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Environmental Monitoring Branch
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STUDY 299: Monitoring in Urban Areas in Northern California (FY 2018/2019)

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1.0 INTRODUCTION

The Surface Water Protection Program (SWPP), Environmental Monitoring Branch of the California Department of Pesticide Regulation (CDPR) has monitored urban runoff in Northern California since 2007 (Kelley, 2007). This monitoring helped define pesticide runoff patterns from urban neighborhoods and watersheds (Budd et al., 2015; Ensminger et al., 2013). Urban pesticide use remains high (CDPR, 2013a), pesticide loading into urban waterways persists, (Budd et al., 2015; Ensminger et al., 2013; Gan, et al., 2012; Weston and Lydy, 2014), and many urban waterbodies do not meet water quality standards (SWRCB, 2017). These facts justify the need to further monitor the state's urban waterways.

Study 299 is a continuation of CDPR's urban monitoring in Northern California (Ensminger, 2017). SWPP will continue to evaluate sources of pesticide runoff, monitor larger urban watersheds, and evaluate toxicity. In FY2018/2019 some changes to monitoring frequency in the San Francisco Bay area, pesticides of interest, and site locations were made. Of these, the biggest change for FY2018/2019 was the addition of several new sites. A new, recently developed tool in the Surface Water Monitoring Priority model allows for predicting areas of potentially high pesticide runoff (Luo et al. 2017). As a result of this tool, in the San Francisco Bay area, two new watershed sites were added and one existing watershed site was changed. In the Sacramento area, one new watershed site was added and two existing watershed sites were changed. Data from all the sites will be used to evaluate urban pesticide water quality trends.

2.0. OBJECTIVES

For Study 299 (FY2018/2019), Northern California urban monitoring, the objectives are:

1) Identify the presence and concentrations of pesticide contamination in urban waterways;
2) Evaluate the magnitude of measured concentrations relative to water quality or aquatic toxicity thresholds;
3) At selected monitoring sites, determine the toxicity of water samples in laboratory toxicity tests conducted with *Hyalella azteca* and *Chironomus dilutus*;
4) Evaluate the effectiveness of surface water regulations or label changes through long-term (multi-year) monitoring at selected sampling locations.

3.0 PERSONNEL

The study will be conducted by staff from the CDPR's Environmental Monitoring Branch, Surface Water Protection Program, under the general direction of Nan Singhasemanon, Ph.D. Environmental Program Manager I (Supervisory). Key personnel are listed below:

- Project Leader: Michael Ensminger, Ph.D.
- Field Coordinator: Kevin Kelley
- Reviewing Scientist: Robert Budd, Ph.D.
- Statistician: Dan Wang, Ph.D.
- Laboratory Liaison: Sue Peoples
- Analytical Chemistry, water: Center for Analytical Chemistry, California Department of Food and Agriculture (CDFA)
- Analytical Chemistry, sediment: California Department of Fish and Wildlife

Please direct questions regarding this study to Michael Ensminger, Senior Environmental Scientist (Specialist), at (916) 324-4186 or michael.ensminger@cdpr.ca.gov.

4.0 STUDY PLAN

4.1 Site Selection. Historically, sites for CDPR's Northern California urban monitoring project were selected based on various criteria with professional judgement accounting for a large portion of the final site selection (Ensminger, 2008). However, Luo et al. (2017) has recently modified the Surface Water Prioritization Model (SWMP) by adding a component to identify priority areas of interest (AOIs) for monitoring. AOIs are determined from pesticide use, aquatic toxicity, and population density information. Model output ranks HUC8 and HUC12 (hydrological unit code; USGS, 2018a) watersheds for monitoring consideration. SWMP limits personal bias, although number of pesticides to run and the number of HUC8 watersheds to incorporate into the model are still determined by the user. However, precedent was set for these inputs in Luo et al. (2017). Of the 105 HUC8 watersheds for Northern California, Luo considered the top nine Northern California HUC8s; they also considered the top 20 SWMP ranked pesticides, statewide.

For this study, HUC12 AOIs were considered if they met the following criteria: 1) Northern California HUC4s as defined in Luo et al. (2017); 2) top ranked pesticides from SWMP (either top 10 or top 25 ranked pesticides); 3) top 10 HUC8s from SWMP; and 4) top three ranked mainstem or tributary watersheds at the HUC12 level. Final site selection was then based on historical monitoring, fulfilling study objectives, site access and safety, and distribution between top ranked HUC12s selected by the model. Sacramento area and the San Francisco Bay area were chosen for monitoring in FY2018/2019.

