Permit Application Contents

NOI

Documents referenced:

Receiving Waters

Figure 1. Vicinity Map

Table 1. List of named waterways

Target Organisms

Table 2. List of species controlled

Pesticides Used

Table 3. Larvicides Used

Table 4. Adulticides Used

Pesticide Application Plan

SMCMVCD Pesticide Application Plan

Additional documents referenced in the PAP:

Table 5. Source Types

Notification

Table 6. Agencies Notified

Copies of letters to agencies

References Enclosed

Best Management Practices for Mosquito Control in California

California Arbovirus Response Plan

Statement of Best Management Practices for the San Mateo County Mosquito & Vector Control District

ATTACHMENT G – NOTICE OF INTENT

WATER QUALITY ORDER NO. 2011-0002-DWQ
GENERAL PERMIT NO. CAG 990004

STATEWIDE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT FOR BIOLOGICAL AND RESIDUAL PESTICIDE DISCHARGES TO WATERS OF THE UNITED STATES FROM VECTOR CONTROL APPLICATIONS

I. NOTICE OF INTENT STATUS (see Instructions)

Mark only one item ☐ A. New Applicator ☐ B. Change of Information: WDID# 241AP00018

☐ C. Change of ownership or responsibility: WDID# ______

II. DISCHARGER INFORMATION

A. Name San Mateo County Mosquito and Vector Control District			
B. Mailing Address 1351 Rollins Road			
C. City Burlingame	D. County San Mateo	E. State CA	F. Zip Code 94010
G. Contact Person Chindi Peavey	H. Email address cpeavey@smcmad.org	I. Title Laboratory Director	J. Phone 650-344-8592 ext 32

III. BILLING ADDRESS (Enter Information *only* if different from Section II above)

A. Name			
B. Mailing Address			
C. City	D. County	E. State	F. Zip Code
G. Email address	H. Title	I. Phone	

IV. RECEIVING WATER INFORMATION

A. Biological and residual pesticides discharge to (check all that apply)*:

1. ☐ Canals, ditches, or other constructed conveyance facilities owned and controlled by Discharger.
   Name of the conveyance system: ______

2. ☑ Canals, ditches, or other constructed conveyance facilities owned and controlled by an entity other than the Discharger.
   Owner's name: (see attached map, Figure 1)
   Name of the conveyance system: most do not have names, see attached map for ones with names

3. ☑ Directly to river, lake, creek, stream, bay, ocean, etc.
   Name of water body: (see attached map, Figure 1)

* A map showing the affected areas for items 1 to 3 above may be included.

B. Regional Water Quality Control Board(s) where application areas are located (REGION 1, 2, 3, 4, 5, 6, 7, 8, or 9): Region 2
(List all regions where pesticide application is proposed.)

A map showing the locations of A1-A3 in each Regional Water Board shall be included.

V. PESTICIDE APPLICATION INFORMATION

A. Target Organisms: x Vector Larvae x Adult Vector

B. Pesticides Used: List name, active ingredients and, if known, degradation by-products
(See Table 3 Larvicides and Table 4 Adulticides)

C. Period of Application: Start Date ongoing End Date none anticipated

D. Types of Adjuvants Added by the Discharger: PBO

VI. PESTICIDES APPLICATION PLAN

A. Has a Pesticides Application Plan been prepared?*
☑ Yes ☐ No

If not, when will it be prepared? ______

* A copy of the PAP shall be included with the NOI.

B. Is the applicator familiar with its contents?

☑ Yes ☐ No

VII. NOTIFICATION

Have potentially affected governmental agencies been notified?
☑ Yes ☐ No

* If yes, a copy of the notifications shall be attached to the NOI.

VIII. FEE

Have you included payment of the filing fee (for first-time enrollees only) with this submittal?
☑ Yes ☐ NO ☐ NA

IX. CERTIFICATION

"I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment. Additionally, I certify that the provisions of the General Permit, including developing and implementing a monitoring program, will be complied with."

A. Printed Name: ROBERT B. GAY

B. Signature: [signature] **Date:** JUNE 14, 2011

C. Title: District Manager

X. FOR STATE WATER BOARD USE ONLY

WDID:	Date NOI Received:	Date NOI Processed:
Case Handler's Initial:	**Fee Amount Received:** $	**Check #:**

Pesticide Application Plan for the San Mateo County Mosquito and Vector Control District

a. Description of the target area and adjacent areas, if different from the water body of the target area;

The San Mateo County Mosquito and Vector Control District (SMCMVCD) controls mosquitoes throughout the entire county and may potentially apply larvicides to any body of standing water where mosquito larvae are found. The attached map (Figure 1) shows the area covered by the district.

b. Discussion of the factors influencing the decision to select pesticide applications for mosquito control;

A detailed description of the factors influencing the decision to use pesticides to control mosquito larvae can be found in the "**Best Management Practices for Mosquito Control in California**" and in "**Statement of Best Management Practices for the San Mateo County Mosquito and Vector Control District**". This district does not use temephos or any other organophosphate product to control mosquitoes in the larval or adult stage. The district focuses control efforts on the larval stage of mosquitoes and rarely finds it necessary to apply adulticides. The decision to treat mosquitoes in the adult stage is based on the following:

1) The presence of mosquitoes positive for West Nile virus
2) Adult floodwater mosquitoes detected by CO2 traps at high densities near places of human habitation AND a high volume of reports from members of the public experiencing high numbers of mosquito bites. These conditions are reflective of a failure of larval control to prevent emergence of adult mosquitoes from seasonal impounds (typically saltmarsh) causing a significant impact on the health and quality of life of the district's residents. This situation has occurred historically on 3 occasions in the past 11 years.

c. Description of the types and locations of the anticipated application area* and the target area to be treated by the Discharger, recognizing that, with vector control, the precise locations may not be known until after surveillance;

Any site that holds water for more than 96 hours (4 days) can produce mosquitoes. Table 1 contains a list of named waterways in which mosquito control applications could be made. In addition there are a far greater number of unnamed temporary water bodies which are treated. Source reduction is the District's preferred solution, and whenever possible the district works with property owners to effect long-term solutions to reduce or eliminate the need for continued applications as described in "**Best Management Practices for Mosquito Control in California**". The typical types of sources treated for larval mosquitoes by this district include those listed in Table 5.

d. Other control methods used (alternatives) and their limitations;

With any mosquito or other vector source, the district's first goal is to look for ways to eliminate the source, or, if that is not possible, for ways to reduce the vector potential. The most commonly used methods and their limitations are included in the "**Best Management Practices for Mosquito Control in California**".

Specific methods used by the District include stocking mosquito fish (*Gambusia affinis*), educating residents that mosquitoes develop in standing water and encouraging them to remove sources of standing water on their property, and working with property owners to find long-term water management strategies that meet their needs while minimizing the need for public health pesticide applications. However, each of these alternatives present significant limitations and cannot always be used. Introduction of fish is restricted to manmade sources such as backyard ornamental ponds and horse troughs in this county. Public education is helpful, but small sources of standing water in yards are only a fraction of the places where mosquito larvae develop in this county and cannot, in itself, remove the threat of vector-borne disease. The district works with property owners whenever possible to reduce sources, but there are many other environmental regulations which restrict a property owner's ability to make physical changes to wetlands on their land or makes such work a monumental undertaking. The district does not have the resources to carry out large physical control projects and under the Health and Safety code, such projects are the responsibility of property owners themselves. For a detailed description of the limitations of each type of alternative please see attached document **"Statement of Best Management Practices for the San Mateo County Mosquito and Vector Control District"**

e. **Approximately how much product is anticipated to be used and how this amount was determined**
It is anticipated that the district will apply materials in amounts similar to those applied in previous years. In 2010, the district applied the following active ingredients in the following amounts

Active Ingredient	Lbs AI Applied
Bacillus sphaericus	9
Bacillus thuringiensis israelensis	**43**
Methoprene	**211**
BVA 2 Oil	**20,903**
Golden Bear Oil	**114**

The district does not anticipate applying adulticides, but has needed to apply them on occasion in the past. Reviewing past records, adulticiding from truck foggers has occurred in 3 of the past 11 years. In the past 4 years, the district has applied less than 35 fluid ounces of pyrethrins per year and it has been used under buildings, nowhere near waters of the US. In 2006, a fly-off of salt marsh mosquitoes occurred, and it became necessary to treat 3,000 acres in residential areas with truck mounted ULV foggers. Approximately 1 gal of pyrethrins and 1.3 gal of resmethrin were used that year. No adulticiding is currently planned for future years, but the district may apply similar amounts if there is a mass emergence again that cannot be controlled with larvicides.

f. **Representative monitoring locations* and the justification for selecting these monitoring locations**
The district is a member of the MVCAC Monitoring Coalition. Please see the MVCAC NPDES Coalition Monitoring Plan for monitoring locations

g. **Evaluation of available BMPs to determine if there are feasible alternatives to the selected pesticide application project that could reduce potential water quality impacts; and**
Please see the discussion of alternatives and their limitations in the **"Statement of Best Management Practices for the San Mateo County Mosquito and Vector Control District".**

h. **Description of the BMPs to be implemented**
The BMP's described in detail in the **"Best Management Practices for Mosquito Control in California"** will be implemented whenever feasible. Their use on individual sources will depend on conditions such as 1) the presence of endangered species or sensitive habitat, 2) the willingness of landowners to expend the resources necessary to implement physical control, and 3) whether

regulatory agencies such as Calif. Fish and Game, the USFW and the State Board of Water Resources will allow these activities to occur.

