TARRANT COUNTY

Arboviral Surveillance and Mosquito Control Program

Tarrant County Public Health

3/15/2021

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

List of Tables and Figures

I. Introduction:

Arboviral and other arthropod-borne diseases are those 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 a given time, we will focus this document on five viruses of concern here in North Texas. The agents of concern currently include West Nile virus (WNV), St. Louis encephalitis virus (SLEV), chikungunya virus (CHIKV), dengue virus (DENV) and Zika virus (ZIKV). Due to the nature of these diseases, WNV and SLEV can be discussed together as zoonotic diseases which are shared between animals and humans, whereas CHIKV, DENV and ZIKV can be discussed together as epidemic diseases that are shared among humans. The content of this document is subject to change dependent upon the most current information and potential upcoming events. Tarrant County Public Health (TCPH) staff conducts surveillance for the presence of WNV and SLEV by studying, surveying, sampling and testing local *Culex* populations in Tarrant County. The presence of CHIKV, DENV and ZIKV will predominantly be determined by the presence of these viruses in the human population; however, the presence and abundance of *Aedes aegypti* and *Aedes albopictus* will be surveyed to help determine high risk areas. Additionally, illness due to Yellow Fever may still be a risk to Americans because most Americans are not vaccinated for Yellow Fever, and populations of *Aedes aegypti* exist and flourish in Texas. Tarrant County Public Health recognizes that though there is a vaccine for Yellow Fever there is still a risk for this disease. Responses to a possible outbreak of Yellow Fever would be similar to that of CHIKV, DENV and ZIKV with the addition of vaccine intervention.

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 both in humans and in other animals. Approximately 80% of people who acquire these viruses will not experience symptoms. Of the twenty percent who do, roughly one percent will develop serious symptoms. WNV was first isolated in a febrile patient in the African country of Uganda circa 1937 (Smithburn et al., 1940). After the first appearance of WNV in the in New York City in the summer of 1999, it spread west and eventually reached north Texas in 2002 (AAM, 2013). Both West Nile virus and St. Louis encephalitis virus are predominantly carried by mosquitoes found in the *Culex* genus. The primary vector of these diseases in North Texas is known to be *Culex quinquefasciatus* (Ward, 2002). *Culex restuans* and *Culex nigripalpus* have also tested positive for WNV and are considered secondary vectors. Therefore, much of this program will target surveillance and control of these disease-carrying mosquitoes. Other species of *Culex* that may be possible 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 the first full week of April 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 mosquitoes over-winter as adults and are virtually inactive at times of cold temperatures (Strickman, 1988). Minimal surveillance will be conducted when temperatures remain consistently low (below 8°C/46°F). 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 and cannot acquire the virus from a human or horse which is infected with WNV or SLEV. This is due to the low number of viral particles in our bloodstreams. After a period, 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. Tarrant County Public Health continues to assess the possible establishment of thresholds to determine mosquito control activities. These thresholds may include mosquito infection rates, vector indices, abundance of mosquitoes, weather patterns, and timing/rate of increase of mosquito positivity (see section III).

B. Chikungunya virus, Zika virus, and Dengue virus

Chikungunya virus (CHIKV), Zika virus (ZIKV), and dengue virus (DENV) are three arboviruses that are a potential threat to people living in North America. All three viruses share the primary vector, *Aedes aegypti,* and a potential 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 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 has been noted to happen periodically on the Texas-Mexico border (Rodrigues-Tan and Weir, 1998).

Like dengue virus, Zika virus is in the family *Flaviviridae*. Symptoms from acquisition of this virus are also similar to CHIKV and DENV. Most cases result in a maculopapular rash (flattened raised red patches) on the torso, joint pain and conjunctivitis. Symptoms are believed to be less severe than that of CHIKV and speculated to be manifested by roughly 20% of people who acquire the virus. Guillian-Barre Syndrome and encephalitis-like diseases have been associated with Zika in a very small percentage of the people who have developed Zika-related illness. Deaths associated with Zika virus are rare. The cause of major concern with the spread of Zika is the effects it has on fetuses if women are infected during pregnancy. In April of 2016, CDC scientists announced that Zika can cause microcephaly and other severe fetal brain defects (Rasmussen et al, 2016). Microcephaly can be defined as a condition where a baby is born with an abnormally small head, likely due to the under-development of the brain. For more information on microcephaly, visit:
https://www.cdc.gov/ncbddd/birthdefects/microcephaly.html

Pregnant women should avoid travel to places where Zika is being transmitted. Most cases of Zika-illness in the United States are related to international travel. In 2016, two outbreaks of Zika occurred in the intercontinental US in Miami, Florida and Brownsville, Texas. Additionally, there were four cases of Zika in Hidalgo and Cameron Counties in 2017. Though most cases of Zika are transmitted through the bite of an infected mosquito, it may also be transmitted sexually.

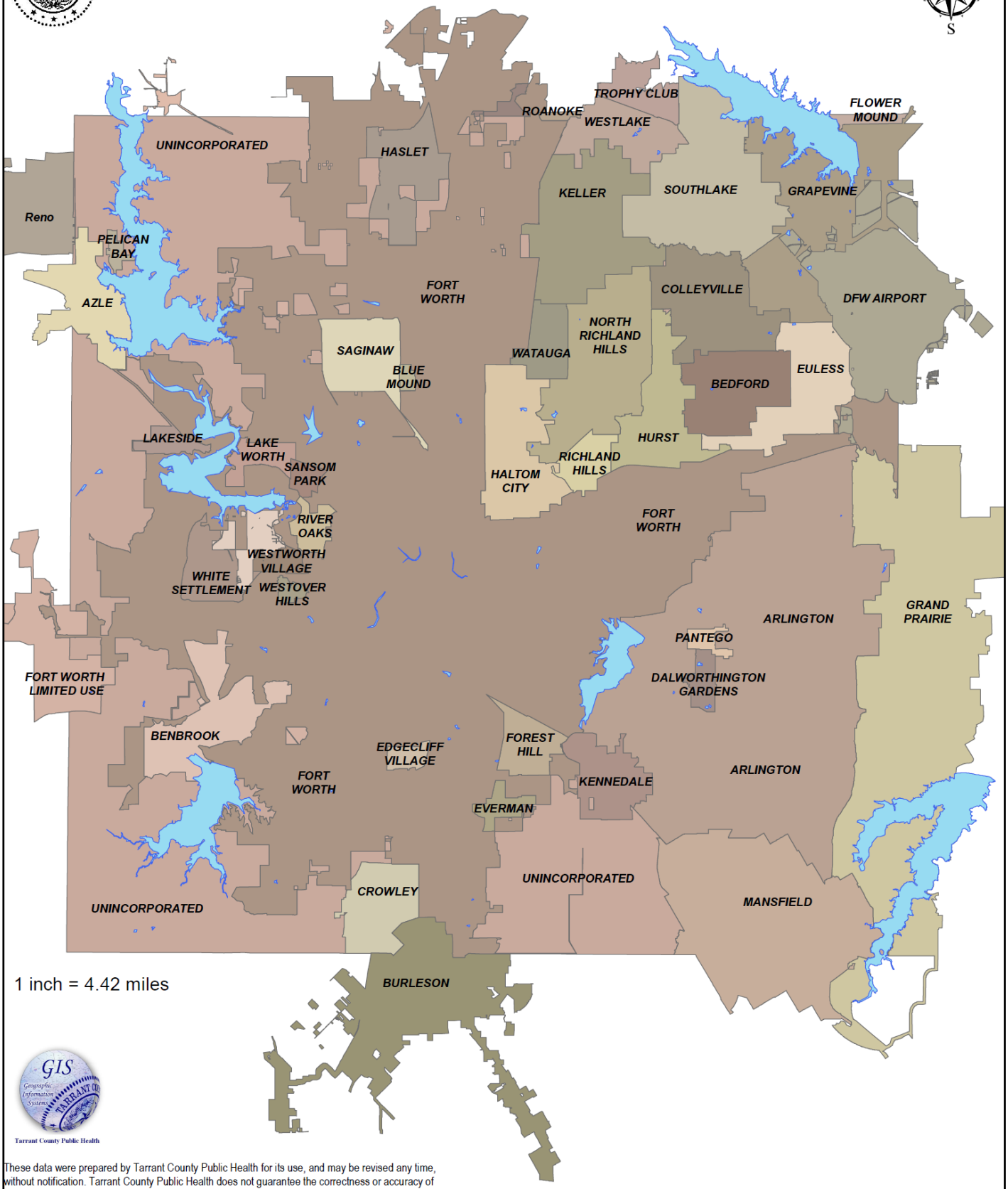
All three of these viruses are transmitted by mosquitoes in the genus *Aedes,* subgenus *Stegomyia*. These mosquitoes are unlike those found in the *Culex* genus because that they are diurnal (active during the day), overwinter as eggs, and predominantly take bloodmeals from humans. Surveillance of these mosquitoes will take place during the in-season WNV/SLEV surveillance at TCPH (see section A.) utilizing BG Sentinel traps baited with CO_2. Surveillance of these mosquitoes will only be utilized to find potential problem areas and not for surveillance of these viruses since there is no autochthonous transmission and humans are the current preferred sentinel.

II. Tarrant County management area description

Tarrant County Public Health vector control staff (TCVC) is responsible for all areas of unincorporated Tarrant County. TCVC will also provide assistance and recommendations to incorporated entities within the county who participate in the program.