4.1.1 Sacramento Area. Monitoring will occur in three SWMP top ranked HUC12 watersheds in the Sacramento area. SWPP will continue monitoring in the Arcade Creek and Pleasant Grove Creek watersheds and add a new site in the highest ranked mainstem HUC12, Gibson Lake-Dry Creek watershed. This watershed receives inputs from Antelope and Miners Ravine watersheds, also highly ranked in SWMP. If monitoring shows that the Gibson Lake-Dry Creek watershed contains pesticides above water quality thresholds, it may trigger additional future monitoring in these other two watersheds.

The Arcade Creek watershed sampling site will be moved to a more upstream location to allow for better access and more runoff during dry monitoring. In Upper Coon-Upper Auburn, SWPP will monitor at two stormdrain outfalls and one receiving water. One stormdrain outfall (PGC021) will be removed from sampling due to lack of runoff during dry events and small drainage area.

Receiving waters will also be consolidated. In previous monitoring, two receiving water sites were monitored. For this year, PGC058 (the furthest downstream receiving water site) will become the main receiving water site for monitoring. However, PGC058 is often dry or intermittent-ponded during dry events. Then PGC040 will be monitored as it regularly has water in it year-round. If PGC058 is dry, there are no/limited additional inputs into the creek past PGC040 (other inputs have also become dry). This change will free up more resource for monitoring in additional watersheds and for the use of autosamplers during all storm events (see 4.4, Water Sampling). In the Gibson Lake-Dry Creek watershed, SWPP will monitor after the union of Miners Ravine and Antelope Creeks, but upstream of the waste water treatment input near Atkinson Street (Roseville). See Appendix 1 and Figure 1 for more detailed site descriptions.

SWMP does not select monitoring areas for stormdrain (source) monitoring but notes that most CDPR source sites are located in HUC12s of monitored receiving water sites. CDPR's urban monitoring program recommends up to 50% of its monitoring sites be source sites (Ensminger et al., 2017). For FY 2018/2019, the Northern California Urban Monitoring program will monitor at three source sites (27% of all sites), two in Pleasant Grove Creek watershed and one in the American River watershed (Appendix 1, and Figure 1). These sites have been monitored for at least 7 years, are considered source long-term monitoring sites. The American River watershed (site FOL002) does not rank in the top three HUC12s for monitoring in SWMP as described in the criteria for HUC12 selection. However, it ranks 4th for tributaries, and because of its monitoring history, we will continue to use this site for source identification.

4.1.2 San Francisco Bay Area. Monitoring will occur in five SWMP top ranked HUC12 watersheds in the San Francisco Bay area. Three of these watersheds were monitored in previous years: Guadalupe River, Walnut Creek, and South San Ramon Creek. In the Guadalupe River watershed, we will continue to monitor at the site near the San Jose Airport, although storm sampling may be moved approximately 0.5 miles downstream to accommodate the use of automated sampling equipment (see 4.4, Water Sampling). At this downstream site, there are no additional inputs from the FY2017/2018 monitoring site. In the South San Ramon watershed, FY2017/2018, we monitored at two closely located sites; MCC040 and SRC_JD. MCC040 receives inputs from part of Dublin; SRC_JD receives inputs from MCC040, other areas of Dublin, and San Ramon. Detections at both sites were similar. Because SRC_JD drains a larger area with similar detections, we will limit monitoring to SRC_JD. The monitoring site in the Walnut Creek watershed will not change location (Appendix 1; Figure 2).

Two new HUC12 watersheds will be added for FY 2017/2018: Silver Creek and San Lorenzo Creek. Silver Creek watershed covers the eastern section of San Jose and drains into Coyote Creek. SWPP monitored Coyote Creek in 2014-2017, but results from SWMP indicate that it receives agricultural inputs and thus is not appropriate for urban monitoring. Silver Creek drains into Coyote Creek, drains a large portion of highly populated eastern San Jose, and is not diluted by lakes and reservoirs in the area (as is Guadalupe River). Without this diluting factor Silver Creek may better reflect the true urban pesticide contamination by San Jose. San Lorenzo Creek HUC12 ranks high in the SWMP output; monitoring in 2017 by the USGS at upstream sites and tributaries of San Lorenzo Creek suggest that pesticides as fipronil, 2,4-D, MCPA, pyrethroids, bromacil, and simazine may be common in the urban runoff (CEDEN, 2018). There will be one monitoring site at each watershed (Appendix 1, Figure 2).

