Santa Rosa Subregional Long-Term Wastewater Project

EVALUATION OF BIOACCUMULATION IN ORGANISMS EXPOSED TO RECLAIMED WATER FROM THE SANTA ROSA SUBREGIONAL WATER RECLAMATION SYSTEM

SANTA ROSA SUBREGIONAL LONG-TERM WASTEWATER PROJECT

Prepared for

City of Santa Rosa
and
U.S. Army Corps of Engineers

MAY 1996

Prepared by

Merritt Smith Consulting
Environmental Science and Communication
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and

Parsons Engineering-Science, Inc.
8000 Centre Park Dr. #200 Austin, TX 78754

For

HARLAND BARTHOLOMEW & ASSOCIATES, INC.

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AUTHORS

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1.0 SUMMARY

This technical report presents the 1994 Kelly Farm Demonstration Wetland (KFDW) bioaccumulation/ magnification information and evaluates these data, in comparison with previous KFDW bioaccumulation/magnification data and with reference studies. In addition, California State Mussel Watch Program (SMWP) and Toxic Substances Monitoring Program (TSMP) data are evaluated with regard to differences above and below Santa Rosa's reclaimed water discharge.

1.1 BIOACCUMULATION IN PLANT TISSUES AT KFDW

All metals present at detectable concentrations in KFDW sediments have substantially lower concentrations in rhizomes and seeds of the vegetation than in sediment, suggesting no unusual bioaccumulation. Concentrations of aluminum, arsenic, chromium, lead, and nickel in vegetation tissues were equivalent to less than 12 percent of their concentration in sediments. Reduced concentrations in vegetation relative to the sediments were also documented for copper, mercury, and zinc (less than 30 percent of the sediment concentration). Bioaccumulation (as indicated by the ratio of sediment to tissue concentration) of three other metals (cadmium, selenium, and silver) cannot be assessed because their concentrations in sediments were below analytical detection limits. Organics compounds were analyzed but not detected in sediment and plant tissues in the 1994 study.

1.2 BIOACCUMULATION IN ANIMAL TISSUES AT KFDW

The concentration of aluminum, arsenic, chromium, lead, and nickel was lower in animal tissues than in sediment at KFDW. The concentration of copper in mosquitofish tissues was less than in sediment, but a bioaccumulation factor (ratio of tissue to sediment concentration) of 3.5 was calculated for crayfish. Accumulation of copper in crayfish tissues can be expected because copper is a major component of the respiratory pigment hemocyanine of crustaceans. Bioaccumulation factors for zinc in crayfish and mercury in crayfish and mosquitofish ranged from 0.56 to 1.24, indicating that the concentrations of these metals in animal tissues and in sediments are similar. Zinc concentration in mosquitofish, however, was twice as high as that measured in sediments suggesting a possible accumulation, or concentration from water, in fish tissues. Like copper, zinc is a micronutrient that is required by fish for proper metabolism. Organics compounds were analyzed but not detected in sediment and animal tissues in the 1994 study.

1.3 COMPARISON OF KFDW DATA FROM 1991 AND 1994

The evaluation of data for plant and mosquitofish tissue and sediments collected from KFDW in August 1994 in comparison to samples collected in KFDW in 1991 was limited to metals because organic compounds (including pesticides and PCBs) were not present at

detectable concentrations in mosquitofish and sediments in both studies. Organic compounds were not analyzed in plant tissue in the 1991 study. Five metals had reduced concentrations in 1994 relative to the 1991 data, both in sediments and in wetland vegetation: aluminum, chromium, lead, nickel, and zinc. Increases in metals content of the sediments in 1994 relative to 1991 were documented for arsenic and mercury. However, the average concentration of these metals in Santa Rosa's reclaimed water was the same or slightly lower in 1994 than in 1991. If the concentrations of metals in sediments in 1991 had reached equilibrium with reclaimed water, this would indicate the sediment increases were not due to increases in these metals in reclaimed water discharge. If the metals in sediment had not reached equilibrium with reclaimed water in 1991, the increase may be due to continued loading from reclaimed water.

1.4 EVALUATION OF BIOACCUMULATION AT KFDW

Sediments of Kelly Farm had similar or lower concentrations of metals relative to comparable reference sites. Bioaccumulation factors for those metals in vegetation were generally similar or lower at KFDW than at reference sites. KFDW faunal tissue concentrations of five out of six metals evaluated for potential bioaccumulation (aluminum, arsenic, cadmium, lead, and zinc) were similar, or lower, than concentrations reported for the Clark Fork River reference site where benthic organisms are exposed to sediments with low metals content.

Potential adverse effects of metals from Kelly Farm sediments on aquatic organisms were evaluated by the use of benchmark values for assessment of ecological risk. No significant risks for adverse effects on vegetation and aquatic fauna from exposure to Kelly Farm sediments were identified.

Toxicological benchmarks for food intake were used to evaluate the risks for adverse effects on terrestrial fauna from ingestion of Kelly Farm wetland vegetation and aquatic organisms. Based on available benchmarks for food ingestion, metals concentrations in vegetation and aquatic organisms of the Kelly Farm wetlands are considered to pose no significant potential risk for effects on terrestrial wildlife. A more extensive analysis of potential risk of reclaimed water to aquatic and terrestrial wildlife is presented in the *Ecological Risk Assessment* Technical Report (Parsons ES 1996).

1.5 STATE MUSSEL WATCH PROGRAM RESULTS

Average concentrations of trace elements in SMWP clam tissues were very similar above and below the discharge and were similar to the concentrations in control clams. However, there was high variability between stations within years. There was no discernible pattern of increased tissue concentration of metals below Santa Rosa's reclaimed water discharge relative to above the discharge.

Total benzenehexachloride (BHC) (alpha and gamma only, beta and delta BHC were below detection) in SMWP clam tissue was found in elevated concentrations below the discharge (Laguna at Wohler Bridge) during 1990-1992 but total BHC was below detection in clams 1993 and 1994. However, elevated total BHC in clams did not coincide with elevated BHC in reclaimed water. Since the clams are deployed for only about three months, the elevated BHC levels are not likely due to a lagged effect of reclaimed water. The lack of a relationship between concentration in reclaimed water discharge and concentration in clam tissues indicates another source of BHC may be present in the Laguna watershed. A likely source is from pesticide application. The remaining organic compounds found in detectable concentrations in clams were either similar or lower below the discharge or showed no regular pattern above versus below the discharge.

1.6 TOXIC SUBSTANCE MONITORING PROGRAM RESULTS

The only TSMP data available for comparisons of trace elements and organic compounds in tissue above and below Santa Rosa's discharge are on one date from the Russian River at Wohler Bridge, the Laguna at Stony Point, and Santa Rosa Creek at Willowside (all above the confluence with the Laguna) and the Russian River at Hacienda Bridge (below the confluence) in 1987. These values are shown in bold in Tables 26 and 27. The data from all other stations are for different species above and below the discharge. Concentrations of trace metals in tissues were very similar in above and below the discharge with the possible exception of lead which ranged from below detection to 0.1 mg/L above the discharge and was 0.2 mg/L below the discharge. Only one organic compound, total DDT, was detectable in tissues below the discharge and it was found in the same concentration as two of the three stations above the discharge.

2.0 INTRODUCTION

The discharge of reclaimed water to surface water has the potential to cause accumulation of water quality constituents in biota of the receiving water environment. The purpose of this technical report is to summarize information that characterizes the potential for bioaccumulation of reclaimed water constituents. This report is intended to provide a basis for the wildlife risk assessment (see *Ecological Risk Assessment T*echnical Report, Parsons ES 1996). This technical report is based on data from the Kelly Farm Demonstration Wetland (KFDW) which was created to determine how best to develop enhancement wetlands to provide wildlife and reclaimed water polishing benefits using reclaimed water produced by Santa Rosa Subregional Water Reclamation System. An assessment of the concentrations of those contaminants that may accumulate directly in wetland ecosystem components (bioaccumulation) or indirectly through food consumption (biomagnification) is an integral measure of the potential effects of reclaimed water discharge on the receiving water environment, whether it be the Russian River, Laguna de Santa Rosa or another wetland.

The first step in an assessment of bioaccumulation and biomagnification into the food chain was made in early 1991 by analyzing freshwater clams (*Corbicula* sp.) that had been deployed in KFDW for about three months. In addition, samples of sediments, plants, invertebrates, and fish were collected in 1991 and analyzed for trace elements and organochlorine compounds (CH_2M Hill, et al. 1992). Further investigation of bioaccumulation/magnification in the food chain in KFDW was conducted during August 1994, four years after the ponds were constructed. This technical report presents the 1994 KFDW bioaccumulation/magnification information and evaluates these data, in comparison with previous KFDW bioaccumulation/magnification data and with reference studies. In addition, California State Mussel Watch Program (SMWP) and Toxic Substances Monitoring Program (TSMP) data are evaluated with regard to differences above and below Santa Rosa's reclaimed water discharge. This document provides information on the following:

- Description of KFDW
- Bioaccumulation/magnification monitoring plan
- Bioaccumulation/magnification monitoring results at KFDW
- Comparison of 1994 bioaccumulation/magnification results with 1991 bioaccumulation/magnification results
- An evaluation of bioaccumulation in KFDW vegetation and fauna
- A comparison of the KFDW bioaccumulation results with reference studies
- SMWP and TSMP data

3.0 DESCRIPTION OF FACILITY

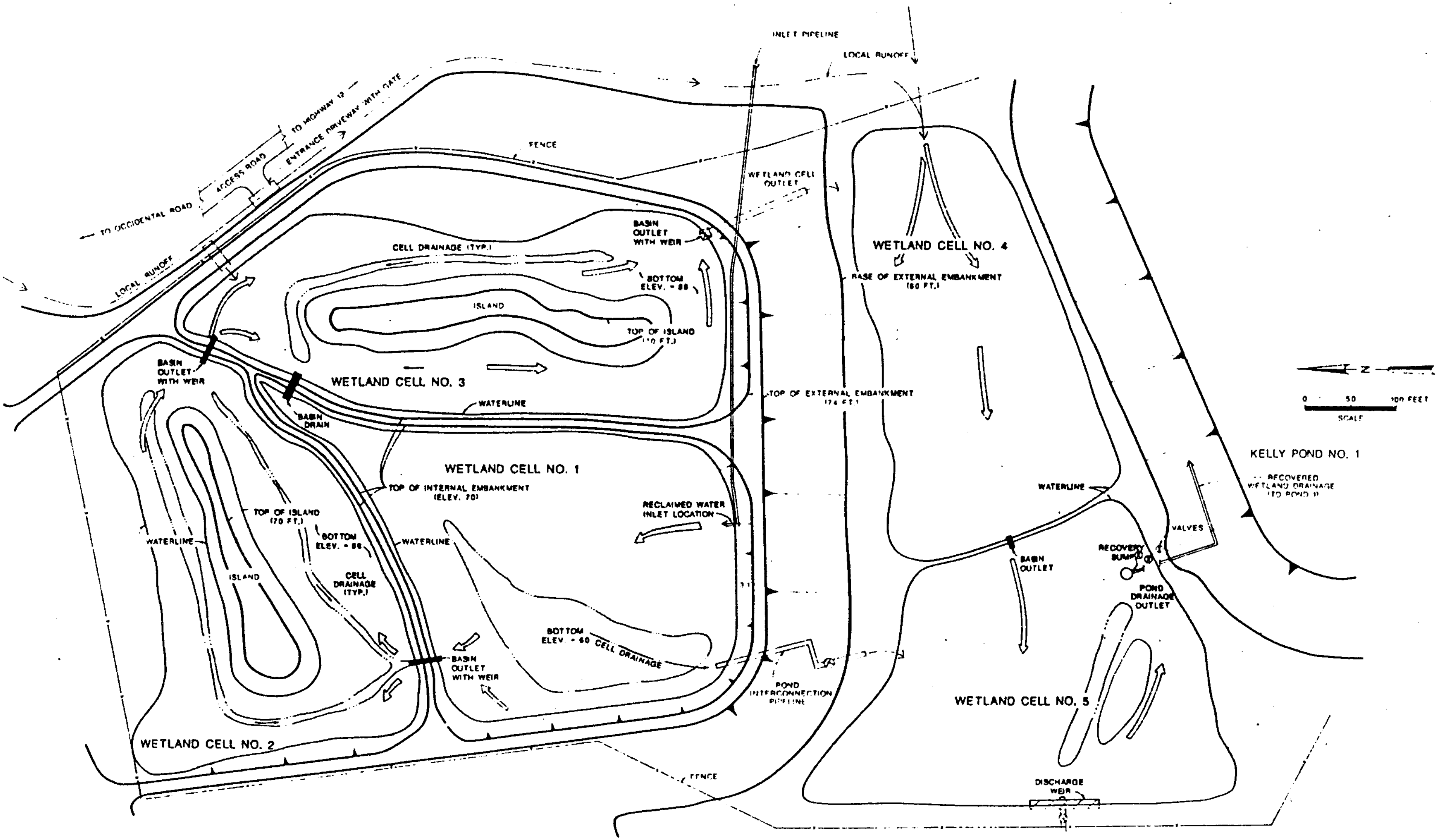
3.1 PROJECT LOCATION

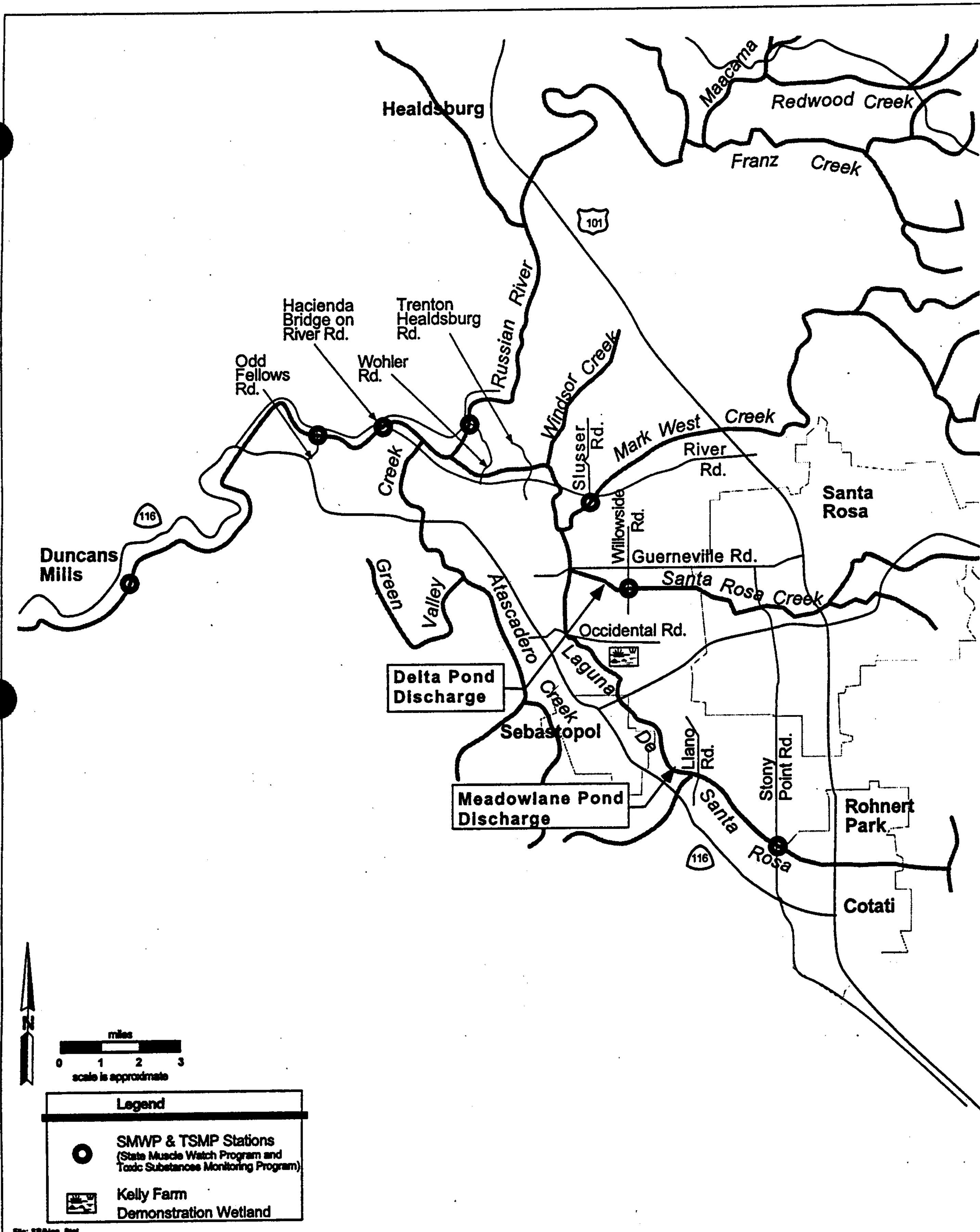
The KFDW is located on Kelly Farm, which is owned by the Santa Rosa Subregional System. The water supply for the KFDW is the reclaimed water from the Santa Rosa Subregional Water Reclamation System on Llano Road. This study was conducted in Cell 3, the third cell in a series of five connected cells (Figure 1). At the time this study was designed, wetland creation was potentially part of the Project description. Cell 3 was selected for the study because it is most similar to the type of wetland that would have been created for the Project. Kelly Farm is located between Santa Rosa and Sebastopol, near the Laguna de Santa Rosa (Figure 2).

3.2 HABITAT DESCRIPTION

KFDW is a “palustrine” wetland which is characterized by emergent wetland plants and open water areas that are less than 20 acres and not more than 6 feet deep at low water. Vegetation currently covers approximately 90 percent of Cell 3. Vegetation in Cell 3 is dominated by stands of bulrush (*Scirpus californicus*) with some cattails (*Typha latifolia*) also present.

Figure 1. Kelly Farm Demonstration Wetland





Santa Rosa
Subregional Long-Term Wastewater Project

Kelly Farm Demonstration Wetland and SMWP and TSMP Stations

Figure 2

4.0 MONITORING PLAN

A field sampling and quality assurance project plan was developed prior to implementation of sampling. This plan is included in Appendix 1.

Samples were collected from the Kelly Farm Demonstration Wetland Cell 3 during August 1994. The sample collection plan is described in Table 1. Samples of sediment, bulrush seeds, cattail rhizomes, crayfish, and mosquitofish were collected.

4.1 SEDIMENT SAMPLING

Three to four composite sediment samples were collected to analyze for the constituents shown in Table 1. The dense nature of the vegetation in Cell 3 prevented the use of standard sampling devices so repeated grabs of sediment were collected by gloved hand. Samples from the top 2-3 inches of sediment were collected. Every effort was made during sample collection to preclude contamination and cross-contamination of the samples. Each sample was composed of 5 subsamples taken from widely spaced locations throughout the pond. Sediment sampling was done prior to biological sampling and shore subsamples were collected prior to offshore samples to minimize disturbance to the sediment. Sediment samples were placed into glass jars which were then put into an ice chest and cooled to 4°C.

Table 1.

Sample Collection Plan

Tissue	# Samples	Constituent
Sediment	4 composite	moisture, pH, TOC, Al, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Zn, organochlorine pesticides and PCBs, organophosphorus pesticides, herbicides, acid volatile sulfides
Bulrush seeds	3 composite	moisture, lipids, Al, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Zn, organochlorine pesticides and PCBs, organophosphorus pesticides, herbicides
Cattail rhizomes	3 composite	moisture, lipids, Al, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Zn, organochlorine pesticides and PCBs, organophosphorus pesticides, herbicides
Crayfish	3 composite	moisture, lipids, Al, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Zn, organochlorine pesticides and PCBs, organophosphorus pesticides, herbicides
Mosquitofish	4 composite	moisture, lipids, Al, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Zn, organochlorine pesticides and PCBs, organophosphorus pesticides, herbicides

4.2 Biological Sampling

Triplicate or quadruplicate composite samples of four tissue types as shown in Table 1 were collected. Each sample was composed of 3 to 5 subsamples taken from widely spaced locations throughout cell 3. Every effort was made to preclude contamination and cross-contamination of the samples during sample collection. Bulrush seeds, cattail rhizomes, and mosquito fish samples were placed in glass jars. Crayfish were wrapped in aluminum foil and then placed in Ziploc bags. All biological samples were then placed in an ice chest with dry ice and frozen. Wrapping large organisms in aluminum foil prior to freezing is part of EPA’s fish sampling protocol and the laboratory has empirical data to indicate there is no problem with metals contamination using this method (pers. comm. Jim Nettum, Hazleton Environmental Services to M. Commins 21 May 1996).

For all biological samples, the entire sample was analyzed. For mosquito fish and crayfish, the contents of the guts were analyzed as well as tissue, which may have resulted in an increase in some constituents due to the fraction that was in the guts and not actually incorporated into tissue. Crayfish may store metals in the exoskeleton and get rid of them when they molt. Thus, the metals in crayfish may be overestimated. Since several crayfish were composited for analysis, the stage of the molt would be averaged (i.e. crayfish not all in a very early or very late molting stage). Aluminum in particular may be overestimated in crayfish because aluminum is a primary component of sediment, and the crayfish guts were not depurated prior to analysis.

A numerical simulation study conducted by the United States Environmental Protection Agency (EPA) evaluated the effects of composite sampling on the statistical power of a sampling design. This study indicated that the increase in the number of subsamples in the composite sample will l) increase the confidence in the estimate of mean values, and 2) increases the probability of detecting differences among mean values of multiple sampling sites. For the collection of five composite samples from five sampling sites, the EPA study concluded that three to thirty subsamples were required to obtain a minimum detectable difference equivalent to the overall mean value. This range of values was dependent on the variability of the data, an unknown parameter at KFDW. Assuming that data variability in the survey locations falls within the intermediate range evaluated by the EPA study (coefficient of variation = 101.6 percent), a number of organisms from three to five per composite sample will yield a 55 to 70 percent probability of statistically detecting differences equal to the overall mean among sampling sites. This was the basis for collecting three to five subsamples per sample for this study.

4.3 Ecological Risk Analysis

Risk assessment methods recommended by the EPA (1989, 1992) were used to evaluate bioaccumulation potential and ecological risks to vegetation, aquatic organisms, and terrestrial wildlife from contaminants in Kelly Farm wetlands sediments.

4.3.1 Bioaccumulation

Potential bioaccumulation of contaminants in organisms tissues from sediments was evaluated from collected samples of cattail rhizomes, bulrush seeds, crayfish, and mosquitofish. As an initial screening tool, a bioaccumulation factor was calculated as the ratio of concentration in organism tissues to the concentration in sediments. In a long-term exposure, bioaccumulation factors below a value of 1.0 are indicative of low or no potential for accumulation of a particular compound in organism tissues. Tissue concentrations greater than those in the sediments, or any other exposure media, indicate potential increases of the compound along the food chain (bioaccumulation factors greater than 1.0). A more extensive evaluation of bioaccumulation impacts is described in *Ecological Risk Assessment T*echnical Report (Parsons ES 1996).

4.3.2 Exposure Pathways and Receptors

Surface water and sediments may function as direct or indirect pathways of exposure of aquatic and terrestrial organisms (ecological receptors) to contaminants. Domestic and wildlife species typically obtain drinking water from creeks, ponds, and other surface water sources. Contaminants dissolved in surface water may also affect plants such as wetland vegetation, fish and other aquatic organisms. Aquatic plants and invertebrates are directly exposed to contaminants in sediments, and serve as an indirect pathway for exposure of birds and wildlife.

Potential ecological receptors at the site include organisms representative of wetland vegetation (cattails and bulrushes), aquatic organisms (crayfish and mosquitofish), and wildlife closely-associated with aquatic environments (mallard duck, heron, otter, and mink).

4.3.3 Benchmark Values

Benchmark values were used as the ecological effects endpoints for the risk assessment. Benchmarks identify contaminant concentrations above which adverse effects on organisms are likely to occur. These benchmarks were obtained from toxicological studies documenting lethal and sublethal effects of potential contaminants on test organisms in experimental conditions. Benchmark values are further developed in the *Ecological Risk Assessment T*echnical Report (Parsons ES 1996).

Benchmarks for sediments. Due to the lack of federal criteria for sediment quality, the apparent effects thresholds were used as the benchmarks for potential effects of sediment-sorbed contaminants on aquatic organisms. These benchmarks have been summarized by the National Oceanic and Atmospheric Administration (NOAA 1994).

Benchmark levels for terrestrial plants. Benchmark levels for effects on terrestrial plants were obtained from soil remediation criteria for parkland and residential use, as derived by the Canadian Council of Ministers of the Environment (CCME 1991).

Benchmark levels for terrestrial wildlife. Results of toxicological studies documenting potential effects on mammals and birds were used for development of benchmark values for food ingestion (Table 2). Toxicological data are typically reported as a dose per unit weight of the test organism.

Experimental doses resulting in a no-observed-effect level (NOEL) in laboratory conditions were used as the benchmark for each compound. When NOEL data were unavailable, an extrapolation was made from the reported lowest-observed-effect level (LOEL). The extrapolation used factors ranging from 5 to 100, depending on the exposure duration (chronic, subchronic, or acute exposures), and the reported effect (NOEL, LOEL, or lethal concentration). This approach is considered to be extremely conservative, and the rationale for derivation of extrapolation factors is described by Ford et al. (1992).

4.3.4 Risk Assessment Procedures

The risk for adverse effects on organisms was quantified using the ratio between the exposure concentration (concentration in food source), and the selected benchmark value (E/B ratio). The use of E/B ratios is a semi-quantitative approach to measure the degree of potential risk for adverse effects on receptor organisms. This is a very conservative approach, as described in *Ecological Risk Assessment* Technical Report (Parsons ES 1996). According to guidelines proposed by Menzie et. al (1993), E/B ratios less than or equal to 1.0 identify a minimal or no probable risk for effects on organisms; ratios from 1.0 and 10.0 identify a moderate potential risk; and ratios greater than 10.0 indicate significant potential for effects.

For the calculation of the E/B ratio, benchmarks presented as a dose per unit weight were converted to a dietary concentration assuming a food intake rate of 20 percent of the organism body weight per day. This ingestion rate is typical of several small mammals and ducks (EPA 1993,*Ecological Risk Assessment*Technical Report, Parsons ES 1996).

Table 2.

Benchmarks for Dietary Intake of Metals by Mammals and Birds

	Experimental Dose [a] (mg / kg bw / day)	Test Species	Type of Exposure	Observed Effect	Extrapolation Factor [b]	Benchmark Value (mg / kg bw / day) [c]
Mammals						
Antimony	1.25	Mouse	Chronic	Lowest effect level	5	0.25
Arsenic	5.1	Mouse	Chronic	Lowest effect level	5	1.02
Barium	5.06	Rat	Chronic	No effect level	1	5.06
Beryllium	0.66	Rat	Chronic	No effect level	1	0.66
Cadmium	2.52	Mouse	Chronic	Lowest effect level	5	0.50
Chromium III	4000	Rat	Chronic	No effect level	1	4,000
Chromium VI	3.28	Rat	Chronic	No effect level	1	3.28
Copper	11.7	Mink	Chronic	No effect level	1	11.7
Lead - inorganic	8	Rat	Chronic	No effect level	1	8.00
Lithium	9.39	Rat	Chronic	No effect level	1	9.39
Manganese	88	Rat	Chronic	No effect level	1	88
Mercury - inorganic	13.2	Mouse	Chronic	No effect level	1	13.2
Mercury - methyl	0.032	Rat	Chronic	No effect level	1	0.032
Nickel	40	Rat	Chronic	No effect level	1	40
Selenium	0.75	Mouse	Chronic	Lowest effect level	10	0.075
Silver	50	Mouse	Acute	50% mortality	100	0.5
Strontium	263	Rat	Chronic	No effect level	1	263
Thallium	0.74	Rat	Subchronic	Lowest effect level	20	0.037
Vanadium	5	Rat	Chronic	No effect level	1	5
Zinc	160	Mouse	Chronic	No effect level	1	160

Table 2. cont.

