A Brief Summary of the 2004 TMDL monitoring for Diazinon in California's Sacramento Valley Waterways

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Introduction

This report describes the monitoring results, including the loads of diazinon and chlorpyrifos, at seven locations in five waterways of the Sacramento River Basin associated with runoff events that occurred between January and March 2004. The monitoring was conducted by the John Muir Institute of the Environment, University of California, Davis under the contract from the Central Valley Regional Water Quality Control Board (CVRWQCB). For the purposes of this report a "storm event" is defined as the period of time encompassed by sample collection, and over which pesticide loads were assumed to have occurred.

Objective

The primary objective of the sampling project was to monitor seven selected sites (Table 1) in the Sacramento River Basin (Sacramento River at Colusa, Wadsworth Canal, Sacramento River at Tower Bridge, Colusa Basin Drain, Sacramento River at Veterans Bridge, Feather River near Nicolaus/Verona, and Sacramento Slough) during the 2003-2004 orchard dormant spray season to further characterize and define the sources of diazinon and other organophosphates that cause surface water contamination and toxic conditions to aquatic life. The results of this study will be used to support the implementation of Total Maximum Daily Loads (TMDL's) for diazinon in the Sacramento River Basin.

Table 1. Sampling sites, initial sampling frequency for each storm event and final Storm event sampling dates for the Sacramento River Basin, California

Sampling sites	Initial sampling frequency for each storm event	Final storm event sampling dates
Colusa Basin Drain near Knights Landing	1 sample/day x 7 days	28 Jan – 3 Feb 2004 16 Feb – 22 Feb 2004
Sacramento River at Veterans Bridge	1 sample/day x 8 days	28 Jan – 4 Feb 2004 16 Feb – 23 Feb 2004
Feather River near Nicolaus / Verona	1 sample/day x 8 days	28 Jan – 3 Feb 2004 16 Feb – 22 Feb 2004
Sacramento River at Tower Bridge	1 sample/day x 8 days	28 Jan – 6 Feb 2004 16 Feb – 23 Feb 2004
Sacramento River at Colusa	1 sample/day x 7 days	28 Jan – 3 Feb 2004 16 Feb – 22 Feb 2004
Sacramento Slough	1 sample/day x 8 days	28 Jan – 4 Feb 2004 16 Feb – 22 Feb 2004
Wadsworth Canal at South Butte Rd	3 samples/day x 3 days then 1 sample/day x 2 days	27 Jan – 31 Jan 2004 15 Feb – 19 Feb 2004

Hydrologic conditions in the Sacramento River Basin during the study

Two storm events were sampled for the 2004 TMDL project in the Sacramento River Basin. The first storm event (Storm 1) was the period 28 January to 6 February 2004. The second storm event (Storm 2) was the period 15-23 February, 2004. The following summarizes historic data collected from www.weatherunderground.com and weather updates from State Climatologist Bill Mork.

Four weather-monitoring stations were used: Redding, Red Bluff, Oroville and Marysville. The Redding and Red Bluff stations provided rainfall data for Sacramento River basin while the Oroville and Marysville stations provided rainfall data for the Feather River Basin.

Storm 1 was a strong/complex Pacific weather system,, tropical in origin (Bill Mork, personal communication). The storm event was preceded by a dry period in the sampling basin of 17 days. The storm event began on 27 January with 0.58 in. of precipitation recorded at Redding, 0.76 in. at Red Bluff, 0.91 in. at Oroville and 0.74 in.

at Marysville over a 24 hour period (Figure 1). Sampling was conducted from 28 January to 3 February at most sites, and as late as 6 February at the Tower Bridge at Sacramento site. From 28 January through 1 February precipitation was minimal with values ranging from zero to 0.17 in. at Red Bluff on 1/30. On 2 February significant precipitation occurred within the basin, ranging from 0.67 in. at Marysville to 1.53 in. at Redding. February 3rd saw relatively less precipitation than the proceeding day, with a significant amount in Redding (0.74 in.), and Red Bluff and Oroville receiving even less.