Figure 1. Tarrant County Region

Tarrant County Mosquito Surveilance Region, 2021



1 inch = 4.42 miles

Tarrant County Public Health

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Date: 03/01/2021

III. Surveillance for arboviruses and arboviral disease

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

Surveillance for WNV/SLEV in the local mosquito population enables TCVC to assess the risk of transmission to humans through 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 guide: Guidelines for Surveillance, Prevention and Control. Mosquitoes will typically test positive for WNV/SLEV before human cases appear.

Tarrant County Vector Control (TCVC) staff will trap adult *Culex* mosquitoes in unincorporated portions of Tarrant County (for more information about trap location, see Appendix A). Cities may collaborate with TCVC by trapping adult mosquitoes at chosen locations within their city. There are greater than 200 static trap locations around the county. Each entity will be expected to perform certain duties as stated in the following protocol:

Tarrant County Vector Control will supply traps, bins, nets, batteries and delivery containers based on population/size of city. They will also perform maintenance on these traps during the winter season.

i. Seasonal surveillance

A. Collaborating cities will be expected to: Brew gravid water that consists of 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 mosquito surveillance forms (including if no mosquitoes were captured) to Environmental Health Division room 2300 (vector control room) no later than 24 hours prior to date of testing. If all traps set yield no mosquitoes, paperwork may be e-mailed to mosquitoinfo@tarrantcounty.com or faxed (with attention: vector control) to (817) 321-4961.

B. TCVC 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) Bioterrorism Response and Emerging Agents (BREA) section no later than 10:00 AM on predetermined date to be tested.

C. BREA will: Store frozen samples until ready for processing, 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 TCVC on the same day or early the following morning. Mosquito samples will typically be tested on Mondays, Tuesday, and Wednesdays barring holidays and special circumstances.

D. TCVC will: Notify municipalities of any mosquito pools that test positive for WNV or SLEV via telephone and secondarily via e-mail. All results will be received via e-mail. TCVC will also complete the internal notification (see appendix B). Locations and results of WNV/SLEV trap sites will be added to the Tarrant County website by vector control personnel or designee before receiving results, but results will not be posted on the TCPH website until the day after receiving results from the lab to allow for the municipalities to properly notify their personnel/public.
E. TCVC will: report positive mosquito pool results to Texas Department of State Health Services (DSHS) once/week on Fridays barring unforeseen circumstances.

ii. Off-season surveillance

A. Collaborating cities will be expected to: Brew gravid water with grassclippings/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 Fahrenheit (Strickland, 1988), and deliver mosquitoes and completed paper work (including if no mosquitoes were captured) to TCVC room 2300.B.
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.West Nile virus and St. Louis Encephalitis Virus Risk Assessments

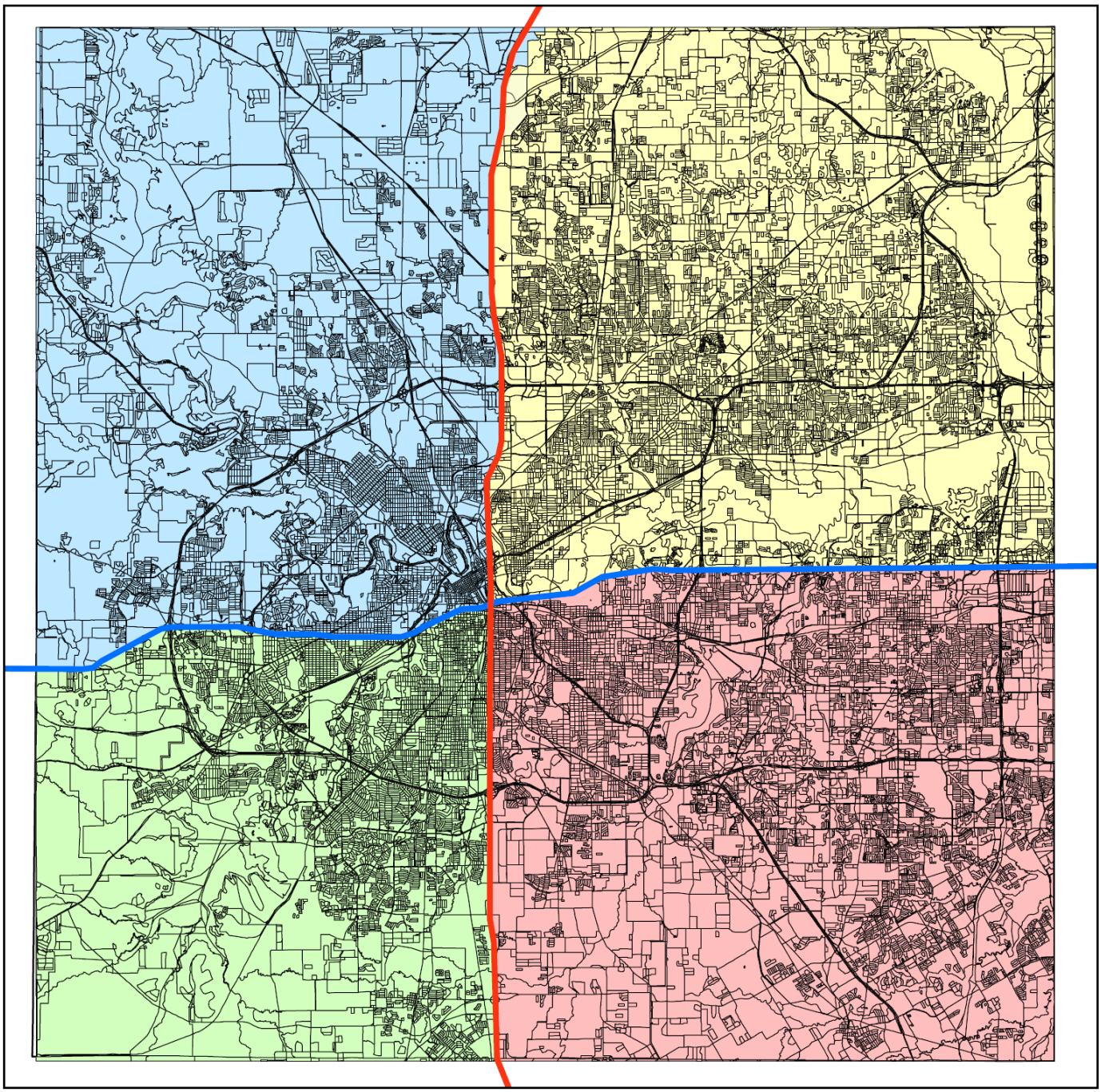
iii. Quadrants

Tarrant County is approximately 902 sq miles; 864 of which are land, and 39 arewater. It is common to report risk for the entire county; however, this is not a helpful way to report risk to specific areas. There are many ways to break up a county. In general , the more data that can be collected more areas, the better.However, this is not something that works well in the real world. In Tarrant County, we are bound by sample size based on how many samples can be passed through our laboratory on a weekly basis which is limited by funding, resources, equipment and personnel. Traps have been distributed throughout the county based on human population density since we are looking at the risk associated with people acquiring a disease. It is also option for cities to participate in this program. To keep our error rates low and have a somewhat robust sample size, the county has been broken up into quadrants. These quadrants range from trap quantity anywhere from 25 traps per quadrant in the southwest, which is more sparsely populated, to around 75 in the northeast quadrant, which is the most densely populated. To help quell the unevenness of this scenario, Tarrant County will consider testing more

pools from each trap out of the SW and NW quadrants, but this will only happen, when the abundance is somewhat high. Tarrant County has been divided up into quadrants using I35W as the north/south running dividing line and I30 as the east/west dividing line.

Figure 2. Tarrant County Quadrants

Tarrant County, Texas



0 2.5 5 10 Miles

IH 35W Line
IH 30 Line
NE quad TC 2010 census
NW quad TC 2010 census
SW quad TC 2010 census
SE quad TC 2010 census

Total 2010 Population:

NE = 634,388
NW = 278,328
SW = 304,993
SE = 615,191

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iv. Infection Rates

An infection rate may be related to either people or mosquitoes within a population. When the infection rate is calculated in a human population, it is usually given as a value per 100,000 people. This is known as the incidence rate (IR). For example, if Tarrant County Division of Epidemiology reports 25 cases in a certain quadrant of the county, that 25 is first divided by the total population of that quadrant (like 306,000 for example), and then multiplied by 100,000 (this would be stated as 8.17 people infected per 100,000). For mosquitoes this is calculated a bit differently, but using similar concepts. Since mosquitoes are tested in pools between 1 and 50, they are typically reported as the number of WNV positive pools/total number of mosquitoes tested. This is known as the Minimum Infection Rate (MIR). This leaves a bit of uncertainty in the calculation. Since there are anywhere from 1 to 50 mosquitoes in each pool we must make and limit the assumption that only one mosquito is positive in the pool. Since this may *not* be the case, it seems prudent to point out that there *may be* multiple mosquitoes that are testing positive within the pool. This is impossible to know. Though it would be most accurate to test every mosquito by itself, it is not efficient. The RT-PCR test that is utilized is qualitative rather than quantitative. This means that positive test results determine if the virus is present, but not the quantify how *much* virus is present. Even if the PCR test were quantitative, the level of virus may vary depending on when a positive single mosquito was infected as to when it was captured, and how many body parts of that mosquito(s) made it into the test tube. Therefore, using cycle threshold values to determine how many mosquitoes are infected is impossible. It should also be noted that even if a mosquito tests positive for WNV, it is not known if the mosquito would have been able to transmit the virus. For example, since RT-PCR is simply looking for the presence of the virus above a certain Ct value, it cannot distinguish WNV that is present in a mosquito blood meal rather than present in mosquito salivary glands. Because this is the case, though rare in gravid traps, staff are encouraged to avoid placing freshly blood-fed mosquitoes in tubes during processing. The ability for a mosquito to transmit the virus is usually determined by experimentally infecting mosquitoes, allowing them to feed on a susceptible host and later testing the host for illness and viral presence in blood (HC Barnett 1960)..