4.2 Selection of pesticides to monitor

For ambient monitoring, SWPP uses the SWMP to assist in pesticide selection. SWMP is based on current use patterns (PUR 2014-2016), aquatic toxicity benchmarks, and physiochemical properties; the output is presented as a relative prioritization (final) score (Budd et al., 2013; Luo et al., 2014). The final score provides guideline for monitoring. Actual pesticides selected may vary due to sampling logistics, previous monitoring data, budget constraints, and laboratory analytical capabilities. Pesticides that receive a final score ≥ 9 are given priority for monitoring. Pesticides with lower scores have either low urban use or low potential toxicity.

A modified ranking system from previous years will be used to allow for maximum number of monitoring sites. As in previous monitoring, pesticides with a "false" recommendation from SWMP will not be monitored (rejected due to physiochemical properties). Pesticides were then chosen based on the following criteria:

1. All pesticides with a final score ≥ 18 will be monitored at all sites. This includes pyrethroids (bifenthrin, cyfluthrin, deltamethrin, lambda-cyhalothrin, permethrin), fipronil, and imidacloprid as pesticides with the highest scores.
2. Pesticides with final scores between 9 and 18 will be considered for monitoring. Pesticides with this ranking may have reduced temporal and spatial monitoring. However, because at all sites fipronil and imidacloprid will be analyzed in CDFA's LC multiscreen, many of the 9 – 18 ranked pesticides will be monitored alongside fipronil and imidacloprid in if they are available in this screen.
3. Pesticides with a score of less than 9 will not be monitored unless they fall into the same analytical screen as 1 or 2 above.
4. Historical monitoring data, current use trends, residential products, CDFA analytical methods, and budget constraints were also used to decide a final monitoring list.

For Northern California, SWMP was run for two distinct geographical areas, Sacramento and San Francisco Bay areas. In Sacramento, SWMP selected 26 pesticides for monitoring with a final score ≥ 9. CDFA has analytical methods for 22 of these pesticides. In the San Francisco Bay area, SWMP selected 30 pesticides; CDFA has methods for 26 of the pesticides (Appendix 2). SWPP will monitor all the selected pesticides with a CDFA analytical method except chlorfenapyr, DDVP (dichlorvos), and tebuthiuron (Appendixes 2 and 3).

4.3 Water Sampling.

Water samples will be collected at all sites four times a year; two dry-season events and two rain events (Table 1). Dry season events will take place in August and in June; Rain events will occur in September – December (the first flush rainstorm of the 2018-2019 water year, if possible) and in the winter months (January – March). During dry season monitoring, water samples will be collected as grab samples directly into 1-L amber bottles (Bennett, 1997). Where the stream is too shallow to collect water directly into these bottles, a secondary stainless-steel container will be used to initially collect the water samples. During storm events, samples will be collected with Teledyne ISCO automatic 6700 series samplers. Aliquots of the entire storm sample will be collected as a composite sample (Jones, 2000). Samples will be transported on wet ice and then refrigerated at 4°C until analyzed. Approximately 10% of the field samples will be field blanks or field duplicates.

4.4 Sediment sampling. Sediments will be collected twice a year at sampling sites in Roseville and Folsom (Table 1). Sediments will be collected using passive sampling techniques where practical, but substituting 1-quart Mason glass jars with 1-quart stainless steel AirScape® (http://planetarydesign.com) containers (Budd et al., 2009). Otherwise, sediments will be collected with stainless steel scoops from the top bed layer (Mamola, 2005). Sediments will be sieved through a 2-mm sieve to remove gravel and plant material. Sediments will be analyzed for pyrethroids.

4.5 Toxicity. Water samples will be collected from a subset of the sampling sites and sent to the University of Davis, Aquatic Health Program, to be tested for toxicity to *Hyalella azteca* or *Chironomus dilutus*. Roseville long-term monitoring sites are the focus for toxicity testing because of long-term testing at these sites.

4.6 Field measurements. Water physiochemical properties (dissolved oxygen, electrical conductivity, pH, and temperature) will be measured *in situ* during all sampling events with a calibrated YSI EXO 1 multiparameter water quality sonde (https://www.ysi.com/productsdetail.php?EXO1-Water-Quality-Sonde-89). SWPP will not take flow measurements during monitoring, but several sites are near or at USGS gaging stations (Arcade Creek, Guadalupe River, and San Lorenzo Creek; USGS, 2018b).

4.7 Sample Transport. SWPP staff will transport samples following the procedures outlined in CDPR SOP QAQC004.01 (Jones, 1999). A chain-of-custody record will be completed and accompany each sample.

4.8 Organic carbon and suspended sediment analysis. SWPP staff will analyze water and sediment samples for total organic carbon (TOC) and dissolved organic carbon (DOC) using a TOC-V CSH/CNS analyzer (Shimadzu Corporation, Kyoto, Japan) (Ensminger and Goh, 2011; Ensminger, 2013a). Water samples will also be analyzed for suspended sediment (Lisker and Goh, 2010; Ensminger, 2013b).