2. The Discharger shall update the PAP periodically and submit the revised PAP to the State Water Board for approval if there are any changes to the original PAP.
The district reviews its practices and conditions in the field regularly and will contact the water board if there are any changes in the PAP.

D. Best Management Practices (BMPs)
The Discharger shall develop BMPs that contain the following elements:

The district's BMPs are described in the **"Best Management Practices for Mosquito Control in California"** and the **"California Mosquito-borne Virus Surveillance and Response Plan"** and the **"Statement of Best Practices for the San Mateo County Mosquito and Vector Control District"**.

1. **Identify the Problem**
   Prior to first pesticide application covered under this General Permit that will result in a discharge of residual pesticides to waters of the US, and at least once each calendar year thereafter prior to the first pesticide application for that calendar year, the Discharger must do the following for each vector management area:
   a. **Establish densities for larval and adult vector populations to serve as action threshold(s) for implementing pest management strategies**

      Only those mosquito sources that District staff determine to represent imminent threats to public health or quality of life are treated. The presence of any mosquito may necessitate treatment, however, higher thresholds may be applied depending on the district's resources, disease activity, or local needs. Treatment thresholds are based on a combination of one or more of the following criteria:
      - Mosquito species present
      - Mosquito stage of development
      - Pest, nuisance, or disease potential
      - Disease activity
      - Mosquito abundance
      - Flight range
      - Proximity to populated areas
      - Size of source
      - Presence/absence of natural enemies or predators
      - Presence of sensitive/endangered species.

   b. **Identify target vector species to develop species-specific pest management strategies based on developmental and behavioral considerations for each species;**

      Please see Table 2 for a list of species controlled in San Mateo County. The strategies used for these species is described in the **"Best Management Practices for Mosquito Control in California"** and the **"California Mosquito-borne Virus Surveillance and Response Plan"**.

   c. **Identify known breeding areas for source reduction, larval control program, and habitat management; and**

      Any site that holds water for more than 96 hours (4 days) can produce mosquitoes. Source reduction is the district's preferred solution, and whenever possible the District works with property owners to effect long-term solutions to reduce or eliminate the need for continued applications as described in **"Best Management Practices for Mosquito Control in California".** The district maintains a database of known sources of larval development and field technicians carry a copy of this database while recording larval control applications.

d. **Analyze existing surveillance data to identify new or unidentified sources of vector problems as well as areas that have recurring vector problems.**

This practice is included in the **"Best Management Practices for Mosquito Control in California"**, the **"California Mosquito-borne Virus Surveillance and Response Plan"** and the **"Statement of Best Management Practices for the San Mateo County Mosquito and Vector Control District"** that describe the district's control program. The district continually collects adult and larval mosquito surveillance data, dead bird reports, and sentinel chicken test results and uses them to guide mosquito control activities. The district maintains a computerized database of sources of mosquito development and work that has been carried out at each location. Vector control technicians carry laptop computers in the field with copies of this database and have access to records of all the work that has been done at each site. The schedule of inspections and decisions on the kind of control applied are based on information they obtain from this database. In addition, technicians continually search for new sites, sample water for larvae and answer requests for service from the public.

2. **Examine the Possibility of Alternatives**
Dischargers should continue to examine the possibility of alternatives to reduce the need for applying larvicides that contain temephos and for spraying adulticides. Such methods include:
a. Evaluating the following management options, in which the impact to water quality, impact to non-target organisms, vector resistance, feasibility, and cost effectiveness should be considered:
   - **No action**
   - **Prevention**
   - **Mechanical or physical methods**
   - **Cultural methods**
   - **Biological control agents**
   - **Pesticides**

b. Applying pesticides only when vector are present at a level that will constitute a nuisance
c. Using the least intrusive method of pesticide application.
d. Public education efforts to reduce potential vector breeding habitat.
e. Applying a decision matrix concept to the choice of the most appropriate formulation.

This describes the district's existing integrated vector management (IVM) program, as well as the practices described in the **"California Mosquito-borne Virus Surveillance and Response Plan"** and **"Best Management Practices for Mosquito Control in California"** that are used by this agency. This district does not use temephos or malathion or Naled. Analysis of the alternatives and their limitations is presented in the **"Statement of Best Management Practices for the San Mateo County Mosquito and Vector Control District".**

3. **Correct Use of Pesticides**
Users of pesticides must ensure that all reasonable precautions are taken to minimize the impacts caused by pesticide applications. Reasonable precautions include using the right spraying techniques and equipment, taking account of weather conditions and the need to protect the environment.
   a. **All errors in application and spills are reported to the proper authority.**

b. Staff training in the proper application of pesticides and handling of spills.

This is an existing practice of the district, and is required to comply with the Department of Pesticide Regulation's (DPR) requirements and the terms of our California Department of Public Health (CDPH) Cooperative Agreement. All pesticide applicators receive annual safety and spill training in addition to their regular continuing education.

E. Pesticide Application Log

The Discharger shall maintain a log for each pesticide application. The application log shall contain, at a minimum, the following information, when practical, for larvicide or adulticide applications:

1. Date of application;
2. Location of the application and target areas (e.g., address, crossroads, or map coordinates);
3. Name of applicator;
4. The names of the water bodies treated (i.e., canal, creek, lake, etc.);
5. Application details, such as application started and stopped, pesticide application rate and concentration, flow rate of the target area, surface water area, volume of water treated, pesticide(s) and adjuvants used by the Discharger, and volume or mass of each component discharged;

This is an existing practice of the district as required to comply with DPR regulations and our CDPH Cooperative Agreement requirements. This district maintains a computerized database in which applicators log this information for all pesticide applications.

References:

Best Management Practices for Mosquito Control in California. 2010. Enclosed and available from the California Department of Public Health—Vector-Borne Disease Section, (916) 552-9730 or by download from http://www.westnile.ca.gov/resources.php under the heading Mosquito Control and Repellent Information.

California Mosquito-borne Virus Surveillance and Response Plan. 2011. [Note: this document is updated annually by CDPH]. Enclosed and available from the California Department of Public Health—Vector-Borne Disease Section, (916) 552-9730 or by download from http://www.westnile.ca.gov/resources.php under the heading Mosquito Control and Repellent Information.

Statement of Best Management Practices for the San Mateo County Mosquito and Vector Control District. 2011. This document was written in 2004 and has been updated several times. The enclosed document is the most recent update. Additional copies of this document are available from the San Mateo County Mosquito and Vector Control District (650) 344-8592.

MVCAC NPDES Coalition Monitoring Plan. [due to the short time frame allowed by the recent hearing in Sacramento, the final plan is In development at the time of this submission, a draft has been submitted to the state water board by the coalition for review]