As mentioned in the previous section, the number of infected mosquitoes in a positive pool greater than one mosquito is uncertain. Because this is the case, it is more accurate to utilize the maximum likelihood estimate (MLE). The Microsoft ® Office Excel © Add-In PooledInfRate, Version 4.0 by Brad Biggerstaff is used to calculate the MLE for mosquitoes in each quadrant in Tarrant County as well as the whole county. The MLE helps weigh the mathematical differences between the probability of more mosquitoes being positive in a pool of 1 vs a pool of any other number by placing heavier weights on pools of mosquitoes with lower numbers. MLE is currently the most accurate way of calculating infection rate with mosquito data and what Tarrant County uses to determine the infection rate.

v. Vector Index

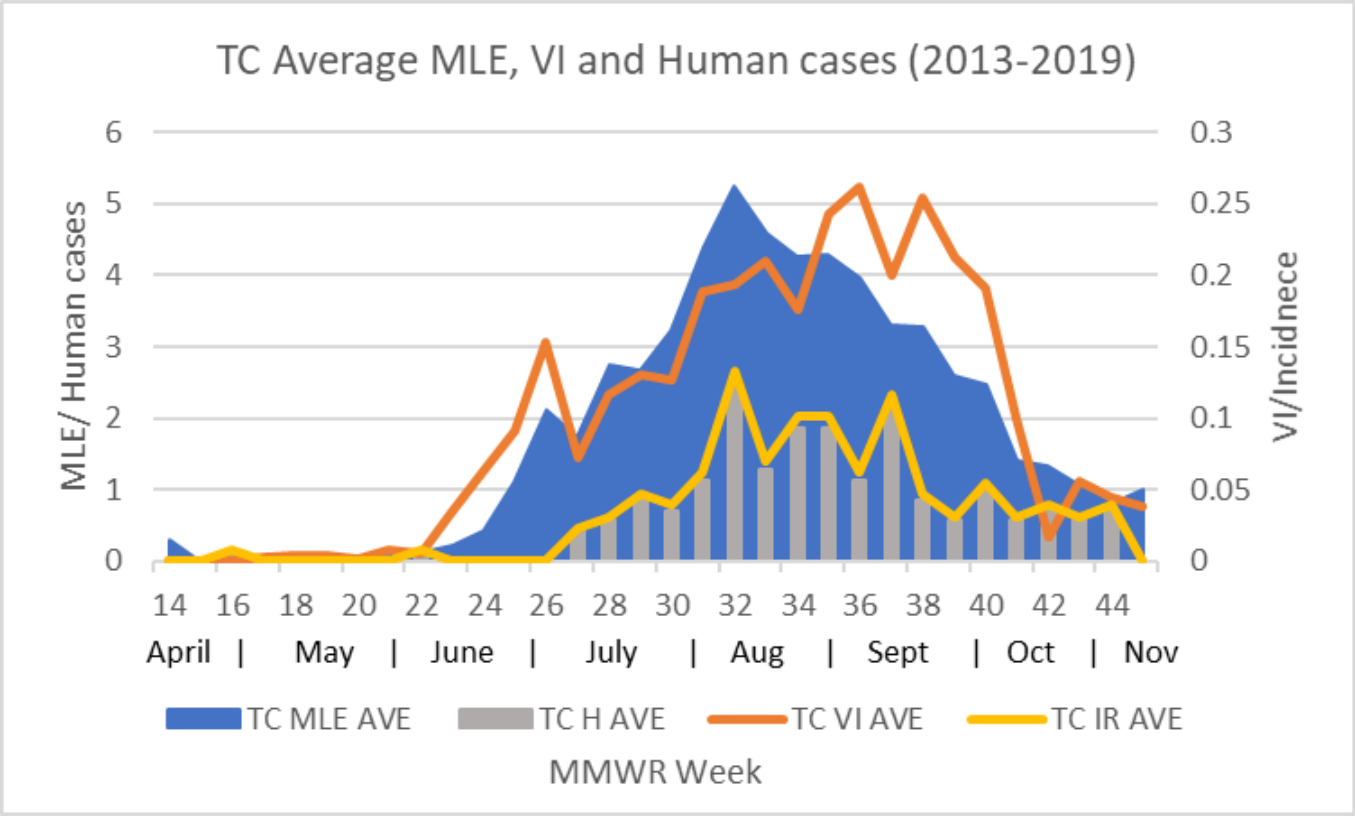
Another calculation used to calculate risk of acquiring WNV is the vector index (VI). The VI is most simply the MLE multiplied by the average number of mosquitoes per trap. Vector indices do not only incorporate the infection rate, but also incorporates the size of the population of mosquitoes. When no biases are present, it is expected that the larger the population of mosquitoes present in a given area, the more mosquitoes will be captured in a trap. This may be easily misinterpreted. It should be cautioned here that we utilize gravid traps to look for viral infection, not for the abundance of mosquitoes. Though it may be true that the larger the population of mosquitoes, the more mosquitoes would end up in a trap, it should be mentioned that gravid traps only capture gravid mosquitoes, rather than all mosquitoes. Carbon dioxide bated CDC light traps target host seeking mosquitoes. Removing the light bulb from the trap may yield a greater number of *Culex* mosquitoes. Regular sampling with this trap type can establish a base line for host seeking mosquitoes in the area. Light traps may be used post treatment event to determine the effectiveness.

vi. Thresholds

Many believe that thresholds are a good decision-making tools to answer questions like should adulticiding commence? Or is the risk to West Nile disease so great that aerial applications should take place? These are valid questions that are difficult to answer. It is rare that trends of positivity in the mosquito population lead to the same results in the human population every time these data are analyzed. Ergo, setting thresholds in stone is not recommended. Risk to acquisition of human disease is complex. One needs to consider the time of year in which things are happening. West Nile activity in mosquitoes in Tarrant County is variable, but there are “what happens most often”. Most often mosquito activity ramps up in later March when the weather is most typically warming up and overnight lows are above 40 degrees Fahrenheit. April is when our season of regular testing starts. Most typically we observe *Culex restuans* during this time. It isn’t abnormal to get a few overwintered positive WNV samples early on in the season. It would be abnormal to get more than a few per week. During late May is when our main vector *Culex quinquefasciatus* populations start building and we expect West Nile virus activity to start becoming more normal. WNV is usually at its peak of activity around weeks 29 through 32 or late July through early August. After August, activity should gradually wane until freezing temperatures arrive in late November. This being stated, one can categorize risk probability differently throughout the season.

Below is a graph of cumulative human and mosquito data over the course of several seasons from 2013 through 2019. The strip of color below shows the general trend of when risk moves from lowest to greatest throughout the season

Figure 3. Tarrant County Average MLE, VI and Human Case (2013- 2019).



Risk level	
Very low	
Low	
Med	
High	
Very High	

Though the multicolored bar represents the typical risk for seasons over time, every season must be looked at individually. There have been some years where the rise of activity happens earlier in the season, like in early July. This is more worrisome than when the heavier risk starts later in the season. Seasons are finite, and the risk will eventually subside, but when heavier risk comes earlier in the season, there is a greater probability that the heavier risk portion of the season will last longer than usual. Other risks that should be taken into consideration include the activity from previous years. If there are multiple years with little to no activity, one must assume that the local bird population immunity has declined. It is figured that birds develop life-long immunity (Nemeth et al. 2009). Birds develop immunity through acquisition of the virus after a period of time. Once an immune bird dies, it

will eventually be replaced by a susceptible bird. This will eventually lead to less birds in the population having immunity and increases the probability that a larger proportion of birds within the population will be able to spread the virus. When these risk probabilities are taken into consideration, the best-case scenario would include a year with medium viral activity within the bird population to keep a large proportion of birds immune to the virus for future seasons. The worst-case scenario would be a year where increasing viral activity starts exhibiting early in a season preceded by multiple years with little to no activity. There may also be rainy weather that may contribute to mosquito abundance. There may be a dry spell where mosquitoes and birds are more likely to interact in limited water holes (Shaman et al., 2005). Human behavior may also play a part. Are people regularly wearing repellent? Is it so hot that people are going outside less often? How high is the density of the human population? Are people contributing to increased mosquito breeding conditions? Are people educated about how to prevent mosquito breeding/biting? Are people leaving their windows or doors open during times of the evening when mosquitoes may seek shelter in their house? Other risks may include weather. Was the winter season warmer than usual, resulting ina larger number of overwintering mosquitoes survived the winter? Have windy conditions blown in a migratory bird that is viremic for West Nile virus? Has there been a bust in the bird population (which may or may not be susceptible) therefore increasing the number of mosquitoes that are feeding on the same bird? This is why there are no solid answers, and no solid thresholds, but predictable possibilities that may happen upon certain weather, immunity, and behavior trends.

All of this being said, there *are* some threshold suggestions that we can take into consideration. Throughout the past 8 years, there are risk numbers that do not happen often that indicate a looming outbreak. It is atypical that 30% or more of mosquito pools within a certain quadrant will test positive for more than two consecutive weeks within a season (especially early on). It is atypical that the MLE is greater than 13. It is also atypical that the vector index remains above 0.5 for more than one week during the season. When all three of these risk indicators happen at the same time, Tarrant County will prepare for aerial treatment.