4.9 Modifications for FY2018/2019. The current sampling plan is an extension of urban monitoring in Northern California (for details of previous sampling protocols, see http://www.cdpr.ca.gov/docs/emon/pubs/protocol.htm for Studies 269 and 299). The sampling and analysis schedule similar to previous years. Main differences are the changes in sampling sites to reflect recommendations from SWMP (Table 2).

5.0 CHEMICAL ANALYSIS

CDFA will conduct pesticide analysis for water and sediment samples. CDFA will analyze up to 40 different pesticides and degradates in five different analytical screens (Appendixes 4 and 5). All laboratory QA/QC will follow CDPR guidelines and will consist of laboratory blanks, matrix spikes, matrix spike duplicates, surrogate spikes, and blind spikes (Segawa, 1995). Laboratory blanks and matrix spikes will be included in each extraction set.

6.0 DATA ANALYSIS

All data generated by this project will be entered to a Microsoft® Office Access database that holds site information, field measurements, and laboratory analytical data. All ambient monitoring analytical data will also be uploaded into the CDPR Surface Water Database (SURF) (http://cdpr.ca.gov/docs/emon/surfwtr/surfdata.htm). Previous analysis of CDPR's urban monitoring data has shown that the data contains numerous non-detections and that the data is heavily skewed (non-normal distribution) (Ensminger et al., 2013). Analyzing the data using parametric statistics may violate the normality and equal variance assumptions. Also, the presence of non-detections and multiple RLs limit the application of some widely-used parametric procedures, such as analysis of variance (ANOVA) and *t*-tests. Helsel (2012) has shown that the substitution of non-detections can result in inaccuracy of estimate and test result. While some other parametric procedures, such as the censored regression by using maximum likelihood estimate (MLE), are capable of handling censored data with multiple RLs, the validity of their results depends on the selection of correct distribution. Therefore, we will analyze the data with various non-parametric statistical procedures (Table 3).

7.0 TIMETABLE

Field Sampling:	August 2018 – June 2019
Chemical Analysis:	August 2018 – December 2019
Summary Report:	February 2020
SURF Data Upload:	June 2020

8.0 LABORATORY BUDGET

The estimate cost (for planning purposes) for the CDFA chemical analyses of water samples for ambient monitoring is estimated at $158,310 (Table 1). All costs are estimated and include field QC sample analysis (field blanks and field duplicates) but not laboratory QC. These costs are slightly less than total ambient monitoring costs for FY2017/2018 ($159,640).

9.0 LITERATURE CITED

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Table 1. Water and sediment monitoring for FY20181/2019. For chemical screen information, see Appendixes 4 and 5.

	First Dry					Second Dry					First Storm					Second Storm				
Screen*	DN	LC	PY		SA	DN	LC	PY		SA	DN	LC	PY		SA	DN	LC	PY		SA
Site ID			water	sed				water	sed				water	sed				water	sed	
PGC010	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X
PGC022	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X
PGC040/58	X	X	X		X	X	X	X		X	X	X	X		X	X	X	X		X
DRY_COL		X	X				X	X				X	X				X	X		
FOL2	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X
ARC_ARC	X	X	X		X	X	X	X		X	X	X	X		X	X	X	X		X
WAL_CA	X	X	X		X	X	X	X		X	X	X	X		X	X	X	X		X
SRJ_JD		X	X				X	X				X	X				X	X		
GUA_AG/ TRM		X	X				X	X				X	X				X	X		
SLV_KNG	X	X	X		X	X	X	X		X	X	X	X		X	X	X	X		X
SLC_LA		X	X				X	X				X	X				X	X		
QC	X	X	X	X	X		X	X			X	X	X		X	X	X	X		X
Sample Number	8	12	12	4	8	7	12	12	3	7	8	12	12	0	8	8	12	12	0	8
Screen Cost**	$720	$1700	$600	$600	$690	$720	$1700	$600	$600	$690	$720	$1700	$600	$600	$690	$720	$1700	$600	$600	$690
Screen Total	$5760	$20400	$7200	$2400	$5520	$5040	$20400	$7200	$1800	$4830	$5760	$20400	$7200	$0	$5520	$5760	$20400	$7200	$0	$5520
Event Total	$41,280					$39,270					$38,880					$38,880				
Grand Total																				$158,310

*DN, dinitroaniline herbicides + oxyfluorfen; LC, liquid chromatography multi-screen; PY, pyrethroid; SA, synthetic auxin. An “X” indicates monitoring.