Figure 1. Vicinity Map

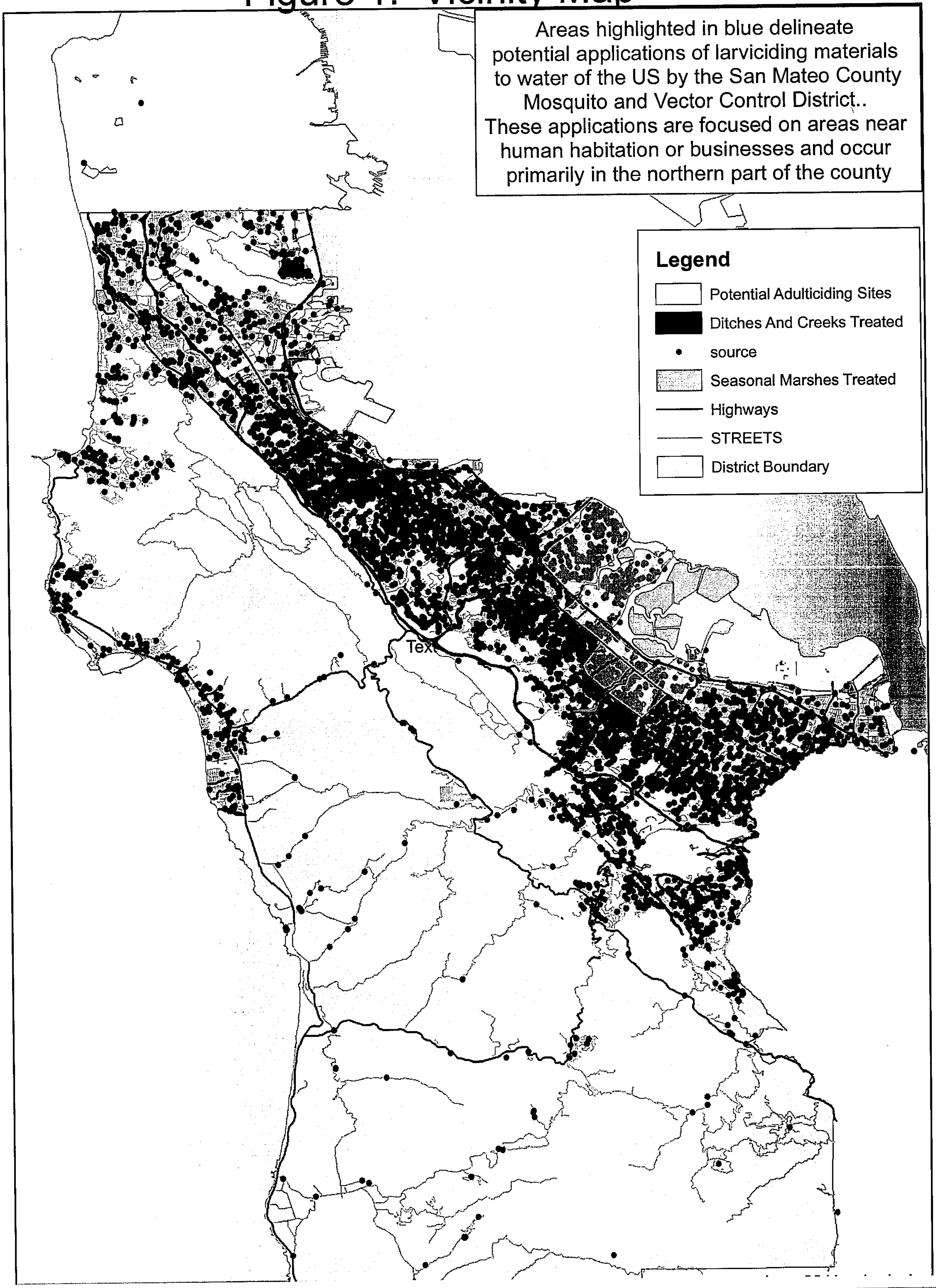

Table 1. List of named waterways, portions of which are treated for mosquitoes. Most of the sources treated by the San Mateo County Mosquito and Vector Control District are temporary, seasonal bodies of water which do not have officially recognized names. The list below represents only those water bodies with names. Furthermore, when a named source is treated, the area treated is not the entire extent of the water body, but only those sections that have been found to produce mosquitoes.

Waterway Name	City
Atherton Channel	Atherton
Millbrae Creek	Millbrae
Adeline Creek	Burlingame
Davis Creek	Burlingame
Easton Creek	Burlingame
Sanchez Creek	Burlingame
7^{th} Day Adventist Creek	Burlingame
Ralston Creek	Burlingame
Burlingame Creek	Burlingame
Cherry Creek	Burlingame
Mills Creek	Burlingame
San Mateo Creek	San Mateo
Borel Creek	San Mateo
Laurel Creek	San Mateo
Fernwood Creek	San Mateo
East Laurel Creek	San Mateo
Peninsula Creek	San Mateo
Polhemus Creek	San Mateo
Portola Creek	San Mateo
Notre Dame Creek	Belmont

Belmont Creek	Belmont
Los Trancos Creek	Menlo Park
Cordilleras Creek	Redwood City
Club Creek	Redwood City
Granger Creek	Redwood City
Stulstaft Creek	Redwood City
Bair Island	Redwood City
Belmont/Ralston Creek	San Carlos
Brittan Creek	San Carlos
Pulgas Creek	San Carlos
Dry Creek	Woodside
Bear Gulch Creek	Woodside
Corte Madera Creek	Portola Valley
Searsville Lake	Portola Valley
Alambique Creek	Woodside
Sausal Creek	Woodside
West Union Creek	Woodside
Westridge Creek	Woodside
Arroyo Canada Verde	Half Moon Bay
Pilarcitos Creek	Half Moon Bay
Mori Point Marsh	Pacifica
Laguna Salada	Pacifica

Table 2. Target Organisms. The following is a description of the mosquito species controlled by the San Mateo County Mosquito and Vector Control District.

***Aedes dorsalis* (Salt marsh mosquito)**
This species is found year-round in tidal salt marsh areas. The eggs are laid in the marsh and hatch when the marsh is filled by high tides. Adults are strong fliers and aggressively pursue hosts, including humans. This species is capable of producing very high numbers near marsh areas and can fly great distances. Adults are commonly active within 7 miles and have been documented up to 20 miles from their larval source.
Threshold = 0.25 per dip (ie: 1 per 4 dips)

***Aedes squamiger* (Winter salt marsh mosquito)**
This species is produced in the marshes and impounds along the edges of the Bay. The eggs are laid on the marsh in the spring and hatch as soon as the marsh fills with rainwater in the fall. Adults emerge the following spring. Most of the control effort occurs during the winter. Adults can fly long distances. The adult is a very aggressive biter and is very noticeable to the public. This species is capable of reaching very high numbers.
Threshold = 0.25 per dip (ie: 1 per 4 dips)

***Aedes washinoi* (Woodland pool mosquito)**
This mosquito is produced in woodland depressions that fill with water. Eggs are laid on the mud and organic material along the edges of receding water in these areas. Adults, generally present in the early spring, are very aggressive, and may be found in large numbers. *Aedes washinoi* is one of a complex of closely related species with similar ecology that includes *Ae. increpitus* and *Ae. clivis*. *Aedes washinoi* occurs along the coast and into the Central Valley, *Ae. increpitus* is found primarily on the Eastern slope of the Sierra Nevada to the crest. *Ae. clivis is* found from the crest westward into the western foothills of the Sierra Nevada.
Threshold = 0.25 per dip (ie: 1 per 4 dips)

***Aedes sierrensis* (Tree hole mosquito)**
This species breeds in tree holes (rot cavities or depressions in tress which hold water). If near trees and partially filled with organic debris, containers such as tires and buckets may produce these mosquitoes. The eggs hatch when the tree hole or container fills with water. The adults hatch in March and remain in the area until early summer. This mosquito has a short flight range, is an aggressive biter, and is the primary vector of Canine heartworm in California. It is found in any area where suitable tree holes are found.
Threshold = 0.25 per dip (ie: 1 per 4 dips)

***Anopheles freeborni* (Western malaria mosquito)**
Anopheles freeborni and *An. hermsi* cannot be separated morphologically. *Anopheles freeborni* is found throughout California, except on the coast and interior valleys that border the deserts south of the Tehachapi Mountains where *An. hermsi* occurs. Larvae of these species are found in clear water that contains algae and is well-lit. In the fall, the adult females may travel long distances and enter homes while seeking overwintering sites. On warm days during the winter and in the spring, females emerge from overwintering sites and seek a blood meal. Females are large, aggressive, and active during the day. *An freeborni* was the primary vector of human malaria in the Sacramento Valley in the early 1900s and the principal reason mosquito control was instituted in California. Although malaria is no longer endemic in this state, this species is capable of vectoring the disease, should the pathogen be re-introduced.
Threshold = 0.25 per dip (ie: 1 per 4 dips)

Anopheles hermsi

Anopheles hermsi and *An. freeborni* cannot be separated morphologically. *Anopheles hermsi* is found mostly along the coast and interior valleys of southern California south of San Francisco with smaller separate populations in northern California. Larval habitat, overwintering mechanism, and adult feeding behavior are similar to *An. freeborni*. *Anopheles hermsi* is the most efficient transmitter of the human malaria in the United States.

Threshold = 0.25 per dip (ie: 1 per 4 dips)

***Culex erythrothorax* (Tule mosquito)**

Culex erythrothorax is widely distributed throughout the lower elevations of California. Larvae usually live in permanent or semi-permanent sources of water which contain large stands of cattails or tules. They are extremely sensitive to vibration and dive quickly so detecting them as immature is difficult. Adult females feed at night equally on mammals and birds; they will feed on humans in the shade or after sunset. *Culex erythrothorax* can become a major pest to human and other vertebrates that reside near their breeding habitats. This mosquito has been found naturally infected with St. Louis encephalitis virus, western equine encephalitis virus and West Nile virus. This species overwinters as mature larvae.

Threshold = 0.25 per dip (ie: 1 per 4 dips)

***Culex pipiens* (House mosquito)**

This mosquito is generally an urban problem. It thrives in small sources and containers with a high concentration of organic material. Storm drains, catch basins, utility vaults, septic tanks, flooded basements, and sumps provide ideal development sites. This species is also commonly found in discarded containers in residential yards that fill with rainwater. Adults can be found all year but are most common during warmer months (spring through fall). These mosquitoes readily enter homes, usually biting at night.

Threshold = 1 per dip

***Culex stigmatosoma* (Banded foul water mosquito)**

This species breeds in a variety of natural and man-made sources, including dairy waste ponds and sewage treatment ponds. The females can fly far from their larval sources. Peak adult activity occurs during the summer months.

Threshold = 1 per dip

***Culex tarsalis* (Encephalitis mosquito)**

This mosquito is produced in rain pools, marshes, swimming pools, ponds, and other relatively clean fresh-water sources. This species feeds primarily on birds and is only moderately aggressive towards man. However, they are potential vectors of mosquito-borne encephalitis viruses and are therefore of special concern to MVCDs.

