TARRANT COUNTY

Arboviral Surveillance and Mosquito Control Program

Tarrant County Public Health

3/1/2015

Disclaimer: Vector surveillance and control is a dynamic process and as such this document is subject to change during the operational period.

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I. Introduction:

Arboviral diseases are that in which the disease causing agent is spread by the bite of an infected arthropod. As there are many arboviral diseases that have the potential to show up in any area, at any time, we will be focusing this document on four diseases of concern in north Texas. The agents of concern currently include West Nile virus (WNV), St. Louis encephalitis virus (SLEV), Chikungunya virus (CHIKV) and Dengue virus (DENV). Due to the nature of these diseases WNV and SLEV can be discussed together as zoonotic diseases, shared between animals and humans, where as CHIKV and DENV can be discussed together as epidemic diseases, shared among humans. The content of this document is subject to change dependent on the most current information and potentially upcoming events. Tarrant County Public Health conducts surveillance for the presence of WNV and SLEV by studying, surveying, sampling and testing local *Culex* populations in unincorporated portions of Tarrant County. The presence of CHIKV and DENV on the other hand will be dominantly determined by the presence of these viruses in the human population; however, the presence and abundance of *Aedes aegypti* and *Aedes albopicuts* will be surveyed if human cases arise.

A. West Nile virus and St. Louis encephalitis virus

West Nile virus and St. Louis encephalitis virus are endemic mosquito-borne viruses that have the potential to cause febrile disease, myelitis, encephalitis and/or meningitis in humans and other animals. Roughly eighty percent of people who acquire the virus will experience no symptoms. Of the twenty percent who do experience symptoms, roughly one percent will develop serious symptoms. WNV was first isolated in a febrile patient in the African country of Uganda circa 1937. After first appearing in the US in New York City in the summer of 1999, it spread west eventually reaching north Texas in 2002. (AAM, 2013). Both West Nile virus and St. Louis encephalitis virus are carried by the genus of mosquito, *Culex.* The primary vector of these diseases in North Texas is known to be *Culex quinquefasciatus* (Ward, 2002). *Culex restuans* has tested positive in the past and will be considered as another vector. Therefore, part of this program targets the surveillance and control of these disease carrying mosquitoes. Other species of *Culex* that may be vectors for these diseases will also be tested when sampled in abundance.

Culex surveillance will be conducted year round. Regular in-season testing will begin April 1st and end in mid-November when cooler temperatures are most likely. Off-season surveillance will be conducted to monitor the mosquito populations in cooler winter months. Female *Culex* over-winter as adult mosquitoes which are virtually inactive at times of cold temperatures (Strickman, 1988). Minimal surveillance will be conducted when temperatures remain consistently low (below 8°C). Being nocturnal, these mosquitoes are most active between dusk and dawn.

WNV and SLEV have a bird-mosquito-bird transmission cycle that includes humans, horses and other animals as dead-end hosts. This means that a mosquito can only acquire the virus from a bird, but

cannot acquire the virus from a human or horse (that is infected with WNV or SLEV) because of the inability to produce viral particles in our bloodstreams. After a period of time the infected mosquito can pass these viruses on to other animals. Data pertaining to information about WNV/SLEV in human, horse and bird populations will also be considered as important information in decision making and recommendations for the county as a whole.

B. Chikungunya virus and Dengue virus

Chikungunya virus (CHIKV) and Dengue virus (DENV) are two arboviruses that are a potential threat to people of North America. Though they are not currently endemic, it seems to be only a matter of time until autochthonous or locally transmitted cases are common place. Both viruses share the primary vector *Aedes aegypti* and secondary vector *Aedes albopictus*, which are present and abundant in many areas of Tarrant County. These mosquitoes behave differently than *Culex* mosquitoes, so surveillance for these viruses will be different than that of WNV/SLEV.

Chikungunya virus is an *alphavirus* in the family *Togaviridae*. Disease manifested by this virus, known as Chikungunya fever (CHIK) can result in high fever, headaches, intense joint pain and sometimes a rash. It was first isolated in 1952 on the Makonde plateau in Tanzania, Eastern Africa. The word "Chikungunya" roughly translates to "that which bends up" in the Makonde dialect which describes the actions of those experiencing symptoms of the disease. Since 2004, the distribution of the virus has been spreading from the African islands, to Asia, Europe and has most recently made a stronghold in the Caribbean and other popular North American island destinations (PAHO, 2011). Chikungunya may be severely debilitating, but is rarely fatal. Symptoms typically last less than two weeks, but may persist for months and in rare cases, even years.

Dengue virus (*Flaviviridae*: *flavivirus*) continues to spread around tropical and subtropical regions. Disease resulting from DENV can range from febrile to hemorrhagic and it exists in four different serotypes, 1,2,3 and 4. The symptoms of Dengue fever can be similar to CHIK, however the onset of fever is more gradual, there is more commonly a rash, and it is more likely to be fatal (PAHO, 2011). Once an infected person overcomes illness from one serotype of DENV, they become susceptible to develop more severe Dengue fever symptoms upon reinfection with another serotype (WHO, 2009). Recently, local transmission has been documented in the Florida Keys (Richards *et al*. 2012) and happens periodically on the Texas-Mexico border (Rodrigues-Tan and Weir, 1998).