**Costs estimated for laboratory planning purposes

Table 2. Listed below are modifications for Study 299 FY2018/2019.

Change from FY 17/18	Justification
Discontinue sampling PGC021(stormdrain outfall) in Roseville	Site is frequently dry in summer months. Area drained is small (141 homes) so not best representations of a larger urban area and runoff is limited because of the drainage size. Removing this site frees up resource for adding receiving water sites to the study.
Discontinue sampling at MCC040 in Dublin	SRC_JD replaces MCC040 in Dublin and San Ramon. SRC_JD has a larger drainage area and is more representative than MCC040 is of the urban runoff from Dublin and San Ramon. Removing this site frees up resource for adding receiving water sites to increase the temporal distribution of monitoring sites.
Modify the Pleasant Grove Creek receiving water site in Roseville. PGC058 will be the main site with PGC040 the backup site	PGC058 receives more runoff from the city of Roseville, has better access to set up autosamplers for storm events, and is a SPoT* sediment monitoring site (allowing for a full characterization of the pesticide contamination at PGC058). PGC040 will serve as a backup site when PGC058 is dry during summer months.
Discontinue sediment sampling at PGC040 in lieu of sediment sampling at PGC058	With PGC058 the main receiving water site, sediments would be collected at this site. However, SPoT program collects sediment at PGC058, and there is no need to duplicate this effort.
Add a new receiving water site in the Sacramento area, in the Gibson Lake-Dry Creek HUC12 watershed (site: DRY_COL)	In SWMP model, the Gibson Lake-Dry Creek HUC12 watershed is the highest ranked watershed in Northern California. In addition, it receives runoff from two other highly ranked HUC12s suggesting that pesticide contamination will be high. Data can also be used to calibrate the AOI tool in SWMP.
Move Arcade Creek monitoring site upstream	Better site access and the site is more likely to contain water during dry season events.
Add two new receiving water sites in the San Francisco Bay area (sites: SLC_LA [San Lorenzo Creek watershed] and SLV_KNG [Silver Creek watershed)	Monitoring in the San Francisco Bay area has been under-represented in previous years. Top ranked HUC8 watersheds from SWMP give evidence that additional monitoring in this area is warranted. San Lorenzo Creek and Silver Creek watersheds rank highest of all other HUC12 watersheds not currently being monitored.

*SPoT, Stream pollution trends monitoring program.
http://www.waterboards.ca.gov/water_issues/programs/swamp/spot/

Table 3. Non-parametric procedures frequently used for comparing paired data, two samples and three or more samples.

Data	Non-Parametric Procedure
Paired data	*Wilcoxon signed-rank test* for uncensored data *Sign test* (modified for ties) for censored data with one RL *Score tests* for censored data with multiple RLs (the PPW test and the Akritas test)
Two samples	*Wilcoxon rank-sum (or Mann-Whitney) test* or *Kolmogorov-Smirnov test* for censored data with one RL *Score tests* for censored data with multiple RLs (the Gehan test and generalized Wilcoxon test)
Three or more samples in one-way layout	*Kruskal-Wallis test* (for unordered alternative) or *Jonckheere-Terpstra test* (for ordered alternative) for censored data with one RL *Generalized Wilcoxon score test* for censored data with multiple RLs *Multiple comparison* to detect which group is different
Three or more samples in two-way layout	*Friedman's test* (for unordered alternative) or *Page's test* (for ordered alternative) for censored data with one RL Multiple comparison to detect which group is different