Benchmarks for Dietary Intake of Metals by Mammals and Birds

	Experimental Dose [a] (mg/kg bw/day)	Test Species	Type of Exposure	Observed Effect	Extrapola-tion Factor [b]	Benchmark Value (mg/kg bw/day) [c]
Birds						
Arsenic	100	Mallard duck	Chronic	No effect level	1	100
Barium	208	Chicken	Subchronic	No effect level	10	20.8
Cadmium	1.45	Mallard duck	Chronic	No effect level	1	1.45
Chromium III	1	Black duck	Chronic	No effect level	1	1
Copper	33.2	Chicken	Chronic	No effect level	1	33.2
Lead - inorganic	3.85	American kestrel	Chronic	No effect level	1	3.85
Mercury - methyl	0.064	Mallard duck	Chronic	Lowest effect level	5	0.013
Nickel	77.4	Mallard duck	Chronic	No effect level	1	77.4
Selenium	0.4	Mallard duck	Chronic	No effect level	1	0.4
Silver	50	Mouse	Acute	50% mortality	100	0.5
Vanadium	11.4	Mallard duck	Chronic	No effect level	1	11.4
Zinc	300	Mallard duck	Subchronic	Lowest effect level	20	15

[a] Daily dose in mg of the element per kg body weight. Data from multiple sources summarized by Opresko et al. 1994. Silver data from Sax 1984.

[b] Extrapolation factors from Ford et al. 1992.

[c] Benchmarks are calculated as the experimental dose divided by an extrapolation factor to obtain a no-effect concentration.

5.0 MONITORING RESULTS

The results of the 1994 field collection as averages of replicates are presented in this section. Raw (unaveraged) data are presented in Appendix 2. QA/QC information is presented in Appendix 3.

5.1 TRACE ELEMENTS

The average dry weight concentration of trace elements (metals and metalloids) in KFDW sediment and tissues are shown in Table 3. Table 3 also shows the average concentrations of these metals in Santa Rosa Treatment Plant reclaimed water between 1991 and 1994.

The highest tissue concentrations of aluminum, arsenic, cadmium, chromium, mercury, selenium, silver, and zinc were found in mosquitofish. Crayfish contained the highest concentrations of copper, and cattail rhizomes contained the highest concentrations of lead and nickel. Mosquitofish prey items were not analyzed since sufficient biomass could not be collected.

Table 3.

Average[a] dry weight concentration of trace elements in Kelly Farm tissues and sediment in the 1994 study and average concentration of trace elements in Santa Rosa reclaimed water between 1991 and 1994 (ppm)

	Cattail rhizomes	Crayfish	Mosquito-fish	Bulrush seeds	Sediment	Reclaimed water
Aluminum	1183[b]	449	1232	35.4	18500	0.024
Arsenic	0.30	0.77	0.325	0.063[c]	3.38	0.0020
Cadmium	0.20[c]	0.15[c]	0.26[c]	0.063[c]	0.345[c]	0.0017
Chromium	4.09	1.88	4.9375	0.30	63.5	0.0026
Copper	7.38	85.7	6.79	4.35	24.6	0.011
Lead	1.24	0.94	1.06	0.27	11.1	0.015
Mercury	0.040[c]	0.05	0.11	0.017	0.089	0.0008
Nickel	7.10	4.49	4.86	3.56	97.1	0.0064
Selenium	0.40[c]	0.59	0.84	0.2	0.675[c]	0.0010
Silver	0.92	0.596	1.36	0.804	3.32[c]	0.0012
Zinc	15.4	62.2	142.25	4.97	63.8	0.024

a For concentrations below the reporting limit, the reporting limit was used in averages
b Large value possibly due to outlier.
c All replicates were below the reporting limit. Values shown are the average reporting limit.

5.2 ORGANIC COMPOUNDS

The concentrations of all organic compounds that were analyzed in all tissue and sediment samples were below the reporting limit. The organic compounds analyzed and their reporting limits are shown in Table 4. Reporting limits for each compound were the same for all tissue replicates. The values shown for sediment are the average reporting limit for each compound.

Table 4.

Organic compounds analyzed in Kelly Farm tissue and sediment samples All organics were below the reporting limits. Shown are the reporting limits (ppb dry weight)

Constituent	Cattail Rhizomes	Crayfish	Mosquito-fish	Bulrush Seeds	Sediment
Percent Moisture	75.3	46.5	80.9	23.1	41.95
Percent Lipid	0.143	1.06	2.93	0.725	
Herbicides					
2,4-D	<100	<100	<100	<100	<172.5
2,4,5-TP	<20	<20	<20	<20	<34.5
2,4,5-T	<20	<20	<20	<20	<34.5
Organophosphorous Pesticides					
Azinphos methyl	<8	<8	<8	<8	<5.7
Bolstar	<5.6	<5.6	<5.6	<5.6	<3.975
Chloropyrifos	<8	<8	<8	<8	<5.7
Coumaphos	<16	<16	<16	<16	<11.5
Demeton, O,S	<9.6	<9.6	<9.6	<9.6	<6.925
Diazinon	<16	<16	<16	<16	<16.25
Diclorovos	<64	<64	<64	<64	<46.75
Dimethoate	<21	<21	<21	<21	<15.25
Disulfoton	<5.6	<5.6	<5.6	<5.6	<3.975
EPN	<3.2	<3.2	<3.2	<3.2	<2.275
Ethoprop	<16	<16	<16	<16	<11.5
Fensulfothion	<6.4	<6.4	<6.4	<6.4	<4.675
Fenthion	<8	<8	<8	<8	<5.7
Malathion	<8.8	<8.8	<8.8	<8.8	<6.425
Merphos	<16	<16	<16	<16	<11.5
Mevinphos	<40	<40	<40	<40	<29.25

Table 4.

Organic compounds analyzed in Kelly Farm tissue and sediment samplesAll organics were below the reporting limits. Shown are the reporting limits (ppb dry weight)

Constituent	Cattail Rhizomes	Crayfish	Mosquito-fish	Bulrush Seeds	Sediment
Naled	<40	<40	<40	<40	<29.25
Ethyl parathion	<4.8	<4.8	<4.8	<4.8	<3.45
Methyl parathion	<9.6	<9.6	<9.6	<9.6	<6.925
Phorate	<3.2	<3.2	<3.2	<3.2	<2.275
Ronnel	<5.6	<5.6	<5.6	<5.6	<3.975
Sulfotep	<5.6	<5.6	<5.6	<5.6	<3.975
Tepp	<64	<64	<64	<64	<46.75
Stirophos	<64	<64	<64	<64	<46.75
Tokuthion	<8.8	<8.8	<8.8	<8.8	<6.425
Trichloronate	<64	<64	<64	<64	<46.75
Monocrotophos	<16	<16	<16	<16	<86.75
Organochlorine Pesticides and PCBs					
Gamma-BHC (Lindane)	<8	<8	<8	<8	<2.925
Heptachlor	<8	<8	<8	<8	<2.925
Aldrin	<8	<8	<8	<8	<2.925
Heptachlor epoxide	<8	<8	<8	<8	<2.925
Endosulfan I	<8	<8	<8	<8	<2.925
Dieldrin	<8	<8	<8	<8	<5.7
Endosulfan II	<8	<8	<8	<8	<5.7
4,4'-DDT	<8	<8	<8	<8	<5.7
Alpha-BHC	<8	<8	<8	<8	<2.925
Beta-BHC	<8	<8	<8	<8	<2.925
Delta-BHC	<8	<8	<8	<8	<2.925
Gamma-chlordane	<8	<8	<8	<8	<2.925
Alpha-chlordane	<8	<8	<8	<8	<2.925
4,4'-DDE	<8	<8	<8	<8	<5.7
Endrin	<8	<8	<8	<8	<5.7
4,4'-DDD	<8	<8	<8	<8	<5.7
Endosulfan sulfate	<8	<8	<8	<8	<5.7
Endrin aldehyde	<8	<8	<8	<8	<5.7
Toxaphene	<40	<40	<40	<40	<292.5

Table 4.

Organic compounds analyzed in Kelly Farm tissue and sediment samples All organics were below the reporting limits. Shown are the reporting limits (ppb dry weight)

Constituent	Cattail Rhizomes	Crayfish	Mosquito-fish	Bulrush Seeds	Sediment
Aroclor 1016	<40	<40	<40	<40	<44.63
Aroclor 1221	<40	<40	<40	<40	<115
Aroclor 1232	<40	<40	<40	<40	<57
Aroclor 1242	<40	<40	<40	<40	<57
Aroclor 1248	<40	<40	<40	<40	<57
Aroclor 1254	<40	<40	<40	<40	<57
Aroclor 1260	<40	<40	<40	<40	<57
Methoxychlor					<29.25
Endrin ketone					<5.7
Total organic carbon (ppm)					5862.5
pH					8.38
Acid volatile sulfide (ppm)					168.4

6.0 COMPARISON OF 1994 RESULTS WITH 1991 RESULTS

In this section the results of the 1994 bioaccumulation/magnification KFDW study are compared to the results obtained in the 1991 KFDW study. Replicate samples were taken in 1994 but not in 1991 so assessment of changes in concentrations cannot be evaluated statistically.

6.1 TRACE ELEMENTS

The concentrations of trace elements in KFDW tissues and sediment in the 1991 and the 1994 studies are presented in Tables 5 through 15.

6.1.1 Aluminum

Table 5.

Concentration (ppm dry weight) of aluminum in KFDW tissue and sediment

	1994		
Sample Type	**Mean[a]**	**Range**	**1991**
Cattail Rhizomes	1183	317-2420	2000
Bulrush Seeds	35.4	32.9-37	45.1
Crayfish	449	387-556	725
Mosquitofish	1232	626-1630	397
Sediment	18500	14400-20900	26200

[a] For concentrations below the reporting limit, the reporting limit was used for averages

Most tissue types and sediment show a decrease in aluminum concentration in 1994 with respect to the 1991 samples. The exception to this decrease in aluminum is in mosquitofish which greatly increased in aluminum concentration since 1991. The minimum value of aluminum in mosquitofish for any of the four replicate samples in 1994 was 626 ppm. This minimum is higher than the 1991 concentration of aluminum, indicating that the difference between years may be genuine.

6.1.2 Arsenic

Table 6.

Concentration (ppm dry weight) of arsenic in KFDW tissue and sediment

	1994		
Sample Type	**mean[a]**	**range**	**1991**
Cattail Rhizomes	0.30	0.19-0.48	<1.54
Bulrush Seeds	<0.063[b]	0.06-0.07	<0.35
Crayfish	0.77	0.30-1.71	<0.97
Mosquitofish	0.325	0.25-0.51	<0.85
Sediment	3.38	3.2-3.5	2.97

[a] For concentrations below the reporting limit, the reporting limit was used for averages

[b] All concentrations below the reporting limit, the value shown is the reporting limit

An increase in arsenic was found in the KFDW sediment from 1991 (2.97 ppm) to 1994 (3.38) ppm. The arsenic in the sediment in 1994 ranged from 3.2 to 3.5 ppm. Although in 1994 arsenic was detectable in at least one of the replicates for each of the tissue types, the average concentrations were less than the reporting limits for the 1991 samples.

6.1.3 Cadmium

Table 7.

Concentration (ppm dry weight) of cadmium in KFDW tissue and sediment

	1994		
Sample Type	**mean[a]**	**range**	**1991**
Cattail Rhizomes	<0.20[b]	0.19-0.22	<0.38
Bulrush Seeds	<0.063[b]	0.06-0.07	<0.09
Crayfish	<0.15[b]	0.14-0.15	<0.24
Mosquitofish	<0.26[b]	0.25-0.28	<0.21
Sediment	<0.34[b]	0.33-0.36	<0.12

[a] For concentrations below the reporting limit, the reporting limit was used for averages
[b] All concentrations below the reporting limit, the value shown is the reporting limit

KFDW tissue and sediment cadmium levels in 1991 and in all replicates in 1994 were below the reporting limits.

6.1.4 Chromium

Table 8.

Concentration (ppm dry weight) of chromium in KFDW tissue and sediment

	1994		
Sample Type	**mean[a]**	**range**	**1991**
Cattail Rhizomes	4.09	1.58-7.87	5.46
Bulrush Seeds	0.30	0.28-0.32	<0.87
Crayfish	1.88	1.73-2.14	<2.42
Mosquitofish	4.94	3.26-5.74	<2.14
Sediment	63.5	51.8-70.5	89.1

[a] For concentrations below the reporting limit, the reporting limit was used for averages

Most KFDW tissue types and sediment show a decrease in chromium concentration in 1994 with respect to the 1991 samples. For the tissues that chromium concentrations were below detection in 1991, the 1994 concentrations were below the 1991 reporting limit. The exception to the decrease in chromium is in mosquitofish which increased in chromium concentration from <2.14 ppm in 1991 to 4.94 ppm in 1994. The minimum value of chromium in mosquitofish for any of the four replicate samples in 1994 was 3.26 ppm. This minimum is higher than the 1991 concentration of chromium in mosquitofish, indicating that the difference between years may be genuine.

6.1.5 Copper

Table 9.

Concentration (ppm dry weight) of copper in KFDW tissue and sediment

	1994		
Sample Type	**mean[a]**	**range**	**1991**
Cattail Rhizomes	7.38	5.12-9.49	4.62
Bulrush Seeds	4.35	4.12-4.66	4.69
Crayfish	85.7	65.1-107	45.4
Mosquitofish	6.79	6.61-7.08	3.42
Sediment	24.6	24.3-27.7	42.1

[a] For concentrations below the reporting limit, the reporting limit was used for averages

Copper concentrations in most KFDW tissue types increased from 1991 to 1994 but decreased in bulrush seeds and in the KFDW sediment. In all cases, the 1991 concentrations were outside the ranges of the respective 1994 data, indicating that the differences may be genuine.

6.1.6 Lead

Table 10.

Concentration (ppm dry weight) of lead in KFDW tissue and sediment

	1994		
Sample Type	**mean[a]**	**range**	**1991**
Cattail Rhizomes	1.24	0.73-2.02	3.85
Bulrush Seeds	0.27	0.21-0.33	0.69
Crayfish	0.94	0.45-1.7	<0.48
Mosquitofish	1.06	0.73-1.42	<0.43
Sediment	11.1	10.3-12.1	13.6

[a] For concentrations below the reporting limit, the reporting limit was used for averages

Lead concentrations in cattail rhizomes, bulrush seeds, and sediment were lower in 1994 than in 1991. Lead concentrations in mosquitofish and crayfish tissues were higher in 1994 than in 1991. The 1991 values except for crayfish were outside the ranges of the 1994 data, indicating that the differences may be genuine.

6.1.6 Mercury

Table 11.

Concentration (ppm dry weight) of mercury in KFDW tissue and sediment

	1994		
Sample Type	**mean[a]**	**range**	**1991**
Cattail Rhizomes	<0.040[b]	0.038-0.041	<0.15
Bulrush Seeds	0.017	0.017-0.018	<0.03
Crayfish	0.05	0.035-0.069	0.11
Mosquitofish	0.11	0.099-0.11	0.27
Sediment	0.089	0.079-0.10	<0.05

a For concentrations below the reporting limit, the reporting limit was used for averages

b All concentrations below the reporting limit, the value shown is the reporting limit

Mercury concentrations in crayfish and mosquitofish tissues were lower in 1994 than the concentrations measured in 1991. Sediment concentrations of mercury were higher in 1994 than in 1991. Mercury is the only trace element (in detectable levels) that increased in KFDW sediment since 1991. Because the 1991 values for crayfish, mosquitofish, and sediment fall outside their respective ranges in 1994, the differences may be genuine.

6.1.8 Nickel

Table 12.

Concentration (ppm dry weight) of nickel in KFDW tissue and sediment

	1994		
Sample Type	**mean[a]**	**range**	**1991**
Cattail Rhizomes	7.10	3.33-12.3	22.3
Bulrush Seeds	3.56	3.12-4.28	3.65
Crayfish	4.49	2.47-8.48	14.5
Mosquitofish	4.86	2.96-5.96	7.26
Sediment	97.1	86.4-107	124

[a] For concentrations below the reporting limit, the reporting limit was used for averages

The average concentration of nickel was lower in the KFDW tissues and sediment examined in 1994 than was observed in 1991. The 1991 concentrations of nickel for sediment and all tissue types except bulrush seeds fell outside the range of the 1994 data, indicating that the differences may be genuine.

6.1.9 Selenium

Table 13.

Concentration (ppm dry weight) of selenium in KFDW tissue and sediment

	1994		
Sample Type	**mean[a]**	**range**	**1991**
Cattail Rhizomes	<0.40[b]	0.38-0.43	<1.54
Bulrush Seeds	0.20	0.13-0.34	<0.35
Crayfish	0.59	0.30-1.16	<0.97
Mosquitofish	0.84	0.51-1.76	<0.85
Sediment	<0.68[b]	0.6-0.7	<0.50

[a] For concentrations below the reporting limit, the reporting limit was used for averages
[b] All concentrations below the reporting limit, the value shown is the reporting limit

The concentration of selenium in KFDW sediment and tissues in 1994 cannot be directly compared to the 1991 data since the concentration of selenium in 1991 was below the reporting limits for all tissues and sediments. However, the 1994 detectable average concentrations did not exceed the 1991 detection limits.

6.1.10 Silver

Table 14.

Concentration (ppm dry weight) of silver in KFDW tissue and sediment

	1994		
Sample Type	**mean[a]**	**range**	**1991**
Cattail Rhizomes	0.92	0.43-1.36	<0.38
Bulrush Seeds	0.80	0.76-0.83	<0.09
Crayfish	0.60	0.29-1.04	0.29
Mosquitofish	1.36	0.50-1.74	<0.21
Sediment	<3.32[b]	3.15-3.57	0.59

[a] For concentrations below the reporting limit, the reporting limit was used for averages

[b] All concentrations below the reporting limit, the value shown is the reporting limit

The average concentrations of silver in all tissue types in 1994 were higher than the concentrations found in the 1991 study. The 1991 concentrations of silver in all tissue types except crayfish fell outside the range of the 1994 data, indicating that the differences may be genuine. The high reporting limit for the concentration of silver in the sediment in 1994 precludes any comparison with the 1991 sediment data.

6.1.11 Zinc

Table 15.

Concentration (ppm dry weight) of zinc in KFDW tissue and sediment

	1994		
Sample Type	**mean[a]**	**range**	**1991**
Cattail Rhizomes	15.4	10.5-18.8	41.5
Bulrush Seeds	4.97	4.74-5.17	10.2
Crayfish	62.2	61.1-63.4	91.8
Mosquitofish	142	138-150	128
Sediment	63.8	59.9-75.5	139

[a] For concentrations below the reporting limit, the reporting limit was used for averages

The concentrations of zinc in KFDW sediment and cattail rhizome, bulrush seed, and crayfish tissues were lower in 1994 than in 1991. The concentration of zinc in mosquitofish tissue was higher in 1994 than in 1991. Since the 1991 concentrations of zinc in sediment and all tissue types fell outside the respective ranges of the 1994 data, the differences may be genuine.

6.2 ORGANICS

Organochlorine pesticides analyzed in the 1991 study in mosquitofish and sediment were all below the reporting limit. All of the organics analyzed in the 1994 study were below the reporting limits. The reporting limits for organics in the 1994 study were lower than the reporting limits in the 1991 study (Table 16).

Table 16.

Organic substances analyzed in the 1991 and the 1994 studies. All organics were below the reporting limits. Shown are the reporting limits (ppb dry weight)

	Mosquitofish		Sediment	
Constituent	**1994**	**1991**	**1994**	**1991**
Chlordane	<8	<90	<2.9	<500
4,4'-DDD	<8	<40	<5.7	<250
4,4'-DDE	<8	<40	<5.7	<250
4,4'-DDT	<8	<40	<5.7	<250
Dieldrin	<8	<40	<5.7	<250
Lindane	<8	<40	<2.9	<20
PCBs	<40	<210	<57	<1240

6.3 SUMMARY OF 1991 AND 1994 COMPARISON

The evaluation of data for sediments collected from KFDW in August 1994 in comparison to 1991 data was limited to metals because organic compounds (including pesticides and PCBs) were not present at detectable concentrations. An identification of general trends in the metals concentrations was conducted by comparison of average values for 1994 to data from single measurements in 1991. This comparison is not conclusive since only single samples were collected and there may be high variability at the site, which is not adequately represented by a single sample.

Five metals had reduced concentrations in 1994 relative to the 1991 data, both in sediments and in wetland vegetation: aluminum, chromium, lead, nickel, and zinc (Table 17). The concentrations of aluminum, chromium, and lead were slightly higher in reclaimed water in 1994 than in 1991 and the concentration of nickel was only slightly lower in 1994 than in 1991. Therefore, changes in reclaimed water concentrations in aluminum, chromium, lead and nickel are unlikely to be the cause of the reduced concentrations in vegetation and sediments. The average concentration of zinc in reclaimed water was 48 percent lower in 1994 than in 1991. Although the higher average reclaimed water concentration of zinc in 1991 was due primarily to one particularly high value, it is possible that reductions in reclaimed water concentrations lead to a reduction in zinc in KFDW vegetation and sediments. Concentration reductions ranged from 18 percent to 54 percent for sediments, and from 2 percent to 68 percent for vegetation tissues. An average 42 percent concentration reduction in sediments was also observed for copper during the 1994 survey. The average concentration of copper in reclaimed water in

1994 was 15 percent lower than in 1991 (Table 18), but this change is probably too small to account for the change in copper in sediments. These changes do not appear to be related to changes in reclaimed water concentrations (Table 18).

Increases in metals content of the sediments in 1994 relative to 1991 were documented for arsenic and mercury. However, the average concentration of these metals in Santa Rosa's reclaimed water was the same or slightly lower in 1994 than in 1991 (Table 18). If the concentrations of metals in sediments in 1991 had reached equilibrium with reclaimed water, this would indicate the sediment increases were not due to increases in these metals in reclaimed water discharge. If the sediment content of the metals in 1991 had not yet reached equilibrium with reclaimed water, the increase may be due to increased loading from reclaimed water. The reclaimed water concentrations of these metals in the intervening years (1992 and 1993) were not appreciably different than 1991 and 1994 (Table 18). Changes in plant tissue content for these two metals could not be documented because their concentrations were below analytical detection limits. The 1994 data showed silver and copper as the only metals in plant tissue for which concentrations increased relative to 1991. The increase in silver and copper concentrations in plants is not likely due to changes in reclaimed water since the average concentrations of both copper and silver in reclaimed water were lower in 1994 than in 1991 (though only slightly for copper).

The increase in the aluminum concentration in mosquitofish in 1994 relative to 1991 may be due to the increase in the average concentration in aluminum in reclaimed water between 1991 and 1994. However, the increase in reclaimed water concentration was not reflected in sediments and vegetation which decreased between 1991 and 1994.

Table 17.

Concentration of Metals in Sediments and Organism Tissues of Kelly Farm Demonstration Wetlands

	Concentration in Sediments (mg/kg)	Tissue Concentration (mg/kg)			
		Wetland Vegetation		Aquatic Fauna	
		Cattail Rhizomes	**Bulrush Seeds**	**Crayfish**	**Mosquitofish**
Aluminum					
1994, average concentration[a]	18,500	1,183	35	449	1,232
1991, single sample[b]	26,200	2,000	45	725	397
Change relative to 1991	-29%	-41%	-22%	-38%	210%

Table 17. cont.

Concentration of Metals in Sediments and Organism Tissues of Kelly Farm Demonstration Wetlands

	Concentration in Sediments (mg/kg)	Tissue Concentration (mg/kg)			
		Wetland Vegetation		Aquatic Fauna	
		Cattail Rhizomes	Bulrush Seeds	Crayfish	Mosquitofish
Arsenic					
1994, average concentratio[na]	3.38	0.30	<0.06	0.77	0.33
1991, single sample[b]	2.97	<1.5	<0.35	<0.97	<0.85
Change relative to 1991	14%	-	-	-	-
Cadmium					
1994, average concentration[a]	<0.34	<0.20	<0.06	<0.15	<0.26
1991, single sample[b]	<0.12	<0.07	<0.09	<0.24	<0.21
Change relative to 1991	-	-	-	-	-
Chromium					
1994, average concentration[a]	63.5	4.09	0.30	1.88	4.94
1991, single sample[b]	89.1	5.46	<0.87	<2.42	<2.14
Change relative to 1991	-29%	-25%	-	-	Increased
Copper					
1994, average concentration[a]	24.6	7.38	4.35	85.7	6.79
1991, single sample[b]	42.1	4.62	4.69	45.4	3.42
Change relative to 1991	-42%	60%	-7%	89%	99%
Lead					
1994, average concentration[a]	11.1	1.24	0.27	0.94	1.06
1991, single sample[b]	13.6	3.85	0.69	<0.48	-0.43
Change relative to 1991	-18%	-68%	-61%	Increased	Increased

Table 17. cont.

Concentration of Metals in Sediments and Organism Tissues of Kelly Farm Demonstration Wetlands

	Concentration in Sediments (mg/kg)	Tissue Concentration (mg/kg)			
		Wetland Vegetation		Aquatic Fauna	
		Cattail Rhizomes	Bulrush Seeds	Crayfish	Mosquitofish
Mercury					
1994, average concentration[a]	0.089	<0.038	0.017	0.050	0.110
1991, single sample[b]	<0.050	<0.150	<0.03	0.110	0.270
Change relative to 1991	Increased	-	-	-55%	-59%
Nickel					
1994, average concentration[a]	97.1	7.1	3.6	4.5	4.9
1991, single sample[b]	124.0	22.3	3.7	14.5	7.3
Change relative to 1991	-22%	-68%	-2%	-69%	-33%
Selenium					
1994, average concentration[a]	<0.7	<0.38	0.20	0.59	0.84
1991, single sample[b]	<0.5	<1.54	<0.35	<0.97	<0.85
Change relative to 1991	-	-	-	-	-
Silver					
1994, average concentration[a]	<3.3	0.92	0.80	0.60	1.36
1991, single sample[b]	0.59	<0.38	<0.09	0.29	<0.21
Change relative to 1991	-	Increased	Increased	107%	-
Zinc					
1994, average concentration[a]	63.8	15.4	5.0	62.2	142.2
1991, single sample[b]	139.0	41.5	10.2	91.8	128.0
Change relative to 1991	-54%	-63%	-51%	-32%	11%

[a] Average of four composite samples of sediment and three composite samples of organisms collected in August 1994.
[b] Concentration for single grab sample collected in October 1991.

Table 18.

Average Concentration of trace elements (ppm) in reclaimed water[a]

Constituent	1991	1992	1993	1994
Aluminum	0.024	0.045	0.030	0.037
Arsenic	0.0030	0.0018	0.0019	0.0015
Cadmium	0.0005	0.0009	0.0011	0.0004
Chromium	0.0020	0.0028	0.0022	0.0021
Copper	0.014	0.013	0.011	0.012
Lead	0.0013	0.0085	0.0094	0.0024
Mercury	0.0004	0.0004	0.0004	0.0004
Nickel	0.0051	0.0045	0.0038	0.0049
Selenium	0.0005	0.0005	0.0005	0.0005
Silver	0.0012	0.0013	0.0009	0.0006
Zinc	0.042	0.028	0.020	0.022

[a] Averages were calculated using half the reporting limit for samples that were below detection.

A comparison of crayfish data showed that, similarly to sediments and vegetation, aluminum, nickel and zinc concentrations were lower in 1994 than in 1991 (32 to 69 percent reduction), while concentration increases were detected for silver and copper in 1994 (89 to 107 percent increase). Crayfish data differed from vegetation data in the decrease of mercury and increase of lead concentrations from 1991 to 1994. Temporal changes in the content of arsenic, cadmium, chromium, and selenium in crayfish tissues could not be documented because tissue concentrations reported in 1991 were below analytical detection limits (Table 17).

Temporal trends in metals concentration for mosquitofish largely mirrored those observed in crayfish tissues for mercury and nickel (lower concentrations in 1994 than in 1991), and for copper, lead, and silver (increased concentrations in 1994). Aluminum concentration in mosquitofish, unlike crayfish data, increased in 1994 relative to the previously collected data.

7.0 BIOACCUMULATION

7.1 WETLAND VEGETATION

No evidence of bioaccumulation of metals in tissues of Kelly Farm wetland vegetation was found in this study. All metals present at detectable concentrations in sediments have substantially lower concentrations in the vegetation, both in rhizomes and seeds (Table 19). Concentrations of aluminum, arsenic, chromium, lead, and nickel in vegetation tissues were equivalent to less than 12 percent of their concentration in sediments. Reduced concentrations in vegetation relative to the sediments were also documented for copper, mercury, and zinc (less than 30 percent of the sediment concentration). No data on bioaccumulation of three other metals (cadmium, selenium, and silver) are available because their concentrations in sediments were below analytical detection limits.

7.2 AQUATIC FAUNA

Similarly to wetland vegetation data, aquatic organisms tissues showed no evidence of bioaccumulation for aluminum, arsenic, chromium, lead, and nickel. Average concentrations of these five metals in crayfish and mosquitofish samples were less than 30 percent of the concentrations detected in sediments (Table 19).