Threshold = 1 per dip

***Culiseta inornata* (Winter marsh mosquito)**

Females of this species rest during the summer and become active in the fall after the first rains. Eggs are laid on the surface of rain-filled ponds in the fall. Many generations can be produced in a single season. This mosquito bites at dusk in the fall and spring. They are moderately aggressive, quite large, and may reach very high numbers. It is very noticeable to the public because of its size and activity. Adults this species are generally found close to temporary fresh- water sources. Seasonal waterfowl areas(that range from fresh to brackish) produce high numbers of this species during the fall and winter months.

Threshold = 1 per dip

***Culiseta incidens* (Fish pond mosquito)**
Immatures of this species develop in fishponds, creeks, and containers. Adults are moderately aggressive, biting in the evening or shaded areas during the day. Their large size makes this species very noticeable to urban residents. It is primarily a problem of urban and suburban areas.
Threshold = 1 per dip

Table 3. List of Larvicides used by the San Mateo County Mosquito and Vector Control District

Product Name	Active Ingredient
Agnique MMF	Ethoxylated alcohol
Altosid Liquid Larvicide	s-methoprene
Altosid Pellets 4.25	s-methoprene
Altosid 2.1 XR briquets	s-methoprene
Altosid 8.6 briquets	s-methoprene
Altosid XRG	s-methoprene
Altosid WSP	s-methoprene
BVA 2 Oil	Aliphatic Petroleum Hydrocarbons (highly-refined petroleum distillates)
FourStar Bti Briquets 45	*Bacillus thuringiensis var. israelensis*
FourStar Bti Briquets 150	*Bacillus thuringiensis var. israelensis*
Golden Bear Oil (GB1111)	Aliphatic Petroleum Hydrocarbons (highly refined, petroleum-based "napthenic oil")
Natular	Spinosad
Vectobac 12AS	*Bacillus thuringiensis var. israelensis*
Vectolex CG	*Bacillus sphaericus*
Vectolex G Granules	*Bacillus sphaericus*
Vectolex WDG	*Bacillus sphaericus*
Vectolex WSP	*Bacillus sphaericus*

Table 4. List of products used by the San Mateo County Mosquito and Vector Control District to control adult mosquitoes.

Product Name	Active Ingredient
Pyrenone Crop Spray	Pyrethrins
Pyrenone 25-5 Public Health Insecticide	Pyrethrins
Scourge Insecticide with Resmethrin/Piperonyl Butoxide 18%+54% MF	Resmethrin
Scourge Insecticide with Resmethrin/Piperonyl Butoxide 4%+12% MF	Resmthrin
Zenivex E20	Etofenprox

Table 5. Description of the types of sources treated for larval mosquitoes by the San Mateo County Mosquito and Vector Control District

Sources are any place that holds water and provides a habitat for mosquito larva to grow. The below defined sources are the types generally used by the San Mateo County Mosquito and Vector Control District for describing the place where mosquito larva are found or adult mosquitoes have emerged. Categorizing by Agricultural, Natural, Domestic or Commercial is used to loosely define where these sources are found, but is not restrictive in the use e.g. a fish pond is a fish pond whether in a commercial establishment or private residence, etc.

AGRICULTURAL

Pastures: Irrigated fields. Water source - irrigation water

Stock Ponds: Artificially constructed ponds to catch and hold runoff water used for stock watering or irrigation. Source of water - natural runoff.

Horse troughs: Tanks, troughs, or other containers used for watering stock. Source of water - pumped.

NATURAL

Creeks: Natural, or slightly modified main channels of creeks. Source of water - rainfall, natural runoff, domestic or agricultural runoff.

Creek potholes: Potholes holding water that are separated from main creek channel. Source of water - natural runoff, seepage from main channel.

Freshwater marshes: Shallow marshy areas, artificial or natural with emergent vegetation. Source of water - natural or artificial runoff, rainfall.

Impounds: Water that collects in low areas or depressions in vacant lots, fields or other areas. Source of water – rainfall, natural runoff, domestic or agricultural runoff.

Saltmarshes (tidal): Marshes subject to natural tidal action. Source of water - tidal, rain.

Saltmarshes (diked): Marshes not subject to natural tidal action, usually contained by levees or other water control structures. Source of water - rain, tidal (control structures or overflow of levees).

Lakes: Large (20 acres+) natural or artificial bodies of water, usually deeper than 20 feet. Source of water - natural runoff, rainfall, pumped.

Ponds: Small (less than 20 acres) natural or artificial bodies of water, usually shallower than 20 feet. Source of water - natural runoff, drainage from artificial watershed, rain, pumped.

Treeholes: Rot cavities or cavities caused by tree growth (pans).

Source of water - rainfall and occasionally from irrigation.

Other: This source is used for natural sources not covered above.

DOMESTIC

Fish ponds: Artificially constructed landscape ponds for fish or accent. Source of water - pumped, rainfall.

Septic tanks: Underground storage and processing tanks for sewage. Source of water - sewer.

Wells: Drilled or dug wells for water, usually old and no longer used. Source of water - natural water table level.

Swimming pools: In ground or above ground swimming pools. Source of water - pumped, rainfall.

Bird baths: Small pools or ornamental structures for bird watering. Source of water - pumped, rain.

Cesspools: Open collection ponds for sewage (no longer legal). Source of water - sewage.

Water under buildings: Water in basements or under a structure. Source of water - sewage, seepage, runoff.

Domestic - containers: Any container - buckets, tubs, boat, barrel, wheelbarrows, etc. found in a yard and containing water. Source of water - rainfall, irrigation, pumped.

COMMERCIAL

Catch basins, gutters: Basins or gutters used to collect and direct runoff water. Found in streets, parking lots, loading docks or private driveways. Source of water - rainfall, irrigation, seepage, pumped.

Storm drains: Underground structures for carrying runoff water. Source of water - rainfall, runoff from irrigation, seepage.

Gravel pit: Pond or pit created to mine gravel. Source of water - rainfall, natural ground water.

Borrow pit: Pits or depressions created to obtain soil for construction. Usually found along railroad tracks, highways or occasionally buildings. Source of water - rainfall, runoff.

Sewer treatment plants: Ponds and water holding structures used for sewage treatment.

Source of water - sewer.

Utility vaults: Underground structures constructed for utilities - PG&E, water departments, telephone, Western Union, or private. Source of water - rainfall, seepage, runoff.

Cemetery urns: Containers provided for flower on grave sites. Source of water - rainfall, irrigation.

Sumps: Holding ponds or structures for collecting industrial waste water or runoff. Source of water - rainfall, runoff, industrial processes.

Sewer lines: Underground structures for collecting and carrying sewage. Source of water - sewer.

Tanks: Tanks and vats. Source of water - rainfall, pumped, irrigation.

Channel (lined): Channels lined with rock or concrete used for flood control or to collect runoff. Source of water - rainfall, runoff.

Channel (unlined): Channels with soil bottoms and sides used for flood control or to collect runoff. Source of water - rainfall, runoff.

Waste water marsh: Marsh constructed to hold or treat waste water, usually sewage. Source of water - sewage, runoff, occasionally industrial waste water.

Tires: Stored or discarded tires. Source of water - rain, irrigation.

Broken or Leaking pipes: Water sources created by broken or leaking pipes. Source of water – pumped.

Seepage: Water sources created by seepage from natural or unknown sources. Source of water -seepage from springs, ground water, or subterranean runoff.

Commercial other: Commercial sources not covered by above.

Definitions for the source of the water

The general descriptions of the source of the water are used throughout these descriptions.

Irrigation: Water used for irrigating crops or watering landscaping.

Rainfall: Water accumulating directly from rain.

Runoff: Water from surface runoff from rain, irrigation, or other sources.

Pumped: Water from municipal, well, or commercial source.

Sewer: Water from black or gray water sewage.

Seepage: Water from subterranean natural or unknown source.

Table 6. List of government agencies notified

California State Dept of Fish and Game
Charles Armor, Regional Manager
7329 Silverado Trail
Yountville, CA 94558

Midpeninsula Regional Open Space District
Administrative Office
330 Distel Circle
Los Altos, CA 94022-1404

Joanne Kerbavaz, Ecologist
San Mateo Coast Sector Office for California State Parks
Half Moon Bay State Beach
95 Kelly Avenue
Half Moon Bay, CA 94019

Meg Marroitt, Biologist
San Francisco Bay National Wildlife Refuge Complex
PO Box 524
Newark, CA 94560

Sam Herzberg, Senior Planner
San Mateo County Parks
455 Government Center, 4th Floor
Redwood City, CA 94063-1646

San Mateo County
Mosquito and Vector Control District
1351 Rollins Rd
Burlingame CA 94010
(650) 344-8592 Fax (650) 344-3843
www.smcmad.org

Statement of Best Management Practices for San Mateo County Mosquito and Vector Control District

BACKGROUND

The San Mateo County Mosquito and Vector Control District (SMCMVCD) conducts vector control activities under health and safety statutory mandates and requirements laid out in the California Health and Safety Code, Division 3. While various mosquito larvicides used by the SMCMVCD are directly applied to water bodies with the purpose and intent of killing mosquito larvae, extensive research has indicated that little or no lasting environmental impacts are imparted. Currently used aquatic pesticides (*Bacillus thuringiensis israelensis*, *B. sphaericus* and *methoprene*) degrade rapidly in the environment, thus the real extent and duration of residues may be considered negligible. When integrated with other strategies including physical and biological control, these aquatic pesticides constitute safe and effective best management practices (BMPs).