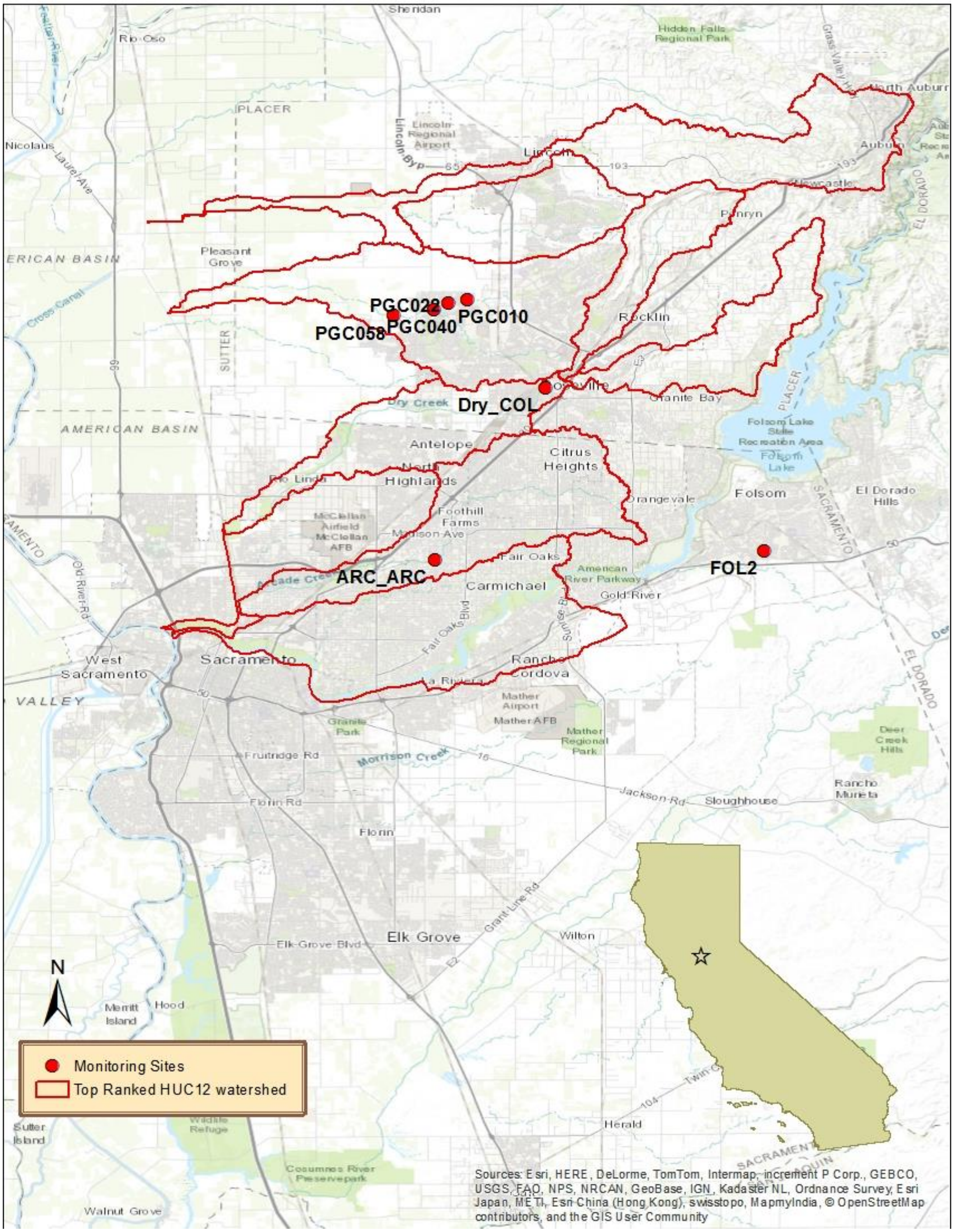

Figure 1. Sacramento Area monitoring sites for FY2018/2019.

Figure 2. San Francisco Bay Area monitoring sites for FY2018/2019.

Appendix 1. Sampling site details for FY2018/2019.

Site Id	Site Type*	Sample Type	Description	City	HUC12/Name	Site GPS Coordinates (NAD83)	
						Latitude	Longitude
PGC010	SD	Water Sediment	Stormdrain outfall at Diamond Woods Circle,	Roseville	180201610302 Pleasant Grove Creek	38.80477	-121.32733
PGC022**	SD	Water Sediment	Dual stormdrain outfall at Opal and Northpark Drive			38.802599	-121.338787
PGC040 or PGC058	RW	Water	at Veteran's Park			38.79857	-121.34802
			near Hayden Pkwy and Blue Oaks Blvd			38.79477	-121.37251
ARC_ARC	RW	Water	Arcade Creek at American River College	Sacramento	180201110302 Arcade Creek	38.645293	-121.347359
FOL2	SD	Water Sediment	Brock Circle	Folsom	180201110202 Lower American	38.6503	-121.14494
DRY_COL	RW	Water	Columbia Circle and Miners Ravine Trail	Roseville	180201110105 Gibson Lake-Dry Creek	38.750489	-121.279182
WAL_CA	RW	Water	Walnut Creek near Concord Avenue	Concord	180500010204 Walnut Creek	37.980630	-122.0516
SLC_LA	RW	Water	San Lorenzo Creek at Lorenzo Avenue	San Leandro	180500040502 San Lorenzo	37.684572	-122.139337
SRC_JD	RW	Water	South San Ramon Creek at Johnson Drive	Pleasanton	180500040502 South San Ramon Creek	37.700976	-121.919837
GUA_AG/ GUA_TRM	RW	Water	Guadalupe River at Airport Green Parking lot access near Airport Blvd or at Trimble Road	San Jose	180500030304 Guadalupe River	37.373560 37.38062	-121.932830 -121.93802
SLV_KNG	RW	Water	Silver Creek at McKee Road and King Road	San Jose	180500030201 Silver Creek	37.35815	-121.861192