The concentration of copper in mosquitofish tissues was less than in sediment, but a bioaccumulation factor of 3.5 was calculated for crayfish (Table 19). Accumulation of this metal in crayfish tissues can be expected because copper is a major component of the respiratory pigment hemocyanine of crustaceans, therefore this metal can be expected to be actively accumulated and regulated by these and many other organisms for their benefit.

Bioaccumulation factors for zinc in crayfish and mercury in crayfish and mosquitofish ranged from 0.56 to 1.24, indicating that the concentrations of these metals in animal tissues and in sediments are similar. Zinc concentration in mosquitofish, however, was twice as high as that measured in sediments suggesting a possible accumulation, or concentration from water, in fish tissues. However, zinc is an essential micronutrients in the metabolism of fish. The typical concentration of zinc in prepared fish food is 100,000 ppb. The potential effect of zinc on aquatic and terrestrial life is explored further in the *Ecological Risk Assessment* Technical Report (Parsons ES 1996).

Table 19.

Potential Bioaccumulation of Metals in Organism Tissues Of Kelly Farm Demonstration Wetlands

	Concentration in Sediments (mg/kg)	Ratio of Tissue Concentration to Sediment Concentration[a]				Tissue Concentration (mg/kg)			
		Cattail Rhizomes	Bulrush Seeds	Crayfish	Mosquitofish	Cattail Rhizomes	Bulrush Seeds	Crayfish	Mosquitofish
Aluminum	18,500	0.06	< 0.01	0.02	0.07	1,183	35	449	1,232
Arsenic	3.38	0.09	< 0.02	0.23	0.10	0.30	< 0.06	0.77	0.33
Cadmium	< 0.36	-	-	-	-	< 0.22	< 0.06	< 0.15	< 0.28
Chromium	63.5	0.06	< 0.01	0.03	0.08	4.09	0.30	1.88	4.94
Copper	24.6	0.30	0.18	3.48	0.28	7.38	4.35	85.7	6.79
Lead	11.1	0.11	< 0.01	0.08	0.10	1.24	0.03	0.94	1.06
Mercury	0.089	-	0.19	0.56	1.24	< 0.038	0.017	0.050	0.110
Nickel	97.1	0.07	0.04	0.05	0.05	7.1	3.6	4.5	4.9
Selenium	< 0.7	-	-	-	> 1.0	< 0.38	0.20	0.59	0.84
Silver	< 3.6	-	-	-	-	0.92	0.80	0.60	1.36
Zinc	63.8	0.24	0.08	0.97	2.23	15.4	5.0	62.2	142.2

[a] Ratio of average concentration in tissues (3 replicates) relative to the average concentration in sediments (4 replicates). Data for cadmium, selenium, and silver are unavailable (sediment concentrations below analytical detection limits).

8.0 COMPARISON TO REFERENCE STUDIES

8.1 WETLAND STUDIES

8.1.1 Wetland Vegetation

Two recent wetlands studies were used to evaluate concentration levels of metals in sediments and vegetation of the Kelly Farm wetland demonstration project. The first study analyzed the content of copper, lead, and zinc in sediments and vegetation of Crandall Creek marsh in Fremont, California (Demgen 1993). The 55-acre constructed marsh is a demonstration project for the treatment of contaminated urban runoff. The second study, conducted in the Milltown Reservoir in western Montana, evaluated the content of five metals (arsenic, cadmium, copper, lead, and zinc) in soils and vegetation of wetlands receiving metal-contaminated sediments from a mining district (Linder et al. 1994). Data for the two reference studies are summarized in Table 20. Sediments of Kelly Farm and Crandall Creek marsh had similar concentrations of copper, lead, and zinc, and comparable bioaccumulation factors for those metals in roots and rhizomes of vegetation (Table 20). In both wetlands, metals concentrations in plant tissues were less than 41 percent of those detected in the sediments.

Compared to the Milltown Reservoir wetlands, Kelly Farm wetlands had lower concentrations of arsenic, cadmium, copper, lead, and zinc, both in sediments and organism tissues (Table 20). Bioaccumulation factors (except for zinc) were also lower at Kelly Farm, which had values from 0.09 to 0.61. At Milltown Reservoir, the vegetation content of cadmium and lead was similar or exceeded the concentration measured in the sediments. At Milltown Reservoir, zinc levels in vegetation were very elevated relative to Kelly Farm, but the bioaccumulation factor was low due to the high concentration of the metal sediments of the Milltown Reservoir. This suggests that physiological regulation of zinc may occur in emergent plants.

8.1.2 Aquatic Fauna

Few reference studies are available that relate metals bioaccumulation in aquatic organisms to concentrations in wetland sediments. For evaluation of the potential bioaccumulation of metals in aquatic organisms of Kelly Farm wetlands, a recent study of the Clark Fork River (Western Montana) at six locations exhibiting a well-defined gradient of metals concentrations was selected. This study provided data on metals accumulation in the aquatic amphipod *Hyallela azteca* from sediments (Ingersoll et al. 1994). The bioaccumulation evaluation was a component of a multidisciplinary evaluation of potential effects to aquatic and terrestrial organisms in a stream segment where mining activities have resulted in sediments with elevated content of arsenic, cadmium, copper, lead, manganese, and zinc.

Table 20.

Comparison of Metals concentrations In Wetland Vegetation

Concentration (mg / kg)	Kelly Farm Wetlands, CA	Crandall Creek Marsh, CA	Milltown Reservoir Wetlands, MT
Arsenic			
Sediments	3.38	-	15.0
Roots of vegetation	0.30	-	4.2
Cadmium			
Sediments	0.36	-	3.0
Roots of vegetation	0.22	-	5.4
Copper			
Sediments	24.6	50.3	50.0
Roots of vegetation	7.4	16.1	21.9
Lead			
Sediments	11.1	8.0	22.0
Roots of vegetation	1.2	3.2	22.9
Zinc			
Sediments	63.8	99.5	930.0
Roots of vegetation	15.4	40.8	73.8
Bioconcentration Factors			
Arsenic	0.09	-	0.28
Cadmium	0.61	-	1.79
Copper	0.30	0.32	0.44
Lead	0.11	0.40	1.04
Zinc	0.24	0.41	0.08

1. Kelly Farm: August 1994 average values for sediments and cattail rhizomes (this report).
2. Crandall Creek: data for marsh sediments and cattail roots (*Typha latifolia*) (Demgen 1993).
3. Milltown Reservoir: data for soils and below ground tissues of aquatic vegetation at sites where the minimum contamination levels were detected (Linder et al. 1994).

For comparison to the Kelly Farm data, results of the three sites at Clark Fork River with the lowest detected concentrations of metals were used: a reference site located upstream of the mining area (CF-06), and two sites where sediments exhibited moderately elevated metals concentrations (CF-05 and CF 04). Sediment and organism tissue data for these sites, along with the Kelly Farm data are summarized in Table 21. As an indication of the potential long-term bioaccumulation, the metals content in tissues as a fraction of the sediment concentration is presented in Table 21. Tissue concentrations significantly exceeding those found in sediments are indicative of a potential for bioaccumulation.

Comparison of the Kelly Farm wetlands data to values reported for Clark Fork River indicates that, after four years of operation, increased metals concentrations are not present in tissues of aquatic invertebrates collected from Kelly Farm wetland. At this location, tissue concentrations of five out of six metals evaluated for potential bioaccumulation (aluminum, arsenic, cadmium, lead, and zinc) were similar, or lower, than concentrations reported for the Clark Fork River reference site (CF-06) where benthic organisms are exposed to sediments with low metals content. At sites CF-05 and CF-04 in Clark Fork River, where metals concentrations in sediments were similar or greater than at Kelly Farm sediments, invertebrate tissues had substantially higher concentrations than crayfish from Kelly Farm for metals other than copper (Table 21).

Comparison of crayfish and sediment data from Kelly Farm wetlands showed that there is not a trend toward long-term bioaccumulation of metals. With the exception of copper, tissue concentrations were lower than those in sediments (from 2 to 97 percent of the sediment concentration). As discussed previously, copper is a major component of the respiratory pigment hemocyanine of crustaceans, and thus would be expected to be high. The following trends were observed in the data from the two studies (Table 21):

- For Clark Fork River, aluminum was present in organisms tissues at concentrations similar to those in sediments. At Kelly Farm wetlands, where sediment concentrations were elevated relative to the Clark Fork River, aluminum concentrations in crayfish tissues were less than 2 percent of the sediment concentration.
- While arsenic in Clark Fork River has shown a potential for bioaccumulation (tissue concentrations up to 5 times greater than sediment values), there was no indication of bioaccumulation in Kelly Farm organisms. At this location, tissue concentrations were less than 23 percent of the sediment value.
- Cadmium, a metal likely to bioaccumulate in organisms at the base of the aquatic food chain, was found at Clark Fork River invertebrates at concentrations up to 240 percent of the sediment concentration. In Kelly Farm, cadmium was below detection in sediment and tissues.
- Relative to sediment values, concentrations of copper in KFDW and Clark Fork River invertebrates ranged from 62 percent to 348 percent. The highest value of this range corresponds to crayfish collected from Kelly Farm.
- Potential for bioaccumulation of lead was not observed at any of the four locations evaluated. Concentration in invertebrate tissues ranged from 8 to 64 of the reported sediment concentration
- Zinc did not exhibit a potential for bioaccumulation in crayfish, as concentrations detected in organisms were similar levels to those in sediments (tissue to sediment ratios from 0.8 to 1.2 at Kelly Farm wetlands and two Clark Fork River locations). The Clark Fork River reference site, which had a very low zinc content in sediments,

had a high tissue to sediment ratio (14.1). This difference may be due to active physiological regulation over a wide range of sediment concentrations.

Table 21.

Comparison of Kelly Farm Monitoring Data to Reference Values on Metal Bioaccumulation in Sediment Organisms

	Concentration (mg / kg dry weight)			
	Kelly Farm	Clark Fork River, MT [b]		
Sediment Concentration (mg / kg)	Wetlands, CA [a]	Reference Site	Site CF-05	Site CF-04
Aluminum	18,500	1,532	990	2,124
Arsenic	3.38	<0.50	2.70	10.8
Cadmium	0.36	0.07	0.76	1.9
Copper	24.6	<12.0	77	251
Lead	11.1	3.5	19.4	50.2
Zinc	64	<15	294	562
Concentration in Tissues of Aquatic Invertebrates (mg/kg)				
Aluminum	449	830	591	4,193
Arsenic	0.80	2.7	3.4	27
Cadmium	0.15	0.13	1.8	2.2
Copper	86	26	48	266
Lead	0.9	0.5	3.8	32
Zinc	62	212	359	453
Ratio of Tissue Concentration to Sediment Concentration				
Aluminum	0.02	0.54	0.60	1.97
Arsenic	0.23	5.40	1.26	2.50
Cadmium	0.42	1.86	2.36	1.14
Copper	3.48	2.17	0.62	1.06
Lead	0.08	0.15	0.20	0.64
Zinc	0.97	14.1	1.22	0.81

[a] Average values of August 1994 data for sediments and crayfish.
[b] Average values for sediments (Kemble et al. 1994) and the amphipod crustacean *Hyalella azteca* (Ingersoll et al. 1994) at
reference site CF-06 and two sites receiving sediments from a mining area.

8.2 Reference Values for Effects on Organisms

8.2.1 Direct Exposure to Sediments

Potential adverse effects of metals from Kelly Farm sediments on aquatic organisms were evaluated by the use of benchmark values for assessment of ecological risk. These values identify threshold concentrations of metals and/or other contaminants in the sediment above which there is a potential risk for effects on rooted vegetation or aquatic fauna. Table 22 presents benchmark values for potential effects on those organisms by direct exposure to the sediments, and the ratio of sediment concentration to benchmark values (E/B ratio). Ratio values smaller than 1 indicate minimal or no risk to organisms, while potential risks are identified by E/B ratios greater than 1.

No significant risks for adverse effects on vegetation and aquatic fauna from exposure to Kelly Farm sediments were identified. All E/B ratios for both types of organisms were less than the threshold value of 1.0, and well below the E/B ratio of 10 which identifies potential significant risks on organism growth and survival (Table 22).

8.2.2 Exposure by Food Ingestion

Toxicological benchmarks for food intake were used to evaluate the risks for adverse effects on terrestrial fauna from ingestion of Kelly Farm wetland vegetation and aquatic organisms (Table 23). The exposure to benchmark ratios for this analysis were calculated separately for mammals and birds using a daily ingestion rate equivalent to 20 percent of the organism body weight per day. This rate was obtained from data summarized by EPA (1993) for several wildlife species, including the heron and otter (consumers of fish and aquatic invertebrates), and the muskrat and mallards (consumers of aquatic vegetation).

Based on available benchmarks for food ingestion, metals concentrations in vegetation and aquatic organisms of the Kelly Farm wetlands do not pose a significant potential risk for effects on terrestrial wildlife. For herbivore organisms that obtain most of their diet from cattails and bulrushes, E/B ratios for birds and mammals were below the threshold value of 1.0 (except for selenium in cattail rhizomes with an E/B ratio of 1.01) (Table 23). Low E/B ratios were also calculated for organisms that are consumers of fish and macroinvertebrates. Moderate potential risks (E/B ratios ranging from 1.46 to 2.24) were identified for crayfish and mosquitofish ingestion based on available benchmarks for copper, mercury, selenium and zinc (Table 23).

Table 22.

Potential Effects in Organisms from Direct Exposure to Metals in Swdiments at the Kelly Farm Demonstration Wetlands

	Concentration in Sediments[a] (mg/kg)	Benchmarks[b] (mg/kg)		Exposure to Benchmark Ratio[c]	
		Sediment Organisms	Wetland Vegetation	Sediment Organisms	Wetland Vegetation
Aluminum	18,500	-	-	-	-
Arsenic	3.38	57	30	0.06	0.11
Cadmium	0.36	5.1	5	0.07	0.07
Chromium	63.5	260	250	0.24	0.25
Copper	24.6	390	100	0.06	0.25
Lead	11.1	450	500	0.02	0.02
Mercury	0.089	0.410	2	0.22	0.04
Nickel	97.1	140	100	0.69	0.97
Selenium	0.70	-	3	-	0.23
Silver	3.60	6.10	20	0.59	0.18
Zinc	63.8	410	500	0.16	0.13

[a] Average of four composite samples; values for cadmium, selenium, and silver are the analytical detection limits.

[b] Benchmarks are threshold values for potential adverse effects on organisms based on toxicological data.
Benchmarks for sediment organisms (benthos) are the apparent effect thresholds, as summarized by the National Oceanic and Atmospheric Administration (NOAA 1994: Screening Guidelines for Inorganics). Vegetation benchmarks were obtained from soil remediation criteria for parkland and residential use developed by the Canadian Council of Ministers of the Environment (CCME 1991; Report EPC-CS34).

[c] E/B ratios ranging from 1 to 10 identify a low risk for adverse effects on organisms. More significant risks are identified by E/B ratios greater than 10 (Menzies et al. 1993).

Table 23.

Potential Risk for Adverse Effects on Terrestrial Fauna from Metals in Organism Tissues At the Kelly Farm Demonstration Wetlands

Tissue Concentration at KFDW (mg/kg)	Diet Source				
	Cattail Rhizomes	**Bulrush Seeds**	**Crayfish**	**Mosquitofish**	**Dietary Benchmark[a] (mg/kg)**
Arsenic	0.30	0.06	0.77	0.33	Not Applicable (NA)
Cadmium [b]	0.22	0.06	0.15	0.28	NA
Chromium	4.09	0.30	1.88	4.94	NA
Copper	7.38	4.35	85.7	6.79	NA
Lead	1.24	0.27	0.94	1.06	NA
Mercury	0.038	0.017	0.050	0.110	NA
Nickel	7.1	3.6	4.5	4.9	NA
Selenium	0.38	0.20	0.59	0.84	NA
Silver	0.92	0.80	0.60	1.36	NA
Zinc	15.4	5.0	62.2	142.2	NA

Table 23. cont.

Potential Risk for Adverse Effects on Terrestrial Fauna from Metals in Organism Tissues At the Kelly Farm Demonstration Wetlands

	Diet Source				
	Cattail Rhizomes	**Bulrush Seeds**	**Crayfish**	**Mosquitofish**	**Dietary Benchmark[a] (mg/kg)**
Risk for Effects on Small Mammals§					
Arsenic	0.06	0.01	0.15	0.06	1.02
Cadmium	0.09	0.02	0.06	0.11	0.5
Chromium	0.25	0.02	0.11	0.30	3.28
Copper	0.13	0.07	1.46	0.12	11.7
Lead	0.03	0.01	0.02	0.03	8
Mercury	0.24	0.11	0.31	0.69	0.032
Nickel	0.04	0.02	0.02	0.02	40
Selenium	1.01	0.53	1.57	2.24	0.075
Silver	0.37	0.32	0.24	0.54	0.5
Zinc	0.02	0.01	0.08	0.18	160

Table 23. cont.

Potential Risk for Adverse Effects on Terrestrial Fauna from Metals in Organism Tissues At the Kelly Farm Demonstration Wetlands

	Diet Source				
Risk for Effects on Game Birds[c]	**Cattail Rhizomes**	**Bulrush Seeds**	**Crayfish**	**Mosquitofish**	**Dietary Benchmark[a] (mg/kg)**
Arsenic	0.00	0.00	0.00	0.00	100
Cadmium	0.03	0.01	0.02	0.04	1.45
Chromium	0.82	0.06	0.38	0.99	1
Copper	0.04	0.03	0.52	0.04	33.2
Lead	0.06	0.01	0.05	0.06	3.85
Mercury	0.58	0.26	0.77	1.69	0.013
Nickel	0.02	0.01	0.01	0.01	77.4
Selenium	0.19	0.10	0.30	0.42	0.4
Silver	0.37	0.32	0.24	0.54	0.5
Zinc	0.21	0.07	0.83	1.90	15

[a] Benchmarks are reference values for potential adverse effects on organisms by food ingestion (Table 2)
[b] All cadmium concentrations were below the analytical detection limits
[c] Risks are calculated as the ratio of exposure (concentration in food source) to benchmark value (E/B ratio), assuming a food intake rate of 20 percent of the organism's body weight per day. The E/B ratio characterizes the risk for adverse effects on organisms as negligible (values less than 1.0), moderate (values from 1 to 10), and significant (values greater than 10) (Menzies et al. 1993).

9.0 STATE MUSSEL WATCH PROGRAM DATA

This section describes the results of the State Mussel Watch Program (SMWP) for stations in the Project area. The SMWP is part of the State Water Resources Control Board's (SWRCB) long-term water quality monitoring program. Field and laboratory work for the SMWP is conducted by the California Department of Fish and Game (DFG). The City of Santa Rosa funds SMWP stations in the Laguna at the request of the Regional Water Quality Control Board. The purpose of the SMWP is to monitor long-term trends in pollutant concentrations in marine and freshwater organisms, identify locations where higher-than-expected concentrations of pollutants exist, and provide the evidence needed to initiate follow-up studies and actions to correct, and clean up sources of pollution (SWRCB 1988). Data from 1977 through 1987 were obtained from SWRCB (1988). More recent data were provided from Bruce Gwynne (North Coast Regional Water Quality Control Board) and Gary Ichikawa (DFG). Data from the main stations on the Laguna de Santa Rosa, Russian River below Healdsburg, Santa Rosa Creek, and Mark West Creek were used. The stations above Santa Rosa's discharge are Santa Rosa Creek at Willowside Road, Mark West Creek at Slusser Road, the Laguna at Stony Point Road, and the Russian River at Wohler Bridge. The stations below Santa Rosa's discharge are the Laguna at Wohler Road and the Russian River at Hacienda. Control data came from Aptos Creek and Isabella Lake. The entire data set for the project area is given in Appendix 4.

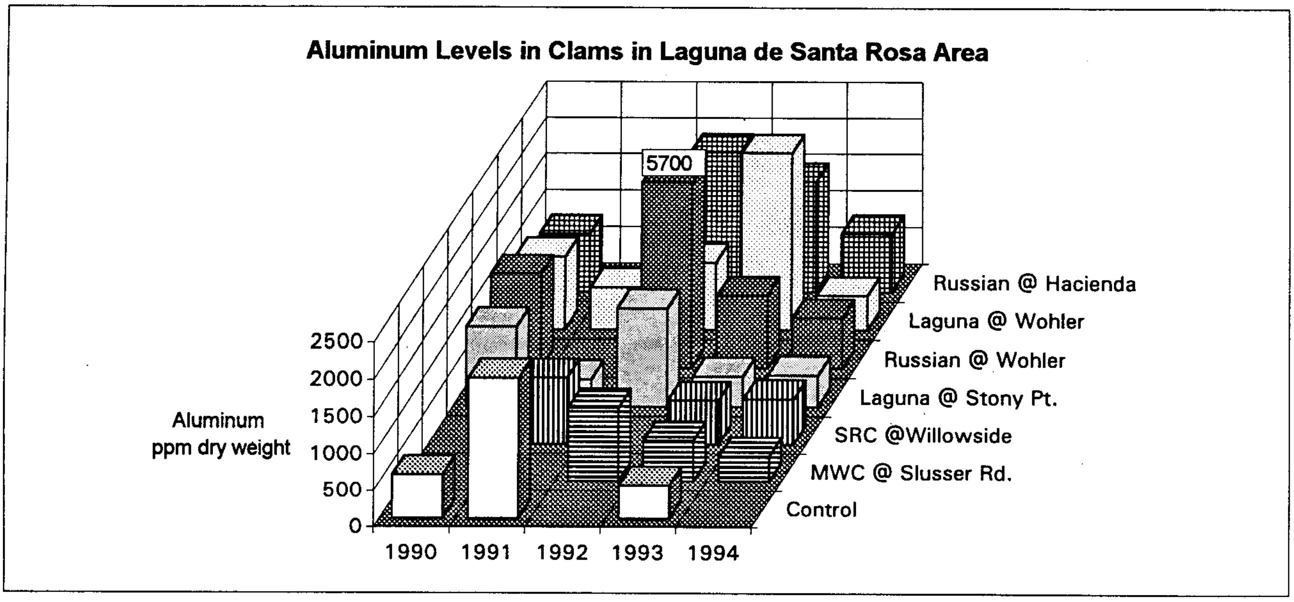
9.1 TRACE ELEMENTS

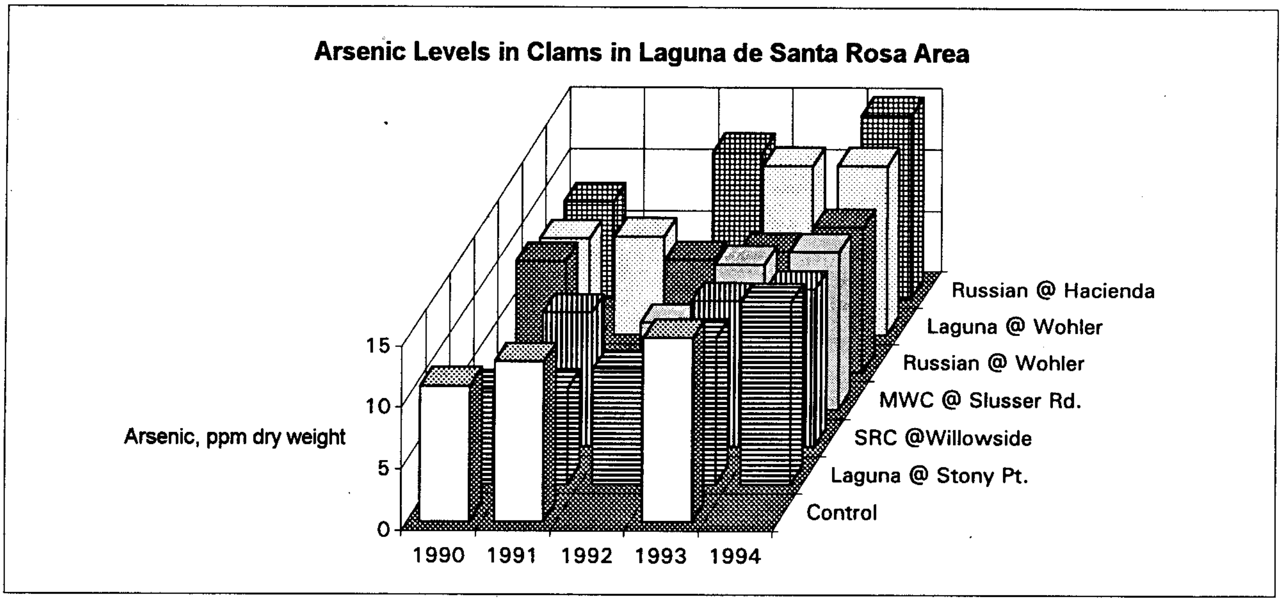
Bivalves (clams for freshwater stations) were collected for analysis of trace elements from on the Laguna de Santa Rosa, Santa Rosa Creek, Mark West Creek, and the Russian River (Figure 2). Tissues were analyzed for aluminum, arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, selenium, silver, and zinc. Most of the samples were collected from 1990 through 1994. Prior to 1990, only four samples were collected (all from the mouth of the Russian River). Samples were not collected from all stations on all dates. This is usually due to loss of some or all bags of bivalves due to adverse environmental conditions. When only part of the bags are retrieved, not all analyses can be conducted. The concentrations of trace elements in clam tissue from the main stations on the Laguna de Santa Rosa and the Russian River are shown in Figure 3.

9.2 ORGANIC COMPOUNDS

Bivalves were collected for analysis of organic compounds from 10 stations within the project area. Most of the samples were collected from 1990 through 1994. Prior to 1990, only two samples were collected in the Project area. As discussed above, samples were not collected from all stations on all dates. Over 150 organic compounds were analyzed. Of these, only eleven compounds or groups of compounds were found in detectable

Figure 3. Trace Elements in Clam Tissues.





