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SACRAMENTO VALLEY
WATER QUALITY COALITION

**Addendum to Surface Water Quality
Management Plan for *Hyalella azteca*
Toxicity in Ulatis Creek:**

**Surface Water Quality Management
Plan for Water Column Pyrethroid
Pesticides in Ulatis Creek**

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1 Introduction and Background

The purpose of this Management Plan is to document the management practices implementation, performance goals, and schedule to address agricultural causes of pyrethroid pesticide exceedances and related toxicity to *Hyalella azteca* in the water column observed in Sacramento Valley Water Quality Coalition (SVWQC) Irrigated Lands Regulatory Program (ILRP) monitoring in Ulatis Creek. The elements included in this Management Plan conform to the Coalition's Waste Discharge Requirements (WDR) General Order No. R5-2014-0030-12 (as most recently amended by Order R5-2025-0045, 22 August 2025), issued under the ILRP. The need for performance goals related to pyrethroid pesticides was prompted by exceedances observed after the Coalition's pyrethroid pesticides baseline monitoring (October 2020 – September 2021) required by the Basin Plan Amendment for a Pyrethroid Pesticide Control Program for the Sacramento and San Joaquin River Basins (Pyrethroid Pesticide BPA). The Pyrethroid Pesticide BPA established a conditional prohibition of pyrethroid discharges at concentrations above specified aquatic life protection-based concentration triggers (prohibition triggers) unless the discharger is implementing a management plan to reduce pyrethroid levels in their discharges. The triggering of this Management Plan for pyrethroid pesticides in Ulatis Creek was the result of exceedances of the prohibition trigger observed in December 2024 and May 2025. The relevant conclusions established related to these observed exceedances are as follows:

- A review of California Department of Pesticide Regulation (CDPR) Pesticide Use Reporting (PUR) data for agricultural uses of pyrethroid pesticides in the Cache Slough drainage for a period of about six weeks prior to the two observed exceedances (December 17, 2024 and May 20, 2025) that triggered the Management Plan showed very few acres treated with pyrethroid pesticides in November and December 2024 in the Cache Slough drainage (see **Table A1**). However, over 10,000 acres across 10 different crops were collectively treated with bifenthrin and lambda-cyhalothrin in April and May 2025 in the Cache Slough drainage (see **Table A2**). Additionally, minor acreages across a handful of crops were treated with cyfluthrin, beta-cyfluthrin, alpha-cypermethrin, and esfenvalerate in April and May 2025, as shown in **Table A2**.
- A review of PUR data for non-agricultural applications of pyrethroid pesticides across all of Solano County showed a number of applications each month during the periods November (110 applications totaling 37.62 lbs. active ingredient) and December 2024 (93 applications totaling 45.68 lbs. active ingredient) and April (109 applications totaling 638.13 lbs. active ingredient) and May 2025 (184 applications totaling 251.24 lbs. active ingredient; see **Table A3** and **Table A4**). Most of the non-agricultural applications made during November and December 2024 and April and May 2025 were bifenthrin and lambda-cyhalothrin applications made for structural pest control purposes. Applications of these two pyrethroid pesticides and several others (cyfluthrin, beta-cyfluthrin, alpha-cypermethrin, esfenvalerate, gamma-cyhalothrin, and permethrin) were also made for landscape maintenance and commodity fumigation purposes during these two periods. Non-agricultural pesticide applications are only reported at the county level by month (not specific date), so it is not possible to determine whether these applications were made within the Cache Slough drainage or elsewhere in Solano County.

- An evaluation of PUR data (as acres treated) from irrigated agriculture shows one pyrethroid pesticide, esfenvalerate, applied to prune at a significant acreage within the Cache Slough drainage during the six weeks prior to the exceedance of the pyrethroid pesticides prohibition trigger observed on December 17, 2024. Small acreages of outdoor nursery plants were also treated with cyfluthrin and lambda-cyhalothrin during this period (see **Table A1**). While bifenthrin, cyfluthrin, esfenvalerate, and lambda-cyhalothrin were detected in the Ulatis Creek water column sample collected in December 2024 that caused the first of two exceedances of the prohibition trigger, the bifenthrin detected in the sample must have been applied earlier than six weeks before the observed exceedance. In fact, agricultural applications bifenthrin geospatially relevant to the UCBRD site were last made to almond in July 2024, illustrating the persistence of bifenthrin in the environment – whether applied by irrigated agriculture or non-agricultural sources.
- An evaluation PUR data (as acres treated) from irrigated agriculture shows two pyrethroid pesticides identified as the most commonly applied to almond, processing tomato, and alfalfa within the Cache Slough drainage during the six weeks prior to the May 20, 2025, exceedance of the pyrethroid pesticides prohibition trigger. The pyrethroid pesticides identified are bifenthrin (almond and processing tomato) and lambda-cyhalothrin (alfalfa and processing tomato). These two pyrethroid pesticides were also used to treat smaller but still sizeable acreages of dried bean, uncultivated agriculture, sunflower, and corn (as grain) (see **Table A2**). Only bifenthrin was detected in the water quality sample collected on May 20, 2025, that exceeded the chronic prohibition trigger and triggered the requirement for this Management Plan. Bifenthrin applications geospatially relevant to the UCBRD monitoring site show that the pyrethroid was applied to almond.
- Pyrethroid pesticides have a high tendency to strongly bind to fine soil particles and organic matter and tend to be transported in irrigation tailwater, storm runoff, by the wind, and/or through application drift or overspray to non-target areas. These physical factors that can mobilize a pyrethroid pesticide from its site of application can affect both agricultural and non-agricultural applications of these pesticides.
- A review of daily precipitation data recorded at the Sacramento International Airport in Sacramento County, approximately 27 miles northeast of the Ulatis Creek monitoring site, showed that only one of five exceedances observed for pyrethroid pesticides during the period August 2018 through May 2025 was directly influenced by rainfall runoff in the Ulatis Creek drainage (see **Table B1**). The exceedance that was directly influenced by antecedent precipitation occurred on December 17, 2024 (Event 223).
- To avoid future pyrethroid pesticide exceedances caused by the activities of irrigated agriculture in the Ulatis Creek drainage and represented drainages, the Dixon/Solano Resource Conservation District (RCD) Water Quality Coalition (Dixon/Solano Coalition), Solano County Agriculture Commissioner’s Office, and University of California Cooperative Extension staff will conduct targeted outreach and education and identify additional practices for implementation by growers and applicators. Additionally, Dixon/Solano Coalition Members who apply pyrethroid pesticides will maintain their high levels of management practice implementation that control or reduce the risk of discharges of these insecticides to surface waters.

The Ulatis Creek monitoring location (Ulatis Creek at Brown Road (UCBRD)) is in the Cache Slough drainage in the Solano Subwatershed. The UCBRD monitoring location is

currently used by SVWQC as a representative monitoring location for the ILRP. The Cache Slough drainage represents the drainages of Putah Creek South, Southwest Yolo Bypass, and the Sacramento River drainage in the Solano Subwatershed (Sacramento River – Solano).

The implementation goals presented in this document are intended to maintain management practices that minimize pyrethroid pesticide discharges and maintain existing management practices that minimize such discharges to prevent associated water column toxicity to sensitive invertebrates due to agricultural uses of pyrethroid pesticides in the Cache Slough, Putah Creek South, Southwest Yolo Bypass, and Sacramento River – Solano drainages. The geographic scope for the implementation of these practices are summarized in **Table 1**.

Table 1: Summary of Scope of Management Plan Implementation for Pyrethroid Pesticides.

Management Plan Category (PRIORITY)	Registered pesticides (HIGH)
Subwatershed	Solano
Representative Water Body	Ulati Creek
Represented Drainages	Cache Slough, Putah Creek South, Southwest Yolo Bypass, and Sacramento River - Solano
Analytes of Concern	Water column pyrethroid pesticides, including: bifenthrin and lambda-cyhalothrin
Crops Identified in PUR Data Review	Alfalfa, almond, corn (as grain), dried bean, melon, processing tomato, sorghum milo, sunflower, uncultivated agriculture, and walnut
Season	Irrigation Season (April – October) Storm Season (November – March)

1.1 CONSTITUENT OF CONCERN (COC)

As a class of pesticides, pyrethroid insecticides are used to kill insects, including mosquitos. Pyrethroids are synthetic derivatives of pyrethrins produced by the flowers of pyrethrums, which includes the genus *Chrysanthemum*. Pyrethrum flowers are a natural insect repellent. Pyrethroids have a high tendency to strongly bind to fine soil particles and organic matter and tend to be transported in irrigation tailwater, storm runoff, by the wind, and/or through application drift or overspray to non-target areas. These physical factors that can mobilize a pyrethroid pesticide from its site of application can affect both agricultural and non-agricultural applications of all pesticides, not just pyrethroids. They show varying persistence in the environment depending on their exposure to air and sunlight. Generally, pyrethroid half-life in soils ranges from 1 to 2 months, and in aquatic sediments from months to years. Pyrethroids are very toxic to sensitive invertebrates, such as *Hyalella azteca*.

Because *Hyalella azteca*, a freshwater amphipod belonging to the family Hyalellidae, is used by the ILRP as a test organism to evaluate acute toxicity impacts to sensitive invertebrates due to exposure to pollutants (primarily, pyrethroids) in the water column

and sediments of receiving waters, it is appropriate to emphasize outreach and education and management practices related to pyrethroid applications and sediment and erosion control practices in Cache Slough and the represented drainages.

PUR data show that the observed water column pyrethroid pesticides exceedances were associated in time with both agricultural and non-agricultural applications of pyrethroids. Due to the way pesticide applications by irrigated agriculture are required to be reported to the Solano County Agricultural Commissioner (including application date and location information), it is possible to determine when and where pyrethroid pesticides were applied by irrigated agriculture in the Cache Slough drainage and represented drainages. In contrast, licensed non-agricultural applications¹ of pesticides are not required to be reported with associated date and location information, leaving these applications traceable only to the month and county of application (see **Table A3** and **Table A4**). Additionally, a variety of pesticide applications are unreported and unknown, many of which occur in urban areas. These unreported and unknown applications are made by the user groups shown in **Table 2**.

Table 2: Pesticide User Groups that Generally Do Not Report Pesticide Use.

Pesticide User Groups ⁽¹⁾
Residents who apply pesticides to their own homes or landscapes
Some maintenance gardeners
Pet groomers/kennels
Employees applying incidental treatments at commercial businesses/buildings
Employees applying incidental treatments at institutional facilities
Employees applying incidental treatments at industrial (factories and warehouses) facilities.
The United States Department of Defense

1. Taken from Kreidich et al. (2005).

The use of pyrethroid-containing products by the general public, such as those user groups listed in **Table 2**, has been identified by CDPR as a concern due to the number of outdoor and indoor products in use and their associated toxicity to sensitive aquatic species. Lambda-cyhalothrin, permethrin, deltamethrin, and bifenthrin are common active ingredients in outdoor pest control products (Budd and Peters, 2018). Although bifenthrin is identified in fewer products than other pyrethroids, it is the most commonly detected insecticide in Northern California ambient waters with a detection frequency of 83%, followed by permethrin at 11% (Ensmiger, 2016). Pyrethroids are also contained in insecticides used for indoor pest control, such as aerosol sprays, fogger products, and direct application flea control products. A survey of indoor products sold between 2012

¹ Non-agricultural pesticides applications reported to the California Department of Pesticide Regulation as monthly summary records include those by Licensed Structural Pest Control Operators, Licensed Landscape Pest Control Professionals, and Licensed Public Agency Pest Control Operators.

and 2016 found that the average sales of cypermethrin-containing products was an order of magnitude greater than the sale of products containing the second most prevalent active ingredient, deltamethrin. Bifenthrin, permethrin, and lambda-cyhalothrin ranked third, fourth, and eighth, respectively, in the same indoor pesticide products sales evaluation (Budd and Peters, 2018). Additionally, permethrin, deltamethrin, and cypermethrin are contained in flea/tick medicines used at home by pet owners and applied to humans for the treatment of scabies and lice. These same three pyrethroid insecticides also are applied topically to skin and to clothing/netting to repel mosquitoes (Chrustek et al. 2018). In short, the use of pyrethroid-containing pesticides by non-licensed user groups in urban areas is significant but cannot be quantified nor compared to uses by professional applicators at this time due to lack of available information.

1.2 TRIGGER LIMITS

The Coalition's WDR requires that Dixon/Solano Coalition members comply with all adopted water quality objectives (WQOs) and established federal water quality criteria applicable to their discharges. The WDR specifies the use of applicable numeric and narrative WQOs in the *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* (Basin Plan), and the criteria in USEPA's 1993 National Toxics Rule (NTR) and 2000 California Toxics Rule (CTR), which constitute numeric WQOs when combined with the Basin Plan's beneficial use designations. The numeric objectives from these sources are compiled in Table 5 of the WDR's Monitoring and Reporting Program (MRP) (see Attachment B of Order No. R5-2014-0030-R1).

The Coalition's WDR also requires that Dixon/Solano Coalition Members comply with other ongoing water quality efforts which may be adopted by the Central Valley Water Board as Basin Plan Amendments. The 2017 Pyrethroid Pesticide BPA established Total Maximum Daily Loads (TMDLs) for five waterbody segments receiving agricultural discharges², as well as a conditional prohibition of pyrethroid discharges to Central Valley waterbodies at concentrations above specified aquatic life protection-based concentration triggers (prohibition triggers). The prohibition triggers (a chronic pyrethroid trigger and an acute pyrethroid trigger) are not adopted WQOs but do function similarly to an ILRP trigger limit in that the prohibition triggers are intended to be used to indicate when a pyrethroid management plan needs to be developed and management practices are to be implemented by those who apply pyrethroid pesticides to prevent exceedances of the prohibition triggers.

The prohibition trigger for pyrethroid pesticides is based on an additive chronic and additive acute concentration goal unit (CGU) of 1 (a unitless value) as required in the Pyrethroid Pesticide BPA. The additive CGU is calculated using the detected concentrations of six pyrethroid pesticides (bifenthrin, cyfluthrin, lambda-cyhalothrin, cypermethrin, esfenvalerate, and permethrin) specified in the Pyrethroid Pesticide BPA

² Del Puerto Creek, Hospital Creek (San Joaquin and Stanislaus counties), Ingram Creek (from confluence with Hospital Creek to Highway 33 crossing), Ingram Creek (from confluence with San Joaquin River to confluence with Hospital Creek), and Mustang Creek (Merced County).

and contemporaneous measurements of particulate organic carbon (POC) and dissolved organic carbon (DOC), where POC concentration is derived from total organic carbon (TOC) concentration minus DOC concentration.