*SD, stormdrain outfall; RW, receiving water on creek or river. **PGC022 sediment sampling will be downstream of the union of PGC021 and PGC022

Appendix 2. Priority pesticides for the Sacramento area. Listed, pesticides with priorities greater or equal to the priority score of 9, with a "TRUE" monitoring recommendation from SWMP (based on acute toxicity). Priority model does not include homeowner pesticide use.

Pesticides with available analytical methods (CDFA)						
Pesticide	CDFA Screen*	3 Yr Average Use (lb ai)	Use Score	Benchmark (µg/L)	Tox Score	Final Score
Permethrin	PY	12668	5	0.010	6	30
Bifenthrin	PY	19903	5	0.07	6	30
Lambda-Cyhalothrin	PY	1553	4	0.0035	7	28
Deltamethrin	PY	1707	4	0.05	6	24
Imidacloprid	LC	4430	4	0.38	5	20
Fipronil	LC	5786	4	0.11	5	20
Cyfluthrin	PY	942	3	0.01	6	18
Pendimethalin	DN	2737	4	5.2	4	16
Oryzalin	LC	7415	5	13	3	15
Cypermethrin	PY	1108	3	0.19	5	15
Diuron	LC	546	3	2.4	4	12
Trifluralin	DN	327	3	9.25	4	12
Prodiamine	DN	1181	3	6.5	4	12
Isoxaben	LC	466	3	10	4	12
Esfenvalerate	PY	50	2	0.02	6	12
Chlorfenapyr**	CF	1026	3	2.91	4	12
Carbaryl	LC	110	2	0.85	5	10
Oxyfluorfen	DN	76	2	0.29	5	10
Tebuthiuron**	PI	730	3	50	3	9
Triclopyr	SA	1194	3	100	3	9
Propiconazole	LC	399	3	21	3	9
Mecoprop-P	SA	566	3	14	3	9
Pesticides with no analytical methods for surface water (CDFA) - these pesticides will not be monitored						
Dichlobenil	No method available	7213	5	30	3	15
Dithiopyr		1800	4	20	3	12
Sulfometuron-methyl		155	2	0.45	5	10
PCNB		576	3	50	3	9

*CF, chlorfenapyr; DN, dinitroaniline herbicides+oxyfluorfen; LC, LC multi-analyte screen; PI, photosynthetic inhibitor herbicide; PY, pyrethroid; SA, synthetic auxin herbicides. See http://cdpr.ca.gov/docs/emon/pubs/em_methd_main.htm

**Will not be monitored. For chlorfenapyr, there has been one detection (in Southern California) in 77 previous samples (1% detection frequency), and it is being monitored in Southern California which has higher use. For tebuthiuron, there were no detections in 21 previous samples. Neither chemical is in the CDFA multi-analyte LC method.

Appendix 3. Priority pesticides for San Francisco Bay area sampling sites. Listed, pesticides with priorities greater or equal to the priority score of 9, with a "TRUE" monitoring recommendation from SWMP. Priority model does not include homeowner pesticide use.

Pesticides with available analytical methods (CDFA)						
Pesticide	CDFA Screen*	3 Yr Average Use (lb ai)	Use Score	Benchmark (µg/L)	Tox Score	Final Score
Permethrin	PY	25964	5	0.01	6	30
Fipronil	LC	16766	5	0.11	5	25
Cyfluthrin	PY	6525	4	0.01	6	24
Bifenthrin	PY	5416	4	0.07	6	24
Deltamethrin	PY	9732	4	0.05	6	24
Lambda-Cyhalothrin	PY	1558	3	0.0035	7	21
Imidacloprid	LC	7590	4	0.38	5	20
Bromacil	LC	3620	4	6.8	4	16
Diuron	LC	6217	4	2.4	4	16
Pendimethalin	DN	6813	4	5.2	4	16
Cypermethrin	PY	2850	3	0.19	5	15
Pyriproxyfen	LC	736	3	0.18	5	15
DDVP (dichlorvos)**	OP	184	2	0.03	6	12
Trifluralin	DN	690	3	9.25	4	12
Oxadiazon	LC	475	3	5.2	4	12
Triclopyr	SA	6405	4	100	3	12
Prodiamine	DN	1391	3	6.5	4	12
Isoxaben	LC	1292	3	10	4	12
Esfenvalerate	PY	114	2	0.02	6	12
Chlorfenapyr**	CF	2576	3	2.91	4	12
Chlorantraniliprole	LC	1215	3	4.9	4	12
Carbaryl	LC	179	2	0.85	5	10
Diazinon	LC	81	2	0.1	5	10
Oxyfluorfen	DN	97	2	0.29	5	10
Oryzalin	LC	3065	3	13	3	9
Propiconazole	LC	994	3	21	3	9
Pesticides with no analytical methods for surface water (CDFA) - these pesticides will not be monitored						
PCNB	No method available	3639	4	50	3	12
Sulfometuron-methyl		238	2	0.45	5	10
Dithiopyr		1449	3	20	3	9
Spinosad		801	3	90	3	9

