Town of Port Hedland

Mosquito Management Plan

Contents

1. Introduction

The Town of Port Hedland's (the Town's) Mosquito Management Plan (MMP) provides a guide to mosquito management by detailing the strategies used to monitor and control population numbers in our community. The MMP is necessary due to some local species in the Pilbara being vectors of disease and the outdoor lifestyle of the community increasing risk of exposure to mosquito bites. Port Hedland experiences significant increases in mosquito breeding due to high water temperatures and certain areas of the Town being vulnerable to flooding during the wet season (November to April). The average temperature of Port Hedland ranges from approximately 19˚C to 33˚C and the average annual rainfall is around 319mm. Over the ten year period 2008-2018, the average number of mosquito borne disease (Ross River virus) cases was below 2, with the highest number of cases typically being reported around the end of the wet season.

The Town of Port Hedland encompasses an area of more than 10,500km^2 within the Pilbara region, including residents of Port and South Hedland, the industrial area Wedgefield and remote areas. To ensure that Town resources are used in the most effective manner, mosquito control activities are focused on the main population centres where residents live and work (Figure 1).

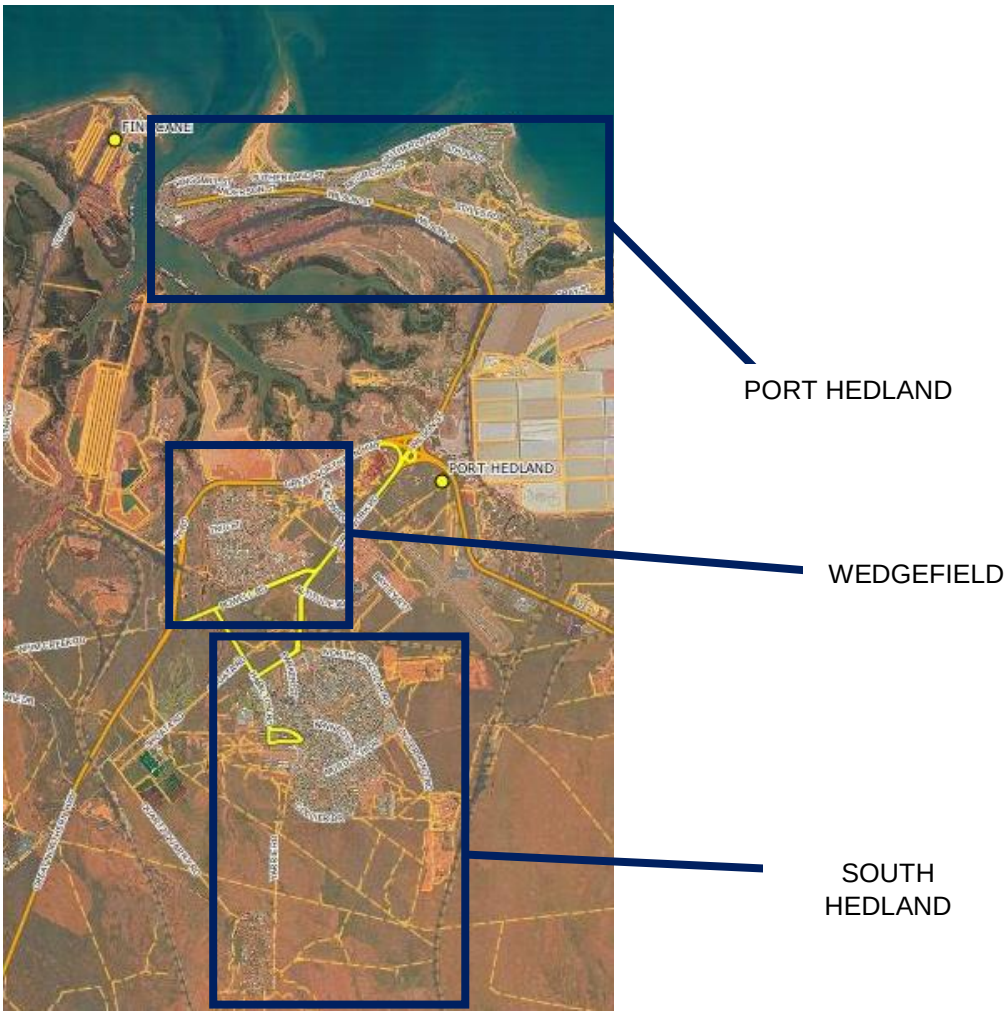

Figure 1. The residential and industrial centres of the Town are main focuses of the MMP.