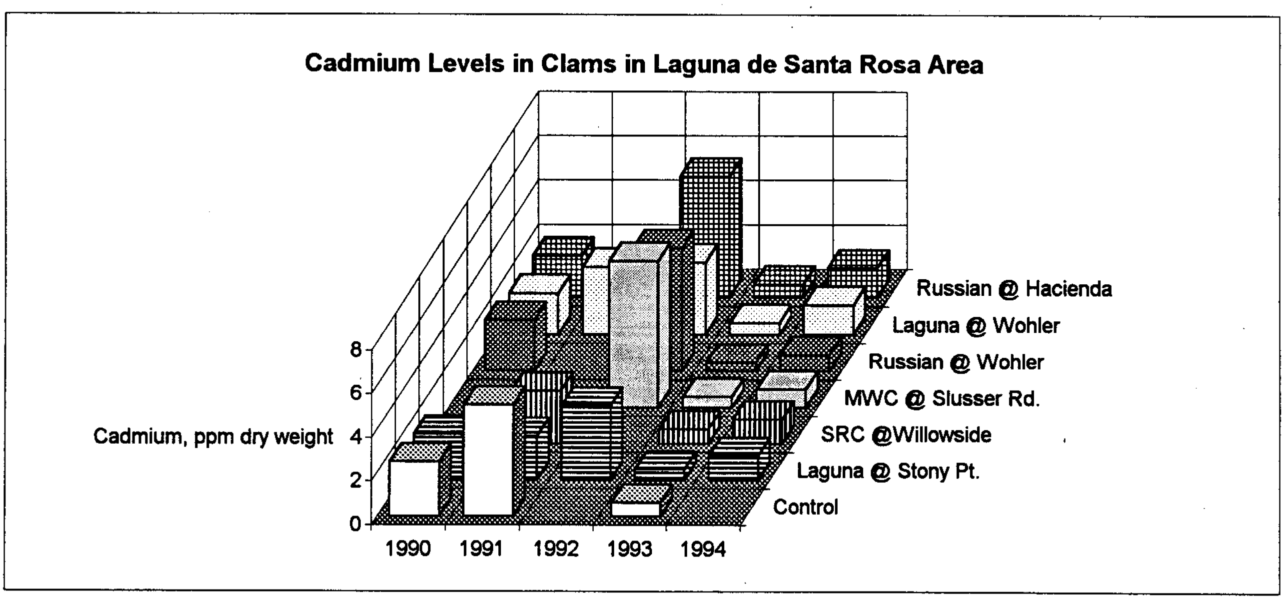
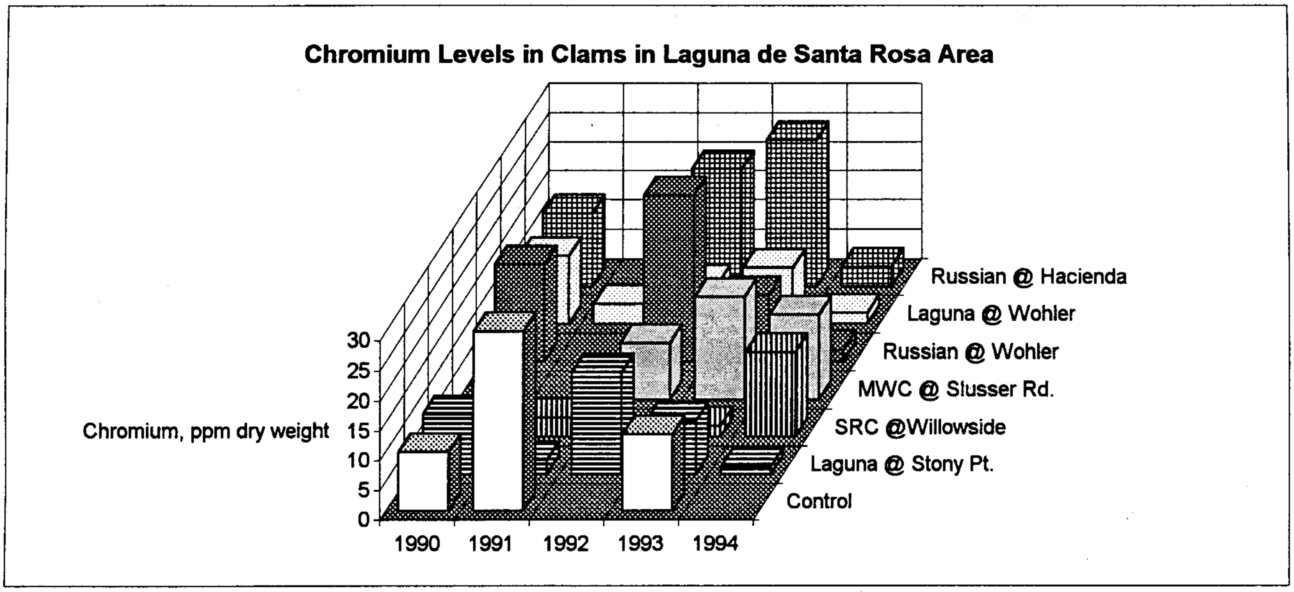
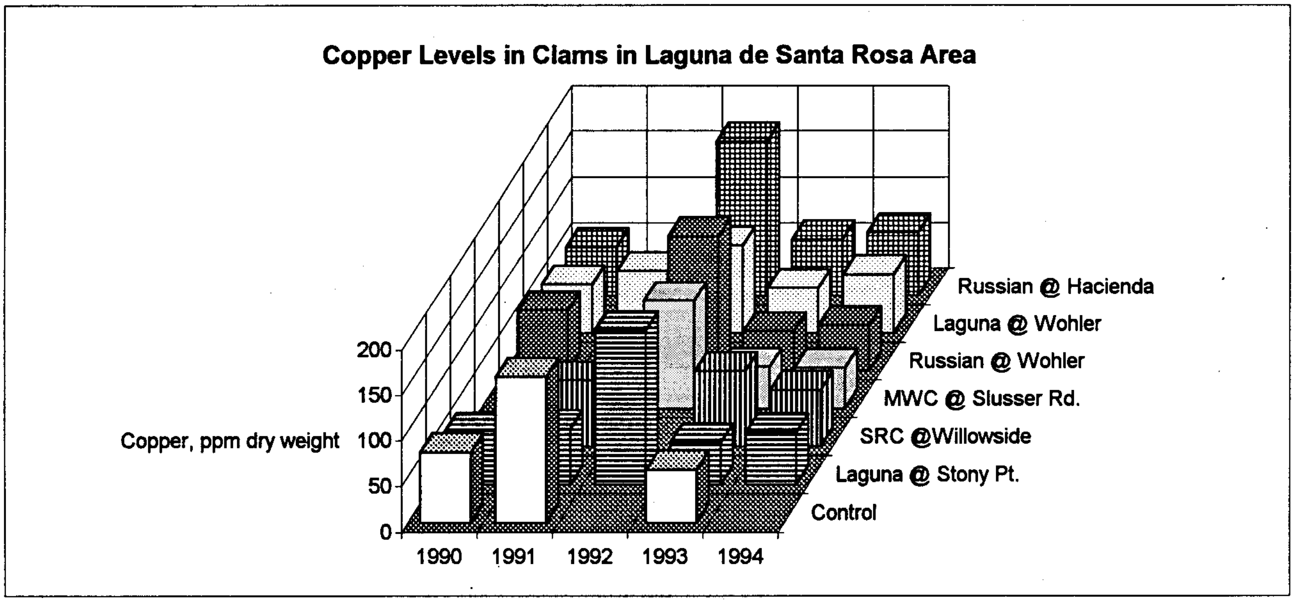


Figure 3. Trace Elements in Clam Tissues.





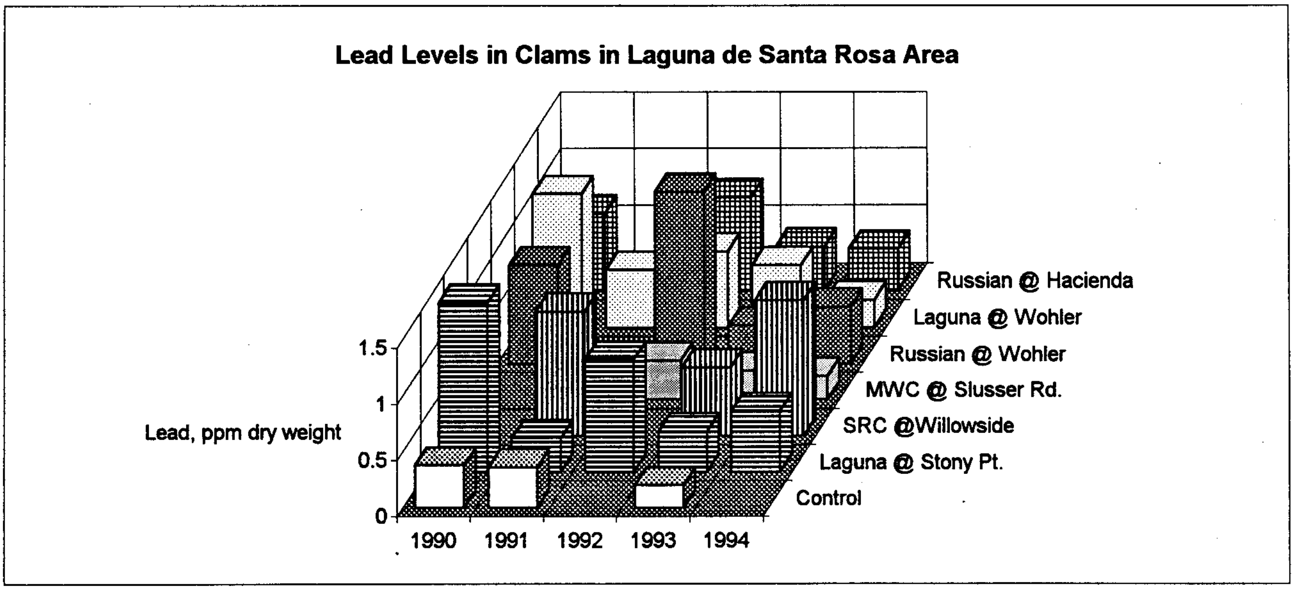
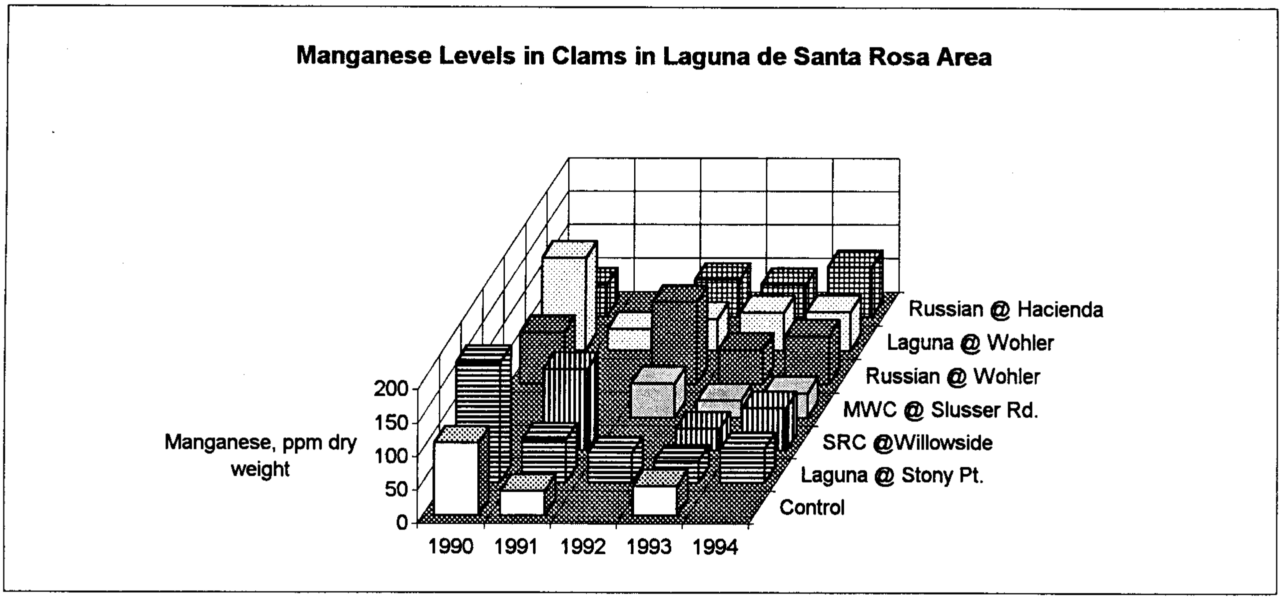
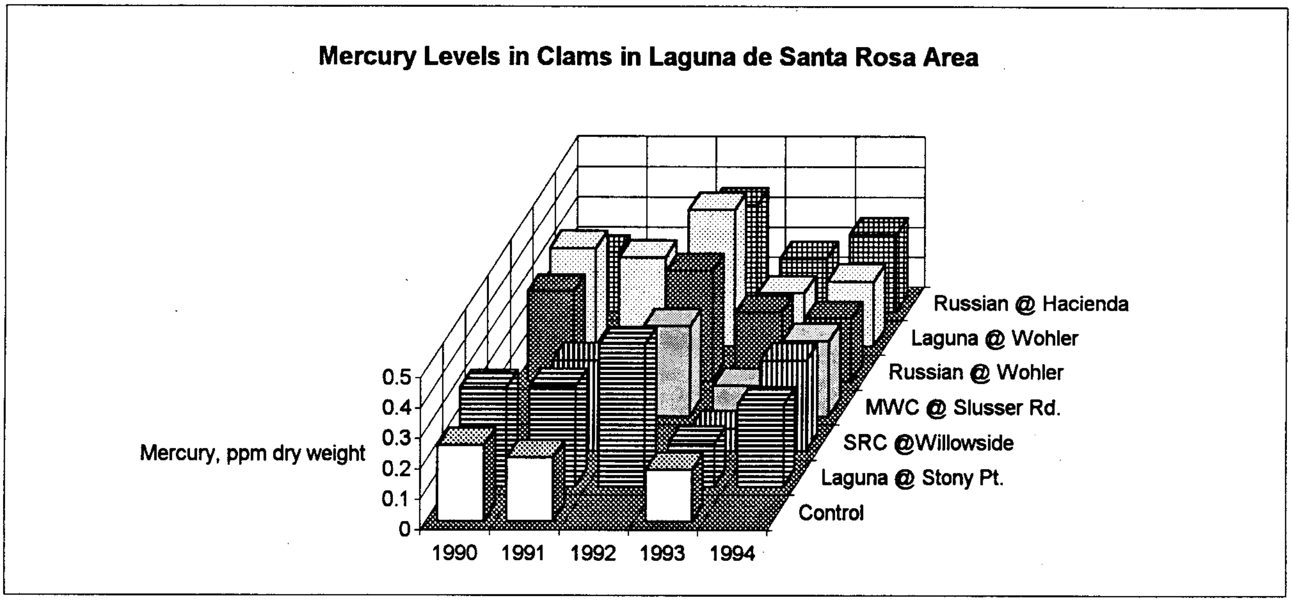


Figure 3. Trace Elements in Clam Tissues.





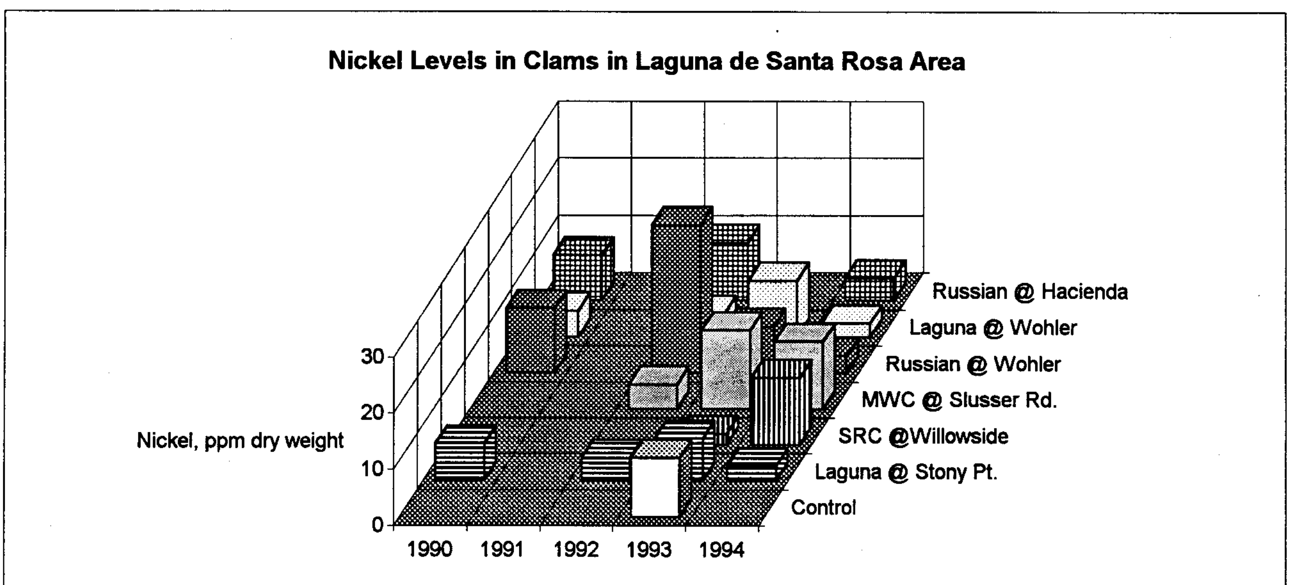
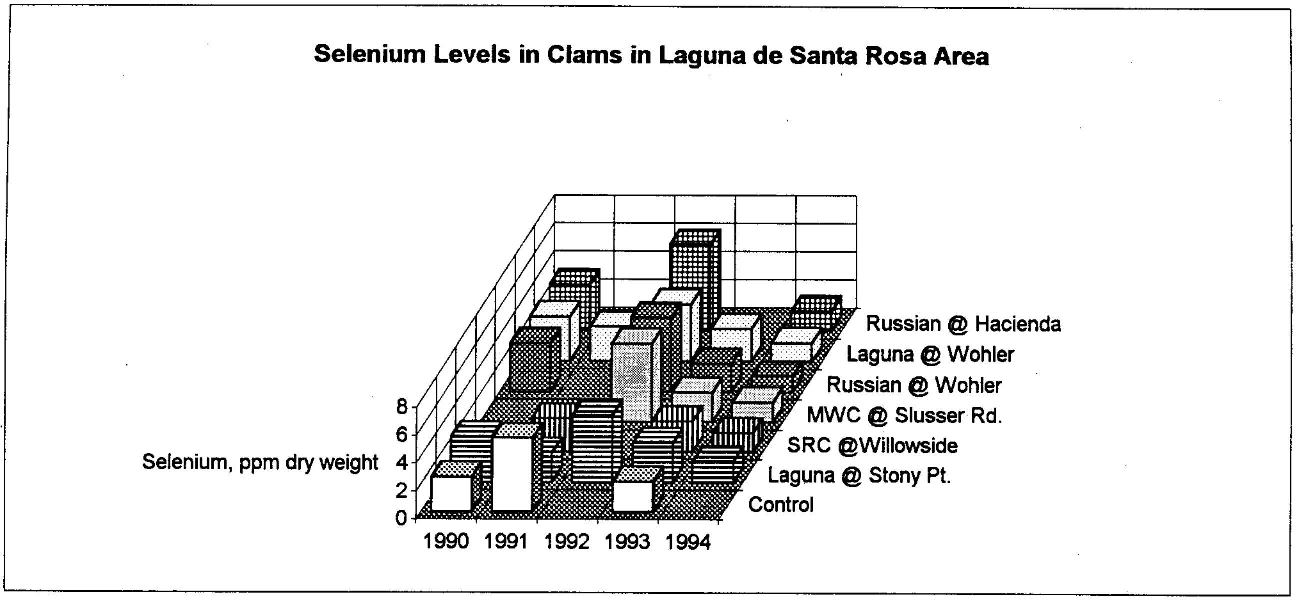
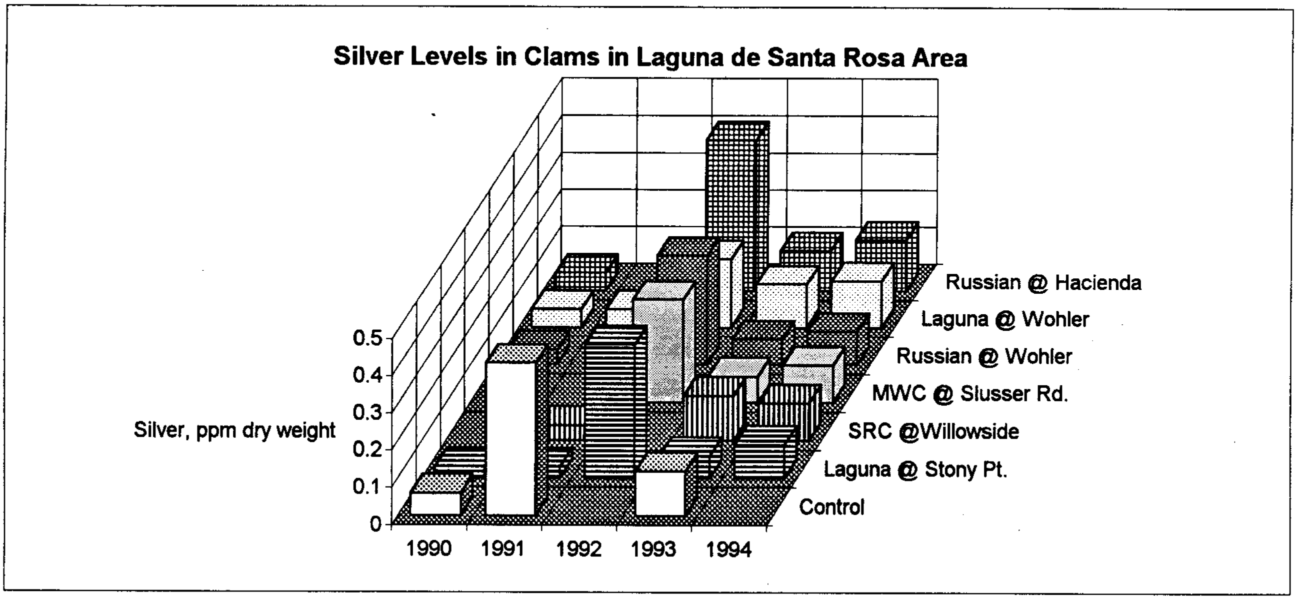
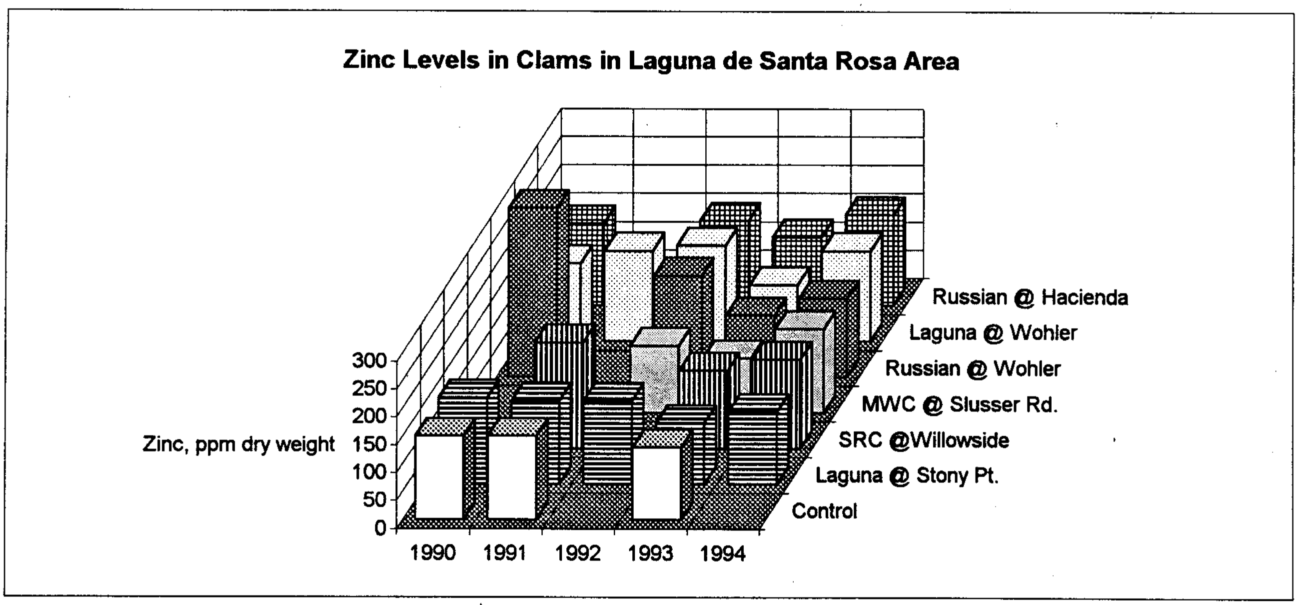


Figure 3. Trace Elements in Clam Tissues.







quantities in clams from stations below the Santa Rosa reclaimed water discharge: total chlordane, total DDT, total PCB, total PAH, chlorpyrifos, dacthal, dieldrin, oxadiazon, total heptachlor, hexachlorobenzene, and total BHC. The concentration of these organic compounds in clam tissue from the main stations on the Laguna and the Russian River are shown in Figure 4.

9.3 COMPARISON ABOVE AND BELOW SANTA ROSA'S DISCHARGE

9.3.1 Trace Elements

Data were analyzed from four stations above Santa Rosa's reclaimed water discharge (Laguna at Stony Point Road, Santa Rosa Creek at Willowside Road, Mark West Creek at Slusser Road, and the Russian River at Wohler Road) and two stations below the discharge (Laguna at Wohler Road and the Russian River at Hacienda) (Figure 2). The mean concentrations of trace elements in tissues for stations above and below the discharge for 1990-1994 along with the average concentrations in control tissues (Aptos Creek in 1990 and 1991 and Isabella Lake in 1993) are shown in Table 24. Data were averaged over time to evaluate major trends. Individual years were plotted (Figure 3) to determine more subtle trends.

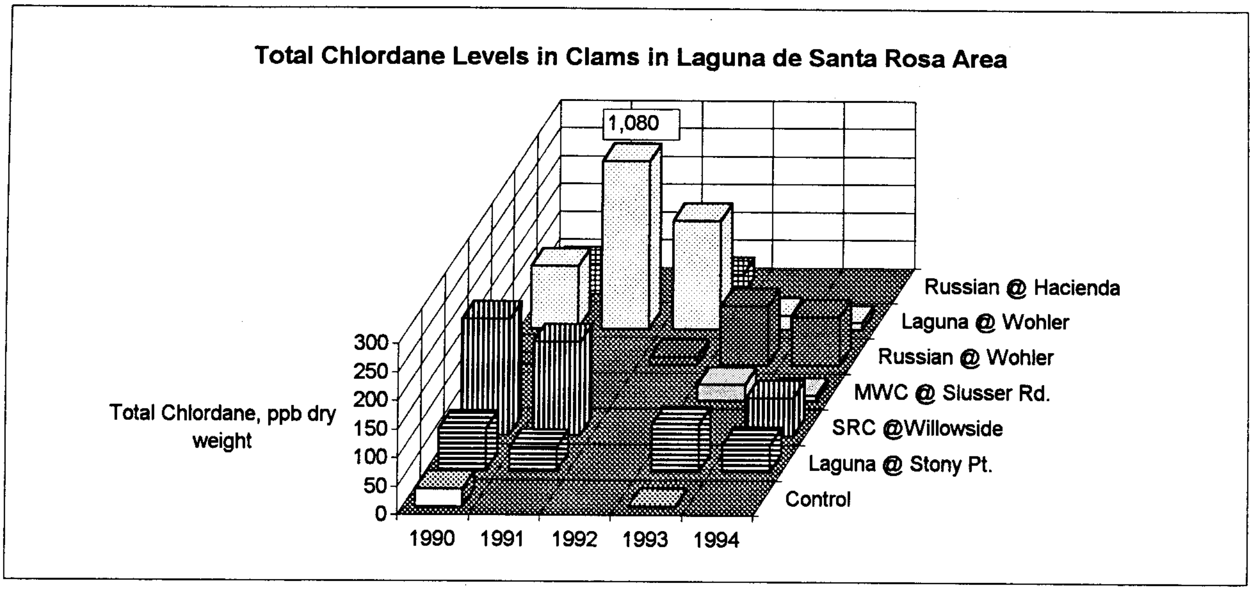
Table 24

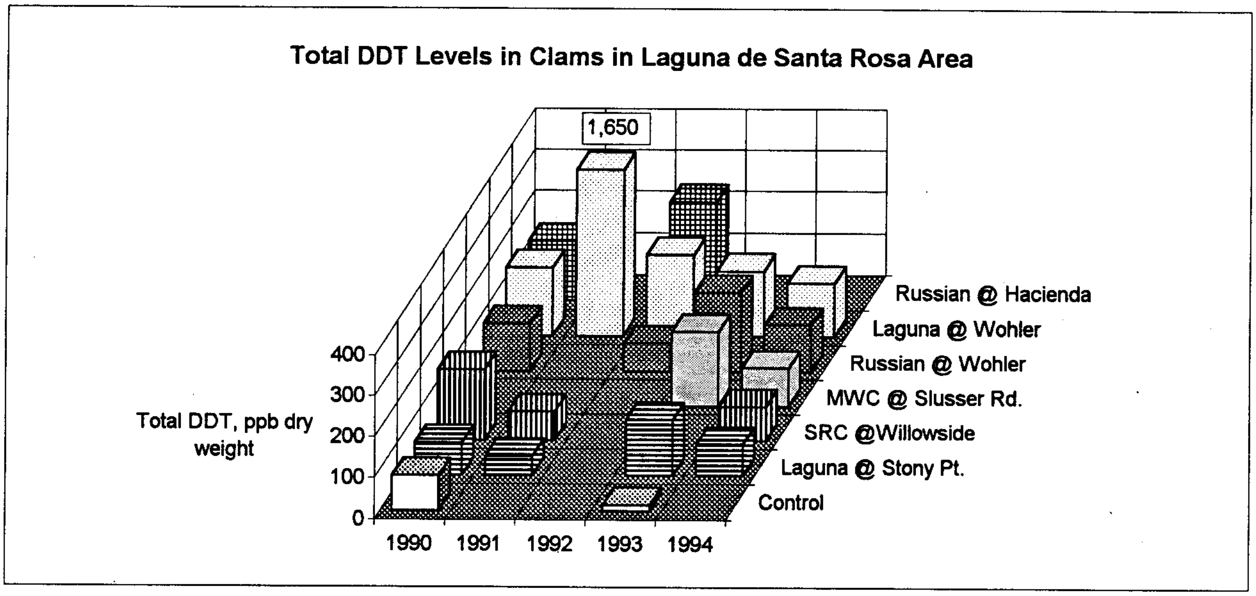
Average concentrations of trace elements in *Corbicula* tissue
ppm dry weight

Constituent	Above discharge	Below discharge	Control	EDL 85[a]
Aluminum	1075	1142	983	693
Arsenic	10.7	10.5	13.7	-
Cadmium	2.0	2.1	2.7	12
Chromium	10.4	10.4	28.0	3
Copper	75.6	77.6	98.3	38
Lead	0.72	0.59	0.31	2
Manganese	67.8	60.9	64.0	66
Mercury	0.26	0.28	0.21	0.31
Nickel	8.7	6.1	10.5	-
Selenium	2.7	3.0	3.3	-
Silver	0.12	0.14	0.20	0.31
Zinc	152	145	143	169

[a] EDL 85 = concentration of toxic substance that equals 85 percent of all SMWP measurements of toxic substance in the same mussel or clam type between 1977 and 1987 (the 85th cumulative frequency percentile)

Figure 4. Organic Contaminants in Clam Tissues.