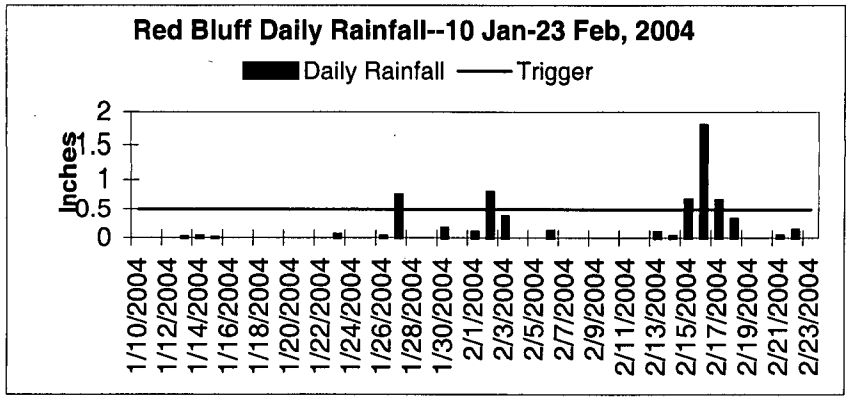
Total precipitation during the 8-day period from 27 January through 3 February ranged from 3.13 in. at Redding, 2.2 in. at Red Bluff, 2.26 in. at Oroville and 1.6 in. at Marysville.

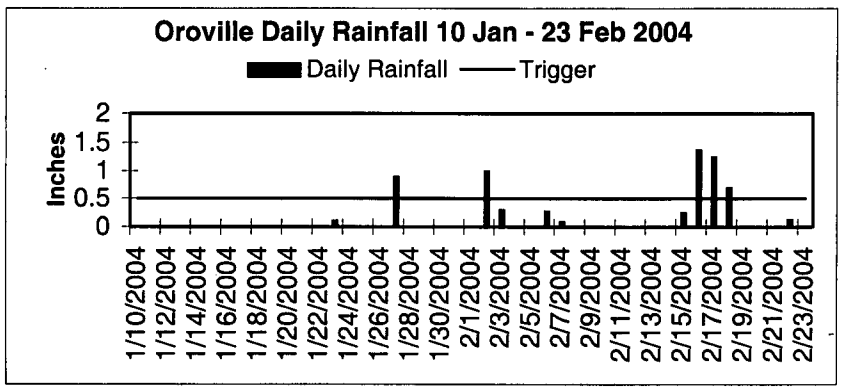
Storm 2 was a broad sub-tropical moisture plume from Hawaii (personal communication, Bill Mork) that produced heavy rainfall throughout Northern California. Storm 2 was preceded by a dry period that varied from 8 days in Oroville, 11 days in Redding and Red Bluff, and 13 days in Marysville.

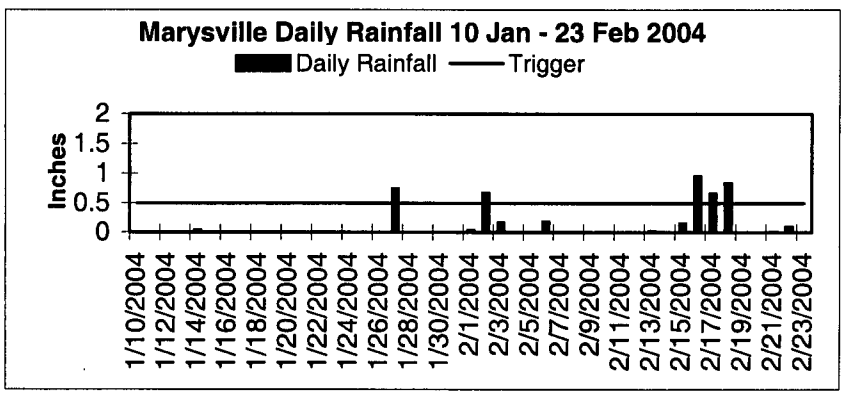
Significant amounts of precipitation were recorded on 15 February, in Redding (0.82 in.), Red Bluff (0.68 in.) and Oroville (0.26 in.). The sampling period began on 16 February and extended until 22 February at most sites, and through 23 February at the Sacramento River at Veterans Bridge and Sacramento River at Tower Bridge sites. The highest precipitation amounts for the storm event were recorded on 16 February with 2.29 in. at Redding, 1.79 in. at Red Bluff, 1.38 in. at Oroville, and 0.95 in. at Marysville. Precipitation continued on 17 February with between 0.5 in. and 1 in. at Redding, Red Bluff and Marysville, and 1.26 in. at Oroville. On 18 February less than 0.5 in. fell at Redding and Red Bluff while 0.71 in. fell at Oroville and 0.84 in. at Marysville. Small amounts of precipitation fell at times at all sites throughout the remainder of the sampling period, however the amount of precipitation was insignificant, never reaching more than about 0.25 inches in a 24 hour period.

The total precipitation during the 8-day period from 15 through 22 February ranged from 4.73 in. at Redding, 3.66 in. at Red Bluff, 3.61 in. at Oroville and 2.7 in. at Marysville.

Figure 1. Rainfall at Red Bluff, Oroville and Marysville, California during the monitoring period 2004. Trigger of 0.5"precipitation in 24 hours was used to determine start of sampling.







