Disease Carrying Insects Program

Maintaining a Sustainable Surveillance Program

I. Mosquito and West Nile Virus Surveillance
2012 Annual Report and Comprehensive Plan for 2013

II. Tick and Tick-borne Disease Surveillance
2012 Annual Report and Comprehensive Plan for 2013

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Disease Carrying Insects Program

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Executive Summary

I. Mosquito and West Nile Virus Surveillance 2012 Report and Comprehensive Plan for 2013

North America continued to experience the effects of West Nile virus (WNV) in 2012 with a great explosion of cases and deaths throughout the country. During this year, at least 5,387 human cases with 243 deaths were reported in the U.S[1], the second worst year for WNV since it was first reported. There were 29 human cases and three deaths reported in Virginia. Eight human cases and one death occurred in Fairfax County. The national report is not finalized at the time of this report. From 2002 to present, there have been 34 human WNV cases, including three deaths, reported in Fairfax County.

This document reviews activities for 2012 and presents a surveillance plan for 2013 that will monitor mosquito populations to aid in minimizing the risk of WNV. The emphasis of the 2013 program will continue to be on surveillance, community outreach and public education, and a proactive larviciding program.

Mosquito Surveillance
The program is anchored by a strong surveillance component that will monitor mosquito populations during the 2013 mosquito season for possible increases in vector abundance and viral activity. It is important to note that absolute high numbers of mosquitoes do not necessarily reflect high risk of human infection with WNV. Mosquitoes were collected during 3,146 routine trap periods in the 2012 season. A trap period was defined as 24 hours since some traps collected mosquitoes that were active during the day and others collected mosquitoes that were active at night. During the 2012 mosquito surveillance season, 69,715 mosquitoes were collected in all routine trapping activities. Of that total, 64,049 mosquitoes were tested in 2,801 mosquito pools (this included mosquitoes collected in Fort Belvoir and mosquitoes collected outside of normal routine surveillance activities), and 255 were positive for WNV.

Risk Communication, Community Outreach and Public Education
Fairfax County will continue to emphasize personal protection measures and mosquito and West Nile virus prevention and control. This is done through distribution of informational materials, media interviews, advertising, Web pages, presentations, and collaborations with community groups and homeowners associations.

The eighth 18-month “Fight the Bite” calendar was produced in 2012. The calendar included colorful and creative graphics, captions, facts, figures, important dates, and helpful hints for backyard mosquito and tick management, personal protection, and information about WNV and Lyme disease. A fourth children’s storybook was created

[1] Data to January 10, 2012 obtained from CDC web site on January 13, 2012.

and printed in 2012. The calendar, storybook, and other materials were distributed in various venues throughout the County.

Human Case Surveillance
West Nile virus is one of over 70 notifiable diseases and conditions in Virginia. The Fairfax County Health Department (FCHD) uses enhanced passive surveillance to monitor physician and laboratory reporting of WNV. The Health Department encourages physicians and laboratories to report cases of WNV by educating medical practitioners about the importance of reporting arboviral infections and by contacting key medical staff at hospital centers to inquire about potential cases of WNV.

Reported WNV cases are classified as either West Nile fever or neuroinvasive WNV according to the case definition. In 2012, there were eight cases of WNV in Fairfax County. Of these, six were neuroinvasive and two were WNV fever.

Environmental Considerations
Air temperature, photoperiod and rainfall affect mosquito development. As in previous years, these factors were monitored in 2012 to better understand the relationship between climate and vector-borne diseases.

Source Reduction
The FCHD continued to promote source reduction (elimination of mosquito breeding sites) in 2012 through the outreach campaign. During 139 site visits and inspections, the Disease Carrying Insects Program (DCIP) educated property owners and managers about the benefits of eliminating breeding sites and/or provided Mosquito Dunks®.

Larval Mosquito Control
Stormwater catch basins (CBs) are located throughout the County and are typically constructed to ensure proper drainage. However, some still hold water and can be important breeding sites for mosquitoes. During the 2012 season, a total of 107,984 CBs were treated over three treatment cycles. From May to October, all the catch basins in the Huntington neighborhood of the Mount Vernon district, which floods periodically, were treated on a weekly basis. In 2013, CBs will be treated in programmed cycles aimed at reducing *Culex pipiens* mosquito populations, as has been done in previous years. The first cycle will begin in May 2013, and the number and magnitude of each cycle will be dependent on climatic factors and mosquito surveillance results. A new larvicide, Natular-G was used in the catch basins in 2012. In 2013, another larvicide (VectoMax^{TM}) will be used. Insecticide rotation will lower the risk of resistance to insecticides which could occur by using the same larvicide every year.

National Pollutant Discharge Elimination System (NPDES), Virginia Pollutant Discharge Elimination System (VPDES) and DCIP plan to employ the nine best management practices components of the Pesticide Discharge Management Plan (PDMP) as part of the operative VPDES permit. (See Appendix 2)

Operational Research

The Fairfax County Health Department conducts operational research and incorporates significant findings into routine actions. This operational research allows the program to keep up and maintain the latest and most advanced methods and techniques to address the related issues.

Adult Mosquito Control

A timely response to surveillance findings can reduce the overall impact of WNV and prevent human disease. Consistent with Center for Disease Control and Prevention (CDC), Virginia Department of Health (VDH) and Metropolitan Washington Council of Government (MWCOG) guidelines, FCHD will implement an appropriate level of response based on surveillance data. The response levels range from a basic response level to a much heightened response (details are in the 2013 plan of action). In 2012, indicators were low enough not to warrant treating for adult mosquitoes. In 2013, mosquito species, mosquito habitat, weather, time of year and the proximity of infected mosquitoes to human populations will be considered in determining the necessity for adult mosquito control. Any use of adulticides will be under the direction of the County Executive and in coordination with any affected county, city or town within or adjacent to the treatment area.

II. Tick and Tick-Borne Disease Surveillance 2012 Report and Comprehensive Plan for 2013

Background

Fairfax County began tick and Lyme disease surveillance in 2005 with a small pilot program. In light of significant results from the first year of tick surveillance, the DCIP implemented an enhanced surveillance program in subsequent years. In 2012, 23,591 ticks (including 625 black-legged (deer) ticks) were collected throughout the year using various techniques. As in previous years, tick surveillance and the tick identification service will be conducted by existing staff in the DCIP and will follow previously-established protocols. In 2013, the program will continue its outreach activities as originally requested by the BOS.

Human Case Surveillance

Lyme disease is one of over 70 notifiable diseases and conditions in Virginia. The Fairfax County Health Department (FCHD) uses passive surveillance to monitor physician and laboratory reporting of Lyme disease and other tick-borne diseases. The Health Department encourages physicians and laboratories to report cases of Lyme disease.

Tick Surveillance

Tick surveillance is carried out throughout the year at previously identified sites throughout the County. Tick traps are used at all locations. The DCIP has a contract

with an external laboratory to test ticks for pathogens. However, with the establishment of a molecular diagnostic laboratory in the FCHD laboratory we hope to bring tick pathogen testing in-house. Results of 2012 tick testing shows that the infection rate of *Borrelia burgdorferi* (the pathogen that causes Lyme disease) in deer ticks is high and other tick species also harbor pathogens. In 2012 we continued collecting ticks from animal clinics and the Fairfax County Animal Shelter. On several occasions, this surveillance method has allowed us to find ticks that we do not find routinely. In 2010, this led to the identification of a population of the Gulf Coast tick in the I-66 landfill. In order to try to eliminate this tick population, four acaricide applications were made at the I-66 transfer station in 2012. In 2013, we will treat this area again in hopes of eliminating the remaining population. Our routine surveillance identified a second population of Gulf Coast ticks in parkland in the Lorton area (Laurel Hills). Together with the Park Authority staff, we are trying to manage this population by mowing and burning, methods not feasible in the I-66 landfill. In December 2012, we identified an infestation of the brown dog tick, a tick not commonly seen in the County. Some of these specimens were tested and found to be infected with a Spotted Fever rickettsia.

Tick Identification Service

The tick identification service that the DCIP began offering the County residents resulted in the identification of 357 ticks from 378 inquiries. Of the ticks identified 55 (15.45%) were deer ticks, 50 (14.04%) were dog ticks, and 251 (70.51%) were lone star ticks.

Operational Research

The DCIP performs limited operational research within the surveillance program. The tick surveillance data is also used as part of the County's 4-Poster Deer Treatment Station pilot study that is being managed by the Wildlife Biologist's office. Additionally, the acaricide treatments at the I-66 landfill and the non-chemical methods that will be employed at the Laurel Hill site are monitored to determine whether or not the methods employed are having an impact on tick abundance.

I. West Nile Virus 2012 Report and Comprehensive Plan for 2013

Background

Public Health Impact

West Nile virus infection causes clinical illness in approximately one-fifth of the people infected. The majority of those infected with the virus do not show any symptoms and may never know they were infected. Symptomatic individuals typically experience "West Nile fever," which includes a relatively mild fever, muscle aches, rash and headache. These cases are often undiagnosed and go unreported. A small percentage of infected persons develop a more significant illness such as meningitis, usually manifesting fever, headache and stiff neck; or encephalitis, which is accompanied with fever, headache and confusion or muscle weakness. Encephalitis, meningitis, and

other WNV neuroinvasive illnesses require hospitalization and can be associated with prolonged recovery, disability, and even death. Post-hospitalization follow-up studies of WNV patients (University of Texas) indicate prolonged effects of the disease for up to three years, which may include personality change, depression or subsequent episodes of encephalitis. Treatment of West Nile virus infections is supportive since there is no specific drug that acts against the virus and no human vaccine available.

Primarily an infection of wild birds, WNV is transmitted by the bite of a mosquito. The virus has been detected in over 60 different mosquito species in the US, according to the CDC. However, a smaller number of mosquito species are responsible for the on-going maintenance and transmission of the virus. The virus appears to be maintained in house sparrows (*Passer domesticus*). Infected mosquitoes can transmit WNV to birds, humans, and other animals while taking a blood meal. After the virus is ingested by the mosquito, it passes though the stomach wall into the body cavity where it replicates and eventually invades the salivary glands. During blood feeding the mosquito injects saliva into the host and in this manner the virus is passed to the animal or human, at times, infecting these hosts. It is important to note that most mosquitoes are not infected with WNV.

Since WNV first appeared in the United States in New York City in 1999, it has expanded across the United States. From its initial appearance to the end of 2012, there have been 36,779[2] cases of WNV human illness in the United States reported to CDC, including 1,496 deaths. During this same period of time, Virginia has reported 116 human cases with nine deaths.

In Fairfax County, WNV was first detected in 2000, when the virus was detected in a dead crow. In 2001, additional infected birds were detected and in 2002, the virus was found in birds, horses, mosquitoes and humans. Since 2002, there have been 34 human cases of WNV with three fatalities reported in Fairfax County. Six neuroinvasive and two WNV fever human case were reported in 2012 (Table 1).

Table 1. West Nile Virus Infections in Birds, Mosquitoes, Horses and Humans in Fairfax County, 1999 – 2012.

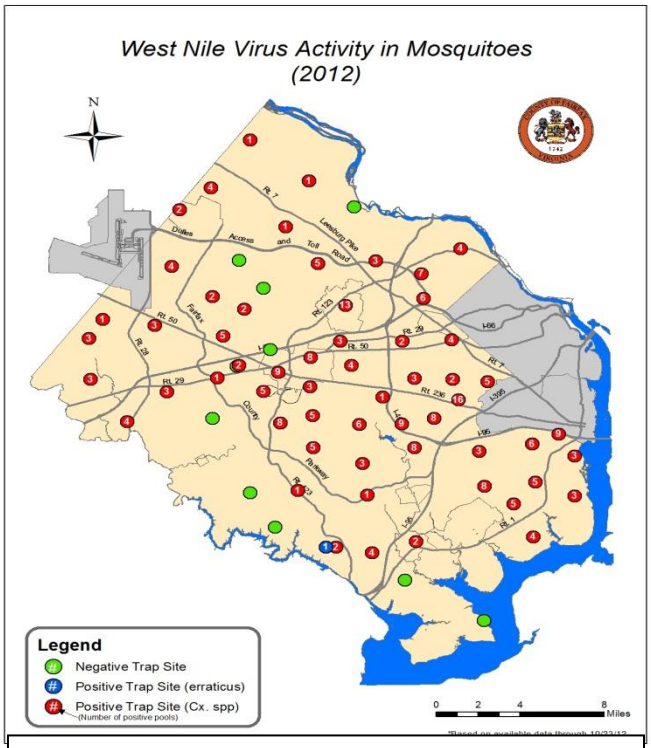
Year	Birds	Mosquito Pools	Humans	Horses
1999	0	0	0	0
2000	1	0	0	0
2001	54	0	0	0
2002	70*	26	13/1**	3/1**
2003	15*	148	3/0**	2/1**
2004	3[&]	234	1/1**	0
2005	4[&]	33	0	0
2006	0[†]	167	3/0**	0

[2] Data to January 10, 2013 obtained from CDC web site on January 13, 2013-- not the final report.