Both CHIKV and DENV are transmitted by mosquitoes in the genus *Aedes,* subgenus *Stegomyia*. These mosquitoes are unlike *Culex* mosquitoes in the fact that they are diurnal- meaning that they are active during the day, overwinter as eggs, and feed predominantly on humans. Surveillance for these mosquitoes will take place during our in season WNV/SLEV surveillance (see section A.) with six traps set over two weeks placed in 12 locations in the unincorporated sections of the county to gather data about the populations of these two mosquitoes.

II. Tarrant County management area description

Tarrant County Public Health (TCPH) is responsible for all areas of unincorporated Tarrant County. TCPH will also provide assistance and recommendations to incorporated entities within the county.

III. Surveillance for arboviruses and arboviral diseases

A. West Nile virus and St. Louis encephalitis virus surveillance in mosquitoes:

Surveillance for WNV/SLEV in the local mosquito population enables TCPH to assess the risk for transmission to humans by calculating the minimum infection rate and the vector index. These methods are recommended for risk assessment by the Centers for Disease Control and Prevention (CDC) in their West Nile Virus in the United States: Guidelines for Surveillance, Prevention and Control. Mosquitoes will typically test positive for WNV/SLEV before human cases appear.

The Environmental Health Division (EHD) of TCPH will perform trapping of adult *Culex* mosquitoes in unincorporated portions of Tarrant County (For more information about trap location, see Appendix A). Cities may collaborate with TCPH by trapping adult mosquitoes at chosen locations within their city. There are greater than 150 static trap locations around the county. Each entity will be expected to perform certain duties as stated in the following protocol:

EHD will supply traps, bins, nets, batteries and delivery containers based on population/size of city or by request with logical reasoning.

i. Seasonal surveillance

A. Collaborating cities will be expected to: Brew gravid water with grass clippings/alfalfa/hay and tap or natural collected water for a minimum of 7 days (14 days preferred), set traps overnight to be collected the following morning (once/week), and deliver mosquitoes in appropriate containers and with completed paper work (including if no mosquitoes were captured) to TCPH room 2300 in supplied containers no later than 24 hours prior to set date to be tested. If all traps yield no mosquitoes, paperwork may be sent via e-mail to the vector control supervisor or fax (with att: vector control) to (817) 321-4961.
B. EHD will: Freeze mosquitoes prior to identification, identify, enumerate, and place up to 50 mosquitoes of the appropriate vector species into each tube. Mosquitoes may be stored in a -30° C freezer and delivered to North Texas Regional Laboratory (NTRL) no later than 12:00 PM on predetermined date to be tested.

C. NTRL will: Store frozen samples until ready for processing (normally performed on Tuesdays and Thursdays), produce homogenates, extract RNA from samples, run a real-time reverse-transcriptase polymerase chain reaction (RT-PCR) assay for detection of WNV and SLEV, determine positive/negative results and report results to EHD the afternoon of the day following laboratory submission, barring unforeseen circumstances.
D. EHD will: Cities with positive mosquito samples will be notified immediately by the vector control personnel or the designee via telephone and email. Vector control personnel or designee will also complete the internal notification (see appendix B). Locations and results of WNV/SLEV positive trap sites will be added to the Tarrant County website by the GIS analyst or designee after data entry has been entered and approved by vector control personnel (usually within 24 to 48 hours after receiving results).
E. EHD will: Vector control personnel or designee will report positive mosquito pool results to Texas Department of State Health Services (DSHS) once/week on Friday or Monday the following week.

ii. Off-season surveillance

A. Collaborating cities will be expected to: Brew gravid water with grass clippings/alfalfa/hay and tap or natural collected water for a minimum of 7 days (14 days preferred), set traps overnight to be collected the following morning (once/every other week) barring temperatures less than 37 degrees (Strickland, 1988), and deliver mosquitoes and completed paper work (including if no mosquitoes were captured) to TCPH room 2300.
B. Off-season collection will follow the same procedures as in-season trapping other than section A. An electronic calendar will be supplied to those cities who participate with trapping periods and testing dates.

Off-season trapping should follow the same procedures as the in-season trapping.

B. Dengue virus and Chikungunya virus surveillance in mosquitoes

Surveillance for CHIKV and DENV in mosquitoes will only happen on a case by case basis where CHIKV and DENV would be most likely to occur. This would be strictly for data collection purposes only and would not determine a response for mosquito treatment. Due to the nature of the way the virus cycles in the environment, directly from humans to mosquitoes to human, it is highly unlikely that these viruses will be found in the mosquito populations *before* human cases appear. Therefore, the dominant form of surveillance for the virus itself will be through recording confirmed human cases. BG Sentinel traps will be placed around Tarrant County every other week to estimate the size of the local *Aedes*

aegypti and *Aedes albopictus* populations to gain understanding of possible human-mosquito interaction if the viruses should circulate in an area of Tarrant County in the future.

i. Mosquito surveillance near imported cases

It should be noted here that a suspected imported case of CHIK or Dengue fever will be determined by the Division of Epidemiology at TCPH. Imported cases must have a travel history that includes a country in which CHIKV and/or DENV are endemic or epidemic, or currently circulating. Upon notification of a suspected human case from the Division of Epidemiology, a member of the vector control team will work collaboratively with the appropriate municipality to inspect the property of the patient for sources of *Aedes* breeding and to determine subsequent mosquito control activities. **Please note that if mosquito testing will ensue, a positive CHIKV/DENV test is NOT required or even recommended for treatment of adult or larval sources on properties with viremic cases.** The patient will also be educated about the feeding behavior of *Aedes* and the application of repellents including *N, N, N* diethyl-*meta*-toluamide (DEET) will be encouraged. If the patient is no longer viremic and therefore cannot spread the virus to a local mosquito population, the patient will be educated about the use of repellent and encouraged to treat larval sources found on their property.

