Ventura Countywide Stormwater Quality Management Program

PYRETHROID INSECTICIDES STUDY

2012 FINAL REPORT

PREPARED BY THE:

VENTURA COUNTY WATERSHED PROTECTION DISTRICT

SUBMITTED ON BEHALF OF:

VENTURA COUNTY WATERSHED PROTECTION DISTRICT
COUNTY OF VENTURA
CITY OF CAMARILLO
CITY OF FILLMORE
CITY OF MOORPARK
CITY OF OJAI
CITY OF OXNARD
CITY OF PORT HUENEME
CITY OF SANTA PAULA
CITY OF SIMI VALLEY
CITY OF THOUSAND OAKS
CITY OF VENTURA

December 3, 2012

EXECUTIVE SUMMARY

Pyrethroid insecticide monitoring of sediments is required by Monitoring Program No. CI 7388, as part of the Ventura County Municipal Separate Storm Sewer System National Pollutant Discharge Elimination System Permit, Order No. R4-2010-0108 (Permit). The Permit specifies that the Principal Permittee shall perform a pyrethroid insecticides study to accomplish the following objectives:

i. Establish baseline data for major watersheds;
ii. Evaluate whether pyrethroid insecticide concentrations are at or approaching levels known to be toxic to sediment-dwelling aquatic organisms;
iii. Determine if pyrethroids discovered are from urban sources; and
iv. Assess any trends over the permit term.

No significant levels of pyrethroids or sediment toxicity were detected at any of the monitored sites.

In April 2012 the Ventura County Watershed Protection District (District), as the Principal Permittee, conducted sediment monitoring for the Pyrethroid Insecticides Study (Study) at two locations in both the Ventura River and Santa Clara River watersheds. In addition, Pyrethroid analysis of sediments in the Calleguas Creek Watershed (CCW) is conducted annually in August as part of the CCW Toxicity Total Maximum Daily Load (TMDL) monitoring program. Data from the TMDL was used to meet the requirements for that watershed, as allowed by the Permit.

Four pyrethroids were detected in the Study samples and varied depending on site. The four detected pyrethroids were bifenthrin (three sites), pendimethalin (two sites), permethrin (one site) and dichloran (one site). Toxicity units were calculated based on the concentration of the pyrethroid (normalized for total organic carbon) and the known *Hyalella azteca* LC50, if available. All calculated toxicity units were less than one indicating the samples were non-toxic. This is also supported by the lack of toxicity seen in the analysis of the sediment samples.

Three years of data (2008-2010) are currently available for the TMDL site (03_UNIV) that was selected as the most representative of urban land use in the Calleguas Creek Watershed. Data for 2011 and 2012 will become available after the TMDL annual reports are submitted in February 2013 and 2014, respectively. Pyrethroids were not detected in the three years of samples, which prevents the calculation of toxicity units; however using the MDL in the calculation provided an estimated upper limit of toxicity units for the sample. Eight of the eighteen calculated data points were above one, which indicates that if pyrethroids were present, but just below detectable levels, there could be a contribution to sediment toxicity. Toxicity was not observed in the corresponding sediment samples, which suggests that concentrations of pyrethroids in the samples, if present, are well below the MDL.

Due to the absence of significant toxicity in the samples, there are no recommendations to mitigate urban contributions of pyrethroids in the three sampled watersheds at this time other than to continue the Ventura Countywide Stormwater Management Program's current pesticide use education and outreach efforts. The Program plans to add Calleguas Creek Watershed sample sites to the Study for 2015 to avoid issues with different detection levels and sampling strategies for the next reporting cycle.

METHODS

The Permit allows the Pyrethroid Insecticides Study (Study) requirement to be satisfied by another tributary monitoring program within the watershed if pyrethroid concentrations and sediment toxicity are being assessed. Monitoring in the Calleguas Creek watershed for the Calleguas Creek Toxicity Total Maximum Daily Load (TMDL) meets the study requirements, so this data was used for the Calleguas Creek watershed component. Monitoring for this project has been conducted annually in August since 2008. The data will be released once the TMDL annual report has been submitted, so data collected in 2011 will become available in February 2013 and data collected in 2012 will become available in February 2014. For this reason, this report summarizes the 2008-2010 data. The 2011 and 2012 data will be included in the next report. The Ventura River and Santa Clara River watersheds do not have monitoring programs that meet the Study requirements, so a Pyrethroid Insecticides Study Quality Assurance Project Plan (QAPP) was developed for monitoring these two watersheds. The Study was designed to be similar to the TMDL monitoring project in regard to sample collection method and analyte list. The two projects differ in placement of sites, sampling frequency, and time of year for analysis.

