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Reference # 85

draft report on

SEDIMENT SAMPLE RESULTS

FOR

ORGANIC CHEMICALS, METALS, AND NUTRIENTS

IN THE

LAGUNA DE SANTA ROSA/MARK WEST CREEK SYSTEM

AND THE

RUSSIAN RIVER

1985-86 AND 1995.

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INTRODUCTION

This is a draft report, and as such contains hand-written comments or notations. Some sections are not complete, and the 1995 data have not been fully incorporated into the report. The author's notes are in *italics* within [brackets] to distinguish them from the actual text of the report.

It is released in this form with the recognition that the results are important in providing information regarding the health of the system and for future sampling programs. We intend to complete the report in the near future, and will send a final copy to interested persons. Please contact the Robert Klamt at 707-576-2693 if you would like a final copy.

Public interest groups from the lower Russian River area hypothesized that the City of Santa Rosa's Wastewater Reclamation Plant caused accumulation of nutrients and toxic chemicals in sediments in the Laguna de Santa Rosa, Santa Rosa Creek, and the Lower Russian River. In response, the North Coast Regional Water Quality Control Board (Regional Board) sampled wastewater pond, stream, and river sediments for nutrients, metals, and pesticides and other chlorinated organic chemicals in 1985 and 1986.

The two objectives of the sampling effort were to: 1)determine if there was a relationship between the concentrations of those chemicals in the sediments and location in the watershed, and 2)attempt to explain the distribution of those chemicals in the sediments with respect to wastewater discharge locations.

The hypothesis to be tested was: "The discharges from the City of Santa Rosa's Laguna Plant caused increased sediment concentrations of complex organics, metals, and nutrients in the sediments of the Laguna de Santa Rosa and the lower Russian River."

Though staff to the Regional Board presented summaries of the results of the sampling in 1988 and 1989 (Church 1989), no detailed, nor statistical analysis of the data was undertaken. Regional Water Board staff performed such analyses on the data collected in the 1985-86 effort precursory to repeating some of the sampling in 1995.

[*methods changed between 1986 and 1995, so results are not directly comparable, i.e., concentrations are not directly relatable. however, the relationships of concentrations among stations in 1995 are valuable information and will be compared to the relationships found in the 1985-86 data.*]

METHODS

Study Design

In order to determine if discharges from the City's storage ponds were causing increases in the previously mentioned constituents, we sampled wastewater ponds ("source sites"), sites upstream of the discharge locations ("reference sites"), and sites downstream of the discharge locations ("downstream sites") (Figure 1). The logic was that if concentrations were higher downstream of the discharge locations than upstream, the discharges were causing the increases. Source samples would confirm the increased concentrations in the wastewater ponds. Also, the wastewater ponds have the highest likelihood of accumulating those chemicals, since the sediments in the ponds come from settled algae grown in the wastewater, and have year-round contact with the wastewater as opposed to the stream sediments being exposed to the wastewater only during the winter discharge period.

Three wastewater ponds were selected as source sites: Meadow Lane Pond, Brown Pond, and Delta Pond. Those ponds were common discharge locations (Figure 1).

Reference sites were selected in Copeland Creek (upstream of Rohnert Park), Santa Rosa Creek at Melita Road (upstream of Santa Rosa), Mark West Creek at Slusser Road (upstream of the Laguna confluence), the Russian River at Alexander Valley (upstream of Healdsburg) (Figure 1).

Downstream sites were located in the Laguna/Mark West Creek system at: 1)Stony Point Road (downstream of Rohnert Park, but upstream of wastewater discharges), 2)Occidental Road (downstream of Meadow Lane and Brown ponds and Sebastopol), 3)upstream of the confluence with Santa Rosa Creek (upstream of the Delta Pond discharge), and 4)at Trenton-Healdsburg Road (downstream of all the City of Santa Rosa's wastewater ponds). The Laguna at Highway 12 was sampled once during the study (Figure 1).

Sites downstream of the City of Santa Rosa were located at: 1)Stony Point Road, and 2)upstream of the confluence with the Laguna de Santa Rosa (Figure 1).

Russian River downstream sites were located at: 1)Healdsburg Memorial Beach (within stormwater drainage influence of some of the City of Healdsburg), 2)Wohler Bridge (downstream of Healdsburg, upstream of the confluence with the Laguna), 3)Cook's Beach (downstream of the confluences of both the Laguna and Green Valley Creek), 4)Odd Fellows Park, 5)Johnson's Beach (in Guerneville), 6)Vacation Beach, and 7)Duncan's Mills (Figure 1).

Sampling site locations and codes are detailed in Table 1.

Sampling Frequency
The original plan was to collect samples systematically on a monthly basis for a year. Weather and stream flow conditions affected accessibility of the sites, and a delay in obtaining a laboratory contract resulted in eight sample collections as detailed in Table 2. Data from the last sampling were not useable, since the sampling sites were coded differently, and we found no key to the codes.

Sample Collection
Sediment samples were obtained with an acid-washed Eckman dredge or 1.5" limnological core sampler from depositional areas at each of the sampling sites. The upper two inches of the sample was placed in appropriately prepared jars, enough samples collected to obtain the required sample volume for each analysis group (metals, organics, nutrients). The sampling results for a single site represent a composite sample for each sampling event. [*in 1995 we used USGS methods - cite*]

Sample Analysis
The contract laboratory supplied staff with prepared bottles for each analyte group at each site. Upon submittal to the laboratory, the samples were logged in and analyzed according to accepted US EPA methods as follows:

Metals extraction was per the Waste Extraction Test (WET), soluble (*California Administrative Code, Title 22, Environmental Health*, 30:66002-67651, October, 1984). Analysis was by atomic adsorption spectrometry per *Methods for chemical analysis of water and wastes*, EPA-600/4-79-020, March 1983 or the most recent US Environmental Protection Agency approved methods. Methods numbers for the analytes and detection limits are detailed in Table 3.

Organics analyses were performed per US Environmental Protection Agency approved methods or methods from the most recent version of *Standard Methods for the Examination of Water and Wastewater*. Methods numbers for the analytes and detection limits are detailed in Table 4.

Nutrients analyses were performed per US Environmental Protection Agency approved methods or methods from the most recent version of *Standard Methods for the Examination of Water and Wastewater*. Methods numbers for the analytes and detection limits are detailed in Table 5.

[*Raw data will be presented in the laboratory reports in the Appendix.*]

Figure 1. Sediment sampling sites in the Russian River and Mark West Creek systems, 1985-86 and 1995.

able 1. Sampling site locations and codes for sediment sampling in the Russian River system, 1985-86 and 1995. Bold type = reference station.

Acronym or Code	Sampling Station Location
MLP	City of Santa Rosa wastewater pond - Meadow Lane Pond
BP	City of Santa Rosa wastewater pond - Brown Pond
DP	City of Santa Rosa wastewater pond - Delta Pond
ALPHA	City of Santa Rosa wastewater pond - Alpha Lane Pond
SRCMR	Santa Rosa Creek at Melita Road (upstream of City of Santa Rosa)
SRCSP	Santa Rosa Creek at Stony Point Road
SRCM	Santa Rosa Creek at the mouth, downstream of City of Santa Rosa and upstream of the Laguna
URP	Copeland Creek upstream of Rohnert Park
SP or LSP	Laguna de Santa Rosa at Stony Point Road, downstream of Rohnert Park
12 or L12	Laguna de Santa Rosa at Highway 12
OCC or LOR	Laguna de Santa Rosa at Occidental Road
USR or LUSR	Laguna de Santa Rosa upstream of Santa Rosa Creek
MWC	Mark West Creek at Slusser Road, upstream of Laguna
TH	Mark West Creek at Trenton-Healdsburg Road, downstream of Laguna and Windsor Creek
AV	Russian River at Alexander Valley
HMB	Russian River at Healdsburg Memorial Beach
WB	Russian River at Wohler Bridge (upstream of Mark West Crk.)
CB	Russian River at Cooks Beach (downstream of Mark West Crk.)
OB or OF	Russian River at Odd Fellows Road
JB	Russian River at Johnson's Beach, Guerneville
JB bl dam	Russian River downstream of Johnson's Beach dam, Guerneville
VB	Russian River at Vacation Beach
DM	Russian River at Duncan's Mill

Table 2. Sample collection matrix for sediment sampling in the Russian River system, 1985-86 and 1995. Codes refer to analysis groups: O=organic chemicals, M=heavy metals, N=nutrients, %=%organic matter.

SAMPLE SITE	4/10/85	6/28/85	10/8/85	10/22/85	11/6/85	12/10/85	1/7/86	Oct '95
URP		O/M/N				O/M/N	O/M/N	O/M/N/%
LSP		O/M/N	O/M/N	O/M/N	O/M/N	O/M/N	O/M/N	O/M/N/%
12		O/M/N						
LOR		O/M/N	O/M/N	O/M/N	O/M/N	O/M/N	O/M/N	O/M/N/%
LUSR		O/M/N	O/M/N	O/M/N	O/M/N	O/M/N	O/M/N	
TH		O/M/N	O/M/N	O/M/N	O/M/N	O/M/N		O/M/N/%
MWC		O/M/N	O/M/N	O/M/N	O/M/N	O/M/N	O/M/N	O/M/N/%
SRCMR		O/M/N	O/M/N	O/M/N	O/M/N	O/M/N	O/M/N	O/M/N/%
SRCSP			O/M/N		O/M/N	O/M/N	O/M/N	
SRCM		O/M/N	O/M/N	O/M/N	O/M/N	O/M/N	O/M/N	O/M/N/%
AV			O/M/N	O/M/N	M/N	O/M/N	O/M/N	O/M/N/%
HMB			O/M/N	O/M/N	M/N	O/M/N	O/M/N	O/M/N/%
WB			O/M/N	O/M/N	M/N	O/M/N	O/M/N	O/M/N/%
CB			O/M/N	O/M/N	M/N	O/M/N	O/M/N	
OF			O/M/N	O/M/N	M/N	O/M/N	O/M/N	O/M/N/%
JB			O/M/N	O/M/N	O/M/N	O/M/N	O/M/N	O/M/N/%
VB			O/M/N	O/M/N	O/M/N	O/M/N	O/M/N	
DM			O/M/N	O/M/N	O/M/N	O/M/N	O/M/N	
MLP	M		O/M/N	O/M/N	O/M/N	O/M/N	O/M/N	
BP	M		O/M/N	O/M/N	O/M/N	O/M/N	O/M/N	O/M/N/%
DP	M					O/M/N	O/M/N	
ALPHA								O/M/N/%

Table 3. Metals analysis methods and reporting limits for the Russian River sediment sampling, 1985-86 and 1995.

Analyte	EPA Method Reference 1985-86	EPA Method Reference 1995	1985-86 Reporting Limit (mg/Kg)	1995 Reporting Limit (mg/Kg)
Arsenic	206.2 [1]	7060	2	1.0
Cadmium	213	6010	0.2	1.0
Chromium (total)	218	6010	0.5	2.0
Chromium (hexavalent)	218.4	----	0.5	--
Copper	220	6010	0.5	2.0
Lead	239	7421	--	2.0
Mercury	245	245.1	0.05	0.10
Silver	272	6010	--	2.0
Zinc	289	6010	0.2	5.0

[1] The 197.2 nm resonance line was used to prevent spectral interference from aluminum.