ii. Mosquito surveillance near autochthonous cases

Autochthonous cases can be described as "locally acquired" cases. This can be determined by suspected symptoms and lack of travel to an endemic/epidemic country. Mosquito control activities on the patient's property will be determined on the likelihood of CHIK/Dengue fever. Once an autochthonous case is confirmed, information on *Aedes* mosquito breeding habitat, prevention of mosquito bites and symptoms of these diseases near an autochthonous case will be the primary means to minimize additional cases. Mosquito control activities including source reduction, larviciding and adulticiding will ensue within a 200 meter radius around an autochthonous case, or the approximate flight range of *Aedes aegypti* and *Aedes albopicuts* (PAHO, 2011). BG Sentinel traps will also be placed within a 200 meter of the human case to monitor the local mosquito population and test for the presence of CHIKV/DENV.

C. Human surveillance:

Arboviral diseases and exotic diseases are nationally-notifiable conditions and reportable in Texas. Most disease cases including suspected cases are reported to the Division of Epidemiology at TCPH. They are responsible for ensuring that reported human disease cases meet the Council of State & Territorial Epidemiologists (CSTE) case definitions* and are investigated promptly. Upon confirmation of a human case, the Division of Epidemiology will notify the Environmental Health Division.

*Please note that CSTE case definitions may differ from doctor diagnoses. If a patient is diagnosed with WNV disease, an investigation by TCPH Epidemiology will follow to determine if this patient meets CSTE definition.

Consequently, the Environmental Health manager or designee will notify cities with confirmed human cases. In compliance with the Health Insurance Portability and Accountability Act (HIPAA), information regarding human cases will not be released on the interactive mapping website.

D. Birds and sentinel chicken surveillance (WNV/SLEV Only):

Passerine birds, or perching birds, serve as the main reservoir for both WNV and SLEV. Many counties, nation-wide have monitored deaths of birds known to be susceptible to WNV and have even tested them for the presence of WNV. Birds usually precede human cases by approximately two weeks (Kulasekera et al 2000; Mostashari et al 2003). This practice has been abandoned by many districts because it is fairly expensive and labor intensive, bird's extensive home ranges may not be a true representation of where WNV is a problem and the long term effectiveness of a bird surveillance program remains uncertain due to natural selection of disease resistant birds (CDC, 2003). Therefore, surveillance of dead birds for WNV activity will be passive. TCPH will not test dead birds. If a citizen (or staff member) reports a dead bird sighting in the unincorporated area we will record that information as a complaint and consider it as a possible surveillance location for an extra mosquito trap *ad hoc*. Should a dead bird sighting be reported in one of Tarrant County's municipalities, we will collect the information as a complaint, record it in a database and forward the information to the affected city.

Sentinel chicken flocks may be useful as a tool in WNV surveillance because they seroconvert IgM (an indicator of WNV infection in their blood) at approximately the same time in the season as do humans. Since WNV infections start with flu-like symptoms as do many other diseases, this may be helpful information to the medical community when making seasonal disease assessments within the region. However, this type of surveillance program should only be used in addition to other types of surveillance and after local transmission dynamics are well understood. It also may put workers at risk for infection while bleeding birds (CDC, 2003). TCPH does not currently implement this type of surveillance, but will consider it for future opportunities.

E. Equine surveillance (WNV/SLEV Only):

Manifestations of WNV infection are similar in horses to that of humans. According to the Texas Health and Safety Code (84.042), veterinarians are required to report disease in animals if it is on the list of reportable diseases for humans. Arboviral encephalitis including WNV and SLEV are also on the list of reportable diseases as listed in Section 97.3 (b) of the Texas Administrative Code, Communicable Diseases. (http://www.dshs.state.tx.us/idcu/health/zoonosis/laws/report/) Veterinary health professionals contact the Texas DSHS directly and thus TCPH is notified through the state when WNV infection has been confirmed in horses.

IV. Prevention and control:

All vector control personnel will be licensed by the Texas Department of Agriculture (TDA) for a non-commercial government entities pertaining to vectors of diseases of public health concern within six months from their start date. Vector control personnel will maintain all documents required by the Texas Department of Agriculture and Texas Commission of Environmental Quality (TCEQ) including the Texas Pollution Discharge elimination System (TPEDS) General Permit. All vehicles will contain all necessary equipment and pertinent documentation for pesticide applications. All vehicles will be calibrated once a year prior to the beginning of in-season WNV/SLEV surveillance. For a list of equipment and pertinent documentation see Appendix C.

A. Larval mosquitoes

Larval surveillance is important in any integrated mosquito management program. Upon findings of a larval mosquito source, vector control technicians will bring a sample back to the lab. Upon returning to the lab, all larvae will be identified and the need for treatment will be assed. Treatment of the larval source will be determined on the estimated density and species (e.g. pest to humans or not).

Reducing, eliminating, and treating mosquito breeding sites are some of the most important aspects of a mosquito control program. It controls mosquitoes before they emerge as host-seeking adults (only adult female mosquitoes are vectors for arboviral diseases). Additionally, pin-pointing sources that need to be treated are more efficient, effective, and safer than treating large areas with adulticide. Humans and terrestrial wildlife are less likely to be exposed to treated aquatic habitat of larval mosquitoes than that of terrestrial airborne adults.