The Pyrethroid Pesticide BPA also requires that agricultural coalitions determine whether pyrethroid pesticides are causing or contributing to the narrative water quality objective for toxicity in surface waters. This assessment is made by running toxicity bioassays with *Hyalella* using both water column and sediment samples collected at the location where a water column sample is analyzed for pyrethroids. With respect to the observance of water column toxicity to *Hyalella*, if the concentration of any one of the six target pyrethroids is detected above its reporting limit, then the detected pyrethroid is considered to have caused or contributed to the observed toxicity of a test organism and is effectively considered an exceedance of the prohibition trigger, even if the calculated, additive chronic CGU is less than or equal to 1 (one). It follows that if two or more pyrethroids are detected above their individual reporting limits, the same rule applies. The ILRP is charged with overseeing that agricultural dischargers in the Central Valley comply with the Pyrethroid Pesticide BPA, including the development of Surface Water Quality Management Plans for pyrethroid pesticides when a prohibition trigger is exceeded twice in a three-year period at a monitoring location.

1.3 MANAGEMENT PLAN BOUNDARIES

As described above, the geographic boundaries of the Management Plan for Ulatis Creek include the representative Cache Slough drainage, as well as the represented drainages of Putah Creek, Southwest Yolo Bypass, and Sacramento River – Solano. All four drainages and the Coalition monitoring site (UCBRD) on Ulatis Creek are shown in **Figure 1**.

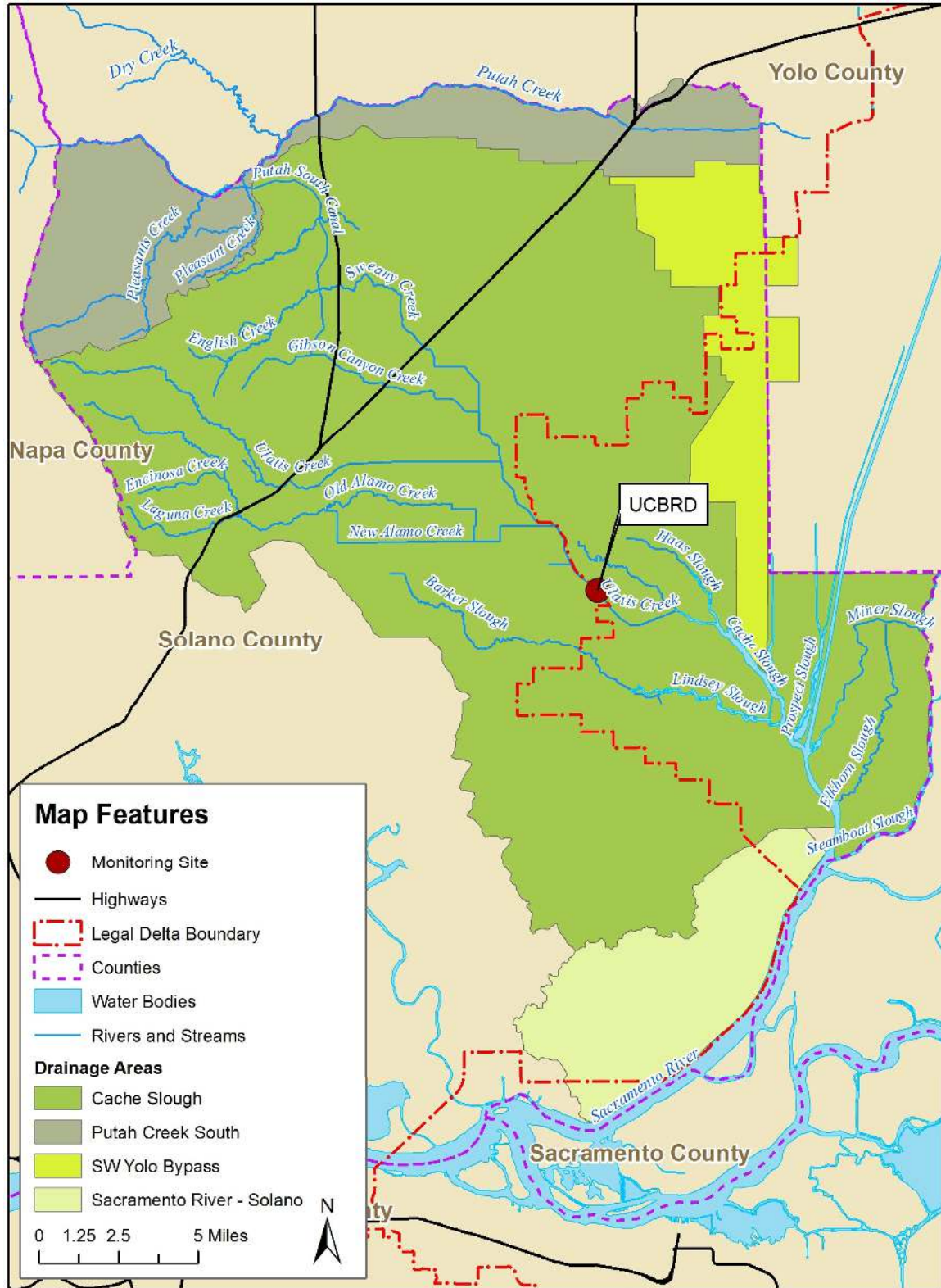


Figure 1: Management Plan Boundaries for the Cache Slough Represented Drainages.

2 Physical Setting and Information

2.1 LAND USE CHARACTERIZATION AND BENEFICIAL USES

The boundaries, crop categories, and land uses within each of the four drainages considered by this Management Plan are shown in **Figure 2**. The boundaries and land use characteristics for the Cache Slough drainage and the three represented drainages are also listed in **Table 3**.

Designated beneficial uses that are relevant to the implementation of the ILRP are municipal and domestic water supply (MUN), agricultural water supply (AGR), contact recreation (REC-1), and aquatic life uses including freshwater habitat, migration, and spawning for cold water and warm water species (WARM, COLD). Specific beneficial uses have been designated in the Central Valley Basin Plan only for the Sacramento River and direct perennial tributaries to the Sacramento River in this subwatershed.

Table 3: Land Use Characteristics for Cache Slough Drainage and Represented Drainages.

Drainage	Drainage Acres ⁽¹⁾	Irrigated Acres (non-rice) ⁽¹⁾	% Irrigated Acres (non-rice) ⁽¹⁾	Major Crop Types ⁽²⁾
Cache Slough	236,346	111,732	47.3	Pasture, Almonds, Grain and Hay, Alfalfa, Tomato, Walnuts, Wheat, Corn, Safflower, Sunflowers, Misc. Grasses
Putah Creek South	38,230	13,684	35.8	Walnuts, Tomato, Almonds, Grain and Hay, Sunflowers, Alfalfa, Corn, Wheat, Pistachio, Melons, Squash, Cucumbers
Southwest Yolo Bypass	22,658	16,999	75.0	Mixed Pasture, Almonds, Alfalfa, Corn, Grain and Hay, Tomato, Sunflowers, Wheat, Melons, Squash, Cucumbers, Walnuts
Sacramento River – Solano	24,836	4,437	17.9	Wheat, Grain and Hay, Safflower, Vineyard, Field Crops, Alfalfa, Mixed Pasture

1. California Department of Water Resources (DWR). 2023. Statewide Crop Mapping dataset. GIS file available at <https://data.cnra.ca.gov/dataset/statewide-crop-mapping>. Accessed October 2025.

2. Total irrigated acres does not include land classified as idle or unclassified with the DWR 2023 Statewide Crop Mapping database. Major crops listed collectively represent approximately 75% or greater of total planted acreage in each drainage.

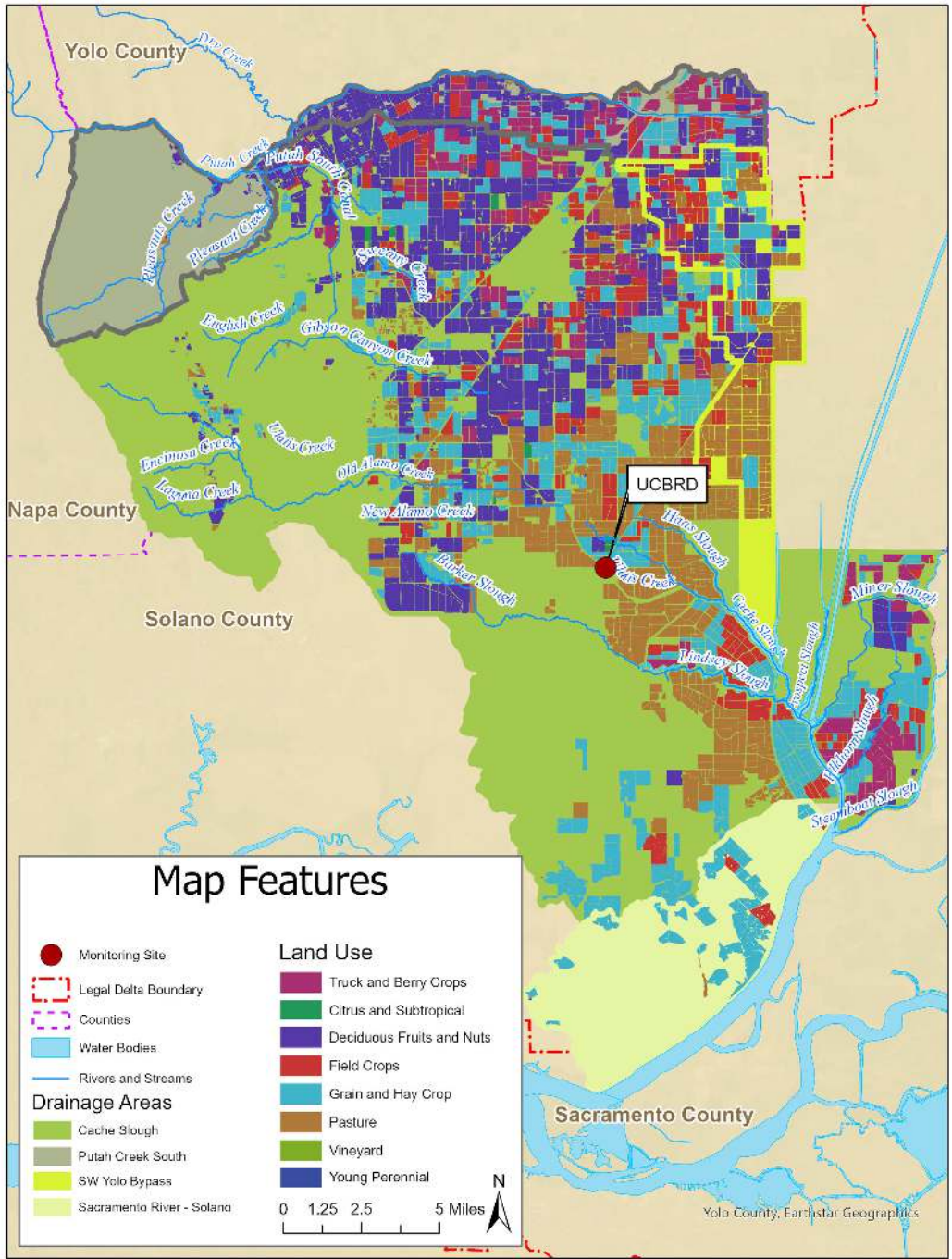


Figure 2: Land Use Characterization of the Cache Slough Represented Drainages.

The beneficial uses for Cache Slough and each of the represented drainages shown in **Table 4** are taken from Table II-1 of the Basin Plan. Various water bodies in the Cache Slough drainage are identified in the Basin Plan (Appendix 42) as Delta Waterways. Those reaches of these Delta Waterways that reside in the “Legal” Delta are assigned the beneficial uses designated for the Sacramento-San Joaquin Delta. Beneficial uses for the Putah Creek South drainage are those designated for the Putah Creek: Lake Berryessa to Yolo Bypass surface water body segment; beneficial uses for the Southwest Yolo Bypass drainage are those designated for the Yolo Bypass surface water body; and the beneficial uses for the Sacramento River drainage in the Solano Subwatershed are those designated for the Sacramento-San Joaquin Delta.

Table 4: Beneficial Uses Designated for Cache Slough and Represented Drainages.

Beneficial Uses for Surface Water as Defined in Basin Plan	Cache Slough⁽¹⁾⁽²⁾	Putah Creek South⁽³⁾	SW Yolo Bypass⁽⁴⁾	Sac River – Solano⁽⁵⁾
Municipal and Domestic Supply (MUN)	E ⁽⁶⁾⁽⁷⁾	E		E
Agricultural Supply: Irrigation (AGR)	E	E	E	E
Agricultural Supply: Stock Watering (AGR)	E	E	E	E
Industrial Process Supply (PRO)	E			E
Industrial Service Supply (IND)	E			E
Water Contact Recreation (REC 1)	E	E	E	E
Non-contact Water Recreation (REC-2)	E	E	E	E
Warm Freshwater Habitat (WARM)	E	E	E	E
Cold Freshwater Habitat (COLD)	E ⁽⁶⁾ or P	P	P	E
Migration of Aquatic Organisms: Warm Water (MIGR)	E ⁽⁶⁾ or n/a		E	E
Migration of Aquatic Organisms: Cold Water (MIGR)	E ⁽⁶⁾ or n/a		E	E
Fish Spawning, Warm Water (SPWN)	E ⁽⁶⁾	E	E	E
Fish Spawning, Cold Water (SPWN)	E ⁽⁶⁾ or n/a			E
Wildlife Habitat (WILD)	E	E	E	E
Commercial and Sport Fishing (COMM)	E or n/a		E	E

Legend/Notes:

E = Existing Basin Plan Designated Beneficial Use, P = Potential Beneficial Use;

Source: Water Quality Control Plan for the Sacramento River and San Joaquin River Basin, Fifth Edition, Revised February 2019 (CVRWQCB, 2019).

1. The following water bodies in the Cache Slough Drainage are identified as Delta Waterways (Basin Plan Appendix 42) having all or a portion of their extent residing within the legal Delta boundary: Alamo Creek (Old Alamo Creek, New Alamo Creek), Barker Slough, Cache Slough, Elkhorn Slough, Haas Slough, Lindsey Slough, Miner Slough, Prospect Slough, Steamboat Slough, Sweany Creek, and Ulatis Creek) and there beneficial uses are those designated for the Sacramento-San Joaquin Delta.

