation Act 1999 (EPBC)

The Shire of Broome is responsible for action to be taken to protect public health as directed from time to time by the Western Australian Department of Health's Executive Director, Public Health.

## 6. MOSQUITO ECOLOGY

The mosquito life cycle is composed of four distinct stages of growth: egg, larva, pupa and adult.



Following emergence, the female mosquito will go in search of a 'blood meal' as blood protein is necessary for egg development. The blood source will depend on species preference and will usually include a variety of mammals, including humans, and bird species.

Mosquito breeding varies in characteristics and location depending on the species. The female mosquito will select the larval habitat depending on physical and chemical parameters of the site including the water type. For example, fresh, salt, brackish and polluted waters are all utilised by different mosquito species.

Eggs are laid in a variety of size, number and location. Dependant on the species of mosquito and the local climatic conditions, it can take from 4 days to 3 weeks for mosquitoes to complete their lifecycle. Given Broome's hot humid climate, mosquitoes are likely to go through their lifecycle in a number of days as opposed to weeks.

Consideration of the lifecycle patterns of particular mosquito species allows for targeted control and management of problem mosquitoes.

## 7. HEALTH IMPACTS OF MOSQUITOES IN THE KIMBERLEY

In addition to the annoying and some times painful 'bite' of a mosquito, these insects are capable of spreading disease to humans. Mosquitoes act as transmitters or 'vectors' of pathogens or parasites. Common mosquito borne diseases in the Kimberley include:

### 7.1 Ross River virus

RRV causes a non fatal but potentially debilitating polyarthritic disease in humans with an incubation period of 3 - 21 days (usually 7 - 11 days). Signs and symptoms include can:

- fatigue, eye irritation
- muscle pain, lethargy
- headache, fever
- flu like stiff neck
- illness, depression
- enlarged glands tingling or numbness of extremities

A rash can appear, usually on limbs and trunk, but also hands, feet and face. Fever and rash usually subside within 2 weeks, joint manifestations and emotional effects may last much longer. After 3 months, symptoms are typically not continuous but with good days interspersed with bad days. A blood test is needed to confirm the infection. There are no vaccines or specific treatment for RRV.

The common host of RRV are native marsupials, particularly kangaroos and wallabies. This transmission path is of particular interest as people entering areas commonly populated with marsupials and adjacent to mosquito breeding sites will have a high risk of contracting RRV. In the Kimberley region, RRV is endemic, cases occur every year, usually just after the wet season. Cases occurring during the dry season may be associated with tidal mosquito breeding.

### 7.2 Barmah Forest virus

BFV is closely related to RRV but is less common. The BFV disease shows similar signs and symptoms to RRV. Rash may be more common with arthritic and other symptoms milder than RRV and may resolve quickly.

### 7.3 Murray Valley Encephalitis

Previously known as Australian Encephalitis, MVE can cause potentially fatal encephalitis in humans. Many people who contract the virus will not develop symptoms. The incubation period can be from 5 - 15 days however, symptoms usually appear within 8 - 10 days. MVE symptoms can include:

- headache, fever,
- nausea, vomiting,
- neck stiffness, disorientation and dizziness.

In severe cases, the infection progresses to obvious neurological disease which can lead to coma, paralysis and death. Mild cases usually make a complete recovery however serious, non fatal cases may result in severe disability, paraplegia, quadriplegia and various mental defects. Treatment of the severe illness will usually require hospitalisation and with patients possibly requiring rehabilitation to help recovery. Unfortunately, even with appropriate medical care, about a quarter of people who become ill with MVE will die. Young children are most at risk and tend to develop more severe infections.

Birds, especially water birds, are considered the major vertebrate host. The only way humans can be infected MVE or KUNV is to be bitten by a mosquito carrying the virus, you can not contract these viruses from other people or birds. Both MVE and KUNV are always present in the environment of the Kimberley region.

### 7.4 Kunjil virus

KUNV causes similar but generally less severe disease symptoms than MVE. KUNV can also cause joint pain. The transmission routes for the virus are similar to those described above for MVE.