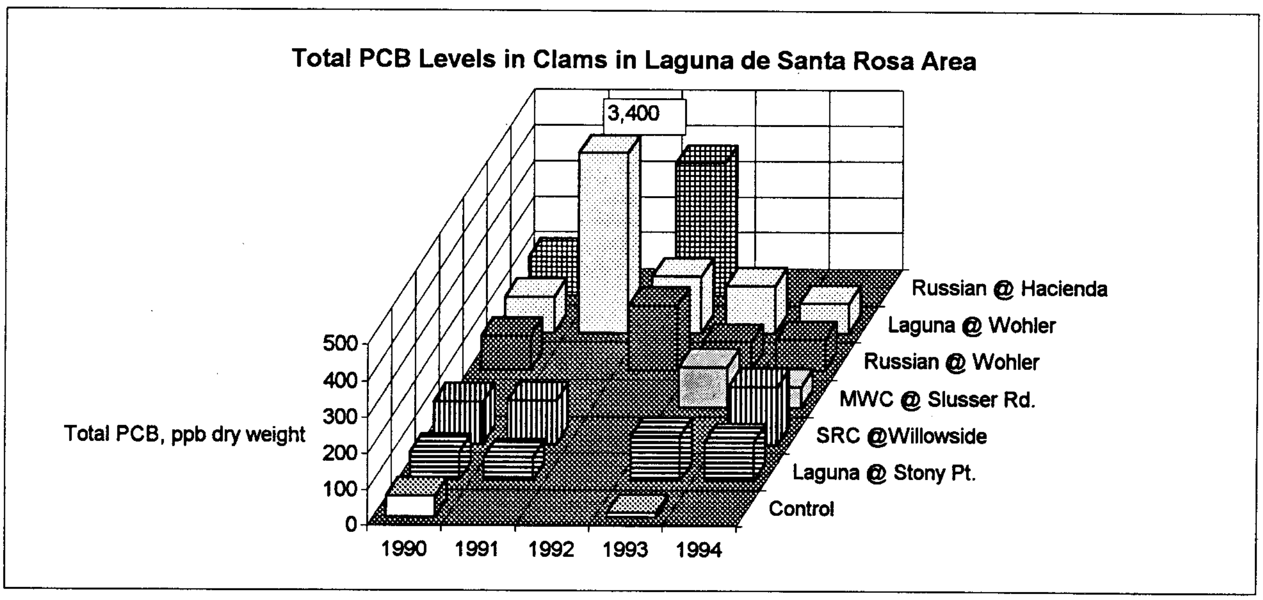


Figure 4. Organic Contaminants in Clam Tissues.

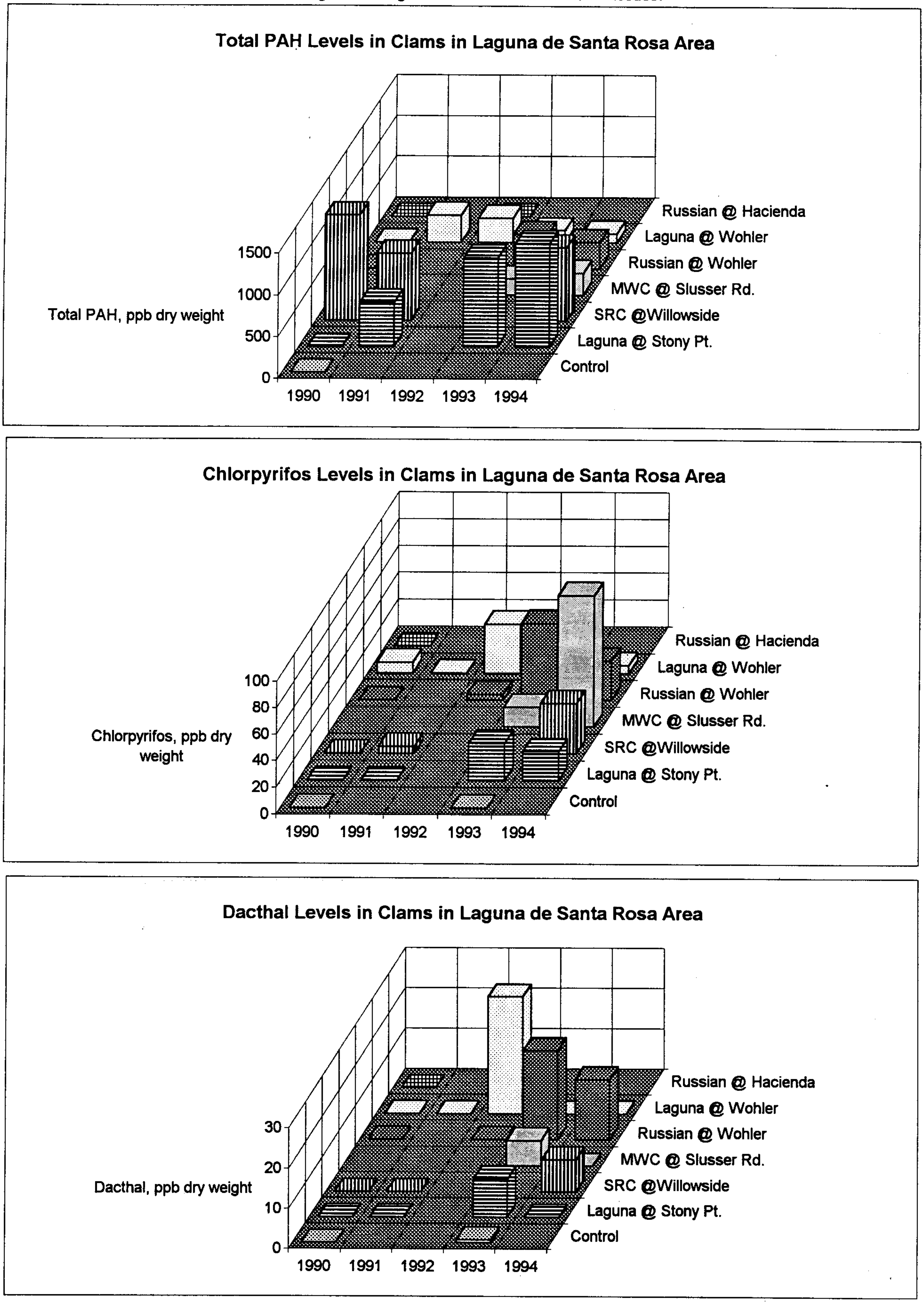
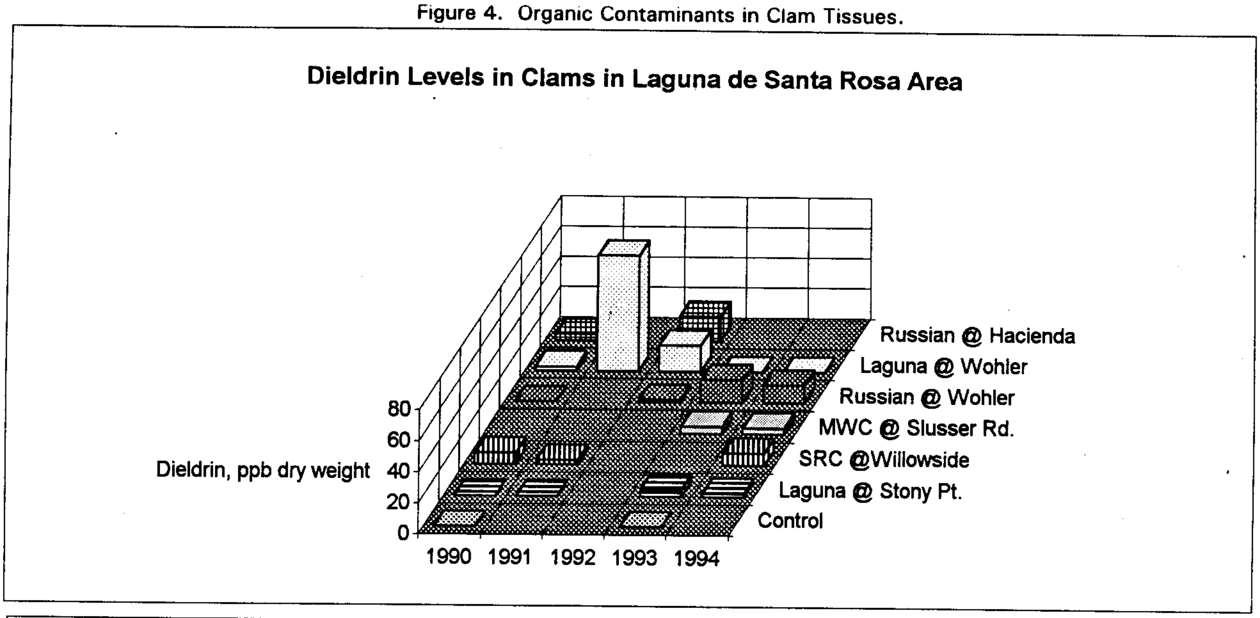
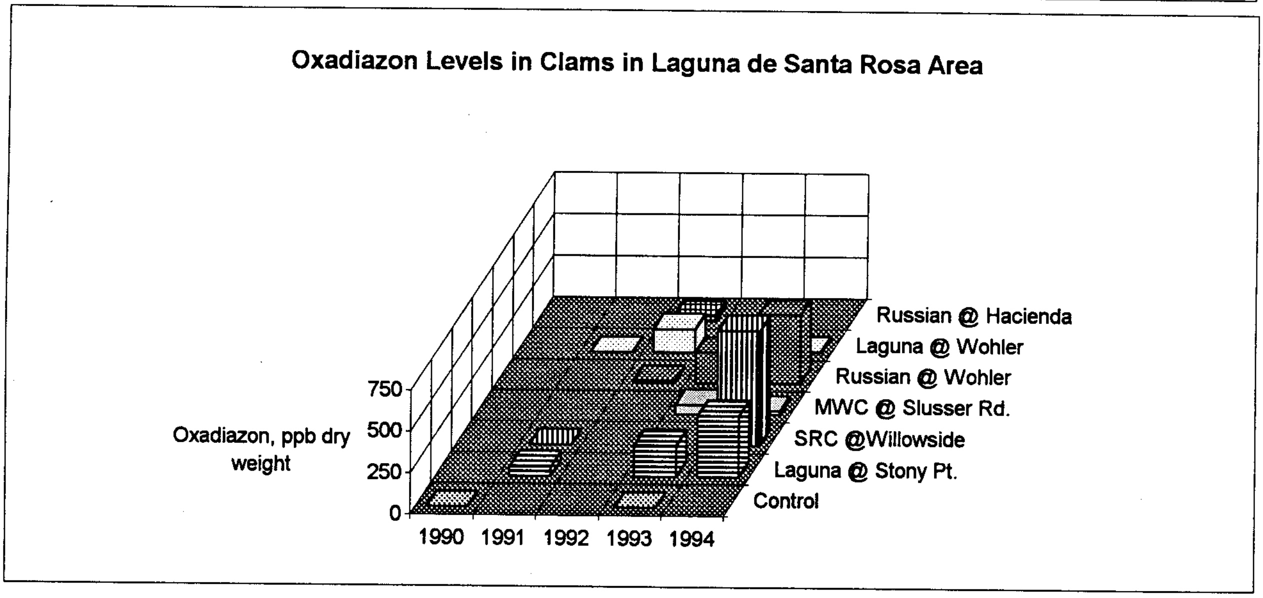


Figure 4. Organic Contaminants in Clam Tissues.





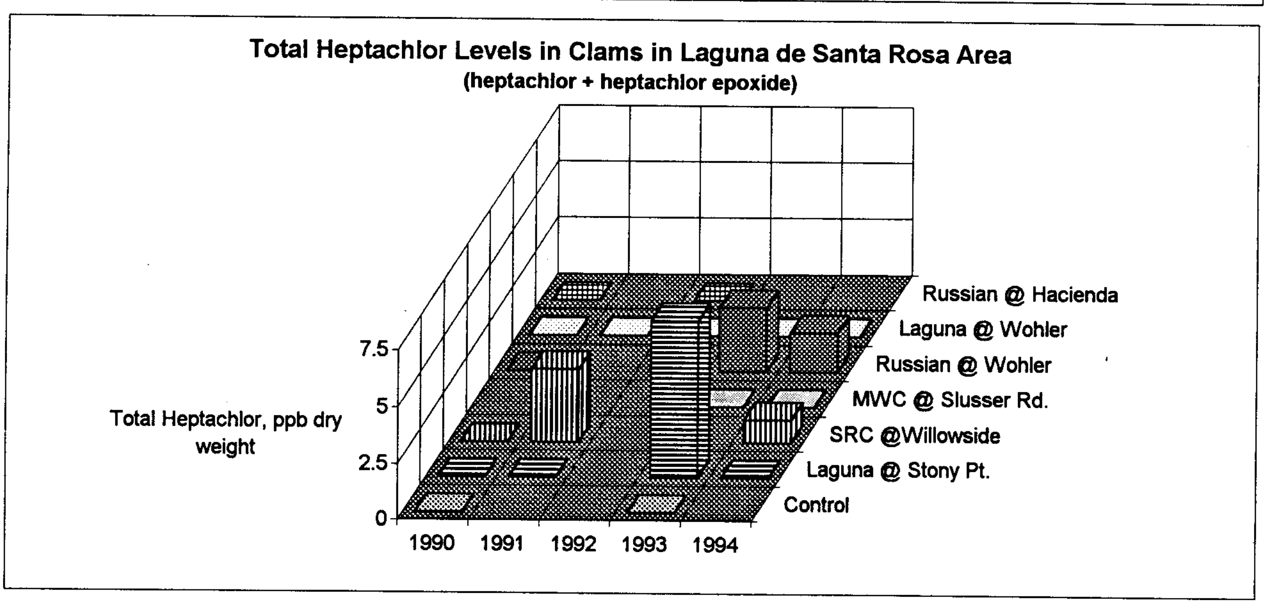
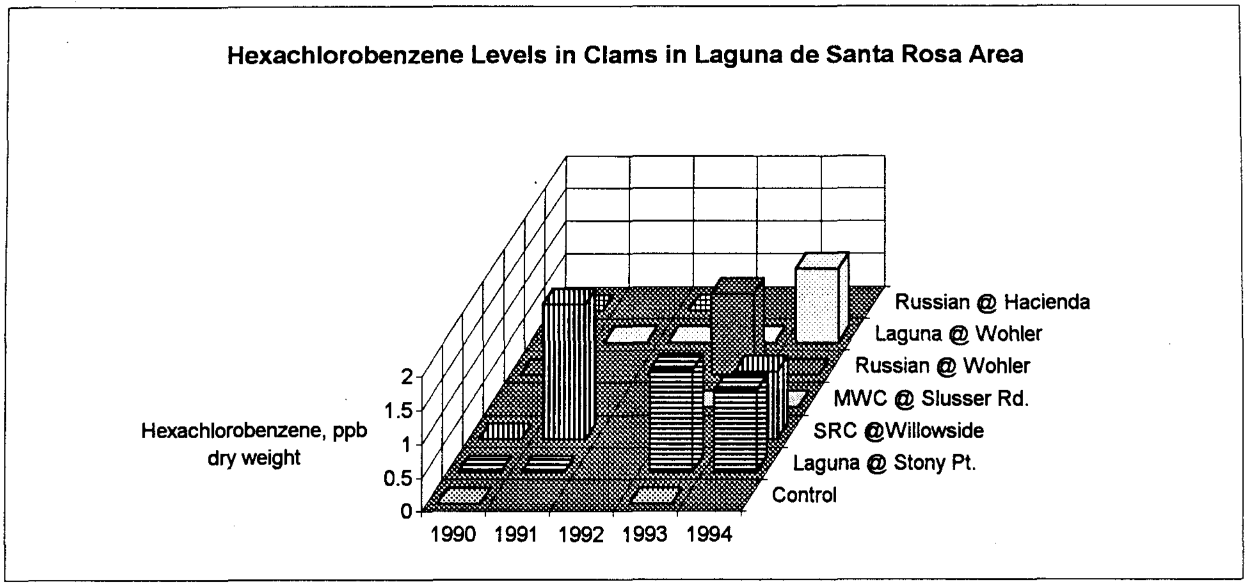
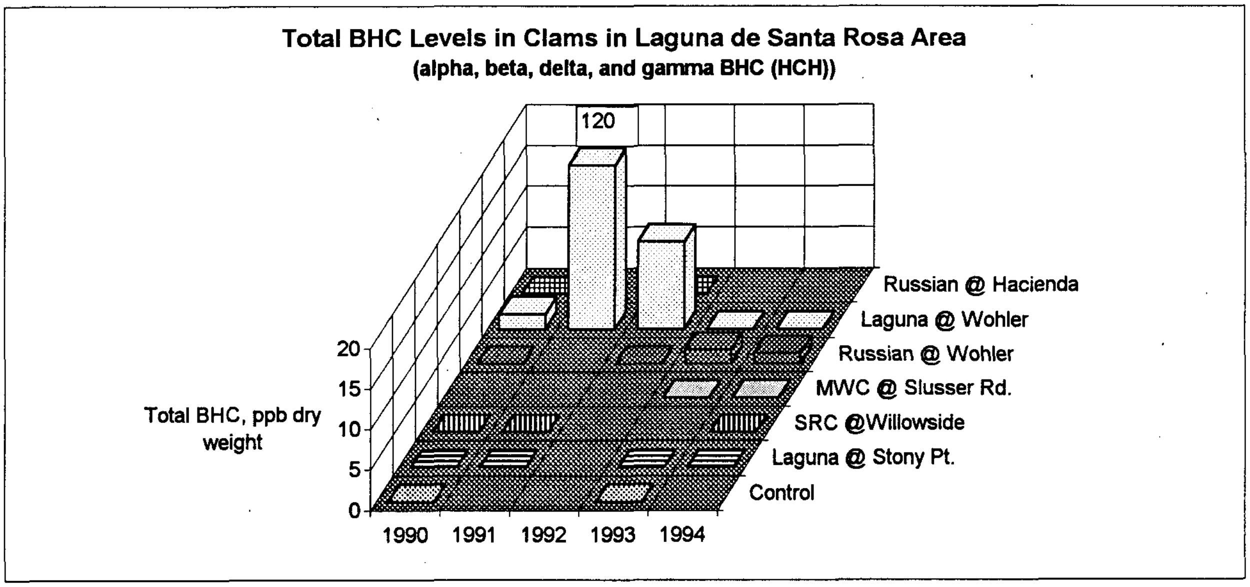


Figure 4. Organic Contaminants in Clam Tissues.





Average concentrations of trace elements in clam tissues were similar above and below the discharge and were similar to the concentrations in control clams. They were also similar to or lower than the EDL 85, with the exceptions of aluminum, chromium and copper. The control tissues also exceeded the EDL 85 for aluminum, chromium and copper. Statistical analyses (t-tests and Mann Whitney rank sum tests) revealed no significant differences between the average concentrations of aluminum, arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, selenium, silver, or zinc in clams above the discharge and below the discharge. No statistically significant differences existed between the average concentrations of any of the metals in clams below the discharge and in the control clams. However, the power of these tests was low, due at least in part to the low N. The high variability between years could also mask an effect of discharge. An examination of Figure 3 reveals high variability between stations within years. For evidence of increased tissue concentration of a metal due to reclaimed water discharge, a regular occurrence of lower concentrations of metals in tissues from the Laguna above the discharge (Stony Point Road) than below the discharge (Laguna at Wohler Road) would be necessary. Also a regular occurrence of lower concentrations from the Russian River above the confluence with the Laguna (Russian River at Wohler River) than in the Laguna below the discharge and in the Russian River below the discharge (Hacienda Bridge) would be necessary. These patterns are not discernible in the data (Figure 3).

9.3.2 Organic Compounds

Data were analyzed for four stations above Santa Rosa's reclaimed water discharge (Laguna at Stony Point Road, Santa Rosa Creek at Willowside Road, Mark West Creek at Slusser Road, and the Russian River at Wohler Road) and two stations below the discharge (Laguna at Wohler Road and the Russian River at Hacienda) (Figure 4). For organic compounds with detectable concentrations below the discharge, the mean concentrations of organic compounds in tissues for stations above and below the discharge for 1990-1994 along with the average concentrations in control tissues (Aptos Creek in 1990 and Isabella Lake in 1993) are shown in Table 25.

Total benzenehexachloride (BHC) (alpha and gamma only, beta and delta BHC were below detection) was found in elevated concentrations below the discharge (Laguna at Wohler Bridge) during 1990-1992 but it was below detection in 1993 and 1994 (Figure 4). Organic compounds have been analyzed in Santa Rosa's reclaimed water since 1991. Elevated BHC in clams did not coincide with elevated BHC in reclaimed water. During 1991 and 1992, when elevated levels of BHC in the Laguna were present, only one detectable value (of five measurements) of gamma BHC, 0.03 ppb, was measured in the reclaimed water discharge. During 1993-1994, when BHC in the Laguna was below detection, three detectable values (of seven measurements) of gamma BHC were measured in the reclaimed water discharge. These detectable values averaged 0.07 ppb. Since the clams are deployed for just three months, the elevated BHC levels are not likely due to a lagged effect of reclaimed water. The lack of a relationship between concentration in reclaimed water discharge and concentration in clam tissues indicates another source of BHC may be present in the Laguna watershed. A likely source is from pesticide application. Gamma BHC, also called Lindane, is a commonly used pesticide. Its primary uses in Sonoma County are for control of tree borers and to treat head lice (Sonoma County Agriculture Commissioners Office).

Table 25.

Average concentrations of organic compounds in *Corbicula* tissue from samples collected from stations above and below Santa Rosa's reclaimed water discharge and in control stations and the EDL 85[a].
ppm dry weight

Constituent	Above Discharge	Below Discharge	Control	EDL 85
Total chlordane	72	216	21.6	586
Total DDT	110	383	61	17895
Total PCB	105	621	13	1395
Total PAH	535	125	ND	-
Chlorpyrifos	23.1	10.0	ND	500
Dacthal	4.7	5.3	0.7	3845
Dieldrin	4.8	16.5	ND	1865
Oxadiazon	202	35.6	ND	--
Total heptachlor	1.2	0	ND	11
Hexachlorobenzene	0.54	0.16	ND	24
Total BHC	0.23	18.9	ND	8.59

[a] EDL 85 = The concentration of the toxic substance that equals 85 percent of all SMWP measurements of the toxic substance in the same mussel or clam type between 1977 and 1987 (the 85th cumulative frequency percentile)

Although PAHs and total hexachlorobenzene were found at detectable levels in clam tissue from the Laguna below the discharge, the levels were lower or equal to the levels in clams above the discharge for all years examined (Figure 4).

Total heptachlor, found in detectable concentrations in tissues above the discharge, was not detectable in clams below the discharge (Figure 4).

The remaining organic compounds found in detectable concentrations in clams (chlordane, DDT, PCB, chlorpyrifos, dacthal, dieldrin, and oxadiazon) showed no regular pattern above versus below the discharge (Figure 4). In some years, the concentrations were higher above the discharge and in some years lower. Average concentrations of total chlordane, total DDT, and total PCB were higher below the discharge but this is largely due to relatively high levels in one year (1991). Concentrations of total chlordane, total DDT, and total PCB have been decreasing every year since 1991. Chlordane, DDT, PCBs, and dieldrin are measured in the Santa Rosa reclaimed water and have not been found in detectable quantities. Chlordane, DDT, and dieldrin are banned pesticides and would not be expected to be present in reclaimed water.

10.0 TOXIC SUBSTANCES MONITORING PROGRAM DATA

This section describes the results of the Toxic Substances Monitoring Program (TSMP) for stations in the Project area. The TSMP is conducted by the SWRCB and the California Environmental Protection Agency with cooperation from DFG. The purpose of the TSMP is to provide a uniform statewide approach to the detection and evaluation of the occurrence of toxic substances in fresh, estuarine, and marine waters of the State through the analysis of fish and other aquatic life (SWRCB 1993). As stated in the 1993 TSMP report (SWRCB 1993) different aquatic organisms tend to bioaccumulate a given toxic substance in water to different levels; however, the differences usually do not prevent a general interpretation of the data. The limited number of samples obtained and analyzed at each station in a single year is generally too small to provide a statistically sound basis for making absolute statements on toxic substance concentrations. Data from 1978 through 1991 were obtained from reports (SWRCB 1990, 1991, 1992, and 1993). More recent data were provided by Del Rasmussen of the SWQCB. Data for whole organism tissues from the Laguna, Santa Rosa Creek, Mark West Creek, and the Russian River below Healdsburg are presented in this report. The entire data set for the project area is given in Appendix 5.

10.1 TRACE ELEMENTS

Samples for analysis of trace elements were collected in the Project area between 1978 and 1993. Complete data for these stations are presented in Appendix 5. The number of times each station was sampled varied from 1 to 9, with the Russian River at Oddfellows Bridge sampled the most frequently. Trace element concentrations in whole organisms from stations in the Russian River, Laguna de Santa Rosa, Santa Rosa Creek and Mark West Creek are shown in Table 26.

Table 26.

Results of TSMP trace elements () in whole organisms in the Laguna, Santa Rosa Creek, Mark West Creek, and Russian River
ppm wet weight

Station Name	Species[a]	Date	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
Russian River at Odd Fellows Bridge	COR	7/11/78	0.54	0.16	1.1	4.2	ND[b]		1.1		0.04	18
Russian River at Odd Fellows Bridge	PACI	7/11/79	0.2	0.01	ND	9.9	ND		ND		0.02	13
Russian River at Wohler Bridge	**TFC**	**12/30/87**	**0.77**	**0.52**	**0.79**	**6.6**	**ND**	**0.05**	**1.7**	**0.51**	**0.02**	**13**
Russian River at Hacienda Bridge	**TFC**	**12/30/87**	**0.7**	**0.68**	**0.41**	**4.8**	**0.2**	**0.03**	**1.4**	**0.48**	**0.02**	**15**
Laguna De Santa Rosa at Stony Pt	**TFC**	**12/30/87**	**0.88**	**0.72**	**0.14**	**3.7**	**ND**	**0.04**	**0.3**	**0.57**	**0.02**	**12**
Santa Rosa Creek at Willowside	**TFC**	**12/30/87**	**0.84**	**0.68**	**0.4**	**4.6**	**0.1**	**0.08**	**0.9**	**0.54**	**0.02**	**14**
Mark West Creek at Slusser	SKR	10/8/92	0.14	0.02	1.1	1.1	0.2	0.04	0.97	0.25	ND	19
Russian River at Duncans Mills	PCP	7/17/91	0.16	ND	0.09	1	ND	0.26	1.2	0.21	ND	5.6
Russian River at Duncans Mills	PCP	7/22/92	0.19	ND	0.07	0.92	ND	0.29	ND	0.23	ND	15
Russian River at Odd Fellows Bridge	GSF	7/23/92	0.07	ND	0.25	0.94	ND	0.19	0.29	0.33	ND	22
Russian River at Wohler Bridge	SMB	10/8/92	0.12	ND	0.11	0.71	ND	0.24	ND	0.3	ND	21
Mark West Creek at Slusser	WCR	9/8/93	0.09	0.01	0.1	0.72	ND	0.07	ND	0.17	ND	26
NAS Guidelines (whole fish)								0.5				
Median International Standards (freshwater fish)[c]			1.5	0.3	1	20	2	0.5		2		45
TSMP EDL 85 (whole freshwater fish)[d]			0.44	0.08	0.23	3.4	0.2	0.1	0.2	1.4	0.03	40
TSMP EDL 95 (whole freshwater fish)[e]			0.92	0.15	0.48	4.34	0.5	0.19	0.56	1.86	0.05	49

Table 26.

Results of TSMP trace elements () in whole organisms in the Laguna, Santa Rosa Creek, Mark West Creek, and Russian River
ppm wet weight

Station Name	Species[a]	Date	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn

[a] COR = Asiatic clam (Corbicula), PACI = crayfish, SKR = sucker, TFC = transplanted Asiatic clam, PCP = prickly sculpin, GSF = green sunfish, SMB = smallmouth bass, WCR = white crappie
[b] ND = the concentration was below detection. Detection limits, where available, are given in Appendix 5.
[c] NAS Guidelines = maximum concentrations of toxic substances in freshwater fish tissue recommended by the National Academy of Science (SWRCB 1993).
[d] Median International Standards = the median of health protection criteria used by members of the United Nations (SWRCB 1993).
[e] TSMP EDL 85 and TSMP EDL 95 = The concentration of the toxic substance that equals 85 percent (or 95 percent) of all TSMP measurements of the toxic substance in the same fish and tissue type from 1978 through 1991 (the 85th or 95th cumulative frequency percentile) (SWRCB 1993).