2. For all or a portion of the extent of the following water bodies that reside outside of the legal Delta boundary, it is assumed that their beneficial uses are the same as those designated for Putah Creek: Lake Berryessa to Yolo Bypass segment: Alamo Creek (Old Alamo Creek, New Alamos Creek), Barker Slough, Encinosa Creek, English Creek, Gibson Canyon Creek, Laguna Creek, Putah South Canal, Sweany Creek, and Ulatis Creek.
3. Beneficial uses for the Putah Creek South Drainage are described in the Basin Plan by the Putah Creek: Lake Berryessa to Yolo Bypass segment.
4. Beneficial uses for the Southwest Yolo Bypass Drainage are described in the Basin Plan by the Yolo Bypass segment.
5. Beneficial uses for the Sacramento River drainage in the Solano Subwatershed are described in the Basin Plan as those beneficial uses designated for the Sacramento-San Joaquin Delta.
6. MUN, COLD, MIGR, and SPWN do not apply to Old Alamo Creek (Basin Plan II-2.00).
7. New Alamo Creek and Ulatis Creek are designated with the MUN beneficial use (Basin Plan IV-37.05).

2.2 CONSTITUENT OF CONCERN SOURCES, FATE, AND TRANSPORT

Monthly PUR data for the Cache Slough drainage show agricultural applications of the six target pyrethroid pesticides from January 2018 through May 2025 as having a bimodal distribution with peaks in May and July-August (see **Figure A1**). Non-agricultural applications across Solano County also show two peaks in application: April and October (see **Figure A2**). The initial pyrethroid prohibition trigger that was exceeded in December 2024 occurred at a time when very few crops were treated with pyrethroid pesticides. Only outdoor nursery plants and prune were treated during the November and December 2024 time period (see **Table A1**). Cyfluthrin and lambda-cyhalothrin were applied to outdoor nursery plants during both months and esfenvalerate was applied to prune only during December.

In contrast, non-agricultural applications of pyrethroid pesticides did occur in November (110 applications totaling 37.62 lbs. active ingredient) and December 2024 (93 applications totaling 45.68 lbs. active ingredient) in Solano County at a frequency about two-thirds of that in April (109 applications totaling 638.13 lbs. active ingredient) and May 2025 (184 applications totaling 251.24 lbs. active ingredient; see **Table A3** and **Table A4**). The bifenthrin detected in the water quality sample collected on December 17, 2024, in contrast to the detected cyfluthrin, esfenvalerate, and lambda-cyhalothrin, likely came from either irrigated agriculture applications or non-agricultural applications made earlier in time and transported downstream to the UCBRD monitoring site in stormwater runoff. An evaluation of PUR data show that bifenthrin applications geospatially relevant to the UCBRD site were last made to almond in July 2024. The December 17 prohibition trigger exceedance was preceded by greater than 0.25 inches (in.) of rain 1 day earlier and by greater than 0.75 in. of precipitation 3 days earlier (see **Table B1**). Among the five recorded exceedances for pyrethroid pesticides in the water column at the UCBRD site, only the December 17, 2024, exceedance was associated with a recent, antecedent precipitation event.

With regard to the second of the two pyrethroid water column exceedances that occurred on May 20, 2025, and triggered this Management Plan, it represents the month in which the first pyrethroid application peak occurs in the Cache Slough drainage (see **Figure A1**). PUR data for agricultural applications of pyrethroids in April and May 2025

show the largest number of acres treated with bifenthrin and lambda-cyhalothrin. The crops receiving the majority of the applications of those two pyrethroids in 2025 on a treated acre basis include: alfalfa, almond, corn (as grain), dried bean, melon, processing tomato, sorghum milo, sunflower, uncultivated agriculture, and walnut (see **Table A2**). The May 20, 2025, exceedance was caused by bifenthrin and was not preceded by a precipitation event (see **Table B1**). No other pyrethroids were detected in the water quality sample. Non-agricultural applications of pyrethroids in Solano County during April and May 2025 were dominated by bifenthrin and lambda-cyhalothrin applications primarily for structural pest control purposes (see **Table A4**). As shown in **Figure A2**, April is the month with the highest total pounds of pyrethroids applied by non-agricultural sources in Solano County, with lambda-cyhalothrin and bifenthrin being applied at the highest and second highest rates, respectively, among the six pyrethroids specified in the Pyrethroid Pesticide BPA.

The total acres of crops treated with pyrethroid pesticides by irrigated agriculture in the Cache Slough drainage and represented drainages also shows a bimodal distribution with an initial peak in May, followed by a reduction in treated acres in June, then by significantly greater numbers of treated acres in July and August, and finally dropping precipitously from September through December (see **Figure A3**). The total number of treated acres in the Cache Slough drainage and represented drainages has varied from year-to-year, as shown in **Figure A4**. Among the 7.5 years represented in the stacked bar plots, 2023 had the greatest number of treated acres and 2021 had the fewest number of treated acres. The small number of treated acres in 2021 is likely an artifact of the COVID-19 pandemic that occurred that year. It should be noted that the bar plot representing 2025 only tracks pyrethroid applications through May 2025.

When comparing the total pounds of all six pyrethroid pesticides applied in the Cache Slough Drainage and represented drainages (see **Figure A5**) to the total acres treated with pyrethroids in the same area (see **Figure A4**), one can calculate the pounds of pesticides applied per acre from January 2018 to May 2025 (see **Table B2**). Because 2021 represents a non-typical year and the data for 2025 only go through May, leaving out those two years results in a calculated average of 0.07 pounds per acre of pyrethroid pesticides applied in the Cache Slough drainage and represented drainages for the years 2018-2020 and 2022-2024. Finally, a comparison of the total pounds of pyrethroid pesticides applied by irrigated agriculture (see **Figure A5**) to the total pounds of pyrethroid pesticides applied by non-agricultural sources (see **Figure A6**) reveals that non-agricultural applications of pyrethroid pesticides show less variation from year-to-year than do applications made by irrigated agriculture, and non-agricultural applications average about 26% of irrigated agricultural applications on a weight basis per year (again leaving out the years 2021 and 2025).

A review of daily precipitation data recorded at the Sacramento Metropolitan Airport³, approximately 27 miles northeast of the Ulatis Creek monitoring site, revealed that the

³ Precipitation data collected at the CDEC Sacramento Metropolitan Airport (SMF) gauge in Sacramento County. https://cdec.water.ca.gov/dynamicapp/staMeta?station_id=SMF

only monitoring event likely influenced by rainfall runoff in the Cache Slough drainage was the December 17, 2024, event (Event 223; see **Table B1**). Approximately 0.67 in. of rainfall was recorded on December 16 and an additional 0.91 in. fell on December 14. This amount of rain would cause significant runoff in upstream portions of the Cache Slough drainage and it is likely that upstream urban and municipal discharges contributed to the concentrations of the four pyrethroids measured in the water quality sample collected on December 17, 2025. The pyrethroid pesticides exceedance observed on May 20, 2025, was not preceded by a rainfall event. In fact, it had been 51 days since 0.10 in. was measured at the Airport (see **Table B1**). Similarly, the three prior pyrethroid pesticide water column exceedances (Events 150, 157, and 182) observed at the monitoring were not influenced by antecedent precipitation.

Pyrethroids, as a class of pesticide, are highly non-polar and feature low water solubility, low volatility, high octanol-water partition coefficients, and have high affinity for soil and sediment particulate matter. Pyrethroids have low mobility in soil and are sorbed strongly to the sediments of natural water systems. Due to these characteristics, pyrethroids are not readily transported in dissolved form, but have a high tendency to attach to fine soil and organic particles and be tend to be transported in irrigation tailwater, storm runoff, by the wind, and/or through application drift or overspray. These physical factors that can mobilize a pyrethroid pesticide from its site of application can affect both agricultural and non-agricultural applications of all pesticides, not just pyrethroids. They show varying persistence in the environment depending on their exposure to air and sunlight. Generally, pyrethroid half-life in soils ranges from 1 to 2 months, and in aquatic sediments from months to years. They have a moderate to high potential to persist in the environment.

Based on potential transport pathways, effective best management practices (BMPs) that *could* be employed, and in many cases are already employed, by growers and applicators to minimize the risks of pyrethroid contamination in surface waters and sediments include:

- Using alternative pest control materials (i.e., using non-pyrethroid pesticides)
- Reducing the quantity of pesticides applied by monitoring pest and beneficial populations to determine the need for pesticides and the best timing for maximum control
- Reducing the quantity of pesticides applied with spray buffers at field edges and near ditches
- Reducing drift by regular calibration of sprayers for pesticide applications
- Reducing drift by using electrostatic sprayer equipment
- Reducing drift by using effective drift control mechanisms
- Maximizing time between application and planned irrigation runoff and/or predicted storm runoff events in order to reduce loss of applied pesticides from foliage, transport on soils, and transport of pesticides bound to particles in tailwater
- Changing to more efficient application methods (e.g., ground vs. aerial applications and/or equipment that provides more precise applications)

- Installation of vegetated filters between application areas and ditches and/or allowing vegetation to grow in drainage ditches to reduce movement of pesticides bound to soil particles and contamination from aerial overspray (Note: vegetated BMPs may be less effective for very fine-textured clay soils)
- Reducing irrigation tailwater through conversion from flood or furrow irrigation to buried drip, sprinkler, or micro-irrigation where applicable
- Reducing irrigation tailwater with tailwater return systems
- Reducing or delaying irrigation tailwater through irrigation water management
- Sediment and erosion control practices

A diagram showing the general pathways for transport of agriculturally applied pyrethroid pesticides to surface waters and practices to minimize the risk of off-site pyrethroid transport is provided in **Appendix C**.

2.3 BASELINE PRACTICES INVENTORY

The baseline practices inventory for the management of pyrethroid pesticides in the Cache Slough drainage and represented drainages can be obtained by reviewing the 2023 Management Practices Implementation Reporting (MPIR) results for the existing *Surface Water Quality Management Plan: Hyalella azteca Toxicity in Ulatis Creek*. These data show that growers and applicators who apply pyrethroid pesticides in the Cache Slough drainage and represented drainages are currently implementing a suite of practices in the following three categories that contribute to preventing pesticides from entering surface waters: pesticide application practices, irrigation practices for managing sediment and erosion, and cultural practices to manage sediment and erosion. A baseline summary of practices by (1) practice category and (2) number of acres represented by an individual practice is provided in **Table 5**. The term *baseline* is used because it represents the starting point considered for comparisons to future rates of management practices implementation. The 2023 MPIR results were also summarized in the *2024 Water Quality Management Plan Progress Report* and are the most current available for reporting.

Table 5: 2023 MPIR Baseline Summary of Practices Implemented in the Cache Slough Drainage and Represented Drainages to Prevent Pyrethroid Pesticides from Entering Surface Waters.

PRACTICE CATEGORY	Acres Reported	Percent of Total Acres (19,265 acres)
Individual Practice		
PESTICIDE APPLICATION PRACTICES		
County Permit Followed	19,265	100.0%
Monitor Wind Conditions	19,265	100.0%
Use PCA Recommendations	19,265	100.0%
End of Row Shutoff When Spraying	19,199	99.7%
Follow Label Restrictions	19,195	99.6%
Avoid Surface Water When Spraying	19,078	99.0%
Use Drift Control Agents	19,044	98.9%
Monitor Rain Forecasts	18,854	97.9%
Sensitive Areas Mapped	16,983	88.2%
Use Appropriate Buffer Zones	16,854	87.5%
Attend Trainings	16,721	85.4%
Reapply Rinsate to Treated Field	9,189	47.7%
Use Vegetated Drain Ditches	5,699	29.6%
Chemigation	1,905	9.9%
Target Sensing Sprayer used	1,301	6.8%
Other	0	0.0%
IRRIGATION METHODS AND EFFICIENCY PRACTICES		
Primary Irrigation Methods Employed		
Drip	9,340	48.5%
Flood	4,658	24.2%
Furrow	3,092	16.0%
Sprinkler	1,648	8.6%
Border strip	420	2.2%
Subsurface irrigation	107	0.6%
Dry-land (alfalfa)	0	0.0%
Microsprinkler	0	0.0%
Not reported	0	0.0%

PRACTICE CATEGORY	Acres Reported	Percent of Total Acres (19,265 acres)
Individual Practice		
Secondary Irrigation Methods Employed		
Sprinkler	340	1.8%
Flood	0	0.0%
Irrigation Efficiency Practices		
Water application scheduled to need	19,074	99.0%
Laser leveling	11,276	58.5%
Use of moisture probe	9,005	46.7%
Use of ET in scheduling irrigation	6,783	35.2%
Use of soil moisture neutron probe	157	0.8%
Use of pressure bomb	118	0.6%
CULTURAL PRACTICES TO MANAGE SEDIMENT AND EROSION		
Soil water penetration has been increased through the use of amendments, deep ripping and/or aeration.	15,746	81.7%
Crop rows are graded, directed and at a length that will optimize the use of rain and irrigation water.	15,513	80.5%
Storm water is captured using field borders.	8,863	46.0%
Vegetated ditches are used to remove sediment as well as water soluble pesticides, phosphate fertilizers and some forms of nitrogen.	6,796	35.3%
Minimum tillage incorporated to minimize erosion.	5,663	29.4%
Berms are constructed at low ends of fields to capture runoff and trap sediment.	5,305	27.5%
Sediment basins / holding ponds are used to settle out sediment and hydrophobic pesticides such as pyrethroids from irrigation and storm runoff.	3,829	19.9%
Subsurface pipelines are used to channel runoff water.	2,480	12.9%
Field is lower than surrounding terrain.	2,466	12.8%
No storm drainage due to field or soil conditions.	2,437	12.6%
Vegetative filter strips and buffers are used to capture flows.	1,588	8.2%
Cover crops or native vegetation are used to reduce erosion.	1,323	6.9%

PRACTICE CATEGORY	Acres Reported	Percent of Total Acres (19,265 acres)
Individual Practice		
Hedgerows or trees are used to help stabilize soils and trap sediment movement.	724	3.8%
Creek banks and stream banks have been stabilized.	323	1.7%
Other	18	0.1%

2.4 CONSTITUENT OF CONCERN: WATER QUALITY DATA

The analysis of water column samples for pyrethroid pesticides in Ulatis Creek began during the 2018 Monitoring Year (October 2017 through September 2018), due to the adoption and implementation of the Central Valley Water Board’s Pesticides Evaluation Protocol (PEP). Beginning in April 2019⁴, the Central Valley Water Board required SVWQC to compare detected water column concentrations of six pyrethroid pesticides to the additive acute and chronic concentration goal units (CGUa and CGUc, respectively) specified in the Pyrethroid Pesticide BPA. SVWQC implemented 12 months of pyrethroid pesticide baseline monitoring required by the Pyrethroid Pesticide BPA during the 2021 Monitoring Year (October 2020 through September 2021), which paired water column pyrethroid pesticide analyses with water column *Hyalella azteca* toxicity tests. *Hyalella* sediment tests were also required by the baseline monitoring at a frequency comparable to the sediment toxicity testing requirements included in SVWQC’s WDR. With the implementation of baseline pyrethroid pesticides monitoring, ILRP staff notified SVWQC that two exceedances of the prohibition trigger in a three-year period would trigger the requirement to develop a Management Plan to control or reduce the risk of discharges of pyrethroid pesticides to surface waters.