B. Dengue virus, Zika virus, and chikungunya virus surveillance in mosquitoes and surveillance for *Aedes* mosquitoes

Surveillance for CHIKV, ZIKV and DENV in mosquitoes will only happen on a case by case basis where one of these viruses 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 these viruses cycle in the environment, strictly between humans and mosquitoes, 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. Tarrant County Public Health and municipalities within Tarrant County deploy BG Sentinel traps to monitor the populations of *Aedes aegypti* and *Aedes albopictus*. Static trap locations have been chosen based on human population density and breeding habitat availability. BG Sentinel traps with the addition of dry ice should also be placed at suspect case addresses during warmer seasons (during the WNV in-season period). TCPH has distributed BG Sentinel traps for the surveillance of *Ae aegypti* and *Ae*

albopictus mosquitoes to our municipalities. Results of BG Sentinel traps will be turned in with gravid trap samples and results will be returned with gravid trap results. It is important to keep these traps in static locations to monitor these mosquito populations over time.

i. Mosquito surveillance and control near imported cases

Suspected imported case of CHIK, Zika or dengue fever will be determined by the Division of Epidemiology at TCPH. Suspect imported cases must have a travel history that includes a country in which CHIKV, ZIKV and/or DENV are endemic, 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 personnel to inspect the property of the patient for sources of *Aedes* breeding and to determine subsequent mosquito control activities. It is anticipated that municipality personnel will be able to handle complaints independently after a few inspections. Permission forms should be utilized to enter private residences (Appendix D). Personnel conducting the inspection will record observations on the backyard mosquito checklist (Appendix E). It should be noted here that risk is determined by, but not limited to a number of factors including, the viremia of the patient while they were present in the county, the number of vector mosquitoes found on or near the property, the use of and type of repellents utilized during the viremic period and/or reports of patient outdoor activity/reports of being bitten by vector mosquitoes. BG Sentinel traps should be deployed with the addition of dry ice for a twenty-four hour period during times where *Ae aegypti* and *Ae albopictus* are known to be active (typically from May to November) to monitor risk to adult mosquitoes. BG Sentinel trap samples should be brought to Tarrant County vector control staff the day follow trap placement where vector control staff may be able to make risk assessments on a case-by-case basis. Adulticiding the patient residence and all adjoining properties may be recommended where high risk is determined to be present along with larvicidng and education to all residences within a 150 meter radius. Handing out repellents including *N, N*-diethyl-*meta*-toluamide (DEET) and properly labeled larvicides within the neighborhood may also be encouraged. All larval source containers should be overturned or treated with the appropriate larvicide. Upon observation of adult mosquitoes, adulticiding should be considered. Adulticiding may include thermal fogging or residual spray to surrounding resting areas (low-laying non-flowering plant life and eves). Treatment of flowering plants should be avoided to minimize exposure to non-target insects. ULV targeted backpack application is not recommended in the daytime due to a lack of inversion layer where the chemical will evaporate and be ineffective. The placement of a post-treatment BG Sentinel trap is recommended to monitor effectiveness of treatment. This data should be reported to TCPH for data collection purposes. 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/DENV/ZIKV fever. Once an autochthonous case is confirmed, both the Texas Department of State Health Services and the Centers for Disease Control and Prevention will be notified and consulted. 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 150 meter radius around an autochthonous case, or the approximate flight range of *Aedes aegypti* and *Aedes albopictus* (PAHO, 2011). BG Sentinel traps will also be placed within a 150 meter of the human case to monitor the local mosquito population. Control measures should remain similar to that of imported cases.

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 WNV or SLEV case, the Division of Epidemiology will notify a designee in Vector Control. In compliance with the Health Insurance Portability and Accountability Act (HIPAA), information regarding human cases will not be released on the interactive mapping website. Vector Control staff will report an intersection nearby the human case to the municipality where the case resides and TCPH recommends setting additional gravid traps near this area to test additional pools of mosquitoes for WNV/SLEV. This is recommended due to the nature of acquisition not being isolated to the patient's home and also to help protect HIPAA information in reasons to treat.

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 expensive and labor intensive.The home range of a birdmay 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 the municipalities in Tarrant County, 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.

*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.

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 one year 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 at least once per calendar year prior to the beginning of in-season WNV/SLEV surveillance. For a list of equipment and pertinent documentation see Appendix C. TCPH also has contracts in place for assistance with mosquito surveillance (trapping) and mosquito control activities (aerial and ground based) in cases where vector control staff are needed for other situations, or when vector control staff is overloaded.

A. Larval mosquitoes

Larval surveillance is important in any integrated mosquito management program. Vector Control is to be conducted in unincorporated Tarrant County. 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(s) will be determined on the estimated density and species (e.g. pest to humans or not). All treatments will be numbered and recording in the TCPH larviciding database. This will ensure proper record keeping in case of routine audits by Texas Department of Agriculture and ease of retrieval upon request of treatment sites by the public. Treatment for larval mosquitoes will happen year-round.

Reducing, eliminating, and treating mosquito breeding sites are some of the most important aspects of a mosquito control program. These methods control 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 aquatic stages of mosquitoes. 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 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. A record of the quantity of fish given and which city is asking for the fish will be maintained for stocking purposes.

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. Since 2015 these have included gravid traps, CO_2- baited light traps and BG Sentinel traps. Some limited resting collections and

New Jersey Light trap data is also included. 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. TCPH continues to collect data to be able to establish infection rate and vector indices threshold range that will help aid in adulticiding activity, but until these relationships are firmly established vector control personnel or accepted contractors will continue to 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. Upon evidence of elevated risk, such as a year preceded by multiple years of inactivity, areas around positive trap sites may be treated for two consecutive nights without consecutive positive samples. Research has shown that treating areas for multiple consecutive nights is more efficient than just one night. (Andris et al. 1987). Areas to be treated should be approximately a one-mile radius from a trap site. The size of this spray area is according to the flight range of *Culex quinequefasciatus* mosquito. If an area continues to test positive for WNV and/or SLEV after it has been treated, TCPH will elevate this response to adulticiding multiple 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 andthephased response plan for Tarrant County.

One more item to mention here is the effectiveness of a ULV control event. People may be tempted to utilize the abundance of gravid mosquitoes in their gravid traps before an adulticiding event as compared to after an adulticiding event. It should be mentioned here that adulticiding events target mosquitoes that are "on the wing" or actively flying around. Female *Culex* would be predominantly on the wing while host seeking or getting ready to lay eggs. Because this is the case, it should be pointed out that gravid traps only target those mosquitoes that are ready to lay eggs (and therefore have been resting for a few days while eggs develop). Measuring abundance of gravid females in gravid traps is not the best way to assess how effective treatments are for adult *Culex*. One should consider assessing control measure based on abundance in CO2 baited light traps without a lightbulb or other host seeking traps, and also consider the age structure of the population. These methods may be difficult to assess, but will be considered by Tarrant County as options of measuring effectiveness aside from a reduction of human cases.

C. Resistance management

Tarrant County Public Health uses integrated mosquito management techniques meant to avoid insect resistance to the pesticides we use in our program. 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 previously tested field captured mosquitoes in various laboratories when opportunities became available. TCPH set up an adult mosquito resistance laboratory late in the year 2020. This lab is located offsite within Tarrant County Resource Connection. All species of mosquito will be tested separately for each individual pesticide utilized in each select area. The method of determining resistance currently includes conducting CDC bottle bioassays. Initial staff training was provided by CDC personnel. CDC SOPs and protocols are followed and can be found here: https://www.cdc.gov/malaria/resources/pdf/fsp/ir_manual/ir_cdc_bioassay_en.pdf There are three phases to set up this resistance lab. Phase one consists of being able to test field captured mosquitoes for select pesticide resistance. Phase two includes maintaining susceptible mosquito colonies of various species to be tested. Phase three consists of the ability to perform caged resistance tests in the field using actual ULV equipment. TCPH has currently completed phase one of resistance lab set-up. Locations to be tested will be prioritized based on the number of treatments that are made historically as staff is very limited to be able to perform these labor intensive tasks. 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. It is recommended that municipalities consider testing their mosquito populations when these services are not available through TCPH.

V. Education, outreach, and media

Educating the public is an essential aspect of the arboviral surveillance program in Tarrant County. This includes giving the public tips on how to control mosquitoes in their homes and yards, stating the risks and symptoms of these arboviral diseases and informing people on how to protect themselves from host-seeking female mosquitoes. To educate the public, vector control personnel with the help of Medical Reserve Corps (MRC) volunteers 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 and trained MRC volunteers are also 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 host an Arboviral Surveillance Program Kick-off meeting before the start of the WNV/SLEV season, where vector control personnel discuss the past year, review cumulative progress of the program and assess the program based on suggestions from municipalities. Vector control personnel 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 work with our Public Information Officers (PIO)s to create original pamphlets, fliers, and other educational materials. These materials will be available for the public visiting Tarrant County Public Health as well as on the TCPH Website.The PIO handles official press releases, ground treatment notifications, social media blogs, and other media involved items. Our PIO is also responsible for education campaigns, such as “Be Mosquito Free” and for the production of educational videos for the public about mosquito control.

VI. Mosquito complaints

If mosquito breeding is suspected on any property within unincorporated Tarrant County, vector control personnel will conduct a thorough investigation of the suspect property. Complaints are filed as an investigation request and tracked in the TCPH larviciding database for the Vector Control Department. After they are entered into the TCPH larviciding database, 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 remedies and contact the complainant (if listed) to give an update of complaint status. All complaints will be numbered in consecutive order in which they are received. Any required treatment will be referenced in the complaint. 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 choose trap locations based on sources of standing water, usually the places to hold 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. Trap locations are updated to maximize coverage of the unincorporated portions of the county (2016). 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. Mosquito Management areas are based on a one-mile radius from the trap location in the unincorporated area.