10.2 ORGANIC COMPOUNDS

Samples for analysis of organic compounds were collected in the Project area between 1978 and 1993. Complete data for these stations are presented in Appendix 5. The number of times each station was sampled varied from 1 to 9, with the Russian River at Oddfellows Bridge sampled the most frequently. Usually 46 different organic constituents were analyzed. Detectable organic concentrations in whole organisms from stations in the Russian River, Laguna de Santa Rosa, Santa Rosa Creek and Mark West Creek are shown in Table 27.

10.3 COMPARISON ABOVE AND BELOW SANTA ROSA'S DISCHARGE

The only data available for comparisons of trace elements and organic compounds in tissue above and below Santa Rosa's discharge are on one date from the Russian River at Wohler Bridge, the Laguna at Stony Point, and Santa Rosa Creek at Willowside (all above the confluence with the Laguna) and the Russian River at Hacienda Bridge (below the confluence) in 1987. These values are shown in bold in Tables 26 and 27. The data for other stations are for different species above and below the discharge. Concentrations of trace metals in tissues were very similar in above and below the discharge with the possible exception of lead which ranged from below detection to 0.1 mg/L above the discharge and was 0.2 mg/L below the discharge. Only one organic compound, total DDT, was detectable in tissues below the discharge and it was found in the same concentration as two of the three stations above the discharge.

Table 27.

Results of TSMP detectable organic compounds (ppb wet weight) in whole organisms in the Laguna and Russian River.

Station Name	Species	Date	Total chlordane	Chlorpyrifos	Dacthal	Dieldrin	Total DDT	Total HC	Chemical group A
Russian River at Odd Fellows	COR	7/11/78	ND[b]	ND	ND	ND	35	ND	ND
Russian River at Hacienda	**TFC**	**12/30/87**	**ND**	**ND**	**ND**	**ND**	**11**	**ND**	**NA**
Russian River at Wohler	**TFC**	**12/30/87**	**ND**	**ND**	**ND**	**ND**	**11**	**ND**	**NA**
Laguna de Santa Rosa at Stony Pt	**TFC**	**12/30/87**	**10.2**	**ND**	**11**	**6.2**	**8.4**	**ND**	**NA**
Santa Rosa Creek at Willowside	**TFC**	**12/30/87**	**31.2**	**12**	**ND**	**6.2**	**11**	**ND**	**NA**
Russian River at Duncans Mills	PCP	7/17/91	ND	ND	ND	ND	16	ND	ND
Russian River at Duncans Mills	PCP	7/22/92	5.1	ND	ND	ND	19	ND	5.1
Russian River at Odd Fellows	GSF	7/23/92	ND	ND	ND	ND	24	ND	ND
Russian River at Wohler	SMB	10/8/92	ND	ND	ND	ND	15	ND	ND
Mark West Creek at Slusser	SKR	10/8/92	ND	ND	ND	ND	14	ND	ND
NAS Guidelines (whole fish)[c]			100			100	1000	100	
TSMP EDL 85 (whole freshwater fish)[d]			144.8	26.2	95.6	49.4	2479.2	4	1686.6
TSMP EDL 95 (whole freshwater fish)[d]			204.8	73.6	426	473.5	5358.2	9.6	3498.7

a COR = Asiatic clam (Corbicula), PACI = crayfish, TFC = transplanted Asiatic clam, PCP = prickly sculpin, GSF = green sunfish, SMB = smallmouth bass, SKR = sucker
b ND = the concentration was below detection. Detection limits, where available, are given in Appendix 5.
c NAS Guidelines = maximum concentrations of toxic substances in freshwater fish tissue recommended by the National Academy of Science (SWRCB 1993).
d TSMP EDL 85 and TSMP EDL 95 = The concentration of the toxic substance that equals 85 percent (or 95 percent) of all TSMP measurements of the toxic substance in the same fish and tissue type from 1978 through 1991 (the 85th or 95th cumulative frequency percentile) (SWRCB 1993).

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12.0 APPENDICES

APPENDIX 1. FIELD SAMPLING AND QUALITY ASSURANCE PROJECT PLAN

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APPENDIX 1. FIELD SAMPLING AND QUALITY ASSURANCE PROJECT PLAN

SAMPLING PROCEDURES

After approval of the study work plan, the field activities will be executed. This section discusses the standard sampling procedures. Other sampling procedures may be used as determined necessary by the field supervisor.

Detailed reports on all sampling activities will be kept in field logbooks. This book will note the date, time, location, and identification of each sample, along with the collector's name, a description of all equipment used and any problems encountered, and general comments of the sampling team. Logbooks also are used to record pertinent information regarding the site itself.

Proper identification and labeling of samples is crucial to an effective sampling program. Immediately upon collection, each sample must be sealed and tagged. The tag should be marked with a sample identification number, station location, type (composite or grab), the parameters requested, collector's name, and the date and time of sample collection.

It is important that QA/QC be maintained for each sample. The purpose of this section is to outline specific procedures for field crew to use while acquiring and handling samples during the field work to ensure that quality data are obtained.

Sample Collection

The following principles and procedures should be adhered to during the sample collection phase of the study:

- Obtain ice and dry ice before visiting a site where sample collection is involved.
- Sample methods, recommended containers, and preservation methods are listed in Table 1.
- Collect samples from the most near-shore location and proceed offshore to next sample location. Care should be taken when working at a site not to cause disturbances of other sample locations.
- Change disposable gloves between sampling different tissues, placing used gloves in a plastic bag for disposal
- When reusing sampling devices, use the specified decontamination procedures between sampling points.
- At each sampling location record in the logbook:

    1. Sample number
    2. Location (show on site sketch)
    3. Type of sample

4. Time

5. Relevant observations.

- Place samples in appropriate cooler (ice for sediment, dry ice for tissues). Before placing in cooler:

- Complete the sample tags and labels, and place clear tape over the sample labels to protect the writing from moisture.

- Wrap the glass jars with plastic foam, bubble pack or equivalent to protect against breakage.

- Place the sample containers in plastic Ziploc bags or equivalent to prevent melted ice from contacting the container.

- Remove water from melted ice frequently, and replace with fresh ice. Place ice in plastic Ziploc or sealable bags to minimize water leakage during shipment.

Table 1.

Sample Methods and Recommended Containers.

Sample Parameter	Analytical Method	Holding Time	Containers	Preservative
Metals				
Aluminum	7020	6 months	glass jars for sediment and small tissue, foil wrapped and put into Ziploc bags for larger tissue	cool to 4°C for sediment, freeze on dry ice for tissue
Arsenic	7060	6 months	same as for aluminum	same as for aluminum
Cadmium	7131	6 months	same as for aluminum	same as for aluminum
Chromium	7190	6 months	same as for aluminum	same as for aluminum
Copper	7211	6 months	same as for aluminum	same as for aluminum
Lead	7421	6 months	same as for aluminum	same as for aluminum
Mercury	7470	28 days	same as for aluminum	same as for aluminum
Nickel	7520	6 months	same as for aluminum	same as for aluminum
Selenium	7780	6 months	same as for aluminum	same as for aluminum
Silver	7760	6 months	same as for aluminum	same as for aluminum
Zinc	7951	6 months	same as for aluminum	same as for aluminum
Organochlorine Pesticides/ PCB's	8081	14 days	same as for aluminum	same as for aluminum

Sample Parameter	Analytical Method	Holding Time	Containers	Preservative
Organophosphate Pesticides	8141	14 days	same as for aluminum	same as for aluminum
Herbicides	8150	14 days	same as for aluminum	same as for aluminum
% Lipid		-	same as for aluminum	same as for aluminum
% Moisture		-	same as for aluminum	same as for aluminum
TOC	415.1	-	same as for aluminum	same as for aluminum
pH	150.1	-	same as for aluminum	same as for aluminum
AVS	EPA draft method	-	same as for aluminum	same as for aluminum

Sample Locations

Samples will be collected from the Kelly Farm Demonstration Wetland Cell 3.

Field Sampling

The proposed field sampling methodology is described below. Alternative methods or approaches may also be necessary based on characteristics in the field.

Sediment Sampling

Triplicate composite sediment samples will be collected for the constituents shown in Table 2. MSC will use a Petit Ponar sediment sampler to collect samples for organic analysis and a core sampler constructed of PVC to collect samples for metals analysis. Samples from the top 2-3 inches of sediment will be collected. Every effort to preclude contamination and cross contamination of the samples shall be exercised during sample collection. Each sample will be composed of 3-5 subsamples taken from widely spaced locations throughout the pond. Sediment sampling will be done prior to biological sampling and shore subsamples will be collected prior to offshore samples to minimize disturbance to the sediment. Sediment samples will be placed into glass jars. Sediment samples will then be put into an ice chest and cooled to 4°C.

Table 2.

Sample Collection Plan

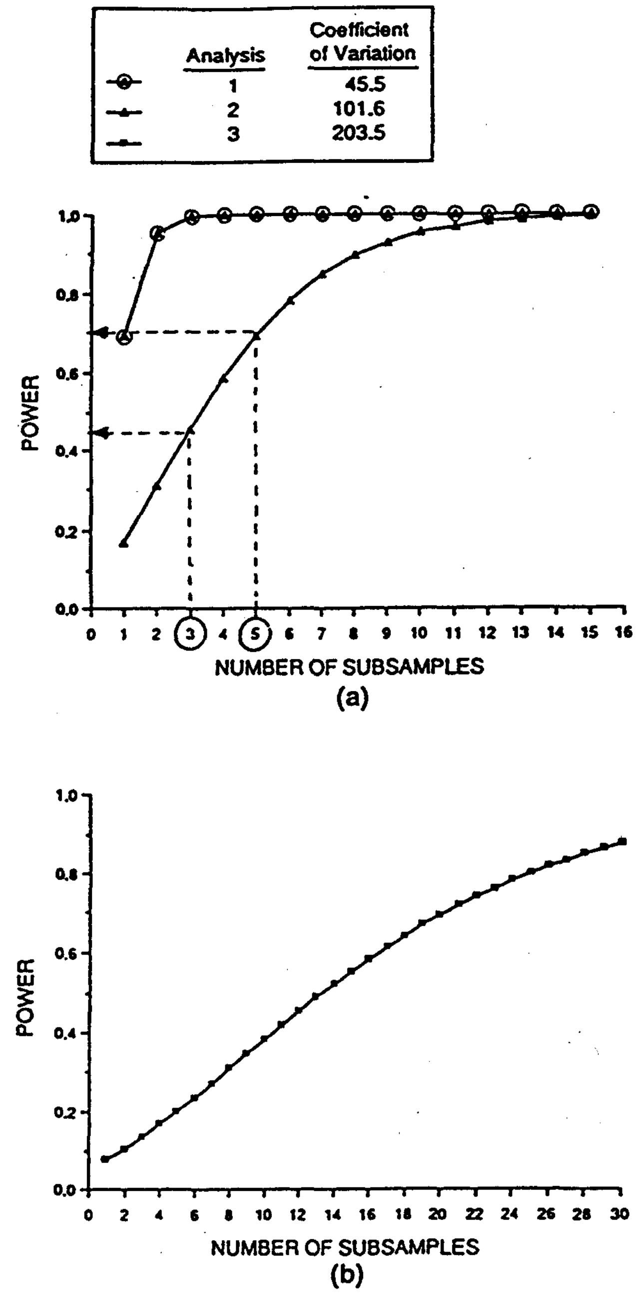
Tissue	# Samples	Constituent
Sediment	3 composite	% moisture, pH, TOC, Al, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Zn, organochlorine pesticides and PCBs (8080), organophosphorus pesticides (8140), herbicides (8150), AV sulfides
Bulrush seeds	same as for sediment	% moisture, % lipids, Al, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Zn, organochlorine pesticides and PCBs (8080), organophosphorus pesticides (8140), herbicides (8150)
Cattail rhizomes	same as for sediment	same as for bulrush seeds
Crayfish	same as for sediment (6-10 organisms/ composite	same as for bulrush seeds
Mosquitofish	same as for sediment	same as for bulrush seeds

Biological Sampling

MSC will collect triplicate composite samples of four tissue types as shown in Table 2. Each sample will be composed of 3-5 subsamples taken from widely spaced locations throughout the pond. Every effort to preclude contamination and cross contamination of the samples shall be exercised during sample collection. Bulrush seeds, cattail rhizomes, and mosquito fish samples will be placed in glass jars. Crayfish will be wrapped in aluminum foil and then placed in Ziploc bags. All biological samples will then be placed in an ice chest with dry ice and frozen.

Number of Subsamples Per Composite Sample.

A numerical simulation study conducted by EPA evaluated the effects of composite sampling on the statistical power of a sampling design. This study indicated that the increase in the number of subsamples in the composite sample will 1) increase the confidence in the estimate of mean values, and 2) increases the probability of detecting differences among mean values of multiple sampling sites. For the collection of five composite samples from five sampling sites, the EPA study concluded that three to thirty subsamples were required to obtain a minimum detectable difference equivalent to the overall mean value (Figure 1). This range of values was dependent on the variability of the data, an unknown parameter for the proposed survey. Assuming that data variability in the survey locations falls within the intermediate range evaluated by the EPA study (coefficient of variation = 101.6 percent), a number of organisms from three to five per composite sample will yield a fifty-five to seventy percent probability of statistically detecting differences equal to the overall mean among sampling sites.



Reference: Tetra Tech (1986b)

Figure 1. Power of statistical tests vs. number of subsamples in composite replicate samples. Fixed design parameters: number of stations = 5, number of replicates = 5, significance level = 0.05, minimum detectable difference = 100 percent of overall mean value.

Ref.: EPA, 1989. "Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish." (EPA/8-89-002)

Decontamination Procedures

To prevent contamination of samples by materials originating from the variety of onsite sampling tools and equipment, all sampling equipment will be decontaminated. All equipment to be used at one site will be decontaminated in one batch prior to initiating any sampling. In the event that additional sampling is required or a sampling tool's integrity is questionable, then that tool will go through a decontamination process. The decontamination procedures are as follows:

1. Rinse equipment with tap (potable) water.
2. Clean the equipment with a brush in a solution of laboratory-grade detergent (Liquinox, Alconox, or equivalent) and potable water.
3. Rinse with isopropanol.
4. Rinse with distilled or deionized water.
5. Air dry.
6. Place in plastic sealable bag if immediate use is not expected.

The sampling equipment will be cleaned as described above before its use for collecting each sample. After sampling is complete, each sample tool will be cleaned with a detergent wash and a rinse with distilled water to remove any potential contamination.

Record Keeping

All information pertinent to sampling will be recorded in a logbook. This book will be bound and have consecutively numbered pages. Entries in the logbook will be made in ink and will include, at a minimum, a description of all activities, the names of all individuals involved (sampling and oversight), date and time of sampling, weather conditions, any problems, and all field measurements.

SAMPLE CUSTODY

Sample custody is an integral part of any sample collection and analysis plan. Several steps for maintaining sample custody apply to field sample custody versus laboratory sample custody. First, in the field, the appropriate collection, identification, preservation, and shipment of the samples will ensure sample integrity. The second step is correct sample bottle identification and preparation. Lastly, when samples reach the laboratory, they are assigned a laboratory number and maintained at 4°C or frozen on dry ice until sample preparation and analyses can be performed.

Field Sample Custody

Sample custody and documentation procedures described in this section will be followed throughout all sample collection. Components of sample custody are field logbooks, sample labels, sample tags, and chain-of-custody forms.

Field Logbooks

Field logbooks will be maintained by the field supervisor to provide a daily record of significant events, observations, and measurements during the field investigation. All entries will be signed and dated.

All information pertinent to the field survey and sampling will be recorded in the logbooks. Waterproof ink will be used in making all entries. Entries in the logbook will include, at the minimum, the following:

- Names of field personnel, date and time of sampling, and physical/environmental conditions during field activity
- Location of sampling activity
- Sampling documentation:
- Description of sampling point(s)
- Date and time of collection
- Sample identification numbers (each sample description shall include the appropriate sampling site numbers as specified above)
- Field observations and unusual field conditions (such as description of the samples, e.g., thickness, composition, color, presence of oil sheen or gas bubbles, odor).
- Any field measurements made (such as pH, conductivity, temperature) including specific calibration data and documentation of field equipment (serial number, decontamination, etc.)
- Sample handling information

None of the field logbooks or chain-of-custody documents will be destroyed or discarded, even if they are illegible or contain inaccuracies that require a replacement document. If an item entered is discovered to be incorrect, the wrong information will be crossed out in such a manner that it is still legible, the correction made, and the change initialed and dated. If the change is made by someone other than the original author or if the change is made on a subsequent day, a reason for the change will be recorded at the then-current active location in the logbook, with cross-references.

Full chain-of-custody documentation (Figure 2) will all also be recorded for all samples collected.

Sample Tags

All samples collected will be placed in an appropriate sample container for preservation and shipment to the designated laboratory. Each sample will be identified with a separate identification label and tag. The containers and ice chests will be sealed with custody seals. These identification tags and seals will be provided by MS. The label will contain the sample number. The following information will be recorded on the tag:

- Analyses to be performed
- Sample identification number
- Source/location of sample
- Type of sample (composite sediment, core sediment, species of organism)
- Preservatives used (ice, dry ice)
- Date
- Time (a four-digit number indicating the 24-hour clock time collection)
- Sampler's signature.

Shipping of Samples

Samples will be shipped and delivered to the designated laboratory for analysis daily. The samples will be shipped in ice chests by an overnight carrier such as Federal Express. The chest will be sealed with custody seals and/or tamper-resistant tape. Custody seals will be signed by the sample custodian shipping the samples. The airbill number will be noted on the chain of-custody form.

ANALYTICAL PROCEDURE

Selected Laboratory

Sample analyses will be by the Hazleton Environmental Services, Inc. (HES), of Madison, Wisconsin. The laboratory has been selected based upon their relevant experience and unique capabilities for sediment and biological tissue analyses. HES is involved in many national and regional environmental programs.

CHAIN OF CUSTODY RECORD

PROJECT NO.	PROJECT NAME
SAMPLERS (Signatures)	

DATE	TIME	MATRIX	SAMPLE IDENTIFICATION	NO. OF CONTAINERS	Analysis Required										REMARKS

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)

White: laboratory returns with data, yellow: laboratory copy, pink: sampler copy

Figure 2 Chain of Custody Record

Analytical Parameters and Quantitation Limits

HES will analyze all samples according to accepted protocols and standard operating procedures (SOPs). Full quality assurance/quality control (QA/QC) procedures, including duplicate and fortified samples, certified reference materials, and procedural blanks, will be analyzed at recommended frequencies. All samples will be analyzed and data reported by the prearranged date.

All samples will be analyzed by EPA methods with method detection limits (MDL's) as shown in Table 3.

Holding Times

Holding times specified by EPA protocols will apply for the samples collected under this QAPP. Refer to Table 1 for a list of analyses and their holding times.

FIELD SAMPLING AND QUALITY ASSURANCE OBJECTIVES

Introduction

A field sampling and quality assurance project plan is essential to assure the quality, controllability, accountability, and traceability of the work proposed for the City of Santa Rosa to assess bioaccumulation in Kelly Farm Demonstration Wetland. Quality assurance encompasses all actions taken by MSC to achieve results which are accurate, reliable, and legally defensible for all aspects of the project. MSC will adhere to the quality assurance procedures outlined herein and will rigorously implement the QA program throughout the duration of the project.

The primary goal of this field sampling and quality assurance program is to ensure the accuracy and completeness of the data. In order to achieve this accuracy and completeness, it is necessary that all sampling, analysis, and data management activities be conducted in accordance with preset standards, and that these activities be reviewed regularly to maintain full compliance with the standards. This program has been designed so that corrective action can be implemented quickly if necessary without causing undue expense or delay to the project. The standards and review procedures which MSC will use to attain optimum accuracy and completeness of data are outlined in this plan.

Table 3.

Constituents and Method Detection Limits (MDL's).[a]

Sample Parameter	MDL (mg/kg)	
	Sediment	Tissue
Metals		

Sample Parameter	MDL (mg/kg)	
	Sediment	Tissue
Aluminum		
Arsenic	0.4	0.2
Cadmium	0.2	0.01
Chromium		
Copper		
Lead	0.2	0.01
Mercury	0.01	0.01
Nickel		
Selenium	0.4	0.2
Silver		
Zinc		
Organochlorine Pesticides/ PCB's (8081)b		
Aldrin	0.0017	0.0031
Alpha-BHC	0.0017	0.0016
Beta-BHC	0.0017	0.0031
Delta-BHC	0.0017	0.0031
Gamma-BHC	0.0017	0.0011
Alpha-chlordane	0.0017	0.0036
Gamma-chlordane	0.0017	0.0059
4,4-DDE	0.0033	0.0026
4,4-DDD	0.0033	0.004
4,4-DDT	0.0033	0.0023
Dieldrin	0.0033	0.011
Endosulfan I	0.0017	0.0026
Endosulfan II	0.0033	0.0028
Endosulfan sulfate	0.0033	0.012
Endrin	0.0033	0.0067
Endrin ketone	0.0033	0.0021
Endrin aldehyde	0.0033	0.0039
Heptachlor	0.0017	0.0031
Heptachlor epoxide	0.0017	0.0015
Methoxychlor	0.017	0.0038
Toxaphene	0.170	0.010
Araclor 1016	0.033	0.016

Sample Parameter	MDL (mg/kg)	
	Sediment	Tissue
Araclor 1221	0.067	NA
Araclor 1232	0.033	NA
Araclor 1242	0.033	0.012
Araclor 1248	0.033	0.027
Araclor 1254	0.033	0.03
Araclor 1260	0.033	0.01
Hexachlorobenzene	-	0.0089
O,P'-DDE	-	0.0072
O,P'-DDD	-	0.0052
O,P'-DDT	-	0.0062
Pentachloroanisole	-	NA
Oxychlordane	-	0.0016
Trans-nonachlor	-	0.0028
Cis-nonachlor	-	0.0038
Mirex	-	0.0039
Technical BHC	-	0.008
Organophosphorus Pesticides (8141)c		
Azinphos methyl	0.005	
Bolstar (sulprofos)	0.0035	
Chlorpyrifos	0.005	
Coumaphos	0.010	
Demeton, O and S	0.006	
Diazinon	0.0093	
Dichlorvos	0.040	
Dimethoate	0.013	
Disulfoton	0.0035	
EPN	0.002	
Ethoprop	0.010	
Fensulfothion	0.004	
Fenthion	0.005	
Malathion	0.0055	
Merphos	0.010	
Methidathion	0.019	
Mevinphos	0.025	

Sample Parameter	MDL (mg/kg)	
	Sediment	Tissue
Monocrotophos	NA	
Naled	0.025	
Parathion-ethyl	0.003	
Parathion-methyl	0.006	
Phorate	0.002	
Ronnel	0.0035	
Sulfotep	0.0035	
TEPP	0.040	
Stirophos	0.040	
Tokuthion	0.0055	
Trichloronate	0.040	

[a] MDL's for metals other than those shown, for organophosphate pesticides in tissue analyses, and for herbicides in both sediment and tissue analyses are not yet available.

[b] MDL's for organochlorine pesticides and PCB's in tissue are on a wet weight basis.

[c] Most organophosphate pesticide MDL's are based on EPA referened method.

NA = not determined

The quality assurance objectives for all measurement data include considerations of precision, accuracy, completeness, representativeness, and comparability.

Precision

The precision of a measurement is an expression of mutual agreement of multiple measurement values of the same property conducted under prescribed similar conditions. Precision is evaluated most directly by recording and comparing multiple measurements of the same parameter on the same exact sample under the same conditions or a matrix spike and matrix spike duplicate. It is usually expressed in terms of the relative percent difference (RPD). The RPD can be evaluated both internal (laboratory duplicates) and external (field duplicates) to the laboratory. For metals and organic analyses, a control limit of 20 percent RPD will be used for matrix spike and matrix spike duplicate sample values greater than or equal to 5 times the required detection limit. For field duplicates, an RPD of 50 percent will be used as the objective of precision.

RPD is calculated as:

$$RPD = \frac{|x_1 - x_2|}{\overline{x}} \times 100$$

where:

x_1 = analyte concentration of first duplicate

x_2 = analyte concentration of second duplicate

$\overline{x}$ = average analyte concentration of duplicates 1 and 2.

Accuracy

The degree of accuracy of a measurement is based on a comparison of the measured value with the actual true value. Accuracy of an analytical procedure is best determined based on the recoveries of matrix spike, matrix spike duplicate, and surrogate compounds.

The degree of accuracy and the recovery of analyte to be expected for the analyses of QC samples and spiked samples is dependent on the matrix, method of analysis, and the compound or element being determined. For metals analysis, the spike recovery limits of 75-125 percent will be used.

Accuracy is expressed as a percent recovery (PR), calculated by:

$$PR = \frac{(A - B)}{C} \times 100$$

where:

A = spiked sample result (SSR)

B = sample result (SR)

C = spike added (SA).

Representativeness

Representativeness expresses the degree to which the sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is addressed by describing sampling techniques, the rationale used to select sampling locations, decontamination procedures, and sample packaging, shipping, and custody procedures. This can be accomplished by collecting samples from locations that fully represent the site condition, using appropriate sampling equipment, adhering to proper sampling procedures, using appropriate analytical methodologies and quantitation limits, and completing all analysis within the prescribed holding time.

Comparability

Consistency in the acquisition, handling, and analysis of samples is necessary so the results may be compared with previous and future studies. Concentrations will be reported in a manner consistent with general practices. Standard EPA analytical methods and quality control will be used to support the comparability of analytical results with those obtained in other testing. Calibrations will be performed in accordance with EPA or manufacturer's specifications and will be checked with the frequency specified in the methods.

Completeness

Completeness is a measure of the amount of usable data resulting from a data collection activity. Completeness can be evaluated two ways. Field completeness is assessed by comparing the number of proposed sampling locations with the number of actual locations. Laboratory completeness is measured by comparing the number of tests initially requested with the number of tests successfully completed and reported by the testing laboratory. The objective for completeness will be 90 percent, meaning that valid analytical data must be reported by the laboratory for at least 90 percent of the samples collected and shipped to the laboratory for analysis.

The percent completeness (PC) is calculated as follows:

$$P = \frac{A}{I} \times 100$$

where:

A = actual number of valid analytical results obtained

I = theoretical number of results obtainable under ideal conditions

DATA REDUCTION, VALIDATION, AND REPORTING

Laboratory Data

The procedures used for calculations and data reduction are specified in each method referenced previously. It will be the responsibility of the laboratory to follow these procedures.

Validation

At a minimum, the analytical data generated will be validated using the criteria outlined in the EPA document, "EPA Functional Guidelines for Evaluating Inorganic Analyses" (July, 1988).

Data validation procedures ensure that the sample analytical data are accompanied by appropriate QC data and supporting text. The data validation protocol for this project is as follows:

- Check that sample reports are signed by the analyst or laboratory QA officer signifying that the analyses were performed in accordance with the designated methods.
- Ensure that the sample report refers to the corresponding QC data sheets that accompany the sample data.
- Check that a log of the sample identification (designated in the field), the corresponding laboratory sample number, and the applicable QC are provided.
- Ensure that standards for precision and accuracy, representativeness, comparability, and completeness were compared with predetermined objectives. If the predetermined objective is not met, an explanation must be provided (e.g., matrix effects) and the corrective action (described below) must be implemented.
- Ensure that a cover letter accompanies each set of data, giving a case narrative for each batch and denoting any peculiarities of the samples or analyses.
- Verify that the lab provided appropriate control limits for MS/MSDs and calibrations performance on the corresponding reporting forms.
- Review the data package for compliance with QAPP objectives, method QC objectives, and deliverable requirements.

Reporting

The project analytical report from the laboratory will contain data sheets and the results of analysis of QC samples. Analytical reports may also contain the following items:

- Units of measurement
- Project identification
- Field sample number
- Laboratory sample number
- Sample matrix description

- Date of sample collection
- Analytical method description and reference citation
- Individual parameter results
- Date of analysis (extraction, first run, and subsequent runs)
- Quantitation limits achieved
- Dilution or concentration factors
- Corresponding QC report (including duplicates, spikes, laboratory control sample results, initial and continuing calibration percent recovery results, and calibration blank and preparation blank results)
- Laboratory name.