2007	0†	469	1/0**	0
2008	0†	414	1/0**	0
2009	0†	148	1/0	0
2010	0†	166	2/0	0
2011	0†	124	1/0	0
2012	0†	255	8/1	0

*Testing of birds was suspended after 70 positive birds were detected in 2002 and 15 in 2003.
** Cases / deaths.
&Limited (select) number of birds collected and tested.
†No birds tested.

In Fairfax County, *Culex pipiens, Culex restuans, Culex erraticus, Aedes albopictus, Aedes vexans* and *Anopheles punctipennis* are the species that have tested positive for WNV and would most likely transmit WNV to humans. *Culex pipiens* and *Culex restuans* have been identified as the principal vectors by calculating mosquito infection rates from 2002 through 2012. The vector status of *Culex pipiens* is supported by the findings of A.M. Kilpatrick et al. (Consortium for Conservation Medicine) demonstrating that this species shifts its feeding preferences from birds to humans by seven-fold during late summer and early fall, coinciding with the dispersal of its preferred host (American robins, *Turdus migratorius*) and the rise in human WNV infections. This mosquito species prefers to lay its eggs in stagnant water rich in organic matter, such as that found in some storm water catch basins. Larvae will hatch from these eggs before turning into pupae and finally become adult mosquitoes.



Map 1. West Nile Virus Activity in Mosquitoes,

In the 2012 routine mosquito season in Fairfax County, 64,049 mosquitoes were tested in 2,801 pools. Of the pools tested, 255 were positive for WNV (see map 1). During 2011, 91,699 mosquitoes were tested in 4,413 routine pools, of which 109 were positive. In 2012, only three species of mosquitoes (*Culex erraticus*, *Culex pipiens,* and *Culex restuans*) tested positive for West Nile virus. In previous years, three other species have also tested positive for WNV in the County. During the 2012 season Fairfax County continued its comprehensive mosquito surveillance program, including 68 routine collection sites for a total of 3,146 trapping periods.

Preparation and Planning for WNV in Fairfax County

The established, in-house surveillance system will continue to be the foundation of the Disease Carrying Insects Program. This will enable the FCHD to detect WNV and respond to any threat in a timely fashion.

The County is participating in a wide array of ongoing Integrated Mosquito Management activities and undertaking new initiatives to enhance WNV prevention and mosquito control and better understand the transmission dynamics of the virus.

Effective July 1, 2003, the majority of funding for the Fairfax County WNV program was moved to Fund 40080 (formerly Fund 116), The Integrated Pest Management Program Fund, giving it the resources necessary for stability and effectiveness by including the program in a special tax district.

Working with a contractor, the FCHD has monitored mosquito breeding sites in Fairfax County for nine years. These breeding sites will continue to be monitored in 2013 and treated with the biological larvicide VectoLex® (*Bacillus sphaericus*), as necessary, when mosquito breeding is detected.

To keep County residents informed, the FCHD constantly reviews and updates public information materials in English and other select languages. In order to meet the needs of ethnic groups in the County, key elements of these materials have been translated into Chinese, Farsi, Korean, Spanish, Urdu, and Vietnamese. Fact sheets, brochures, and posters discussing actions Fairfax County residents can take to reduce mosquito populations (by eliminating sources of standing water), as well as personal protection from mosquito bites, have been widely disseminated from 2003 to present. In 2012, an eighth calendar and a fourth children's book were prepared, published and distributed.

Interim Report and Action Plan by Activity

1. Community Outreach and Public Education

Goal: *To increase the public's knowledge about WNV, its consequences and mosquito control; to promote behavioral changes and to encourage the community to take an active role in reducing the risk of mosquito-borne diseases through preventive measures such as source reduction and personal protection.*

Background and Report on 2012 Activities

In 2012, the County continued to aggressively disseminate public information materials to encourage Fairfax County residents to eliminate and/or treat standing water around their homes and to reduce their risk of infection by avoiding mosquito bites. Most of the mosquitoes that bite around the house also breed and develop around the house, so removing or treating breeding sites, using repellent, and treating the property with an adulticide, as necessary, will help reduce human–mosquito contact. News releases and

expert interviews with print and broadcast media were used to deliver prevention messages in English and Spanish. Documents and brochures with the slogan "Fight the Bite" have been distributed through County Supervisors' offices, libraries, fairs, presentations, by mail and schools during the last seven mosquito seasons. Information has also been provided regarding the clinical spectrum of illness and prevention of WNV infection. In all of the WNV public information messages, the Health Department underscored the importance of eliminating standing water and using personal protection against mosquito bites.

In June 2012, the DCIP presented its eighth 18-month calendar full of bright, colorful, and humorous graphics. The graphics in the calendar were accompanied by captions, facts, figures, important dates, and helpful reminders relating to West Nile virus, Lyme disease, prevention, and personal protection measures. Important behaviors such as cleaning gutters, emptying bird baths, filling depressions in the yard, and wearing insect repellent were strategically stressed throughout the calendar. General facts, local figures, and brief descriptions of the County's efforts were included to educate the public about basic mosquito biology and inform them specifically about mosquitoes and West Nile virus in Fairfax County. These calendars were distributed at DCIP events and to all Fairfax County fourth grade students through a collaborative effort with the Fairfax County Public Schools. By the end of the year, 20,000 calendars were distributed. Another 18-month calendar for 2013-2014 is in preparation.

The DCIP prepared a fourth children's book entitled "Bite Buster in FIGHT THE BITE" as a means of presenting information on mosquitoes and ticks to parents and children. The author/illustrator was once again present with us at an outreach event to sign autographs as part of a "Meet the Author" activity.

Many inquiries regarding WNV and mosquito breeding sites were received by the DCIP via direct telephone calls, e-mails, and a Web-submission form. The DCIP receives complaints directly via a new, dedicated phone line and the "Fight the Bite" e-mail address, which is the Fairfax County Health Department's dedicated WNV e-mail (fightthebite@fairfaxcounty.gov). The Web submission form routes messages directly to the Fairfax Inspection Database Online (FIDO) system. We made 139 house visits during the summer months, helping people resolve their mosquito and tick problems.

Planned Activities for Risk Communication, Public Education and Community Outreach

Public outreach, information, and education are mainstays of the DCIP and will continue to be emphasized during the 2013 season. All materials that we use will be reviewed and updated as needed and new materials will be prepared to better reach County residents.

The FCHD, with assistance from the Office of Public Affairs (OPA), will be the lead agency on content for WNV publications, posters, etc. and will make this information

available to all interested County agencies and pertinent jurisdictions. The County will continue to use the "Fight the Bite" theme during 2013.

Key Communication, Education and Outreach activities:

- Revise and update the DCIP Web page.
- Prepare, proof, print, and distribute a 2013-2014 18-month calendar.
- Promote Mosquito Control Awareness Week throughout the County.
- Distribute CDC literature on WNV
- Evaluate media strategies used in other regions and incorporate them into the program as feasible.
- Beginning mid-April, key messages will be disseminated through news releases, interviews, and public service announcements. Most will aim to elevate the population's awareness of WNV and steps that individuals can take for personal protection.
- Prepare, proof, print, and, distribute a fifth children's book on mosquitoes and the actions that can be taken to protect oneself against West Nile virus.
- DCIP staff will work with OPA and the Board of Supervisors' offices to reach the constituents in each of the districts.
- Fairfax County Print Shop will be contacted to produce outreach and educational material, as needed.
- Brochures and other educational materials will be distributed at, by or through:
    - Fairs
    - Homeowners Associations
    - Civic Associations
    - Posters in public buildings
    - Clinic room aides and public health nurses (schools)
    - Farmers Markets
    - "Fight the Bite" Web page (www.fairfaxcounty.gov/fightthebite)
    - HD/Community Health and Safety staff
    - Clinic and physician waiting rooms
    - Conferences and scientific meetings
    - Other distribution methods as available.
- During special events and through the Board of Supervisors' offices:
    - Information about the use of Mosquito Dunks® and other larvicides will be presented to the community as an option for larval reduction, in areas where the "tip and toss" campaign cannot be implemented.
    - Information about the use of repellents containing DEET, Picaridin, IR3535 or oil of lemon eucalyptus will be presented to the community as an option for personal protection against mosquito bites.
- If surveillance demonstrates potential human risk of infection with WNV, media messages will
    - Emphasize personal protection against mosquito bites using "Fight the Bite" recommendations.

    - Help Fairfax County residents ensure personal protection for themselves and family members.
    - Target traditional media outlets as well as community newspapers in multiple languages and in multiple neighborhoods.
- If the available surveillance data suggest imminent and substantial risk to human health and adult mosquito control is recommended, the FCHD will enhance its efforts to provide complete, timely, and accurate information on spray areas, spray schedule, and measures people can take to reduce exposure.
- Timeline of Activities:
    - Throughout the year, as necessary, the County will prepare and provide WNV-related media stories.
    - From June to October 2013, as determined by mosquito and WNV activity, the "Fight the Bite" campaign to prevent infection by reducing mosquito bites will be intensified.
    - Throughout the year outreach activities will be implemented as the need demands.
    - New materials will be prepared or acquired to target specific issues or groups for WNV information and protection.
    - During winter months (2013-2014), the DCIP will review and update all outreach materials and prepare new material as needed. Material will be printed and prepared for distribution to targeted groups.

2. Human Case Surveillance

Goal: *To promptly detect, investigate, and report cases of human WNV disease to enable timely implementation of prevention and control measures to prevent further cases, if indicated; to assess and document the public health impact of WNV disease in Fairfax County.*

Introduction and Report of Previous Activities

In 2012, the Fairfax County Health Department (FCHD) continued to use a system of enhanced passive surveillance to detect cases of WNV disease. FCHD also continued efforts to identify suspected WNV cases with higher risk of non-vector borne disease transmission, including individuals who had recently received or donated blood products or organs, and nursing or pregnant mothers.

Arboviral infection, including infection with West Nile virus, is one of more than 70 reportable diseases and conditions in Virginia, and physicians are required to report all suspect cases to local health departments (including FCHD). In addition to physician reports, FCHD also receives reports of suspect cases of arboviral infection from commercial laboratories, hospitals, the Division of Consolidated Laboratory Services (DCLS), and the Virginia Department of Health's Office of Epidemiology.

All suspect cases of arboviral disease reported to FCHD are investigated. Suspect cases meeting the clinical criteria for West Nile neuroinvasive disease or West Nile

fever with laboratory evidence of recent infection are classified as “confirmed” or “probable,” depending on the strength of the supporting laboratory evidence. Cases of arboviral disease are classified either as neuroinvasive or non-neuroinvasive (West Nile fever) according to the following clinical criteria:

Neuroinvasive disease

- Fever (≥100.4°F or 38°C) as reported by the patient or a health-care provider, AND
- Meningitis, encephalitis, acute flaccid paralysis, or other acute signs of central or peripheral neurologic dysfunction, as documented by a physician, AND
- Absence of a more likely clinical explanation.

Non-neuroinvasive disease (West Nile fever)

- Fever (≥100.4°F or 38°C) as reported by the patient or a health-care provider, AND
- Absence of neuroinvasive disease, AND
- Absence of a more likely clinical explanation.

Whenever possible, serological and/or Cerebral Spinal Fluid (CSF) specimens from suspect arboviral cases are forwarded to DCLS for laboratory confirmation. Patient information and laboratory data is shared between the VDH Office of Epidemiology and FCHD in person, via telephone or via fax to facilitate case surveillance and timely reporting of laboratory results to FCHD. Results reported to the FCHD about residents of other districts are forwarded by fax or mail to the appropriate local health department (in VA and the DC metro area) or state health department (for out-of-state residents). When laboratory results are negative, a report is sent to the original collecting physician. When laboratory results are equivocal, the collecting physician is notified and a convalescent sample may be requested. When laboratory results are positive, the collecting physician is notified and a convalescent serum sample may be requested, if needed for case confirmation. Positive results are investigated and assigned a PIN number in AVATAR (an FCHD database). In addition, positive results are entered into the Virginia Electronic Disease Surveillance System.

<u>Cases of West Nile Virus Disease in Fairfax County in 2012</u>

In 2012, eight human cases of WNV disease were identified in Fairfax County with one death. Six of these cases met the criteria for neuroinvasive disease while two of these cases met the criteria for non-neuroinvasive disease.

Please note that this case data is subject to change as 2012 cases are finalized during the first several months of 2013.

<u>Planned Surveillance Activities for WNV</u>

In 2013, FCHD will continue to implement a system of enhanced passive surveillance for human arboviral infection, including WNV disease. FCHD will use the 2011 Centers for Disease Control and Prevention/Council of State and Territorial Epidemiologists case definition. If deemed necessary, active surveillance will be instituted based on the results of passive human case surveillance, mosquito surveillance, and any changes in the epidemiology of WNV disease in surrounding counties or in the state.

As in 2012, enhanced passive surveillance will have two main components:

1) *Educating the medical community*. The FCHD will work to maximize physician reporting of WNV disease by: raising awareness within the medical community of the importance of reporting suspected infection, educating hospital infection control personnel and physicians on the criteria for reporting cases, and providing instructions for submission of appropriate laboratory specimens.