Figure 4. Locations of in-season gravid trap locations in west Tarrant County.

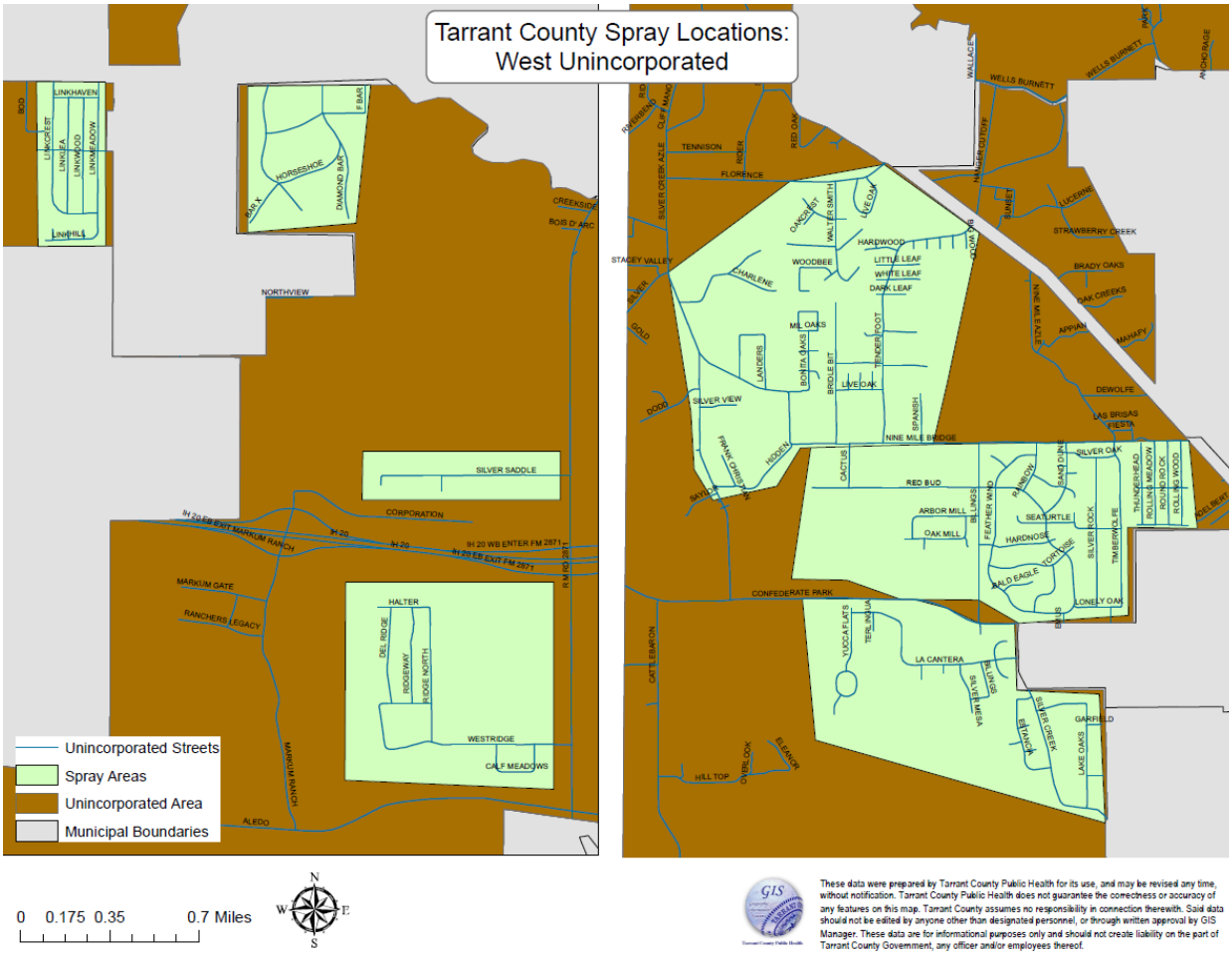


Figure 5. Locations of in-season gravid trap locations in south west Tarrant County.

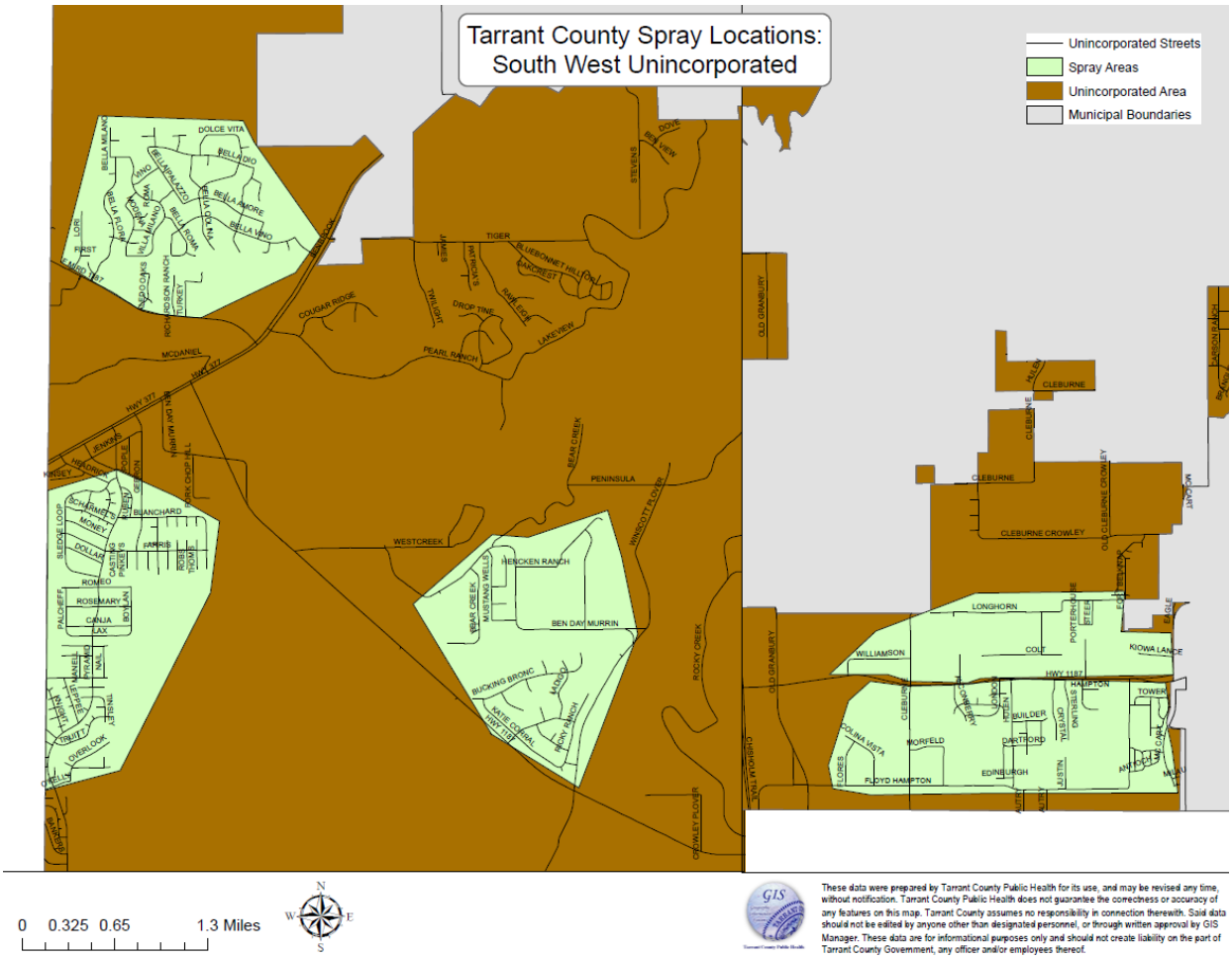


Figure 6. Locations of in-season gravid trap locations in south east Tarrant County.