South Hedland is the main residential centre of the Town where most (more than 60%) of the population resides. South Hedland is approximately 15km from Port Hedland and it is less influenced by tidal movement. However, South Hedland may be susceptible to localised flooding during rainfall events.

Port Hedland is the coastal centre of the population where less than half of the population resides. Due to being surrounded by marshland and coastal water, Port

Hedland is influenced by tidal movement and susceptible to flooding during the wet season which creates a significant public health risk to residents.

Wedgefield is a low-lying area that is strongly influenced by tidal movements and vulnerable to flooding. It is the main industrial centre of the Town which creates a significant public health risk to workers. Populations of mosquito numbers in Wedgefield are also often significantly higher as a result of container breeding on industrial sites. While education campaigns are conducted, this issue continues to hamper effective mosquito control in the area.

2. Goal and Objectives

The goal of the MMP is to minimise the risk of mosquito-borne disease in the community.

The plan is designed to achieve the following objectives:

- Identify mosquito species relevant to the Town's community
- Explain the public health implications of mosquito-borne diseases that are relevant to the community
- Identify potential breeding sites to aid mitigation works prior to rainfall
- Identify and map common breeding sites within the Town
- Explain the Town's strategies of mosquito surveillance and monitoring
- Provide measures to control the risk of mosquito-borne disease in the community
- Identify financial and resource considerations of the MMP
- Identify the frequency of review for the MMP

3. Legislation & Policy considerations

The definition provided for nuisance under Part VII of the *Health (Miscellaneous Provisions) Act 1911* may incorporate mosquitoes as they have capacity to be injurious or dangerous to health. EHOs are authorised officers under the Act to deal with nuisances. The required nuisance response actions of authorised officers are detailed under sections 183 and 184 of the Act.

Sections 6.6, 6.7 and 6.8 of the Town's Health Local Law 2016 details the responsibilities of land owners, land occupiers and Environmental Health Officers around mosquito management.

4. Stakeholders

The Town interacts with a number of stakeholders in relation to the mosquito management plan.

Government departments

At federal level, the Town recognises border security efforts conducted by the Department of Agriculture and Water Resources.

At state level, the Town is supported by the Department of Health (DoH) in the implementation and delivery of the MMP.

At a regional level, the Town's EHOs liaise with EHOs of other local government authorities within the Pilbara and Kimberley regions when necessary to discuss mosquito-related issues.

At local level, cooperation between the Town's Environmental Health, Planning and Infrastructure services ensures that objectives of the MMP are met.

Local community

Members of the local community are significant stakeholders in the MMP due to their occupational and residential exposure in areas susceptible to mosquitoes. There is also responsibility of community members to control mosquito breeding at home and at work.

5. Mosquitoes and Public Health

Mosquito life cycle

The mosquito life cycle begins when a female mosquito lays eggs. Each egg develops into an immature *larva*, which develops through four stages, increasing in size until finally reaching a non-feeding *pupa*. The aerial adult emerges from the pupa and as the adult feeds and mates, the cycle begins for another generation. Depending on climatic conditions, particularly temperature and rainfall, a mosquito species may have one or several generations per year.

Larvae require an aquatic environment to complete development to pupae. Lakes, wetlands, estuarine marshes, tidal reaches, tree hollows, sewage ponds, water tanks and any vessel capable of holding water are sufficient aquatic environments for larval development. Each species prefers breeding habitats with specific characteristics, such as salinity, temperature, pollution and vegetation. These characteristics influence the time taken for completion of larval development. Under favourable summer temperatures, particularly in tropical and sub-tropical environments including the Pilbara, some species can complete development in only 5 days.