This document presents and discusses the BMPs of the SMCMVCD. The SMCMVCD is confident that currently established practices are environmentally safe due to the use of non-toxic or less toxic alternatives and proven BMP systems. Additionally, the aquatic pesticides are applied at rates sufficiently low to leave the physical parameters of the environment (i.e., temperature, salinity, turbidity and pH) unchanged.

<u>Statement of Best Management Practices</u>

INTRODUCTION

The SMCMVCD is one of the oldest organized programs of mosquito control in North America, it has been in existence since 1916. The district was formed (pursuant to California Health and Safety Code Sections 2200-2280) by local citizens and governments to reduce the risk of vector-borne disease or discomfort to the residents of San Mateo County. This includes vector-borne diseases such as mosquito-borne encephalides and malaria. Vector control districts are indirectly regulated by the Department of Pesticide Regulation (DPR). Supervisors and applicators are licensed by the California Department of Public Health (CDPH). Pesticide use by the district is reported to the County Agricultural Commission (CAC) in accordance with a Memorandum of

Understanding between DPR, CDPH, and the CAC for the Protection of Human Health from the Adverse Effects of Pesticides. Pursuant to Health and Safety Code section 116180, local vector control districts operate under a cooperative agreement with the CDPH for applications of public health pesticides,

The SMCMVCD has implemented Best Management Practices (BMP)s based on the philosophy of integrated vector management (IVM). The basic components of the program is: (1) surveillance of vector populations, (2) determination of treatment thresholds, (3) selection from a variety of control options including physical, cultural, biological and chemical techniques, (4) training and certification of applicators and (5) public education.

1. MOSQUITO SURVEILLANCE

Surveillance of vector populations is essential for assessing the necessity, location, timing and choice of appropriate control measures. It reduces the areal extent and duration of pesticide use, by restricting treatments to areas where mosquito populations exceed established thresholds. The 20 mosquito species known in San Mateo County (Table 2) differ in their biology, nuisance and disease potential and susceptibility to larvicides. Information on the species, density, and stages present is used to select an appropriate control strategy from integrated pest management alternatives.

A. Larval Mosquito Surveillance

SMCMVCD staff assigned to zones within the district conduct surveillance of immature mosquitoes. These technicians maintain a list of known mosquito developmental sites and visit them on a regular basis. When a site is surveyed, water is sampled with a 1-pint dipper to check for the presence of mosquitoes. Samples are examined in the field or laboratory to determine the abundance, species, and life-stage of mosquitoes present. This information is compared to historical records and used as a basis for treatment decisions.

B. Adult Mosquito Surveillance

Although larval mosquito control is preferred, it is not possible to identify all larval sources. Therefore, adult mosquito surveillance is needed to pinpoint problem areas and locate previously unrecognized or new larval developmental sites. Adult mosquitoes are sampled using standardized trapping techniques (i.e., New Jersey light traps, carbon dioxide-baited traps and oviposition traps).

Mosquitoes collected by these techniques are counted and identified to species. The spatial and seasonal abundance of adult mosquitoes is monitored on a regular basis and compared to historical data.

C. Service Requests

Tracking mosquito complaints from residents augments information on adult mosquito abundance from traps. Analysis of service requests allows district staff to gauge the success of control efforts and locate undetected sources of mosquito development. The SMCMVCD conducts public outreach programs and encourages local residents to contact them to request services. When such requests are received, technicians visit the area, interview residents and search for sources that may have been missed. Residents are asked to provide a sample of the insect causing the problem. Identification of these samples provides information on the species present and can be helpful in locating the source of the complaint.

2. PRE-TREATMENT DECISION-MAKING

A. Thresholds

Treatment thresholds are established for mosquito developmental sites where potential disease vector and/or nuisance risks are evident. Therefore, only those sources that represent imminent threats to public health or quality of life are treated. Treatment thresholds are based on the following criteria:

- Mosquito species present
- Mosquito stage of development
- Nuisance or disease potential
- Mosquito abundance
- Flight range
- Proximity to populated areas
- Size of source
- Presence/absence of natural enemies or predators
- Presence of sensitive/endangered species

B. Factors in Selection of Strategy for Control

1. Factor Considered for Control of Immature Mosquitoes

The District's integrated vector management program focuses on controlling mosquitoes in the larval stage, before they emerge as biting adults. **The decision to apply larval control is based on a number of criteria:**

- Mosquito species present and their density
- Disease potential
- Flight range – larval control for species with small ranges is only done when the sources is close to human residences or businesses
- Stage of development -when adults, later stage larvae or pupae are present, control is more urgent. Also, no all control products work equally well on all stages.
- Proximity to populated areas – mosquitoes with small ranges that are not near humans are less of a health threat and less likely to be controlled
- Size of source and extent of area colonized by mosquitoes
- Presence/absence of predators
- Presence/absence of sensitive/endangered species

Control strategies are selected to minimize their impact on the environment while maximizing the degree of control. **The method used is based on the criteria above as well as:**

- Habitat type

- Water conditions and quality
- Cost and feasibility
- Site accessibility
-Weather conditions
- Cost, and Resources available

Potential control strategies include
- Physical alteration of the site to discourage mosquito development (source reduction or physical control)
- Application of biological agents (biological control)
- Application of chemicals (chemical control).

Ultimate decisions regarding the need for the application of pesticides rest on the field staff based on information acquired from surveillance data. Decisions to apply a particular product are made in accordance to the district's California Environmental Quality Act (CEQA) Mitigated Negative Declaration including threshold levels and other information regarding habitat type, distance from populated areas, and water quality data. When thresholds are exceeded an appropriate control strategy is implemented. Control strategies are selected to minimize potential environmental impacts while maximizing efficacy and protecting public health.

3. CONTROL STRATEGIES

A. Source Reduction

Source reduction includes elements such as physical control, habitat manipulation and water management, and forms an important component of the IVM program of the SMCMVCD.

B. Physical Control

The goal of physical control is to eliminate or reduce mosquito production at a particular site through alteration of habitat. Physical control is usually the most effective mosquito control technique because it provides a long-term solution by reducing or eliminating mosquito developmental sites and ultimately reduces the need for chemical applications.

Historically (circa 1908), the first efforts to control mosquitoes in San Mateo County were projects undertaken to reduce the populations of salt marsh mosquitoes in diked, reclaimed marshes. Networks of ditches were created by hand to enhance drainage and promote tidal circulation. Since then, various types of machinery have been used since then to create ditches necessary to promote water circulation in mosquito control districts in the San Francisco Bay region. In recent years, a number of environmental modification projects have been undertaken by some Coastal Region Districts in collaboration with the U.S. Fish and Wildlife Service (USFWS) to reduce potential mosquito developmental sites and enhance wildlife habitat. Re-circulation ditches allow tidewater to enter the marsh at high tide and drain off at low tide. Water remaining in the ditch bottoms at low tide provides habitat for mosquito-eating fish. These projects have reduced the need to apply chemicals on thousands of acres of salt marsh in the San Francisco Bay. Similar projects have been undertaken with other agencies. Physical control programs conducted by the SMCMVCD may be categorized into three areas: "maintenance", "new construction", and "cultural practices" such as vegetation management and water management.

Maintenance activities are conducted within tidal, managed tidal and non-tidal marshes, seasonal wetlands, and diked, historic bay lands and in some creeks adjacent to these wetlands. The following activities are classified as maintenance:

- Removal of sediments from existing water circulation ditches
- Repair of existing water control structures
- Removal of debris, weeds and emergent vegetation in natural channels
- Clearance of brush for access to streams tributary to wetland areas
- Filling of existing, non-functional water circulation ditches to achieve required water circulation dynamics and restore ditched wetlands.

The preceding activities are included within the permits required by U.S. Army Corps of Engineers (USACE) and San Francisco Regional Water Quality Control Board (SFRQWB) (Waste Discharge) and coordinated by the California DHS. Additional agencies involved include the Coastal Conservancy and San Francisco Bay Conservation and Development Commission.

New projects, such as wetland restoration, excavation of new ditches, construction of new water control structures, all require application by individual districts directly to the USACE. Currently, the SMCMVCD does not have the resources available to conduct physical control projects. Instead, the district tries to work with landowners to manage their lands in a manner that does not promote mosquito development. Staff from the SMCMVCD review proposals for wetlands construction to assess their impact on mosquito production. District staff then submit recommendations on hydrological design and maintenance that will reduce the production of mosquitoes and other vectors. This proactive approach involves a collaborative effort between landowners and SMCMVCD. Implementation of these standards may include cultural practices such as water management and aquatic vegetation control.