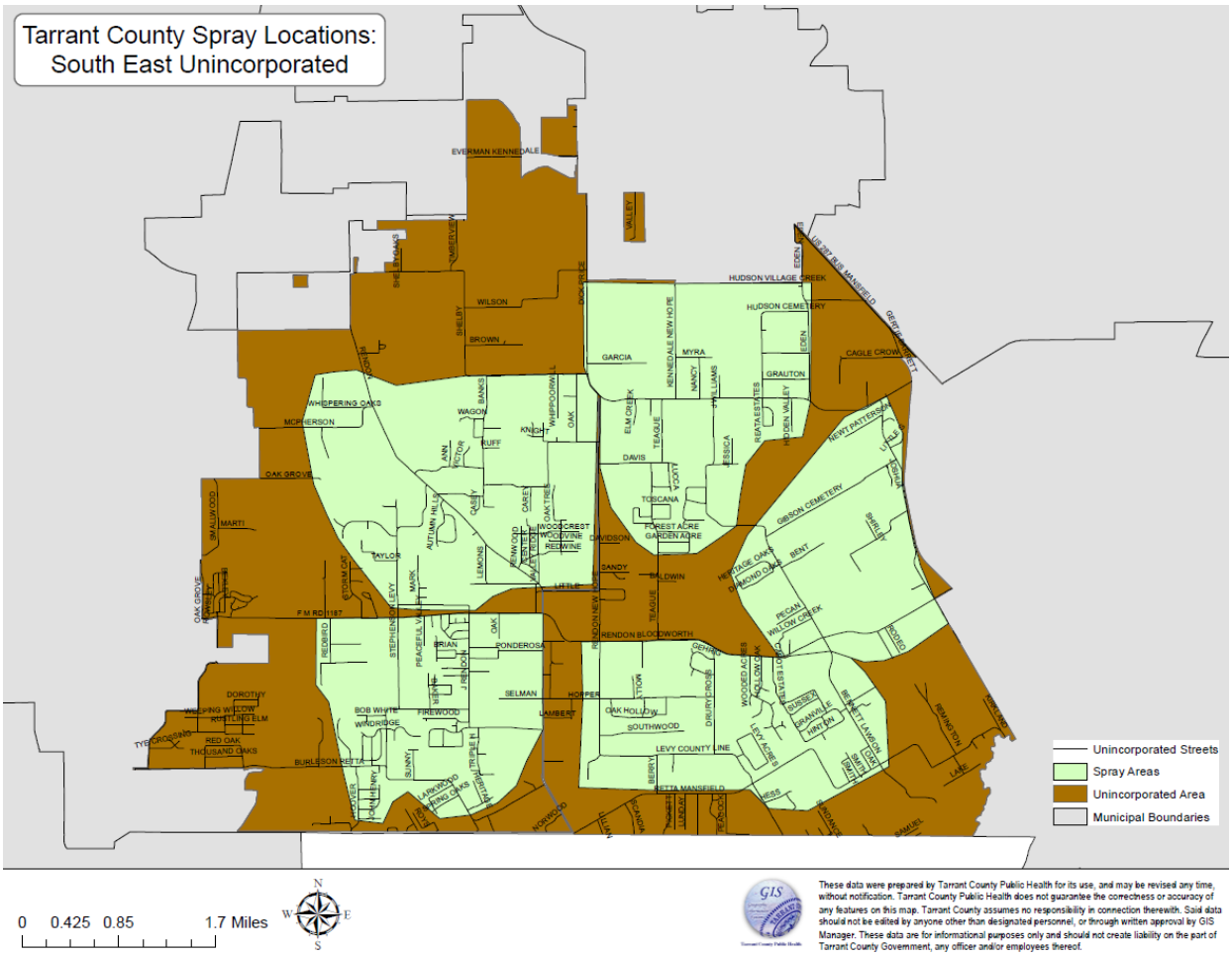


Figure 7. Locations of in-season gravid trap locations in north west Tarrant County.

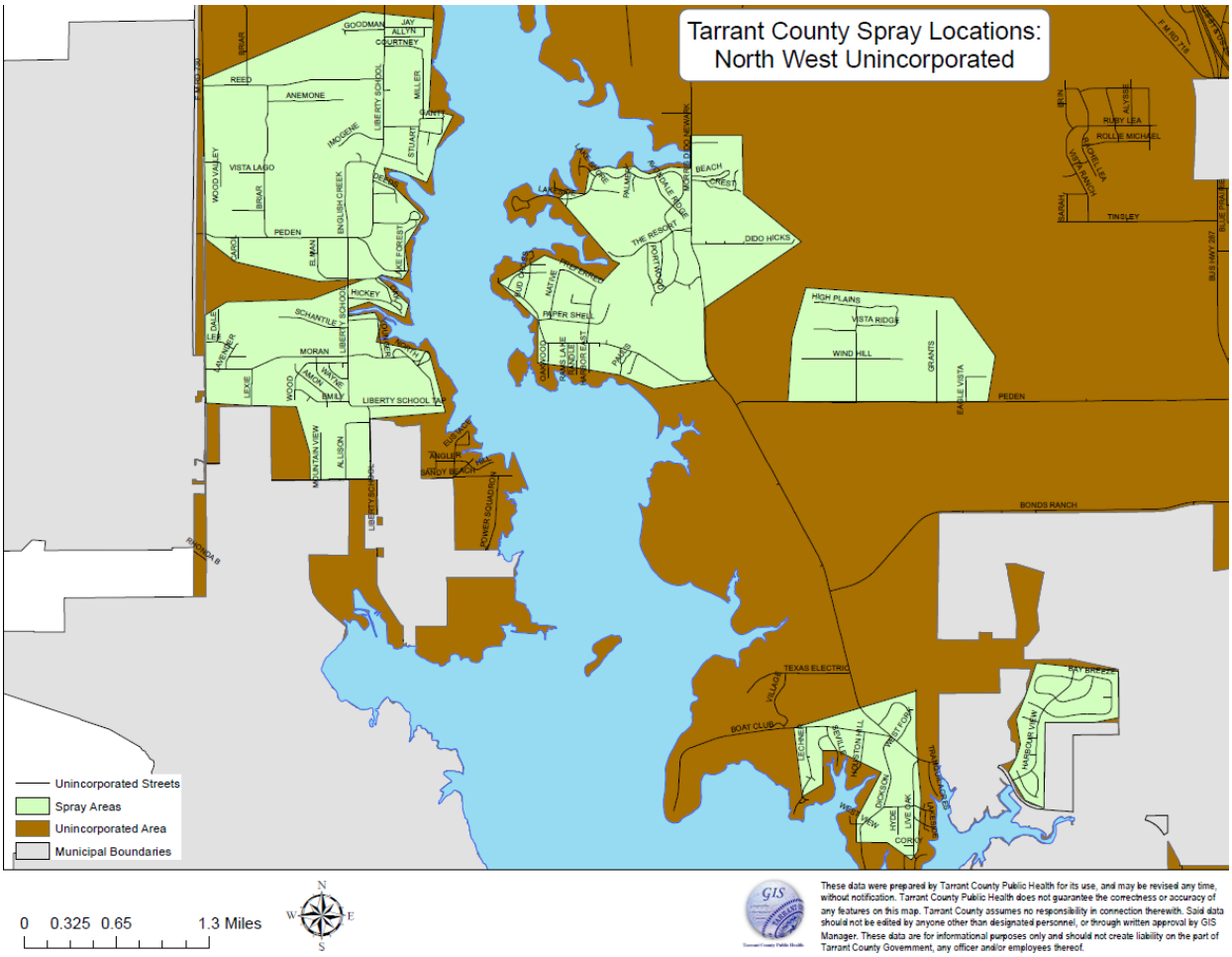
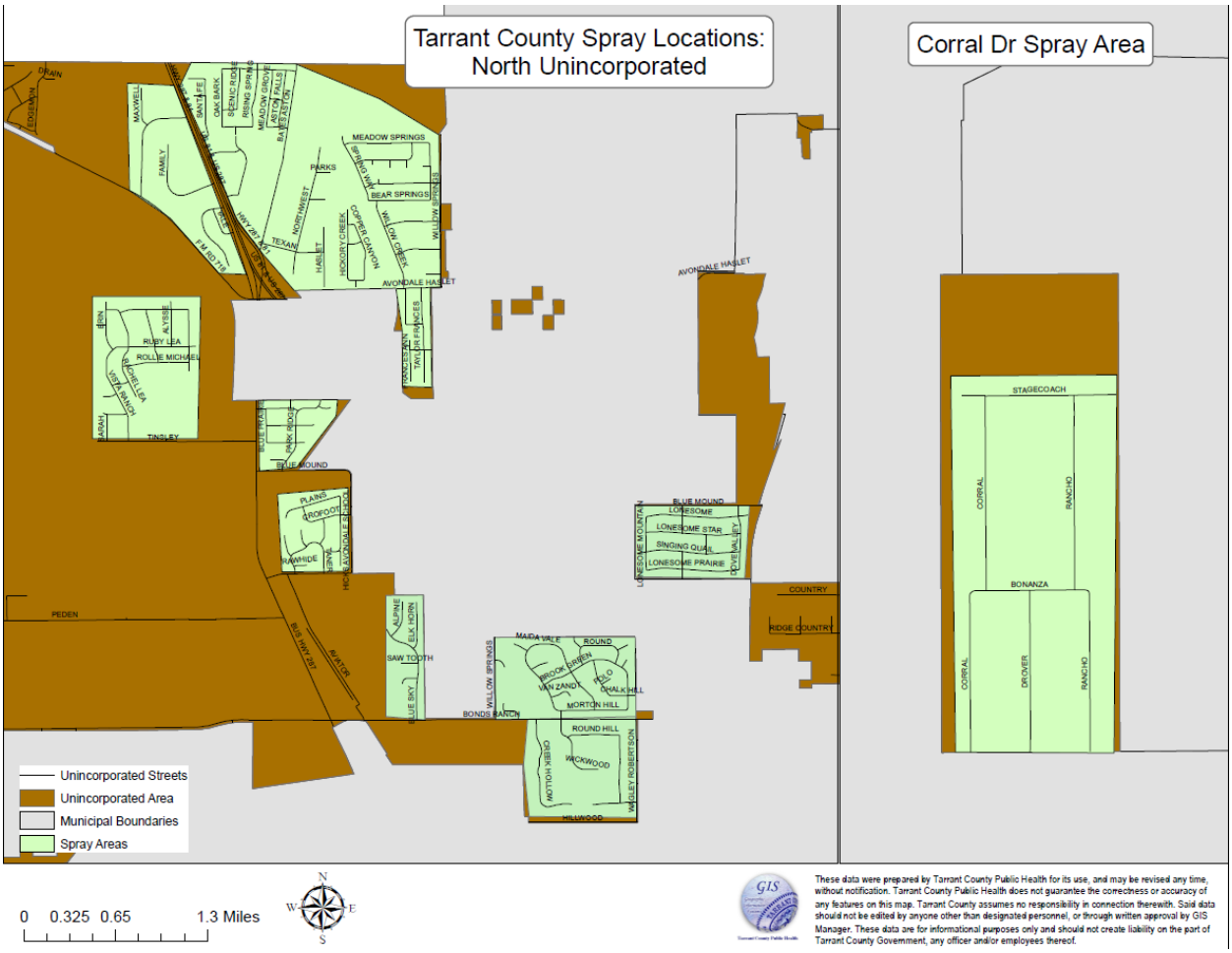


Figure 8. Locations of in-season gravid trap locations in north Tarrant County.