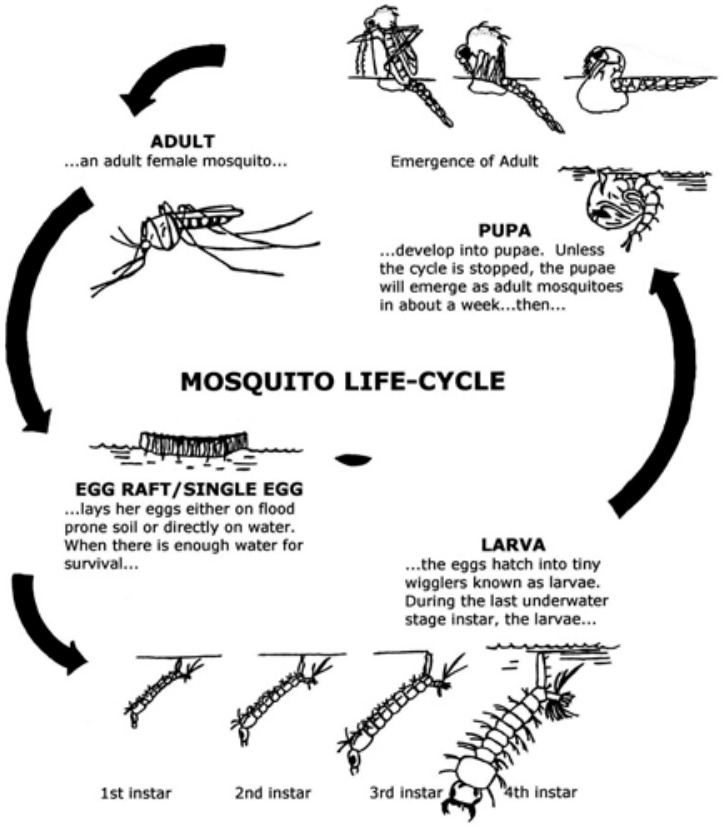

Figure 2. Mosquito Life Cycle

Mosquito-borne diseases

Some mosquitoes in WA are disease vectors, capable of transmitting a range of viruses that can have a significant impact on human health. Local mosquito-borne viruses are maintained within the environment in a mosquito-animal-mosquito cycle. Virus transmission occurs incidentally when the female mosquito seeks a blood meal, which provides the protein required for the development of her eggs. The female mosquito is infected with the virus when she feeds on an animal host who is also infected. The virus may then be transmitted to a person if the infected female mosquito seeks a human blood meal. It is important to note that people can only

become infected from the bite of an infected mosquito, and not through direct contact with another human or animal. In WA, the mosquito-borne diseases of concern are:

Ross River Virus (RRV) causes symptoms of fatigue, lethargy, muscle pain, fever, headache, neck stiffness, enlarged glands, throat soreness, eye irritation, depression, rash, joint pain and tingling in palms and soles of feet. The duration of the illness varies from person to person with symptoms likely to reduce after several months.

Barmah Forest Virus (BFV) causes similar symptoms to RRV with a more pronounced rash and symptoms generally persist for several weeks.

Murray Valley Encephalitis Virus (MVEV) causes symptoms of headaches, fever, nausea, vomiting, neck stiffness, disorientation and dizziness. Severe cases may lead to coma, paralysis, permanent brain damage or death. The duration of the illness is variable from person to person. MVEV is limited to the northern half of WA.

Kunjin virus (KUN) disease is a rare disease also occurring in northern WA. Generally the symptoms are similar, but milder than MVE. The duration is variable from person to person.

Each of the above viruses can only be diagnosed via blood tests. It is possible for individuals to be carriers of the disease where they do not experience any symptoms. However, for those diagnosed with the disease, an incubation period of 7-10 days exists between the time of the mosquito bite and the presentation of symptoms. Unfortunately, there are no vaccines or specific treatments for the diseases detailed above. Patients may be prescribed pain relief or anti-inflammatory medications and are usually advised to rest, engage in gentle physical therapies and emotional support. Vulnerable populations, including children, the elderly and pregnant women are particularly susceptible due to a reduced immune capacity against the virus.

Local species of concern

The most common mosquitoes that are of public health significance in the Pilbara region are:

Aedes vigilax (Figure 3) is present in various coastal regions of WA, including the Pilbara region. The species breeds in coastal saltmarsh areas and is most active after heavy rainfall periods and flooding. *Aedes vigilax* may disperse up to 100km from breeding sites in search of blood meals and it has capacity to carry RRV and BFV. The species is relatively vicious with a tendency to bite at all times of day and is therefore a significant pest species and relatively small numbers can result in many nuisance biting complaints from the public.

Aedes notoscriptus (Figure 4) is present throughout WA and tends to breed in domestic environments and artificial containers, including water ponds, septic tanks, pet water bowls, bird baths, roof gutters, leaf axils and pot plant drip trays. The species is active all year round with particularly high activity during the wet season at dawn and dusk and occasionally during the day and night time. The species does not disperse far and tends to remain around houses in search of blood meals and can contribute to RRV transmission cycles.