Table 4. Methods and reporting limits for organic chemicals analysis for the Russian River sediment sampling, 1985-86 and 1995.

Analytes	1985-86		1995	
	EPA Method	Reporting Limit	EPA Method	Reporting Limit
aldrin, alpha BHC, beta BHC, delta BHC, dieldrin, endosulfan I, endosulfan II, endosulfan sulfate, endrin, endrin aldehyde, heptachlor, heptachlor epoxide, lindane	8080 3540	0.03 ug/g	8080	0.020 ug/g
DDT, DDD, DDE, methoxychlor	8080 3540	0.08 ug/g	8080	0.020 ug/g
chlordane, PCBs	8080 3540	0.5 ug/g	8080	1.0 ug/g
toxaphene	8080 3540	1.0 ug/g	8080	10 ug/g
chlorpyrifos, diazinon, dichlorvos, disulfoton, ethion, fensulfothion, fenthion, malathion, ethyl parathion, phorate, ronnel, tetrachlorvinphos	-------------		8140	0.50 ug/g
ethoprophos, mevinphos	-------------		8140	1.0 ug/g
demeton, dimethoate	-------------		8140	2.0 ug/g
methyl parathion	-------------		8140	0.20 ug/g
methyl azinphos, coumaphos	-------------		8140	2.5 ug/g

Table 5. Methods and reporting limits for nutrients analyses for the Russian River sediment sampling, 1985-86 and 1995.

Analyte	**Method Reference**	**1985-85 Reporting Limit (mg/Kg)**	**1995 Reporting Limit (mg/Kg)**
Total Kjeldahl Nitrogen	351.4	1	150
Total Phosphate Phosphorus	365.2	0.2	1.0

Data Analysis
Values reported as "non-detect" (ND) were entered into the analysis as one-half the reporting limit to be conservative on the side of detection and to include all values in the statistical analysis. Values reported as "less than or equal to" (≤) were entered into the analysis as the "equal to value." For example, a result of "ND" with a reporting limit of 0.5 was entered as 0.25 and a result of ≤ 0.5 was entered as 0.5. For those analytes detected in more than 50% of the samples the following analysis sequence was employed:

A visual nonparametric analysis was used first by drawing box plots for each analyte on a by-station basis to visually compare reference sites to pond sites to downstream sites. The common procedure is to test differences between sites as indicated from the box plots, i.e., they appear to be different.

However, a standard parametric analysis of variance (ANOVA) was performed on each analyte on data sets grouped by function (reference sites, ponds) and by location (reference sites, ponds, and downstream sites for each stream section). Duncan's multiple range test (DMRT) of the means was performed at the 95% confidence level (alpha of 0.05) on each group, regardless of the significance of the ANOVA. Sites significantly different from other sites or groups of sites were described in relation to the hypothesis and sampling objectives with regard to their location in the stream/pond system.

Results of the statistical data analysis for the 1985-86 data are presented by analyte in the following section for:

- differences among ponds
- differences among reference sites
- differences between reference, ponds, and downstream sites on a by-stream basis.

The 1995 sampling occurred only once for selected stations due to resource constraints. For that reason, box plots and other statistical analyses were not appropriate and the data are presented separately from the 1985-86 data and compared as single values on a by function and by location basis.

RESULTS - ORGANIC CHEMICALS

No chlorinated organic chemicals were detected in sediments in 1985, 1986, nor 1995. Analytes and detection limits are presented in Table 4.

RESULTS - METALS

The metals chromium, copper, and zinc were routinely detected in the 1985-86 sampling and subsequently subjected to the statistical analysis. Hexavalent chromium (chromium VI) and mercury were not detected in any of the 1985-86 samples. Mercury was detected in six of the 15 samples collected in 1995, and lead was detected in all 15.

Box plot boundaries are the 25th and 75th percentiles. Box height references in the following statement of results refers to the distance between the box plot boundaries, e.g., a "short" box has less range between the two percentiles than a "tall" box.

Reference to "significance" in the DMRT tests is at the 95% confidence level (alpha=0.05).

Differences among ponds
1985-86 Data

Delta Pond had the largest variation (tallest box plots) in metals concentration, though little difference was noted among the three wastewater ponds with respect to median or average metals concentrations (Figures 2, 3, 4). Duncan's multiple range test of the means (DMRT) grouped Brown and Meadow Lane together (no significant difference) and significantly lower than Delta Pond for chromium (Table 6). There was no significant difference among the ponds for copper or zinc.

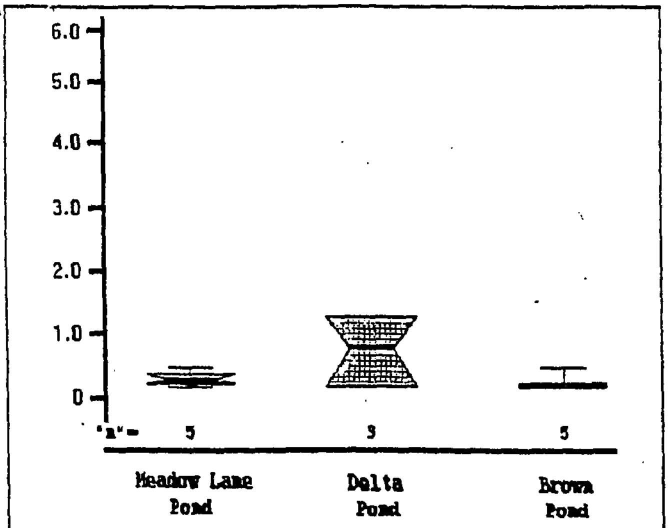


Figure 2. Sediment chromium concentrations (mg/Kg) for the three wastewater ponds, 1985-86.

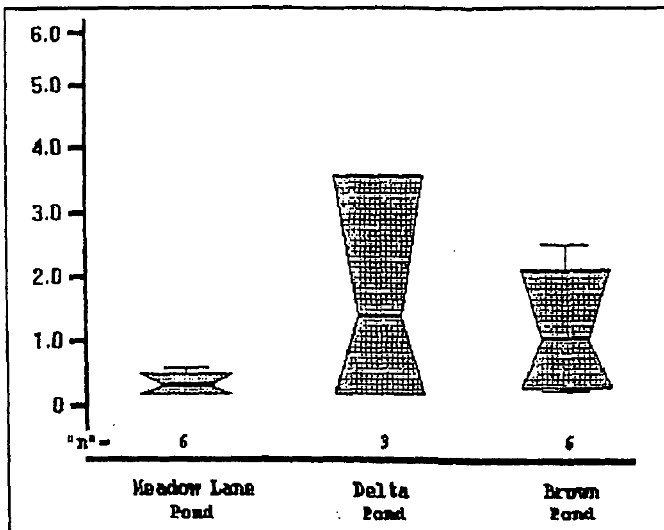


Figure 3. Sediment copper concentrations (mg/Kg) for the three wastewater ponds, 1985-86.

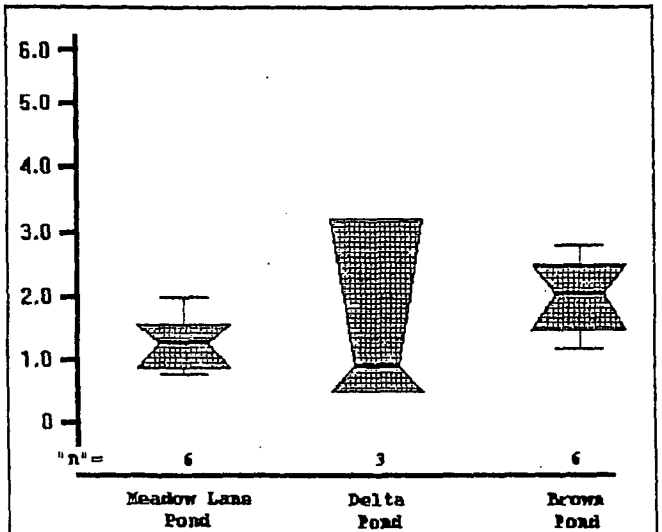


Figure 4. Sediment zinc concentrations (mg/Kg) for the three wastewater ponds, 1985-86.

Table 6. Duncan's multiple range test of the means for sediment chromium, copper, and zinc in the wastewater ponds. Means are in parentheses as mg/Kg. Underlined means are not significantly different at the 95% confidence level, those not underlined are significantly different from the underlined means. ~~Please refer to Table 1 for station codes.~~

CHROMIUM

Brown Pond	Meadow Lane Pond	Delta Pond
(0.27)	(0.33)	(0.77)

COPPER

Meadow Lane Pond	Brown Pond	Delta Pond
(0.36)	(1.2)	(1.7)

ZINC

Meadow Lane Pond	Delta Pond	Brown Pond
(1.3)	(1.5)	(2.0)

1995 Data

- Due to sampling constraints (worker safety, pond access) only Alpha and Brown ponds were sampled. Arsenic, chromium, copper, lead, and zinc were detected at similar concentrations in each pond. [*insert data table here*]

Differences among reference sites

1985-86 Data

Zinc concentrations were higher in the sediments than chromium or copper. Metals concentrations varied among reference sites (Figures 5, 6, & 7). Zinc concentrations exhibited the least variation of the metals, except for the Petaluma Hill Road site (URP). DMRT grouped the stations similar to the visual interpretation: the Petaluma Hill Road and Mark West Creek sites grouped and significantly lower than Alexander Valley and Santa Rosa Creek at Melita Road (Table 7). For copper, all reference stations were grouped together, while for zinc, Alexander Valley stands out as significantly lower than any of the other stations (Table 7).

1995 Data

[*fill in with conclusions; Figure 7A*]

Differences on a by-stream basis - Laguna de Santa Rosa/Mark West Creek

1985-86 Data

In general there was little relationship of metals to location in the Laguna. Chromium and zinc concentrations were higher at Stony Point Road than at the upstream reference site (Petaluma Hill Road), and higher at Trenton-Healdsburg Road than at the upstream reference site (Slusser Road) (Figures 8, 9, & 10). There appeared to be a slight relationship of increased zinc in sediments downstream of urban areas: sediment concentration at Stony Point (downstream of Rohnert Park) was significantly higher than Petaluma Hill Road (upstream of Rohnert Park), and Trenton-Healdsburg Road (downstream of all urban areas) was higher (though not significant at 95% confidence level) than immediately upstream of Santa Rosa Creek (upstream of the City of Santa Rosa, though downstream of Rohnert Park and Sebastopol) (Figure 10, Table 8). Wastewater pond sediment concentrations were essentially the same or lower than the Laguna sites.

The DMRT for all three metals grouped the ponds with the reference sites as significantly lower in average concentration (Table 8). The only other notable rankings were that all sites were grouped together for copper (none of the sites was significantly different from another), and the groupings for zinc exhibited more spread than for chromium.

The wastewater ponds were not significantly different from the reference sites, and had no effect on sediment concentrations in the Laguna.