Matrix interferences on some of the samples may result in increased detection limits. Matrix interference will be reported as the cause of increased detection limits. These data will be valid.

Internal Quality Control Checks and Frequency

Quality Assurance Batching

Quality assurance for analytical work on this project will involve analysis of laboratory blank samples, spiked samples, and duplicate samples. For each group of 20 samples (or less if fewer than 20 samples are collected) of similar matrix (i.e., sediment or tissue) collected at each site, analysis will be conducted on one blank one spiked, and one duplicate spiked sample.

Performance and System Audits

QA audits may be performed by the project quality assurance manager (QAM) or his designees. Functioning as an independent agent, the QAM or his designee will plan, schedule, and approve system and process audits according to company procedure, customized to specific project requirements. These audits will be implemented to evaluate the capability and performance of project, activities, and documentation of the measurement system(s).

The QAM will be Marcie Commins, Ph.D. who will report directly to the technical director. The QAM will coordinate and monitor the overall QA program, including all onsite activities and the quality control program of the laboratories. Implementing prompt, effective, and accurate corrective action in response to noncompliance that may occur on projects is absolutely essential in assuring the quality of the end product.

A quality system audit refers to a detailed evaluation of the project's quality assurance program to determine its conformance to contractual commitments and standard company procedures. Such an audit includes preparation of formal plans and a checklist based on established requirements. Audits may be performed on MSC and subcontractor work.

APPENDIX 2. 1994 BIOACCUMULATION STUDY RAW DATA

Appendix 2. Kelly Farm Demonstration Wetland. 1994 Bioaccumulation Study Raw Data.

Constituent	Cattail Rhizomes						Crayfish						Mosquito Fish					
	Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3	
Moisture	74		75.2		76.8		6.6		65.2		67.6		80.3		82.1		80.2	
Lipid	0.145		0.13		0.155		1.74		0.415		1.03		3.11		2.45		3.24	
Aluminum	317		2420		811		387		403		556		1390		1280		1630	
Chromium	1.58		7.87		2.81		1.73		1.78		2.14		5.74		4.97		5.78	
Copper	5.12		9.49		7.54		107		65.1		84.9		6.74		6.61		7.08	
Nickel	3.33		12.3		5.68		2.47		2.53		8.48		5.96		4.94		5.58	
Silver	1.36		0.426		0.976		0.294	*	1.04		0.454		0.501	*	1.74		1.74	
Zinc	10.5		16.8		18.8		63.4		61.1		62		134		147		150	
Arsenic	0.19	*	0.48		0.22	*	0.3		0.29		1.71		0.51		0.28	*	0.25	*
Cadmium	0.19	*	0.2	*	0.22	*	0.15	*	0.14	*	0.15	*	0.25	*	0.28	*	0.25	*
Mercury	0.038	*	0.04	*	0.041	*	0.035		0.045		0.069		0.101		0.099		0.107	
Lead	0.96		2.02		0.73		0.45		1.7		0.66		1.42		1.12		0.96	
Selenium	0.38	*	0.4	*	0.43	*	0.3	*	1.16		0.3	*	0.51	*	0.56	*	0.51	*
2,4-D	100	*	100	*	100	*	100	*	100	*	100	*	100	*	100	*	100	*
2,4,5-TP	20	*	20	*	20	*	20	*	20	*	20	*	20	*	20	*	20	*
2,4,5-T	20	*	20	*	20	*	20	*	20	*	20	*	20	*	20	*	20	*
Organophosphorous Pest																		
Azinphos Methyl	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Bolstar	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*
Chloropyrifos	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Coumaphos	16	*	16	*	16	*	16	*	16	*	16	*	16	*	16	*	16	*
Demeton, O,S	9.6	*	9.6	*	9.6	*	9.6	*	9.6	*	9.6	*	9.6	*	9.6	*	9.6	*
Diazinon	16	*	16	*	16	*	16	*	16	*	16	*	16	*	16	*	16	*
Diclorovos	64	*	64	*	64	*	64	*	64	*	64	*	64	*	64	*	64	*
Dimethoate	21	*	21	*	21	*	21	*	21	*	21	*	21	*	21	*	21	*
Disulfoton	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*
EPN	3.2	*	3.2	*	3.2	*	3.2	*	3.2	*	3.2	*	3.2	*	3.2	*	3.2	*
Ethoprop	16	*	16	*	16	*	16	*	16	*	16	*	16	*	16	*	16	*
Fensulfothion	6.4	*	6.4	*	6.4	*	6.4	*	6.4	*	6.4	*	6.4	*	6.4	*	6.4	*
Fenthion	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Malathion	8.8	*	8.8	*	8.8	*	8.8	*	8.8	*	8.8	*	8.8	*	8.8	*	8.8	*
Merphos	16	*	16	*	16	*	16	*	16	*	16	*	16	*	16	*	16	*
Mevinphos	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*
Naled	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*

* = below detection. Number to left is reporting limit.

Appendix 2. Kelly Farm Demonstration Wetland. 1994 Bioaccumulation Study Raw Data.

Constituent	Cattail Rhizomes						Crayfish						Mosquito Fish					
	Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3	
Ethyl Parathion	4.8	*	4.8	*	4.8	*	4.8	*	4.8	*	4.8	*	4.8	*	4.8	*	4.8	*
Methyl Parathion	9.6	*	9.6	*	9.6	*	9.6	*	9.6	*	9.6	*	9.6	*	9.6	*	9.6	*
Phorate	3.2	*	3.2	*	3.2	*	3.2	*	3.2	*	3.2	*	3.2	*	3.2	*	3.2	*
Ronnel	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*
Sulfotep	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*	5.6	*
Tepp	64	*	64	*	64	*	64	*	64	*	64	*	64	*	64	*	64	*
Stirophos	64	*	64	*	64	*	64	*	64	*	64	*	64	*	64	*	64	*
Tokuthion	8.8	*	8.8	*	8.8	*	8.8	*	8.8	*	8.8	*	8.8	*	8.8	*	8.8	*
Trichloronate	64	*	64	*	64	*	64	*	64	*	64	*	64	*	64	*	64	*
Monocrotophos	16	*	16	*	16	*	16	*	16	*	16	*	16	*	16	*	16	*
Gamma-BHC (Lindane)	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Heptachlor	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Aldrin	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Heptachlor Epoxide	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Endosulfan I	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Dieldrin	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Endosulfan II	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
4,4'-DDT	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Alpha-BHC	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Beta-BHC	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Delta-BHC	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Gamma-Chlordane	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Alpha-Chlordane	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
4,4'-DDE	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Endrin	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
4,4'-DDD	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Endosulfan Sulfate	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Endrin Aldehyde	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*	8	*
Toxaphene	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*
Aroclor 1016	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*
Aroclor 1221	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*
Aroclor 1232	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*
Aroclor 1242	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*
Aroclor 1248	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*
Aroclor 1254	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*
Aroclor 1260	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*	40	*

* = below detection. Number to left is reporting limit.

Appendix 2. Kelly Farm Demonstration Wetland. 1994 Bioaccumulation Study Raw Data.

Constituent	Cattail Rhizomes						Crayfish						Mosquito Fish					
	Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3	
Methoxychlor																		
Endrin Ketone																		
Total organic carbon																		
pH																		
Acid volatile sulfide																		

* = below detection. Number to left is reporting limit.

Appendix 2. Kelly Farm Demonstration Wetland. 1994 Bioaccumulation Study Raw Data.

Constituent			Bullrush Seeds						Kelly Farm Pond Sediment						
	Rep 4		#1		#2		#3		Rep1		Rep 2		Rep 3		Rep 4
Moisture	80.9		24.9		22.2		22.3								
Lipid	2.9		0.785		0.755		0.635								
Aluminum	626		36.4		37		32.9		14400		19500		19200		20900
Chromium	3.26		0.295		0.321		0.28		51.8		65.7		66		70.5
Copper	6.73		4.66		4.26		4.12		22		24.5		24.3		27.7
Nickel	2.96		4.28		3.12		3.29		86.4		95.7		99.3		107
Silver	1.45		0.757		0.827		0.828		3.15	*	3.41	*	3.15	*	3.57
Zinc	138		5.17		4.74		5		53.5		75.5		66.2		59.9
Arsenic	0.26	*	0.07	*	0.06	*	0.06	*	3.2		3.5		3.4		3.4
Cadmium	0.26	*	0.07	*	0.06	*	0.06	*	0.33	*	0.35	*	0.34	*	0.36
Mercury	0.114		0.017		0.018		0.017		0.1		0.079		0.093		0.085
Lead	0.73		0.33		0.27		0.21		11		10.3		11		12.1
Selenium	1.76		0.13	*	0.34		0.13	*	0.6	*	0.7	*	0.7	*	0.7
2,4-D	100	*	100	*	100	*	100	*	170	*	170	*	170	*	180
2,4,5-TP	20	*	20	*	20	*	20	*	33	*	35	*	34	*	36
2,4,5-T	20	*	20	*	20	*	20	*	33	*	35	*	34	*	36
Organophosphorous Pest															
Azinphos Methyl	8	*	8	*	8	*	8	*	5.2	*	6	*	5.5	*	6.1
Bolstar	5.6	*	5.6	*	5.6	*	5.6	*	3.6	*	4.2	*	3.8	*	4.3
Chloropyrifos	8	*	8	*	8	*	8	*	5.2	*	6	*	5.5	*	6.1
Coumaphos	16	*	16	*	16	*	16	*	11	*	12	*	11	*	12
Demeton, O,S	9.6	*	9.6	*	9.6	*	9.6	*	6.3	*	7.3	*	6.7	*	7.4
Diazinon	16	*	16	*	16	*	16	*	15	*	17	*	16	*	17
Diclorovos	64	*	64	*	64	*	64	*	43	*	49	*	45	*	50
Dimethoate	21	*	21	*	21	*	21	*	14	*	16	*	15	*	16
Disulfoton	5.6	*	5.6	*	5.6	*	5.6	*	3.6	*	4.2	*	3.8	*	4.3
EPN	3.2	*	3.2	*	3.2	*	3.2	*	2.1	*	2.4	*	2.2	*	2.4
Ethoprop	16	*	16	*	16	*	16	*	11	*	12	*	11	*	12
Fensulfothion	6.4	*	6.4	*	6.4	*	6.4	*	4.3	*	4.9	*	4.5	*	5
Fenthion	8	*	8	*	8	*	8	*	5.2	*	6	*	5.5	*	6.1
Malathion	8.8	*	8.8	*	8.8	*	8.8	*	5.8	*	6.8	*	6.2	*	6.9
Merphos	16	*	16	*	16	*	16	*	11	*	12	*	11	*	12
Mevinphos	40	*	40	*	40	*	40	*	27	*	31	*	28	*	31
Naled	40	*	40	*	40	*	40	*	27	*	31	*	28	*	31

* = below detection. Number to left is reporting limit.

Appendix 2. Kelly Farm Demonstration Wetland. 1994 Bioaccumulation Study Raw Data.

Constituent			Bullrush Seeds						Kelly Farm Pond Sediment						
	Rep 4		#1		#2		#3		Rep1		Rep 2		Rep 3		Rep 4
Ethyl Parathion	4.8	*	4.8	*	4.8	*	4.8	*	3.2	*	3.6	*	3.3	*	3.7
Methyl Parathion	9.6	*	9.6	*	9.6	*	9.6	*	6.3	*	7.3	*	6.7	*	7.4
Phorate	3.2	*	3.2	*	3.2	*	3.2	*	2.1	*	2.4	*	2.2	*	2.4
Ronnel	5.6	*	5.6	*	5.6	*	5.6	*	3.6	*	4.2	*	3.8	*	4.3
Sulfotep	5.6	*	5.6	*	5.6	*	5.6	*	3.6	*	4.2	*	3.8	*	4.3
Tepp	64	*	64	*	64	*	64	*	43	*	49	*	45	*	50
Stirophos	64	*	64	*	64	*	64	*	43	*	49	*	45	*	50
Tokuthion	8.8	*	8.8	*	8.8	*	8.8	*	5.8	*	6.8	*	6.2	*	6.9
Trichloronate	64	*	64	*	64	*	64	*	43	*	49	*	45	*	50
Monocrotophos	16	*	16	*	16	*	16	*	79	*	91	*	84	*	93
Gamma-BHC (Lindane)	8	*	8	*	8	*	8	*	2.7	*	3.1	*	2.8	*	3.1
Heptachlor	8	*	8	*	8	*	8	*	2.7	*	3.1	*	2.8	*	3.1
Aldrin	8	*	8	*	8	*	8	*	2.7	*	3.1	*	2.8	*	3.1
Heptachlor Epoxide	8	*	8	*	8	*	8	*	2.7	*	3.1	*	2.8	*	3.1
Endosulfan I	8	*	8	*	8	*	8	*	2.7	*	3.1	*	2.8	*	3.1
Dieldrin	8	*	8	*	8	*	8	*	5.2	*	6	*	5.5	*	6.1
Endosulfan II	8	*	8	*	8	*	8	*	5.2	*	6	*	5.5	*	6.1
4,4'-DDT	8	*	8	*	8	*	8	*	5.2	*	6	*	5.5	*	6.1
Alpha-BHC	8	*	8	*	8	*	8	*	2.7	*	3.1	*	2.8	*	3.1
Beta-BHC	8	*	8	*	8	*	8	*	2.7	*	3.1	*	2.8	*	3.1
Delta-BHC	8	*	8	*	8	*	8	*	2.7	*	3.1	*	2.8	*	3.1
Gamma-Chlordane	8	*	8	*	8	*	8	*	2.7	*	3.1	*	2.8	*	3.1
Alpha-Chlordane	8	*	8	*	8	*	8	*	2.7	*	3.1	*	2.8	*	3.1
4,4'-DDE	8	*	8	*	8	*	8	*	5.2	*	6	*	5.5	*	6.1
Endrin	8	*	8	*	8	*	8	*	5.2	*	6	*	5.5	*	6.1
4,4'-DDD	8	*	8	*	8	*	8	*	5.2	*	6	*	5.5	*	6.1
Endosulfan Sulfate	8	*	8	*	8	*	8	*	5.2	*	6	*	5.5	*	6.1
Endrin Aldehyde	8	*	8	*	8	*	8	*	5.2	*	6	*	5.5	*	6.1
Toxaphene	40	*	40	*	40	*	40	*	270	*	310	*	280	*	310
Aroclor 1016	40	*	40	*	40	*	40	*	52	*	60	*	5.5	*	61
Aroclor 1221	40	*	40	*	40	*	40	*	110	*	120	*	110	*	120
Aroclor 1232	40	*	40	*	40	*	40	*	52	*	60	*	55	*	61
Aroclor 1242	40	*	40	*	40	*	40	*	52	*	60	*	55	*	61
Aroclor 1248	40	*	40	*	40	*	40	*	52	*	60	*	55	*	61
Aroclor 1254	40	*	40	*	40	*	40	*	52	*	60	*	55	*	61
Aroclor 1260	40	*	40	*	40	*	40	*	52	*	60	*	55	*	61

* = below detection. Number to left is reporting limit.

Appendix 2. Kelly Farm Demonstration Wetland. 1994 Bioaccumulation Study Raw Data.

Constituent			Bullrush Seeds						Kelly Farm Pond Sediment						
	Rep 4		#1		#2		#3		Rep1		Rep 2		Rep 3		Rep 4
Methoxychlor									27	*	31	*	28	*	31
Endrin Ketone									5.2	*	6	*	5.5	*	6.1
Total organic carbon									3950		6590		5770		7140
pH									8.38		8.36		8.41		8.36
Acid volatile sulfide									39.1		107		359		

* = below detection. Number to left is reporting limit.

Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

DAVE SMITH
MERRIT SMITH CONSULTING
SUITE 156
3732 MT. DIABLO BOULEVARD
LAFAYETTE, CA 94549

SAMPLE NUMBER: 40900061
DATE ENTERED: 09/02/94
REPORT PRINTED: 10/28/94

TISSUE: KELLY FISH REP #4; 8/26/94
PROJECT NO. 201.34

PURCHASE ORDER NUMBER: 01

ICP SPECTROSCOPY

ELEMENTS	MG/KG
ALUMINUM	626.
CHROMIUM	3.26
COPPER	6.73
NICKEL	2.96
SILVER	1.45
ZINC	138.

GC PESTICIDE/PCB FRACTION

REPORT TO BE GENERATED MANUALLY

MOISTURE	80.9	%
% LIPID DETERMINATION	2.90	%

MISC. ENVIRONMENTAL ANALYSIS

COMPOUND NAME	UG/KG
2,4-D	< 100
2,4,5-TP	< 20
2,4,5-T	< 20

DILUTION FACTOR	1.0
DATE RECEIVED	08/30/94
DATE EXTRACTED	09/23/94
DATE ANALYZED	10/04/94

ARSENIC IN TISSUE	< .26	PPM
CADMIUM IN TISSUE	< .26	PPM

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SAMPLE NUMBER: 40900061

TISSUE: KELLY FISH REP #4; 8/26/94
PROJECT NO. 201.34

ASSAY	ANALYSIS	UNITS
MERCURY IN TISSUE	.114	PPM
LEAD IN TISSUE	.73	PPM
SELENIUM IN TISSUE	1.76	PPM

ORGANOPHOSPHOROUS PESTICIDES-TISSUE

COMPOUND NAME	UG/KG
AZINPHOS METHYL	< 8.0
BOLSTAR	< 5.6
CHLOROPYRIFOS	< 8.0
COUMAPHOS	< 16
DEMETON, O,S	< 9.6
DIAZINON	< 16
DICHLOROVOS	< 64
DIMETHOATE	< 21
DISULFOTON	< 5.6
EPN	< 3.2
ETHOPROP	< 16
FENSULFOTHION	< 6.4
FENTHION	< 8.0
MALATHION	< 8.8
MERPHOS	< 16
MEVINPHOS	< 40
NALED	< 40
ETHYL PARATHION	< 4.8
METHYL PARATHION	< 9.6
PHORATE	< 3.2
RONNEL	< 5.6
SULFOTEP	< 5.6
TEPP	< 64
STIROPHOS	< 64
TOKUTHION	< 8.8
TRICHLORONATE	< 64
MONOCROTOPHOS	< 16

DILUTION FACTOR	1
DATE RECEIVED	08/30/94
DATE EXTRACTED	09/28/94
DATE ANALYZED	10/08/94

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printed on recycled paper

SAMPLE NUMBER: 40900061

TISSUE: KELLY FISH REP #4; 8/26/94
PROJECT NO. 201.34

METHOD REFERENCES

ICP SPECTROSCOPY
DAHLQUIST, R. L., AND KNOLL, J. W., "INDUCTIVELY COUPLED PLASMA - ATOMIC EMISSION SPECTROMETRY: ANALYSIS OF BIOLOGICAL MATERIALS AND SOILS FOR MAJOR, TRACE, AND ULTRA-TRRACE ELEMENTS," ALLIED SPECTROSCOPY, 32(1):1-29 (JAN./FEB).
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U.S.EPA, "TEST METHODS FOR EVALUATING SOLID WASTE", SW-846, SECOND EDITION, METHOD 7131, WASHINGTON, DC (REVISED APRIL 1984).
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TISSUE: KELLY FISH REP #4; 8/26/94
PROJECT NO. 201.34

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U.S. EPA, "TEST METHODS FOR EVALUATING SOLID WASTE", SW-846, SECOND EDITION, METHOD 7421, WASHINGTON, DC (REVISED APRIL 1984).
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USEPA, CLP, STATEMENT OF WORK ILM02.0, 1990.

ORGANOPHOSPHOROUS PESTICIDES-TISSUE
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"ORGANOPHOSPHORUS PESTICIDES," TEST METHODS FOR EVALUATING SOLID WASTE SW846, 3RD EDITION, METHOD 8141, DECEMBER 1987.

ORGANIC ANALYSIS DATA SHEET   PESTICIDE / PCB'S

Laboratory Name: HES, Inc.
Client: MERRIT SMITH CONSULTING
Matrix: TISSUE

Laboratory
Sample Number: 40900061

Client
Sample Number: KELLY FISH REP 4

Date Received: 8/30/94
Date Extracted/Prepared: 9/28/94
Date Analyzed: 10/6/94 & 10/9/94
GPC Cleanup: YES
Concentration: LOW

% Lipids: 2.90 %
% Moisture: 0.00 %
Moist. Corr. Factor: 1.00

CAS Number	Compound	Pesticide Fraction Results ug/kg	Aroclor Fraction Results ug/kg	Pesticide Fraction Dilution Factor	Aroclor Fraction Dilution Factor
58-89-9	Gamma-BHC (Lindane)	8 u		1	
76-44-8	Heptachlor		8 u		1
309-00-2	Aldrin		8 u		1
1024-57-3	Heptachlor Epoxide	8 u		1	
959-98-8	Endosulfan I	8 u		1	
60-57-1	Dieldrin	8 u		1	
33213-65-9	Endosulfan II	8 u		1	
50-29-3	4,4'-DDT	8 u	8 u	1	1
319-84-6	Alpha-BHC	8 u		1	
319-85-7	Beta-BHC	8 u		1	
319-86-8	Delta-BHC	8 u		1	
5103-74-2	Gamma-Chlordane	8 u	8 u	1	1
5103-71-9	Alpha-Chlordane	8 u	8 u	1	1
72-55-9	4,4'-DDE	8 u	8 u	1	1
72-20-8	Endrin	8 u		1	
72-54-8	4,4'-DDD	8 u		1	
1031-07-8	Endosulfan Sulfate	8 u		1	
7421-93-4	Endrin Aldehyde		8 u		1
8001-35-2	Toxaphene	40 u		1	
N.A.	Aroclor 1016		40 u		1
N.A.	Aroclor 1221		40 u		1
N.A.	Aroclor 1232		40 u		1
N.A.	Aroclor 1242		40 u		1
N.A.	Aroclor 1248		40 u		1
N.A.	Aroclor 1254		40 u		1
N.A.	Aroclor 1260		40 u		1

N.A. = Not Available   W = Weight of sample extracted (g)
Vm = Volume of extract injected on megabore (ul)
T = Volume of total extract (ml)

W: 20.00 g Vm: 2 ul T 8.0 ml

File Name: F1-61   FORM I

Hazleton
Environmental
Services, Inc.

REPORT OF ANALYSIS

DAVE SMITH
MERRIT SMITH CONSULTING
SUITE 156
3732 MT. DIABLO BOULEVARD
LAFAYETTE, CA 94549

SAMPLE NUMBER: 40900062

DATE ENTERED: 09/02/94

REPORT PRINTED: 10/28/94

TISSUE: KELLY FISH REP #4; 8/26/94, DUPLICATE
PROJECT NO. 201.34

PURCHASE ORDER NUMBER: 01

ICP SPECTROSCOPY

DUPLICATE OF 40900061

ELEMENTS	MG/KG
ALUMINUM	639.
CHROMIUM	3.45
COPPER	6.84
NICKEL	2.91
SILVER	1.53
ZINC	140.

ARSENIC IN TISSUE

DUPLICATE OF 40900061

ELEMENTS	UG/KG
ARSENIC	< 0.26

CADMIUM IN TISSUE

DUPLICATE OF 40900061

ELEMENTS	MG/KG
CADMIUM	< 0.26

MERCURY IN TISSUE .168 PPM

LEAD IN TISSUE

DUPLICATE OF 40900061

ELEMENT	MG/KG
LEAD	0.58

SAMPLE NUMBER: 40900062

TISSUE: KELLY FISH REP #4; 8/26/94, DUPLICATE
PROJECT NO. 201.34

SELENIUM IN TISSUE

DUPLICATE OF 40900061

ELEMENTS	MG/KG
SELENIUM	1.62

METHOD REFERENCES

ICP SPECTROSCOPY
DAHLQUIST, R. L., AND KNOLL, J. W., "INDUCTIVELY COUPLED PLASMA - ATOMIC EMISSION SPECTROMETRY: ANALYSIS OF BIOLOGICAL MATERIALS AND SOILS FOR MAJOR, TRACE, AND ULTRA-TRRACE ELEMENTS," ALLIED SPECTROSCOPY, 32(1):1-29 (JAN./FEB).
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CADMIUM IN TISSUE
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"MERCURY IN FISH, "AOAC OFFICIAL METHODS OF ANALYSIS, 15TH EDITION, METHOD 977.15 (MODIFIED), (1990).

SAMPLE NUMBER: 40900062

TISSUE: KELLY FISH REP #4; 8/26/94, DUPLICATE
PROJECT NO. 201.34

METHOD REFERENCES (CONTINUED)

LEAD IN TISSUE
U.S. EPA, "METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES", METALS 1-19 AND METHOD 239.02, CINCINNATI, OH (1979).
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SELENIUM IN TISSUE
U.S.EPA, "METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES", METALS 1-19 AND METHOD 272.02, CINCINNATI,OH (1979).
U.S.EPA, "TEST METHODS FOR EVALUATING SOLID WASTE", SW-846, SECOND EDITION, METHOD 7841, WASHINGTON, DC (REVISED APRIL 1984).
USEPA, CLP, STATEMENT OF WORK ILM02.0, 1990.

Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

DAVE SMITH
MERRIT SMITH CONSULTING
SUITE 156
3732 MT. DIABLO BOULEVARD
LAFAYETTE, CA 94549

SAMPLE NUMBER: 40900063

DATE ENTERED: 09/02/94

REPORT PRINTED: 10/28/94

TISSUE: KELLY FISH REP #4; 8/26/94, MATRIX SPIKE
PROJECT NO. 201.34

PURCHASE ORDER NUMBER: 01

ICP SPECTROSCOPY

RECOVERY OF 40900061

ALUMINUM			
	FOUND IN SAMPLE	626.	PPM
	ADDED	103.	PPM
	TOTAL FOUND	729.	PPM
	RECOVERY	100.0	%
CHROMIUM			
	FOUND IN SAMPLE	3.26	PPM
	ADDED	10.3	PPM
	TOTAL FOUND	13.2	PPM
	RECOVERY	96.5	%
COPPER			
	FOUND IN SAMPLE	6.73	PPM
	ADDED	12.9	PPM
	TOTAL FOUND	19.4	PPM
	RECOVERY	98.2	%
NICKEL			
	FOUND IN SAMPLE	2.96	MG/KG
	ADDED	25.8	MG/KG
	TOTAL FOUND	27.9	MG/KG
	RECOVERY	96.7	%
SILVER			
	FOUND IN SAMPLE	1.45	MG/KG
	ADDED	2.58	MG/KG
	TOTAL FOUND	3.71	MG/KG
	RECOVERY	87.6	%
ZINC			
	FOUND IN SAMPLE	138.	MG/KG
	ADDED	25.8	MG/KG
	TOTAL FOUND	164.	MG/KG
	RECOVERY	100.8	%

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Hazleton Environmental Services, Inc.

SAMPLE NUMBER: 40900063

TISSUE: KELLY FISH REP #4; 8/26/94, MATRIX SPIKE
PROJECT NO. 201.34

GC PESTICIDE/PCB FRACTION

REPORT TO BE GENERATED MANUALLY

MISC. ENVIRONMENTAL ANALYSIS

COMPOUND NAME	SPIKE ADDED UG/KG	SAMPLES RESULTS UG/KG	MS RESULTS UG/KG	MS % REC.
2,4-D	1000	0.0	580	58 %
2,4,5-TP	200	0.0	85	43 %
2,4,5-T	200	0.0	28	14 %

ARSENIC IN TISSUE

SPIKE OF SAMPLE 40900061			
SAMPLE SIZE		5.069	G
FOUND IN SAMPLE	<	0.05	MG/KG
ADDED		7.89	MG/KG
TOTAL FOUND		7.10	MG/KG
RECOVERY		90.0	%

CADMIUM IN TISSUE

SPIKE OF SAMPLE 40900061			
SAMPLE SIZE		5.069	G
FOUND IN SAMPLE	<	0.26	MG/KG
ADDED		5.18	MG/KG
TOTAL FOUND		5.81	MG/KG
RECOVERY		112.	%

MERCURY IN TISSUE

SPIKE OF SAMPLE 40900061		
SAMPLE SIZE	2.062	G
FOUND IN SAMPLE	.114	MG/KG
ADDED	0.254	MG/KG
TOTAL FOUND	0.353	MG/KG
RECOVERY	94.1	%

LEAD IN TISSUE

SPIKE OF SAMPLE 40900061		
SAMPLE SIZE	5.069	G
FOUND IN SAMPLE	0.14	MG/KG
ADDED	3.95	MG/KG
TOTAL FOUND	4.04	MG/KG
RECOVERY	98.7	%

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TISSUE: KELLY FISH REP #4; 8/26/94, MATRIX SPIKE
PROJECT NO. 201.34

SELENIUM IN TISSUE

SPIKE OF SAMPLE 40900061		
SAMPLE SIZE	5.069	G
FOUND IN SAMPLE	0.34	MG/KG
ADDED	1.97	MG/KG
TOTAL FOUND	2.53	MG/KG
RECOVERY	111.2	%

ORGANOPHOSPHOROUS PESTICIDES-TISSUE

COMPOUND NAME	SPIKE ADDED UG/KG	SAMPLE CONC. UG/KG	MS CONC. UG/KG	MS % REC.
DICHLOROVOS	50	00	40	80 %
PHORATE	50	00	20	40 %
DIAZINON	50	00	74	147 %
RONNEL	50	00	52	105 %
M. PARATHION	50	00	75	150 %
MALATHION	50	00	77	154 %
E. PARATHION	50	00	65	130 %

METHOD REFERENCES

ICP SPECTROSCOPY
DAHLQUIST, R. L., AND KNOLL, J. W., "INDUCTIVELY COUPLED PLASMA - ATOMIC EMISSION SPECTROMETRY: ANALYSIS OF BIOLOGICAL MATERIALS AND SOILS FOR MAJOR, TRACE, AND ULTRA-TRRACE ELEMENTS," ALLIED SPECTROSCOPY, 32(1):1-29 (JAN./FEB).
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SAMPLE NUMBER: 40900063

TISSUE: KELLY FISH REP #4; 8/26/94, MATRIX SPIKE
PROJECT NO. 201.34

METHOD REFERENCES (CONTINUED)

ARSENIC IN TISSUE
U.S.EPA, "METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES", METALS 1-19 AND AND METHOD 206.2, CINCINNATI, OH (1979).
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U.S.EPA, (CLP), STATEMENT OF WORK ILM02.0, 1990.