Culex annulirostris (Figure 5) is widespread across WA, including the Pilbara region. The species tends to breed in a variety of freshwater sites where vegetation occurs. It bites usually around dusk and after dark and is most active from November to March when water temperatures are high. The species has capacity to carry MVEV, WNV_{KUN}, RRV and BFV and may disperse up to 10km from breeding sites in search of blood meals.

Culex quinquefasciatus (Figure 6) is a common species to WA and is widespread across the state. The species tends to prefer artificial containers and clean or polluted water, such as poorly maintained sewage lagoons, inadequately sealed septic tanks

and silt traps. Containers of water, such as tyres, buckets, pot-plant trays and any container present on an industrial or residential property. The species is active throughout the year with highest activity during winter months, the mosquito species is a relatively poor vector of disease in WA but can cause nuisance biting issues

Figure 3. *Aedes vigilax*

Figure 4. *Aedes notoscriptus*

Figure 5. *Culex annulirostris*

Figure 6. *Culex quinquefasciatus*

Exotic species

The Commonwealth Department of Agriculture and Water Resources (DAWR) is responsible for exotic mosquito management at a national level at the Australian border. The enforcement agency uses vector surveillance strategies at the Port Hedland seaport and international airport to monitor exotic mosquitoes that may be entering from other nations. Adult mosquito traps are set on a weekly basis to document recent activity and record numbers of local species. Due to the international significance of Port Hedland, management of exotic mosquito species

by DAWR is complementary to the Town's MMP. Further information can be accessed via the official DAWR website: http://www.agriculture.gov.au/biosecurity.

6. Mosquito Monitoring & Surveillance

The surveillance and monitoring strategies of the MMP include the identification of breeding sites, larval surveillance, adult mosquito trapping, monitoring notifiable diseases and the sentinel chicken programme.

Identifying breeding sites

The species of concern in the Town tend to breed in groundwater sources, freshwater sites, brackish water and artificial containers. Vegetated sites are preferable to most species as the vegetation provides shelter and a food source for larvae in stagnant water. The below images show examples of common areas of mosquito breeding that form after rainfall (Figures 7-11).

Figures 7 & 8. Mosquito breeding sites at Anderson St Port Hedland.


Figures 9 & 10. Stormwater drains at Wilson St Port Hedland.

Larval surveillance

It is important to conduct surveys of mosquito larvae to establish where and when mosquitoes are breeding, particularly after rainfall and major tidal events. Surveys are conducted by sampling water (Figure 12) from ground water habitats including stormwater drains, flooded areas, tidal flood plains and any artificial containers and under-maintained septic tanks. Larvae are commonly referred to as 'wrigglers' due to their movements and they are easily identifiable against the white background of the dipper. The density of the larvae, usually around 10 larvae per cup within each sample cup indicates the need for control measures, which may be physical or chemical (larviciding and adulticiding). Control measures are explained under section 6.

Figure 11. Sample cup of water containing mosquito larvae.

Adult surveillance

The purpose of adult surveillance via trapping is to identify mosquito species that are present in the community and record fluctuations in the population over time. The Town uses Light and Carbon Dioxide traps (Figure 13) for adult surveillance to determine the density of mosquitoes in certain areas. Adult surveillance also involves identification of the trapped mosquitoes under a light microscope which provides further detail of potential breeding locations within the Town as each species requires specific characteristics of an aquatic environment to achieve egg development. Through an agreement with BOC, the Town is supplied with carbon dioxide cylinders to produce dry ice for the mosquito traps.

Trapping is usually conducted after larvicide treatments in order to indicate their effectiveness and identify any additional areas that require treatment. The traps are

set up strategically in areas that represent the breeding sites that have been treated with larvicide.

Larval surveillance and adult surveillance is also conducted in response to public complaints, however generally, a minimum of fifty (50) mosquitoes must be captured in a single trap in order to classify as a public nuisance. However, a lower threshold of about twenty (20) mosquitoes is considered a public nuisance for more aggressive biters such as *Aedes vigilax.* The area around where the trap was located is surveyed for mosquito breeding sites and larval surveillance is carried out.

Figure 12. Light and Carbon Dioxide mosquito trap set up in sheltered area.