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. When a sample tests positive in the unincorporated area of Tarrant County, the vector control supervisor or designee will notify the associate director over EHD. Information will include all unincorporated areas and a summary of all positives in the Tarrant County region. This information will also be sent to various administrators of the county, Emergency Management folks, Public Information Officers, and other pertinent internal personnel who may be involved in relaying the message that we will be adulticiding. The Public Information Officers will post pertinent information on social media and Tarrant County related websites. Vector Control staff will post information such as treatment announcements and adulticiding area maps to the interactive map located on the Tarrant County Public Health web page.

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.

Piggy-backing on Tarrant County Contracts

Municipalities may “piggy-back” on Tarrant County contracts (Request for Bids or Request for Proposals (RFP)s) if they are included in the Tarrant County cooperative agreement list. Information on how to be added to this list is included here:

http://www.tarrantcounty.com/en/purchasing/cooperative-purchasing-information.html?linklocation=Iwantto&linkname=Cooperative%20Purchasing

Info on RFBs/RFPs may be included here: http://www.tarrantcounty.com/en/purchasing/bids---rfps/bid-rfp-awards.html?linklocation=Iwantto&linkname=Bid/RFP%20Awards

If the information that you're looking for is not located on the above links, contact the Tarrant County Purchasing Department during their business hours:

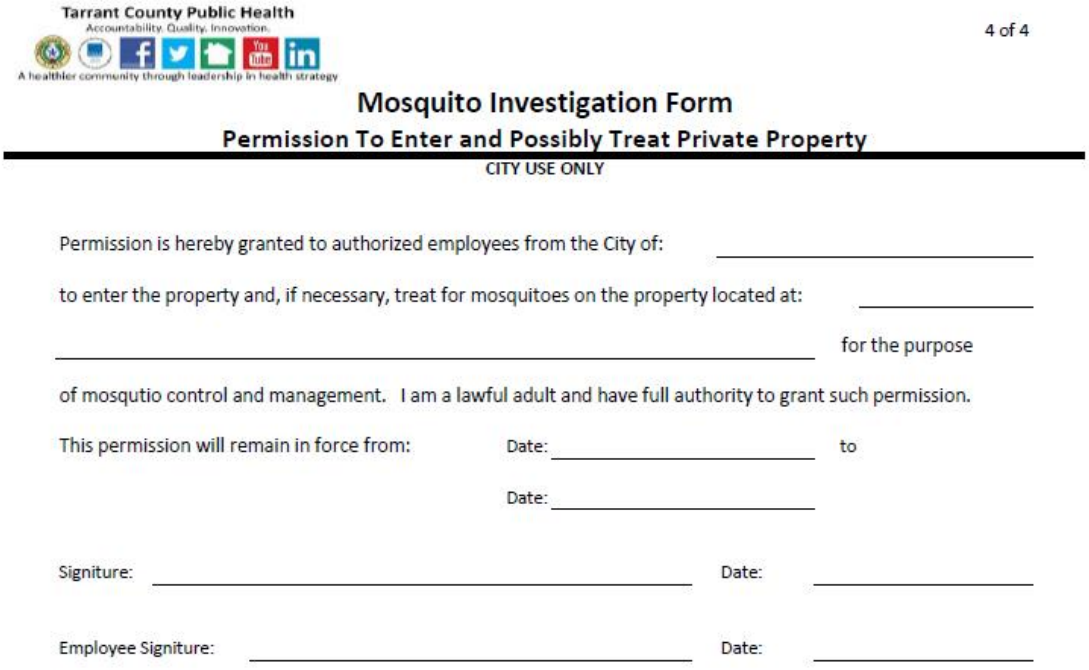
Mosquito Control RFBs/RFPs include:

1. Ground-Based Mosquito Control and Surveillance Activities
2. Annual Contract for Aerial Application of Pesticides for Mosquito Control
3. Annual Contract for Mosquito Control Pesticides and Products

Appendix D: Forms Utilized in Zika Response

Upon entering private property, personnel should obtain permission from the residence. If the person living at the residence does not give permission to enter the premises, then the person asking permission should record the date and time that assistance was offered and denied. A date range in which one may return to treat the property should be noted.

The following is the body of the Tarrant County Permission to Enter and Possibly Treat Private Property:



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4 of 4

Mosquito Investigation Form

Permission To Enter and Possibly Treat Private Property

CITY USE ONLY

Permission is hereby granted to authorized employees from the City of: _____

to enter the property and, if necessary, treat for mosquitoes on the property located at: _____

_____ for the purpose

of mosqutio control and management. I am a lawful adult and have full authority to grant such permission.

This permission will remain in force from: Date: _____ to

Date: _____

Signiture: _____ Date: _____

Employee Signiture: _____ Date: _____

Below is an example of a backyard checklist. It should be made available for uniform inspections of properties during backyard investigations.

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Street Name: _____

Mosquito Investigation Form - Backyard Checklist

CITY USE ONLY

Investigation Instructions:

1.) Inspect back and front yard using the Back Yard Check List.
2.) Set BG Sentinel trap in or near the yard. (May through November)
3.) Collect BG Sentinel trap the next afternoon.
4.) Fill out the Mosquito Surveillance form and deliver sample to TCPH Vector Control. 1101 S. Main St., Rm. 2300, Fort Worth, TX. 76104
5.) TCPH Vector Control will contact you with risk status and recommendations.
6.) If treatment is recommended and conducted, set a BG Sentinel trap after treatment.
7.) Deliver post - treatment BG Sentinel Trap to TCPH Vector Control for further evaluation.

Did you provide a Home Care Kit to Patient?	☐ Yes	☐ No	**Date:**
Were there mosquito larvae present on the patient's property?	☐ Yes	☐ No	
Were there adult mosquitoes present on the patient's property?	☐ Yes	☐ No	
Does the patient have mosquitoes inside their house?	☐ Yes	☐ No	

Checklist:		Observations / Actions / Recommendations
Bird Baths / Fountains	☐	
Flower Pots	☐	
Wheel Barrows	☐	
Gutters	☐	
Buckets	☐	
Boats / Boat Covers	☐	
Swimming Pool / Wading Pools	☐	
Hot Tub	☐	
Tires	☐	
Animal Dishes / Troughs	☐	
French Drains	☐	
Child Play Stations	☐	
Ornamental Ponds	☐	
Tarp Covers	☐	
Other Open Container Misc.	☐	
Other Open Container Misc.	☐	
Other Open Container Misc.	☐	
Other Open Container Misc.	☐	

Contacts: Nina Dacko (817) 321-4986 Shannon Solberg (817) 321-4989 Bethany Hambrick (817) 321-4971
Ivana Terry (817) 321-5364 Joe Carr (817) 321-5372

Below is an example of the backyard investigation form:

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Mosquito Investigation Form - Mosquito Surveillance Form

CITY/COUNTY USE ONLY

Static Trap ☐ Roaming Static Trap ❑ Temporary Trap ❑

ID: - - City: _____ County: _____

Address: _____ Trap Type BG Sentinel

Zip: _____ Lat: _____ Long: _____ Mapsco: _____

Collector's name: _____ Department: _____

Set Time: _____ Temperature: _____ °F Date: _____

Pick-up Time: _____ Temperature: _____ °F Date: _____

Has there been an overnight rain event?: ◻ Yes ◻ No Trap malfunction?: ◻ Yes ◻ No

BG Sentinal Trap Use Only: Dry Ice used?: ◻ Yes ◻ No

Trap Notes: _____

Identification (COUNTY USE ONLY)

Name: _____ Date/Time: _____

Species: _____ _____

_____ _____

Combined Number of Vector Species: _____

Recommendations

Risk Level: _____

Low:	Educate patient and other residents on property on proper mosquito bite prevention. Conduct neighborhood inspection for mosquito breeding.
Medium:	Apply barrier treatment around patient's yard and adjacent houses. Provide education material to the public up to 150 m surrounding the patient's house.
High:	Apply barrier treatment around patient's yard and all surrounding houses up to 150 m. Provide education to all houses within 150 m of patient's house. Conduct larvacide treatment on all houses up to 150 m from patient's house. Consider adulticiding within 150 m of patient's house.