In-stream sediment samples for chemical analysis and toxicity testing were collected using stainless steel scoops according to methods developed by the USGS and outlined in *Guidelines for Collecting and Processing Samples of Stream Bed Sediment for Analysis of Trace Elements and Organic Contaminants for the National Water Quality Assessment Program (1994)*. When possible, sediment sampling stations encompassed a section of the reach approximately 100 meters in length upstream from water-column sampling stations but this varied depending on site conditions. Five to ten wadeable depositional zones (low energy areas where fine-grained particles can accumulate) within the reach were targeted to obtain a sample representative of the site.

All sediment samples were analyzed for total organic carbon (TOC) by EPA 9060 and pyrethroids, GC/MS NCI-SIM for the Study and EPA 8270C (SIM) for the TMDL. Two of five TMDL sites and all Study sites were analyzed for toxicity to 7 to 10 day old *Hyalella azteca*, as described in *Aquatic Toxicity Due to Residential use of Pyrethroid Insecticides*[1]. Water quality field measurements were taken with hand-held probes.

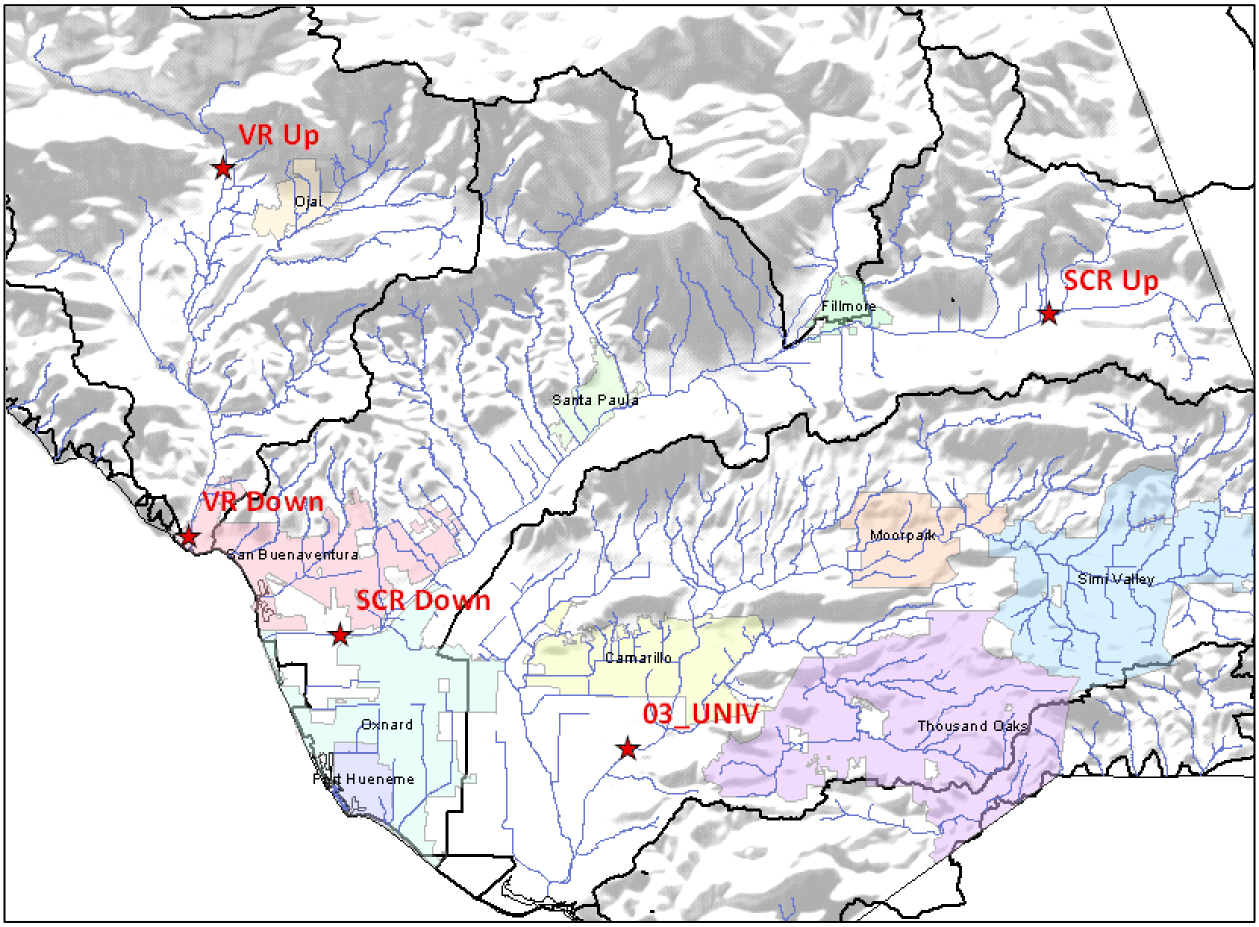
The stainless steel trowels used by the Study were cleaned prior to sample collection with Citranox laboratory detergent and tap water, rinsed with distilled water, and air dried. They were then sealed individually in Ziploc bags until arrival at the site. An equipment blank was collected by the laboratory from one clean, unused stainless steel trowel by rinsing with one liter of laboratory grade de-ionized water and analyzing the rinsate for TOC by SM 5310C and pyrethroids by GC/MS NCI-SIM. The re-analysis of the equipment blank required a second rinse of the trowel (to collect the required sample volume) with one liter of laboratory grade de-ionized water and analysis by GC/MS NCI-SIM.