Notifiable diseases

Mosquito-borne diseases are required to be notified to the WA DoH. The Town's EHOs receive the notification and contact the patient to conduct an interview and determine the most likely timing of infection and location where they were exposed to mosquitoes. This information is then used to coordinate appropriate mosquito surveillance and control measures. The EHO returns the completed interview reports to the Department of Health for statistical purposes.

The DoH releases quarterly reports for the Pilbara and other regions of WA that provide a summary of mosquito-borne disease in the region according to notified

cases within the 3-month period. Quarterly reports for 2017 have revealed relatively low activity of RRV, BFV and no activity of MVE and Kunjin disease in Port Hedland, compared to other local government areas of the Pilbara, with the lowest number of cases recorded for Port Hedland. This is a positive result for the Town, as it indicates the effectiveness of local mosquito surveillance and control measures that are in place.

Sentinel chicken programme

The DoH coordinates a sentinel chicken programme to provide early warning of MVE and WNV_{KUN} activity in WA. In northern WA, MVE and WNV_{KUN} viruses survive within a cycle between mosquito and native water birds. Sentinel chicken flocks are kept in several regions of WA, including Port Hedland. When bitten by an infected mosquito, a chicken develops antibodies to the virus but will not develop clinical signs of infection. The virus cannot be spread from the sentinel chickens to humans, as the chicken does not develop high enough levels of the virus in their blood. When a chicken tests antibody positive, this indicates that a recent infection has occurred and that the virus is active within the environment. Regular analysis of sentinel chicken blood samples provides a unique early warning of virus activity in the area and triggers an increase in mosquito surveillance and control efforts when virus activity is detected.

On a monthly basis, the Town's EHOs work in partnership with WACHS-Pilbara and the DoH to take blood samples from a flock of chickens and submit to PathWest for testing. When antibodies to MVE and WNV_{KUN} viruses are detected, the Town warns residents and travellers to affected regions via a media release of the increased risk of mosquito-borne diseases and the need to take additional precautions to avoid mosquito bites. The DoH distributes a regional warning at the first detection for the season. The frequency of blood sampling increases to a fortnightly basis during the

wet season and when results indicate detection of a mosquito-borne virus. A fortnightly report is submitted to local governments detailing the blood sample results from chickens kept by all participating local governments of WA.

Figure 13. Sentinel chicken flock at Hedland Health Campus, South Hedland.

7. Mosquito Control Strategies

Physical control

In addition to chemical controls, the Town uses physical measures to control mosquitoes by removing the source of breeding. The following measures are used to remove favourable breeding conditions and reduce the need for chemical treatment:

Clearing drains and depressions of vegetation (Figures 15 & 16)

Clearing of vegetation from stormwater drains is conducted regularly as required, at a minimum frequency of once per year. The work is organised internally and staff members of depot operations are contacted.


Figures 14 & 15. Stormwater drains cleared of vegetation on Wilson St Port Hedland.

Controlling tidal movements (Figure 17)

- Removing water via a pump, or a similar mechanism
- Physical manipulation of the environment
    - For example by creating or removing drainage pathways, runnelling and removing any potential for water-ponding via engineering solutions

Figure 16. Tidal water on Cooke Point Drive, Port Hedland.

Chemical control

The Town utilises a chemical response to escalating mosquito numbers as a means of controlling large areas of breeding environments. Application of chemicals aerially through fogging to control adult mosquitoes also occurs when numbers have

exceeded larvicidal treatment options and are creating both a nuisance and a health risk to the community.

Larviciding targets mosquitoes in their larval form. Larvicides are applied to aquatic breeding environments.

The Town uses the following larvicides:

VectoLex® (active ingredient, Bacillus sphaericus)

VectoLex® is a bio-larvicide powder dissolved in water and applied by means of spraying across aquatic environments. VectoLex® is produced by the bacterium *Bacillus sphaericus* and kills larvae by destroying the gut lining. The larvicide provides a residual treatment lasting several weeks. It is the preferred larvicide for high-nutrient environments, including sewage ponds.

It is important to note that VectoLex® must be dissolved in naturally occurring water only (water taken from the environment to which the product will be applied). The use of domestic supply water will result in the death of the bacteria due to residual chlorine levels.