Contacts: Nina Dacko (817) 321-4986 Shannon Solberg (817) 321-4989 Bethany Hambrick (817) 321-4971
Ivana Terry (817) 321-5364 Joe Carr (817) 321-5372

Below is an example of our Response Data Capture Form:

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Mosquito Investigation Form - Response Data Capture Form

CITY USE ONLY

Did you conduct community education?: ◻ Yes ◻ No Date: _____ How did you educate?: _____

Number of houses contacted?: _____ Number of houses you anticipated contacting?: _____

Did you apply any larvicide in response?: ◻ Yes ◻ No Date/s: _____

What type of larvicide used?: _____ How applied?: _____

How many houses received larvicide treatment?: _____

Did you contract larvicide service with a company?: ◻ Yes ◻ No What company?: _____

Did you apply barrier treatment?: ◻ Yes ◻ No Date/s: _____

What kind of barrier treatment used?: _____ How applied?: _____

How many houses received barrier treatment?: _____

Did you contract barrier treatment with a company?: ◻ Yes ◻ No What company?: _____

Did you apply adulticide treatment?: ◻ Yes ◻ No Date/s: _____

What kind of adulticide used?: _____ How applied?: _____

How many houses received adulticide treatment?: _____

Did you contract adulticide treatment with a company?: ◻ Yes ◻ No What company?: _____

Did you adulticide from the road?: ◻ Yes ◻ No What kind of adulticide used?: _____

Did any houses refuse treatment?: ◻ Yes ◻ No Number who refused larvicide treatment: _____

Number who refused barrier treatment: _____ Number who refused adulticiding: _____

Addresses of houses that refused treatment:	What type of treatment refused?:	Reason for refusal:

Contacts: Nina Dacko (817) 321-4986 Shannon Solberg (817) 321-4989 Bethany Hambrick (817) 321-4971
Ivana Terry (817) 321-5364 Joe Carr (817) 321-5372

Appendix E: 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. IGRs 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

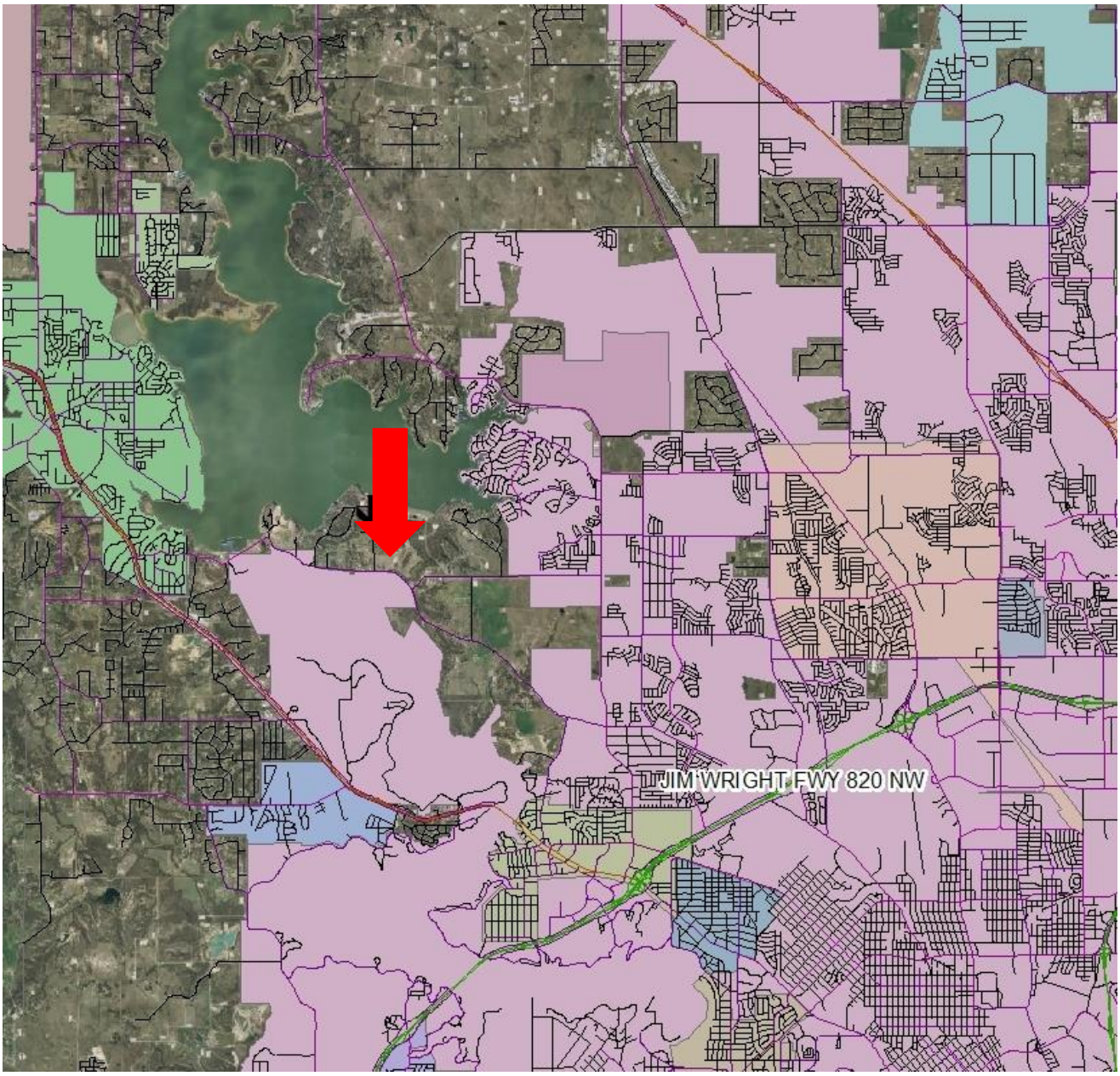
Oils are insecticides that spread over the top of the water to create a barrier. Mosquito larvae and pupae cannont push their breathing apparati through this oil resulting in suffocation. This is one of the quickest ways to eradicate mosquito larvae and is another insecticide mosquitoes cannot become 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 F: *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 9. Aerial picture of live wells for storage of *Gambusia affinis*

Figure 10. Location of TRWD fish hatchery in northwest Tarrant County



Appendix G: 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 njh 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.

Appendix H. Phased response Guidelines

Table 1 Tarrant County Public Health Guidelines for Phased Response to WNV/SLEV 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 • Consider aerial application if detection of virus is widespread and when infection rates in mosquitoes are high and increasing, even in the absence of human cases
3	High	Virus detected in multiple mosquito samples from different times and locations and confirmed human cases	**Surveillance** • 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"

Table 2 Tarrant County Public Health Guidelines for Phased Response to CHIKV/DENV/ZIKV cases

Risk Category	Definition	Jurisdictional Action Steps
Preparation	**Vector Present or Possible in Jurisdiction**	**Vector Control Preparation:** • Prepare for surveillance of *Aedes aegypti* and *Aedes albopictus* by deploying BG Sentinel traps. • Recommend municipalities to enforce and encourage community clean-up efforts. • Disseminate Public education materials to municipalities & county residents. • Update plans for mosquito reduction tactics around travel-associated cases. • Update appropriate contracts for Zika-type response including localized adulticiding and larviciding. • Update permission forms for entrance into private residences and standardized response backyard checklists. • Communicate Tarrant County response plan with each municipality individually. • Reiterate response plan during Arthropod-borne diseases kick-off meeting. • Increase vector personnel and expand abilities to respond to surveillance and control needs. • Plan for Resistance Testing • Research new methods of *Aedes sp.* control
Category 1	**Mosquito Season** *(Aedes aegypti* or *Aedes albopictus* mosquito biting activity)	***Continue preparation category activities in addition to the following steps:*** **Vector Control:** • Monitor *Aedes aegypti* and *Aedes albopictus* populations. • Identify potential *Aedes sp.* breeding sources and concentrate on eliminating the sources of the mosquitoes, continue public education efforts and encourage community cleanup. • Consider distributing Zika care kits supplied by Tarrant County Public Health to all suspect or confirmed Zika/CHIK/DEN patients. • After identification of a **suspected** travel-associated human case outside the viremic phase, consider educating the patient about mosquito breeding sources and/or showing them how to perform backyard inspections.

		• After identification of a **suspected** travel-associated human case within the viremic phase of disease: • Consider inspecting the patient's yard for mosquito larval sources/activity. • Consider gaining entry into property and utilize permission form. • Upon entry to the private property, record any larval or adult activity on the property. • Set a BG trap within the mosquito season to determine vector abundance and help determine risk. • If mosquito activity is observed, consider larviciding, pupiciding and/or adulticiding the property. • Consider residual barrier treatments for adulticiding responses • Thermal fogging may be advantageous in serious problem areas with high adult activity (such as tire piles or dumping areas). • Set a BG Sentinel trap post treatment to monitor and assess effectiveness of vector control activities. • After identification of a **confirmed** travel-associated human case outside of the viremic phase of disease: • Source reduction, larvicide and personal protective information should be supplied to houses up to a 150 meter radius within the block location. • After identification of a **confirmed** travel-associated human case within the viremic phase of disease, consider taking the same measures as one would in the suspected travel-associated human case with adjacent properties to the patient property. • Source reduction, larvicide and personal protective information should be supplied to houses up to a 150 meter radius where mosquito activity is observed around a travel-associated case. • Intensify community cleanup up to a 150 meter radius around suspected case. • Consider utilizing autocidal gravid trapping strategies for additional adult control. • Continue to monitor information distributed by the CDC for the most up to date information.

Category 2	**Confirmed Local Transmission** (single case, or cases clustered in a single household/community in a county or jurisdiction)	***Continue category 1 activities, in addition to the following steps.*** **Vector Control:** • Expand larvicide, pupicide and adulticiding activities up to 150 meter radius around initial case(s) in addition to supplying source reduction, larvicide and personal protective information and intensified community cleanup. • Monitor *Aedes aegypti* and *Aedes albopictus* activity around suspected local transmission with BG Sentinel traps. • Continue to assess effectiveness of vector control activities.
Category 3	**Widespread Local Transmission** (multiple locations within a county or jurisdiction)	***Continue category 2 activities, in addition to the following step.*** **Vector Control:** • Consider expanding areas and utilizing ground based and/or aerial control adulticiding/larvidicing activities. • Intensify community cleanup with messages on media. • Intensify public education regarding the need of mosquito control and personal protective measures. • Continue to assess effectiveness of vector control activities
Category 4	**Local Transmission in Multiple Counties**	***Continue category 3 activities, in addition to the following step.*** • Expand response activities regionally or state-wide

Appendix I: 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.

Glossary of acronyms

WNV- West Nile virus

SLEV- St. Louis encephalitis virus

CHIKV- Chikungunya virus

ZIKV- Zika 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

IR- Infection Rate

MIR- Minimum Infection Rate

MLE- Maximum Likelihood Estimate

VI- Vector Index

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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