   FCHD will continue to encourage physicians to:
   - Consider arboviral infection in patients hospitalized with encephalitis of unknown etiology, particularly during the peak months of mosquito activity and viral amplification (July-October);
   - Consider WNV in suspected cases of Guillain-Barré syndrome, botulism, and muscle weakness or flaccid paralysis; and
   - Determine if there is a history of donating or receiving blood or organs or if the patient is pregnant or breast-feeding when WNV infection is diagnosed.

   As in 2012, testing for WNV will be performed by DCLS. FCHD will continue to work with health care providers to ensure that appropriate specimens are submitted for testing.

2) *Laboratory surveillance*. The FCHD will continue to investigate reports of sero-positive cases of arboviral infection submitted by commercial laboratories, hospitals, physicians, Division of Consolidated Laboratory Services (DCLS), and the Office of Epidemiology. FCHD will ensure that hospitals and laboratories are aware of the latest surveillance criteria, and have the information and materials necessary to forward diagnostic specimens to DCLS.

FCHD will also continue to encourage both physicians and laboratories to complete all essential information on the laboratory submission forms. Accurate interpretation of serological findings requires knowledge of the patient's clinical history.

<u>Additional Surveillance Activities for WNV</u>

Given evidence suggesting the potential for non-vector borne WNV transmission, FCHD will continue to determine if any human cases of probable or confirmed WNV infection:

- Received an organ transplantation or blood transfusion within the four weeks prior to illness onset, or acted as a blood donor during the two weeks prior to illness onset;

- Are pregnant or breast-feeding mothers; or
- Resulted from occupational exposure.

The VDH Office of Epidemiology will be notified in a timely fashion of any potential non-vector borne WNV transmissions. A trace-back investigation of transplant or transfusion cases would involve the CDC and the Food and Drug Administration (FDA).

Please note: This Human Case Surveillance Plan may be updated, as needed, to reflect local surveillance needs, resources, or changes to guidelines from the Virginia Department of Health or the Centers for Disease Control and Prevention.

3. Mosquito Surveillance

Goal: *To maintain a sustainable surveillance program to monitor vector mosquito populations and their WNV infection rates, as well as other associated factors that will allow the program to minimize the risk of potential WNV transmission to humans.*

Background and Report on 2012 Activities

It is important to note that absolute high numbers of mosquitoes do not necessarily reflect high risk of human infection with WNV. High mosquito counts, even if the mosquito species involved may bite humans, are usually from large broods of floodwater "nuisance mosquitoes" such as *Psorophora* sp., which are less important than *Culex* or *Aedes* mosquitoes in WNV transmission. Fortunately, the Northern house mosquito, *Culex pipiens* (the principal WNV vector), feeds much less frequently on humans than *Aedes vexans* or *Aedes albopictus*.

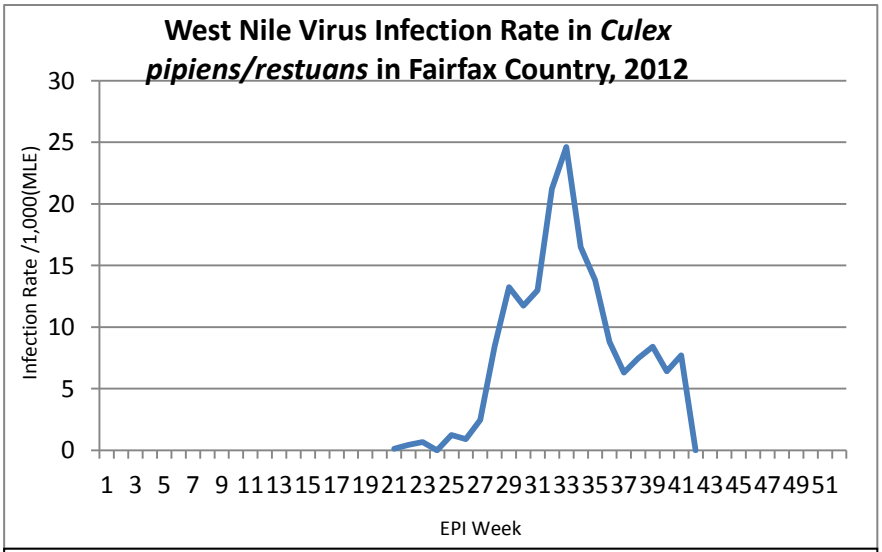


Fig. 1- Maximum Likelihood Estimates of West Nile virus infection, per 1,000 mosquitoes, in *Culex* mosquitoes found in Fairfax County, 2012.

In 2012 a total of 69,515 mosquitoes were collected over 3,146 trap-days. The FCHD tested 2,801 samples (pools) (which included 64,049 mosquitoes) for WNV testing and 255 of those pools were positive. From this information the DCIP was able to determine that the Maximum Likelihood Estimate (MLE), or infection rate, of *Culex* mosquitoes ranged from zero to 24.63 per 1,000 mosquitoes during the season (Figure 1).

The first WNV-positive mosquito was collected in week 21 (mid-May) and the peak infection rate was seen in week 33 (mid-August). The virus was active throughout the rest of the surveillance season to week 41 (mid-October). The observed infection rates were comparable to those seen in most years, and higher than those seen in 2005 and 2009.

The infection rate in *Culex erraticus*, the only other mosquito found infected in 2012 was low (4.97 per 1,000) and was seen only in week 34 (mid-August).

In Fairfax County, catch basins and artificial containers appear to be the preferred breeding site for *Culex pipiens*, while above-ground pools of stagnant water are the preferred breeding sites for *Culex restuans*.

The Asian tiger mosquito (*Aedes albopictus*) was again the source of the majority of mosquito-related complaints received in 2012. This mosquito is an aggressive, persistent biter that can be found in large numbers around residences. Several factors contributed to the presence of *Aedes albopictus* around these homes; however, the presence of black corrugated pipes at the end of the downspouts from the roof gutters, even when placed underground, seemed to be a frequent source of the problem. Most of these corrugated pipes do not drain adequately and they retain water throughout the season, thus providing great mosquito breeding habitat. Furthermore, foreclosed houses and the breeding sites associated with them continue to impact the number of complaints due to *Aedes albopictus.*

In 2012, the FCHD continued to monitor and identify mosquito breeding sites throughout Fairfax County and sites where the treatment threshold was reached were treated with a larvicide. The five year database of breeding sites will continue to serve as a guide to inspect and treat the breeding sites in the County on a monthly basis during 2013.

Beginning in 2012, the FCHD Laboratory performed molecular diagnostic (RT-PCR) testing to detect the presence of WNV in mosquitoes, and this will continue in 2013.

Fort Belvoir continues to carry out regular mosquito surveillance activities and the mosquitoes are being tested by the County and incorporated into the data set.

<u>Planned Activities for Mosquito Surveillance</u>

FCHD mosquito surveillance activities for 2013 are as follows:

- Continue to conduct mosquito surveillance at approximately 68 trap sites throughout the County.
- Associate mosquito trap data with risk factors to assess how to predict human risk and refine “triggers” for mosquito control activities.
- Sort each trap collection by mosquito species and record information on location, collection data, trap type and the total number of female mosquitoes and test mosquitoes for WNV.

- Re-evaluate trap sites to be used during the 2012 season to ensure homogeneous coverage of the County and best trap efficiency.
- Conduct additional adult mosquito trapping in areas where conditions suggest a public health threat. This will help determine zones of potential local transmission and determine the extent of viral activity thus guiding interventions.
- Conduct additional mosquito trapping to evaluate the efficacy of control measures in the event that pesticides are applied for adult mosquito control.
- Increase trapping efforts in areas where surveillance indicators suggest an increase in WNV activity.
- Continue to evaluate new traps and products (attractants, baits, etc.), particularly those that will enhance mosquito surveillance, capture species that are not readily collected by other trapping methods (i.e. *Aedes albopictus*) or collect WNV vector species more efficiently.
- Ensure adequate routine inspection of suspected breeding sites to determine the presence of larvae.
- Collect and update larval habitat information throughout the season (May-October) and treat sites that produce mosquitoes.
- Work with the FCHD Laboratory to ensure that mosquito testing is performed in a timely manner so that a response, if necessary, occurs opportunely.
- Respond to residents' concerns regarding mosquitoes in a timely manner.
- Share information in a timely fashion with the contractor, county agencies and neighboring jurisdictions regarding sites needing larvicide, as appropriate.

4. Environmental Considerations

Goal: *To monitor environmental factors (temperature, rainfall, and photoperiod) to correlate with surveillance results and WNV circulation to determine those factors that may influence WNV transmission.*

Background and Report on 2012 Activities

It is apparent that some of the factors associated with WNV transmission are temperature, rainfall, and photoperiod (day length). Cooler temperatures prolong the development of the virus in the mosquito, requiring a longer period for mosquitoes to become infective. Lower temperatures also prolong the larval development of mosquitoes, keeping them in breeding sites for longer periods of time. Frequent and abundant precipitation may flush out catch basins and other breeding sites, washing away mosquito larvae that may be present. However, it ultimately creates more breeding sites for mosquitoes.

While climatic factors cannot be controlled or modified, monitoring them will help understand their effect on mosquito-transmitted diseases. In 2013, the FCHD will continue to monitor climatic factors, in order to be able to correlate them with either disease or mosquito abundance.

Planned Activities for Environmental Considerations

- Continue to monitor climatic factors in 2013, and correlate them with both disease and mosquito abundance.
- Official (NOAA) weather data will be collected from weather stations at Ronald Reagan Washington National Airport and Washington Dulles International Airport on a daily basis and recorded electronically.
- Weather trends will be monitored and correlated with surveillance information to help better understand mosquito population variation, viral activity, and human infection.
- As necessary, site-specific temperature data will be collected using environmental data loggers.

5. Operational Research

Goal: *To carry out designed experiments in a scientific manner which will answer specific operational questions that will allow us to better understand mosquito ecology, distribution and mosquito-borne illnesses.*

Background and Report on 2012 Activities

In 2012, a study evaluating autocidal gravid ovitraps was carried out. The traps, designed by the Centers for Disease Control and Prevention's Dengue Branch, were deployed at seven mosquito surveillance sites and checked on a weekly basis. The traps were designed to collect *Aedes aegypti* mosquitoes and are being evaluated for their ability to collect *Aedes albopictus* mosquitoes. While the traps did collect *Aedes albopictus*, their use as a management or surveillance tool is still being evaluated.

Planned Activities for Operational Research

- Test selected mosquito species for resistance to commonly-used pesticides.
- Change the color of the body of the BG Sentinel trap to see if different colors would affect the trap's attractiveness to mosquitoes.

6. Source Reduction (elimination of standing water)

Goal: *To reduce the number of adult mosquitoes by eliminating potential mosquito development sites.*

Background and Report on 2012 Activities

All mosquitoes begin their life in water. *Culex pipiens* and *Culex restuans*, the primary vectors of WNV in Fairfax County, and the Asian tiger mosquito (*Aedes albopictus*) are three mosquitoes commonly found in urban areas. The *Culex* mosquitoes breed quickly and lay their eggs on standing water. The Asian tiger mosquito is the primary nuisance and main backyard mosquito in the County and usually appears later in the summer. It lays its eggs in artificial containers and is commonly found around homes. Prime sites for all these mosquitoes to develop include tires left outdoors, poorly-maintained bird baths, clogged rain gutters, poorly-maintained swimming and plastic wading pools, pots, black corrugated drain pipes (even if placed underground) and puddles that last for a week or more. Eliminating these containers or preventing standing water is the simplest

and most effective way to reduce the number of mosquitoes. Every residential and commercial property owner should regularly (at least weekly) inspect their property and buildings to determine if conditions are conducive to mosquito development and endeavor to eliminate those conditions. Mosquito development can be prevented by either eliminating the standing water (source reduction) or treating the water with larvicide if source reduction is not possible.

The County's WNV community outreach, information, and public education campaign highlights the need for residents to eliminate mosquito-breeding sites around their homes. Diagrams of potential sources around the home were described in multiple media events and languages as well as on the WNV Web page.

In 2012, the DCIP assisted residents in 139 complaints. Most of the mosquito complaints were related to the Asian tiger mosquito. Many complaints were associated with either foreclosed houses or neglected swimming pools.

In 2013, the DCIP will continue to receive complaints from residents regarding standing water and mosquito development sites throughout the County and take the appropriate action to abate them.

Planned Activities for Source Reduction

- The DCIP will work with homeowners' associations to promote community participation and distribute printed information on the need to eliminate mosquito-breeding sites on their property or to properly treat them with larvicide.
- FIDO, the telephone lines (703-246-8931, TTY 711), and the "Fight the Bite" e-mail will continue to receive complaints on mosquitoes and standing water.
- Complaints will be logged in the FIDO system and addressed by the DCIP staff.
- County residents will be asked to eliminate standing water on private property or to report standing water to (703-246-8931, TTY 711), if it is on public property.
- The FCHD will work closely with the Department of Public Works and Environmental Services (DPWES) on mosquito problems in storm water retention/detention ponds, particularly those that are being retrofitted to wetlands.
- FCHD will route mosquito issues in roadside canals and blocked catch basins to the Virginia Department of Transportation (VDOT).
- In collaboration with Fairfax County Public Schools, mosquito populations will be monitored on school campuses in the County.