Mosquito borne diseases of concern for the Kimberley region include:

### 7.5 Dengue

Currently, Western Australia is 'dengue free' due to the known vector mosquito, *Aedes aegypti*, having been eradicated from Western Australia for approximately 40 years. This species of mosquito has colonised in Northern Queensland and has led to an outbreak of Dengue in Cairns and Townsville. There is a real risk of *Aedes aegypti* re-establishing itself in Western Australia due to our mobile tourist population with residents returning with Dengue infections. We have seen an increase in caravanning Australians travelling from Queensland to WA, and our proximity to Indonesia combined recent cheap airfares has resulted in increasing tourism to Asia. A critical factor to re-establishment of this mosquito is the location of the Australian Fisheries Management Authority illegal fishing boat facility at Willie Creek. Illegal fishing vessels have been known to bring this mosquito to our shores.

Dengue is regarded as a debilitating infection with short duration and a high attack rate but low fatality rate. There is no cross immunity to the 4 strains however there is an enhancement reaction, an increase in severity of symptoms, following a second infection with a different strain of the Dengue virus. There are 2 clinical forms being Dengue Fever which most patients fully recover from, and Dengue Haemorrhagic Fever which is a severe infection involving excessive bleeding

internally and from the nose, mouth and gums. It may be followed by severe shock and can be fatal.

The normal cycle of infection is human-mosquito-human. This species is a container breeding mosquito that flourishes in conditions of poor housing, overcrowding, inadequate sanitation, accumulated rubbish and tyres, especially in tropical and subtropical areas. This mosquito rests and feeds indoors, biting during the day and feeds almost exclusively on humans. Minimising container breeding 'habitat' is important to keep mosquitoes from establishing in our environment. The WA Department of Health undertakes monitoring for the known Dengue vectors to keep Western Australia 'Dengue Free'.

## 8. MOSQUITO BREEDING SITES

There are a number of known areas of significant mosquito breeding that creates a high risk to the health of the community from mosquito borne disease ( See BOP for map of locations). The majority of Broome's known breeding areas are large, inaccessible areas of seasonal pooling water. Known sites include:

### 8.1 Wetland Areas

This area includes the inter dune area from Cable Beach to Coconut Well and wetland areas behind the Waste Management Facility and Roebuck Plains. This area comprises large, naturally occurring areas of pooling fresh/brackish water from seasonal wet season rainfall. Seasonal rainfall provides these large, vegetated expanses with an environment conducive to fresh or brackish water breeding mosquitoes, most noticeably *Culex annulirostris*. This species of mosquito is a known vector of RRV, BFV, MVEV and KUNV. Combined with the large population of wallabies and other marsupials as well as water birds, these factors can lead to large outbreaks of disease. This was the case during the 2011 wet season where by the end of March 2011, approximately 100 cases of RRV and 2 BFV notifications had been received for the Broome area. Mapping of these cases has not yet been completed; however there are a higher number of cases in the town areas closer to these naturally occurring season wetland areas.

### 8.2 Tidal Mangroves (Roebuck Bay)

Broome townsite is located adjacent to a large expanse of tidal mangrove salt marsh that fringes Roebuck Bay. This area provides an optimum breeding environment for common salt water breeding mosquitoes including *Aedes vigilax*. This species of mosquito is very common in Broome especially following high tide events. It is an aggressive biter that will bite all hours of the day. This is a known vector of RRV and MVE. *Aedes vigilax* mosquitoes lay their eggs in mud or sand on the edge of the mangrove area. These eggs can lie dormant for up to 12 months until inundated with water from a high tide that then instigates the breeding cycle. There is evidence virus can remain in the eggs and once emergence as adults can be a vector of disease.

Control of the tidal mangrove areas is extremely difficult and not economically viable due to the significant size and inaccessibility of the area. A southern portion of the mangrove from the Broome Bird Observatory heading south is a Commonwealth RAMSAR wetland. This has ramifications for potential control

methods as approval for physical and chemical control options will need to be approved by the Commonwealth Government.

The area not identified as a RAMSAR site, however, is the area closest to the townsite and therefore more of a risk to the community. Investigation into control options for this area may be beneficial.

As this species of mosquito is an aggressive biter, the Shire experiences an increase in calls from concerned residents during times of increased *Aedes vigilax* numbers. It is critical to time community education and control to coincide with high tide events. This will ensure the community is informed of the potential risk of increase mosquito numbers following a high tide.