The Permit specifies that monitoring is to be conducted every three years, after sediment has settled within the water body and safe access can be assured. For the Study, this translated to April 3, 2012, three

[1] *Aquatic Toxicity Due to Residential Use of Pyrethroid Insecticides*; Weston, D., Holmes, R., You, J., Lydy, M.J (2005). Environ. Sci. Technol.; (Article); 2005; 39(24); 9780 pp.

days after a small storm (<0.3” precipitation) and 9 days after a larger storm (1.5” precipitation). Sampling for the TMDL is conducted annually in August.

Figure 1. Pyrethroid Sampling Locations 2012



Ventura and Santa Clara River Watersheds

For the Study, an upstream and a downstream site were selected on the main stems in the Ventura and Santa Clara River watersheds (Figure 1). The upstream site was located high in the watershed to reduce the influence of urban sources and the downstream site was located low in the watershed to include urban contributions. For the Ventura River, the upstream site is above the Casitas Municipal Water District’s diversion structure near the north end of Rice Road in Meiners Oaks (VR Up, Figure 2). The downstream site is near the Main Street Bridge in Ventura (VR Down, Figure 3). For the Santa Clara River, the upstream site is east of Torrey Road in Fillmore[2] (SCR Up, Figure 4) and the downstream site is near the Victoria Avenue Bridge in Ventura (SCR Down, Figure 5). Factors such as safety, ease of entry, upstream land use, hydrology, and long term accessibility including landowner permission were considered in site selection.

[2] Note that urban and agricultural areas are present upstream of Fillmore beyond the Ventura County boundary.


Figure 2. VR Up


Figure 3. VR Down


Figure 4. SCR Up


Figure 5. SCR Down

As described in the Ventura County MS4 Pyrethroid Insecticides Monitoring Quality Assurance Project Plan (QAPP), the top layer (~1 cm) of recently deposited sediment was collected with a pre-cleaned stainless steel scoop as specified in the permit. The quantity of sediment required for the tests precluded sampling directly into glass jars, so the sediment was deposited in a 24” by 36” 2mm polyethylene bag per site. The bag was closed and the sediment was manually homogenized onsite by squeezing and rotating the bag. Homogenized sediment was placed in two 8 oz wide-mouth glass jars and placed on ice for TOC and pyrethroid analysis. The jars were placed in the freezer at the end of the sampling day so that they could be frozen for pickup by the chemistry lab courier the following day. The remaining sediment (~ 3 liters) was double- bagged and put on ice for (same day) delivery to the toxicity lab.

Calleguas Creek Watershed

The Calleguas Creek Watershed is unusual because most of its developed areas are in the upper portions of the watershed with the lower portions heavily influenced by agriculture. The monitoring plan for the TMDL selected sites by subwatershed, and appears to have focused on agricultural areas. The TMDL site that best represents the urban contribution of the watershed is 03_UNIV, which is on Calleguas Creek at University Drive, downstream of the Cities of Thousand Oaks, Moorpark, Simi Valley, and parts of

Camarillo (Figure 1). This site has been monitored for total organic carbon, pyrethroids in sediment, and toxicity to *Hyalella azteca* since August 2008.