1995 Data

[*fill in with conclusions; Figure 10A*]

Differences on a by-stream basis - Santa Rosa Creek

1985-86 Data

Sediment concentrations were essentially the same at all sites in Santa Rosa Creek and the Delta Pond, except for zinc (Figures 11, 12, & 13, Table 9). The wastewater pond did not affect sediment concentrations in Santa Rosa Crekk. Zinc was significantly higher in sediments downstream of the reference site (Melita Road), presumably from urban runoff, which may have high levels of zinc (Figure 13, Table 9) (NCRWQCB 1992).

1995 Data

[*fill in with conclusions and data table*]

Differences on a by-stream basis - Russian River

1985-86 Data

Duncan's Mills sediments were the highest for all three metals, with a slight trend towards higher zinc as one moved downstream (Figures 14, 15, & 16). Zinc concentrations generally were lower than in the Mark West Creek system (Laguna and Santa Rosa Creek). The DMRT grouped reference sites with downstream sites, and showed no apparent downstream trend except possibly for zinc, where the

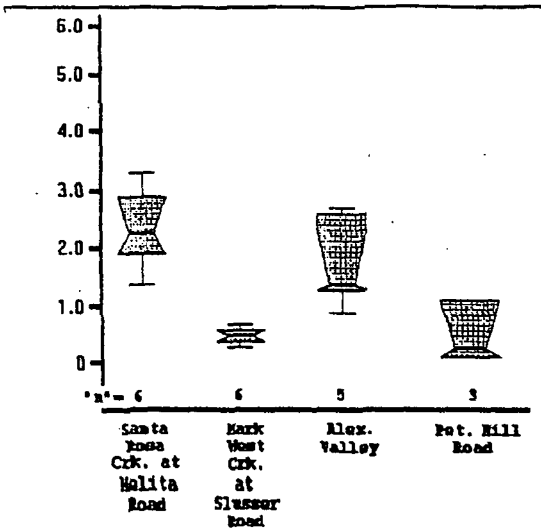


Figure 5. Sediment chromium concentrations (mg/Kg) for reference sites, 1985-86.

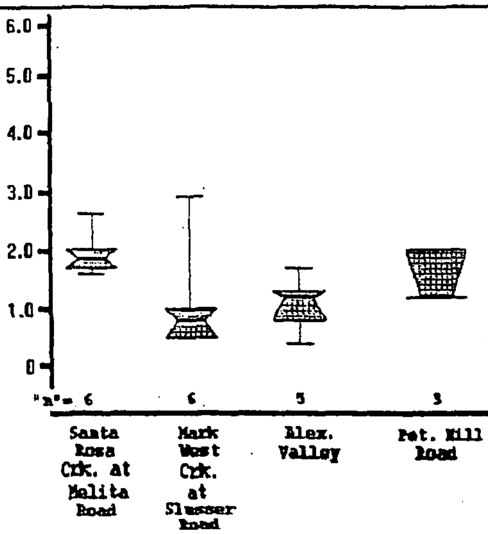


Figure 6. Sediment copper concentrations (mg/Kg) for reference sites, 1985-86.

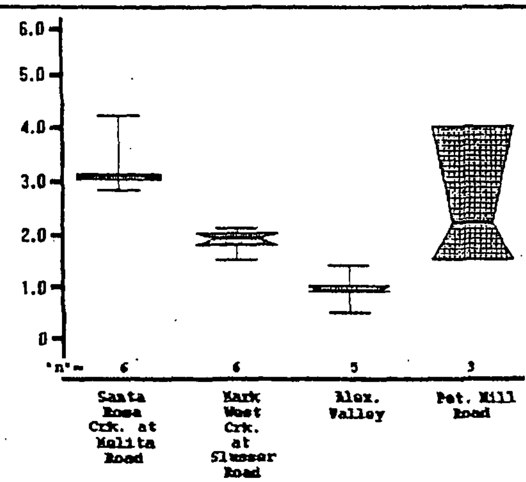


Figure 7. Sediment zinc concentrations (mg/Kg) for reference sites, 1985-86.

Table 7. Duncan's multiple range test of the means for sediment chromium, copper, and zinc at the reference sites in the Laguna/Mark West Creek watershed and the Russian River. Means are in parentheses as mg/Kg. Underlined means are not significantly different at 95% confidence level, those not underlined are significantly different from the underlined means. ~~Please refer to Table 1 for station codes.~~

CHROMIUM

Pet. Hill Rd.	Mark West	Alex. Valley	Melita Road
(0.48)	(0.50)	(1.8)	(2.3)

COPPER

Alex. Valley	Mark West	Pet. Hill Rd.	Melita Road
(1.1)	(1.1)	(1.5)	(1.9)

ZINC

Alex. Valley	Mark West	Pet. Hill Rd.	Melita Road
(0.94)	(1.9)	(2.6)	(3.2)

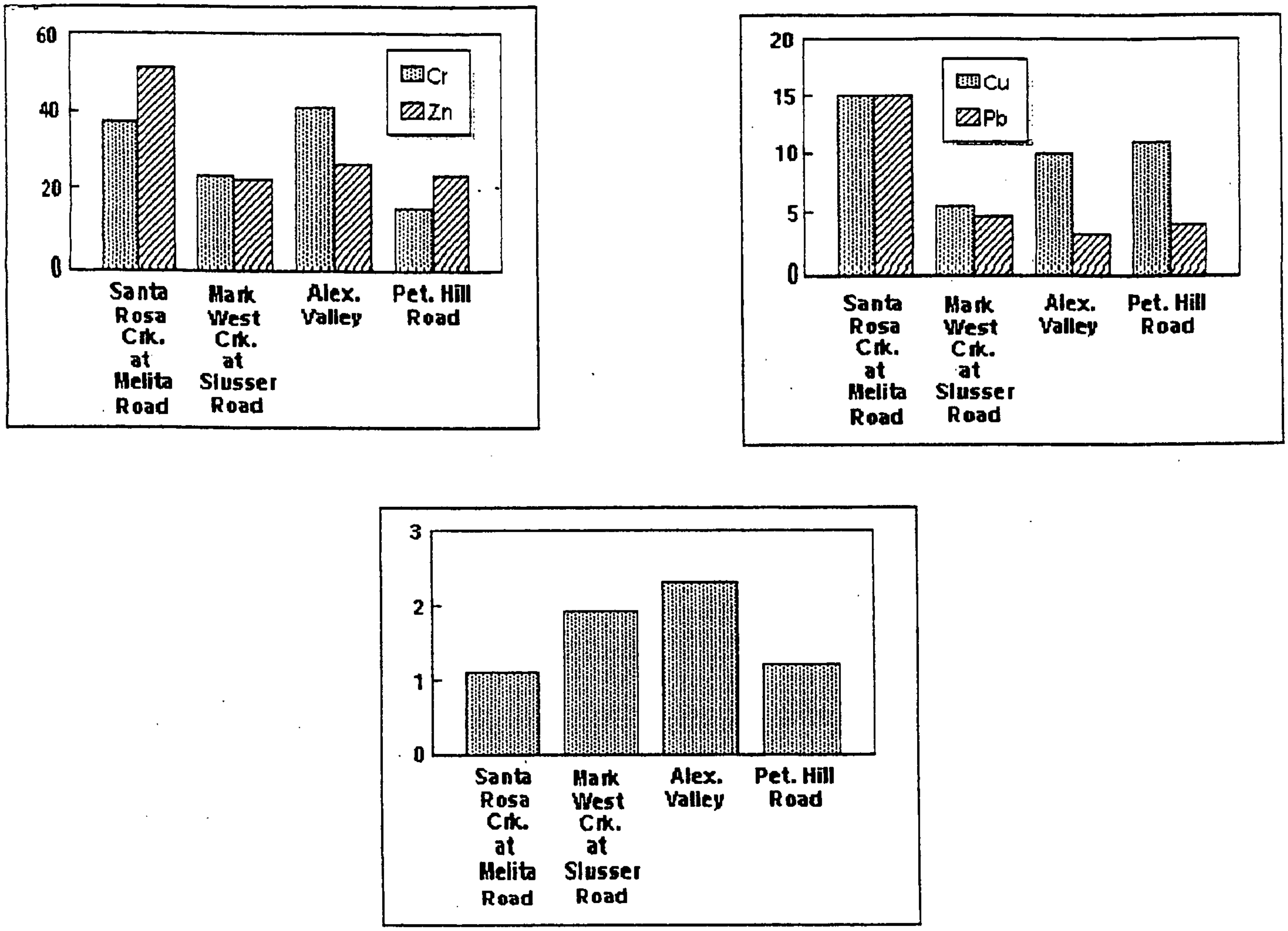


Figure 7A. Sediment concentrations (mg/Kg) for chromium (CR), zinc (Zn), copper (Cu), lead (Pb), and arsenic (As) at the four reference sites, 1995. Please refer to Table 1 for station codes.

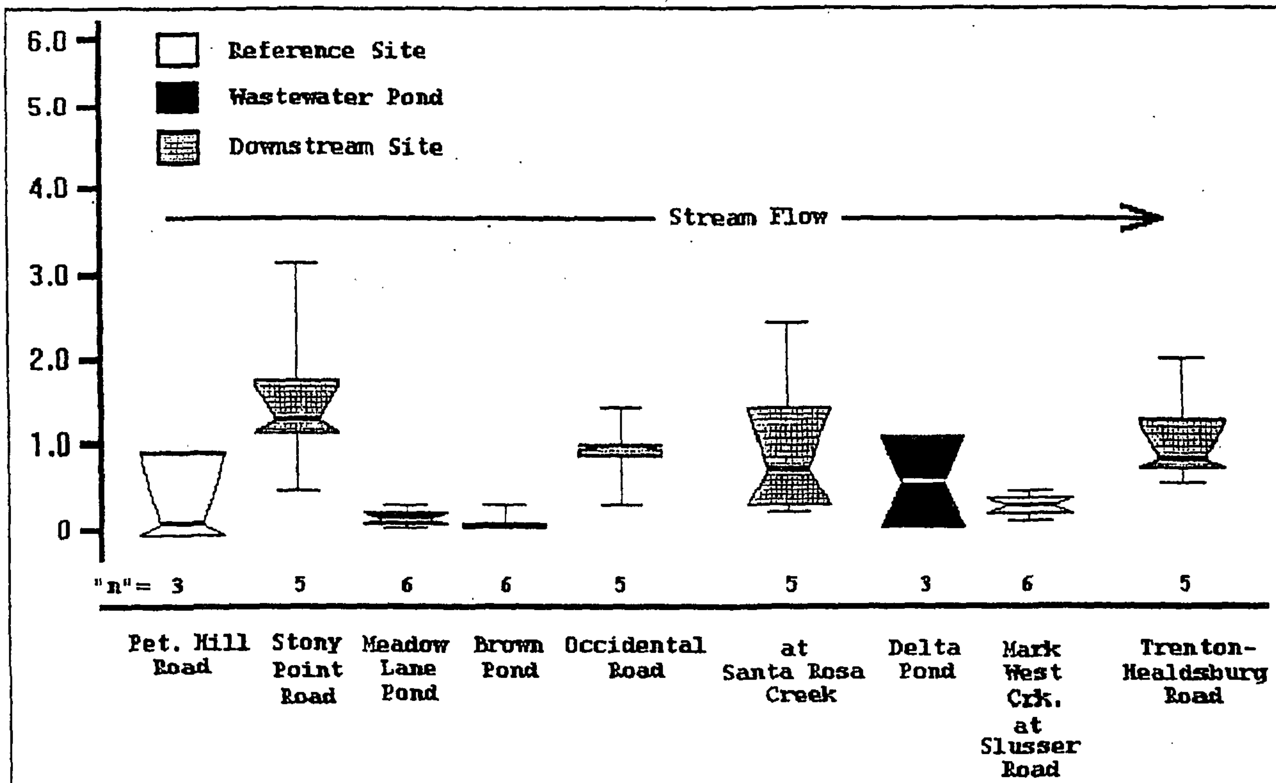


Figure 8. Sediment chromium concentrations (mg/Kg) for the Laguna de Santa Rosa/Mark West Creek sites, 1985-86.