### 8.3 Recycled Water Reuse System

The Water Corporation and Shire of Broome managed recycled water reuse system irrigates 4 sites within the Broome Townsite including the golf course, Haynes Oval, St Mary's school oval and the Broome Recreation and Aquatic Centre ovals. This is positive program that uses recycled water to maintain regularly used community recreation areas. However, proper management and operation of this system needs to be maintained to ensure breeding is not occurring in infrastructure and over watering in times of heavy rainfall does not result in areas of nutrient rich pooling water in community accessible location. Regular inspections of the site and tanks are recommended to monitor breeding.

Approvals from State Government agencies require this system to be switched off in times of heavy rainfall. Communication between the Shire of Broome and Water Corporation needs to be maintained to ensure this system is not creating a risk to community health by creating mosquito breeding sites on our popular community recreation areas.

### 8.4 Broome Townsite

Through surveillance of the townsite, the Shire of Broome has highlighted a number of areas of known and potential mosquito breeding sites that will require monitoring during the wet season until such time as water has evaporated from the environment. A range of mosquito species are common in this area including container breeders, salt water breeders namely *Aedes vigilax*, from nearby mangroves and freshwater breeding mosquitoes including *Culex annulirostris*. Weekly monitoring of the sites highlighted below is suggested however this will be significantly dependant on the limited availability and quality of dry ice resources in Broome.

- Industrial areas with specific focus on Blue Haze: due to proximity to tidal mangroves and Roebuck Plains. Inspection of onsite wastewater systems, drainage and any water holding containers.
- Grey water reuse sites including Broome Recreation and Aquatic Centre ovals, Golf Course, Haynes Oval and Saint Mary's College.
- Tidal mangroves (Broome Road).
- Monitoring of Shire drainage systems: inspection of low areas or areas holding water.

- Corner of Broome Highway and Gubinge Rd: this poses a small mosquito breeding threat however due to steep sides preventing vegetative growth for mosquito harbourage in shallow water has lead to no larvae having been detected in this area. Road runoff contaminated with surface oils and hydrocarbons may also be preventing breeding. This site will need to be monitored as it has the potential to act as a large mosquito breeding threat if it is not maintained.

## 9. MOSQUITO MONITORING

### 9.1 Adult Mosquito Trapping and Identification( See BOP for further info)

A comprehensive adult mosquito trapping program is suggested as this action will give an indication of the numbers and species of mosquitoes in and around breeding sites and will give an overall view of mosquito breeding, indicating potential for disease outbreak, however availability and quality of dry ice resources in Broome can be prohibitive.

Dependant on the limited availability of dry ice, adult mosquito traps are to be set weekly from February - April and monthly from May - January. Flexibility is necessary dependant on mosquito numbers. Six traps are to be set with suggested locations being:

- Broome Speedway
- End of Lullfitz Dr
- Roebuck Estate
- Roebuck Plains
- BRAC/Lotteries House
- Archer St Heavy Industrial Area
- Complaint location or other town locations

All trapped mosquitoes will be identified and counted with results recorded on trapping sheets and filed for later comparison.

### 9.2 Larval Surveillance( See BOP for further info)

As dry ice supplies may be prohibitive for an adult mosquito trapping program, a comprehensive larval surveillance program is a suitable alternative that can be implemented to monitor larvae numbers in areas of pooling water including drains, tidal areas, flood plains, residences and commercial properties, also giving a good overview of mosquito breeding in known areas.

Larval Surveillance is to occur weekly from January - April or following rainfall and major tidal events. Flexibility is necessary dependant on larval numbers. Sites for monitoring include:

- Recycled water irrigated ovals and golf course
- Old Broome drainage systems
- Broome North drainage systems
- Janaburu Six Seasons drainage system
- Drainage sump on the corner of Gubinge Road and Old Broome Road

- Samphire/mangrove area on Old Broome Road adjacent to Broome Airport
- End of Lullfitz Drive
- Broome Waste Management Facility

Following identification of areas breeding mosquitoes, an appropriate control method is to be undertaken where possible. A follow up inspection is to be completed following treatment.