As described in the Calleguas Creek Watershed Management Plan Quality Assurance Project Plan Monitoring and Reporting Program Plan for the Nitrogen, OC and PCBs, Toxicity, and Metals and Selenium Total Maximum Daily Loads (TMDL QAPP), sediment samples were collected from the top two to three centimeters (cm) of sediment using pre-cleaned stainless steel trowels. Collecting a thicker layer of sediments is a common approach to conducting sediment sampling for the purpose of sediment toxicity testing and is the approach used in sediment toxicity studies conducted by the Southern California Coastal Water Research Project (SCCWRP) Bight Program and the State Water Resources Control Board Bay Protection and Toxic Cleanup Program (BPTCP). The sediment samples were collected directly into a clean polyethylene bag and mixed. Subsamples from the bag were placed into glass jars for pyrethroid and TOC analysis and the remaining sediment was kept in the bag for toxicity analysis. All samples were stored at 4ºC until arrival at the contract laboratory.

RESULTS

Study Equipment Blank

The initial analysis of the equipment blank detected a small amount of TOC and detectable amounts of the pyrethroids bifenthrin, cypermethrin, and pendimethalin (Table 1). In order to have sufficient volume to re-test the equipment blank, the laboratory rinsed the trowel a second time with one liter of deionized water and the rinsate was analyzed for pyrethroids. Pyrethroids were not detected in the second sample (please refer to discussion section, below).

Table 1. Equipment Blank Results

Analyte	Trowel Blank (Initial Analysis) (µg/L, MDL varies)	Trowel Blank (Initial Analysis) Total Mass (µg)	Trowel Blank (Re-analysis) (µg/L, MDL varies)
Allethrin	ND (<0.00085)	ND (<0.00085)	ND (<0.00085)
Bifenthrin	**0.0041**	**0.0041**	ND (<0.00079)
Cyfluthrin	ND (<0.00083)	ND (<0.00083)	ND (<0.00083)
Cypermethrin	**0.0026**	**0.0026**	ND (<0.00066)
Deltamethrin/Tralomethrin	ND (<0.0019)	ND (<0.0019)	ND (<0.0019)
Dichloran	ND (<0.00080)	ND (<0.00080)	ND (<0.00080)
Esfenvalerate	ND (<0.00098)	ND (<0.00098)	ND (<0.00098)
Fenvalerate	ND (<0.00098)	ND (<0.00098)	ND (<0.00098)
L-Cyhalothrin	ND (<0.0012)	ND (<0.0012)	ND (<0.0012)
Pendimethalin	**0.0025**	**0.0025**	ND (<0.00050)
Permethrin	ND (<0.0050)	ND (<0.0050)	ND (<0.0050)
Prallethrin	ND (<0.00092)	ND (<0.00092)	ND (<0.00092)
Sumithrin	ND (<0.0024)	ND (<0.0024)	ND (<0.0024)
Tefluthrin	ND (<0.00093)	ND (<0.00093)	ND (<0.00093)
TOC	0.17 mg/L (DNQ)	0.17 mg (DNQ)	N/A

Analyte listed in Permit
Detections
ND = Not Detected
N/A = Not Applicable

Santa Clara and Ventura Rivers

Toxicity (survival) was not observed in any of the four samples collected by the Study (SCR Up, SCR Down, VR Up, and VR Down). The *H. azteca* percent survival ranged from 83.75% at VR Up to 98.75% at SCR Up. TOC amounts were lower in the Santa Clara River (5.4 g/kg SCR Up and 11 g/kg SCR Down) than in the Ventura River (22 g/kg VR Up and 26 g/kg VR Down), which may be due to the sandy substrate of the Santa Clara River. TOC was higher in the downstream site for each watershed. Detectable amounts of bifenthrin, dichloran, pendimethalin, and permethrin were seen at least one of the four sites (Table 2). Each site had a detectable amount of at least one pyrethroid (permethrin, dichloran, bifenthrin, and/or pendimethalin).