7. Larviciding

Goal: *To reduce the number of* Culex *mosquitoes by applying environmentally-safe larvicides in breeding sites that cannot be drained.*

Background

Catch basins (CBs), also called storm sewers or storm water catch basins are located throughout the County. Catch basins usually drain well and do not present an opportunity for mosquito breeding; however, some (particularly those in older

communities in the County) may have structural problems or may be partially blocked, retain water and produce excellent breeding sites for *Culex* mosquitoes. The exact number of CBs in the County is unknown, but it is estimated there are over 100,000. Based on WNV data from previous years, the FCHD worked with a contractor and began treating CBs proactively, in predetermined areas of the County. The larvicides that will be used on a rotation basis in order to reduce resistance are Natular-G (contains the active ingredient spinosad, a product derived from a naturally-occurring soil bacterium), VectoLex® (*Bacillus sphaericus*, a naturally-occurring soil bacterium that produces toxins which cause death in mosquito larvae) or Vectomax™ (a combination of *Bacillus sphaericus* and *Bacillus thuringiensis* var. *israelensis* also a naturally-occurring bacterium). All three of these products are considered ideal for mosquito management because they only affect mosquitoes and very few other non-target organisms. During the 2012 season, 110,223 CBs were treated in three treatment cycles. The number of CBs treated in a season is dependent on several factors, including weather, degree of viral activity, resources, etc. In addition to the routine CB treatments, all the catch basins in the Huntington area were treated once a week to lower the *Culex* population.

Dr. Roger Nasci (CDC) has stated, "[WNV] programs with the most intensive larviciding had proportionally fewer human WNV cases." Dr. Linn D. Haramis, (Illinois Department of Health), indicated that Cook County programs with the most intense larviciding programs had proportionately fewer WNV cases. Dr. Ned Walker, (Michigan State University), noted that in Michigan, the infection rate in mosquitoes was four per 1,000 in areas with catch basin control and 28 per 1,000 in areas without such control activities. Even though this data is not conclusive, it strongly supports CB larviciding at least until WNV transmission and factors affecting it are better understood.

Planned Activities for Larviciding

- The DCIP is planning three larviciding cycles in 2013. If needed, an additional cycle will be conducted.
- The Huntington (Cameron Run Park) area will be treated with a larvicide as necessary early in the season as an effort of reducing the mosquito populations.
- The Huntington area CBs will be treated on a weekly basis due to the tidal effect.
- The first round of CB treatments will begin in mid-May and will follow the programmed CB treatment order in the County tax map areas treated in 2012.
- The second and third rounds of treatment will follow the pre-established order.
- The DCIP will purchase sufficient larvicide for the FCHD staff to treat larval development sites, as necessary, to abate immediate problems as identified during complaint inspections.
- The FCHD will routinely inspect and larvicide previously identified larval development sites.
- The FCHD will work in collaboration with the DPWES in the surveillance and larviciding of storm water detention/retention ponds.

- The FCHD will verify WNV control and mosquito management plans of action through the regular meetings of the Mosquito Surveillance Management Subcommittee (MSMS).
- The FCHD will to monitor CBs outside the treatment area and treat them, as necessary.
- The FCHD will comply with the NPDES and VPDES and implement the DCIP plan to employ the nine best management components of the Pesticide Discharge Management Plan (PDMP) as part of the operative VPDES permit as stated at the end of Appendix 1.

8. Adult Mosquito Control

Goal: *To reduce the abundance of infected adult mosquitoes through the judicious use of pesticides in targeted areas when there is significant risk of mosquito-borne disease transmission.*

Background and Report on 2012 Activities

While source reduction and the application of larvicides are the principal and most effective interventions to reduce mosquito populations, situations may arise in which infected adult mosquitoes are present in significant numbers and pose a threat to human health. In these situations, judicious application of adulticides to control mosquito populations will be added to all other mosquito control activities as an additional measure to reduce risk of illness and death in humans. WNV guidelines from CDC state that adulticiding based on surveillance data is an extremely important part of any integrated mosquito management program and should be used when there is significant risk of human illness.

Some of the insecticides that are used against adult mosquitoes include synthetic pyrethroids and malathion (an organophosphate) that have been used for more than 30 years and are registered by the U.S. Environmental Protection Agency and the Virginia Department of Agriculture and Consumer Services for adult mosquito control in residential areas. These insecticides provide a rapid knockdown, killing adult mosquitoes upon contact. They also have low toxicity to mammals and birds, degrade rapidly in sunlight and water, and provide little or no residual activity.

There are two principal strategies in adulticiding that can be employed in mosquito control. One is to produce tiny droplets of insecticide from a machine (frequently mounted on a truck or aircraft) in such a way that a cloud of insecticide is produced. In this method, called Ultra Low Volume (ULV), the effect of the insecticide lasts a very short period of time and will only kill those mosquitoes which come in contact with these tiny droplets. A second strategy, called barrier spraying, is to lay down a thin, residual coat of insecticide on vegetation or man-made structures. In this case, the insecticide lasts for a longer period of time and will kill any mosquito that comes into contact with the insecticide during the time that it is active.

In the event that ULV adulticiding is necessary, the FCHD will define the areas in the County where risk of WNV infection to humans is highest and require such action. Drivers and trucks from the contractor will be escorted by police and will apply adulticide to the defined areas.

All adulticiding activities will be conducted under the direction of the County Executive and in consultation with MWCOG and the VDH, and in coordination with any affected county, city or town within or adjacent to Fairfax County.

Mosquito species and habitat, weather, time of year, the presence of the virus and the proximity of infected mosquitoes to human populations will be considered in determining the necessity for adult mosquito control. If the application of an adulticide becomes necessary, the FCHD will provide advance notice to the public and health care providers in affected areas.

Prior to 2005, even in the years when there were human WNV cases, the use of insecticides against adult mosquitoes had not been indicated by the surveillance program. In 2005, 2006, and 2007 it was determined that it would be necessary to apply a barrier spray in an area where the surveillance program showed high WNV activity in the mosquitoes. Subsequent surveillance data showed that the barrier spray reduced the vector index, thus lowering the risk of WNV to humans in the area. All activities were conducted under the direction of the County Executive, and all of the residents in the affected areas were notified before treatment by hand-delivered letters. None of the human cases reported in Fairfax County were from these areas. In 2012, no adulticiding for mosquitoes was deemed necessary.

At a minimum, the following factors will be considered when deciding the scope of the adulticiding effort:

- The general ecology of the area, e.g., key habitat types and the presence of natural barriers such as rivers.
- The population composition, density, distribution and flight range of the target mosquito species.
- The human population characteristics – spatial distribution and density relative to the positive locality (e.g. urban vs. rural), age demographics, etc.
- Evidence of persistent WNV activity detected by the surveillance program, season of the year, and how long WNV activity can be expected to persist until the epizootic/epidemic vector(s) enter their overwintering phase.

<u>Planned Activities for Adult Mosquito Control</u>

The presence of mosquito-borne pathogens in Fairfax County will result in one or more responses or interventions recommended by the FCHD. These interventions can range from continuing existing surveillance, education, and outreach to the targeted application of adulticides.

The FCHD will utilize its surveillance data to assess the risk of an outbreak of human disease and the need to apply insecticides in a limited and targeted area to control adult mosquitoes. Vector considerations include level of documented virus, the distribution, density, and infection rate of the vector population. Other factors must also be considered before insecticide is used. Environmental considerations include habitat, time of year, weather conditions. The density and proximity of human populations are also considered before adulticide treatments are made. Because conditions can vary greatly and cannot be predicted, a consultation process with VDH, CDC and surrounding jurisdictions may be used to determine which, if any, responses are appropriate, on a case-by-case basis.

If adulticides are used, advance notification will be disseminated to surrounding residents indicating when and where the insecticides will be applied. This allows residents who wish to avoid exposure to take necessary actions and precautions. The Virginia Poison Control Center, area hospitals, and health care providers will be provided information on the pesticide being used. All insecticides considered for use are registered with the U.S. Environmental Protection Agency and the Virginia Department of Agriculture and Consumer Services and will be used according to the label directions. When choosing pesticides for mosquito control, preference will be given to those insecticides that pose the least risk to humans and the environment.

In order to categorize the use of adulticides in Fairfax County, any responses initiated by the FCHD can be grouped into six broad categories or levels of risk. These levels are tailored after those of CDC, yet are modified to specifically reflect Fairfax County's position based on previous findings.

Level 0
Definition: Fall/winter; vector inactive, climate unsuitable for WNV transmission.

Response: Prepare material and equipment for the upcoming WNV season. Surveillance and control programs continue as outlined in the County's Surveillance and Control Plan. Identify locations where source reduction activities can be applied; secure surveillance and control resources necessary to enable response to WNV activity; initiate community outreach and public education programs; enhance communication with surrounding jurisdictions; recruit and train new staff; communicate with and educate large property owners of the importance of source reduction in areas such as cemeteries, golf courses, country clubs; communicate status of WNV activity to Director of the Health Department, the Board of Supervisors and the public, as the WNV season starts.

Level 1
Definition: Spring/summer/fall; anticipating WNV activity based on previous activity in region. No current surveillance findings indicating WNV activity in the area.

Response: Respond as in level 0, plus: continue and enhance source reduction; conduct larval control in identified breeding habitats where source reduction is not possible (emphasis will be placed on known *Culex* species breeding sites); continue community outreach and public education; work with other County departments on source reduction and mosquito control activities; initiate catch basin treatment rounds.

Level 2
Definition: Spring/summer/fall; initial, sporadic or limited WNV activity in mosquitoes.

Response: Respond as in level 1, plus: increase larval control activities; continue source reduction in cooperation with other County departments; and increase public education, emphasizing personal protection measures, particularly the use of products containing DEET, Picaridin, IR-3535 or oil of lemon eucalyptus. Enhance human surveillance and activities to quantify epizootic activity (e.g. mosquito trapping and testing) in areas of concern. Consider recommending to the public that they decrease outdoor activities when mosquitoes are biting.

Level 3
Definition: Spring/summer/fall; initial confirmation of WNV in a human or a horse, or moderate WNV activity in mosquitoes.

Response: Respond as in level 2, plus: expand public information programs (repellent use, personal protection, source reduction, risk communication about adult mosquito control program); prepare to implement adult mosquito control, if surveillance findings indicate the likely potential for human risk to persist or increase.

Level 4
Definition: Spring/summer/fall; surveillance findings indicate high risk of human infection, (high mosquito infection rates and vector index, multiple positive mosquito species, horse or other mammalian cases indicating increasing epizootic transmission, or a human case and high levels of epizootic activity) and abundant adult vectors.

Response: Respond as in level 3, plus: continue active surveillance for human cases; make final arrangements to implement adult mosquito control program in areas of potential human risk. The use of adulticides will be used in a limited manner as needed.

Level 5
Definition: Spring/summer/fall; marked increase of confirmed multiple WNV cases in humans and conditions favoring continued transmission to humans.

Response: Respond as in level 4, plus: implement or intensify emergency adult mosquito control program; monitor effectiveness of adulticiding on target mosquito populations; coordinate adult mosquito control activities with surrounding jurisdictions. The FCHD activities related to adulticiding will include the following:

- Various mosquito traps, including CDC miniature light traps and gravid traps will be used in the treatment area if additional surveillance data are required.
- The FCHD will work with state entomologist and/or CDC personnel, as well as the contractor, to design and implement feasible measures to monitor the efficacy of the adulticiding activities.
- The public will be notified of adulticide schedules in advance. This will allow residents with special health concerns sufficient time to take any precautions to reduce pesticide exposure (see Public Education and Community Outreach).
- Hospitals will be notified regarding the adulticiding schedule. Information on the pesticide used will be provided to the public, physicians, and other health care providers.
- Adult mosquito control will be scheduled when mosquitoes are active and weather conditions are conducive to its success.
- Information will be released, in advance, through the media, the FCHD WNV Web page, and through news releases, the MSMS, as well as pertinent county agencies and the community.

Table 2. Factors to consider when establishing thresholds for the use of larvicides, pupicides and adulticides to control mosquitoes in order to address public health threats

Factor	Description	Consideration
Mosquito species	The ability of mosquito species to carry and transmit disease organisms (Vector Competence); flight distance; feeding preferences; seasonality; type of breeding habitat; biology.	Often species, vector competence and biology of the mosquito are more important in developing thresholds than relative abundance of mosquitoes.
History of mosquito-borne pathogens in the area	Surveillance results of mosquito-borne pathogen activity in the area in mosquitoes, reservoir hosts and humans in the area.	Areas with evidence of mosquito-borne pathogens will likely have lower thresholds.
Proximity to human populations	The distance from potential mosquito habitats to human population centers (number and density).	The potential to produce large numbers of mosquitoes in close proximity to population centers may result in less tolerance and lower action thresholds.