A total of 34 monitoring events for the analysis of water column pyrethroid pesticides in Ulatis Creek has been conducted by SVWQC from February 2018 through August 2025 (see **Table B3**). In five of these events, the additive dissolved fraction calculation exceeded one or both CGU limits. These five pyrethroid pesticide exceedances are shown in **Table 6**. The last two exceedances observed at the UCBRD site (December 2024 and May 2025) triggered the development of this Management Plan. Additional water column and sediment *Hyalella* survival results also are included in **Table B3**. Finally, *Hyalella* sediment toxicity results are shown in **Table B4**, including sediment chemistry results where *Hyalella* toxicity was determined to be statistically significant and there was less than 80% survival of the test organism as compared to the control sample.

⁴ On April 22, 2019, the United States Environmental Protection Agency (USEPA) approved the Pyrethroid TMDLs included in the BPA. With USEPA approval, the BPA and TMDLs became fully approved and effective.

Table 6: Pyrethroid Pesticide Acute and Chronic Results Contributing to Exceedances of the Prohibition Trigger Observed in the Cache Slough Drainage: January 2018 – May 2025.

Event	Date	Detected Pyrethroids	Chronic and Acute CGU
150	08/21/2018	Lambda-Cyhalothrin	2 [chronic] ^[1]
157	03/19/2019	Lambda-Cyhalothrin	2 [chronic] ^[1]
182	06/23/2021	Lambda-Cyhalothrin	5 [chronic], 2 [acute]
223	12/17/2024	Bifenthrin, Cyfluthrin, Esfenvalerate, Lambda-Cyhalothrin	3 [chronic]^[2]
228	05/20/2025	Bifenthrin	2 [chronic]^[2]

[1] Exceedances prior to April 1, 2019, were not required to be reported to the Central Valley Water Board.

[2] Exceedances of the prohibition trigger that led to the requirement for a Management Plan are shown in bold.

3 Management Plan Strategy

The five observed pyrethroid pesticide exceedances are indicative of one or more pyrethroid pesticides being present in the Cache Slough drainage at levels that have potential for affecting aquatic life. It is possible that the exceedances may not be associated with the agricultural use of pyrethroid pesticides since non-agricultural uses are documented in PUR data obtained for the six weeks prior to the observed Ulatis Creek exceedances (see **Table A3** and **Table A4**). There are also known urban uses of pyrethroid pesticides discussed in **Section 1.1** that may result in the discharge of these pesticides from the City of Vacaville to the upstream portion of the Cache Slough drainage. However, due to the use of pyrethroids by irrigated agriculture during the period leading up to the observed water column exceedances and the persistence of pyrethroids in the environment, Dixon/Solano Coalition Members in the Cache Slough represented drainages are required to implement a management strategy to reduce the risk of pyrethroid pesticide discharges and thus, improve surface water quality in these drainages.

3.1 MANAGEMENT PLAN APPROACH

The Dixon/Solano Coalition continues its efforts to avoid or reduce the discharge of pyrethroid pesticides from agricultural fields through the implementation of the existing *Surface Water Quality Management Plan: Hyalella azteca Toxicity in Ulatis Creek*. This Management Plan is still in effect due to infrequent observations of toxicity to *Hyalella* associated primarily with low-level concentrations of pyrethroids in sediment that are reported by the laboratory as DNQ (Detected Not Quantifiable). Because both this Management Plan and the existing Management Plan have at their core the responsibility to avoid or reduce the discharge of pyrethroid pesticides to receiving waters in the Cache Slough drainage and represented drainages, the existing Management Plan's approach can be continued for both Management Plans.

The same outreach and education approach at all levels (growers, applicators, pest control advisors (PCAs)) will be employed to ensure that applicators of pyrethroids are

aware of the water column exceedances that occurred in December 2024 and May 2025, as well as recommended practices to minimize the discharge of pyrethroid pesticides to surface waters. Growers will continue to implement practices focused on the management of irrigation tailwater, the implementation of cultural practices to control sediment and erosion and pesticide application practices to control drift, the use of alternative pest control materials, and additional pesticide application practices, as necessary. Dixon/Solano Coalition staff will focus on targeted outreach, education, and gathering feedback on specific practices from growers and applicators during the first 18 months of implementation of this new Management Plan. Growers and applicators will maintain their current high levels of management practice implementation to control or reduce the risk of discharges of pyrethroids to surface waters. The Dixon/Solano Coalition's current recommended management practices for the control of pyrethroids are shown in **Appendix D**.

The Dixon Resource Conservation District (RCD) will continue to utilize the Dixon/Solano Coalition's online data management system to track (1) pesticide application practices, (2) irrigation practices for managing sediment and erosion, (3) cultural practices to manage sediment and erosion, and (4) the use of pyrethroid pesticides as a dormant season insecticides by those growers who apply pyrethroids in the Cache Slough drainage and represented drainages. These data will be reported annually to the Central Valley Water Board as the Management Practices Implementation Reporting (MPIR) results for this new Management Plan and the existing Management Plan (i.e., one set of MPIR results for both Management Plans). These MPIR results also will be reported annually in SVWQC's *Water Quality Management Plan Progress Report*. This targeted survey information will be reviewed and integrated as appropriate to update the Dixon/Solano Coalition's *Pyrethroid Facts and Recommended Practices (Appendix D)*. The suite of updated management practices for the control of discharge of pyrethroid pesticides to surface waters will then be used by the Dixon/Solano Coalition staff to educate growers and applicators.

The Solano Subwatershed's current and future approach to managing water column chemistry and toxicity exceedances, as well as sediment toxicity exceedances in the Cache Slough drainage and represented drainages includes the continuation of a robust education campaign. The impetus for this effort is to maintain a high degree of awareness of past water column and water column and sediment toxicity exceedances associated with pyrethroid pesticides and the implementation of management practices known to avoid or reduce the movement of pyrethroid pesticides from their points of application. Based on the 2023 MPIR results for the existing Management Plan that are summarized in **Table 5**, nearly all growers in the four drainages are already implementing the agricultural practices necessary to prevent the discharge of pesticides to surface waters. The Dixon/Solano Coalition staff will continue to strongly encourage its Members in the Cache Slough represented drainages to continue implementation of the practices summarized in **Table 5** under this new Management Plan.

3.2 ACTIONS AND TASKS

3.2.1 Summary of Actions Taken to Date

Since the Dixon/Solano Coalition was made aware of the two most recent water column exceedances for pyrethroid pesticides, it has initiated the following actions:

- Email ALERT sent to 524 coalition members including pesticide applicators on January 29, 2025. The ALERT included notification of a water column pyrethroid exceedance observed on December 17, 2024, the historical connection between pyrethroid water column detections and water column toxicity, as well as a list of product trade names with pyrethroids as active ingredients and best management practices to avoid waterways when applying pyrethroid pesticides.
- Presentations at the Solano County Agricultural Commissioner Spray Safe event on February 19, 2025, with 65 participants. This event included targeted outreach about the history of the exceedances in Ulatis Creek, current exceedances, product trade names with pyrethroids as active ingredients that most likely caused the recent exceedance, and best management practices to mitigate the issue.
- Pre-season of use email alert was sent on April 8, 2025, to 375 growers and PCAs reminding them to use best practices and alternate methods whenever possible.
- Additional emails were sent on June 17 and July 3, 2025, about recent exceedances again in Ulatis Creeks with reminders to share this information with all others in their operations and to use extreme caution when applying pyrethroids near waterways.
- On August 13, 2025, 70 growers, PCAs, and professional applicators attended a grower meeting on pyrethroids with targeted presentations from the Coalition's water quality consultant and a UCCE advisor about the recent water column exceedances and best practices to avoid future exceedances.

3.2.2 Performance Goals

Beginning in December 2010 and continuing currently, Coalition Members in the Cache Slough represented drainages have received targeted outreach and education associated with pyrethroid pesticide application and runoff management practices that minimize the potential for these insecticides to impact surface waters that are informed by both the *2010 Pyrethroid Action Plan* developed for Z-Drain and the *2019 Surface Water Quality Management Plan: *Hyalella azteca* Toxicity in Ulatis Creek*. Monitoring results from 2013⁵ through August 2025 for the Ulatis Creek at Brown Road site reflect the increased attention and implementation of management practices that have reduced the levels of pesticides and toxicity exceedances in the receiving water observed over this period. The effectiveness of these actions implemented by growers and applicators in the Cache Slough drainage and represented drainages will continue to be evaluated through review of Assessment and/or Management Plan monitoring data and evaluation

⁵ Beginning with the 2013 Monitoring Year (October 2012 through September 2013), the Solano Subwatershed began to record many fewer exceedances for pesticides and toxicity as compared to earlier years in the Subwatershed's monitoring history.

of annual MPIR data collected for the two Ulatis Creek Management Plans. The Dixon/Solano Coalition and its Members in the Cache Slough represented drainages seek to meet the three performance goals shown in **Table 7** as they relate to the application of pyrethroid pesticides.

Table 7: Management Practice Performance Goals for Pyrethroid Applications in the Cache Slough Drainage and Represented Drainages.

Performance Goal	Mechanism of Achieving Goal	Quantitative Measure of Progress	Schedule for Achieving Goal
<p>1. Maintain education and awareness of pyrethroid application and runoff management practices that minimize the potential for impacts to surface waters. Use targeted grower survey information, beginning with 2023 MPIR results and consultation with growers, PCAs, applicators, and technical advisors to refine, as necessary, existing management practices for the control of pyrethroid pesticide discharges.</p>	<p>Dixon/Solano Coalition to provide Water Column Pyrethroid Pesticide Management Plan updates annually through presentations at Solano County Ag Commissioner pesticide applicator trainings, written updates in annual newsletter, and/or direct season of use mailings (through email and US mail) to all Coalition members who apply or may apply pyrethroids, as well as PCAs and commercial applicators operating locally.</p> <p>The updates will include information to educate applicators in the Cache Slough and represented drainages on management practices that minimize the potential for pyrethroids to be discharged to surface waters. Mailings and/or phone calls to growers regarding appropriate BMPs will also be counted as successful completion of these goals.</p>	<p>Achievement of this performance goal will be measured based on attendance and/or receipt of outreach materials. Outreach activities to be documented in Annual Monitoring Report and MPIR results tabulated in SVWQC’s annual Management Plan Progress Report.</p> <p><i>Reporting Basis:</i> <i>Meeting dates, numbers of attendees at meetings, and recipients of mailings and/or phone calls covering these management practice topics.</i></p>	<p>Ongoing: 100% achievement of this performance goal will occur in every year from the date the Management Plan is submitted for approval to the Executive Officer.</p>

Performance Goal	Mechanism of Achieving Goal	Quantitative Measure of Progress	Schedule for Achieving Goal
<p>2. Maintain implementation of pyrethroid application and runoff management practices that minimize the potential for impacts to surface waters in the Cache Slough and represented drainages. Use targeted grower survey information beginning with 2023 Crop Year and consultation with growers, PCAs, applicators and technical advisors to refine, as necessary, existing management practices for the control of pyrethroid discharges.</p>	<p>Maintain awareness of and employ ideas of growers, PCAs, and applicators in the Cache Slough represented drainages through annual outreach activities and targeted outreach about management practices that are effective in reducing or preventing the discharge of pyrethroid pesticides to surface waters.</p>	<p>Achievement of this performance goal will be measured by comparing and reporting 2023 MPIR results (see Table 5) to future MPIR results reported by growers in the Cache Slough represented drainages during the compliance timeframe for this Management Plan.</p> <p><i>Reporting Basis:</i></p> <p><i>Acreages of implemented management practices in the Cache Slough and represented drainages and annual reporting of outreach statistics.</i></p>	<p>Achievement of this performance goal will occur annually through the proposed 3-year compliance timeframe for this Management Plan.</p>
<p>3. Avoid exceedance (caused by agricultural activities) of ILRP prohibition trigger limit for pyrethroid pesticides in Ulatis Creek at Brown Road water column samples.</p>	<p>Educate applicators in the Cache Slough represented drainages through outreach activities on how to reduce or prevent discharge of pyrethroids to surface waters.</p>	<p>Achievement of this performance goal will be measured through evaluation of SVWQC’s water column pyrethroid pesticide data collected in the Ulatis Creek at Brown Road monitoring site.</p> <p><i>Reporting Basis:</i></p> <p><i>All annual monitoring results, including exceedance reports, if applicable.</i></p>	<p>Maintain 100% compliance with the ILRP prohibition trigger limit through the proposed 3-year compliance timeframe for this Management Plan (August 2025 through August 2028).</p>

3.2.3 Member Education

Member education takes the forms of general outreach to all members of the Dixon/Solano Subwatershed and more targeted outreach to growers, pest control advisers (PCAs), and pesticide applicators (including potential users of pyrethroid products), as necessary. General outreach at the Subwatershed level is directed to landowners, farm operators, pesticide applicators, and PCAs. Outreach is focused on the potential cause(s) of water column exceedances of the prohibition triggers for pyrethroid pesticides and the continued implementation of best management practices (BMPs) that prevent the movement of pyrethroids into Sacramento Valley surface waters. These general outreach efforts are carried out through presentations at grower meetings and via direct outreach (mailings, phone calls, emails). Targeted outreach will be directed to landowners, growers, pesticide applicators, and PCAs operating in high priority lands near Ulatis Creek and throughout the Cache Slough represented drainages.

The effectiveness of future Management Plan outreach efforts will be assessed by tracking the number of attendees at meetings, tracking management practice implementation related to irrigation systems and management, cultural practices to manage sediment and erosion, pesticide application practices, and compliance with WQOs for Assessment and/or Management Plan monitoring events.