Table 2. Study Results 2012 - as reported by laboratory

Analyte	VR Up	VR Down	SCR Up	SCR Down	MRL	Units
Allethrin	ND	ND	ND	ND	0.5	ng/g
Bifenthrin	ND	**1.2**	**0.78**	**0.74**	0.5	ng/g
Cyfluthrin	ND	ND	ND	ND	0.5	ng/g
Cypermethrin	ND	ND	ND	ND	0.5	ng/g
Deltamethrin/Tralomethrin	ND	ND	ND	ND	0.5	ng/g
Dichloran	ND	ND	ND	**0.54**	0.5	ng/g
Esfenvalerate	ND	ND	ND	ND	0.5	ng/g
Fenpropathrin (Danitol)	ND	ND	ND	ND	0.5	ng/g
Fenvalerate	ND	ND	ND	ND	0.5	ng/g
L-Cyhalothrin	ND	ND	ND	ND	0.5	ng/g
Pendimethalin	ND	ND	**0.69**	**5.4**	0.5	ng/g
Permethrin	**5.3**	ND	ND	ND	0.5	ng/g
Prallethrin	ND	ND	ND	ND	0.5	ng/g
Sumithrin	ND	ND	ND	ND	0.5	ng/g
Tefluthrin	ND	ND	ND	ND	0.5	ng/g
TOC	**22**	**26**	**5.4**	**11**	Varies	g/kg
Toxicity	**83.75%**	**88.75%**	**98.75%**	**96.25%**		% Survival

Analyte listed in Permit
Detections
ND = Not Detected
NA = Not Applicable

Calleguas Creek

Toxicity to *Hyalella azteca* (survival) was not observed in the three samples collected at 03_UNIV between 2008 and 2010. The percent survival ranged from 96.3% in 2008 to 77.5% in 2010. TOC amounts were between 0.2 g/kg (2008) and 3.8 g/kg (2009). Pyrethroids were not detected in any of the three samples. The TMDL results for 03_UNIV are shown in Table 3.

Table 3. TMDL Results 2008-2010 - as reported by laboratory

	2008		2009		2009		
Analyte	**Results**	**MDL**	**Results**	**MDL**	**Results**	**MDL**	**Units**
Allethrin	ND	0.5	ND	0.5	ND	0.616	µg/kg
Bifenthrin	ND	0.5	ND	0.5	ND	0.616	µg/kg
Cyfluthrin, beta	ND	10	ND	10	NS	NS	µg/kg
Cypermethrin	NS	NS	NS	NS	NS	NS	µg/kg
Danitol	ND	0.5	ND	0.5	ND	0.616	µg/kg
Deltamethrin	ND	0.5	ND	0.5	ND	0.616	µg/kg
Dichloran	NS	NS	NS	NS	NS	NS	µg/kg
Esfenvalerate/Fenvalerate, total	ND	0.5	NS	NS	NS	NS	µg/kg
Fenvalerate	ND	0.5	ND	0.5	ND	0.616	µg/kg
Fluvalinate	ND	0.5	ND	0.5	ND	0.616	µg/kg
L-Cyhalothrin	ND	0.5	ND	0.5	ND	0.616	µg/kg
Pendimethalin	NS	NS	NS	NS	NS	NS	µg/kg
Permethrin	ND	5	ND	5	ND	6.16	µg/kg
Prallethrin	ND	0.5	ND	0.5	ND	0.616	µg/kg
Resmethrin	ND	5	ND	5	NS	NS	µg/kg
Sumithrin	NS	NS	NS	NS	NS	NS	µg/kg
Tefluthrin	NS	NS	NS	NS	NS	NS	µg/kg
Total Organic Carbon (g/kg)	0.2	0.01	3.8	0.01	1.5*	0.1	g/kg
Toxicity to Hyalella azteca	96.3		88.8		77.5		% Survival

Analyte listed in Permit
Detections
* = DNQ
ND = Not Detected
NS = Not Sampled

DISCUSSION OF RESULTS

The source of the detected amounts of the pyrethroids bifenthrin, cypermethrin, and pendimethalin in the original equipment blank is uncertain. Since the laboratory only collected sufficient volume of rinsate to analyze for pyrethroids once, the re-analysis required additional volume which was collected by rinsing the trowel a second time with one liter of laboratory grade deionized water. No pyrethroids were detected in the second analysis. Because the original sample was not available for re-analysis, the source of the contamination cannot be determined. The original rinse may have removed the pyrethroid contaminants from the trowel, they may have dissipated in the time between rinses, or the equipment blank may have been contaminated during rinsate collection and/or analysis at the laboratory.