(S)-methyoprene (insect growth regulator)

(S)-methoprene mimics the effect of the mosquito juvenile hormone. When exposed to the larvicide, levels of the hormone are raised and maintained at abnormally high levels, preventing the mosquito from developing into pupae and functional adults. The Town uses (S)-methoprene in the forms of briquettes and granules. In briquette form, the chemical is active for up to 6 weeks.

Adulticiding is the destruction of adult mosquitos via application of low volumes of chemical into the air (fogging). The Town uses the following adulticide:

Permethrin-based Fogging Agent (Aqua K-Orthrine)

The Town EHOs apply the adulticide via an ultra-low volume (ULV) fogging machine, which is conducted to provide a barrier against flying mosquitoes. Fogging occurs before dawn when mosquitoes are more likely to be present in high numbers and there are less members of the public outside. Dusk is also a suitable time for fogging, however it is more likely to be interrupted as there tends to be more members of the public outside. The vehicle and machine are shown in Figures 10 and 11. Fogging is conducted as per chemical label rates and in a manner that does not impact on sensitive ecosystems. Wetlands, aquatic environments and other sensitive areas of the environment are avoided. Fogging only occurs in areas of human occupation, including housing estates, industrial estates and built-up areas. Examples of the fogging tracks taken in Wedgefield, Port Hedland and South Hedland are presented below (Figures 12-15).

It is important to note that larviciding is preferable to adulticiding (fogging) as larvicides are very target specific when used at label rates, whereas adulticides will kill any insects they come into contact with. It is also much more effective to target mosquito larvae and prevent the development of adult mosquitoes and the transmission of mosquito-borne disease, as opposed to targeting adult mosquitoes alone.

Figure 17. Fogging machine on Town vehicle.

Figure 18. Fogging machine operating around South Hedland.

Figure 19. An example path for fogging in Wedgefield.

Figure 20. An example path for fogging in South Hedland. Other pathways include the more internal streets of the area, however due to the time taken to complete one route, South Hedland requires more than one day to complete.

Figure 21. An example path for fogging in the surrounding areas of South Hedland.

Figure 22. An example path for fogging in Port Hedland.

Cultural control

The Town provides community education about the public health risks associated with mosquitoes via media releases and community notices at times where mosquito population numbers are elevated and when the EHOs are undertaking mosquito control measures. The Town also undertakes active community engagement by hosting education sessions with interested parties such as schools, private industries and agencies responsible for maintaining public health and managing remote communities.

While the Town is responsible for carrying out activities to protect public health from mosquitoes, land owners are equally responsible for mosquito control on their property. As mentioned previously, mosquitoes may breed in ground water sources or artificial water containers, such as pet water bowls, pot plant drip trays, poorly sealed septic tanks and poorly maintained swimming pools. Residents and land owners must ensure to empty water containers and change pet water every 2-3 days, ensure that septic tanks are adequately sealed and that swimming pools are adequately filtered and disinfected (e.g. via chlorination) to prevent mosquito breeding. Bite prevention information is also provided to the community when mosquito numbers are expected to become elevated. The likelihood of a mosquito bite may be reduced by:

- using mosquito repellent containing DEET or picaridin,
- avoiding camping in coastal areas or ensuring tents are mosquito-proof,
- avoiding outdoors around dawn and dusk where possible,
- wearing long, loose-fitting clothing

Upon request, the Town's EHOs may assist land owners in relation to monitoring mosquito breeding and providing physical and chemical control measures, where necessary.

Land use planning is an important factor that influences public exposure to mosquitoes. Proposals for residential and industrial development may present significant public health impacts where the development is in close proximity to known areas of mosquito breeding. Widespread breeding sites such as marshland present a significant public health risk and as mentioned previously, the effectiveness of chemical and physical treatments is limited. Referral must be made to the environmental health department when considering development in areas that are highly susceptible to significant mosquito exposure. It may then be possible to reduce the public health risk.

8. Other Biting Insects – Midges / 'Sandflies'

In Australia, midges do not transmit disease to humans. However, their bite can cause a significant nuisance. During the bite of the female midge, the midge sucks blood while injecting saliva that produces a skin reaction of variable intensity from person to person. Some midges in the Pilbara may induce a severe allergic reaction in some people that may require hospital treatment, however this is very rare. Midges tend to be present in coastal and inland areas of WA, however they are most commonly present around sandy estuarine and foreshore areas and mangrove swamps in tropical and sub-tropical climates, including the Pilbara. Chemical treatment of midge larvae is difficult to achieve, due to the financial costs associated with targeting their extensive breeding area of mangroves. The insecticide must be specific for targeting midges and have the ability to penetrate through dense mangrove tree cover, which is a rare combined capacity for an insecticide. There is a risk that other insects inhabiting the area would also be eliminated by the chemical.