Pre and post treatment larval surveillance results are to be recorded on Larval Surveillance Sheet and filed for later comparison.

### 9.3 Sentinel Chicken Program( See BOP for further info)

MVEV and KUNV activity in the North West of Western Australia is monitored by detecting seroconversions from blood samples of sentinel chicken flocks. This involves Shire of Broome environmental health staff taking a blood sample from the chickens fortnightly. Currently this task is also completed by Nirrumbuk Aboriginal Corporation when they have staff available. It is evident the Shire of Broome need to complete this task to ensure sampling is occurring fortnightly to provide an early warning detection for MVEV and KUNV.

The University of Western Australia oversee and fund the program as well as undertaking analysis of samples and providing monthly reports. There are 4 chicken flocks located in the Shire of Broome, these being Broome town, Roebuck Plains Station, Beagle Bay and Lombadina.

## 10. MOSQUITO MINIMISATION

### 10.1 Cultural Control

The generation of locally appropriate communication information, including posters and flyers, would be beneficial. Timed information releases to be sent to the following organisations:

- Shire staff: especially those who work in the field;
- Caravan parks: due to minimal protection from the environment;
- Schools: to inform teachers and parents;
- Department of Environment and Conservation;
- BRAMS and KAMSC (if not already receiving health warnings from Department of Health).
- Aboriginal communities: to be completed by the Environmental Health Officer for Indigenous Communities (Nirrumbuk Aboriginal Corporation) and Kimberley Population Health Unit.
- Other community stakeholders as identified.

Shire of Broome EHO's to follow up and complete case interviews as notified by the Kimberley Population Health Unit. This action enables the EHO to provide mosquito information to the patient, case specifics to the Department of Health and monitor number of cases being reported in the Shire of Broome.

Assist EHO IC to lobby Department of Housing to improve door and window screening of housing at aboriginal communities to improve protection from mosquitoes. Renovation of houses was completed in 2009 at a Broome town based community by the Department of Housing following a human case of MVEV in a

resident from the community. It was highlighted that residents had no option to 'move indoors' to protect themselves and their families from mosquito bites. Extension of this program of renovation to other communities in mosquito prone areas is critical for providing protection from mosquito bites.

Condition Development Applications require Developers to submit Mosquito Management Plans for new developments. New developments are to be designed to not encourage mosquito breeding in drainage and constructed wetlands. These developments are to be designed and constructed in accordance with the WA Department of Health's 'Chironomid Midge and Mosquito Risk Assessment Guide for Constructed Water Bodies'.

Consideration needs to be given to planning residential developments that encroach on known breeding areas that are inhabited by vectors including wallabies and waterbirds. Whilst it is evident these areas of land are critical for development of additional residential housing areas, mosquito control and prevention of breeding must be planned in the development of these sites.

## 10.2 Physical Control

Physical control or modification of habitats can take the form of filling low lying land and depressions, draining inundated areas, improving existing drainage systems. This action can take the form of filling depressions on ovals associated with the effluent reuse areas, rectifying low areas in drainage systems, residents removing unused or poorly maintained swimming pools and fish ponds etc.

Physical control methods are the preferred control method as they are generally more permanent options of mosquito control and reduce the need for chemical use in the environment.

## 10.3 Chemical Control( See BOP for further info)

Involves the application of chemical to control or destroy either larvae or adult mosquitoes. Chemical control includes:

### Larviciding

Destroys mosquito larvae or prevents larvae from forming into functioning adult mosquitoes. Larvicides take the form of liquid, granule, pellets or briquettes and can be applied by hand or chemical spreading equipment. Larviciding is considered an effective form chemical treatment as it prevents the adult mosquito from emerging and hence reducing the impact of mosquitoes. A number of products available on the market do not impact the environment and enable the larvae to continue its role in an aquatic food chain.

Larviciding is considered an effective treatment option for breeding areas in the townsite area including drain networks. However, during the wet season, water pools in large, broad acre areas that are inaccessible prevent treatment with larvicides. It is for this reason the Shire may need to rely on adult mosquito control, adulticiding, to destroy mosquitoes flying from these areas into populated areas.