Regardless of whether the pyrethroid contamination occurred at the laboratory or was present on the trowel, the amount of contamination is insignificant in comparison to the amounts detected in the environmental samples. The total mass of each pyrethroid detected in the one liter of equipment blank rinsate is equal to the concentration, since the total rinsate volume was one liter. This amount is at least two orders of magnitude below the concentrations detected in the environmental samples. The amounts of pyrethroids detected in the environmental samples could be considered to be upper limits for those constituents that were also detected in the equipment blank. The laboratory determined that the initial detection of pyrethroids in the equipment blank may have been due to laboratory contamination, however since the re-analysis involved collecting a separate volume of rinsate, this cannot be confirmed.

The amount of TOC measured in the equipment blank was at least four orders of magnitude below the environmental samples and so can be considered insignificant.

Toxicity levels vary between pyrethroids. Toxicity units (TU) can be used to compare the relative toxicity of different samples and pyrethroids. This is done by normalizing the sediment pyrethroid concentrations to TOC concentration to account for hydrophobicity and then dividing by the *Hyalella azteca* ten day median lethal concentration (LC50) for each detected pyrethroid, if available. The overall pyrethroid toxicity of a particular sample can be calculated by summing the calculated pyrethroid TU for that sample.

The calculated toxicity units from the Study samples were all less than one (Table 4) and so the samples can be considered non-toxic. Even though an LC50 for dichloran or pendimethalin is unavailable, the lack of toxicity in the environmental sample infers a calculated TU of less than one for these analytes. The calculated TUs were inversely correlated with the observed toxicity, possibly due to the presence of unanalyzed constituents in the sample.

Pyrethroids were not detected in the samples collected in 2008, 2009, and 2010 from the Calleguas Creek watershed site (03_UNIV). The Permit requested that pyrethroid detection limits be as close to 1 ng/g (dry weight) as reasonably achievable. Since the pyrethroid detection limits for the TMDL were above this amount and all the results were non-detects, the MDL was used in place of a measured result in order to calculate the maximum possible TU for each analyte in each sample, for pyrethroids with available LC50s. Pyrethroid concentrations at the MDL were above one for eight of the eighteen calculable data points (Table 5). Toxicity was not observed in any of the three 03_UNIV samples, which suggests that concentrations of pyrethroids in the samples, if present, would be at concentrations well below the MDL for each analyte. Pyrethroids were detected in sediment samples from some of the other TMDL sites in the Calleguas Creek watershed; however they were at sites where agriculture is the predominant land use.

PESTICIDE REDUCTION EFFORTS

Integrated Pest Management Programs

A model integrated pest management (IPM) program was drafted through the Public Agencies Activities Subcommittee and used as a template by the Permittees to develop their own plans by November 2009. This standardized protocol is posted on Program's website at www.vcstormwater.org/documents/subcommittees_publicagency/publications/VC_Pesticide_Protocol_10-09.pdf.

The prevention of pesticides from harming non-target organisms is the primary goal of the Permittees IPM program. The intent is to focus on preventing pesticides, fertilizers, and herbicides from entering the storm drain system and discharging to receiving waters. This protocol is applicable to 1) the outdoor use of pesticides, herbicides, and fertilizers; 2) the use of pesticides and fertilizers where the materials may come into contact with precipitation; 3) the use of pesticides, herbicides, and fertilizers where these materials may come into contact with runoff (natural or induces); and 4) the use of pesticides, herbicides, or fertilizers anywhere where they may be directly or indirectly discharged to a storm drainage system.
An effective IPM program includes the following elements:

- Pesticides are used only if monitoring indicates they are needed according to established guidelines.
- Treatment is made with the goal of removing only the target organism.
- Pest controls are selected and applied in a manner that minimizes risks to human health, beneficial, nontarget organisms, and the environment.
- Its use of pesticides, including Organophosphates and Pyrethroids do not threaten water quality.
- Partner with other agencies and organizations to encourage the use of IPM.
- Adopt and verifiably implement policies, procedures, and/or ordinances requiring the minimization of pesticide use and encouraging the use of IPM techniques (including beneficial insects) in the Permittees' overall operations and on municipal property.
- Policies, procedures, and ordinances shall include commitments and timelines to reduce the use of pesticides that cause impairment of surface waters by implementing the following procedures:
    - Quantify pesticide use by its staff and hired contractors.
    - Prepare and annually update an inventory of pesticides used by all internal departments, divisions, and other operational units.
    - Demonstrate reductions in pesticide use.