C. Biological control

Biological control agents of mosquito larvae include predatory fish, predatory aquatic invertebrates and mosquito pathogens. Of these, only mosquitofish are available in sufficient quantity for use in mosquito control programs. Natural predators may sometimes be present in numbers sufficient to reduce larval mosquito populations. Biological control is sometimes used in conjunction with selective bacterial or chemical insecticides.

Mosquitofish (*Gambusia affinis*)

The mosquitofish, *Gambusia affinis*, is a natural predator of mosquito larvae used throughout the world as a biological control agent for mosquitoes. Although not native to California, mosquitofish are now ubiquitous throughout most of the State's waterways and tributaries, where they have become an integral part of aquatic food chains. They can be stocked in mosquito larval sources by trained district technicians or distributed to the public for stocking in backyard ornamental ponds and other artificial containers.

Advantages: The use of mosquitofish as a component of an IPM program may be environmentally and economically preferable to habitat modification or the exclusive use of pesticides, particularly in altered or artificial aquatic habitats. Mosquitofish are self-propagating, have a high reproductive potential and thrive in shallow, vegetated waters preferred by many mosquito species. They prefer to feed at the surface where mosquito larvae concentrate. These fish can be readily mass-reared for stocking or collected seasonally from sources with established populations for redistribution.

Barriers to Use: Water quality conditions, including temperature, dissolved oxygen, pH and pollutants may reduce or prevent survival and/or reproduction of mosquitofish in certain habitats. Other predators may prey upon mosquitofish. They are opportunistic feeders and may prefer alternative prey when available. Introduction of mosquitofish may modify food chains in small-contained pools and have potential impacts on endemic fish and shrimp in such situations. Some wildlife agencies suspect mosquitofish may impact survival of amphibian larvae through predation. Recent research has shown no significant impact on survival of the threatened California red-legged frog (Lawler et al. 1998), but mosquitofish have been shown to negatively impact the survival of the California tiger salamander (Leyse and Lawler 2000).

Impact on water quality: Mosquitofish populations are unlikely to impact water quality.

Solutions to Barriers: Strict stocking guidelines adopted by SMCMVCD restrict the use of mosquitofish to habitats such as artificial containers, ornamental ponds, abandoned swimming pools, cattle troughs, stock ponds, etc., where water quality is suitable for survival and sensitive or endangered aquatic organisms are not present.

Natural predators: aquatic invertebrates

Many aquatic invertebrates, including diving beetles, dragonfly and damselfly naiads, backswimmers, water bugs and hydra are natural predators of mosquito larvae.

Advantages: In situations where natural predators are sufficiently abundant, additional mosquito control measures including application of pesticides may be deemed unnecessary.

Barriers to Use: Predatory aquatic invertebrates are frequently not sufficiently abundant to achieve effective larval control, particularly in disturbed habitats. Most are generalist feeders and may prefer alternative prey over mosquito larvae if available and more accessible. Seasonal abundance and developmental rates often lag behind mosquito populations. Introduction or augmentation of natural predators has been suggested as a means of biological control, however there are currently no commercial sources since suitable mass-rearing techniques are not available.

The presence and abundance of natural predators is noted and taken into account during the larval surveillance process. Conservation of natural predators, whenever possible, is achieved through use of highly target-specific pesticides including bacterial insecticides, with minimal impacts on non-target taxa.

Impact on water quality: As predatory invertebrates represent a natural part of aquatic ecosystems, they are unlikely to impact water quality. There are no established standards, tolerance, or EPA approved tests for aquatic invertebrate populations.

D. Bacterial insecticides

Bacterial insecticides contain naturally produced bacterial proteins that are toxic to mosquito larvae when ingested in sufficient quantity. Although they are biological agents, such products are labeled and registered by the Environmental Protection Agency as pesticides and are considered by some to be a form of Chemical Control.

***Bacillus thuringiensis* var. *israelensis* (BTI)**

Product names: Acrobe, Bactimos pellets, Teknar HP-D, Vectobac 12AS, Vectobac G, Vectobac TP.

Advantages: BTI is highly target-specific and has been found to have significant effects only on mosquito larvae, and closely related insects (e.g., black flies and some midges). It is available in a variety of liquid, granular and pelleted formulations, which provide some flexibility in application methods and equipment. BTI has no measurable toxicity to vertebrates and is classified by EPA as "Practically Non-Toxic" (Caution). BTI formulations contain a combination of five different proteins within a larger crystal. These proteins have varying modes of action and synergistically act to reduce the likelihood of resistance developing in larval mosquito populations.

Barriers to Use: To be effective, bacterial insecticides must be ingested by the mosquito larvae during feeding. Therefore, applications must be carefully timed to coincide with periods in the life cycle when larvae are actively feeding. Pupae and late 4th stage larvae do not feed and therefore will not be controlled by BTI. Low water temperature inhibits larval feeding behavior, reducing the effectiveness of BTI during very cold periods. High organic conditions also reduce the effectiveness of BTI. And therefore it is not feasible to use this material in sources with a high concentration of decaying organic material. The cost per acre treated is generally higher for BTI than for surfactants or organophosphate insecticides.

Bti is used extensively by the district when feasible, but other products may be used when later stages are present.

Impact on water quality: BTI contains naturally produced bacterial proteins generally regarded as environmentally safe. It leaves no residues and is quickly biodegraded. At the application rates used in mosquito control programs, BTI is unlikely to have any measurable effect on water quality. There are no established standards, tolerances, or EPA approved tests. Other naturally occurring strains of this bacterium are commonly found in aquatic habitats.

***Bacillus sphaericus* (Bs)**

Product names: Vectolex CG, Vectolex G Granules Vectolex WDG, Vectolex WSP

Advantages: BS is another bacterial pesticide with attributes similar to those of BTI. The efficacy of this bacterium is not affected by the degree of organic pollution in larval development sites and it may actually cycle in habitats containing high densities of mosquitoes, reducing the need for repeated applications.

Barriers to Use: Like BTI, BS must be consumed by mosquito larvae and is therefore not effective against non-feeding stages such as late 4th instar larvae or pupae. BS is also ineffective against certain mosquito species such as those developing in salt marshes, seasonal forest pools or tree holes. Toxicity of BS to mosquitoes is due to a single toxin rather than a complex of several molecules as is the case with BTI. Development of resistance has been reported in Brazil. Thailand and France in sites where BS was the sole material applied to control mosquitoes for extended periods of time.

Information obtained from larval surveillance on the stage and species of mosquitoes present can increase the effectiveness of this material, restricting it use to sources containing susceptible mosquitoes. Development of resistance can be delayed by rotating BS with other mosquitocidal agents. In some instances, other materials should be used instead of BS. District applicators use a variety of different materials and choose the appropriate one based on conditions present at the time of the application.

Impact on water quality: BS is a naturally occurring bacterium and is environmentally safe. It leaves no residues and is quickly biodegraded. At the application rates used in mosquito control programs, BS is unlikely to have any measurable effect on water quality. There are no established standards, tolerances, or EPA approved tests. Other naturally occurring strains of this bacterium are commonly found in aquatic habitats.

E. Chemical Control

Methoprene

Product Names: Altosid briquets, Altosid liquid larvicide, Altosid pellets, Altosid SBG, Altosid XR briquets, Altosid XRG

Advantages: Methoprene is a larvicide that mimics the natural growth regulator used by insects. Methoprene can be applied as liquid or solid formulation or combined with BTI or BS to form a "duplex" application. Methoprene is a desirable IPM control strategy since affected larvae remain available as prey items for predators and the rest of the food chain. This material breaks down quickly in sunlight and when applied as a liquid formulation it is effective for only 3 to 5 days. Methoprene has been impregnated into inert, charcoal-based carriers such as pellets and briquets that release a consistent dose of active ingredient for 150 days. The availability of different formulations provides options for treatment under a wide range of environmental conditions. Studies on nontarget organisms have found methoprene to be nontoxic to vertebrates and most invertebrates when exposed at concentrations used by mosquito control.

Barriers to Use: Methoprene products must be applied to the late fourth and pupal stages of mosquitoes since it is not effective against the other life stages. Monitoring for effectiveness is difficult since mortality is delayed. Effectiveness can be assessed with emergence traps to detect adult mosquitoes as they emerge from the water. Bringing samples of larvae in treated source water into the lab to observe whether emergence occurs also provides a gauge of its effectiveness. Methoprene is more expensive than most other mosquitocidal agents. This consideration may come into play if large areas are treated. Like the other larvicidal products, the decision to use methoprene is made based on a careful consideration of conditions present at the time of the application.

Impact on Water Quality: Methoprene does not have a significant impact on water quality. It is rapidly degraded in the environment and is not known to have persistent or toxic breakdown products. It is applied and has been shown to be effective against mosquitoes at levels far below those that can be detected by any currently available test. The World Health Organization for use in drinking water containers has approved methoprene.

Surface Oils

Product Names: Golden Bear Oil (GB 1111), BVA 2 Oil, Agnique MMF

Surfactants are "surface-acting agents" that are either petroleum (GB1111 and BVA2 Oil) or isostearyl alcohol-based (Agnique) materials that form a thin layer on the water surface. These materials typically kill surface-breathing insects by mechanically blocking the respiratory mechanism.