Summary of Sampling

Isokinetic, depth integrated water samples were collected at 6-10 equally spaced points across the channel width with a USGS D-77 sampler using the equal-width-increment method (EWI) (Shelton, 1994). Samples were collected from a boat at three sites (Sacramento River at Veterans Bridge, Feather River near Nicolaus/Verona and

Sacramento Slough) and from a bridge at one site (Sacramento River at Tower Bridge)(Table 2). At the Colusa Basin Drain and the Sacramento River at Colusa, depth integrated samples were collected in 3-L (liter) PTFE (polytetrafluoroethylene) bottles strapped to a weighted cage and lowered by line at three points across the width of each channel. The PTFE bottles were used at all sites, except for Wadsworth Canal (autosampler), to minimize loss of pesticide due to sorption to container walls. At Wadsworth Canal an ISCO 6700 autosampler was used to collect samples.

At Wadsworth Canal the sample was pumped through Teflon tubing into a 1 gallon certified pre-cleaned bottle then poured into the 1L amber glass sample bottle. The intake for the autosampler was covered with a stainless steel screen and located approximately 18" from the concrete channel bottom along the west wall of the channel[1]. The intake tubing was purged of residual water prior to each sample being pumped. Three samples per day were collected at Wadsworth Canal during the first three days of each storm event. Each sample was an 8-hour composite consisting of sixteen sub-samples; one sub-sample was pumped every 30 minutes. On the fourth and fifth day of each storm event a single 24-hour composite sample was collected consisting of 24 sub-samples; one sub-sample was pumped every 60 minutes (see Table 1). During dry weather periods, and between storm events, one 24-hour composite sample was collected each week. Each dry weather composite sample consisted of 24 sub-samples: one sub-sample was pumped every 60 minutes. The dry weather samples were collected on 13 and 22 January, 11 and 26 February and 3 and 10 March.

At sites were the EWI method was used, the water from each point (vertical) was mixed in a stainless steel churn, thoroughly agitated then poured into the 1-L glass sample bottle. At sites were a 3-L PTFE bottle was lowered by line the collection bottle was capped, thoroughly agitated and then poured into the glass sample bottle.

At the Tower Bridge site two additional days of sampling were performed during the first storm event because ELISA (Enzyme-Linked Immunosorbent Assay) tests indicated a continuing presence of diazinon in the water. These two samples (5 and 6 February) were collected using a 3L PTFE bottle lowered by line from three equally spaced points across the channel width. The variation in sampling technique was due to

[1] Due to physical limitations it was not possible to locate the intake away from the edge of the channel.

the unscheduled nature of the sampling and the fact that the sampling occurred late in the day – after receiving ELISA results – when the availability of sampling personnel was limited.

On 2 and 3 February, the boat used for sampling at Sacramento Slough, Feather River, and Sacramento River at Veterans Bridge needed repair and was unavailable, therefore a single grab sample was collected from the bank at each site.

On 4 February and 20 February the velocities in Sacramento Slough were low enough that the samples collected with the D-77 were representative of an integrated grab sample rather than an isokinetic sample.

On 18 February high water in the Sacramento River backed up into Sacramento Slough forcing it to flow in the opposite direction. Because of this no sample was collected from Sacramento Slough on 18 February. This scenario was repeated on 21 and 23 February. However on those days, in place of the scheduled Sacramento Slough sample, grab samples were collected from the bank at nearby Reclamation Slough - a tributary of Sacramento Slough.

On 23 February it was observed that high water in the Sutter Bypass had breached the levee separating the Sutter Bypass from the Feather River. It was decided not to collect a sample from the Feather River on 23 February because the sample would not be an exclusive representation of runoff from the Feather River Basin. Instead samples were collected from the Sutter Bypass on 23 and 24 February. Although these samples were collected with a D77 using the EWI method, the velocities were low enough that they are not representative of an isokinetic samples, but rather of integrated grab samples. We suspect that water from the Sutter Bypass may also have been mixing with the Feather River when we sampled there on 22 February.

Immediately after collection, sample bottles were placed on ice and delivered to the California Department of Food and Agriculture (CDFA) Center for Analytical Chemistry in Sacramento. Samples were usually delivered on the same day and no later than 48 hours after collection.