### Adulticiding

Includes 'fogging' or 'misting' adult mosquitoes using thermal foggers or Ultra Light Vapour (ULV) misters to pump out a fine fog or mist that destroys mosquitoes on the wing at the time of treatment. There is no residual effect however timed application when target mosquitoes are most active will reduce mosquito numbers and prevent them from continuing their breeding cycle. When considering adulticiding programs, it must be highlighted that the product used will kill other insects on the wing at the time of application including bees and natural mosquito predators such as dragonflies. Adulticiding can only be completed in favourable weather conditions and is not as effective in windy, rainy conditions.

Whilst adulticiding may not be considered to be an as effective form of chemical control, it is the only option available when naturally occurring wetland areas are inaccessible for larviciding treatments. Adulticiding will be considered appropriate following disaster events and during time of increased virus notifications and sentinel chicken conversions, as adulticiding is an effective method to reduce adult mosquito numbers when disease transmission is imminent.

In order to undertake adulticiding, the Shire of Broome purchased equipment and chemical in 2012. This was in the form of a trailer mounted ULV mister which assists to complete barrier misting of targeted mosquito species to reduce the spread of mosquito borne viruses. Extensive consideration has been given to the minimal impact that this action may have on the environment through the destruction of other flying insects. Furthermore local environmental factors must be taken into consideration to mitigate risk to public health and the environment before usage. The ULV mister has occasionally been used as a management tool only when the risk to the health of community far outweighs the minimal environmental risk.

Adulticiding also includes the application of residual surface sprays to the exterior of buildings. These sprays work by destroying adult mosquitoes and other insects that contact the spray on the surface of buildings. These products have a residual of up to 6-8 weeks and can be effective for the treatment of mosquitoes at remote sites or around Shire Buildings including recreation centres, public toilet blocks and public buildings. In 2014 the Shire of Broome purchased 2 Maruyama Mister/Duster units that are now available to apply surface spray to mitigate exposures of vector borne disease to the community.

## **11. RESOURCE CONSIDERATIONS**

This plan has identified a number of actions to be undertaken and resourcing these commitments will need consideration especially in the short term. For the plan to function and achieve the best results, a collaborative approach between all parties needs to be established. This will include Council, other Shire departments, state government agencies and private and commercial property owners. Mosquito programs can use large amounts of both financial and human resources if undertaken with commitment.

It is very difficult to budget accurately a year in advance for such programs as it is largely dependant on climatic conditions including cyclones, flooding and rainfall.

### **11.1 Financial Resources**

From a financial viewpoint it is necessary to budget for known and probable activities that are anticipated, for example, a reasonable amount of chemical to enable larviciding. A nominal budget will be completed prior to each financial year to enable the purchase of some larvicide and adulticide as well as monitoring equipment.

However, there will be situations during disease outbreaks or following a disaster where quick access to funds will be required to respond to such events. Support from Council is imperative to ensure the Shire is resourced appropriately to respond to such situations, assisting to minimise harm to the health and safety of the community during disease outbreaks. The Chief Executive Officer and Shire President will be consulted during these events to approve release of funds where applicable.

### **CLAG funding ( Contiguous Local Authority Group)**

As of 2014, the Shire of Broome has its own CLAG group which is supported by a memorandum of understanding (MOU) between the Shire of Broome and the Health Department. Through this group, funding can be sought yearly for 50% of the cost of larvicide used in our management program. To be considered for this funding, the Shire is invited in May each year to submit a proposed budget based on past and predictive expenses for approval.

### **FIMMWA funding (2013-2017)**

The Funding Initiative for Mosquito Management in Western Australia (FIMMWA) provides additional funding to Local Governments (LGs) to enhance mosquito management and control in Western Australia (WA), for the benefit of public health. Grants of up to \$50,000 are available on a competitive basis yearly from 2013-2017 to LGs within the Contiguous Local Authorities Group (CLAG) funding scheme. FIMMWA aims to provide additional funds for the purchase of goods/services outside the scope of the existing CLAG scheme.

#### **11.2 Human Resources**

Having identified trained staff to assist in minimisation efforts as required is vitally important for the success of the program.