The protocol is applicable to any Permittee staff and contracted services that apply pesticides, fertilizers, or herbicides. Such staff commonly include, park, public works, purchasing, building/grounds maintenance, hazardous materials, and pesticide application staff. It is not applicable to the indoor use of pesticides, herbicides or fertilizers, but is applicable to the consequential outdoor handling, mixing, transport, or disposal of materials related to indoor use. This protocol also does not apply when another NPDES permit and/or abatement orders are in effect at the selected site. Furthermore, this protocol is not intended to replace federal or state requirements or provide complete directions for applying, handling, transporting, mixing, or storing pesticides, fertilizers, or herbicides.

Public Outreach and Education on Pesticide Use

Timed to coincide with the spring planting season, the Program's outreach effort (Community for a Clean Watershed) ran a five-week pesticide campaign in 2010 utilizing television and radio campaign elements from past year's creative arsenal. The animated "More, Better" television commercial graphically demonstrated how using too much pesticide runs into the storm drains, eventually making it into the Watershed, adversely affecting plants and animals. The radio spot was a humorous adaptation of the television ad, featuring the two animated characters as they defend their house against garden pests and inadvertently poison the watershed. An animated web banner corresponded with both broadcast media while the transit shelters took a more direct approach showing a snail and telling residents "Don't kill an ocean just to keep pests out of your garden."

Spanish Language Pesticide Outreach

Retail Partnership Brochures: Nurseries and Gardeners,

Watershed Protection Tip pamphlets aimed at residents were created to encourage best practices in their homes. These brochures were distributed to targeted retail stores to reach the population that is likely involved in the activities. The colorful pamphlet defines the Watershed, explains the storm drain system, how polluted water is damaging and gives both overall and topic-specific tips for how to keep the Watershed clean. In this case the one aimed at gardeners talks about plant selection, irrigation, fertilizer and pesticide practices, integrated pest management and proper yard maintenance.

Newspaper Advertisement

RECOMMENDATIONS

Due to the absence of significant toxicity in the samples, there are no recommendations to mitigate urban contributions of pyrethroids in the three sampled watersheds at this time other than to continue the Ventura Countywide Stormwater Management Program's current pesticide use public education and outreach efforts. The Program plans to include Calleguas Creek Watershed sample sites in the Study for 2015 to avoid issues with different detection levels and sampling strategies for the next reporting cycle. Additionally, the Program will review its procedures and methods to ensure the highest quality data is generated from the 2015 Pyrethroid Study.

Gardening Retail Partnership Brochure

Table 4. Study Normalized TOC Results and Toxicity Units

	NORMALIZED TO TOC [Pyrethroid]/TOC					LC_{50} *H. azteca* (µg/g TOC)	TOXICITY UNITS ([Pyrethroid]/TOC)/LC50				
Analyte	**VR Up**	**VR Down**	**SCR Up**	**SCR Down**	**Units**	**LC50* (µg/g)**	**VR Up**	**VR Down**	**SCR Up**	**SCR Down**	**Units**
Allethrin	ND	ND	ND	ND	µg/g		ND	ND	ND	ND	TU
Bifenthrin	ND	**0.046**	**0.144**	**0.067**	µg/g	0.52	ND	**0.088462**	**0.27692**	**0.128846**	TU
Cyfluthrin	ND	ND	ND	ND	µg/g	1.08	ND	ND	ND	ND	TU
Cypermethrin	ND	ND	ND	ND	µg/g	0.38	ND	ND	ND	ND	TU
Deltamethrin/Tralomethrin	ND	ND	ND	ND	µg/g	0.79	ND	ND	ND	ND	TU
Dichloran	ND	ND	ND	**0.049**	µg/g		ND	ND	ND	**NA**	TU
Esfenvalerate	ND	ND	ND	ND	µg/g	1.54	ND	ND	ND	ND	TU
Fenpropathrin (Danitol)	ND	ND	ND	ND	µg/g	1.1**	ND	ND	ND	ND	TU
Fenvalerate	ND	ND	ND	ND	µg/g		ND	ND	ND	ND	TU
L-Cyhalothrin	ND	ND	ND	ND	µg/g	0.45	ND	ND	ND	ND	TU
Pendimethalin	ND	ND	**0.128**	**0.491**	µg/g		ND	ND	**NA**	**NA**	TU
Permethrin	**0.241**	ND	ND	ND	µg/g	10.83	**0.022253**	ND	ND	ND	TU
Prallethrin	ND	ND	ND	ND	µg/g		ND	ND	ND	ND	TU
Sumithrin	ND	ND	ND	ND	µg/g		ND	ND	ND	ND	TU
Tefluthrin	ND	ND	ND	ND	µg/g		ND	ND	ND	ND	TU
TOC	**22**	**26**	**5.4**	**11**	g/kg		**22**	**26**	**5.4**	**11**	g/kg
Toxicity, survival	**83.75**	**88.75**	**98.75**	**96.25**	%		**83.75**	**88.75**	**98.75**	**96.25**	%