Physical elimination and/or larviciding of mosquito breeding sites will be conducted by TCPH vector control personnel upon observation when possible. If sources are known to exist on private property, TCPH vector control technicians will notify the property owner of mosquito breeding activity and request elimination and/or treatment of the breeding sources where possible. If the property owner does not eliminate/treat sources, TCPH may use applicable laws to seek legal remedy (Texas Health and Safety Code Chapters 341 and 343). See Appendix G for more information pertaining to larvicide.

Gambusia affinis, also known as mosquito fish, are natural endemic predators of mosquito larvae. They have the ability to continuously control mosquito larvae in a single source, are fairly easy to maintain, and are typically environmentally friendly. In partnership with the Tarrant Regional Water District (TRWD), vector control personnel will maintain *Gambusia* in four cement live wells near their Eagle Mountain Lake fish hatchery facility (See Appendix E for map). Vector control personnel will keep a stock tank of *Gambusia* at Tarrant County Public Health. Incorporated city personnel may request *Gambusia* at any time during business hours to be able to use for purposes of larval mosquito control within their municipalities.

B. Adult mosquitoes

Surveillance of adult mosquitoes helps vector control technicians understand complex dynamics in mosquito ecology and the relationship between species. Different techniques of sampling will be utilized to assess different aspects of life within local adult mosquito populations. In 2015 these will include gravid traps, CO_2- baited light traps and BG Sentinel traps. Using different types of traps captures a wider variety of mosquito species. Specifically gravid traps target *Culex quinquefasciatus* and *Culex restuans,* whereas BG Sentinel traps target *Aedes aegypti* and *Aedes albopictus*.

Though larval elimination will be the main focus of mosquito control, it is impossible to know and eliminate every source of mosquito breeding. Mosquito borne illness can only be transmitted in the adult life stage of the mosquito vectors. Vector control personnel will apply adulticide via ground-based truck mounted Ultra Low Volume (ULV) sprayers in response to a mosquito sample that tests positive for WNV and/or SLEV. If an area continues to test positive for WNV and/or SLEV after it has been treated, TCPH will consider elevating this response to adulticiding two or three consecutive nights. Vector control personnel will also apply adulticide in response to a confirmed WNV human case after additional mosquito traps also test positive for WNV within a quarter of a mile radius around the location of the human case in accordance with CDC recommendations. As mentioned in the CHIKV/SLEV surveillance portion of this document, when large populations of adult *Ades* are determined to be present on a suspected CHIKV/DENV patient's property, ULV or thermal fogging via backpack mounted/all-terrain vehicle (ATV) mounted sprayer will commence when appropriate. Tarrant County has a supplemental ground-based mosquito control contract with a commercial entity should additional assistance be required. Additionally, an aerial spray contract is in place for use during an arboviral related epidemic. See Appendix F for more information pertaining to adulticide and Tarrant County's phased response plan.

C. Resistance management

Tarrant County Public Health uses integrated mosquito management techniques meant to avoid insect resistance. These include a combination of physical, chemical, biological and natural mosquito control techniques. Since there are limited classes of pesticides able to be used for control of adult mosquitoes (as opposed to the many options for larval control) TCPH will contract with an outside entity to conduct CDC approved resistance bioassays to determine adult mosquito resistance. If mosquitoes are determined to be resistant to a preferred adulticide, a secondary alternate adulticide will be utilized in future adulticiding activities. All possible contractors with TCPH will be notified of the adult mosquito conditions prior to treatment.

V. Education, outreach, and media

Educating the public is an essential aspect of Tarrant County's arboviral surveillance program. This includes giving the public tips on how to control mosquitoes in their homes and backyards, stating

the risks and symptoms of these arboviral diseases and informing people on how to protect themselves from host-seeking female mosquitoes. To help educate the public, vector control personnel will attend local health fairs with tables including displays of larvae and adult mosquitoes, pamphlets and fliers that include information about mosquitoes, WNV/SLEV/CHIKV/DENV, and protection from mosquitoes, and answer general questions about these subjects. Vector control personnel will also be available for classes upon request to educate home owners associations (HOAs), elementary school classes, high-school classes and community outreach programs throughout the county. EHD and collaborating divisions will also be hosting an Arboviral Surveillance Program Kick-off meeting before the start of the WNV/SLEV season where vector control personnel will review the past year, review cumulative progress of the program and asses the program based on suggestions from municipalities. Vector control personnel will attend Texas Mosquito Control Association (TMCA) and American Mosquito Control Association (AMCA) meetings to be educated and to network with other vector control professionals when possible. Vector control personnel will be responsible for creating original pamphlets, fliers, and other educational material available for the public visiting Tarrant County Public Health and on the Tarrant County Public Health Website. TCPH's public information officer (PIO) handles official press releases.