*CF, chlorfenapyr; DN, dinitroaniline herbicides+oxyfluorfen; LC, multi-analyte screen; OP, organophosphate; PY, pyrethroid; SA, synthetic auxin herbicides. See http://cdpr.ca.gov/docs/emon/pubs/em_methd_main.htm

**Will not be monitored. For chlorfenapyr, there has been one detection (in Southern California) in 77 previous urban samples (1% detection frequency), and it is being monitored in Southern California which has higher use. For DDVP, there have been no detections in 212 previous urban samples. Neither chemical is in the CDFA multi-analyte LC method.

Appendix 4. Chemical analysis of pesticides in Northern California urban monitoring Study 299. The California Department of Food and Agriculture (CDFA) will analyze all water samples. Specific methods can be found at http://www.cdpr.ca.gov/docs/emon/pubs/em_methd_main.htm.

Analyte Screen (Method ID)	Pesticide	Method Detection Limit (µg L^{-1})	Reporting Limit (µg L^{-1})
Dinitroaniline (DN) (EMON-SM-05-006)	oxyfluorfen	0.0101	0.05
	pendimethalin	0.012	0.05
	prodiamine	0.0124	0.05
	trifluralin	0.0144	0.05
LC-multi screen (LC)* (EMON-SM-05-037)	azoxystrobin	0.0004	0.02
	bromacil	0.0004	0.02
	carbaryl	0.0004	0.02
	chlorantraniliprole	0.0004	0.02
	chlorpyrifos	0.0004	0.02
	diazinon	0.0004	0.02
	etofenprox	0.0004	0.02
	diuron	0.0004	0.02
	fipronil	0.0004	0.01
	fipronil amide	0.0004	0.01
	fipronil desulfinyl	0.0004	0.01
	fipronil desulfinyl amide	0.0004	0.01
	fipronil sulfide	0.0004	0.01
	fipronil sulfone	0.0004	0.01
	imidacloprid	0.0004	0.02
	indoxacarb	0.0004	0.02
	isoxaben	0.0004	0.02
	malathion	0.0004	0.02
	oryzalin	0.0004	0.02
	oxadiazon	0.0004	0.02
	propiconazole	0.0004	0.02
	pyraclostrobin	0.0004	0.02
	pyriproxyfen	0.0004	0.02
	trifloxystrobin	0.0004	0.02
Pyrethroid (PY-6) (EMON-SM-05-022)	bifenthrin	0.00176	0.005
	cyfluthrin	0.00173	0.015
	cypermethrin	0.00175	0.015
	deltamethrin/tralomethrin	0.00177	0.005
	esfenvalerate/fenvalerate	0.00167	0.005
	lambda-cyhalothrin	0.00115	0.015
	permethrin cis	0.00352	0.015
	permethrin trans	0.00768	0.015
Synthetic Auxin Herbicides (SA) EMON-SM-05-012)	2,4-D	0.015	0.05
	dicamba	0.017	0.05
	MCPA	0.022	0.05
	triclopyr	0.020	0.05

Appendix 5. Chemical analysis of pyrethroids in Northern California urban monitoring Study 299. The Department of Food and Agriculture will analyze sediment samples (Method EMON-SM 52-9; https://www.cdpr.ca.gov/docs/emon/pubs/anl_methds/imeth_292.pdf).

Pesticide	Method Detection Limit (ng g^{-1} dry wt)	Reporting Limit (ng g^{-1} dry wt)
Bifenthrin	0.1083	1.0
Cyfluthrin	0.183	1.0
Cypermethrin	0.107	1.0
Deltamethrin/Tralomethrin	0.0661	1.0
Esfenvalerate/Fenvalerate	0.143	1.0
Lambda-cyhalothrin	0.1154	1.0
Permethrin cis	0.1159	1.0
Permethrin trans	0.1352	1.0