In most cases the need to undertake large larvicide or adulticide treatments will be dependant on the weather conditions experienced at that time. Unfortunately, it is the type of work that can't be accurately programmed into work schedules or be completed at a specific time. It is more of a case of 'all hands on deck' when the need arises which can be frustrating and difficult especially when other priorities have been set.

In saying this, there are other functions that can be performed as routine to ensure that mosquito breeding is minimised. For example, habitat modifications can be implemented during the dry season.

The tasks of monitoring, surveillance and control would be that of the Shire's Environmental Health Services however, during times of significant mosquito

breeding and disease outbreaks, assistance may need to be sought from other departments including Engineering Services and commercial pest control operators may be considered. The Department of Health's Medical Entomology section in Perth can be called upon for guidance and advice. Ideally, an additional Environmental Health position would be largely beneficial to implement this plan, in the form of a Technical Officer. Furthermore the Shire of Broome applied for funding under: Funding Initiative for Mosquito Management in Western Australia (FIMMWA) and was successful in complementing the Environmental Health Services team with a Mosquito Technical Officer for a period of 3 months (February - April). The role of this person was to provide expert advice and training to the existing Environmental Health Services team and bolster resources during the wet season (January- May)

The SoB shall ensure that enough EHOs have undertaken the DoH mosquito management course which is conducted every two years teaching skills and competencies required under the *Health (Pesticides) Regulations 2011* and covers(DOH,2014):

- Basic mosquito ecology;
- Principles of integrated mosquito management;
- Surveillance/monitoring techniques;
- Collection and recording of mosquito samples;
- Standard operating procedures for equipment;
- Safe storage, handling and application of chemicals/larvicides in accordance with product labelling and MSDS;
- Use of appropriate PPE in accordance with product labelling, MSDS and environmental conditions;
- Calibration techniques;
- Information technologies/geographical information systems;
- Budget management;
- First aid.

The SoB shall ensure all that all employees (DoH, 2009):

- Have received appropriate training in the type of pest control work required by SOB in the safe and effective use of pesticides
- Are adequately supervised by a person who holds appropriate qualifications in this area
- Are provided with well maintained equipment and PPE that is appropriate to the pesticide being used
- Understand their obligation and rights under the Occupational safety and health legislation
- Adopt safe practices at the work site, including the use of appropriate Occupational Safety and health checklists and procedures
- Comply with all applicable legislation, policies, codes and the Local Government Authority pesticide use plans.
- If an external contractor is used to undertake the application the Mosquito controls and pesticide use, then a Memorandum of Understanding (MoU) is to be negotiated so as the contractor complies with SoB regulations

- 13.3 Equipment resources

In the event of an emergency or when triggers are met, the SOB has the ability to mobilise a Cougar Fogger to control Mosquitoes on the wing and keeps adequate supplies of chemical as outlined in BOP.

Also part of an annual funding program by FIMMWA, Broome received in 13/14 funding for:

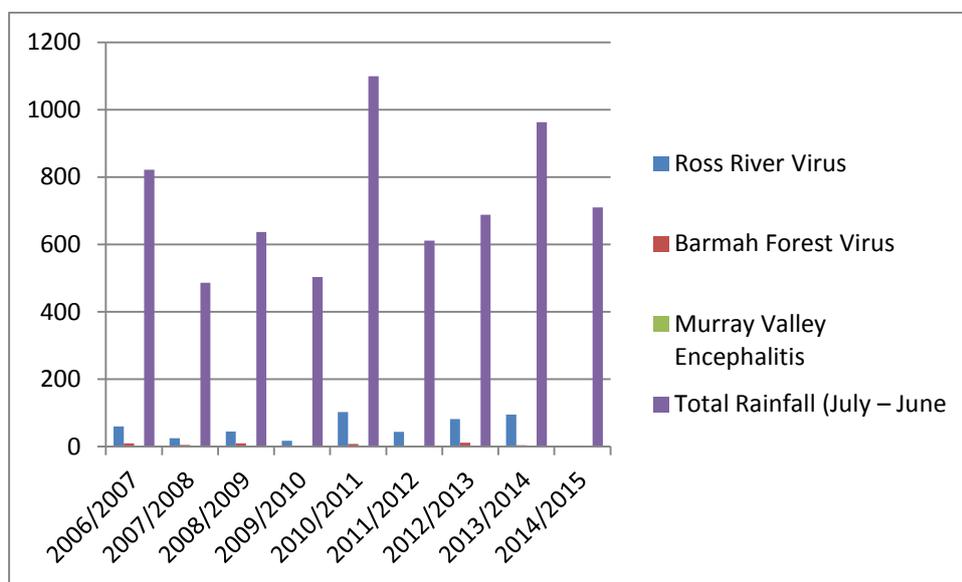
Signage, 2x Maruyama spray Backpacks, Flashing light and breeding containers.