VI. Mosquito complaints

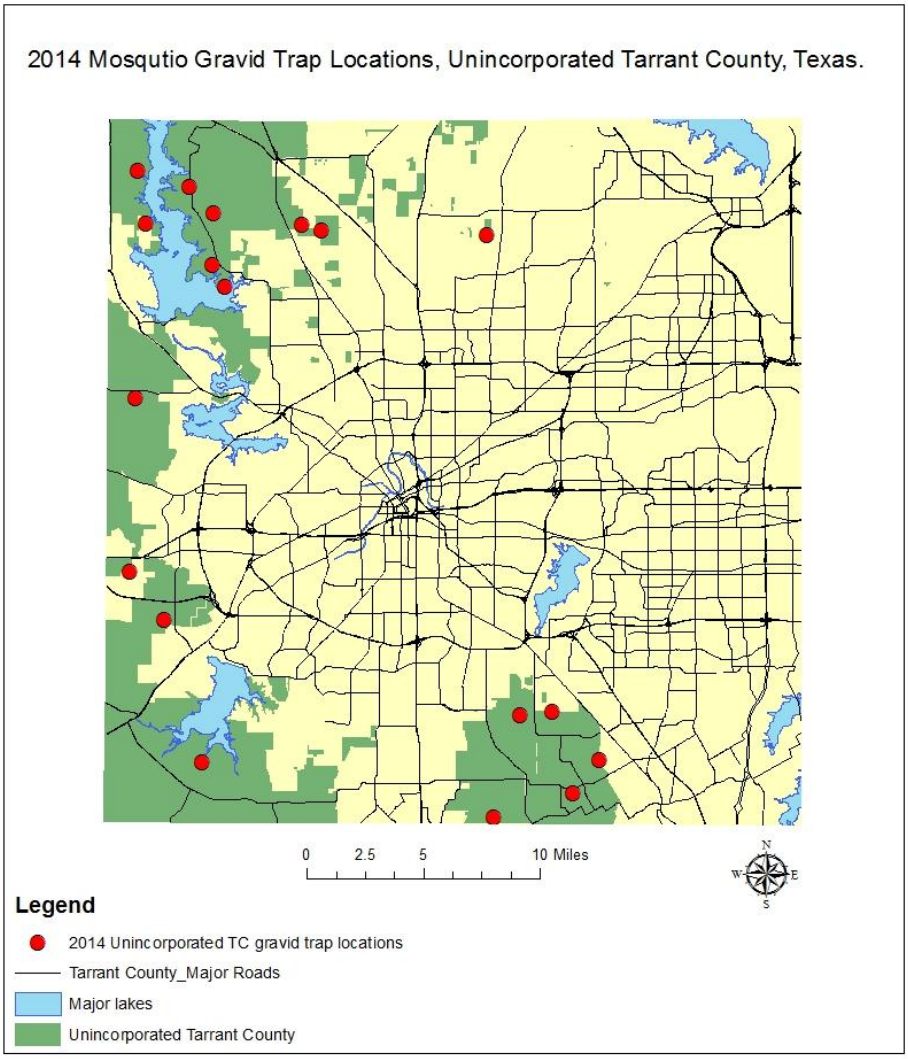
If mosquito breeding is suspected on any property within unincorporated Tarrant County, vector control personnel will conduct a thorough investigation of this property. Complaints will be filed as an investigation request and tracked in the SWEEPS database for the Environmental Health Division. After they are entered into SWEEPS the complaints will be reviewed and prioritized in relation to severity of potential breeding sites (e.g. discarded tires, green swimming pools, observed containers holding stagnant water etc.). Priority complaints will be investigated within 48 hours. After investigation vector control personnel will speak with the property owners to suggest remedy and contact complainant (if listed) to give an update of complaint status. Vector control personnel will seek legal remedy when necessary (for list of applicable Texas Laws, see Appendix G).

Appendix A:

Trap locations

Vector control personnel have chosen trap locations based on sources of standing water, usually the first places which obtain water first, and the last to dry out. Temporary trap locations are chosen on a complaint basis, or when *Culex* sources are suspected by personnel. Cities choose their own locations. We recommend that cities choose permanent trap locations where sources are known to occur and/or where there is a historical presence of WNV/SLEV. They may also choose temporary trap locations on a complaint basis, or when scouting a new location. Good sources for *Culex quinquefasciatus* include catch basins, ditches with organically laden water, tires, and unkempt pools on abandoned properties.

Figure 1. Locations of in-season gravid trap locations in Tarrant County.



These data were prepared by Tarrant County Public Health for its use, and may be revised any time, without notification. Tarrant County Public Health does not guarantee the correctness or accuracy of any features on this map. Tarrant County assumes no responsibility in connection therewith. Said data should not be edited by anyone other than designated personnel, or through written approval by GIS Manager. These data are for informational purposes only and should not create liability on the part of Tarrant County Government, any officer and/or employees thereof.

Appendix B:

Internal notification of positive mosquito pools and trap location

North Texas Regional Laboratory sends results of PCR testing for WNV/SLEV presence in mosquito pools from around the county to personnel within TCPH, including those in EHD. The vector control supervisor or designee will record details of samples including the location coordinates and address, the species and number of mosquitoes transferred to tube, the total number of tested species of mosquito within the trap and the precinct in which the trap was placed. This information will be forwarded to vector control personnel, the EHD manager and acting associate director.

Appendix C: List of documents, emergency response and other documentation

1. Certified applicator license
2. TDA pesticide application form
3. TPEDS general permit
4. Material Safety and Data Sheets (MSDS)s for chemicals used
5. Labels for chemicals used

Emergency response

Occasionally during the loading or unloading of pesticide or in worst case, an accident, there may be spillage of the chemical. In the case of spillage action must be taken to contain and clean up the chemical. In addition, a person may have come in contact with the chemical.

If the chemical gets on someone, have the person leave the area immediately, wash quickly and thoroughly, change clothes and see a doctor if necessary (chemical is inhaled, swallowed, or comes in contact with highly susceptible areas such as the eyes).

Clear the area except for the cleanup staff. The cleanup staff must wear proper personal protective equipment and clothing.