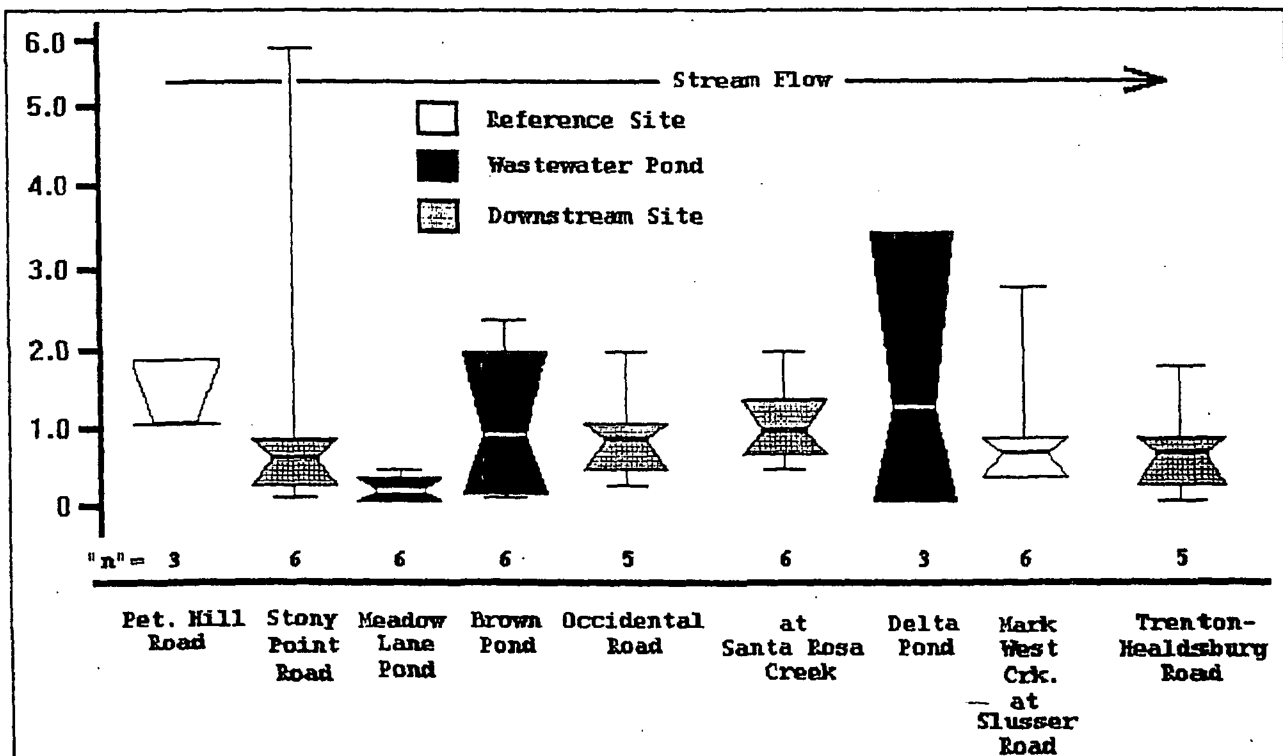


Figure 9. Sediment copper concentrations (mg/Kg) for the Laguna de Santa Rosa/Mark West Creek sites, 1985-86.

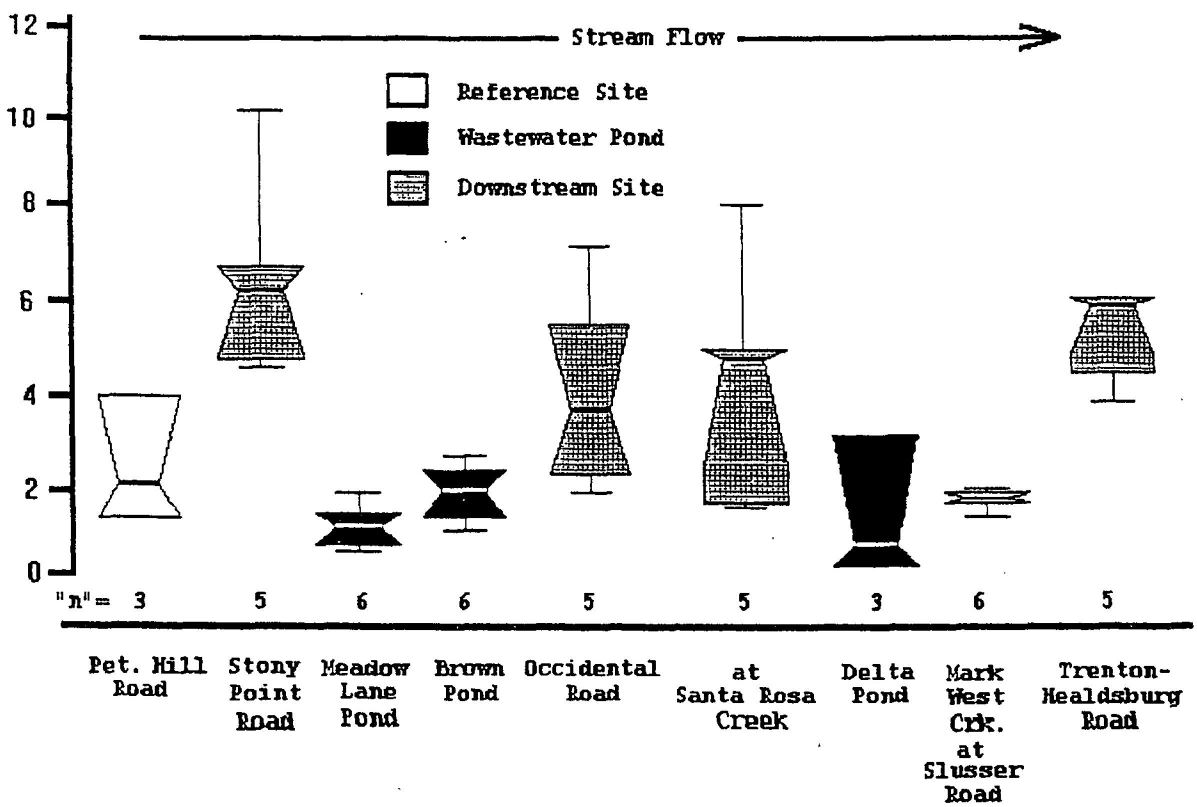


Figure 10. Sediment zinc concentrations (mg/Kg) for the Laguna de Santa Rosa/Mark West Creek sites, 1985-86.

Table 8. Duncan's multiple range test of the means for chromium, copper, and zinc in the Laguna/Mark West Creek watershed and the wastewater ponds. Means are in parentheses as mg/Kg. Underlined means are not significantly different at 95% confidence level, those not underlined are significantly different from the underlined means. Please refer to Table 1 for station codes.

CHROMIUM

BP	MLP	URP	MWC	DP	LOR	LUSR	TH	LSP
(0.27)	(0.33)	(0.48)	(0.50)	(0.77)	(1.1)	(1.2)	(1.3)	(1.7)
—	—	—	—	—				
	—	—	—	—	—	—		
		—	—	—	—	—	—	
					—	—	—	—

COPPER

MLP	TH	LOR	MWC	LUSR	BP	URP	LSP	DP
(0.36)	(0.86)	(1.1)	(1.1)	(1.2)	(1.2)	(1.5)	(1.5)	(1.7)
—	—	—	—	—	—	—	—	—

ZINC

MLP	DP	MWC	BP	URP	LOR	LUSR	TH	LSP
(1.3)	(1.5)	(1.9)	(2.0)	(2.6)	(4.2)	(4.3)	(5.3)	(6.5)
—	—	—	—	—				
			—	—	—			
				—	—	—		
					—	—	—	
							—	—

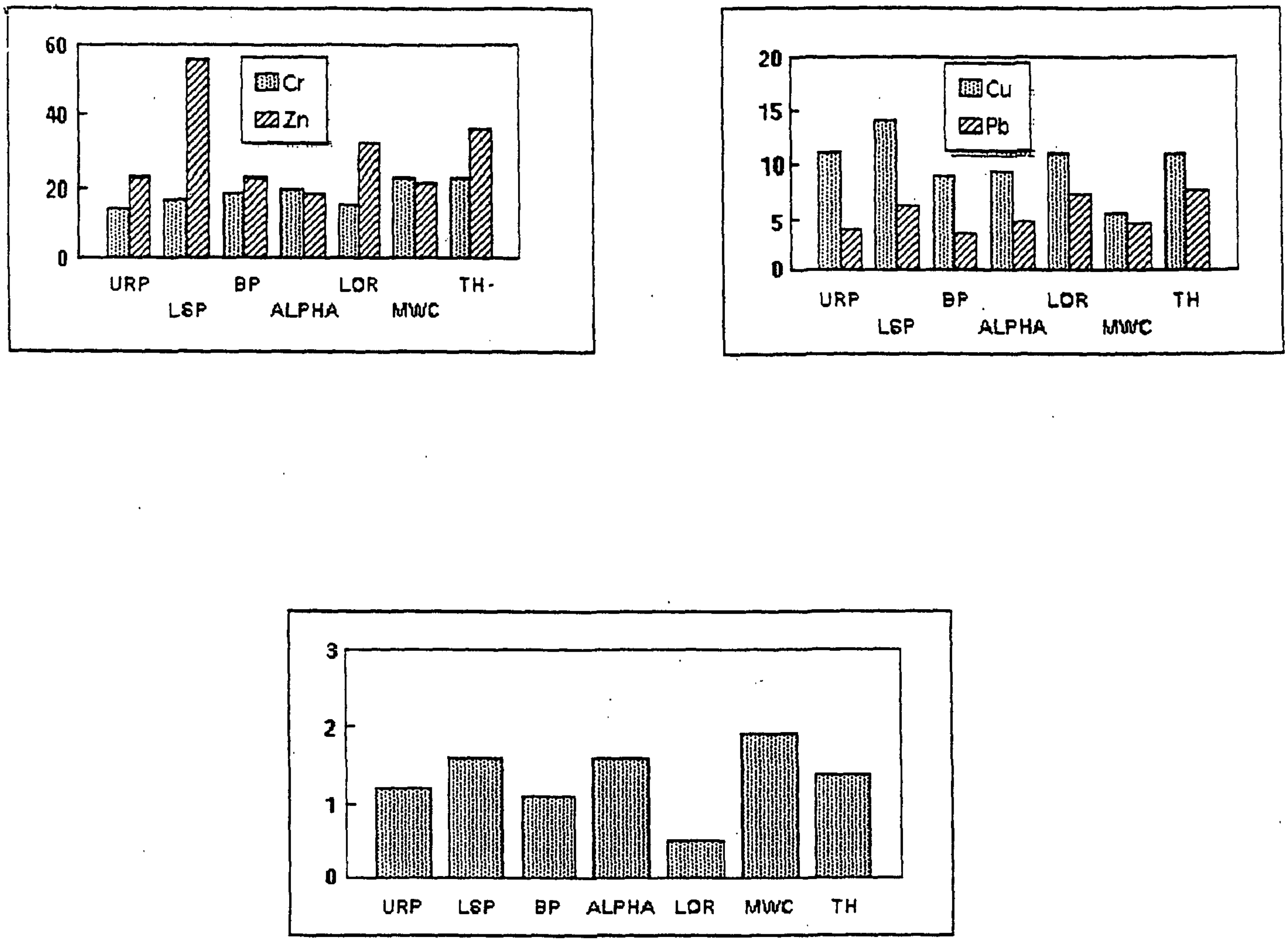


Figure 10A. Sediment concentrations (mg/Kg) for chromium (CR), zinc (Zn), copper (Cu), lead (Pb), and arsenic (As) in the Laguna de Santa Rosa, 1995. Please refer to Table 1 for station codes. Reference stations are: URP and MWC. Pond stations are: BP and ALPHA.