Weather patterns	Prevailing wind patterns, precipitation and temperatures.	High precipitation may produce man-biting flood water mosquitoes; prevailing wind patterns may carry mosquitoes to populated areas requiring lower action thresholds.
Mosquito tolerance	Tolerance to mosquitoes varies from person to person.	Highly-populated areas may require lower action thresholds due to more intolerance to mosquitoes.
Natural predator populations	Balanced predator-prey populations may limit mosquito production.	Larval habitats that have high predator populations are adequate to control mosquito populations and may require higher action thresholds.
Type of mosquito habitat	Preferred developmental habitat for mosquitoes is species specific.	Since developmental habitat is species specific, adult nuisance mosquito species should be correlated to each individual habitat.
Water quality	Water quality influences mosquito productivity.	Since water quality can be species specific, adult nuisance mosquito species should be correlated to the specific habitat.
Water and vegetation management	Management of water levels and vegetation may reduce mosquito productivity.	Treatment thresholds should be higher where water level and vegetation can be managed.
Accessibility for surveillance and control	Mosquito developmental habitats may not have adequate access to surveillance or implement mosquito management.	Thresholds will be higher for areas that have limited access for surveillance and control.
Non-target organisms	The presence of non-target organisms in the spray area and their susceptibility to the product used.	Minimize the impact of larvicides, pupicides and adulticides on non-target organisms by using the most target-specific product, apply the product at the best time of day possible to minimize effect on non-targets and use the least amount of product necessary; always following label instructions.

II. Tick and Tick-Borne Disease Surveillance 2012 Report and Comprehensive Plan for 2013

Background

Public Health Impact

Tick-borne diseases continue to impact public health causing serious acute illness, long-term effects and, sometimes, death. The recent and widespread encroachment of suburban sprawl into areas that were once undeveloped or farmland, and the large deer populations in these suburban communities, have increased the prevalence of disease-carrying ticks and the exposure of the human population to the disease pathogens they carry.

Ticks are excellent vectors of pathogens of public health importance. They are the number one disease vector in the United States and second only to mosquitoes as vectors of human disease worldwide. Ticks carry and transmit a remarkable array of pathogens, including bacteria, viruses, spirochetes, rickettsiae, protozoa, nematodes and toxins. Furthermore, a single tick bite can transmit multiple pathogens -- a phenomenon that has led to atypical clinical presentations of some classic tick-borne diseases.

Ticks are among the most common disease vectors in the United States and are capable of transmitting *Borrelia burgdorferi* (the agent for Lyme disease), *Rickettsia rickettsii* (the agent for Rocky Mountain spotted fever), *Rickettsia parkeri* (the agent for Tidewater spotted fever), other spotted fever rickettsias, *Anaplasma phagocytophilum*, *Ehrlichia chaffeensis*, *Babesia microti*, the agents for relapsing fever, Colorado tick fever virus, *Francisella tularensis* (the agent for tularemia), *Coxiella burnetii* (the agent for Q fever), Powassan virus and can cause tick paralysis.

Vector Biology

Knowledge of tick biology is important in understanding the tick's role in disease transmission and is equally important in the prevention of tick-borne diseases. There are four distinct life stages in a tick: egg, larva, nymph, and adult. The length of the life cycle, host-specificity, and the number of hosts fed upon depends on the tick species. Most ticks have a one or two-year life cycle and will have from one to three hosts.

The essential characteristic of ticks, in terms of disease transmission to humans, is their need to ingest a blood meal to develop into the next stage of their life cycle. Ticks will take their requisite blood meal from all classes of vertebrates, with the exception of fish. Ticks find their host by questing, a behavior in which they perch on low vegetation and wait for a suitable host to pass by, onto which they can attach and feed or by actively following chemical cues such as carbon dioxide. Once on a host, the tick attaches its hypostome (mouthpart) a central piercing element with hooks, into the host's skin. Some ticks may secrete an adhesive to fasten themselves to the host, as well as inject

anticoagulant, immunosuppressive, and anti-inflammatory substances into the area of the bite. These prevent hosts from noticing ticks and thus aid the tick in obtaining a blood meal. This behavior and these same substances also help transmit any pathogens that the tick may be carrying.

Introduction to Vector Surveillance

The Disease Carrying Insects Program began tick surveillance in 2005, and since then has continued monitoring the tick population in select areas. The surveillance methods used are drags, flags, traps, alcohol jars in veterinary clinics and the Animal Shelter, and a tick identification service for residents that bring ticks in to the HD.

Part of this surveillance is to support the Police Department in the four-poster station pilot program.

Progress Report for 2012 and Action Plan for 2013, by Activity

1. Risk Communication, Community Outreach and Public Education

Goal: *To increase the public's knowledge about ticks, Lyme disease and other tick-borne diseases; to promote behavioral change; and to encourage the community to take an active role in reducing their risk of tick-borne diseases through preventive and control measures.*

Background and Report on 2012 Activities

Demand for information about ticks and tick-borne diseases (particularly Lyme disease) continued to increase over the last year, and the Board of Supervisors once again requested that efforts be amplified in this area.

The DCIP brochure on ticks, Lyme disease, and other tick-borne diseases continued to be an important outreach tool in 2012. The DCIP staff was invited to give several presentations throughout the County to a variety of groups where information regarding ticks and Lyme disease was distributed. Tick and Lyme disease information and graphics were also incorporated into the DCIP 18-month calendar that was distributed through Fairfax County schools and to the public.

In order to reach a wider range of the population, a brochure was developed for children on ticks, Lyme disease and best practices to avoid infection. This brochure will be printed in the spring of 2013 and distributed in all outreach activities.

Planned activities for Risk Communication, Community Outreach and Public Education

The following activities will be carried out in 2013:

- Prepare and distribute educational materials on ticks and Lyme disease.
- Distribute educational material at all relevant venues.

- Inform residents about personal protection and the actions they can take to keep their property free from ticks.
- Emphasize the importance of personal protection, the use of EPA-registered insect repellents, and proper dress when spending time outdoors.
- Stress the importance of tick checks on people and pets.
- Give presentations to community groups as requested.
- Prepare media alerts when necessary.
- Update the Web page on ticks, their control, the diseases they transmit, and personal protection.
- Educate people one-on-one when they bring a tick in for identification.

2. Human Case Surveillance

Goal: *To monitor the burden of tick-borne diseases (particularly Lyme disease) in Fairfax County through laboratory and physician case reporting.*

Background and Report on 2012 Activities

In 2012, FCHD continued to use a system of passive surveillance to detect cases of Lyme disease and other tick-borne diseases and worked closely with local physicians and laboratories to improve the quality and timeliness of disease reporting.

Virginia state law requires that physicians, directors of medical care facilities, and directors of laboratories report cases of Lyme disease, ehrlichiosis, spotted fever rickettsiosis, anaplasmosis, and Q fever within one to three days of diagnosis (depending on the disease). All suspect cases of these tick-borne diseases reported to FCHD are investigated, classified, and entered into an FCHD database and the Virginia Electronic Disease Surveillance System. Of note, babesiosis is not currently included on the Virginia list of reportable diseases.

In 2012, FCHD and VDH used the most current CDC surveillance case definitions for the four reportable tick-borne diseases. For Lyme disease (the most commonly reported tick-borne illness), this case definition uses the following classifications:

- *Confirmed*: a) a case of erythema migrans (an expanding rash that is the best clinical marker of the disease) with a known exposure, b) a case of erythema migrans with laboratory evidence of infection and without a known exposure, or c) a case with at least one late manifestation (involvement of the musculoskeletal, nervous and cardiovascular systems without an alternate explanation) that has laboratory evidence of infection.
- *Probable*: any other case of physician diagnosed Lyme disease that has laboratory evidence of infection.
- *Suspected*: a) a case of EM with no known exposure and no laboratory evidence of infection, or b) a case with laboratory evidence of infection but no clinical information available.

For surveillance purposes, exposure to Lyme disease is defined as having been (less than 30 days before onset of EM) in wooded, brushy, or grassy areas (i.e., potential tick habitats) in a county in which Lyme disease is endemic (including Fairfax County). A history of tick bite is not required.

Laboratory criteria for confirmation of Lyme disease cases for 2012 were as follows:

- Positive Culture for *B. burgdorferi*, or
- Two-tier testing interpreted using established criteria, where:
  - Positive IgM is sufficient only when ≤30 days from symptom onset
  - Positive IgG is sufficient at any point during illness
- Single-tier IgG immunoblot seropositivity using established criteria.
- CSF antibody positive for *B. burgdorferi* by Enzyme Immunoassay (EIA) or Immunofluorescence Assay (IFA), when the titer is higher than it was in serum.

Cases of Lyme Disease and other tick borne illnesses in Fairfax County in 2012

Using the case criteria outlined above, the FCHD detected and reported a total of 89 cases of Lyme disease in Fairfax County in 2012. By comparison, 148 cases of Lyme disease were reported in 2011.

Twenty-five cases of spotted fever rickettisiosis (including Rocky Mountain spotted fever), three cases of ehrlichiosis, one case of anaplasmosis, and one case of an undetermined ehrlichiosis/anaplasmosis were reported in 2012. No cases of Q fever were identified.

Please note that 2012 data is subject to change as case reports from 2012 are finalized in the first several months of 2013.

Planned activities for Human Case Surveillance

In 2013, FCHD will continue to implement a passive surveillance system for human tick-borne diseases. FCHD will use the 2012 Centers for Disease Control and Prevention/Council of State and Territorial Epidemiologists case definition. In an effort to improve the quality and timeliness of Lyme disease reporting, particular emphasis will be placed on:

- *Educating the medical community*. FCHD will work to maximize physician reporting of Lyme disease by: continuing to emphasize with the medical community the increasing incidence of disease in Northern Virginia and the importance of timely and accurate diagnosis and disease reporting.
- *Laboratory surveillance*. FCHD will continue to investigate all laboratory reports suggestive of Lyme disease that are submitted by commercial laboratories, hospitals, and physicians.

FCHD will also continue to encourage both physicians and laboratories to complete all essential information on Lyme disease reporting forms. Accurate classification of cases normally requires knowledge of both the patient's clinical history and laboratory test

results.

Please note: The Human Case Surveillance Plan for tick-borne diseases may be updated as needed to reflect local surveillance needs and changes to surveillance guidelines published by VDH or the CDC.

3. Tick Surveillance

Goal: *To determine the density and distribution of various tick vector species (including* Ixodes scapularis*) in order to estimate the prevalence of various infectious agents (including* Borrelia burgdorferi*) the agent that causes Lyme disease, in the tick populations.*

Background and Report on 2012 Activities

The black-legged tick (*Ixodes scapularis*) is the most important arthropod vector of human disease in Virginia and the primary focus of the DCIP's tick surveillance efforts. Nevertheless, we carry out surveillance of all the principal tick species collected in the County as well as the pathogens that they carry.

In 2012, a total of 23,591 ticks were collected, the majority of which were lone star ticks (*Am. americanum*). The American dog tick (*Dermacentor variabilis*) was the second most common tick collected, followed by the black-legged tick or deer tick (*Ixodes scapularis*) and lastly by the Gulf Coast tick (*Amblyomma maculatum*). Other ticks that were occasionally collected were the brown dog tick (*Rhipicephalus sanguineus*) and the rabbit tick (*Haemaphysalis leporispalustris*). Some of the ticks were submitted for pathogen detection.

To date, 107 *Ixodes scapularis* have been tested; of these, 26 were positive for *Borrelia burgdorferi*, the causative agent for Lyme disease. The majority of *Ixodes scapularis* collected in 2012 were collected late in the year from deer. Table 3 shows the different infection rates of the developmental stages of this tick. Fully- or partially-engorged female *Ixodes scapularis* are not tested per laboratory protocol.

Tick Stage	Infection Rate (number tested)	Comments
Female	31.25% (16)	Few females were tested since many were collected feeding on deer. A component of deer blood lyses the Lyme-causing bacteria so a tick that has deer blood in it will almost always test negative even if it has been exposed to the bacteria.
Male	50.00% (12)	Some males were collected from deer, but these had not fed.
Nymph	**18.99%** (79)	This is the stage that causes the most infections in humans; they are inconspicuous and many times not seen by the person it is feeding on.
All stages	24.30% (107)	This infection rate is influenced by the large number of nymphs tested

Table 3. Infection rates of *Ixodes scapularis* tested to date in Fairfax County, 2012.

Also, 1,683 *Amblyomma americanum* have been tested for pathogens and 6 (0.36%) were positive for *Borrelia lonestari* and 21 (1.25%) for *Ehrlichia chaffeensis*. Of the 2,970 American dog ticks tested, 14 (0.47%) were positive for *Rickettsia parkeri* and three (0.10%) were infected with *Rickettsia montanensis,* a non-pathogenic *Rickettsia.* Of the 69 *Amblyomma maculatum* tested, 17 (24.64%) were positive for *Rickettsia parkeri*, a spotted fever group *Rickettsia*. In 2012, a second established population of *Amblyomma maculatum* was identified in another part of the County. Table 4 shows the ticks and tick pathogens identified this year as well as their infection rates.