When there is a spill, action is to be taken immediately to reduce the spill area and protect sensitive areas. Pet litter will be used as an absorbent to soak up the liquid. This material, along with soil that may have been impacted can be swept or scooped up and stored in a water proof container for proper disposal. A detergent and water can be used to clean-up the remainder of the residue if this appropriate for the surface but this water must also be collected for disposal.

Personal protective equipment (PPE)

Any person involved in the transporting, handling, or dispensing must be wearing long pants, a long sleeved shirt, shoes, and socks. The label for the chemical will list required and recommended personal protective equipment (PPE) but at a minimum the follow items are to be available:

- Head covering
- Non-absorbent covering for clothes
- Chemical resistant gloves
- Eye goggles or face shield
- Respirator or some type of approved mouth covering
- Chemical resistant footwear

Though only the person handling the chemical is required to wear the prescribed PPE it is highly recommended that all personnel on the team have equipment available to them. Each person is to have a change of clothes available and there is to be backup equipment for disposable items such as gloves, respirator filters or mouth covering, or other items outlined by the label.

Spill kit

The Spill Kit shall contain the following items:

- At least five pounds of pet litter
- Broom
- A container to collect waste
- Chemical resistant gloves
- Eye/hand wash station
- First Aid Kit
- At least five gallons of water
- Dust pan
- Detergent
- Paper towels
- List of emergency contacts

Other documents

1. Trap data surveillance forms
2. Maintenance of equipment logs

Since County vehicles will be used for transporting the adulticiding equipment the service schedule outlined by County Transportation will also be adhered to. The following maintenance checks will be conducted each day by staff prior to using the truck or trailer:

- Engine oil level
- Amber light working
- Horn
- Tire air pressure
- All signal and break lights

3. *Gambusia* log
    - Names of city personnel and approximate number of fish will be recorded by the vector control personnel each time fish are distributed.

Appendix D: Larvicides

I. Microbial

a. *Bacillus thurengiensis isrealensis* (Bti)

Bti is environmentally friendly in most situations because it is specific to insect pest species. This means that it will not harm beneficial insects that are natural predators of mosquitoes such as dragonfly nymphs, belastomatids and other aquatic invertabrates and/or fish. The mosquitoes must ingest this insecticide to work, so it is ineffective if a source is discovered when mosquito larvae are in the later part of their fourth instar when larvae stop eating to prepare for metamorphosis. It will also not be effective against pupae who do not eat. This bacterium produces a crystalline toxin that esentially destroys the larval midgut (digestive tract). Bti and Bs must be periodically reapplied.

b. *Lysinibacillus sphaericus* formerly *Bacillus sphaericus* (Bs)

Mode of action is similar to Bti.

c. Spinosad

Spinosad is an insecticide that is based on the soil bacterium *Saccharopolyphora spinosa*. It has relatively low toxicity to birds and mammals, but is a broadrange pesticide. This means it may harm insects other than mosquitoes and so should not be used in benthic environments with an abundance of beneficial insects. Unlike Bti, it does not have to be ingested and should be effective against larvae of all instars and pupae. It alters the function of the nicotinic (acetocholine) and GABA (γ aminobutyric acid) gated ion channels. This results in hyperexcitation of the muscles ultimately resulting in paralysis and death similar to the outcome of organophosphates.

II. Chemical/Physical

a. Insect Growth Regulators (IGRs)

An insect growth regulator is a chemical which interupts a portion of an insect's life cycle. Some of these may be as simple as a chitin inhibitor- meaning that it disrupts forming of the insect exoskeleton. There are also other types of IGRs that may behave similarly to endogenous or naturally occuring chemicals. As with most animals, many internal physiological functions are a result of the presence or absence of hormones. In insects, one of these functions is metamorphosis. When an insect is in its larval stage, a hormone known as juvenile hormone (JH), which is mostly order specific, is constantly present (although much less during the molting process). It is the absence of this hormone that causes the insect to enter into the metamorphic stage where it will transform into an adult insect. An insect growth regulator may be an analog, or similar molecules to JH or any chemical that changes or affects the growth and development of an insect. Therefore, in the presence of an insect growth

regulator, the insect can never become an adult. This in turn disrupts the insect life cycle resulting in death. This should not affect the food web and may be used in a variety of environments. It is not recommended for larger bodies of water, or flowing water, but small places like septic systems, storm drains, catch basins, roadside ditches and the like. It does have to be periodically replied.

b. Monomolecular Films (MMF)

A monomolecular film modifies the surface tension of the water. Mosquito larvae rest at the top of the water by placing their siphons at the top of the water where the natural surface tension keeps them afloat without activity. When the surface tension is modified the mosquito larvae have to constantly swim to the top of the water to breathe. This results in exhaustion of the mosquito larvae (and pupae) and eventually death. This is not harmful to fish and other wildlife. Since the mode of action of this substance is physical, mosquitoes cannot build up resistance. It does require reapplication every few weeks. Since MMFs are self-spreading, if applied correctly, they have great coverage and may be used in larger environments like rice fields, swamps and wetlands.