Table 2. Sampling sites, sampling methods and source for determining discharge, Sacramento River Basin, California

[Integrated= integrated grab sample with 3L PTFE bottle; ADCP, acoustic Doppler current profiler; manual discharge measurements made with Price Type AA current meter, sounding reel and bridgeboard]

Sampling Site	Sampling Method	Source of Discharge Data
Colusa Basin Drain near Knights Landing	Integrated (Bridge)	Manual discharge
Sacramento River at Veterans Bridge	D77 / Boat	ADCP
Feather River near Nicolaus / Verona	D77 / Boat	ADCP or CDEC gage: VON
Sacramento River at Tower Bridge	D77 / Bridge	CDWR gage: IST
Sacramento River at Colusa	Integrated (Bridge)	CDEC gage: COL
Sacramento Slough	D77 / Boat	ADCP
Wadsworth Canal at South Butte Rd	Auto sampler	Manual discharge

Laboratory Analyses

Upon arrival at the CDFA laboratory, samples were weighed and filtered using 0.45μ filter paper. Samples were spiked with 500μL of 1.0 μg/ml chlorpyrifos methyl (0.5μg/mL) surrogate spiking solution. The entire sample was emptied into a 2-liter size separatory funnel and approximately 10-15g of granular sodium chloride was added. 60ml of methylene chloride was added and the sample was mixed for three minutes. The organic fraction was filtered through a bed of granular anhydrous sodium sulfate (approx. 20g). The extraction process was repeated three times and the resultant sample evaporated to 5-7 ml at 40° C, then evaporated to dryness with an N-evaporator. 1.0ml of methylene chloride and 10μL of a 5.0μg/mL internal standard solution were added to each sample. Samples were stored in a –5°C freezer until analysis. Samples were analyzed with an Agilent Model 5973 GC-MSD using a HP-5MS or equivalent GC column. Analysis was performed in the selective ion-monitoring mode.

Discharge Methods

At Colusa Basin Drain and Wadsworth Canal discharge was measured in conjunction with water collection using a Price Type AA current meter, a USGS bridge board and sounding reel, following standard USGS current-meter methods (Nolan 2001).

At Sacramento River at Colusa and the Sacramento River at Tower Bridge discharge was obtained from the California Data Exchange Center (CDEC) gage COL and the California Department of Water Resources gage IST, respectively.

An acoustic Doppler current profiler was used from a boat to measure discharge at the Feather River near Nicolaus and Sacramento Slough. Discharge for Sacramento River at Veterans Bridge was received from CDEC gage VON. Some measurements were taken at this location with the acoustic Doppler current profiler to compare the actual reading with the reading of the CDEC gage. See Sacramento Final Data base for values.

The discharge for the Sacramento River at Tower Bridge was received from the CDEC gage IST. For dates when IST was below the rating table and there were no discharge values available, data from CDEC gage FRE at Freeport (12.5 miles downstream of IST) was used in conjunction with flow routing to account for time offset. Flows at those times for IST and FRE have a correlation coefficient of 0.803324. By subtracting 2054 cfs from the discharge values at FRE at sampling time a reasonable predictor of discharge at IST can be estimated.

Load Calculation

Instantaneous loads were calculated by multiplying the discharge with the measured concentration of diazinon and chlorpyrifos for the appropriate sampling period (24 hours for all the sites except Wadsworth Canal, see Table 3 in Appendix 1.

Because the samples collected at Wadsworth Canal were composites representing a 6, 8 or 24 hour time period, instantaneous loads were determined in the following way:

A simple linear regression (Stage Height = 0.1325(Discharge value in cfs) + 0.145) was calculated by plotting stage[2] against discharge[3] using six discharge

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[2] The autosampler recorded stage every 5 minutes

[3] Discharge was measured each day at the time samples were removed from the autosampler.

measurements that represented a broad range of flows (approx. 140-570 cfs). The stage data recorded during the sampling periods was averaged. For six, eight and 24-hour composites there were approximately 72, 96 and 288 data points, respectively.

Next, the average stage for each sampling period was applied to the linear regression to yield an average discharge for the same time period. The average discharge representing each composite sample was then multiplied by the concentration of pesticide found in that sample to yield an instantaneous load for the corresponding period of time. The autosampler malfunction from January 27-30, as a result a total of ten samples that should have been 8-hour composites were instead 6-hour composites; the autosampler turned off at the end of six hours then started the next composite sample two hours later. Therefore, instantaneous loads were calculated for the period of 6 hours (see inserted comments in Sacramento Final Data base for details).

On February 19 water backed up into Wadsworth Canal from downstream flooding rendering the previously established stage-discharge relationship invalid. The flooding lasted until March 7. Due to the dynamic nature (daily shifts in direction) of the flooding it was impossible to establish a new stage-discharge relationship for estimation of discharge and calculation of instantaneous loads. Therefore the following method[4] was used to estimate discharge for the 24 hour composite samples collected on February 19 and 26, and March 3: the channel width at the autosampler intake (8.4m, uniform concrete channel) was multiplied by the average depth over the time period representing the composite sample, and by the arbitrarily chosen distance of 1m. For the purpose of calculating instantaneous loads the estimated volumes were then assigned a rate of movement of one second. Loads were calculated using the previously described method of multiplying discharge by the sample concentration for the appropriate sampling period.