Tick Species	Pathogen	Infection Rate % (Number Tested)
Amblyomma americanum	*Ehrlichia chaffeensis*	1.25% (1,683)
Amblyomma americanum	*Ehrlichia ewingii*	0.53% (1,683)
Amblyomma americanum	*Borrelia lonestari*	0.36% (1,683)
Amblyomma maculatum	*Rickettsia parkeri*	24.64% (69)
Dermacentor variabilis	*Rickettsia rickettsii*	0% (2,970)
Dermacentor variabilis	*Rickettsia montanensis*	0.10% (2,970)
Dermacentor variabilis	*Rickettsia parkeri*	0.47% (2,970)
Rhipicephalus sanguineus	*Rickettsia parkeri*	5.71% (35)

Table 4. Tick pathogens and Infection Rates found in Fairfax County, 2012.

Planned activities for Tick Surveillance

The following activities will be carried out in 2013:

- Continue to conduct tick surveillance at five sites throughout the County.
- Add new sites as needed.
- Sort each collection by tick species and record information on stage, location, collection date, collection method and the total number ticks.
- Test ticks for pathogens.
- Respond to residents' concerns regarding ticks in a timely manner.
- Collect ticks from at least three local veterinarians and the animal shelter to increase the number of underrepresented species (i.e., the Brown dog tick).
- Participate in deer hunts to obtain ticks from county, state and national parks and wildlife refuges located within Fairfax County.
- Seek out new deer hunts and new opportunities for tick collection.

4. Tick Identification Service

Goal: To combat the threat of tick-borne diseases to County residents by providing a service for tick identification to species, stage of development, and relative degree of engorgement.

Background and Report on 2012 Activities

There are four tick species found in Fairfax County that can transmit disease to humans. The black-legged tick *(Ixodes scapularis)* transmits the bacterium which causes Lyme disease. The Lone Star tick (*Amblyomma americanum*) transmits the bacteria that cause Southern Tick Associated Rash Infection (STARI) and Ehrlichiosis. The American Dog tick (*Dermacentor variabilis*) transmits the pathogen that causes Rocky Mountain Spotted Fever as well as other spotted fever rickettsias that may cause illnesses. The Gulf Coast tick (*Amblyomma maculatum*) transmits *Rickettsia parkeri*, a pathogen that causes a spotted fever illness. Other diseases transmitted by ticks to a lesser degree can be found in Table 4.

In 2008, the FCHD began advertising a tick identification service that encouraged County residents to bring their ticks to the DCIP to help raise awareness of Lyme disease and provide information on ticks and tick-borne diseases in the County. In 2012, 378 specimens were brought to the Health Department for identification, of these 357 were ticks: 251 Lone Star ticks (*Amblyomma americanum*), 55 black-legged ticks (*Ixodes scapularis*), 50 American Dog ticks (*Dermacentor variabilis*) and one unidentified tick from Iowa that was brought in. Seventeen of the 21 specimens that were not ticks were insects or other arthropods. The remainder was not living material.

Planned activities for Tick Identification

The following activities will be carried out in 2012:

- Encourage the public to bring in ticks for identification.
- Continue the tick identification service.
- Continue to stress the importance of tick checks on self, children, and pets.

- Provide those who bring in ticks for identification with appropriate information on ticks and tick-borne disease and make them aware of the symptoms of tick-borne diseases.
- Encourage medical consultation if an engorged black-legged tick is identified or if the person experiences symptoms of a tick-borne illness.

5. Operational Research

Goal: *To carry out designed experiments in a scientific manner which will answer specific operational questions that will allow us to better understand tick distribution and tick-borne illnesses.*

Background and Report on 2012 Activities

We continued collecting ticks at the two 4-poster sites and the two control sites. This baseline tick data was collected as a part of the County's 4-Poster Deer Treatment Station pilot study.

Planned Activities for Operational Research

- Collect ticks as a part of the 4-Poster pilot study that is being carried out by the County Wildlife Biologist.
- Study the effect of acaricides on heavy population of ticks (I-66 landfill).

III. Resources

In 2013, the Fairfax County Disease Carrying Insects Program will be supported by the following resources:

Fund 40080
One Entomologist (Environmental Health Supervisor)
One Senior Biologist (Environmental Health Specialist-III)
Two Merit Biologists (Environmental Health Specialist-II)
One Merit Administrative Assistant (Admin-III)
One E-status Biologist (Environmental Health Specialist-II)
Four E-status (Environmental Health Technician-I)
One G-status (Environmental Health Technician-I)

General Fund (Health Department)
One (10 percent) Environmental Health Specialists (Environmental Health Specialist-III) – GIS Specialist
One (10 percent) Senior Administrative Coordination

Other departments, agencies and jurisdictions
Mosquito Surveillance and Management Subcommittee (MSMS)

MSMS Members
City of Fairfax
City of Falls Church
Fairfax County Department of Public Works and Environmental Services (DPWES)
    Storm Water Planning Division
    Maintenance and Storm Water Management Division
    Forest Pest Management Program
Fairfax County Department of Management and Budget
Fairfax County Department of Information Technology
Fairfax County Park Authority
Fairfax Public Schools
Fairfax County Health Department
Fairfax County Office of the County Attorney
Fairfax County Office of Public Affairs
Fairfax County Police Department, Animal Control
Town of Herndon
Town of Vienna
Virginia Department of Transportation

IV. Mosquito and Tick References and Links

Centers for Disease Control and Prevention (CDC)
Pesticides and Public Health: Integrated Methods of Mosquito Management
http://wwwnc.cdc.gov/eid/article/7/1/pdfs/70-0017.pdf
West Nile Virus
http://www.cdc.gov/ncidod/dvbid/westnile/index.htm
Lyme Disease
http://www.cdc.gov/ncidod/dvbid/lyme/

Centers for Disease Control and Prevention (CDC) National Institute for Occupational Safety and Health (NIOSH)
Information for Outdoor Workers
West Nile Virus
http://www.cdc.gov/niosh/topics/westnile/
Lyme Disease
http://www.cdc.gov/niosh/topics/lyme/

Centers for Disease Control and Prevention (CDC) and Environmental Protection Agency (EPA)
CDC/USEPA Joint Statement on Mosquito Control
http://www.epa.gov/pesticides/health/mosquitoes/mosquitojoint.htm

Environmental Protection Agency (EPA)
Insect Repellent: Use and Effectiveness
http://cfpub.epa.gov/oppref/insect/
Larvicides for Mosquito Control
http://www.epa.gov/mosquitocontrol/Larvicides.html
Synthetic Pyrethroids for Mosquito Control
http://www.epa.gov/mosquitocontrol/Synthetic_Pyrethroids.html
Methods of Mosquito Control
http://www.epa.gov/mosquitocontrol/

Fairfax County Health Department (FCHD)
West Nile Virus and Lyme Disease Web Page
http://www.fairfaxcounty.gov/fightthebite

U. S. Geological Survey (USGS)
http://westnilemaps.usgs.gov/

Virginia Department of Health (VDH)
West Nile Virus Web page
http://www.vdh.state.va.us/epidemiology/DEE/Vectorborne/WestNile/index.htm

American Mosquito Control Association
http://www.mosquito.org

Mid Atlantic Mosquito Control Association
http://www.mamca.org/

Virginia Mosquito Control Association
http://www.mosquito-va.org/

Abbreviations

ASTHO - The Association of State and Territorial Health Officials
BOS - Fairfax County Board of Supervisors
CB(s) - Catch Basin(s)
CDC - Centers for Disease Control and Prevention
CDPH - Chicago Department of Public Health
CO_2 - Carbon dioxide
CSF - Cerebrospinal Fluid
DC - District of Columbia
DCIP - Disease Carrying Insects Program
DCLS - Division of Consolidated Laboratory Services (of Virginia)
DEET - N,N-diethyl-m-toluamide (an insect repellent)
DPWES - Department of Public Works and Environmental Services
EEE - Eastern Equine Encephalitis
FCHD - Fairfax County Health Department
FDA - Food and Drug Administration
FIDO – Fairfax Inspections Database Online
MLE - Maximum Likelihood Estimate (a measure of infection rate of mosquitoes)
MWCOG - Metropolitan Washington Council of Governments
MSMS - Mosquito Surveillance and Management Subcommittee
OPA - Office of Public Affairs
RT-PCR - Reverse Transcriptase Polymerase Chain Reaction (a test to detect virus genetic material)
TTY – Text Telephone
ULV – Ultra-Low Volume
VA - Virginia
VDH - Virginia Department of Health
VDOT - Virginia Department of Transportation
WN - West Nile
WNV - West Nile virus

Definition of Terms as Used in this Report

Adulticide: An insecticide used to kill adult mosquitoes.
Antibody: A type of protein normally present in the body or produced in response to an antigen which it neutralizes, thus producing an immune response.
Antigen: A substance that stimulates an immune response (usually production of an antibody) when introduced into the body. Antigens include toxins, bacteria, viruses, and other foreign substances.
Arbovirus: An **Ar**thropod-**BO**rne **VIRUS**.
Asian tiger mosquito: Common name for *Aedes albopictus*.

BG-Sentinel Trap: A mosquito trap that attracts mosquitoes with its design and appearance, a special lure (BG-Lure) and CO_2 (produced by dry ice). A fan located below the intake tube sucks the mosquitoes into a collecting bag in the trap. The fan is powered by a 12 volt battery. This type of trap collects mosquitoes that are looking for hosts (which exhale CO_2 when they breathe and have a human skin scent). This trap is useful in collecting the Asian tiger mosquito, *Aedes albopictus*.
***Borrelia burgdorferi*:** Scientific name of the bacteria that causes Lyme disease.
Breeding site: Larval mosquito habitat.
Catch basin: Roadside inlet that permits rainwater to flow off the roadways. Part of the County's storm water management system
CDC miniature light trap: A mosquito trap that attracts mosquitoes with light and CO_2 (produced by dry ice). A fan located below a light source sucks the mosquitoes into a collecting receptacle on the trap. The light is powered by a six-volt battery and the trap is covered by a plastic roof. This type of trap collects mosquitoes looking for hosts (which exhale CO_2 when they breathe).
Common house mosquito: In our area it is the common name given to *Culex pipiens*.
Container breeder: Mosquito species that lay their eggs in artificial (e.g., cans, bottles, tires, birdbaths and even catch basins) or natural (e.g., tree holes) containers.
Corvids (Corvidae): Family of birds that includes the crows, blue jays and magpies.
Day degrees above 75^{o}F: The cumulative number of degrees Fahrenheit above 75^{o} during the year.
DCIP: Disease Carrying Insects Program.
DEET: A synthetic chemical used as an ingredient in certain insect repellents. Recommended to protect against mosquitoes and ticks.
Encephalitis: Swelling of the brain (as can be caused by the West Nile virus).
Enhanced passive surveillance: Passive surveillance enhanced by general alerts to health care providers.
Epidemiological Week (EPI Week): This is a period of time that comprises seven days and is used to compare data from place to place and year to year. In the United States the first EPI Week is defined as the first week of the year ending on a Saturday, as long as four days of that year are included in that week.
Epizootic: An epizootic is the non-human equivalent of an epidemic, meaning that large numbers of animals are infected with a disease. An epizootic disease is one in which greater than normal numbers of animals are affected for a given place or time period.
Gravid traps: A mosquito trap baited with yeast-, grass- and hay-infused water that attracts female mosquitoes (primarily *Culex pipiens* and *Culex restuans*) that seek this type of water to lay eggs.
IgM antibodies: The first class of antibodies produced by the immune system in response to the presence of an antigen (e.g. West Nile virus). Presence of IgM antibodies usually indicates a primary or recent infection. Diagnostic laboratories test for the presence of WNV-specific IgM antibodies in human serum or cerebrospinal fluid in order to confirm a case of WNV.
IgG antibodies: The second class of antibodies produced by the immune system in response to the presence of an antigen (e.g. West Nile virus). Presence of IgG

antibodies usually indicates a past infection. Diagnostic laboratories test for the presence of WNV-specific IgG antibodies in human serum or cerebrospinal fluid, in order to confirm a case of WNV.
IMM: Integrated Mosquito Management is a comprehensive mosquito prevention/control strategy that utilizes all available mosquito control methods singly or in combination to exploit the known vulnerabilities of mosquitoes in order to reduce their numbers to tolerable levels while maintaining a quality environment.
IR3535: A synthetic chemical used as an ingredient in certain insect repellents. Recommended to protect against mosquitoes.
Larvicide: An insecticide used to kill mosquito larvae.
Lyme Disease: Lyme disease was first identified in 1975 in Lyme, Connecticut, and is a bacterial illness caused by *Borrelia burgdorferi.* The disease is transmitted through the bite of an infected black-legged tick *(Ixodes scapularis)*.
Medical community: Health care providers.
Meningitis: Swelling of the membrane covering the spinal cord or the membrane covering the brain (as can be caused by the West Nile virus).
MLE: Maximum Likelihood Estimate. An estimate of the maximum number of infected individuals per 1,000 tested. Recommended when pool sizes are variable and/or with large infection rates.
Mosquito Dunks®: A readily-available, non-restricted microbial larvicide which contains the active ingredient *Bacillus thuringiensis israelensis*. This product specifically targets mosquito larvae.
Mosquito larva (plural: larvae): The immature, aquatic, feeding stage of a mosquito. This is the stage that hatches from the mosquito egg and is the best target of a mosquito management program.
Mosquito pool: Mosquitoes that were collected in one location, on the same date, that have been grouped together (pooled) to be tested for the presence of a virus.
MSMS: Mosquito Surveillance Management Subcommittee. This is a subcommittee of Fairfax County's Environmental Coordinating Committee. The MSMS is composed of representatives from various county agencies and departments as well as other jurisdictions that have activities associated with DCIP.
Neuroinvasive: Affecting the nervous system. Refers to West Nile virus meningitis, encephalitis or other serious neurological pathologies.
Oil of lemon eucalyptus: A naturally-occurring chemical used as an ingredient in certain insect repellents. Recommended to protect against mosquitoes.
Overwinter: To pass the winter, like hibernation.
Ovitraps: Traps set out specifically to collect eggs of container-breeding mosquitoes, used to monitor species like the Asian tiger mosquito (*Aedes albopictus*).
Passive surveillance: Medical care providers or medical laboratories report notifiable diseases on a case-by-case basis to the local or state health agency, based upon a published list of conditions.
Pathogen: An infectious organism.
Permethrin: An insecticide that kills ticks and adult mosquitoes.
PCR: Polymerase Chain Reaction; a biochemical process that makes copies of a sequence of genetic material (DNA) so that its source can be identified.