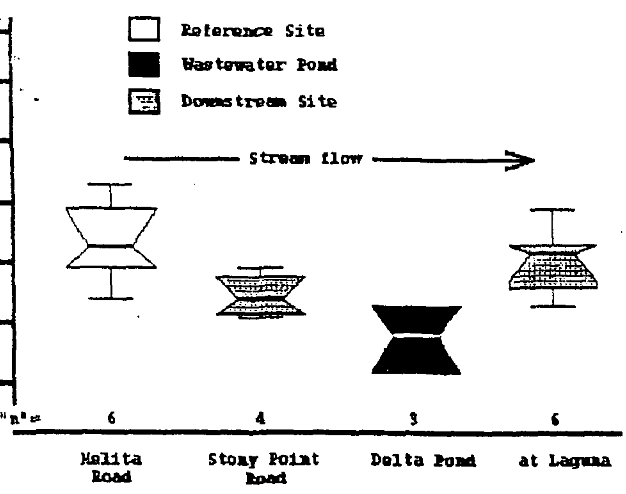


Figure 11. Sediment chromium concentrations (mg/Kg) in Santa Rosa Creek, 1985-86.

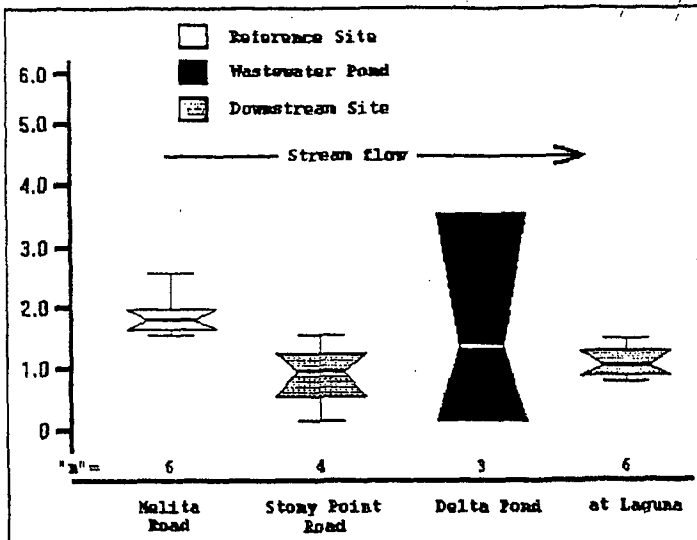


Figure 12. Sediment copper concentrations (mg/Kg) in Santa Rosa Creek, 1985-86.

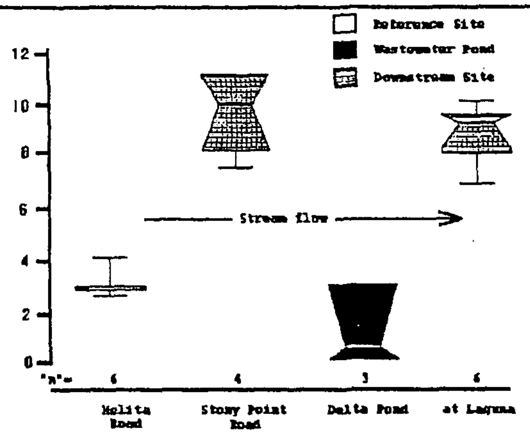


Figure 13. Sediment zinc concentrations (mg/Kg) in Santa Rosa Creek, 1985-86.

Table 9. Duncan's multiple range test of the means for sediment chromium, copper, and zinc from Santa Rosa Creek. Means are in parentheses as mg/Kg. Underlined means are not significantly different at the 95% confidence level; those not underlined are significantly different from the underlined means. Please refer to Table 1 for station codes.

CHROMIUM

DP	SCRSP	SRCM	SRCMR
(0.77)	(1.4)	(2.1)	(2.3)

COPPER

SRCSP	SRCM	DP	SRCMR
(0.95)	(1.1)	(1.7)	(1.9)

ZINC

DP	SRCMR	SRCM	SRCSP
(1.5)	(3.2)	(8.8)	(9.6)

Vacation Beach and Duncan's Mills sites were significantly higher than the other stations as a group, but not significantly different from Healdsburg Memorial Beach, Wohler Bridge, or Odd Fellows as a group (Table 10). There was no apparent relationship of metals concentrations in the sediments from the Russian River to the Mark West Creek system.

There is no evidence from sediment metals concentrations that discharges from the Mark West Creek system affected sediment concentrations in the Russian River.

1995 Data

[*fill in with conclusions; Figure 16A*]

RESULTS - NUTRIENTS

Though the sediments were sampled for nitrate, ammonia, total Kjeldahl nitrogen, orthophosphate, and total phosphate, we analyzed the data with respect to total Kjeldahl nitrogen and total phosphate. Total Kjeldahl nitrogen is the sum of organic nitrogen and ammonia, as such representing organic depositional material and the first nitrogenous breakdown product. Total phosphate represents organic depositional material plus any phosphates that adsorb to particulates and settle, becoming part of the sediments.

Reference to box plots and statistical significance is the same as with the metals results.

<u>Differences among ponds</u>

1985-86 Data

Brown Pond (BP) exhibited the largest variation in nitrogen, with the median value lowest at Meadow Lane (MLP) and highest at Delta Pond (DP) (Figure 17). The DMRT grouped BP and DP together and significantly higher in concentration than MLP (Table 11).

Delta Pond exhibited the largest variation in total phosphate, median concentrations from lowest at MLP to highest at BP (Figure 18). The DMRT grouped all three ponds together: there were no significant differences among the ponds (Table 11).

1995 Data

[*fill in with conclusions and data table*]

<u>Differences among reference sites</u>

1985-86 Data

Most notable in the box plots for nitrogen was the large variation at the Petaluma Hill Road site (URP) (Figure 19). The DMRT grouped all the reference sites together except URP, URP being significantly higher in concentration (Table 12.)

The highest variation in phosphate was observed at URP, though the ranges for all sites were similar (Figure 20). The DMRT grouped all four sites together: no significant differences among the sites (Table 12).

1995 Data

[*fill in with conclusions and data table*]

<u>Differences on a by-stream basis - Laguna de Santa Rosa/Mark West Creek</u>

1985-86 Data

The box plots did not show any clear relationship of sediment nitrogen concentrations to wastewater storage ponds, though were generally higher at the Stony Point Road and Occidental Road sites than anywhere else in the system (Figure 21). The DMRT did not identify any clear relationships either (Table 13).

As with nitrogen, there was no clear relationship of phosphate concentration in the sediments to location of the wastewater storage ponds (Figure 22). The DMRT showed two large groups, MLP being significantly different from LUSR, and all

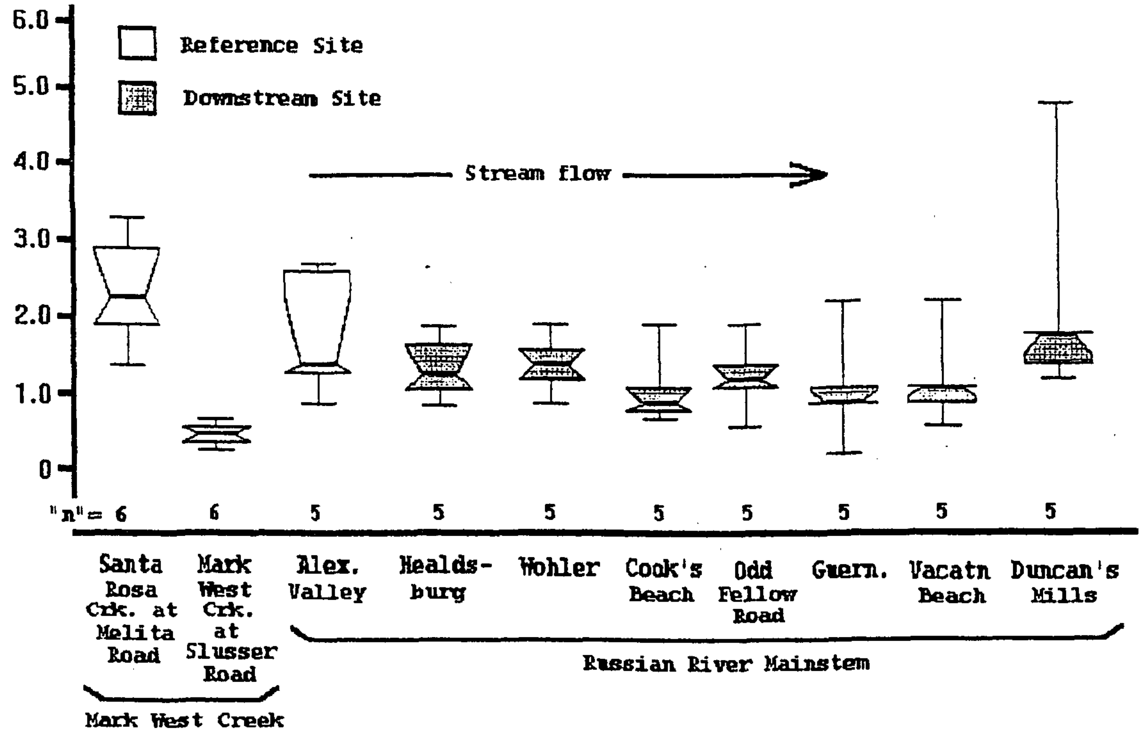


Figure 14. Sediment chromium concentrations (mg/Kg) in the Russian River, 1985-86. Mark West Creek reference stations shown for comparison.