Results

Sample quality control was measured through collection of sequential duplicates (n=8), blanks (n=5) and matrix spikes (n=5) (Table 3). The relative percent difference

[4] The discharge values and consequent loading rates derived from using the improvised discharge method described, should be viewed as rough estimates only, and not on par with discharge measurements derived from the use of commonly accepted methods.

(RPD) between environmental and duplicate sample concentrations of chlorpyrifos ranged from 0-104%. The RPD's between environmental and duplicate sample concentrations of diazinon ranged from 0-40%.

A blank sample collected at Colusa Basin Drain at 09:21 on 30 January had a measured concentration of 0.007 ppb of chlorpyrifos which was above the limit of detection (0.004 ppb) but below the limit of quantification (0.10 ppb).

The percent recovery of chlorpyrifos and diazinon in the matrix spike samples ranged from 73-120%, and 73-105% respectively.

A summary of the environmental data is presented in Table 4.

Table 3. Summary of diazinon and chlorpyrifos concentrations quality-control data for sites in the Sacramento River Basin, California

[NA, not applicable - cannot be calculated because of "less than" concentration; µg/L, microgram per liter; estimate; <, less than]

Site identification number	Site name	Date and time (month/day/year 24-hour time)	Chlorpyrifos (ug/L)	Relative percent difference OR percent recovery (chlorpyrifos)	Diazinon (ug/L)	Relative percent difference OR percent recovery (diazinon)
DUPLICATES [1, 2]						
384649121381101	Sacramento Slough	1/29/04 13:30	0.010		0.038	
		1/29/04 14:26 [1]	E0.005	66.7	<0.007	NA
383430121302001	Sacramento River at Tower Bridge	1/29/04 9:15 [5]	E0.009		0.069	
		1/29/04 9:21 [1, 5]	E0.007	25	0.076	9.6
384752121375301	Feather River near Verona	2/01/04 11:00	E0.005		E0.014	
		2/01/04 11:03 [2]	E0.008	46.2	E0.013	7.4
11389500	Sacramento River at Colusa	2/16/04 15:30	<0.004		<0.007	
		2/16/04 15:33 [2]	E0.005	NA	<0.007	NA
384027121373401	Sacramento River at Veterans Bridge	2/19/04 13:40	0.035		0.037	
		2/19/04 13:43[2]	0.011	104	0.033	11.4
390913121435980	Wadsworth Canal at South Butte Road	1/21/04 10:20	E0.007		0.024	
		1/21/04 10:23[2]	<0.004	NA	0.036	40
390913121435980	Wadsworth Canal at South Butte Road	1/30/04 6:20	0.017		0.12	
		1/30/04 6:23[2]	0.019	11.1	0.12	0
390913121435980	Wadsworth Canal at South Butte Road	2/15/04 12:00	E0.006		0.029	
		2/15/04 12:03[2]	E0.006	0	0.031	6.7
BLANKS						
11390890	Colusa Basin Drain near Knights Landing	1/30/04 9:21	E0.007		<0.007	
384752121375301	Feather River near Verona	2/20/04 10:21	<0.004		<0.007	
383430121302001	Sacramento River at Tower Bridge	2/17/04 9:21	<0.004		<0.007	
384649121381101	Sacramento Slough	2/04/04 12:01	<0.004		<0.007	
390913121435980	[1]Wadsworth Canal at South Butte Road	2/11/04 12:11	<0.004		<0.007	
SPIKES [3, 4]						
11390890	Colusa Basin Drain near Knights Landing	2/19/04 9:20	<0.004		0.180	
		2/19/04 9:29	0.060	120	0.265	85
11389500	Sacramento River at Colusa	1/28/04 10:00	<0.004		0.023	
		1/28/04 10:09	0.0545	109	0.124	101
384027121373401	Sacramento River at Veterans Bridge	1/31/04 13:40	<0.004		0.048	
		1/31/04 13:49	0.0555	111	0.153	105
384649121381101	Sacramento Slough	2/21/04 11:30	<0.004		E0.008	
		2/21/04 11:39	0.054	108	0.107	99
390913121435980	Wadsworth Canal at South Butte Road	1/27/04 14:20	0.028		0.60	
		1/27/04 14:29	0.0645	73	0.673	73

[1] Sequential Duplicate
[2] Split Duplicate
[3]First sample in each pair is the environmental sample; second sample is the spike.
[4]spiked samples were injected with 0.05 ug/L of chlorpyrifos; 0.10 ug/L of diazinon
[5] Samples have wrong sampling times; see Sacramento Final Data base for explanations

Table 4. Summary of environmental data collected on diazinon and chlorpyrifos concentrations and instantaneous loading rates for sites in the Sacramento River Basin, California.