Picaridin: A synthetic chemical used as an ingredient in certain insect repellents. Recommended to protect against mosquitoes.
RT-PCR: Reverse Transcription Polymerase Chain Reaction. A biochemical process that makes copies of a sequence of genetic material (RNA) so that its source can be identified.
Trap period: Period of time elapsed from when one trap is set to when it is collected. The trap period presently used by the DCIP is 24 hours.
"Tip and Toss" campaign: Part of Fairfax County Disease Carrying Insects Program involving the community to remove standing water from their yards, thus reducing mosquito breeding habitats.
ULV: Ultra-Low Volume. A method of applying insecticides to kill adult mosquitoes. It produces very small droplets of insecticide and is usually applied by a truck- or aircraft-mounted machine at a constant, predetermined rate.
VectoLex®: A biological larvicide (*Bacillus sphaericus*) used in catch basins to proactively suppress mosquito populations.
West Nile fever: A febrile condition caused by the West Nile virus, very similar to the flu. The symptoms include fever, body aches, swollen glands, rash and headache.
West Nile virus: A virus transmitted by mosquitoes. The normal transmission cycle is between certain species of mosquitoes and certain species of birds. It can be transmitted to and cause disease in other animals and people.
West Nile virus "season": The period of time (usually May to October) marked by high mosquito activity and West Nile virus transmission.
Zumba™ Mosquito Trap: A mosquito trap. Trap design and appearance, the BG-Lure, and CO_2 (produced by dry ice) draw host-seeking mosquitoes to the trap. A fan located below an intake tube sucks the mosquitoes into a collection bag. The fan is powered by a 12-volt battery. This type of trap collects mosquitoes attracted to hosts (which exhale CO_2 when they breathe). This trap is good at collecting *Culex* mosquitoes as well as *Aedes albopictus*.

Acknowledgments

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Parts of this plan are modeled after plans of the Centers for Disease Control and Prevention (CDC); the Virginia Department of Health (VDH); the Metropolitan Washington Council of Governments (MWCOG); the American Mosquito Control Association (AMCA) and the Chicago Department of Public Health's (CDPH) 2003 WNV report. Recommendations and guidance were also obtained from a document issued by The Association of State and Territorial Health Officials (ASTHO).

AMCA
Best Management Practices for Integrated Mosquito Management
http://www.mosquito.org/assets/Resources/PRTools/Resources/bmpsformosquitomanagement.pdf

CDC
Epidemic/Epizootic West Nile virus in the United States: Guidelines for Surveillance, Prevention and Control
www.cdc.gov/ncidod/dvbid/westnile/resources/wnv-guidelines-aug-2003.pdf

VDH
Virginia Arbovirus Surveillance & Response Plan, 2005
http://www.vdh.virginia.gov/epidemiology/DEE/Vectorborne/responseplan/index.htm

MWCOG
West Nile Virus Response Plan for the National Capital Region
www.mwcog.org/uploads/pub-documents/BFZd20040109135919.pdf

ASTHO
Public Health Confronts the Mosquito: Developing Sustainable State and Local Mosquito Control Programs
http://www.astho.org/WorkArea/DownloadAsset.aspx?id=2333

Appendix 1

Disease Carrying Insects Program (DCIP)
Integrated Mosquito Management Plan[3]

Integrated Pest Management (IPM) was first conceived as a means of achieving sustained, effective control of agricultural pests through concomitant employment of a wide range of control methodologies. IPM has been in widespread usage for many years and its success as a general strategy has led to usage of the term to describe an increasing number of approaches to control strategies — often leading to misunderstanding of its actual conceptual framework. To clarify the concept in terms of its relationship to the unique nature of mosquito prevention/control methodologies, we use the term Integrated Mosquito Management (IMM) in lieu of IPM.

Integrated Mosquito Management is a comprehensive mosquito prevention/ control strategy that utilizes all available mosquito control methods singly or in combination to exploit the known vulnerabilities of mosquitoes in order to reduce their numbers to tolerable levels while maintaining a quality environment. IMM does not emphasize mosquito elimination or eradication. Integrated mosquito management methods are specifically tailored to safely counter each stage of the mosquito life cycle. Prudent mosquito management practices for the control of immature mosquitoes (larvae and pupae) include such methods as the use of biological controls (native, noninvasive predators), source reduction (water or vegetation management or other compatible land management uses), water sanitation practices as well as the use of EPA-registered larvicides. When source elimination or larval control measures are not feasible or are clearly inadequate, or when faced with imminent mosquito-borne disease, application of EPA-registered adulticides by applicators trained in the special handling characteristics of these products may be needed. Adulticide products are chosen based upon their demonstrated efficacy against species targeted for control, resistance management concerns and minimization of potential environmental impact.

IMM requires a thorough understanding of mosquitoes and their bionomics by control personnel; careful inspection and monitoring for their presence and conditions favoring their development; and prevention of oviposition and human/mosquito contact through effective public education, sanitation and facility maintenance. The Disease Carrying Insects Program strives to employ these IMM components to the extent possible, but resource availability may limit what the program will do.

[3] Modified from the AMCA's BMP for IMM document at http://www.mosquito.org/secure/upload/articles/BMPsforMosquitoManagement.pdf accessed 12/10/10

All intervention measures will be driven by a demonstrated need based on surveillance data and action thresholds as defined in the DCIP Annual Report and Plan of Action.

INTRODUCTION

Since the need for mosquito control was recognized as a critical component of public health initiatives in the early twentieth century, increased knowledge of mosquito biology has driven the formulation of a variety of methodologies designed to successfully reduce both mosquito nuisance levels and mosquito-borne disease transmission. As the technologies and knowledge base from which these methodologies were derived have matured, they have been increasingly seen as mostly complementary or synergistic in nature, providing optimal control as part of an overall strategy. This has ultimately evolved into a strategy termed Integrated Mosquito Management (IMM). IMM has been developed to encourage a balanced usage of cultural and insecticidal methodologies and habitat manipulations in order to maximize control while minimizing adverse environmental impacts. IMM is knowledge-based and surveillance-driven, and when properly practiced is specifically designed to accomplish the following:

1. Protect human, animal and environmental health.
2. Promote a rational use of pesticides.
3. Reduce environmental contamination to soil, ground water, surface water, pollinators, wildlife and endangered species as a result of mosquito control activities.
4. Utilize biological controls (native, noninvasive predators) to conserve and augment other control methods.
5. Utilize source reduction (elimination, removal or reduction of larval mosquito habitats) where practical and prudent.
6. Use target specific pesticides at the lowest effective rates to the extent possible.
7. Emphasize the proper timing of applications.
8. Minimize pesticide resistance problems.

All mosquito control programs, including the DCIP mosquito control program are unique to their respective jurisdictions in terms of human population, topography, hydrology, and the bionomics of the mosquito species. Considerable judgment will be exercised in allocation of resources to extract the maximum benefit for both the citizens and the environment. It must be emphasized that program funding and other extrinsic factors will dictate the extent to which the DCIP will implement the Best Management Practices (BMPs) described herein.

To assist in this calculation, we will outline a series of BMP program elements that constitute a fully integrated approach to mosquito management. These BMPs will be viewed as minimums that will be performed in concert with the Virginia Pollutant Discharge Elimination System (VPDES) general permit that will be issued for mosquito control activities falling within the scope of Clean Water Act (CWA) requirements.

The extent and manner to which DCIP will meet or exceed these BMPs will be ultimately based on the best professional judgment of program personnel, occasionally in consultation with other County agencies and government authorities in addition to resources available. It is important to emphasize that adherence to these BMPs to the maximum extent practicable is to be considered the necessary minimum to undertake or perform for purposes of regulatory compliance with VPDES general permit for mosquitocide use.

Best Management Practices for Mosquito Management

Best Management Practices (BMP) will be the fundamental approach to mosquito management in Fairfax County. It is acknowledged that the DCIP does not have the resources to practice all of the specific sub-elements discussed herein, and it will draw on other County agencies or Contractors as deemed necessary to do so. The DCIP will strive to adhere to these BMPs to the maximum extent practicable and will maintain documentation (see attached DCIP Plan to Employ the Nine BMP Components of the Pesticide Discharge Management Plan (PDMP) as Part of the Operative VPDES Permit) as to how we intend to employ the BMP components listed below in a Pesticide Discharge Management Plan PDMP) as part of the operative NPDES permit.

1. Surveillance — Surveillance is the backbone of all IMM programs. It identifies problem mosquito species and their population trends in order to direct and evaluate control methods.

a. Determine species to ensure that the most appropriate control methodologies are chosen.

i. Visually check jurisdiction for potential oviposition habitat and larval populations present that could contribute to unacceptable adult mosquito populations and determine if larval control is appropriate within established parameters.

1. Park Areas - swamps, marshes, woodland pools, flooded fields/ pastures, roadside ditches, storm water retention ponds, tree holes, etc.

2. Urban - flower pots, tires, trash containers holding water, gutters, tree holes, septic ditches, roadside ditches, lawn swales, non-functional swimming pools, stagnant bird baths, street catch basins, junk yards, depressions in tarp covers, etc.

ii. Determine population levels of adult mosquitoes using professionally acceptable techniques, including service requests, trap or collection data, to establish needs for action.

b. Monitor fluctuations in mosquito populations.

2. Mapping — Utilize maps of appropriate scale to continually monitor major sources of larval/adult mosquitoes in addition to documenting areas where control measures have been instituted. These maps will define treatment areas and can be used as appropriate in the PDMP.

3. Set Action Thresholds — Decisions to initiate control measures will be based on the analysis of either larval or adult mosquito surveillance or other available field data.

Programs must establish a mechanism on which decisions to institute control measures are based.

a. Determine which methodology shall be used to determine if and when control measures are instituted.

i. For control of immature stages of mosquitoes, this methodology can consist of numbers of larvae and pupae observed in dip counts or observation of their presence in water sources.

ii. For adult mosquito control this methodology can consist of

1. Number and pattern of citizen's service requests.

2. Visual — numbers of mosquitoes landing on inspector/applicator within one-minute periods while performing duties. Performance of landing rate counts is not advised in the County due to mosquito-borne disease activity.

3. Counts of adult female mosquitoes collected.

b. DCIP has determined threshold values that trigger routine control measures. These values are meant to be for guidance only due to the myriad other factors that can influence when control operations are instituted — particularly in incipient disease scenarios or mosquito-borne disease prevention.

4. Physical Control or Source Reduction —Source reduction (the elimination, removal or modification of larval mosquito habitats) typically is the most effective and economical long-term method of mosquito control, but this may not be practicable for many larval habitats. Source reduction can be as simple as overturning a discarded bucket or disposing of a waste tire or as complex as habitat modification through Open Marsh Water Management techniques. These efforts often minimize and/or eliminate the need for mosquito larviciding in the affected habitat in addition to greatly reducing the need for adulticiding in nearby areas.

a. Determine feasibility of removing or modifying oviposition sites.

b. Encourage proper water management by public/private agencies responsible for storm water retention/detention structures and ditch and impoundment maintenance.

c. Maintain familiarization with jurisdiction health nuisance abatement policy.