c. Oils

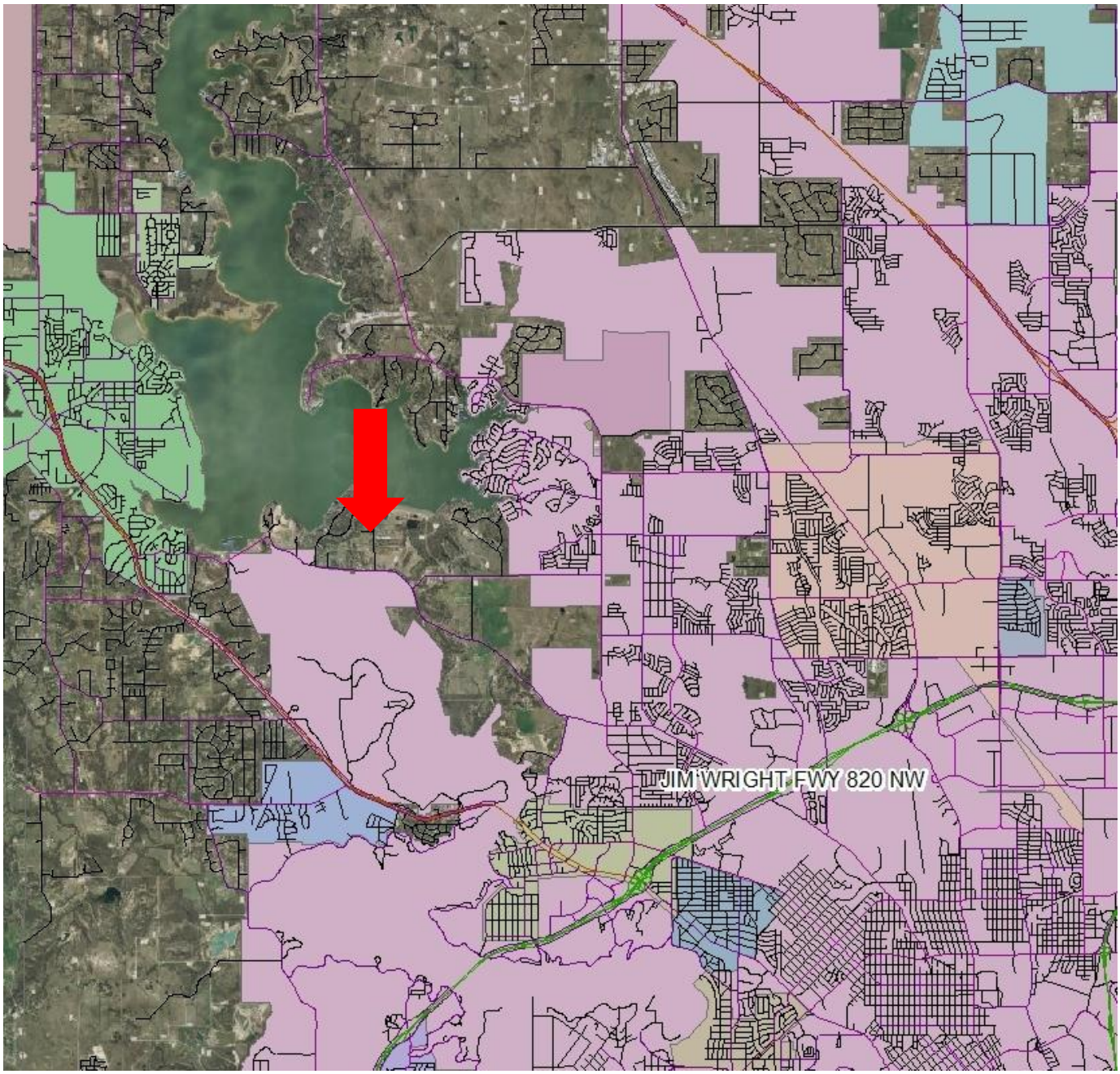
Oils are insecticides that spread over the top of the water to create a barrier. Mosquito larvae and pupae cannont push their breathing apparati through this oil resulting in suffocation. This is one of the quickest ways to eradicate mosquito larvae and is another insecticide mosquitoes cannot become resistant to because of the physical mode of action. These products shouldn't be used in the presence of other aquatic wildlife because it can affect the dissolved oxygen content and also contains petroleum distillate.

Appendix E: *Gambusia affinis*

Our *Gambusia* program stocked live wells are located at the Tarrant Regional Water Distic Eagle Mountain fish hatchery, located at 8665 Eagle Mountain Circle, Fort Worth TX, 76135 in the northwestern portion of Tarrant County. Vetor Control personnel will obtain badges to be able to enter Tarrant Regional Water District Facilities.

Figure 2. Aerial picture of live wells for storage of *Gambusia affinis*

Figure 3. Location of TRWD fish hatchery in northwest Tarrant County



Appendix F: Adulticides

I. Chemical

a. Pyrethroids

Pyrethroids are a class of pesticides which are derived from botanicals found in certain species of flowers in the genus *Chrysanthemum*. They are non-persistent in the environment and are broken down in a short amount of time by UV light (sunlight). These insecticides may be broad range (meaning they can affect many types of insects). To avoid beneficial pollinators such as bees and butterflies, and to optimize the number of adult mosquitoes killed, these insecticides are typically sprayed at night when mosquitoes are most active and pollinators are resting. These chemicals are also applied with ultra-low volume (ULV) equipment, meaning very little of the insecticide is needed for treatment. Tiny droplets of insecticide must come in contact with the adult mosquito for it to be effective. Pyrethroids affect the gated ion channels of the insect's nervous system in such a way to where the muscles become over stimulated and eventually lead to paralysis and death. Bodies of water should be avoided when using these chemicals because they can be toxic to other benthic wildlife including fish and beneficial insects.

b. Organophosphates

Organophosphate pesticides should only be used for adult mosquito control in instances where the local adult population shows resistance to pyrethroid insecticides. Organophosphates may be toxic to other wildlife and humans, birds and other mammals in large doses. The doses required for mosquito control are well below these levels (also applied with ULV equipment). Most organophosphates also break down quickly in sunlight. These pesticides affect acetylcholinesterases which break down acetylcholine, a neurotransmitter that controls muscle function. Inability to break down this neurotransmitter leads to overstimulation of the muscles, and eventually paralysis and death.