Stream flow is in cubic liters per second. IG, integrated grab; BG, bank grab; A, auto sampler; E, estimate; NA, not available; Kg a.i./d, kilograms active ingredient per day; µg/L, microgram per liter; <, less than]

Site number	Site name	Site identification number	Date and time (month/day/year 24-hour time)	Collection method	Stream flow (cfs)	Chlorpyrifos concentration (µg/L)	Chlorpyrifos instantaneous loading rate (kg a.i./d)	Diazinon concentration (µg/L)	Diazinon instantaneous loading rate (kg a.i./d)
1	Colusa Basin Drain near Knight's Landing	11390890	01/28/2004 14:50	IG	1873	<0.004	NA	0.070	0.321
			01/29/2004 9:30	IG	1802	0.012	0.053	0.066	0.291
			01/30/2004 9:20	IG	1687	E 0.005	NA	0.063	0.260
			01/31/2004 9:30	IG	1675	<0.004	NA	0.052	0.213
			02/01/2004 8:40	IG	1425	<0.004	NA	0.066	0.230
			02//02/2004 9:40	IG	1241	<0.004	NA	0.046	0.140
			02/03/2004 15:30	IG	1991	<0.004	NA	0.047	0.229
			02/16/2004 9:00	IG	749	<0.004	NA	0.055	0.101
			02/17/2004 9:10	IG	2781	<0.004	NA	0.056	0.381
			02/18/2004 9:20	IG	2362	<0.004	NA	0.051	0.295
			02/19/2004 9:20	IG	2528	<0.004	NA	0.18	1.113
			02/20/2004 8:50	IG	2575	<0.004	NA	0.18	1.134
			02/21/2004 10:40	IG	2258	E 0.004	NA	0.14	0.774
			02/22/2004 10:10	IG	2680	<0.004	NA	0.13	0.852
2	Sacramento River at Colusa	11389500	01/28/2004 10:00	IG	10600	<0.004	NA	0.023	0.596
			01/29/2004 16:20	IG	14000	E 0.005	NA	0.059	2.021
			01/30/2004 16:40	IG	12100	<0.004	NA	E 0.017	NA
			01/31/2004 15:50	IG	11700	<0.004	NA	E 0.014	NA
			02/01/2004 10:50	IG	11800	<0.004	NA	E 0.019	NA
			02/02/2004 14:00	IG	11400	<0.004	NA	E 0.009	NA
			02/03/2004 13:40	IG	25300	E 0.005	NA	0.14	8.666
			02/16/2004 15:30	IG	10800	<0.004	NA	<0.007	NA
			02/17/2004 15:50	IG	36300	<0.004	NA	0.071	6.306
			02/18/2004 15:20	IG	45600	<0.004	NA	0.043	4.797
			02/19/2004 15:00	IG	49600	<0.004	NA	0.027	3.276
			02/20/2004 11:30	IG	49400	<0.004	NA	E 0.018	NA
			02/21/2004 14:20	IG	47800	<0.004	NA	E 0.007	NA

Table 4. Summary of environmental data collected on diazinon and chlorpyrifos concentrations and instantaneous loading rates for sites in the Sacramento River Basin, California - *Continued*