3.2.4 Management Practices

Dixon/Solano Coalition Members in the Cache Slough represented drainages are expected to continue to employ at high levels the agricultural management practices known to minimize the movement of pesticides into surface waters (see **Table 5**). The performance goals for continued education and awareness of select existing and potential new management practices and their implementation, specific to the use of pyrethroid pesticides, are presented in **Table 7**. The effectiveness of these actions implemented by growers and applicators in the Cache Slough drainage and represented drainages will be evaluated through review of Assessment and/or Management Plan monitoring data, evaluation of future MPIR results, and Solano Subwatershed pesticide application education activities. In the event that a future exceedance of the ILRP water column prohibition trigger limit is observed, and agriculturally applied pyrethroid pesticides are determined to be a potential cause, Dixon/Solano Coalition staff will use PUR data to identify possible sources of the observed exceedance and initiate follow-up actions, as necessary. After every exceedance of an ILRP trigger limit, the Coalition's consultant requests from Dixon/Solano Coalition staff PUR data relevant to the exceedance. These PUR data and event-specific monitoring data collected by the Coalition are used to generate an *Exceedance Follow-up Letter* that describes all that is known about antecedent pesticide applications from both agricultural and non-agricultural sources, as well as any environmental factors that may have affected the exceedance. This information is used by Dixon/Solano Coalition staff to understand the specifics of the exceedance and to assist in the development of outreach and education materials provided to Dixon/Solano Coalition Members.

3.2.5 Management Plan Implementation Schedule

The SVWQC's Order requires that the implementation of Management Plans and management practices result in the compliance of a constituent of concern with its applicable WQOs or trigger limits as soon as is reasonably practicable, but no longer than 10 years from submittal of the Management Plan to the Central Valley Water Board for approval. The Dixon/Solano Coalition Members in the Cache Slough drainage anticipate that implementation of this Management Plan and its proposed management practices will result in compliance with the ILRP prohibition trigger limit for pyrethroid pesticides within three years of submittal of this Management Plan for approval by the Central Valley Water Board. The following schedule of actions is proposed for completing this Management Plan:

- October 2025: Development and submittal of Management Plan to the Central Valley Water Board for approval.
- August 2025 – August 2028: Provide Management Plan-specific outreach and education to growers, PCAs, and applicators; continued implementation of existing management practices and any new practices identified from MPIR results; continued Assessment and/or Management Plan monitoring; and annual reporting of MPIR results. The 3-year compliance timeframe represented here is based on the Dixon/Solano Coalition beginning its outreach and education for this Management Plan in August 2025.
- August 2028: If no additional water column exceedances of the chronic prohibition trigger limit for pyrethroid pesticides are observed during 3 years of Assessment and/or Management Plan monitoring, then document water quality and management practices implementation and effectiveness, followed by submittal of a request to the Central Valley Water Board Executive Officer for approval of completion of the Management Plan.

3.3 DUTIES AND RESPONSIBILITIES

Implementation of the various elements of the Management Plan will be carried out by SVWQC and their contractors, Dixon/Solano Coalition staff, and Coalition Members according to the organizational chart shown in **Figure 3**. The roles and responsibilities of the individuals and groups specified in the organizational chart who will continue to implement the various elements of this Management Plan are described below.

Sample Collection Lead – John Richard, Pacific EcoRisk: Mr. Richard will be responsible for directing the field sample collection efforts for this Management Plan.

Water Quality Data Lead – Sophie McFadin, Larry Walker Associates: Ms. McFadin will have primary responsibility for processing and managing water quality data.

Quality Assurance Lead – Mike Trouchon, Larry Walker Associates: Mr. Trouchon will oversee water quality data management and has primary responsibility for quality assurance of water quality data.

Project Lead – Martha McKeen, Dixon RCD: Ms. McKeen will provide primary review of reports, schedule tracking for Management Plan implementation, including coordination of targeted outreach events. In the event of a future exceedance of the

ILRP chronic prohibition trigger limit for pyrethroid pesticides, Ms. McKeen will review PUR data to identify a possible source of the observed exceedance and initiate follow-up actions, as necessary. She is also responsible for collection, processing, and reporting of Farm Evaluation survey results and other management practice data and will be used to develop outreach materials, tracking and documenting member outreach, and education for the Management Plan.

District Manager – Kelly Huff, Dixon RCD: Ms. Huff will provide general oversight and review of the Management Plan.

Reporting Lead – Steve Maricle, Larry Walker Associates: Mr. Maricle will oversee preparation of the required annual Surface Water Quality Management Plan Progress Reports (MPPR).

Coalition Members in Represented Drainages: Dixon/Solano Coalition Members in the Cache Slough represented drainages are responsible for continued implementation of the agricultural management practices needed to comply with WQOs. Members are also responsible for providing information requested and collected by the Dixon/Solano Coalition pursuant to the implementation of this Management Plan and its implemented management practices.

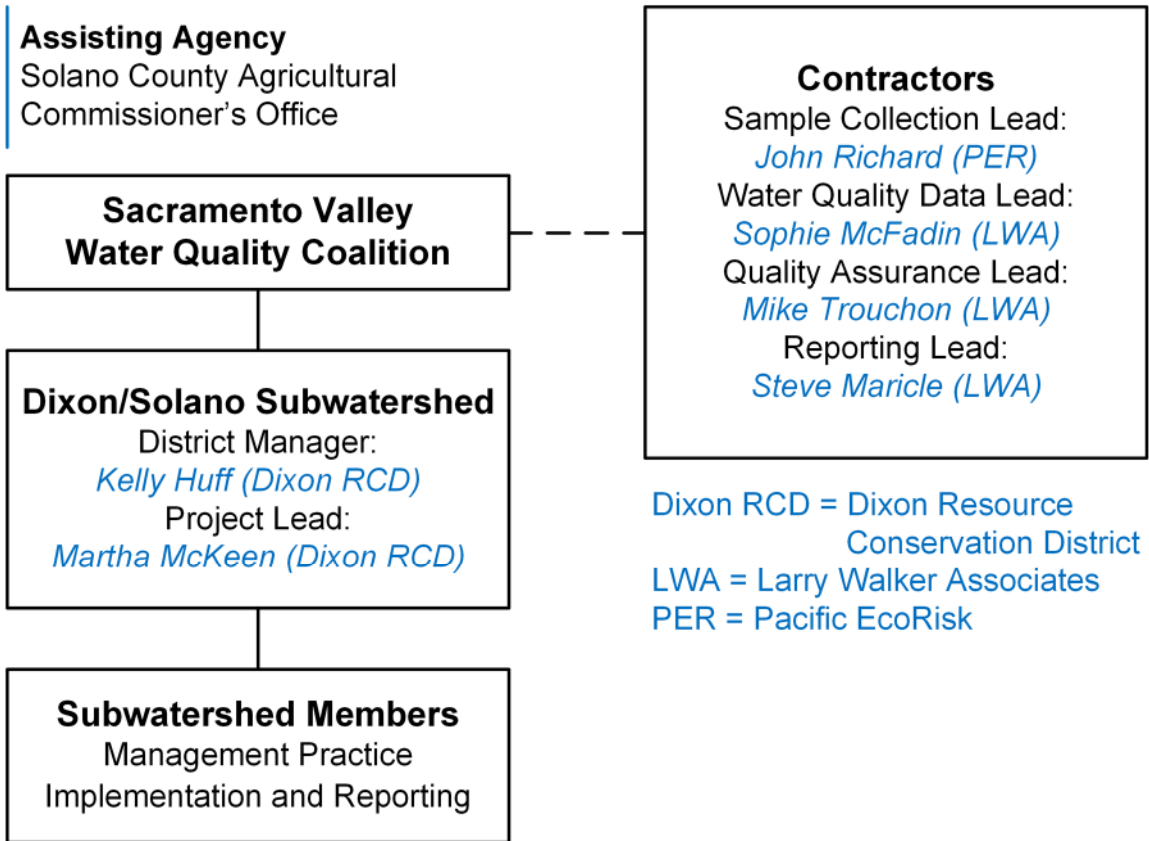


Figure 3: Surface Water Quality Management Plan for Water Column Pyrethroid Pesticides in Ulatis Creek – Project Organization.

4 Monitoring Design

Surface water quality monitoring performed in support of this Management Plan (i.e., Management Plan monitoring) is designed to measure effectiveness at achieving the goals and objectives of the Comprehensive Surface Water Quality Management Plan (CSQMP). This will be achieved by conducting Management Plan monitoring in the representative Cache Slough drainage at the Ulatis Creek at Brown Road (UCBRD) monitoring location (see **Figure 1**) that is used by SVWQC for its Assessment monitoring. The Coalition will use both Assessment monitoring and Management Plan monitoring at UCBRD to show compliance with the ILRP chronic prohibition trigger limit for pyrethroid pesticides. SVWQC submitted its Annual Monitoring Plan Update for the 2026 monitoring year (October 2025 – September 2026) on August 1, 2025, and has not been approved by the Central Valley Water Board as of the submittal date of this Management Plan on 17 October 2025. The proposed monitoring for this Management Plan (until it is approved for completion) is part of the Annual Monitoring Plan Update submitted annually on August 1 to the Central Valley Water Board for approval.

4.1 MONITORING

Management Plan monitoring in the Cache Slough drainage included in the Annual Monitoring Plan Update for the 2026 monitoring year is focused on monitoring events for water column pyrethroid pesticides scheduled for December 2025 and May 2026. The Management Plan monitoring is focused on the months of May and December because these were the months during which the two most recent ILRP prohibition trigger limit exceedances occurred (see **Table 6**). Sample collection and analysis for water quality samples during Management Plan monitoring will be identical to that employed by SVWQC during Assessment monitoring. Monitoring results will be submitted electronically to the Central Valley Water Board with the quarterly data submittals required by the WDR.

5 Data Evaluation

The effectiveness of this Management Plan will be evaluated through (1) review of progress made toward implementation of outreach and education activities proposed to maintain awareness of water quality issues as they pertain to pyrethroid pesticide application, (2) assessment of agricultural management practices known to limit the transport of agriculturally applied pyrethroid pesticides to surface waters, and (3) collection of water column chemistry data to determine the effectiveness of management practices implementation in reducing the exceedances of the ILRP chronic prohibition trigger limit for pyrethroid pesticides in the Ulatis Creek drainage. MPIR survey data (e.g., implementation rates of pesticide application practices, irrigation practices for managing sediment and erosion, cultural practices to manage sediment and erosion, and use of pyrethroid pesticides as dormant season insecticides) collected in the Cache Slough drainage and represented drainages will be used in conjunction with targeted survey results to track progress in implementing specific agricultural practices identified to reduce or eliminate the discharge of pyrethroids in spray drift, irrigation tailwater, and storm runoff to ambient surface waters.

5.1 EVALUATION OF MANAGEMENT PLAN EFFECTIVENESS

The effectiveness of this Management Plan primarily will be judged on maintaining improvements in surface water quality since August 2025 as measured in the representative Cache Slough drainage. Continued lack of exceedances of the ILRP chronic prohibition trigger limit for pyrethroid pesticides, along with documentation of the implementation of management practices described in the Actions and Task subsection, will be used to link observed surface water quality improvements to the actions of growers and applicators in the drainage. Additionally, Management Plan effectiveness will also be assessed with regard to the progress made toward implementation of existing and potential future management actions identified to improve surface water quality in the Cache Slough drainage. Status and effectiveness of this Management Plan will be described annually in the MPPR through presentation of the following information:

- Time series of pyrethroid pesticides additive concentration goals calculated from water column chemistry data collected at the Ulatis Creek at Brown Road (UCBRD) monitoring site;
- Tabular summary of meeting annual Dixon/Solano Coalition outreach and education goals; and
- Tabular summary of management practices implemented under this Management Plan for comparison to baseline 2023 management practices (i.e., MPIR results; see **Table 5**) implemented prior to the initiation of activities for this Management Plan.

6 Records and Reporting

The SVWQC submits a Surface Water Quality Management Plan Progress Report (MPPR) annually on May 1 that summarizes the progress made to date on each active Management Plan. The MPPR will contain the reporting components required for this Management Plan, as well as all other active Management Plans. SVWQC also submits a Monitoring Plan Update to the Central Valley Water Board (annually on August 1) with the monitoring schedules and constituents for the upcoming monitoring year, including those required by Management Plans. These reports and schedules are consistent with the requirements in Appendix MRP-1 of the Coalition's WDR.

6.1 DOCUMENTATION AND REPORTING

The water quality monitoring data collected pursuant to this Management Plan (i.e., Assessment and Management Plan monitoring data) will be submitted electronically to the Central Valley Water Board on a quarterly basis along with all other monitoring data collected by SVWQC. An event-based water quality exceedances report is also provided to the Central Valley Water Board on a more or less monthly schedule. Management Plan monitoring data will be evaluated by the Water Quality Data Lead and Quality Assurance Lead (Sophie McFadin and Mike Trouchon, respectively, of LWA) to ensure that data conform to SVWQC's Quality Assurance Project Plan (QAPP) and meet the requirements of the WDR. The exceedance reports and quarterly submittal of Management Plan monitoring data will provide adequate and timely information regarding compliance of ambient water quality with the ILRP prohibition trigger limits for pyrethroid pesticides. The Subwatershed Project Lead (Martha McKeen) will provide data on management practices implementation and performance goals as set forth in this Management Plan and will report on education and outreach efforts for inclusion in the MPPR. All required information will be summarized annually in the MPPR, along with the most recent and previous year's Management Plan monitoring data.