Table 1 Tarrant County Public Health Guidelines for Phased Response to Mosquito Surveillance

The following recommendations are intended to guide mosquito control programs and may include other applicable community procedures. All actions are subject to change without notice due to organizational priorities, weather or other unforeseen circumstances.

Risk category	Probability of human outbreak	Public Health Threshold	Recommended response
0	None	No evidence of mosquito or viral activity	**Surveillance** • Develop response plan **Information/Education** • Initiate community outreach and public education programs • Conduct audience research to develop/target education & community involvement **Control Measures** • Contact community partners • Secure necessary control resources to enable emergency response
1	Low	Normal mosquito activity with little or no evidence of viral activity	**Surveillance** • Routine monitoring of public health threats Monitor larval and adult mosquito bionomics (trap surveillance) • Identify mosquito samples and laboratory testing for disease **Information/Education** • Public education and community outreach programs focused on risk potential, personal protection and residential source reduction **Control Measures** • Source reduction through physical and environmental measures • Biological – mosquito fish • Larvicides (surface oils, biorational bacterial products and insect growth regulators)
2	Moderate	Virus detected in mosquito samples	**Surveillance** Increase mosquito surveillance in areas of positive traps **Information/Education** • Public health advisory released • Advise the public and emphasize source reduction, personal protection and disease symptoms **Control Measures** • Larviciding of breeding sites around infected trap sites • Consider ground-based ULV adulticide application around positive trap location, with continued mosquito surveillance
3	High	Virus detected	**Surveillance**

		in multiple mosquito samples from different times and locations and confirmed human cases	• Increase surveillance activities in adjacent areas where spread of virus is likely **Information/Education** • Public health warning released • Publicize vector control measures within the target communities • Warn the general public of the probability of disease and provide guidance **Control Measures** • Ground-based ULV adulticide application of area around confirmed human case(s) after mosquito trapping confirms the presence of disease • Ground-based ULV adulticide application of positive mosquito sites and expanded areas around sites • Consider aerial treatment(s)
4	Outbreak in progress	Multiple human cases confirmed and detection of increased or continued viral mosquito activity	**Surveillance** • Continue mosquito surveillance in areas of confirmed human cases **Information/Education** • Public health emergency considered • Declaration of public health emergency/distribution of emergency alerts **Control Measures** • Ground-based ULV adulticide application in areas of clustered human cases • Recommend aerial adulticide applications in targeted zones

Tarrant County mosquito response guidelines were adapted from the Center for Disease Control and Prevention report "Epidemic/Epizootic West Nile Virus in the United States: Guideline for Surveillance, Prevention and Control, 2013"

Appendix G: Laws pertaining to vector control

Texas Health and Safety Code

Title 5, Subtitle A, Chapter 341, Subchapter B,

.011- Defines public health nuisance

.012- Requires abatement of nuisance

.019- Public officials can treat an abandoned or uninhabited property with mosquito breeding sites

Title 5, Subtitle A, Chapter 343, Subchapter B

.011- maintain property so as not to attract mosquitoes, rodents, vermin or disease-carrying pests

.012- States penalty from $50-$200 if nuisance is not abated within 30 days of notice; if previously convicted $200-$1000 and/or jail time up to six months. Each day the violation occurs is a separate offense.

Title 5, Subtitle A, Chapter 341, Subchapter C

.024- Authority to enter premises when presenting proper government identification

Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) (entirety- bound by pesticide license)

Clean Water Act, Section 402 and Chapter 26 of the Texas Water Code- pertains to a general permit to discharge biological pesticides and chemical pesticides that leave a residue in water in or near waters of the US (our current permit is NoTXG870000 and expires on April 9th 2016- does this need to be mentioned?)

Glossary of acronyms

WNV- West Nile virus

SLEV- St. Louis encephalitis virus

CHIKV- Chikungunya virus

DENV- Dengue virus

AAM- American Academy of Microbiology

CHIK- Chikungunya fever

PAHO- Pan American Health Organization

TCPH- Tarrant County Public Health

CDC- Centers for Disease Control and Prevention

EHD- Environmental Health Division

NTRL- North Texas Regional Laboratory

RT-PCR- reverse transcriptase polymerase chain reaction

DSHS- Department of State Health Services

DEET- N, N, diethyl-*meta*-toluamide

CSTE- Council of State and Territorial Epidemiologists

HIPAA- Health Insurance Portability and Accountability Act

TDA- Texas Department of Agriculture

TCEQ- Texas Commission on Environmental Quality

TPEDS- Texas Pollution Elimination Discharge System

TRWD- Tarrant Regional Water District

ULV- Ultra Low Volume

ATV- all-terrain vehicle

HOA- home owners association

TMCA- Texas Mosquito Control Association

AMCA- American Mosquito Control Association

PIO- public information officer

PPE- personal protective equipment

Bti- *Bacillus thurengiensis isrealensis*

Bs- *Bacillus sphaericus*

GABA- gamma aminobutyric acid

IGR- Insect Growth Regulator

JH- Juvenile hormone

MMF- monomolecular film

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