Site number	Site name	Site identification number	Date and time (month/day/year 24-hour time)	Collection method	Stream flow (cfs)	Chlorpyrifos concentration (µg/L)	Chlorpyrifos instantaneous loading rate (kg a.i./d)	Diazinon concentration (µg/L)	Diazinon instantaneous loading rate (kg a.i./d)
3	Feather River at Verona	384752121375301	02/22/2004 12:40	IG	46200	<0.004	NA	<0.007	NA
			01/28/2004 12:50	D77	6060	0.014	0.208	0.11	1.631
			01/29/2004 12:30	D77	5967	E 0.008	NA	0.04	0.584
			01/30/2004 10:50	D77	5424	E 0.007	NA	0.029	0.385
			01/31/2004 10:50	D77	5869	E 0.004	NA	E 0.012	NA
			02/01/2004 11:00	D77	5640	E 0.005	NA	0.014	NA
			02/02/2004 18:10	BG	NA	<0.004	NA	E 0.009	NA
			02/03/2004 16:10	BG	NA	E 0.007	NA	0.04	NA
			02/16/2004 11:20	D77	4869	<0.004	NA	E 0.008	NA
			02/17/2004 13:00	D77	7107	E 0.006	NA	0.027	0.469
			02/18/2004 11:40	D77	13228	E 0.01	NA	E 0.013	NA
			02/19/2004 10:50	D77	24575	0.02	1.202	0.029	1.744
			02/20/2004 10:20	D77	18164	E 0.01	NA	E 0.018	NA
			02/21/2004 10:30	D77	16693	E 0.009	NA	E 0.015	NA
			02/22/2004 10:40	D77	15788	E 0.005	NA	E 0.013	NA
4	Wadsworth Canal at South Butte Road [1]	390913121435980	01/13/2004 11:50	A	284	<0.004	NA	<0.007	NA
			01/21/2004 10:20	A	185	E 0.007	NA	0.024	0.011
			01/27/2004 14:20	A	194	0.028	0.003	0.6	0.071
			01/27/2004 22:20	A	263	<0.004	NA	0.63	0.101
			01/28/2004 6:20	A	200	0.026	0.003	0.4	0.049
			01/28/2004 14:20	A	185	0.018	0.002	0.24	0.027
			01/28/2004 22:20	A	183	0.017	0.002	0.23	0.026
			01/29/2004 6:20	A	176	0.018	0.002	0.15	0.016
			01/29/2004 14:20	A	174	0.028	0.003	0.14	0.015
			01/29/2004 22:20	A	173	0.019	0.002	0.12	0.013
			01/30/2004 6:20	A	172	0.017	0.002	0.12	0.013
			01/30/2004 14:30	A	170	0.014	0.006	0.14	0.058
			01/31/2004 14:30	A	169	0.013	0.005	0.078	0.032
			02/02/2004 13:20	A	269	0.017	0.011	0.312	0.205
			02/11/2004 12:10	A	169	E 0.006	NA	0.037	0.015

Table 4. Summary of environmental data collected on diazinon and chlorpyrifos concentrations and instantaneous loading rates for sites in the Sacramento River Basin, California - *Continued*

Site number	Site name	Site identification number	Date and time (month/day/year 24-hour time)	Collection method	Stream flow (cfs)	Chlorpyrifos concentration (µg/L)	Chlorpyrifos instantaneous loading rate (kg a.i./d)	Diazinon concentration (µg/L)	Diazinon instantaneous loading rate (kg a.i./d)
4	Wadsworth Canal at South Butte Road [1] - *continued*	390913121435980	02/15/2004 12:00	A	169	E 0.006	NA	0.029	0.004
			02/15/2004 20:00	A	169	E 0.007	NA	0.04	0.006
			02/16/2004 04:00	A	174	E 0.010	NA	0.1	0.014
			02/16/2004 12:00	A	372	E 0.006	NA	0.2	0.061
			02/16/2004 20:00	A	429	E 0.008	NA	0.13	NA
			02/17/2004 12:10	IG	357	0.013	0.011	0.2	0.175
			02/17/2004 14:40	A	594	0.013	0.019	0.15	0.218
			02/18/2004 14:40	A	629	0.18	0.028	0.026	0.4
			02/19/2004 14:40	A	NA	E 0.009	NA	0.16	0.316
			02/26/2004 11:00	A	NA	E 0.009	NA	0.089	0.172
			03/03/2004 10:10	A	NA	<0.004	NA	0.025	0.05
			03/10/2004 10:00	A	NA	<0.004	NA	E 0.007	NA
5	Sacramento Slough	384649121381101	01/28/2004 14:50	D77	1189	0.011	0.032	0.042	0.122
			01/29/2004 13:30	D77	1183	0.01	0.029	0.038	0.110
			01/30/2004 12:20	D77	1543	E 0.009	NA	0.124	0.468
			01/31/2004 12:10	D77	1632	E 0.004	NA	0.064	0.256
			02/01/2004 12:10	D77	1581	E 0.007	NA	0.079	0.306
			02/02/2004 19:30	BG	NA	E 0.006	NA	0.071	NA
			02/03/2004 17:20	BG	NA	E 0.004	NA	0.063	NA
			02/04/2004 12:00	IG	483	E 0.006	NA	0.024	0.028
			02/16/2004 12:30	D77	1294	E 0.004	NA	0.031	0.098
			02/17/2004 14:10	D77	1150	<0.004	NA	0.032	0.09
			02/19/2004 12:00	D77	NA	<0.004	NA	0.042	NA
			02/20/2004 11:30	IG	NA	<0.004	NA	0.037	NA
	Reclamation Slough	384649121381101-1	02/21/2004 11:30	BG	NA	<0.004	NA	E 0.008	NA
	Reclamation Slough	384649121381101-1	02/22/2004 11:30	BG	NA	<0.004	NA	<0.007	NA
	Reclamation Slough	384649121381101-1	02/23/2004 10:40	BG	NA	<0.004	NA	<0.007	NA
	Sutter Bypass	384649121381101-2	02/23/2004 11:20	IG	64505	<0.004	NA	E 0.018	NA
	Sutter Bypass	384649121381101-2	02/24/2004 14:50	IG	59809	<0.004	NA	E 0.014	NA