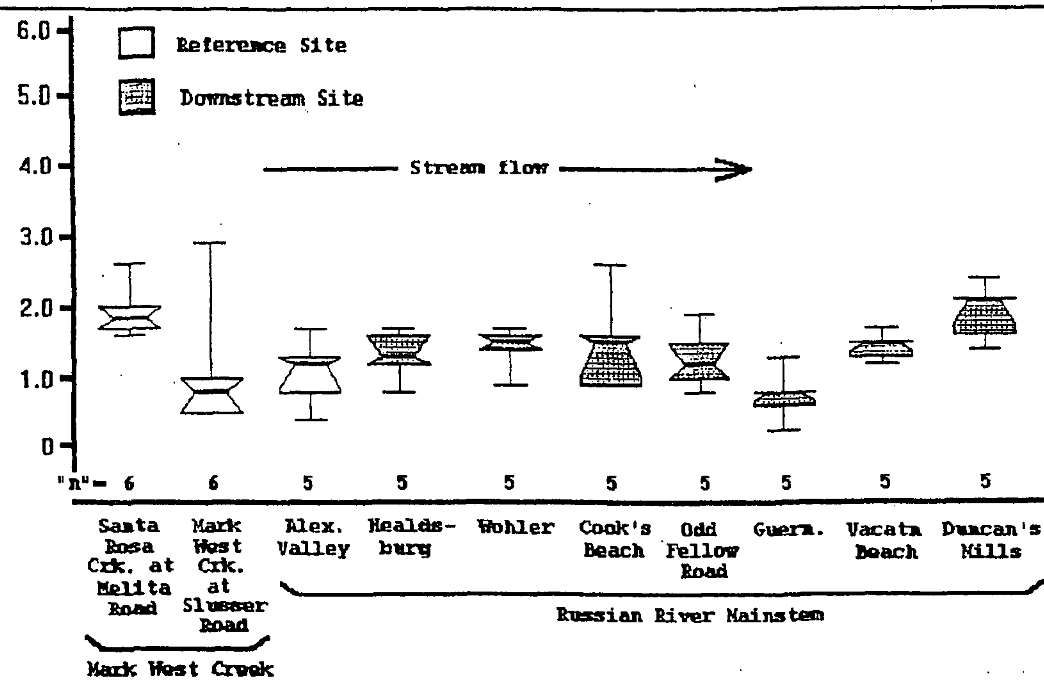
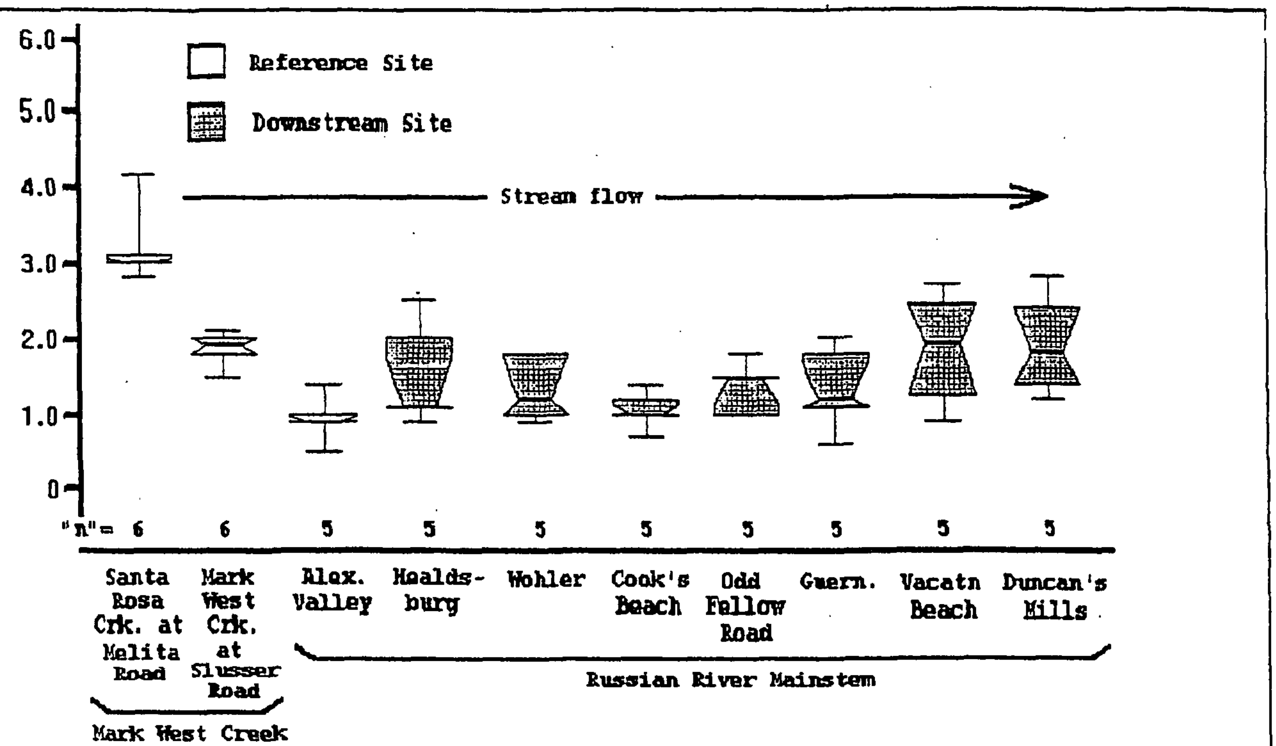


Figure 15. Sediment copper concentrations (mg/Kg) in the Russian River, 1985-86. Mark West Creek reference stations shown for comparison.



16. Sediment zinc concentrations (mg/Kg) in the Russian River, 1985-86. Mark West Creek reference stations shown for comparison.

0. Duncan's multiple range test of the means for sediment chromium, copper, and zinc from the Russian River. Means are in parentheses in mg/Kg. Underlined means are not significantly different at the 95% confidence level; those not underlined are significantly different from the underlined means. Please refer to Table 1 for station codes.

CHROMIUM

	CB	VB	OF	HMB	WB	AV	DM
)	(1.1)	(1.2)	(1.2)	(1.4)	(1.4)	(1.8)	(2.2)

COPPER

	AV	OF	HMB	WB	VB	CB	DM
)	(1.1)	(1.3)	(1.3)	(1.4)	(1.4)	(1.5)	(1.9)

ZINC

	CB	WB	JB	OF	HMB	VB	DM
)	(1.1)	(1.3)	(1.3)	(1.4)	(1.5)	(1.8)	(1.9)

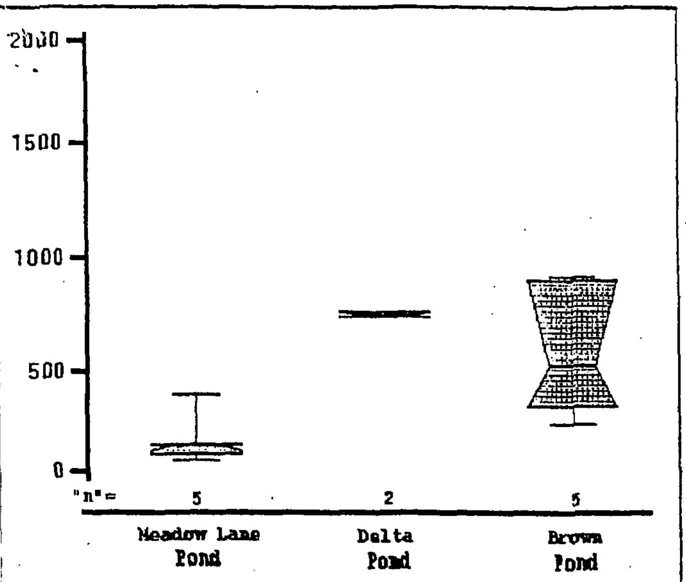


Figure 17. Total Kjeldahl nitrogen concentrations (mg N/Kg) in sediments of three wastewater ponds, 1985-86.

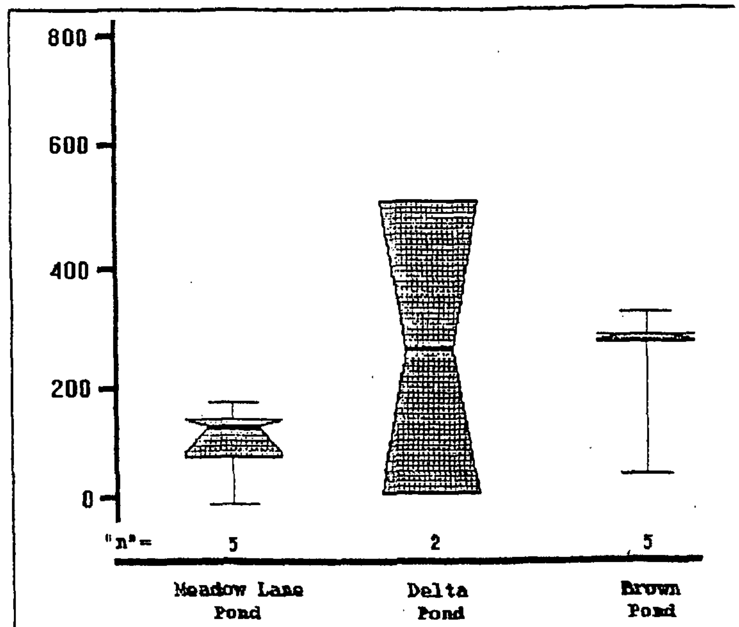


Figure 18. Total phosphate concentrations (mg P/Kg) in sediments of three wastewater ponds, 1985-86.

Table 11. Duncan's multiple range test of the means for sediment concentrations of total Kjeldahl nitrogen (mg-N/Kg) and total phosphate (mg-P/Kg) in three wastewater ponds. Means are in parentheses. Underlined means are not significantly different at the 95% confidence level; those not underlined are significantly different from the underlined means. Please refer to Table 1 for station codes.

TOTAL KJELDAHL NITROGEN

MLP	BP	DP
(202)	(594)	(750)
	________	________

TOTAL PHOSPHATE

MLP	BP	DP
(114)	(250)	(268)
________	________	________

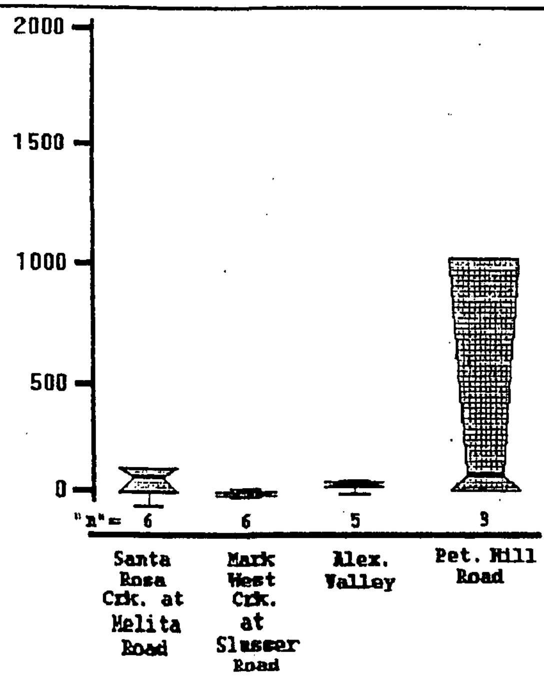


Figure 19. Total Kjeldahl nitrogen concentrations (mg N/Kg) in sediments of four reference sites, 1985-86.