Analyte listed in Permit
Detections
ND = Not Detected
NA = Not Available
* (Amweg, Weston, You, & Lydy, 2006)
** (Delgado-Moreno, Lin, Veiga-Nascimiento, & Gan, 2011)

Table 5. MDL Normalized to TOC and corresponding Toxicity Units

	Method Detection Limit (MDL)				MDL NORMALIZED TO TOC (MDL/TOC)				LC_{50} ***H. azteca*** **(µg/g TOC)**	TOXICITY UNITS AT MDL (MDL/TOC)/LC50			
Analyte	**2008**	**2009**	**2010**	**Units**	**2008**	**2009**	**2010**	**Units**	**LC50* (µg/g)**	**2008**	**2009**	**2010**	**Units**
Allethrin	0.5	0.5	0.616	µg/kg	2.5	0.1316	0.4107	µg/g		NA	NA	NA	TU
Bifenthrin	0.5	0.5	0.616	µg/kg	2.5	0.1316	0.4107	µg/g	0.52	4.81	0.25	0.79	TU
Cyfluthrin, beta	10	10	NA	µg/kg	50	2.6316	NA	µg/g	1.08	46.30	2.44	NA	TU
Cypermethrin	NA	NA	NA	µg/kg	NA	NA	NA	µg/g	0.38	NA	NA	NA	TU
Deltamethrin	0.5	0.5	0.616	µg/kg	2.5	0.1316	0.4107	µg/g	0.79	3.16	0.17	0.52	TU
Dichloran	NA	NA	NA	µg/kg	NA	NA	NA	µg/g		NA	NA	NA	TU
Esfenvalerate/ Fenvalerate, total	0.5	NA	NA	µg/kg	2.5	NA	NA	µg/g	1.54	1.62	NA	NA	TU
Danitol	0.5	0.5	0.616	µg/kg	2.5	0.1316	0.4107	µg/g	1.1**	2.27	0.12	0.37	TU
Fenvalerate	0.5	0.5	0.616	µg/kg	2.5	0.1316	0.4107	µg/g		NA	NA	NA	TU
Fluvalinate	0.5	0.5	0.616	µg/kg	2.5	0.1316	0.4107	µg/g		NA	NA	NA	TU
L-Cyhalothrin	0.5	0.5	0.616	µg/kg	2.5	0.1316	0.4107	µg/g	0.45	5.56	0.29	0.91	TU
Pendimethalin	NA	NA	NA	µg/kg	NA	NA	NA	µg/g		NA	NA	NA	TU
Permethrin	5	5	6.16	µg/kg	25	1.3158	4.1067	µg/g	10.83	2.31	0.12	0.38	TU
Prallethrin	0.5	0.5	0.616	µg/kg	2.5	0.1316	0.4107	µg/g		NA	NA	NA	TU
Resmethrin	5	5	NA	µg/kg	25	1.3158	NA	µg/g		NA	NA	NA	TU
Sumithrin	NA	NA	NA	µg/kg	NA	NA	NA	µg/g		NA	NA	NA	TU
Tefluthrin	NA	NA	NA	µg/kg	NA	NA	NA	µg/g		NA	NA	NA	TU
TOC	0.2	3.8	1.5*	g/kg	0.2	3.8	1.5*	g/kg		0.2	3.8	1.5*	g/kg
Toxicity, survival	96.3	88.8	77.5	%	96.3	88.8	77.5	%		96.3	88.8	77.5	%

Analyte listed in Permit	* (Amweg, Weston, You, & Lydy, 2006)
Detections	** (Delgado-Moreno, Lin, Veiga-Nascimiento, & Gan, 2011)
NA = Not Available	

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