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0 exceedances

Table 4. Summary of environmental data collected on diazinon and chlorpyrifos concentrations and instantaneous loading rates for sites in the Sacramento River Basin, California - *Continued*

Site number	Site name	Site identification number	Date and time (month/day/year 24-hour time)	Collection method	Stream flow (cfs)	Chlorpyrifos concentration (µg/L)	Chlorpyrifos instantaneous loading rate (kg a.i./d)	Diazinon concentration (µg/L)	Diazinon instantaneous loading rate (kg a.i./d)
6	Sacramento River at Veterans Br.	384027121373401	01/28/2004 17:20	BG	18200	0.025	1.113	0.027	1.202
			01/29/2004 15:30	D77	20800	E 0.005	NA	0.028	1.425
			01/30/2004 13:40	D77	21400	E 0.005	NA	0.044	2.304
			01/31/2004 13:40	D77	20500	<0.004	NA	0.048	2.407
			02/01/2004 13:20	D77	19700	E 0.004	NA	0.027	1.301
			02/02/2004 17:10	BG	19400	<0.004	NA	0.02	0.949
			02/03/2004 15:30	BG	22100	E 0.006	NA	0.020	1.081
			02/04/2004 14:00	D77	32500	<0.004	NA	0.22	17.493
			02/16/2004 15:40	D77	17200	<0.004	NA	E 0.009	NA
			02/17/2004 15:20	D77	22200	<0.004	NA	E 0.012	NA
			02/18/2004 15:00	D77	39700	<0.004	NA	0.063	6.119
			02/19/2004 13:40	D77	55700	0.035	4.770	0.037	5.042
			02/20/2004 12:50	D77	64800	E 0.007	NA	0.035	5.549
			02/21/2004 13:00	D77	66900	E 0.006	NA	0.025	4.092
			02/22/2004 12:30	D77	66600	<0.004	NA	E 0.018	NA
			02/23/2004 13:00	D77	65600	<0.004	NA	E 0.019	NA
7	Sacramento River at Tower Bridge	383430121302001	01/28/2004 9:40	D77	16013	<0.004	NA	0.028	1.097
			01/29/2004 9:15 [2]	D77	19346	E 0.009	NA	0.069	3.266
			01/30/2004 9:25 [2]	D77	21746	E 0.005	NA	0.025	1.330
			01/31/2004 9:15 [2]	D77	22280	<0.004	NA	0.078	4.252
			02/01/2004 9:20	D77	21813	<0.004	NA	0.03	1.601
			02/02/2004 9:25 [2]	D77	20846	<0.004	NA	0.024	1.224
			02/03/2004 9:20	D77	22379	<0.004	NA	0.025	1.369
			02/04/2004 9:10	D77	29496	<0.004	NA	0.023	1.660
			02/05/2004 17:50	IG	36356	<0.004	NA	0.069	6.137
			02/06/2004 15:10	IG	34962	<0.004	NA	0.053	4.533
			02/16/2004 10:50	D77	NA	<0.004	NA	E 0.009	NA
			02/17/2004 9:20	D77	NA	<0.004	NA	E 0.008	NA
			02/18/2004 9:10	D77	36288	E 0.004	NA	0.011	NA
			02/19/2004 10:00	D77	52535	E 0.009	NA	0.03	3.856
			02/20/2004 9:10	D77	66863	0.03	4.908	0.039	6.380

Table 4. Summary of environmental data collected on diazinon and chlorpyrifos concentrations and instantaneous loading rates for sites in the Sacramento River Basin, California - *Continued*

Site number	Site name	Site identification number	Date and time (month/day/year 24-hour time)	Collection method	Stream flow (cfs)	Chlorpyrifos concentration (µg/L)	Chlorpyrifos instantaneous loading rate (kg a.i./d)	Diazinon concentration (µg/L)	Diazinon instantaneous loading rate (kg a.i./d)
7	Sacramento River at Tower Bridge - *continued*	383430121302001	02/21/2004 9:10	D77	71246	0.011	1.917	0.03 [1]	5.229
			02/22/2004 9:00	D77	72196	<0.004	NA	E 0.018	NA
			02/23/2004 9:10	D77	71702	<0.004	NA	E 0.012	NA

[1] Discharge is an averaged value for the sampling period, calculated using a stage-discharge relationship (explanation see report)

[2] The instantaneous load is either in Kg/day or Kg/ sampling period (see Sacramento final data base for details)
Sampling times should have been rounded to the closest 10 minutes