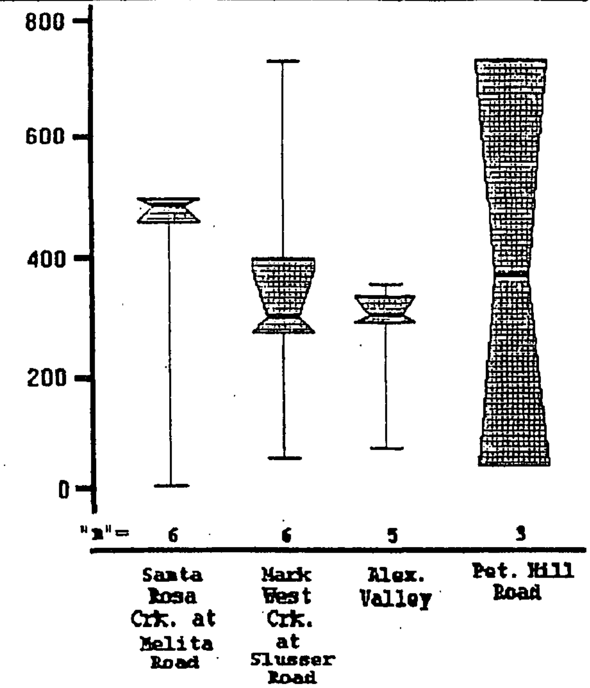


Figure 20. Total phosphate concentrations (mg N/Kg) in sediments of four reference sites, 1985-86.

Table 12. Duncan's multiple range test of the means for sediment concentrations of total Kjeldahl nitrogen (mg-N/Kg) and total phosphate (mg-P/Kg) at four reference sites. Means are in parentheses. Underlined means are not significantly different at the 95% confidence level; those not underlined are significantly different from the underlined means. Please refer to Table 1 for station codes.

TOTAL KJELDAHL NITROGEN

MWC	AV	SRCMR	URP
(55)	(87)	(105)	(386)

TOTAL PHOSPHATE

AV	MWC	URP	SRCMR
(281)	(347)	(383)	(411)

other sites not significantly different from one another (Table 13).

1995 Data

[*fill in with conclusions and data table*]

<u>Table 13.</u> Duncan's multiple range test of the means for total Kjeldahl nitrogen (mg N/Kg) and total phosphate (mg P/Kg) in sediments from the Laguna/Mark West Creek system. Means are in parentheses. Underlined means are not significantly different at the 95% confidence level; those not underlined are significantly different from the underlined means. Please refer to Table 1 for station codes.

TOTAL KJELDAHL NITROGEN

MWC	TH	MLP	URP	LUSR	BP	DP	LSP	LOR
(55)	(110)	(202)	(386)	(448)	(594)	(750)	(908)	(917)
———	———	———	———	———				
		———	———	———	———			
			———	———	———	———		
					———	———	———	———

TOTAL PHOSPHATE

MLP	BP	TH	DP	LOR	LSP	MWC	URP	LUSR
(114)	(250)	(266)	(268)	(294)	(332)	(347)	(383)	(443)
———	———	———	———	———	———	———	———	
	———	———	———	———	———	———	———	———

<u>Differences on a by-stream basis - Santa Rosa Creek</u>

1985-86 Data

The Delta Pond samples were higher in nitrogen than the Santa Rosa Creek sites (Figure 23). The concentrations were more variable at the Stony Point Road site than the other two sites. The DMRT grouped the stream sites together and significantly lower in concentration than Delta Pond: no observed effect on Santa Rosa Creek sediment nitrogen from Delta Pond (Table 14). No other relationships of concentration to location were apparent.

Concentrations were generally higher at the reference site (SRCMR). Otherwise, no clear relationship was apparent for phosphate (Figure 24). The DMRT grouped all sites together with no significant difference among sites: no observed effect on Santa Rosa Creek sediment phosphate from Delta Pond (Table 14).

1995 Data

[*fill in with conclusions and data table*]

<u>Differences on a by-stream basis - Russian River</u>

1985-86 Data

Sediment nitrogen concentrations appeared slightly higher at Healdsburg Memorial Beach (HMB), Wohler Bridge (WB), Vacation Beach (VB), and Duncan's Mills (DM) than at other sites (Figure 25). However, the DMRT grouped all river sites together: no significant difference among the sites (Table 15).

Phosphate concentrations in the sediments were similar throughout the Russian River study area, variance being the only apparent difference among river sites

2

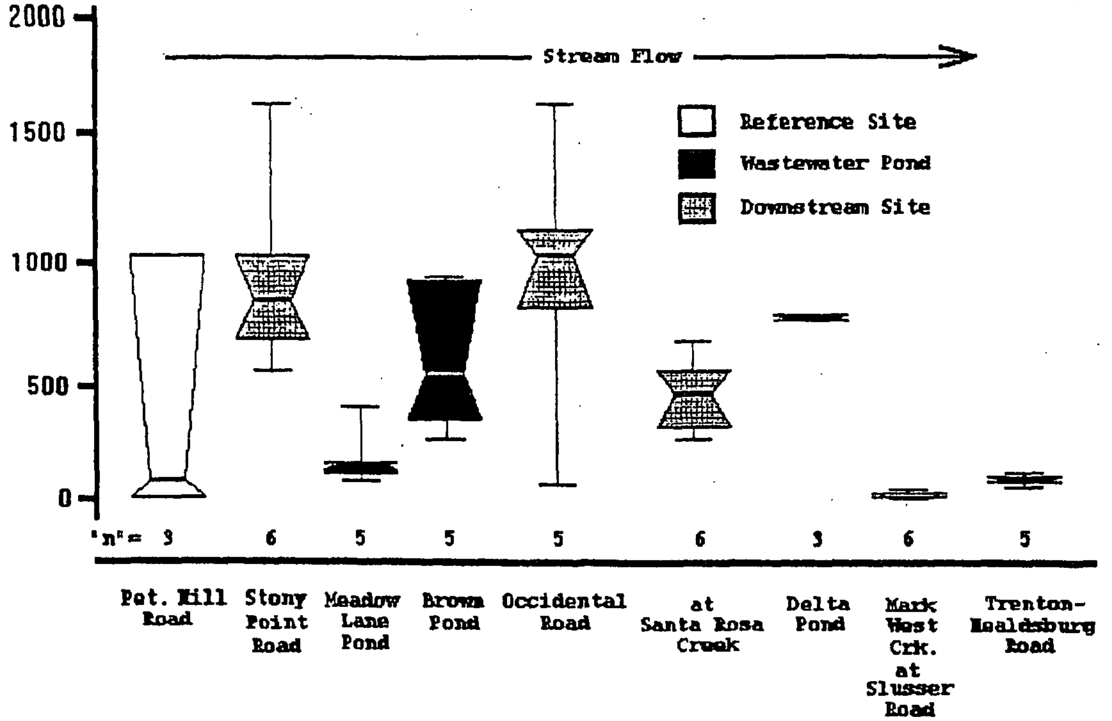


Figure 21. Total Kjeldahl nitrogen concentrations (mg N/Kg) in sediments in the Laguna/Mark West Creek system, 1985-86.

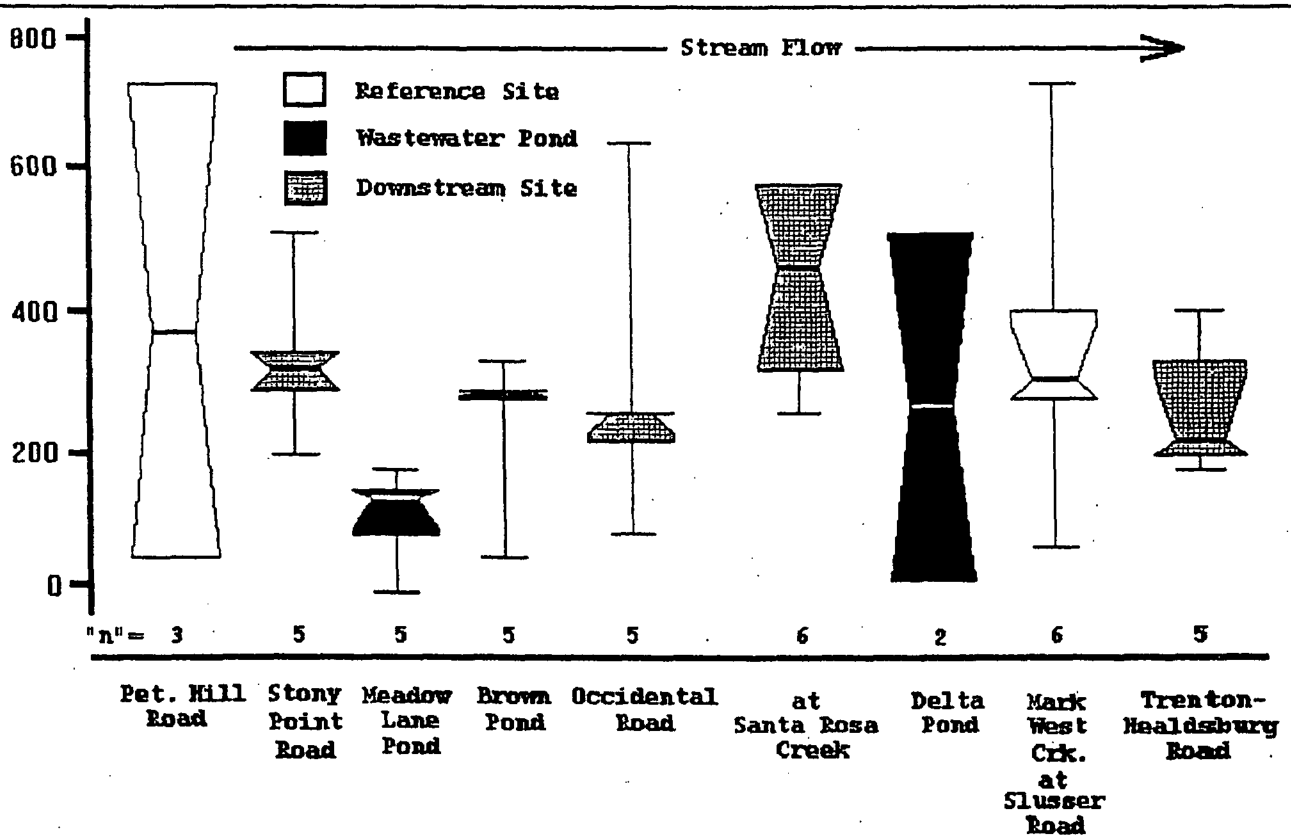


Figure 22. Total phosphate concentrations (mg P/Kg) in sediments in the Laguna/Mark West Creek system, 1985-86.