5. Biological Control — Biological control methodologies are often resource-intensive and have not been found to be practicable in Fairfax County. Nonetheless, their utilization will be held in reserve in case the need ever appears.

a. Even stocking of certain species of native, non-invasive fish known to be predators of mosquito larvae is not readily allowed by the Virginia Department of Game and Inland Fisheries, particularly in waterways where they don't occur, even though they occur in adjacent water sources.

b. Utilization of bats, birds, dragonflies and other putative predators of mosquitoes can be both ecologically problematic and ineffective as a primary control strategy and is therefore not recommended as a major component of any control strategy.

6. Public Health Mosquitocides — handling, disposal, personal protective measures and applications must be made in full accordance with product label specifications.

a. Larvicides — Often may be the primary control method in natural or man-made wetlands (salt marshes or tidal wetlands, riverine bottomlands, woodland pools, freshwater marshes, meadow swales, roadside ditches, stormwater management ponds, etc.). These can also be a primary control method in locations where mosquito populations are determined to be arising from defined, concentrated sources in urban areas or in close proximity to houses. Due to continual influx of adult mosquitoes from outlying areas, larviciding programs may have limited visible effect on mosquito populations in jurisdictions lacking resources to adequately larvicide outlying production areas.

i. Several materials in various formulations registered by EPA are labeled for mosquito larviciding. Choice of active ingredient and formulation chosen will depend on site- specific factors and resistance management, and may include:

1. Biological larvicides
    a. Microbial larvicides
    b. Growth regulators and chitin synthesis inhibitors
    c. Alcohol-derived monomolecular surface films
2. Chemical larvicides
    a. Organophosphates
    b. Oils — petroleum and mineral-based

ii. Larvicides will minimize impacts to non-target organisms. Larvicide formulations (e.g., liquid, granular, solid) must be appropriate to the habitat being treated, accurately applied and based on surveillance data or preemptively applied to known oviposition sites.

iii. Larvicide application equipment will be calibrated and maintained per equipment manufacturer's specifications and timetable, or per instructions from product registrant.

b. Adulticides — Adulticides are applied so as to impinge upon the mosquito target in flight or at rest on vegetation. Adulticiding based on surveillance data is an extremely important part of any IMM program, and may form the primary treatment method for many programs where comprehensive larviciding is not practical.

Adulticides are typically applied as an Ultra-Low-Volume (ULV) spray where small amounts of insecticide are dispersed by aircraft or truck-mounted equipment. Adulticides may also be applied via "thermal fogs", utilizing heat to atomize droplets. Adult mosquitoes may also be targeted by "barrier treatments", which involve application of a residual insecticide to vegetation where mosquitoes are known to rest.

i. Adulticides will only be applied when established spray thresholds have been exceeded.

ii. Non-residual adulticides applied to the air column in order to impinge upon mosquitoes in flight will only be applied when the target species is active.

iii. Adulticides will be applied strictly according to label specifications. This will produce minimal effects on non-target organisms and promote efficacy. Adulticides will not be applied in rainy or windy conditions.

iv. Adulticides will only be applied by personnel trained or certified in their usage and handling, or when operating under the supervision of an individual having met the necessary certification requirements.

v. Adulticides labeled for mosquito control in part may include:

1. Organophosphates
2. Natural pyrethrins
3. Pyrethroids
4. Pyrethroid derivatives

vi. Adulticides will be applied at label rates that are efficacious as determined by monitoring. Applying doses lower than those that provide adequate control can in fact result in the need for additional adulticide treatments and might encourage development of insecticide resistance.

c. Adulticide application equipment will be calibrated and maintained per equipment manufacturer's specifications and timetable, or per instructions from the product registrant to ensure performance meets product label specifications.

7. Monitoring for Efficacy/Resistance — Resistance management techniques attempt to minimize the risk of mosquitoes becoming resistant to the existing chemicals and will be practiced in even basic programs.

a. Basic resistance management techniques can include:

i. Utilizing physical control/source reduction and biological control methodologies to the maximum extent practicable.

ii. Avoiding the use of the same class of chemical against both immature and adult mosquitoes.

iii. Applying pesticide at the rate recommended on the label. Do not underdose.

iv. Utilizing a different chemical class at the beginning and end of treatment season.

v. Assessing susceptibility at the beginning and sometime during the mosquito season.

b. Resistance management can also involve utilizing surveillance methods following larvicide or adulticide applications to continually check for control efficacy.

8. Education & Community Outreach — IMM is knowledge-based and involves a concerted effort by both control personnel and the community to manage mosquito populations based upon informed decision-making.

a. Education of the general public will be encouraged to enlist resident's support in disposing of (or modifying) oviposition habitat, proper screening methods and proper application of personal protective measures such as repellents to minimize human/mosquito contact.

b. Mosquito control programs will keep their constituents informed of surveillance and control activities to the maximum extent practicable.

c. Mosquito control personnel are strongly encouraged to maintain and upgrade their professional knowledge through continuing education training and/or attendance at professional conferences.

9. Record-keeping — Operators/applicators will record the following for each application and maintain the records for the time specified by the lead regulatory agency:

a. Applicator's name, address and pesticide applicator certification number (if applicable)
b. Application date and time of day
c. Product name and EPA registration number
d. General location of application and approximate size of area treated
e. Amount of material applied
f. Rate of application

DCIP Plan to Employ the Nine BMP Components of the Pesticide Discharge Management Plan (PDMP) as Part of the Operative VPDES Permit

1. Surveillance

a. Surveillance methods chosen.

i. Visually check for larval habitats and larval populations and determine if larval control is appropriate. Ovitraps may be used in specific occasions.

1. County Property – treatment of Park areas will only be carried out in total coordination with the Fairfax County Park Authority.
2. Private Property - residents will be encouraged to identify habitats and larval populations on their property, DCIP staff will assist upon request.

ii. Relative abundance of population levels of adult mosquitoes will be determined using one or more of the following trap types: CDC miniature light traps, gravid traps, BG-Sentinel trap, Zumba traps, Faye-Prince traps or other novel traps.

B. Adult mosquito population fluctuations will be determined using traps in ~70 selected collecting sites throughout the County that have been used since 2004.

i. Species composition
ii. Species density
iii. Mosquito testing
iv. Infection rate calculation
v. Vector index calculation
vi. Human WNV case registration

2. Mapping: In collaboration with the GIS section of the Division of EH, maps will be prepared to monitor major sources of larval/adult mosquitoes and to document areas where control measures have been instituted. Maps will help define treatment areas and can be used as appropriate in the PDMP.

3. Action Thresholds
    a. Methodology
        i. For control of immature stages
            - Per dip
            - Visual observation
        ii. For adult mosquitoes
            - Per trap period (including trap type)
            - Infection rate
            - Human cases of WNV
    b. Threshold values that trigger routine control measures.
        i. For control of immature stages:
            - An average of three immature forms per dip (with a minimum of three dips) in non-container habitats or
            - The presence of immatures in artificial containers
        ii. For adult mosquito control this methodology has been defined in the "Plan of Action" as follows:
            - **Level 0**

            Definition: Fall/winter; vector inactive, climate unsuitable for WNV transmission.

            Response: Prepare material and equipment for the upcoming WNV season. Surveillance and control programs continue as outlined in the County's Surveillance and Control Plan. Identify locations where source reduction activities can be applied; secure surveillance and control resources necessary to enable response to WNV activity; initiate community outreach and public education programs; enhance communication with surrounding jurisdictions; recruit and train new staff; communicate with and educate large property owners of the importance of source reduction in areas such as cemeteries, golf courses, country clubs; communicate status of WNV activity to Director of the Health Department, the Board of Supervisors and the public, as the WNV season starts.
            - **Level 1**

            Definition: Spring/summer/fall; anticipating WNV activity based on previous activity in region. No current surveillance findings indicating WNV activity in the area.

            Response: Respond as in level 0, plus: continue and enhance source reduction; conduct larval control in identified breeding habitats where source reduction is not possible (emphasis will be placed on known *Culex* species breeding sites); continue community outreach and public education; begin monitoring avian mortality; work with other County departments on source reduction and mosquito control activities; initiate catch basin treatment rounds.
            - **Level 2**

Definition: Spring/summer/fall; initial, sporadic or limited WNV activity in birds and/or mosquitoes.
Response: Respond as in level 1, plus: increase larval control activities; continue source reduction in cooperation with other County departments; and increase public education, emphasizing personal protection measures, particularly the use of products containing DEET, Picaridin, IR-3535 or oil of lemon eucalyptus. Enhance human surveillance and activities to quantify epizootic activity (e.g. mosquito trapping and testing) in areas of concern. Consider recommending to the public that they decrease outdoor activities when mosquitoes are biting.

- **Level 3**

Definition: Spring/summer/fall; initial confirmation of WNV in a human or a horse, or moderate WNV activity in birds and/or mosquitoes.
Response: Respond as in level 2, plus: expand public information programs (repellent use, personal protection, source reduction, risk communication about adult mosquito control program); prepare to implement adult mosquito control, if surveillance findings indicate the likely potential for human risk to persist or increase.

- **Level 4**

Definition: Spring/summer/fall; surveillance findings indicate high risk of human infection, (e.g. high or clusters of dead bird densities, high mosquito infection rates and vector index, multiple positive mosquito species, horse or other mammalian cases indicating increasing epizootic transmission, or a human case and high levels of epizootic activity) and abundant adult vectors.
Response: Respond as in level 3, plus: continue active surveillance for human cases; make final arrangements to implement adult mosquito control program in areas of potential human risk. The use of adulticides will be used in a limited manner as needed.

- **Level 5**

Definition: Spring/summer/fall; marked increase of confirmed multiple WNV cases in humans and conditions favoring continued transmission to humans.
Response: Respond as in level 4, plus: implement or intensify emergency adult mosquito control program; monitor effectiveness of adulticiding on target mosquito populations; coordinate adult mosquito control activities with surrounding jurisdictions. The FCHD activities related to adulticiding will include the following:

- CDC and gravid traps will be used in the treatment area if additional surveillance data are required.

- The FCHD will work with state entomologist and/or CDC personnel, as well as the contractor, to design and implement feasible measures to monitor the efficacy of the adulticiding activities.
- The public will be notified of adulticide schedules in advance. This will allow residents with special health concerns sufficient time to take any precautions to reduce pesticide exposure (see Public Education and Community Outreach).
- Hospitals will be notified regarding the adulticiding schedule. Information on the pesticide used will be provided to the public, physicians, and other health care providers.
- Adult mosquito control will be scheduled when mosquitoes are active and weather conditions are conducive to its success.
- Information will be released, in advance, through the media, the FCHD WNV Web page, and through news releases, the MSMS, as well as pertinent County and community.

4. Physical Control or Source Reduction
    a. Removing or modifying oviposition sites.
    b. Encourage proper storm water management practices.
5. Biological Control
    a. None foreseen.
6. Public Health Mosquitocides.
    a. Larvicides
        i. Biological larvicides
            a. Microbial larvicides
                1. *Bacillus thuringiensis israelensis* (*Bti*)
                2. *Bacillus sphaericus* (*Bs*)
                3. Spinosad
            b. Growth regulators and chitin synthesis inhibitors
                1. (S)-Methoprene
            c. Alcohol-derived monomolecular surface films
                1. Monomolecular films
        ii. Chemical larvicides
            a. Larvicidal oils
            b. Temephos
    b. Adulticides
        i. Adulticides will only be used with authorization from the County Executive.
        ii. Adulticides will only be applied when thresholds have been exceeded.
        iii. Non-residual adulticides applied to the air column will only be applied when the target species is active.
        iv. Adulticides will be applied according to label specifications.
        v. Adulticides will not be applied in rainy or windy conditions.

vi. Adulticides will only be applied by trained or certified personnel.
vii. Adulticides labeled for mosquito control in part may include:
1. Pyrethrins
2. Synthetic Pyrethroids, Pyrethroid Derivatives, Permethrin
viii. Adulticides will be applied at label rates.

c. Adulticide application equipment will be calibrated and maintained per specifications and timetable.

7. Monitoring for Efficacy/Resistance.
a. Basic resistance management techniques will include:
i. Utilizing physical control/ source reduction and biological control methodologies to the maximum extent practicable.
ii. Not using the same class of chemical against both immature and adult mosquitoes.
iii. Applying pesticide at the rate recommended on the label.
v. Assessing susceptibility when deemed necessary by the resident entomologist.

b. Utilizing surveillance methods following larvicide or adulticide applications.

8. Education & Community Outreach.
a. The public will be encouraged to enlist resident's to dispose of (or modifying) oviposition habitat, and proper application of repellents.
b. Inform constituents of surveillance and control activities.
c. Maintain and upgrade personnel's knowledge.
d. Outreach and Educational material will be evaluated yearly and updated as necessary
e. Material will be produced annually
i. 18-month Calendar
ii Children's reader
iii Reprinting material as necessary.

9. Record-keeping.
a. Applicator's name, address and pesticide applicator certification number (if applicable)
b. Application date and time of day
c. Product name and EPA registration number
d. General location of application and approximate size of area treated
e. Amount of material applied
f. Rate of application