7 References

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Appendix A: Agricultural and Non-Agricultural Pyrethroid Pesticide Use in Colusa County

Table A1. Total Acres Treated with Individual Pyrethroid Pesticides by Irrigated Agriculture in the Cache Slough Drainage by Crop: November–December 2024

Pyrethroid Pesticide	Crop Type	Total Treated Acres by Month		Total Treated Area (acres)
		November 2024	December 2024	
Cyfluthrin	Nursery – Outdoor Plants	1.51	3.55	5.06
	Total	1.51	3.55	5.06
Esfenvalerate	Prune	---	70	70
	Total	---	70	70
Lambda-Cyhalothrin	Nursery – Outdoor Plants	1.36	2.66	4.02
	Total	1.36	2.66	4.02

Table A2. Total Acres Treated with Individual Pyrethroid Pesticides by Irrigated Agriculture in the Cache Slough Drainage by Crop: April – May 2025

Pyrethroid Pesticide	Crop Type	Total Treated Acres by Month		Total Treated Area (acres)
		April 2025	May 2025	
Bifenthrin	Almond	35	2,526	2,561
	Tomato Process	999	271	1,270
	Bean Dried	246	---	246
	Melon	57	---	57
	Total	1,337	2,797	4,134
Cyfluthrin	Nursery – Outdoor Plants	6	---	6
	Total	6	0	6
Cyfluthrin, Beta-	Nursery – Outdoor Plants	3	10	13
	Total	3	10	16
Cypermethrin, Alpha-	Alfalfa	96	---	96
	Total	96	0	96
Esfenvalerate	Almond	---	130	130
	Total	0	130	130
Lambda-Cyhalothrin	Alfalfa	1560	---	1560
	Tomato Process	814	336	1150
	Uncultivated Ag	890	---	890
	Bean Dried	671	91	762
	Sunflower	424	272	696
	Corn, Grain	436	---	436
	Sorghum Milo	249	---	249
	Almond	206	---	206
	Melon	57	57	114
	Walnut	45	---	45
	Total	5,352	756	6,108

Table A3. Total Individual Pyrethroid Pesticide Applications and Pounds of Active Ingredient Applied by Non-Agriculture Sources in Solano County: November–December 2024

Pyrethroid Pesticide	Application Type	Applications by Month			Pounds A.I. ^[1] by Month		
		November 2024	December 2024	Total Applications	November 2024	December 2024	Total Pounds A.I. ^[1]
Bifenthrin	Structural Pest Control	54	45	99	21.81	23.91	45.72
	Landscape Maintenance	3	2	5	0.39	0.32	0.71
Cyfluthrin	Structural Pest Control	4	6	10	0.32	0.19	0.51
	Landscape Maintenance	1	---	1	0.0001	0.00	0.0001
Esfenvalerate	Structural Pest Control	15	10	25	0.76	16.02	16.78
Lambda-Cyhalothrin	Structural Pest Control	31	28	59	14.24	5.19	19.43
	Landscape Maintenance	1	---	1	0.03	0.00	0.03
	Commodity Fumigation	1	2	3	0.07	0.05	0.12
Grand Total		110	93	203	37.62	45.68	83.30

[1] A.I. = Active Ingredient (i.e., pounds of individual pyrethroid pesticide applied).

Table A4. Total Individual Pyrethroid Pesticide Applications and Pounds of Active Ingredient Applied by Non-Agriculture Sources in Solano County: April – May 2025

Pyrethroid Pesticide	Application Type	Applications by Month		Total Applications	Pounds A.I. ^[1] by Month		Total Pounds A.I. ^[1]
		April 2025	May 2025		April 2025	May 2025	
Bifenthrin	Structural Pest Control	3	64	67	26.18	136.53	162.71
	Landscape Maintenance	6	6	12	1.10	2.17	3.27
Cyfluthrin	Structural Pest Control	---	5	5	0.14	0.3	0.44
	Landscape Maintenance	---	1	1	0.00	0.0002	0.0002
Cyfluthrin, Beta-	Structural Pest Control	18	24	42	0.28	0.34	0.62
	Commodity Fumigation	1	2	3	0.04	0.11	0.15
Cypermethrin. Alpha-	Structural Pest Control	9	6	15	14.67	18.66	33.33
Esfenvalerate	Structural Pest Control	17	19	36	0.98	0.54	1.52
Gamma-Cyhalothrin	Structural Pest Control	1	1	2	0.14	0.12	0.26
Lambda-Cyhalothrin	Structural Pest Control	41	40	81	581.15	10.52	591.67
	Landscape Maintenance	1	2	3	0.05	0.10	0.15
	Commodity Fumigation	1	2	3	0.01	0.03	0.04
Permethrin	Structural Pest Control	10	11	21	13.38	81.67	95.05
	Landscape Maintenance	1	1	2	0.01	0.15	0.16
Grand Total		109	184	293	638.13	251.24	889.37

[1] A.I. = Active Ingredient (i.e., pounds of individual pyrethroid pesticide applied).

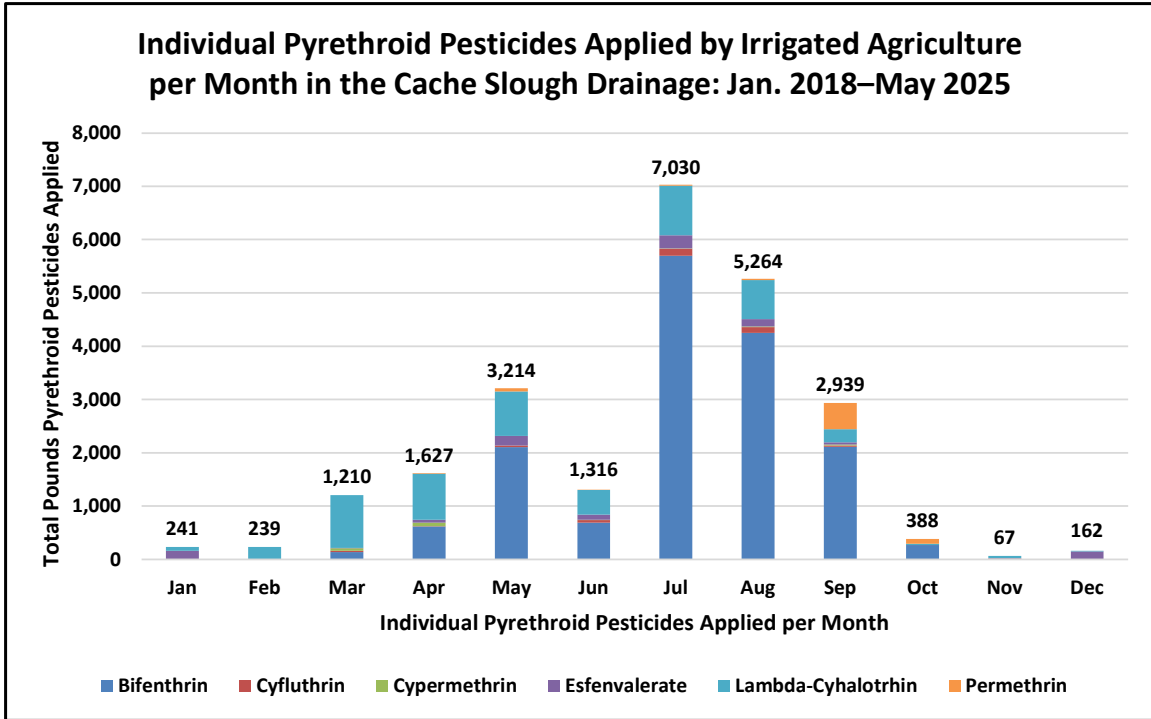


Figure A1. Total Pounds of Individual Pyrethroid Pesticides Applied by Irrigated Agriculture per Month in Cache Slough Drainage: Jan. 2018 – May 2025

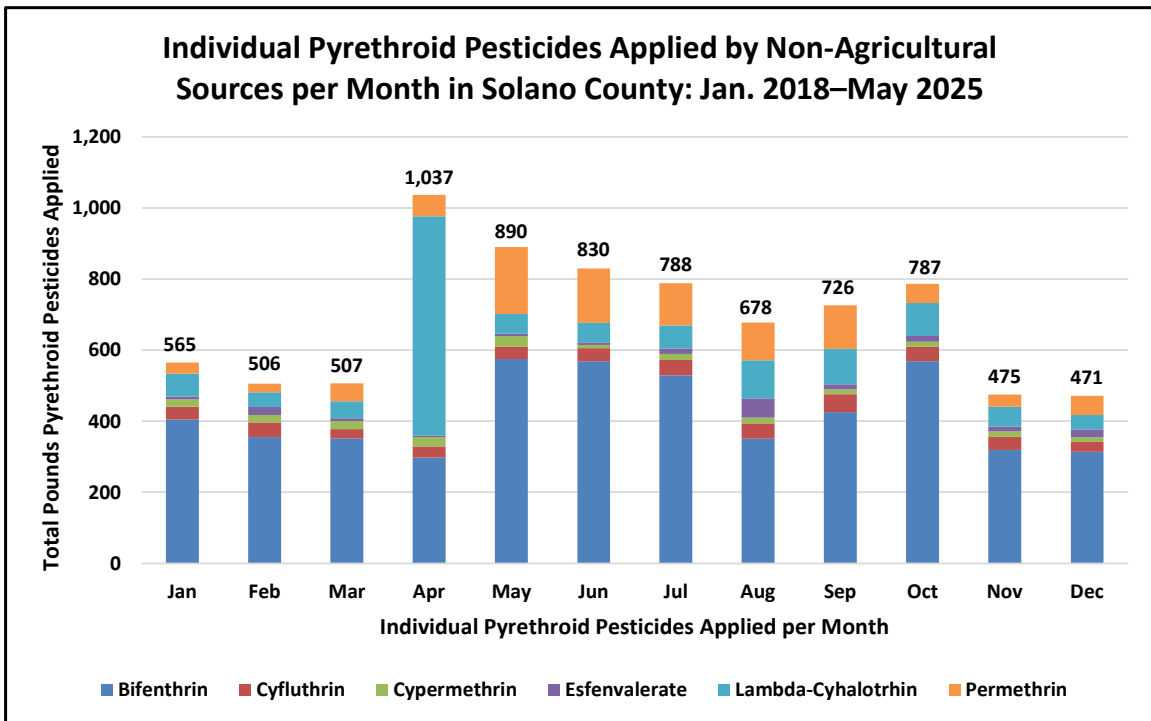


Figure A2. Total Pounds of Individual Pyrethroid Pesticides Applied by Licensed Non-Agricultural Sources per Month in Solano County: Jan. 2018 – May 2025

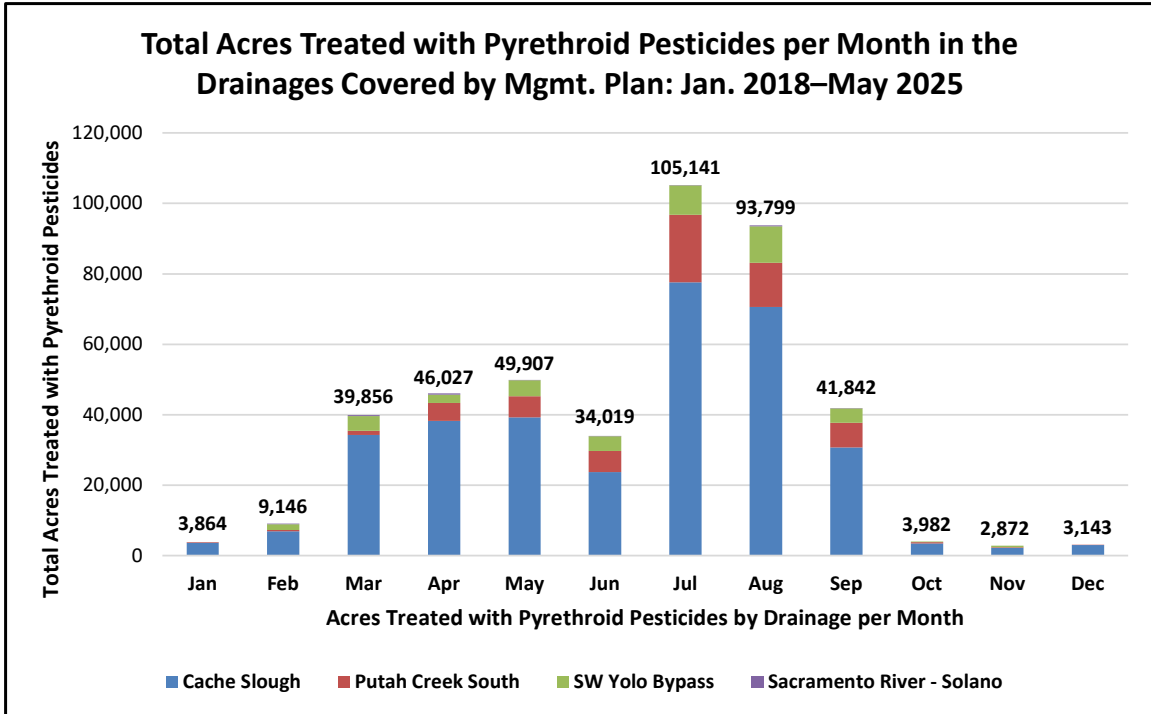


Figure A3. Total Acres Treated with Pyrethroid Pesticides by Irrigated Agriculture per Month in Drainages Covered by the Management Plan: Jan. 2018 – May 2025

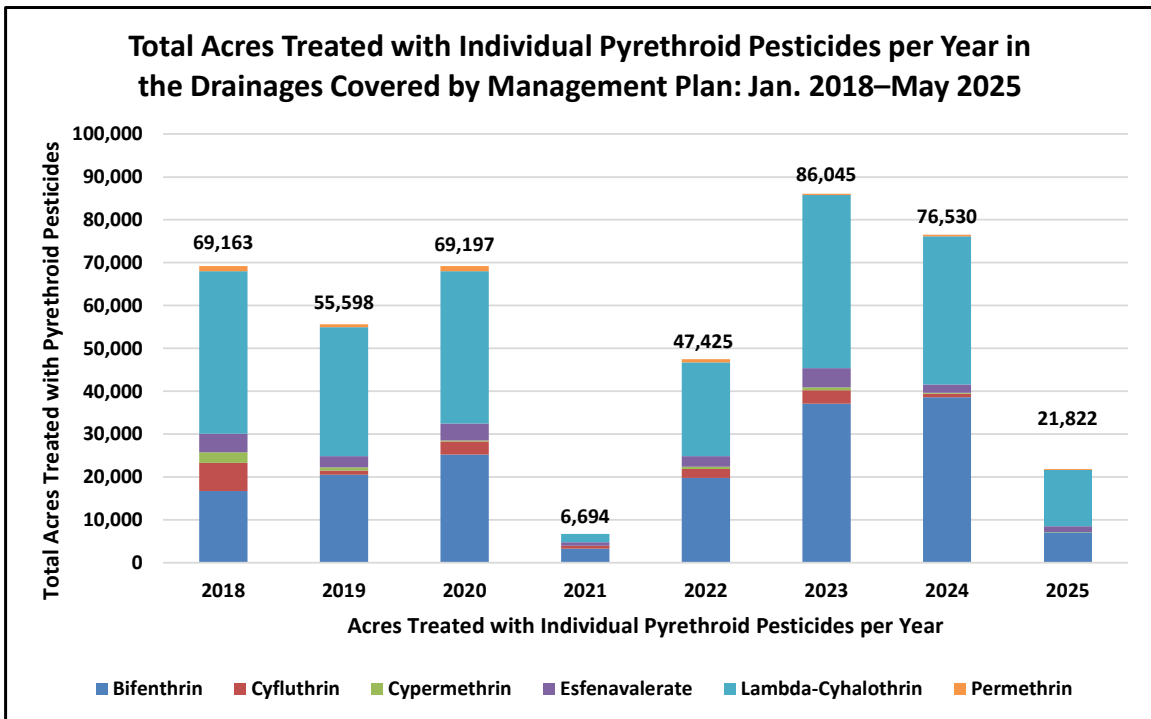


Figure A4. Total Acres Treated with Individual Pyrethroid Pesticides by Irrigated Agriculture per Year in Drainages Covered by the Management Plan: Jan. 2018 – May 2025