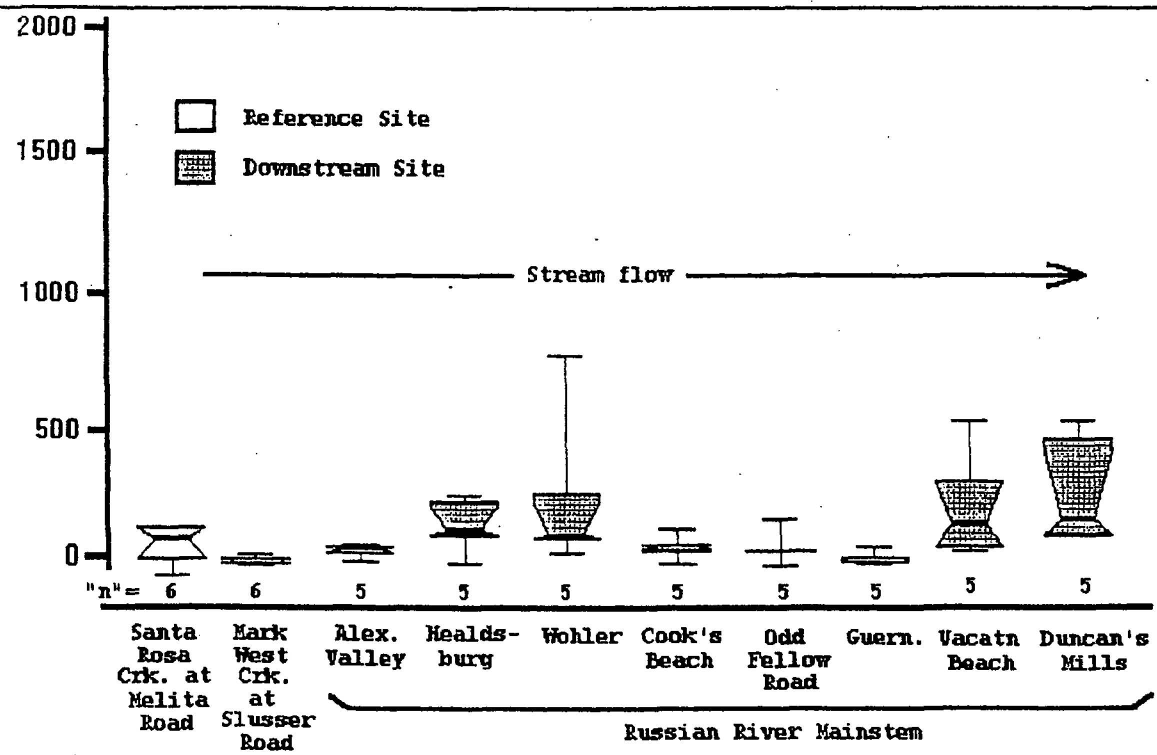


Figure 25. Total Kjeldahl nitrogen concentrations (mg N/Kg) in Russian River sediments, 1985-86.

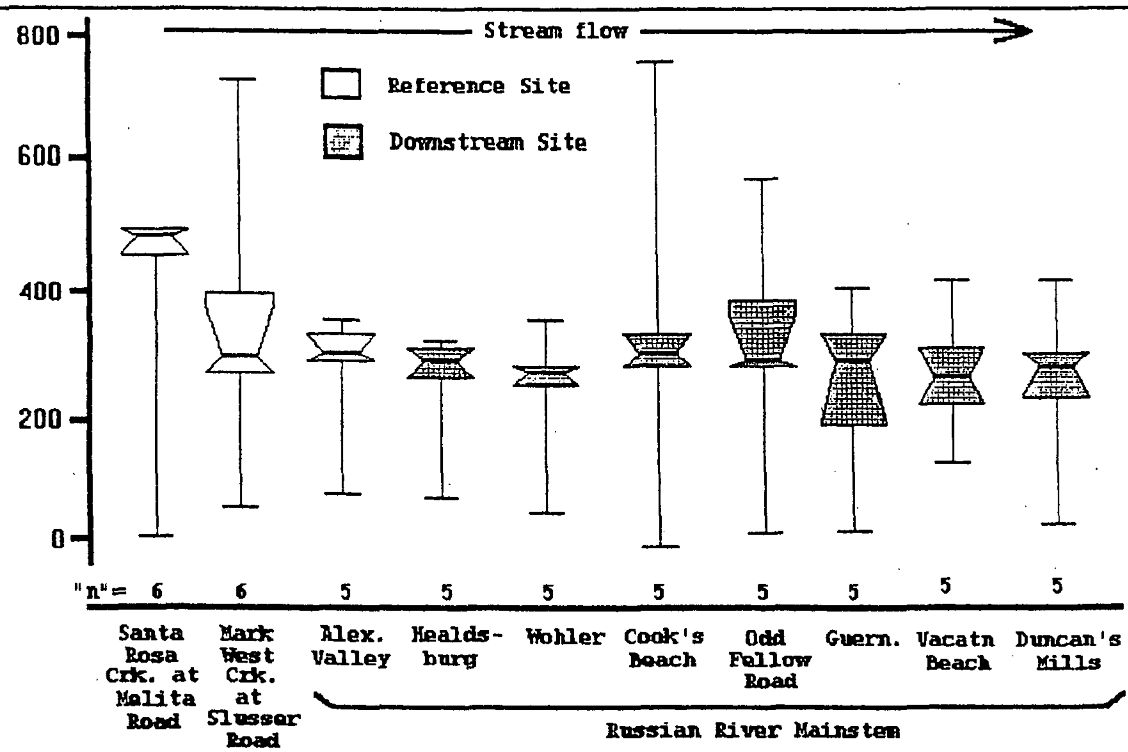


Figure 26. Total phosphate concentrations (mg N/Kg) in Russian River sediments, 1985-86.

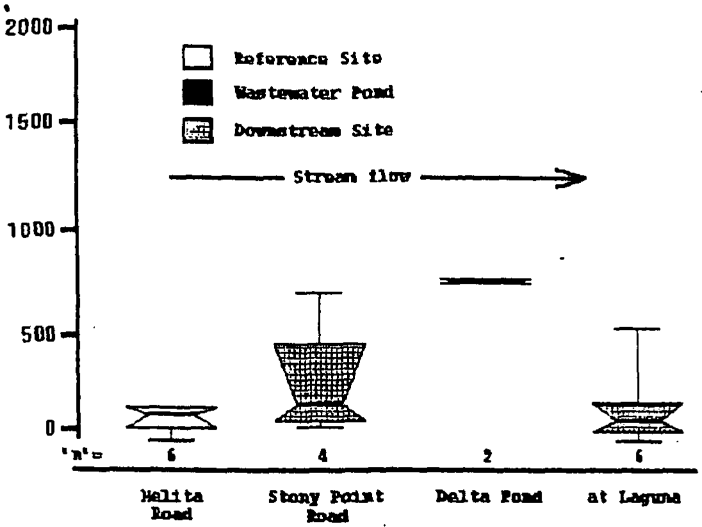


Figure 23. Total Kjeldahl nitrogen concentrations (mg N/Kg) in Santa Rosa Creek sediments, 1985-86.

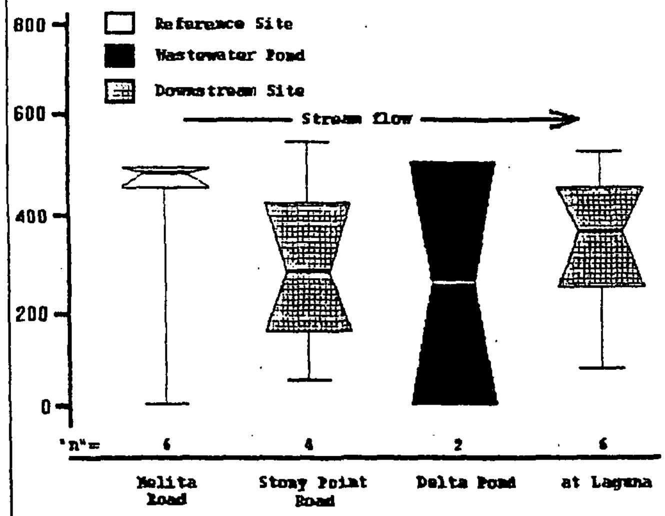


Figure 24. Total phosphate concentrations (mg P/Kg) in Santa Rosa Creek sediments, 1985-86.

Table 14. Duncan's multiple range test of the means for total Kjeldahl nitrogen (mg N/Kg) and total phosphate (mg P/Kg) in sediments from Santa Rosa Creek system. Means are in parentheses. Underlined means are not significantly different at the 95% confidence level; those not underlined are significantly different from the underlined means. Please refer to Table 1 for station codes.

TOTAL KJELDAHL NITROGEN

SRCMR	SRCM	SRCSP	DP
(105)	(158)	(276)	(750)

TOTAL PHOSPHATE

DP	SRCSP	SRCM	SRCMR
(268)	(301)	(348)	(411)

(Figure 26). However, the DMRT grouped all Russian River sites together: no significant difference in sediment phosphate concentrations (Table 15).

1995 Data

[*fill in with conclusions and data table*]

Table 15. Duncan's multiple range test of the means for total Kjeldahl nitrogen (mg N/Kg) and total phosphate (mg P/Kg) in sediments from the Russian River. Means are in parentheses. Underlined means are not significantly different at the 95% confidence level; those not underlined are significantly different from the underlined means. Please refer to Table 1 for station codes.

TOTAL KJELDAHL NITROGEN

JB	AV	OF	CB	HMB	VB	WB	DM
(63)	(87)	(98)	(102)	(171)	(244)	(282)	(298)

TOTAL PHOSPHATE

WB	JB	HMB	DM	VB	AV	OF	CB
(250)	(257)	(261)	(261)	(276)	(281)	(318)	(340)

CONCLUSIONS

[*need more discussion and listing of conclusions*]

1985-86 Data
Organic chemicals
no detections

Metals
The only relationships observed were increased zinc at stations downstream of the urbanized areas in the Santa Rosa Plains.

Metals sediment concentrations were not higher downstream of the City of Santa Rosa's Laguna plant discharges, nor in the Russian River downstream of the Mark West Creek system: no effect of discharges on sediment metals concentrations.

Nutrients
No clear trends were observed from upstream of the City of Santa Rosa discharge points to downstream. Likewise no such trends were observed in the Russian River from upstream of the Mark West Creek system to downstream of that influence.

1995 Data

Discussion of Conclusions
Differences in the analytical methods between the two samplings did not allow us to directly compare actual concentrations between 1985-86 and 1995 samplings. However, no significant trends were observed in the data from either the 1985-86 or 1995 samplings.

The discharges from the City of Santa Rosa's Laguna plant did not appear to cause higher sediment concentrations of organic chemicals, heavy metals, or nutrients. Urban runoff may account for slightly higher levels of zinc in sediments downstream of some urbanized areas.

Some of the differences seen between sites may be due to the sizes of the sediments. Smaller sediment sizes may not have been deposited at some sites, thus less opportunity for adsorbtion of contaminants. If that was the case (as observed in the 1995 sampling) then likewise there was little opportunity for effect: the smaller size of sediments that more readily adsorb contaminants were not present and thus aquatic organisms were not exposed to contaminants. Additionally, organic content and reduction/oxidation state of the sediments may affect adsorbtion. Percent organic content was measured in 1995.

Sampling and analytical methodologies changed. The 1985-86 sample treatments did not include sieving the sediments prior to analysis. Subsequent sampling should employ the same methods as in 1995, even if methods change in the interim. Sediment particle size analysis, redox potential, wet weight/dry weight ratios, and percent organic content should be measured.

Literature Cited

NCRWQCB. 1992. Final Report: Investigations for Nonpoint Source Pollutants in the Laguna de Santa Rosa, Sonoma County. California Regional Water Quality Control Board, North Coast Region, September 24, 1992.

To conserve paper, raw data appendices are not included at this time.

2/28/96

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