Advantages: These materials are the only materials efficacious for reducing mosquito pupae since other larviciding strategies (i.e., methoprene, BTI and BS) are ineffective to that life stage. Agnique forms an invisible monomolecular film that is visually undetectable. Treatments are simplified due to the spreading action of the surfactant across the water surface and into inaccessible areas. These surfactants are considered "practically nontoxic" by the EPA. Agnique is labeled "safe for use" in drinking water.

Barriers to Use: The drawback of using oils in habitats where natural enemies are established is that surface-breathing insects, particularly mosquito predators, are similarly affected. GB1111 forms a visible film on the water surface. BVA oil does not produce a visible sheen and is currently the surface oil of choice in district applications.

As a general rule, surfactant use is considered only after alternate control strategies have been ruled out or in habitats that are not supporting a rich macro-invertebrate community (i.e., manmade sites). Surface oils are sometimes the only feasible choice in cases where the material must have the ability to spread down an underground drain.

F. Cultural Practices

Wetland design criteria were developed and endorsed by DHS and the San Francisco Bay Conservation and Development Commission in 1978 as part of the Suisun Marsh Protection Plan under California State Assembly Bill 1717. These criteria have been sent to various governmental agencies and private parties involved in the planning process for projects having the potential to create mosquito-breeding problems. Guidelines for the following source types are included in the aforementioned marsh protection plan and may be considered cultural control techniques:

- Drainage way construction and maintenance practices
- Dredge material disposal sites
- Irrigated pastures
- Permanent ponds used as waterfowl habitat
- Permanent Water impoundments
- Salt marsh restoration of exterior levee lands
- Sedimentation ponds and retention basins
- Tidal marshes
- Utility construction practices

The SMCMVCD also provides literature and education programs for homeowners and contractors on elimination of mosquito developmental sites from residential property. These sources include rain gutters, artificial containers, ornamental ponds, abandoned swimming pools, tree holes, septic tanks, and other impounded waters.

Water management consists of techniques to control the timing, quantity and flow rate of water circulation in managed wetlands to minimize mosquito development. Mosquito and vector control districts in California have established guidelines for water management based on information from the University of California Agricultural Extension Service (UCAES). The SMCMVCD provides these guidelines to property owners to promote proper irrigation techniques for pastures, duck clubs and other wetlands to reduce mosquito development.
Barriers to Use: While cultural practices are an effective alternative to pesticides, there are situations where they cannot be applied. In most cases, the district does not own or control the property on which mosquito development occurs. Therefore, if the landowners choose not to adopt these practices, they may not be put into effect. Secondly, there are a number of environmental regulations that must be complied with before any physical change to wetlands can be implemented.

H. ORGANOPHOSPHATES (OPs)

Although the organophosphate temephos is registered for use on mosquito larvae, the SMCMVCD does not use any products containing this material in its control program.

Control of Adult Mosquitoes (Adulticiding)

Adulticiding refers to the application of aerosolized materials to control host-seeking adult mosquitoes. In San Mateo County, these materials are applied only when methods used to control larvae fail and large populations of adults emerge in areas close to human habitation. The SMCMVCD rarely applies adulticides, but it has occasionally needed to apply them to residential areas of the surrounding communities, to control mosquitoes emerging from salt marshes. Wide scale truck-mounted adulticiding was last done in 2006, following a mass emergence of salt marsh mosquitoes from Bair Island. Prior to that, fogging was conducted in 1998 and 2004.

The efficacy of adulticiding is dependent upon a number of factors. First, the mosquito species to be treated must be susceptible to the insecticide applied. Some District mosquitoes are resistant or more tolerant to some adulticides, thus affecting the selection of the chemical. Adulticides are applied by hand-held units when applied to limited areas, or by truck mounted sprayers when applications are made on a larger scale.

Each chemical application has its own set of conditions that determine success or failure. The application must be at a dosage rate that is lethal to the target insect and applied with the correct droplet size. The most common form of adulticiding is ultra-low volume (ULV). Typically with ground applications, vegetated habitats may require up to three times the dosage rates that open areas require. This is purely a function of wind movement and its ability to sufficiently carry droplets to penetrate foliage.

Environmental conditions may also affect the results of adulticiding. Wind determines how the ULV droplets will move from the spray equipment into the treatment area. Conditions of no wind will result in the material not moving from the application point. High wind, a condition that inhibits mosquito activity, will disperse the insecticide too widely to be effective. Light wind conditions (<10 mph) are the most desirable because they move the material through the treatment area and are less inhibiting to mosquito activity.

ULV application is avoided during hot daylight hours because thermal conditions will cause the small droplets to quickly rise and become completely ineffective on the adult mosquitoes. Generally, applications are made at night, when a thermal inversion is present, keeping the material near to the ground.

Materials Used to Control Adult Mosquitoes

Pyrethrins and Pyrethroids: General Description

Natural pyrethrins (pyrethrum) are extracted from chrysanthemum flower heads, mainly *Chrysanthemum cinerarnaefolium*, grown commercially in parts of Africa and Asia. The six pyrethrins are esters of three cyclopentenolone alcohols: Pyrethrolone, cinerolone, and jasmolone combined with either chrysanthemic acid or pyrethric acid. In spite of the different isomers possible, the six natural pyrethrins are invariably dextrorotatory isomers of the *trans* form of the carboxylic acids. Synthetic analogues of the natural pyrethrins (pyrethroids) reached commercial success in the 1950's. The first commercial product, allethrin, represented the ester of racemic allethrolone with racemic *cis/trans*-chrysanthemic acid. Bioallethrin is the same ester formed from the natural dextrorotatory trans form of chrysanthemic acid. Other 'first generation' synthetic pyrethroids such as phenothrin and tetrathrin, like the natural pyrethrins, are relatively unstable in light. During the 1960's and 1970's, great progress was made in synthetic light-stable pyrethroids. This was done primarily by Japanese workers studying phenylacetic acid esters (which led to fenvalerate) and by the Elliot team at Rothamsted with esters of the dichlorovinyl analogues of chrysanthemic acid (which led to permethrin and cypermethrin). These photostable pyrethroids represent the 'second generation' of these compounds.

Pyrethroids exhibit rapid knockdown and kill of adult mosquitoes, characteristics that are a major benefit in their use. The mode of action of these compounds is related to their ability to affect sodium-channel function in the neuronal membranes.

Synthetic pyrethroids are not cholinesterase inhibitors, are noncorrosive, and will not damage painted surfaces. They are less irritating than other mosquito adulticides and have a less offensive odor. In comparison to other adulticides, pyrethroids may be effectively applied at much lower rates of active ingredient per acre. The synthetic pyrethroids are mimics of natural pyrethrum, a botanical insecticide. Natural pyrethrum, sold under several trade names, is registered in California, but is used sparingly due to higher cost.

Natural Pyrethrins

Pyrenone 25-5 is a California-registered natural pyrethrin formulation, with a label containing a "Caution" statement. Pyrenone 25-5 contains 5% pyrethrin and 25% piperonyl butoxide. Pyrenone 25-5 is applied as a ULV spray with a dosage per acre of typically 0.87 oz/acre (equivalent to 0.0027 lbs of pyrethrins and 0.0135 pounds of piperonyl butoxide per acre).

Pyrenone 25-5 is labeled for use by government mosquito control programs controlling mosquitoes on residential, industrial, recreational and agricultural areas as well as swamps, marshes, overgrown waste areas and pastures where adult mosquitoes occur. This Public Health Insecticide may be used over agricultural crops because the ingredients are exempt from tolerance when applied to growing crops.

Resmethrin

Resmethrin, a 1st generation synthetic pyrethroid, is the active ingredient in Scourge. Resmethrin provides rapid knockdown and quick kill of all species of adult mosquitoes, and is also effective against many other flying or crawling insects, although it is slower acting than natural pyrethrins. Resmethrin exhibits very low mammalian toxicity, degrades very rapidly in sunlight and provides little or no residual activity. Scourge (the commercial product used for mosquito control) contains 4.14% resmethrin, 12.54% piperonyl butoxide, 5% aromatic petroleum solvent (a mixture of hydrocarbons) and other inert ingredients. Scourge is labeled with the signal word "Caution". The maximum rate of application is 0.007 lbs per acre of active ingredient.

Laboratory studies indicate that resmethrin is potentially toxic to fish. However, with rapid photo degradation in water and low-use rates for mosquito control, the risk impact to fish is minimal. The high cost of resmethrin is also a disadvantage of this adulticide.

EQUIPMENT USED TO APPLY ADULTICIDES IN SAN MATEO COUNTY

Ultra Low Volume (ULV)

When adulticides are used in San Mateo County they are applied from ground-based equipment in San Mateo County in the for of Ultra Low Volume Fog or ULV. The optimum size droplet for mosquito control with ULV applied at ground level has been determined to be in the range of 8-30 microns. The amount of material applied during ground adulticiding operations for control of adult mosquitoes rarely exceeds 1 oz. per acre (this is in contrast to agricultural fogging applications where materials may be applied at up to 36 oz per acre.