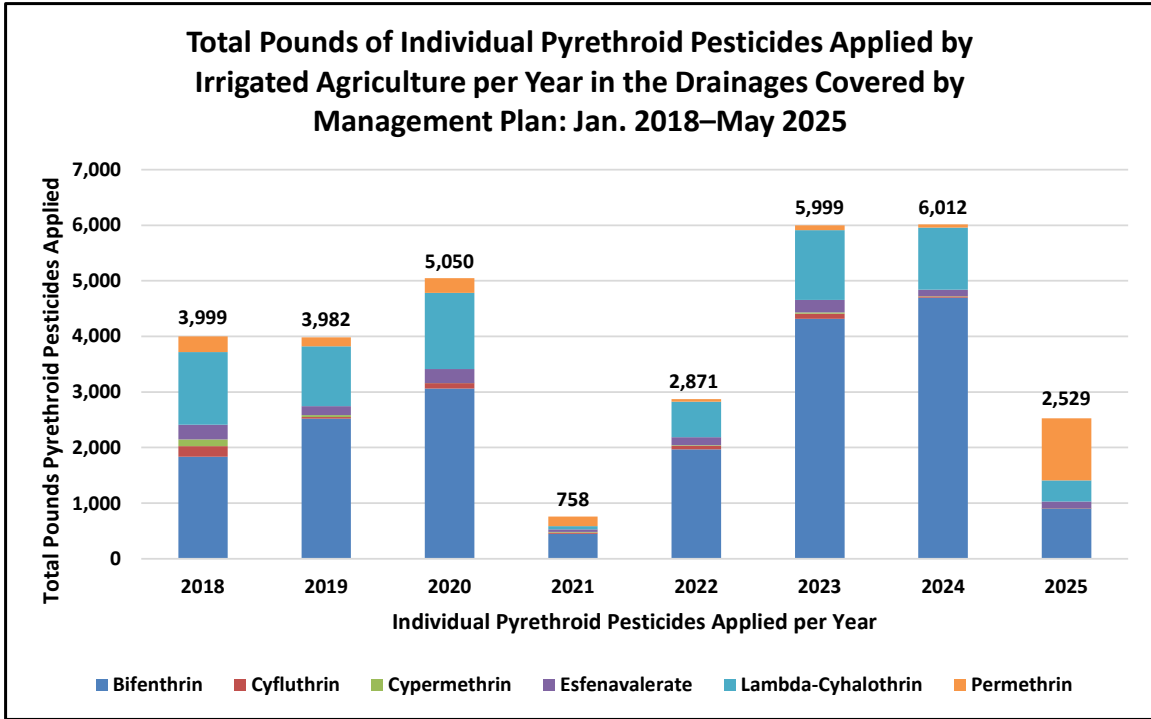


Figure A5. Total Pounds of Individual Pyrethroid Pesticides Applied by Irrigated Agriculture per Year in the Cache Slough Drainage and Represented Drainages: Jan. 2018 – May 2025

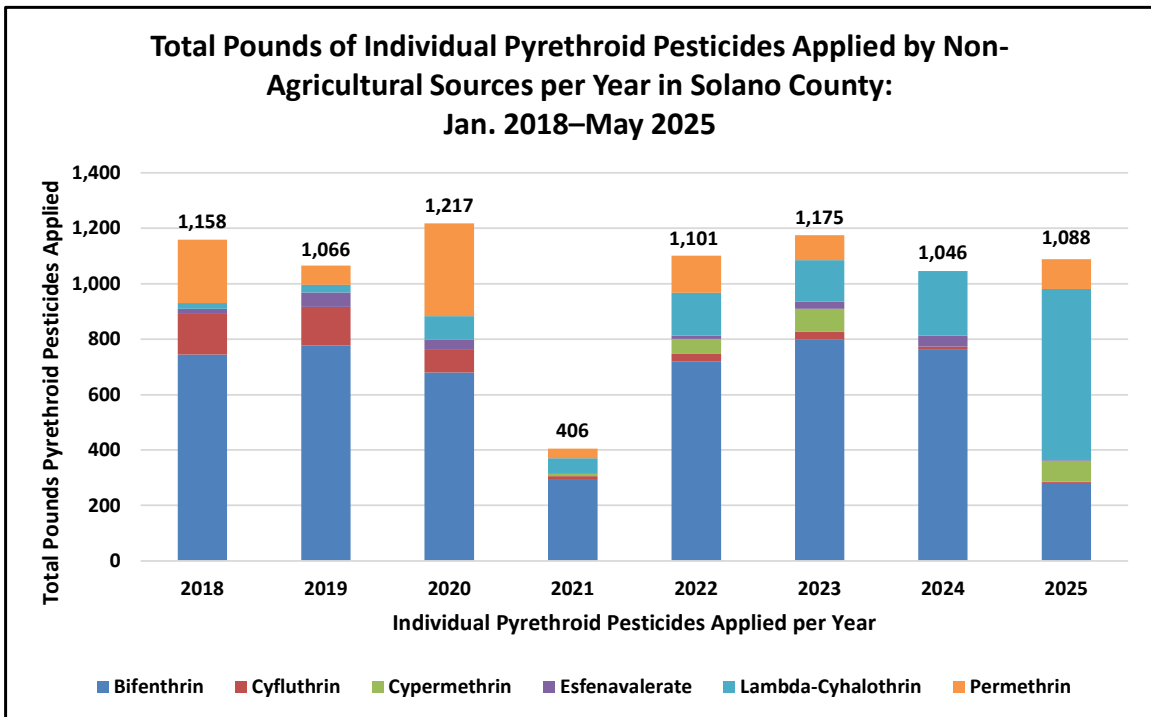


Figure A6. Total Pounds of Individual Pyrethroid Pesticides Applied by Non-Agricultural Sources per Year in Solano County: Jan. 2018 – May 2025

Appendix B: Pyrethroid Pesticide Results and Precipitation Data Associated with Pyrethroid Pesticide Exceedances

Table B1: Antecedent Precipitation Data for Ulatis Creek Monitoring Events with Pyrethroid Pesticide Concentrations that Exceeded the Prohibition Trigger.

Antecedent Rainfall Conditions	Event 150 (08/21/2018)	Event 157 (03/19/2019)	Event 182 (06/23/2021)	Event 223 (12/17/2024)	Event 228 (05/20/2025)
Date of last 0.10"	05/25/2018	03/06/2018	04/25/2021	12/16/2024	03/30/2025
Days since 0.10"	88 days	13 days	59 days	1 day	51 days
Date of last 0.25"	04/16/2018	03/06/2018	03/18/2021	12/16/2024	03/17/2025
Days since 0.25"	127 days	13 days	97 days	1 day	64 days
Date of last 0.75"	04/06/2018	03/06/2018	12/1/2019	12/14/2024	02/13/2025
Days since 0.75"	137 days	13 days	570 days	3 days	96 days

Note: Precipitation data collected at the CDEC Sacramento International Airport (SMF) gauge in Sacramento County.

https://cdec.water.ca.gov/dynamicapp/staMeta?station_id=SMF

Table B2: Pounds per Acre of Pyrethroid Pesticides Applied by Irrigated Agriculture in the Cache Slough Drainage and Represented Drainages: January 2018–May 2025.

Year >>	2018	2019	2020	2021	2022	2023	2024	2025
Lbs. Applied	3,999	3,982	5,050	758	2,871	5,999	6,012	2,529
Treated Acres	69,163	55,598	69,197	6,694	47,425	86,045	76,530	21,822
Lbs./Acre	0.06	0.07	0.07	0.11	0.06	0.07	0.08	0.12

Table B3: Ulatis Creek Pyrethroid Pesticide Results and associated *Hyalella azteca* Water Column and Sediment Toxicity Test Results: February 2018 – August 2025.

Event	Sample Date	Chronic Pyrethroid CGU	Acute Pyrethroid CGU	Pyrethroid Pesticide	Result (ng/L)	<i>Hyalella</i> Survival (% of control) WC	<i>Hyalella</i> Survival (% of control) Sed
144	2/20/2018	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	DNQ 0.2 <0.2 <0.2 <0.2 <0.2 <2	---	---
145	3/14/2018	≤1	≤1	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	0.7 <0.2 <0.2 <0.2 DNQ 0.2 <2	---	---
146	4/17/2018	--	--	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	Water column pyrethroids not analyzed.	---	73.4% <i>Hyalella</i> sediment toxicity observed; pyrethroid sediment results in Table B3 .
147	5/15/2018	≤1	≤1	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.2 1.2 DNQ 0.4 <0.4 <0.4 <4	---	---

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Event	Sample Date	Chronic Pyrethroid CGU	Acute Pyrethroid CGU	Pyrethroid Pesticide	Result (ng/L)	<i>Hyalella</i> Survival (% of control) WC	<i>Hyalella</i> Survival (% of control) Sed
148	6/19/2018	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.1 <0.2 <0.2 <0.2 <0.2 <2	---	---
149	7/17/2018	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.2 <0.4 <0.4 <0.4 <0.4 <4	---	---
150	8/21/2018	2 ⁽¹⁾	≤1	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.5 <1 <1 <1 5.5 <10	---	105.9% No <i>Hyalella</i> sediment toxicity observed
151	9/18/2018	≤1	≤1	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	0.5 <0.2 <0.2 <0.2 <0.2 <2	---	---

Surface Water Quality Management Plan Addendum: Water Column Pyrethroid Pesticides in Ulatis Creek

Event	Sample Date	Chronic Pyrethroid CGU	Acute Pyrethroid CGU	Pyrethroid Pesticide	Result (ng/L)	<i>Hyalella</i> Survival (% of control) WC	<i>Hyalella</i> Survival (% of control) Sed
152	10/16/2018	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.1 <0.2 <0.2 <0.2 <0.2 <2	---	---
156	2/19/2019	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	DNQ 0.2 <0.2 <0.2 <0.2 <0.2 <2	---	---
157	3/19/2019	2 ^[1]	≤1	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.1 <0.2 <0.2 <0.2 2.7 <2	---	---
158	4/18/2019	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.1 <0.2 <0.2 <0.2 <0.2 <2	---	64.6% <i>Hyalella</i> sediment toxicity observed; pyrethroid sediment results in Table B3 .

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Event	Sample Date	Chronic Pyrethroid CGU	Acute Pyrethroid CGU	Pyrethroid Pesticide	Result (ng/L)	<i>Hyalella</i> Survival (% of control) WC	<i>Hyalella</i> Survival (% of control) Sed
160	6/18/2019	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.1 <0.2 <0.2 <0.2 <0.2 <2	---	---
162	8/21/2019	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.1 <0.2 <0.2 <0.2 <0.2 <2	---	97.4% No <i>Hyalella</i> sediment toxicity observed
163	9/25/2019	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	DNQ 0.1 <0.2 <0.2 <0.2 <0.2 <2	---	---
169	4/22/2020	---	---	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	Water column pyrethroids not analyzed.	---	91.2% <i>Hyalella</i> sediment toxicity observed, but effect ≤ 20% so no exceedance; pyrethroids in sediment not analyzed.

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Event	Sample Date	Chronic Pyrethroid CGU	Acute Pyrethroid CGU	Pyrethroid Pesticide	Result (ng/L)	<i>Hyalella</i> Survival (% of control) WC	<i>Hyalella</i> Survival (% of control) Sed
179	3/25/2021	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	DNQ 0.4 <0.4 <0.3 <0.4 <0.3 <2	96.7% No <i>Hyalella</i> water column toxicity observed.	---
180	4/21/2021	---	---	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	Water column pyrethroids not analyzed.	---	93.4% No <i>Hyalella</i> sediment toxicity observed.
182	6/23/2021	5	2	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.3 <0.4 <0.3 <0.4 18 <2	0% <i>Hyalella</i> water column toxicity observed.	---
183	7/21/2021	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	DNQ 0.3 <0.4 <0.3 <0.4 <0.3 <2	100% No <i>Hyalella</i> water column toxicity observed.	---

Surface Water Quality Management Plan Addendum: Water Column Pyrethroid Pesticides in Ulatis Creek

Event	Sample Date	Chronic Pyrethroid CGU	Acute Pyrethroid CGU	Pyrethroid Pesticide	Result (ng/L)	<i>Hyalella</i> Survival (% of control) WC	<i>Hyalella</i> Survival (% of control) Sed
184	8/19/2021	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.3 <0.4 <0.3 <0.4 DNQ 0.3 <2	100% No <i>Hyalella</i> water column toxicity observed.	96.3% No <i>Hyalella</i> sediment toxicity observed.
185	9/23/2021	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.3 <0.4 <0.3 <0.4 <0.3 <2	100% No <i>Hyalella</i> water column toxicity observed.	---
186	10/26/2021	≤1	≤1	<i>Bifenthrin</i> Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	1.6 <0.4 <0.3 <0.4 DNQ 0.4 <2	---	---
190	2/15/2022	0	0	<i>Bifenthrin</i> Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.3 <0.4 <0.3 <0.4 <0.3 <2	---	---

Surface Water Quality Management Plan Addendum: Water Column Pyrethroid Pesticides in Ulatis Creek

Event	Sample Date	Chronic Pyrethroid CGU	Acute Pyrethroid CGU	Pyrethroid Pesticide	Result (ng/L)	<i>Hyalella</i> Survival (% of control) WC	<i>Hyalella</i> Survival (% of control) Sed
191	3/22/2022	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.3 <0.4 <0.3 <0.4 <0.3 <2	---	---
192	4/21/2022	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.3 <0.4 <0.3 <0.4 <0.3 <0.2	---	40.3% <i>Hyalella</i> sediment toxicity observed; pyrethroid sediment results in Table B3 .
193	5/18/2022	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.3 <0.4 <0.3 <0.4 <0.3 <0.2	---	
194	6/23/2022	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.3 <0.4 <0.3 <0.4 <0.3 <0.2	100% No <i>Hyalella</i> water column toxicity observed.	