15/16 funding for: Sea container for storage of equipment, safety ladders.

## 12. REVIEW OF PLAN

This plan is based on a continuous improvement model (**Figure 1**) and is subject to regular review to ensure that implementation techniques are documented and reflect current practises and procedures. This plan is to be reviewed annually prior to common mosquito breeding ‘season’. The monitor and review process has been ongoing, includes completed tasks in **Table 2**. A Mosquito Management Business Operating Procedure (MMBOP) was developed in 2015 to complete the strategy. The results from 2006 through to results from 2014 continue to show a correlation between rainfall and disease incident rates. This supports the need to continue monitoring and educating residents and visitors to lower the risk to vector borne disease within the community.

**Figure 3** Rainfall and disease comparisons



## 13. Emergency Management

In emergency situations where there is a Human Epidemic that is related to Mosquito borne disease this strategy can assist to make effective decisions based on SOB Local Emergency Management Arrangements (LEMA).

LEMA would require an incident controller (IC) to be part of the Department of Health ( DOH) and that the SOB works under the directive of such body and react under part 3 Response LEMA.:

As first responders the LGLO’s key responsibilities are to:

- Make contact with DOH or Controlling Agency Incident Controller;
- Represent the local government at all Incident Support Group ( ISG) meetings;
- Provide the IC with timely information on local issues and key factors affecting response activities;
- Provide the IC with a copy of the Local Emergency Management Arrangements;
- Identify vulnerable groups within the local government area;
- Provide information relating to community evacuation, welfare centres and community safe places.
- Provide Local government response activities;
- Provide Local government impact assessment (if known)
- Provide Local government resource status;
- Significant issues.
- Coordinate local government resources;

Coordinate the transition from response to recovery on behalf of the local government in partnership with the Local Recovery Coordinator.

**14. RECOMMENDED ACTIONS**  
**Table 2**

Action	Frequency	Responsible Officer	Comment	Status
Monitoring of known mosquito breeding sites plus locations of complaints received for that week.	Weekly Jan - Apr	Environmental Health	Larval dipping of sites recording numbers and stage of cycle. Adult trapping.	Adult Trapping and Larval dipping Program established.
Larvicide application where possible to breeding sites identified through surveillance.	As needed Wet season	Environmental Health with assistance from Engineering	Application of granular or briquette larvicide products as appropriate.	Fortnightly application of reuse tanks with Larvicide and application to breeding sites when needed
Annual survey of	Annually	Environmental	Check for evidence	Monitoring and

industrial areas for evidence of mosquito breeding.	March	Health	of breeding and discuss removal of breeding sources with property owner/occupier	education Program established
Annual drainage maintenance program - include evidence of mosquito breeding or areas of pooling water/low points.	Annually  Wet season	Engineering	Determine if drain can be improved to prevent pooling water or need for ongoing larvicide treatment. Maintenance to include herbiciding or physical removal of invasive vegetation.	Ongoing program established. Liaison with Engineering and EHS as required
Health Promotion - engage local artist or communications company to generate locally appropriate mosquito information communication for education programs.	Initially generate resources. Distribute each season as required.	Environmental Health	Combination of poster, flyers stickers etc. Use of graphics instead of wording. Budget \$3000 to complete this action	Health Promotion program established between EHS and DOH to educate community 2015 "Fight the Bite" campaign.
Mosquito management plans to be incorporated into planning process for large scale developments. Drainage system design to consider mosquito breeding in concept phase.	As required.	Environmental Health, Planning, Environment and Engineering.  Developers	Mosquito management plans to be submitted for approval for future developments. Developments to incorporate the WA Department of Health's 'Chironomid Midge and Mosquito Risk Assessment Guide for Constructed Water Bodies' document.	Policy developed between EHS, Planning and Engineering departments requiring all new developments to have Mosquito Management plan.
Distribute Health Warnings to Shire staff, and community stakeholders.	As required.	Environmental Health.	Distribute Health Warnings to staff and community stakeholders as information is received and local monitoring indicates disease risk.	Established BOP with Media program when set parameters are breached
Investigate and implement findings of physical control	Complete by December	Environmental Health and Engineering	Investigate options for physical control methods including	Completed, strategy now in place in