Benefits and Risks of the ULV Treatments

Any mosquito adulticiding activity that does not follow reasonable guidelines, including timing of applications, avoidance of sensitive areas, and strict adherence to the pesticide label, risks affecting nontarget insect species. Ground adulticiding, however, can be a very effective technique for controlling most mosquito species in residential areas economically and with negligible nontarget effects.

A benefit of ULV aerosols is that they do not require large amounts of diluents for application, are therefore much cheaper, and environmentally safe.

Any discussion of risk versus benefits needs to note that this form of control has been in extensive use for more than 40 years. There have not been any glaring adverse impacts attributed to ground adulticiding when it was done properly.

Because adulticiding is primarily carried out within populated areas, humans, and domestic animals are exposed to drifting and deposited insecticide droplets. Since adulticides are usually applied during the night or twilight hours, nocturnal and crepuscular animals may have a greater chance for direct exposure. Fortunately, due to dispersal characteristics of ULV sprays, very little insecticide deposits per unit area. It must be realized that droplet size is of greatest consequence to deposition rates and ultimately the degree of exposure to nontarget organisms. Most modern adulticides are short-lived in the environment, degrading rapidly when exposed to sunlight, water, or soil microbes. Biomagnification has not been documented to occur for currently used adulticides.

4. TRAINING AND CERTIFICATION

All SMCMVCD applicators must be certified to apply public health pesticides. The CDHS Vector-Borne Disease Section administers certification training and testing. All mosquito control personnel applying pesticides or overseeing the application of pesticides must obtain and maintain a Vector Control Technician certificate. The Mosquito and Vector Control Association of California (MVCAC) provides training materials and exams are conducted by the CDHS. All certificate holders must maintain continuing education credit in at least two and as many as four subcategories. Category A (Laws and Regulations) and category B (Mosquito Biology) is mandatory for all certificate holders and requires 12 and 8 continuing education units (CEU) respectively, in a two year period. Category C (Terrestrial Invertebrate Control) and Category D (Vertebrate Control) are optional both with 8 hours of CEU per two-year cycle. The SMCMVCD requires all full time employees to obtain certification under all four categories.

In addition, the SMCMVCD conducts a number of in-house educational and safety programs to increase the expertise of the operational staff. Training opportunities to accumulate CEU credits are made available by the MVCAC regional committees that develop training programs fine-tuned to the local ecology and unique problems of the region. Training programs are submitted to the MVCAC state training coordinator for approval and then to the California Department of Health Services for final approval. Applicators are required to complete 36 hours of CEU credits in each two-year cycle to maintain certification.

5. OVERSIGHT

The SMCMVCD operates under the California Health and Safety Code and the California Government Code (reference Division 1, Administration of Public Health, Chapter 2, Powers and Duties; also Part 2, Local Administration, Chapter 8, State Aid for Local Health Administration; Division 3, Pest Abatement, Chapter 5, Mosquito Abatement Districts or Vector Control Districts, Sections 2200 - 2910). In addition, the SMCMVCD is signatory to a Cooperative Agreement with the California Department of Public Health (pursuant to Section 116180, Health and Safety Code) which requires the following:

1. All application equipment is calibrated using acceptable techniques before use. Calibration records are maintained for review by the CAC and CDPH.

2. Pesticide use data is recorded and maintained for review by the CAC for 5 years. This data includes a record of each pesticide application showing the target vector, the specific location treated, the size of the source, the formulations and amount of pesticides used, the method and equipment used, the type of habitat treated, the date of the application, and the name of the applicator.

3. A Pesticide Use Report on Department of Pesticide Regulation form PR-ENF-060 is submitted monthly to the CAC. The report shall include the manufacturer and product name, the EPA registration number from the label, the amount of pesticide used, the number of applications of each pesticide, and the total number of applications, per county, per month.

4. Any conspicuous or suspected adverse effects upon humans, domestic animals and other non-target organisms, or property from pesticide applications must be reported to the CAC and the CDPH.

5. All employees must obtain appropriate certification by CDPH to verify their competence in using pesticides to control pest and vector organisms, and then must maintain continuing education unit credits every 2 years. The district must record and report information on certification and continuing education status to CDPH on a regular basis.

6. District facilities must be inspected by the CAC and CDPH on a regular basis to ensure that local activities are in compliance with state laws and regulations relating to pesticide use.

Other agencies such as local fire departments, California Department of Fish and Game, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and others have jurisdiction and oversight over our activities. We work closely with these agencies to comply with their requirements.

Public Education

An integral part of the SMCMVCD BMPs is to provide information to the public to assist them in resolving their pest problems. Specialized staff at the SMCMVCD provide public outreach in the form of presentations to schools, utility districts, homeowner associations and other organizations, county fairs, festivals and other community events, as well through the media such as newspaper, television, radio and the internet. Information is provided on biological, physical and cultural control methods (i.e., BMPs) that property owner and managers can use to preclude or reduce mosquitoes and other disease and nuisance pests within their jurisdictions.

X

EVALUATION OF LESS-TOXIC CONTROL METHODS OF MOSQUITO CONTROL

Pesticide use by SMCMVCD is only one aspect of an Integrated Vector Management (IVM) strategy. This strategy includes the use of physical and biological control techniques whenever possible and is based on a program of continuous monitoring of both adult and immature mosquito populations. A complete description of the SMCMVCD IVM strategy is given in the accompanying document "Statement of Best Management Practices". Nonchemical control methods, barriers to their use, and solutions to those barriers are listed below:

Physical control
Cost: high, requires specialized equipment and expertise, may be labor intensive.
Barriers: high cost; the district does not posess the kind of equipment required and does not own or control the property on which problem areas are located; there are laws regulating any activity which results in disturbing habitats of endangered species. Wetlands are sensitive habitats and highly regulated; an extensive permit process must be completed and approved by multiple agencies before physical control can be carried out.

The district tries to address these barriers whenever possible by encourage landowners to do this work themselves; and works with restoration agencies in developing sound land management techniques that do not produce mosquitoes..
Relative usefulness of this technique: Physical control is used whenever possible; it is the district's first choice because it is a permanent solution. If physical control is not feasible, or while working toward a physical control solution, we will use biological or chemical control techniques.

Water management
Cost: cost of equipment and engineering can be very high initially and the work may be labor intensive, requiring someone on hand at all times to monitor water levels and operate tide gates.
Barriers: None of the land we treat is under our control and it is difficult to force landowners to cooperate; the district does not have adequate staff or budget to install and operate flood or tide gates. Water management for mosquito control also often conflicts with that of other uses of wetlands such as waterfowl conservation, recreation (hunting).

District staff work with land owners as much as possible to encourage good water management; and treat only when necessary. However, if managing water for mosquito control is not possible, pesticide applications are necessary.
Relative usefulness of this technique: Water management is used whenever possible. It is the first choice because it is a permanent solution. When water management fails we use biological or chemical control

Biological control
Mosquito fish
Cost: low
Barriers: release of non-native fish into natural sources is controversial. They may compete with native fish. Rearing and maintaining fish requires specialized facilities and trained personnel. The district does not have the space or personnel to operate an fish breeding program and its use of fish

is limited to hold low numbers of fish obtained from other districts and stocking fish in artificial backyard sources.

Relative usefulness of Mosquito fish: Fish are considered when physical control is out of the question. They can be very useful but only under a very restricted set of conditions. If a source is suitable for fish and fish will not impact native species we will use this strategy; however they are only placed in manmade sources.

Bacterial pesticides: The primary pesticides used by SMCMVCD may be considered a form of biological control

Bacillus sphaericus* and *B. thuringiensis* var. *israelensis

Cost: these materials are more expensive than organophosphate pesticides but cheaper than physical control.

Barriers: requires more careful monitoring of mosquito populations and more thorough knowledge of their ecology. Bacterial pesticides are not effective against some species of mosquitoes or some stages in their life cycle, or in some types of larval sources. Bacterial pesticides provide very short duration of control; and must be reapplied frequently. In addition, reliance on a single product may result in development of resistance. Therefore, these larvicides must be used in rotation with other types of materials. monitoring program for mosquitoes; training for district staff; rotate products.

Relative usefulness of this technique: these agents are considered when physical control is out of the question and fish cannot be stocked or maintained. Sometimes used in conjunction with stocking fish since these materials have been shown not to adversely affect fish. In this case, fish may be a long term solution but chemical are needed to initially bring down mosquito populations. Also need to consider possibility of development of resistance, therefore the need to rotate products used.

Chemical Control using methoprene and surface oils instead of organophosphates

Cost: these materials are more expensive than OPs but cheaper in the short term than physical control

Barriers: requires more careful monitoring of population and more thorough knowledge of ecology, resistance

Solutions to barriers: monitoring program for mosquitoes, training for techs, biologists on staff, rotate materials, investigate new materials

Relative usefulness of this technique: Like biological pesticides these materials are considered when physical control is out of the question and fish cannot be stocked or maintained. Sometimes used in conjunction with stocking fish since these materials have been shown not to adversely affect fish.. Decisions on whether to use these materials or bacterial pesticides are based on: stage and species of mosquitoes present, quality of water, access. It is also necessary to consider possibility of development of resistance, therefore the need to rotate products used.