Surface Water Quality Management Plan Addendum: Water Column Pyrethroid Pesticides in Ulatis Creek

Event	Sample Date	Chronic Pyrethroid CGU	Acute Pyrethroid CGU	Pyrethroid Pesticide	Result (ng/L)	<i>Hyalella</i> Survival (% of control) WC	<i>Hyalella</i> Survival (% of control) Sed
195	7/21/2022	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.3 <0.4 <0.3 <0.4 <0.3 <2	---	---
196	8/17/2022	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.3 <0.4 <0.3 <0.4 <0.3 <2	---	101.3% No <i>Hyalella</i> sediment toxicity observed.
197	9/28/2022	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.3 <0.4 <0.3 <0.4 <0.3 <2	---	---
204	4/20/2023	--	--	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	Water column pyrethroids not analyzed.	---	101.3% No <i>Hyalella</i> sediment toxicity observed.

Surface Water Quality Management Plan Addendum: Water Column Pyrethroid Pesticides in Ulatis Creek

Event	Sample Date	Chronic Pyrethroid CGU	Acute Pyrethroid CGU	Pyrethroid Pesticide	Result (ng/L)	<i>Hyalella</i> Survival (% of control) WC	<i>Hyalella</i> Survival (% of control) Sed
215	4/11/2024	--	--	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	Water column pyrethroids not analyzed.	---	97.4 No <i>Hyalella</i> sediment toxicity observed.
219	8/22/2024	--	--	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	Water column pyrethroids not analyzed.	---	93.7 No <i>Hyalella</i> sediment toxicity observed.
223	12/17/2024	3	≤1	<i>Bifenthrin</i> <i>Cyfluthrin</i> Cypermethrin <i>Esfenvalerate/Fenvalerate</i> <i>Lambda-Cyhalothrin</i> Permethrin	4.8 0.85 <0.27 1.4 0.93 <0.95	---	---
226	3/26/2025	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.21 <0.27 <0.47 <0.55 <0.32 <0.95	---	---

Surface Water Quality Management Plan Addendum: Water Column Pyrethroid Pesticides in Ulatis Creek

Event	Sample Date	Chronic Pyrethroid CGU	Acute Pyrethroid CGU	Pyrethroid Pesticide	Result (ng/L)	<i>Hyalella</i> Survival (% of control) WC	<i>Hyalella</i> Survival (% of control) Sed
227	4/16/2025	---	---	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	Water column pyrethroids not analyzed.	---	71.4% <i>Hyalella</i> sediment toxicity observed; pyrethroid sediment results in Table B3 .
228	5/20/2025	2	≤1	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	2.5 <0.27 <0.47 <0.55 <0.32 <0.95	---	---
230	7/30/2025	≤1	≤1	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	0.96 <0.27 <0.47 <0.55 <0.32 <0.95	---	---
231	8/11/2025	0	0	Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate/Fenvalerate Lambda-Cyhalothrin Permethrin	<0.21 <0.27 <0.47 <0.55 <0.32 <0.95	---	96.2% No <i>Hyalella</i> sediment toxicity observed.

Abbreviations: CGU = concentration goal unit; WC = water column; Sed = sediment

Notes: Bolded numbers represent chronic CGU, acute CGU, or toxicity exceedances (toxicity measured as percent survival compared to laboratory control).

Detected pyrethroid pesticides and their concentrations shown in bold italics.

[1] Exceedances prior to April 1, 2019, were not required to be reported to the Central Valley Water Board as exceedances of the prohibition trigger.

Table B4: Ulatis Creek *Hyalella* Sediment Toxicity Test Results and Associated Analyses for Pyrethroids and Chlorpyrifos.

Event	Sample Date	<i>Hyalella</i> Survival, % of Control	Est. TUs in <i>Hyalella</i> Sediment Test	Est. TUs Attributable to Chlorpyrifos	Est. TUs Attrib. to Individual Detected Pyrethroids (ng/g dw)	Sediment TOC (mg/kg)
146	04/17/2018	73.4⁽¹⁾	0.459	0 chlorpyrifos non-detect	Bifenthrin = 0.273 Cyfluthrin = 0.011 Cypermethrin = 0.020 Esfenvalerate = 0.011 Lambda-Cyhalothrin = 0.143 Permethrin = 0.001	31,000
150	08/21/2018	105.9 ⁽³⁾	---	---	---	---
158	04/18/2019	64.6⁽¹⁾	1.164⁽⁴⁾	0 chlorpyrifos non-detect	Bifenthrin = 0.437 Lambda-Cyhalothrin = 0.727	11,000
162	08/21/2019	97.4 ⁽³⁾	---	---	---	---
169	04/22/2020	91.2 ⁽²⁾	---	---	---	---
180	04/21/2021	93.4 ⁽³⁾	---	---	---	---
184	08/19/2021	96.3 ⁽³⁾	---	---	---	---
192	04/21/2022	40.3⁽¹⁾	--- ⁽⁵⁾	0 chlorpyrifos non-detect	Bifenthrin reported as 0.32 DNQ Lambda-Cyhalothrin reported as 0.11 DNQ	1,000
196	08/17/2022	101.3 ⁽³⁾	---	---	---	---
204	04/20/2023	101.3 ⁽³⁾	---	---	---	---
215	04/11/2024	97.4 ⁽³⁾	---	---	---	---
219	08/22/2024	93.7 ⁽³⁾	---	---	---	---
227	04/16/2025	71.4⁽¹⁾	0.055	0 chlorpyrifos non-detect	Permethrin = 3.9	6,510
231	08/11/2025	96.2 ⁽³⁾	---	---	---	---

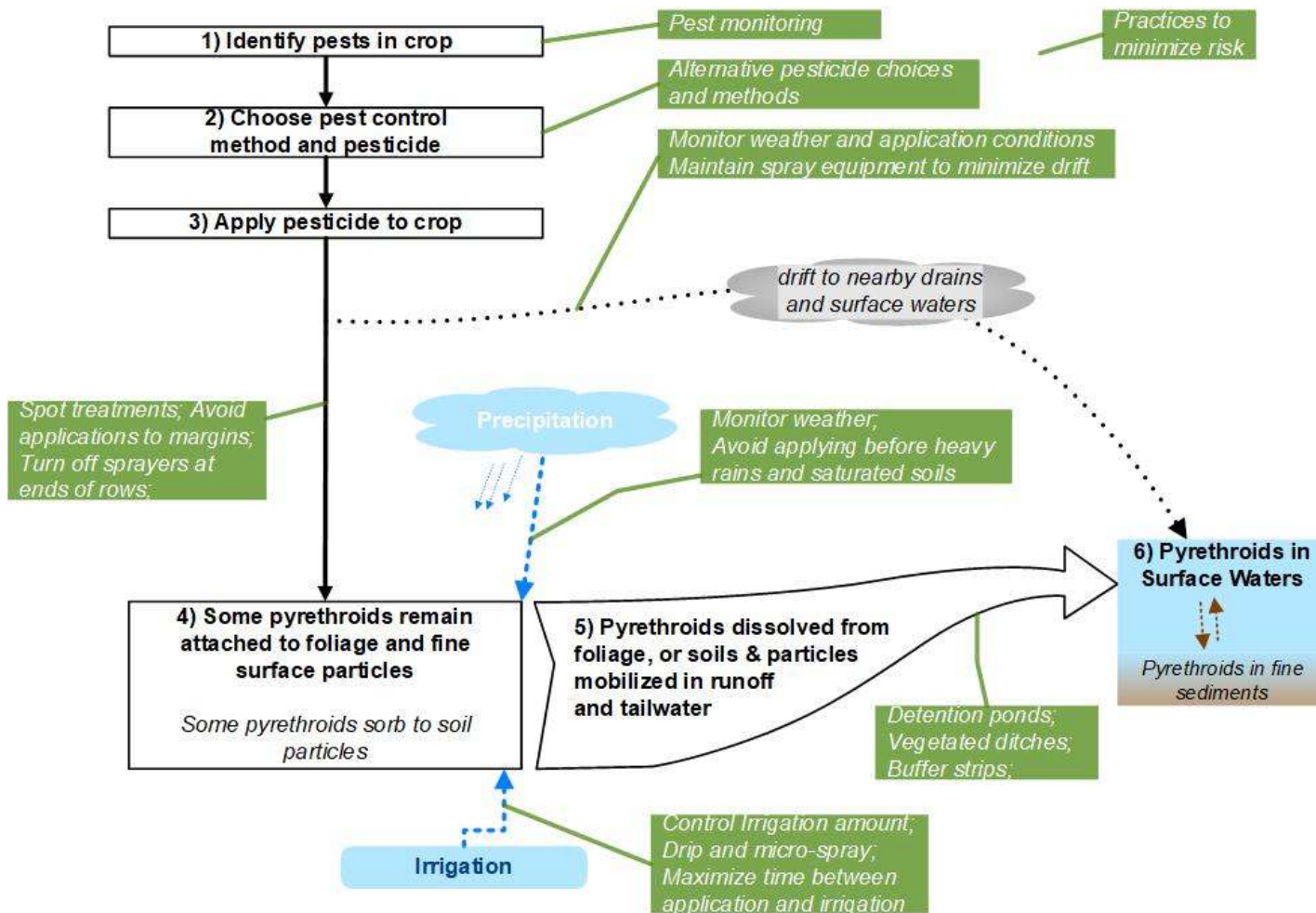
1. Sample showed statistically significant toxicity and < 80% organism survival as compared to controls.

2. Sample showed statistically significant toxicity, but the percent effect as compared to the control was ≤ 20% in which case the result is not reported as a toxicity exceedance and follow-up sediment analysis for pyrethroids and chlorpyrifos is not required

3. Sample did not show toxicity and therefore, follow-up sediment analysis for pyrethroids and chlorpyrifos is not required.
4. Estimated (est.) Toxic Units (TUs) based on the sum of normalized sediment pesticide concentrations (mg/kg total organic carbon (TOC)) measured for bifenthrin, chlorpyrifos, cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, fenpropathrin, lambda-cyhalothrin, and permethrin. A TU sum > 1 suggests that pyrethroid sediment concentrations are sufficient to cause toxicity to *Hyalella* (Amweg et al., 2005).
5. Estimated Toxic Units could not be calculated for this sample because no pyrethroid or chlorpyrifos was detected above its reporting limit. Bifenthrin and lambda-cyhalothrin were reported as DNQ (Detected Not Quantifiable).

Appendix C: Pathways for Transport of Agriculturally Applied Pyrethroids to Surface Waters and Practices to Minimize Risk of Off-site Transport

Figure 1. Pathways for transport of agriculturally applied pyrethroid pesticides to surface waters and practices to minimize risk of pesticide transport



Appendix D: Pyrethroid Facts and Recommended Practices



Dixon/Solano RCD Water Quality Coalition

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Pyrethroid

Active Ingredients: bifenthrin, cyfluthrin, cypermethrin, esfenvalerate, fenprothrin, gamma-cyhalothrin, lambda-cyhalothrin, permethrin

Common Products Names: Adjourn, Ammo, Asana XL, Athena, Baythroid, Bifenture, Bolton, Brigade, Capture, Cobalt, Danitol, Decathlon, Discus, Fanfare, Hero, Karate, Lambda-Cy, Lambdastar, Lamcap, Leverage, Mustang, Paradigm, Perm-Up, Pounce, Province, S-Fenvalostar, Scimitar, Silencer, Sniper, Stiletto, Tame Warrior

Movement: High tendency to attach to fine soil particles. Moving with sediment in irrigation tailwater or stormwater and/or through application drift.

Field Dissipation Half Life: Half-life in soils ranges from 1-2 months. In aquatic sediment, months to years.

Aquatic Toxicity: Very high to Extremely High

Critical Use Activities: Spring and/or summer applications to various crops (including orchards, tomatoes, beans, peppers, alfalfa, corn, and sudangrass)

RECOMMENDED PRACTICES**

- 1) Consider Alternative Products & Integrated Pest Management Strategies (see UCCE Alternatives Products visit: <https://ipm.ucanr.edu/>)
- 2) Where agricultural uses continue, implement one or more of the following:
 - Use extreme caution during applications around **field edges**. Eliminate drift and overspray, especially near ditches (supply and drainage).
 - Pay special attention to buffer zone & vegetated buffer requirements on label following **SPRAY DRIFT PRECAUTIONS**.
 - Use irrigation management practices to reduce and/or slow tailwater runoff:**
 - Drip or micro irrigation.
 - Monitor soil moisture levels and evapotranspiration rates in irrigation management.
 - Avoid applications of pyrethroids just prior to a rainfall event or irrigation to minimize the potential for runoff.**
 - Sediment Retention (especially fines) with the following methods suggested:
 - Direct post-treatment runoff through filter strip, alfalfa field or vegetated drainage ditch.
 - Temporarily impound post-treatment runoff in a sediment basin (although basin sizes necessary to capture fine sediments may be impractical depending on site characteristics); sediment basin effectiveness can be increased by directing the basins outflow through a vegetative filter.
 - Recirculate runoff through a tailwater return system.
 - Reduce and/or delay the release of tailwater after application to allow product to degrade.

Install irrigation socks where gated pipes are used to minimize soil erosion. For furrow irrigated crops, apply water-based Polyacrylamides (PAMs), after the first pyrethroid treatment post-cultivation.

****Reminder to share this information with the applicators in your operation.**

3) Aerial Pesticide Application

- Use ground spray, if possible
- Supply a current map to the applicator of targeted areas to be sprayed with sensitive areas like waterways, clearly marked
- Never spray on days with wind over 6 mph
- Never spray in the direction of a waterway

Best Practices from our Current Management Plan for Sediment Toxicity**

- Using alternative pest control materials (i.e., using non-pyrethroid pesticides);
- Reducing the number of pesticides applied by monitoring pest and beneficial populations to determine the need for pesticides and the best timing for maximum control;
- Reducing the number of pesticides applied with spray buffers at field edges and near ditches;
- Reducing drift by regular calibration of sprayers for pesticide applications;
- Reducing drift by using electrostatic sprayer equipment;
- Reducing drift by using effective drift control mechanisms;
- Maximizing time between application and planned irrigation runoff and/or predicted storm runoff events in order to reduce loss of applied pesticides from foliage, transport on soils, and transport of pesticides bound to particles in tailwater;
- Changing to more efficient application methods (e.g., ground vs. aerial applications and/or equipment that provides more precise applications);
- Installation of vegetated filters between application areas and ditches and/or allowing vegetation to grow in drainage ditches to reduce movement of pesticides bound to soil particles and contamination from aerial overspray (Note: vegetated BMPs may be less effective for very fine-textured clay soils);
- Reducing irrigation tailwater through conversion from flood or furrow irrigation to buried drip, sprinkle micro-irrigation where applicable;
- Reducing irrigation tailwater with tailwater return systems;
- Reducing or delaying irrigation tailwater through irrigation water management;
- Sediment and erosion control practices.

Visit our website: <https://www.dixonrcd.org/bmps-for-pesticides>