methods of natural breeding areas.	2011 for next wet season		depression infilling and draining levelling.	Conjunction with Engineering.
Budget for and purchase trailer mounted mosquito mister.	2011-12 budget.	Environmental Health	Allocate \$12,500 for purchase of fogger. For use during disaster and disease outbreaks to barrier fog town areas adjacent to breeding sites.	ULV trailer mounted unit purchased and used as required Nov 2011
Budget for and purchase chemical and equipment for mosquito control.	2011-12 budget	Environmental Health  DOH CLAG & FIMMWA	Ensure there is suitable budget to purchase a nominal amount of chemical and monitoring equipment to ensure the Shire is 'cyclone ready'.	Ongoing budget established and monitored in line with emergency management Plan
Equipment and Chemical Storage Shed	2015	Environmental Health and Engineering  DOH CLAG & FIMMWA	An equipment and chemical storage shed is required to the storage of ULV mister, hand held fogger and control chemicals, most appropriately at the Shire Depot.	Funding received in 2015 under FIMMA for a sea container and cyclone footings facility shared with Ranger Services . Enclosed safety ladders for reuse tanks.
Letter to tenants of Shire owned premises to eliminate mosquito breeding areas including water tanks, water holding containers, septic tanks etc.	Annually  Wet season	Environmental Health, Engineering and Asset Management	Check for evidence of breeding and discuss removal of breeding sources.	Education program in conjunction with DOH developed using branding of Fight the Bite.
Monitor tide chart and rainfall to time release of information to the community	Monthly	Environmental Health	Monitor tide chart and rainfall (with guide >117mm leading to RRV outbreak) to time release of information to the community regarding potential increase in	Strategy in place for media campaign to coincide with breach of set parameters to warn community members

			mosquito numbers and risk of disease.	
Liaise with Nirrumbuk Aboriginal Corporation to ensure fortnightly chicken bleeding is completed in the Broome town and Roebuck flocks. Community flocks to be monitored by Nirrumbuk.	As required.	Environmental Health.	Ensure fortnightly chicken bleeding is completed to provide an early warning for presence of MVEV and KUNV in the environment.	Co- operation established and information shared to ensure support is available between groups
Document and complete disease notifications as received from Kimberley Population Health Unit.	As received.	Environmental Health.	Document and complete follow up interviews of disease notifications as received from KPHU.	Procedure established with recorded information in Synergy
Commitment from Council to access funds quickly for mosquito control following disaster events or disease outbreaks.	September 2011 Ordinary Council Meeting Strategy adopted	Environmental Health	Council support to enable quick access to funds by Environmental Health Services for mosquito control during a disease outbreak.	Emergency management plan established in line with Shire policy
Apply to the Mosquito Control Advisory Committee for CLAG funding	Annually in May	Environmental Health	Funding to subsidise 50% of cost of larvicide.	CLAG group established in 2014 for Shire of Broome
Apply to the Mosquito Control Advisory Committee for FIMMWA funding	Annually in July	Environmental Health	Funding to subsidise to enhance Mosquito management & control Up to \$50 000/ year	Ongoing for 5 years( 2013-2017)
Review Mosquito Management Strategy	Annually October-November	Environmental Health	Review plan to reflect current practise and procedure.	Monitor and review conducted on annual basis

## References

Department of Health (DoH), 2014. *A guide to developing a mosquito management plan for Local government part A&B*. Government of Western Australia. Perth

Department of Health (DoH), 2009 *A guide to the management of pesticides in Local government pest control programs in Western Australia*. Government of Western Australia. Perth