In order to ensure the most appropriate allocation of Town resources, mosquitoes are the primary focus of the Town's MMP due to their public health significance with the ability to transmit serious illnesses to humans.

9. Resource Registers

The Town maintains registers for monitoring the availability of mosquito control resources, including those detailing all chemicals and equipment purchased and used for mosquito control activities. This ensures that the amount of finances and resources allocated in the budget toward mosquito control is sufficient and identifies any need for the budget to be increased.

10. Occupational Health & Safety Considerations

Environmental Health Officers must be provided with correct PPE for carrying out mosquito control activities, including boots, trousers, long-sleeve shirt, high-visibility vest, respirator, face mask, gloves, sunhat and sunscreen. MSDSs are stored in the Environmental Health office area and are kept current for all chemicals that are stored and used for mosquito control activities. Safe work instructions for activities such as larviciding, adulticiding and making dry ice for the adult traps are used by environmental health staff members. The instructions must be reviewed regularly to maintain relevance and compliance.

11. Resource considerations

Financial

The MMP requires funding to provide environmental health staff members with appropriate chemicals, equipment and personal protective equipment (PPE) required for mosquito surveillance and control procedures.

An effective MMP requires an ongoing commitment from Council to fund, resource and support comprehensive mosquito control initiatives. Due to the Port Hedland landscape, climate and weather patterns, reduced commitment from the Town will inevitably result in significantly increased mosquito population numbers, a clear increase in mosquito-borne disease and a significant public health nuisance overall.

Current annual department budgeting for mosquito control activities incorporates adequate provisions to address mosquito activity throughout Port Hedland's wet season and any isolated rain events and tidal variations that occur at any other time during the year. There are provisions for chemical supplies, equipment and PPE. Any reduced allocations for mosquito control will negatively impact the health of the community.

Currently, the Town of Port Hedland is recognised as a Contiguous Local Authorities Group (CLAG) by the DoH, ensuring eligibility to apply annually for DoH funding for mosquito management. Each year, the Town submits an application to the Mosquito Control Advisory Committee (MCAC) and receives 50% of the funding required for approved mosquito management activities. However, funding is not guaranteed and may depend on the DoH's mosquito budget as well as any funding requests from other CLAGs. Funding is calculated after considering a CLAGs annual spending, spending predictions for the following year and carry-over chemical stock from previous years. CLAG budgets are submitted to the DoH just after the end of the financial year for assessment, with results announced around August or September. This ensures that funding is received in time for the peak mosquito season.

Training

Environmental Health Officers must be provided with comprehensive, on-the-ground training opportunities in order to ensure operation of an effective mosquito control

program. Officers must be equipped with appropriate knowledge and practical skills in effective control measures, entomology, chemical handling and application, mosquito surveillance, habitat assessment and epidemiological responses. In addition to other needs for funding previously mentioned, a commitment to fund staff training opportunities is essential.

The DoH undertakes a biennial 5 day mosquito control training course in Mandurah that is essential to the professional development of EHOs. Three day short courses are also held in regional areas in some years. After undertaking this training, staff are able to deliver and maintain comprehensive control strategies throughout the community. Regional courses are sometimes held in northern WA which are particularly invaluable for Town EHOs, as skills are acquired in an environment where climate, weather patterns and mosquito species are similar.

12. Annual review of MMP

The MMP will be reviewed on an annual basis to ensure that the objectives of the plan are being achieved and to ensure that all information provided remains relevant and accurate to the work carried by the Town's EHOs.

13. Acknowledgements

The Town of Port Hedland acknowledges the following contributors to local mosquito control activities:

- BOC for their generous provision of dry ice for several years for the adult mosquito traps;
- The Medical Entomology Unit (WA DoH) for their ongoing provision of information, training, resources and general support to EHOs;

- Members of the WA Country Health Service (WACHS) for their partnership and involvement in the sentinel chicken programme and following up notifiable disease cases; and
- The WA DoH and the MCAC for assessing CLAG funding applications and dispersing annual funding to enable mosquito control work to occur.