MERCURY IN TISSUE
U.S. EPA, "TEST METHODS FOR EVALUATION SOLID WASTE,"EPA PUBLICATION NO. SW-846 SECOND EDITION, METHODS 3030,3040;AND 7470, WASHINGTON,DC (REVISED APRIL 1984)
"MERCURY IN FISH, "AOAC OFFICIAL METHODS OF ANALYSIS, 15TH EDITION, METHOD 977.15 (MODIFIED), (1990).

LEAD IN TISSUE
U.S. EPA, "METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES", METALS 1-19 AND METHOD 239.02, CINCINNATI, OH (1979).
U.S. EPA, "TEST METHODS FOR EVALUATING SOLID WASTE", SW-846, SECOND EDITION, METHOD 7421, WASHINGTON, DC (REVISED APRIL 1984).
USEPA, CLP, STATEMENT OF WORK ILM02.0, 1990.

SELENIUM IN TISSUE
U.S.EPA, "METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES", METALS 1-19 AND METHOD 272.02, CINCINNATI,OH (1979).
U.S.EPA, "TEST METHODS FOR EVALUATING SOLID WASTE", SW-846, SECOND EDITION, METHOD 7841, WASHINGTON, DC (REVISED APRIL 1984).
USEPA, CLP, STATEMENT OF WORK ILM02.0, 1990.

ORGANOPHOSPHOROUS PESTICIDES-TISSUE
"ORGANOPHOSPHORUS PESTICIDES," 40CFR 455, METHOD 622, OCTOBER 4, 1985.
"ORGANOPHOSPHORUS PESTICIDES," TEST METHODS FOR EVALUATING SOLID WASTE SW846, 3RD EDITION, METHOD 8141, DECEMBER 1987.

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Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

DAVE SMITH
MERRIT SMITH CONSULTING
SUITE 156
3732 MT. DIABLO BOULEVARD
LAFAYETTE, CA 94549

SAMPLE NUMBER: 40900064

DATE ENTERED: 09/02/94

REPORT PRINTED: 10/28/94

TISSUE: KELLY FISH REP #4; 8/25/94, MATRIX SPIKE DUPLICATE
PROJECT NO. 201.34

PURCHASE ORDER NUMBER: 01

GC PESTICIDE/PCB FRACTION

REPORT TO BE GENERATED MANUALLY

MISC. ENVIRONMENTAL ANALYSIS

COMPOUND NAME	SPIKE ADDED UG/KG	SAMPLES RESULTS UG/KG	MSD RESULTS UG/KG	MSD % REC.
2,4-D	1000	0.0	480	48 %
2,4,5-TP	200	0.0	91	46 %
2,4,5-T	200	0.0	14	7 %

ORGANOPHOSPHOROUS PESTICIDES-TISSUE

COMPOUND NAME	SPIKE ADDED UG/KG	SAMPLE CONC. UG/KG	MSD. CONC. UG/KG	MSD % REC.
DICHLOROVOS	50	00	38	76 %
PHORATE	50	00	14	27 %
DIAZINON	50	00	73	145 %
RONNEL	50	00	51	102 %
M. PARATHION	50	00	74	149 %
MALATHION	50	00	74	147 %
E. PARATHION	50	00	64	127 %

METHOD REFERENCES

GC PESTICIDE/PCB FRACTION
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHOD 8080, U.S. EPA, WASHINGTON, DC (REVISED APRIL, 1984).
U.S. EPA METHOD 608 (FEDERAL REGISTER, VOLUME 49, NO. 209, PG. 43321-43336, OCTOBER 26, 1984).

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Hazleton Environmental Services, Inc.

SAMPLE NUMBER: 40900064

TISSUE: KELLY FISH REP #4; 8/25/94, MATRIX SPIKE DUPLICATE
PROJECT NO. 201.34

METHOD REFERENCES (CONTINUED)

ORGANOPHOSPHOROUS PESTICIDES-TISSUE
"ORGANOPHOSPHORUS PESTICIDES," 40CFR 455, METHOD 622, OCTOBER 4, 1985.
"ORGANOPHOSPHORUS PESTICIDES," TEST METHODS FOR EVALUATING SOLID WASTE SW846, 3RD EDITION, METHOD 8141, DECEMBER 1987.

MATRIX SPIKE / MATRIX SPIKE DUPLICATE RECOVERY DATA SHEET

Laboratory Name: HES, Inc.
Client: MERRIT SMITH CONSULTING
Matrix: TISSUE
Concentration: Low

Lab Sample Number: 40900061
: 40900063 MS
: 40900064 MSD
Client Sample Number: KELLY FISH REP 4

CAS Number	Compound	Conc. Spike Added (ug/kg)	Sample Amount	M.S. Concentration Recovered	M.S. Percent Recovered	M.S.D. Concentration Recovered	M.S.D. Percent Recovered	Relative Percent Difference
58-89-9	Gamma-BHC (Lindane)	25 ug/kg	0 ug/kg	32 ug/kg	128%	34 ug/kg	136%	6.1%
76-44-8	Heptachlor	25 ug/kg	0 ug/kg	25 ug/kg	100%	26 ug/kg	104%	3.9%
309-00-2	Aldrin	25 ug/kg	0 ug/kg	29 ug/kg	116%	30 ug/kg	120%	3.4%
1024-57-3	Heptachlor Epoxide	25 ug/kg	0 ug/kg	20 ug/kg	80%	30 ug/kg	120%	40.0%
60-57-1	Dieldrin	50 ug/kg	0 ug/kg	48 ug/kg	96%	60 ug/kg	120%	22.2%
50-29-3	4,4'-DDT	50 ug/kg	0 ug/kg	65 ug/kg *	130%	67 ug/kg *	134%	3.0%
319-84-6	Alpha-BHC	25 ug/kg	0 ug/kg	23 ug/kg	92%	26 ug/kg	104%	12.2%
319-85-7	Beta-BHC	25 ug/kg	0 ug/kg	36 ug/kg	144%	37 ug/kg	148%	2.7%
319-86-8	Delta-BHC	25 ug/kg	0 ug/kg	28 ug/kg	112%	37 ug/kg	148%	27.7%
5103-74-2	Gamma-Chlordane	25 ug/kg	0 ug/kg	22 ug/kg *	88%	22 ug/kg *	88%	0.0%
5103-71-9	Alpha-Chlordane	25 ug/kg	0 ug/kg	21 ug/kg	84%	27 ug/kg	108%	25.0%
72-55-9	4,4'-DDE	50 ug/kg	0 ug/kg	78 ug/kg	156%	79 ug/kg	158%	1.3%
72-20-8	Endrin	50 ug/kg	0 ug/kg	47 ug/kg	94%	66 ug/kg	132%	33.6%
72-54-8	4,4'-DDD	50 ug/kg	0 ug/kg	73 ug/kg	146%	88 ug/kg	176%	18.6%
1031-07-8	Endosulfan Sulfate	50 ug/kg	0 ug/kg	39 ug/kg	78%	67 ug/kg	134%	52.8%

Comments: * - quantitated from confirmation run [illegible]

File Name:

FORM III

Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

DAVE SMITH
MERRIT SMITH CONSULTING
SUITE 156
3732 MT. DIABLO BOULEVARD
LAFAYETTE, CA 94549

SAMPLE NUMBER: 40900071

DATE ENTERED: 09/02/94

REPORT PRINTED: 10/28/94

SOIL: KELLY FARM SOIL REP 4; 8/26/94
PROJECT NO. 201.34

PURCHASE ORDER NUMBER: 01

ASSAY	ANALYSIS	UNITS
ARSENIC	3.4	PPM
LEAD	12.1	PPM
MERCURY	.085	PPM
SELENIUM	< .7	PPM

ICP-ACID EXTRACTION

ELEMENTS	MG/KG
ALUMINUM	20900.
CHROMIUM	70.5
COPPER	27.7
NICKEL	107.
SILVER	< 3.57
ZINC	59.9

ORGANOPHOSPHATE PESTICIDES

COMPOUND NAME	UG/KG
AZINOPHOS METHYL	< 6.1
BOLSTAR	< 4.3
CHLORPYRIFOS	< 6.1
COUMAPHOS	< 12
DEMETON, O,S	< 7.4
DIAZINON	< 17
DICHLORVOS	< 50
DIMETHOATE	< 16
DISULFOTON	< 4.3
EPN	< 2.4
ETHOPROP	< 12
FENSULFOTHION	< 5.0
FENTHION	< 6.1

Hazleton Environmental Services, Inc.

SAMPLE NUMBER: 40900071

SOIL: KELLY FARM SOIL REP 4; 8/26/94
PROJECT NO. 201.34

ORGANOPHOSPHATE PESTICIDES (CONTINUED)

MALATHION	< 6.9
MERPHOS	< 12
MEVINPHOS	< 31
NALED	< 31
ETHYL PARATHION	< 3.7
METHYL PARATHION	< 7.4
PHORATE	< 2.4
RONNEL	< 4.3
SULFOTEP	< 4.3
TEPP	< 50
STIROPHOS	< 50
TOKUTHION	< 6.9
TRICHLORONATE	< 50
MONOCROTPHOS	< 93

DILUTION FACTOR	1
DATE RECEIVED	08/30/94
DATE EXTRACTED	09/08/94
DATE ANALYZED	09/19/94

GC PESTICIDE/PCB FRACTION

COMPOUND NAME	UG/KG
ALPHA-BHC	< 3.1
BETA-BHC	< 3.1
DELTA-BHC	< 3.1
GAMMA-BHC (LINDANE)	< 3.1
HEPTACHLOR	< 3.1
ALDRIN	< 3.1
HEPTACHLOR EPOXIDE	< 3.1
ENDOSULFAN I	< 3.1
DIELDRIN	< 6.1
4,4'-DDE	< 6.1
ENDRIN	< 6.1
ENDOSULFAN II	< 6.1
4,4'-DDD	< 6.1
ENDOSULFAN SULFATE	< 6.1
4,4'-DDT	< 6.1
METHOXYCHLOR	< 31
ENDRIN KETONE	< 6.1
ENDRIN ALDEHYDE	< 6.1
ALPHA-CHLORDANE	< 3.1
GAMMA-CHLORDANE	< 3.1
TOXAPHENE	< 310
AROCLOR-1016	< 61
AROCLOR-1221	< 120

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SAMPLE NUMBER: 40900071

SOIL: KELLY FARM SOIL REP 4; 8/26/94
PROJECT NO. 201.34

GC PESTICIDE/PCB FRACTION (CONTINUED)

AROCLOR-1232		< 61
AROCLOR-1242		< 61
AROCLOR-1248		< 61
AROCLOR-1254		< 61
AROCLOR-1260		< 61
DILUTION FACTOR	1.0	
DATE EXTRACTED	09/08/94	
DATE ANALYZED	09/09/94	

MOISTURE 45.0 %

MISC. ENVIRONMENTAL ANALYSIS

COMPOUND NAME		UG/KG
2,4-D		< 180
2,4,5-TP		< 36
2,4,5-T		< 36
DILUTION FACTOR	1.0	
DATE RECEIVED	08/30/94	
DATE EXTRACTED	09/09/94	
DATE ANALYZED	10/03/94	

TOTAL ORGANIC CARBON - SOILS)	7140.	PPM
PH IN SOILS	8.36	
CADMIUM BY GRAPHITE FURNACE	< .36	PPM

METHOD REFERENCES

ARSENIC
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS (3030, 3040, OR 3050) AND 7060, U.S. EPA, WASHINGTON, D.C. (REVISED APRIL 1984).
CONTRACT LABORATORY PROGRAM STATEMENT OF WORK NO. 785, METHOD 206.2 CLP-M, U.S. EPA, WASHINGTON, D. C. (JULY 1985).

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SOIL: KELLY FARM SOIL REP 4; 8/26/94
PROJECT NO. 201.34

METHOD REFERENCES (CONTINUED)

LEAD
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS (3030, 3040 OR 3050) AND 7421, U.S. EPA, WASHINGTON, DC (REVISED APRIL 1984)

MERCURY
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS (3030, 3040 OR 3050) AND 7470, U.S. EPA, WASHINGTON, DC (REVISED APRIL 1984)

SELENIUM
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS (3030, 3040 OR 3050) AND 7740, U.S. EPA, WASHINGTON, DC (REVISED APRIL 1984)

ICP-ACID EXTRACTION
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS (3030, 3040 OR 3050) AND 6010, U.S. EPA, WASHINGTON, DC (REVISED APRIL 1984)

ORGANOPHOSPHATE PESTICIDES
"ORGANOPHOSPHOROUS PESTICIDES," 40CFR 455, METHOD 622, OCTOBER 4, 1985.
"ORGANOPHOSPHOROUS PESTICIDES," TEST METHODS FOR EVALUATING SOLID WASTE SW846, 3RD EDITION, METHODS 8140 AND 8141, DECEMBER 1987.

GC PESTICIDE/PCB FRACTION
U.S. EPA METHOD 608 (FEDERAL REGISTER, VOLUME 49, NO. 209, PG. 43321-43336, OCTOBER 26, 1984).
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHOD 8080, U.S. EPA, WASHINGTON, DC (REVISED APRIL, 1984).

MOISTURE
OFFICIAL METHODS OF ANALYSIS (1984) 14TH EDITION, METHOD 16.259, 14.002, 7.003, AOAC, ARLINGTON, VA. (MODIFIED).

TOTAL ORGANIC CARBON - SOILS)
DETERMINATION OF TOTAL ORGANIC CARBON IN SEDIMENT. LLOYD KAHN, USEPA, REGION II, EDISON, NJ 08837. 7/27/88

PH IN SOILS
TEST METHODS FOR EVALUATING SOLID WASTE. USEPA, SW-846, THIRD EDITION, NOVEMBER 1990, METHOD 9045.

SAMPLE NUMBER: 40900071

SOIL: KELLY FARM SOIL REP 4; 8/26/94
PROJECT NO. 201.34

METHOD REFERENCES (CONTINUED)

CADMIUM BY GRAPHITE FURNACE
CONTRACT LABORATORY PROGRAM S.O.W. MARCH, 90, METHOD 213.2 CLP-M,
ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D.C. (MARCH 1990).

Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

DAVE SMITH
MERRIT SMITH CONSULTING
SUITE 156
3732 MT. DIABLO BOULEVARD
LAFAYETTE, CA 94549

SAMPLE NUMBER: 40900072
DATE ENTERED: 09/02/94
REPORT PRINTED: 10/28/94

SOIL: KELLY FARM SOIL REP 4; 8/26/94, DUPLICATE
PROJECT NO. 201.34

PURCHASE ORDER NUMBER: 01

ARSENIC

DUPLICATE FOR LIMS #S: 40900052-0077

DUPLICATE OF 40900071

ELEMENTS	MG/KG
ARSENIC	3.2

LEAD

DUPLICATE FOR LIMS #S: 40900052-0077

DUPLICATE OF 40900071

ELEMENTS	MG/KG
LEAD	12.3

MERCURY .097 PPM

SELENIUM

DUPLICATE FOR LIMS #S: 40900052-0077

DUPLICATE OF 40900071

ELEMENTS	MG/KG
SELENIUM	< 0.7

ICP-ACID EXTRACTION

ELEMENTS	MG/KG
ALUMINUM	21100.
CHROMIUM	70.5
COPPER	27.9

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SAMPLE NUMBER: 40900072

SOIL: KELLY FARM SOIL REP 4; 8/26/94, DUPLICATE
PROJECT NO. 201.34

ICP-ACID EXTRACTION (CONTINUED)

NICKEL	107.
SILVER	< 3.60
ZINC	60.1

TOTAL ORGANIC CARBON - SOILS)

DUPLICATE OF 40900071

ELEMENTS	UG/G
TOTAL ORGANIC CARBON	6470.

CADMIUM BY GRAPHITE FURNACE

DUPLICATE FOR LIMS #S: 40900052-0077

DUPLICATE OF 40900071

ELEMENTS	PPM
CADMIUM	< 0.36

METHOD REFERENCES

ARSENIC
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS (3030, 3040, OR 3050) AND 7060, U.S. EPA, WASHINGTON, D.C. (REVISED APRIL 1984).
CONTRACT LABORATORY PROGRAM STATEMENT OF WORK NO. 785, METHOD 206.2 CLP-M, U.S. EPA, WASHINGTON, D. C. (JULY 1985).

LEAD
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS (3030, 3040 OR 3050) AND 7421, U.S. EPA, WASHINGTON, DC (REVISED APRIL 1984)

MERCURY
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS (3030, 3040 OR 3050) AND 7470, U.S. EPA, WASHINGTON, DC (REVISED APRIL 1984)

SOIL: KELLY FARM SOIL REP 4; 8/26/94, DUPLICATE
PROJECT NO. 201.34

METHOD REFERENCES (CONTINUED)

SELENIUM
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS (3030, 3040 OR 3050) AND 7740, U.S. EPA, WASHINGTON, DC (REVISED APRIL 1984)

ICP-ACID EXTRACTION
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS (3030, 3040 OR 3050) AND 6010, U.S. EPA, WASHINGTON, DC (REVISED APRIL 1984)

TOTAL ORGANIC CARBON - SOILS)
DETERMINATION OF TOTAL ORGANIC CARBON IN SEDIMENT. LLOYD KAHN, USEPA, REGION II, EDISON, NJ 08837. 7/27/88

CADMIUM BY GRAPHITE FURNACE
CONTRACT LABORATORY PROGRAM S.O.W. MARCH, 90, METHOD 213.2 CLP-M, ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D.C. (MARCH 1990).

Hazleton
Environmental
Services, Inc.

REPORT OF ANALYSIS

DAVE SMITH
MERRIT SMITH CONSULTING
SUITE 156
3732 MT. DIABLO BOULEVARD
LAFAYETTE, CA 94549

SAMPLE NUMBER: 40900073

DATE ENTERED: 09/02/94

REPORT PRINTED: 10/28/94

SOIL: KELLY FARM SOIL REP 4; 8/26/94, MATRIX SPIKE
PROJECT NO. 201.34

PURCHASE ORDER NUMBER: 01

ARSENIC

SPIKE FOR LIMS BATCH #S: 40900052-0077

SPIKE OF SAMPLE 40900071		
SAMPLE SIZE	1.050	G
FOUND IN SAMPLE	1.87	MG/KG
ADDED	7.62	MG/KG
TOTAL FOUND	9.28	MG/KG
RECOVERY	97.2	%

LEAD

SPIKE FOR LIMS BATCH #S: 40900052-0077

SPIKE OF SAMPLE 40900071		
SAMPLE SIZE	1.050	G
FOUND IN SAMPLE	6.68	MG/KG
ADDED	3.81	MG/KG
TOTAL FOUND	10.76	MG/KG
RECOVERY	107.1	%

MERCURY

SPIKE OF SAMPLE 40900071		
SAMPLE SIZE	2.018	G
FOUND IN SAMPLE	0.085	MG/KG
ADDED	0.090	MG/KG
TOTAL FOUND	0.175	MG/KG
RECOVERY	100.	%

SELENIUM

SPIKE FOR LIMS BATCH #S: 40900052-0077

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SAMPLE NUMBER: 40900073

SOIL: KELLY FARM SOIL REP 4; 8/26/94, MATRIX SPIKE
PROJECT NO. 201.34

SELENIUM (CONTINUED)

SPIKE OF SAMPLE 40900071

SAMPLE SIZE		1.050	G
FOUND IN SAMPLE	<	0.4	MG/KG
ADDED		1.90	MG/KG
TOTAL FOUND		1.89	MG/KG
RECOVERY		99.5	%

ICP-ACID EXTRACTION

RECOVERY FOR LIMS #S: 40900052-0077

RECOVERY OF 40900071

ALUMINUM			
	FOUND IN SAMPLE	20900.	MG/KG
	ADDED	671.	MG/KG
	TOTAL FOUND	24200.	MG/KG
	RECOVERY	N/A	%
CHROMIUM			
	FOUND IN SAMPLE	70.5	MG/KG
	ADDED	67.1	MG/KG
	TOTAL FOUND	140.	MG/KG
	RECOVERY	103.6	%
COPPER			
	FOUND IN SAMPLE	27.7	MG/KG
	ADDED	83.9	MG/KG
	TOTAL FOUND	109.	MG/KG
	RECOVERY	96.9	%
NICKEL			
	FOUND IN SAMPLE	107.	MG/KG
	ADDED	168.	MG/KG
	TOTAL FOUND	273.	MG/KG
	RECOVERY	98.8	%
SILVER			
	FOUND IN SAMPLE	3.57	MG/KG
	ADDED	16.8	MG/KG
	TOTAL FOUND	16.4	MG/KG
	RECOVERY	97.6	%
ZINC			
	FOUND IN SAMPLE	59.9	MG/KG
	ADDED	168.	MG/KG
	TOTAL FOUND	222.	MG/KG
	RECOVERY	96.5	%

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SAMPLE NUMBER: 40900073

SOIL: KELLY FARM SOIL REP 4; 8/26/94, MATRIX SPIKE
PROJECT NO. 201.34

ORGANOPHOSPHATE PESTICIDES

MATRIX SPIKE OF LIMS 40900073

COMPOUND NAME	SPIKE ADDED	CONC. UG/KG	MS CONC.	MS REC
DICHLORVOS	61.7		31	51 %
PHORATE	61.7		45	73 %
DIAZINON	61.7		55	89 %
RONNEL	61.7		44	71 %
METHYL PARATHION	61.7		58	95 %
MALATHION	61.7		57	93 %
ETHYL PARATHION	61.7		54	88 %

GC PESTICIDE/PCB FRACTION

MATRIX SPIKE FOR LIMS BATCH 4090052-0077

MATRIX SPIKE FOR LIMS 40900071

COMPOUND NAME	SPIKE ADDED	SAMPLE CONC.	MS CONC.	MS % REC.	QC LIMITS
GAMMA-BHC (LINDANE)	30.8		26	85 %	46-127
HEPTACHLOR	30.8		28	92 %	35-130
ALDRIN	30.8		25	81 %	34-132
DIELDRIN	61.7		52	85 %	31-134
ENDRIN	61.7		59	95 %	42-139
4,4'-DDD	61.7		51	82 %	23-134

MISC. ENVIRONMENTAL ANALYSIS

MATRIX SPIKE OF SAMPLE #40900071

COMPOUND NAME	SPIKE ADDED UG/KG	SAMPLES RESULTS UG/KG	MS RESULTS UG/KG	MS % REC.
2,4-D	1800	0.0	1700	94 %
2,4,5-TP	360	0.0	270	75 %
2,4,5-T	360	0.0	340	94 %

TOTAL ORGANIC CARBON - SOILS)

SPIKE OF SAMPLE 40900071		
SAMPLE SIZE	10.	MG
FOUND IN SAMPLE	7140.	UG/G
ADDED	5000.	UG/G
TOTAL FOUND	12800.	UG/G
RECOVERY	113.	%

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SAMPLE NUMBER: 40900073

SOIL: KELLY FARM SOIL REP 4; 8/26/94, MATRIX SPIKE
PROJECT NO. 201.34

CADMIUM BY GRAPHITE FURNACE

SPIKE OF SAMPLE 40900071			
SAMPLE SIZE		1.050	G
FOUND IN SAMPLE	<	0.2	MG/KG
ADDED		0.95	MG/KG
TOTAL FOUND		1.07	MG/KG
RECOVERY		112.6	%

METHOD REFERENCES

ARSENIC
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS (3030, 3040, OR 3050) AND 7060, U.S. EPA, WASHINGTON, D.C. (REVISED APRIL 1984).
CONTRACT LABORATORY PROGRAM STATEMENT OF WORK NO. 785, METHOD 206.2 CLP-M, U.S. EPA, WASHINGTON, D. C. (JULY 1985).

LEAD
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS (3030, 3040 OR 3050) AND 7421, U.S. EPA, WASHINGTON, DC (REVISED APRIL 1984)

MERCURY
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS (3030, 3040 OR 3050) AND 7470, U.S. EPA, WASHINGTON, DC (REVISED APRIL 1984)

SELENIUM
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS (3030, 3040 OR 3050) AND 7740, U.S. EPA, WASHINGTON, DC (REVISED APRIL 1984)

ICP-ACID EXTRACTION
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS (3030, 3040 OR 3050) AND 6010, U.S. EPA, WASHINGTON, DC (REVISED APRIL 1984)

ORGANOPHOSPHATE PESTICIDES
"ORGANOPHOSPHOROUS PESTICIDES," 40CFR 455, METHOD 622, OCTOBER 4, 1985.
"ORGANOPHOSPHOROUS PESTICIDES," TEST METHODS FOR EVALUATING SOLID WASTE SW846, 3RD EDITION, METHODS 8140 AND 8141, DECEMBER 1987.

SAMPLE NUMBER: 40900073

SOIL: KELLY FARM SOIL REP 4; 8/26/94, MATRIX SPIKE
PROJECT NO. 201.34

METHOD REFERENCES (CONTINUED)

GC PESTICIDE/PCB FRACTION
U.S. EPA METHOD 608 (FEDERAL REGISTER, VOLUME 49, NO. 209, PG. 43321-43336, OCTOBER 26, 1984).
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHOD 8080, U.S. EPA, WASHINGTON, DC (REVISED APRIL, 1984).

TOTAL ORGANIC CARBON - SOILS)
DETERMINATION OF TOTAL ORGANIC CARBON IN SEDIMENT. LLOYD KAHN, USEPA, REGION II, EDISON, NJ 08837. 7/27/88

CADMIUM BY GRAPHITE FURNACE
CONTRACT LABORATORY PROGRAM S.O.W. MARCH, 90, METHOD 213.2 CLP-M, ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D.C. (MARCH 1990).

Hazleton
Environmental
Services, Inc.

REPORT OF ANALYSIS

DAVE SMITH
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SUITE 156
3732 MT. DIABLO BOULEVARD
LAFAYETTE, CA 94549

SAMPLE NUMBER: 40900074

DATE ENTERED: 09/02/94

REPORT PRINTED: 10/28/94

SOIL: KELLY FARM SOIL REP 4; 8/26/94, MATRIX SPIKE SPIKE
PROJECT NO. 201.34

PURCHASE ORDER NUMBER: 01

ORGANOPHOSPHATE PESTICIDES

MATRIX SPIKE DUPLICATE OF LIMS 40900074

COMPOUND NAME	SPIKE ADDED	MSD CONC.	MSD REC.	LIMITS REC.
DICHLORVOS	61.7	30	49 %	50-130
PHORATE	61.7	42	68 %	50-130
DIAZINON	61.7	64	104 %	50-130
RONNEL	61.7	37	60 4	50-130
METHYL PARATHION	61.7	52	85 %	50-130
MALATHION	61.7	48	78 %	50-130
ETHYL PARATHION	61.7	47	76 %	50-130

GC PESTICIDE/PCB FRACTION

MATRIX SPIKE DUPLICATE FOR LIMS BATCH 4090052-0077

MATRIX SPIKE DUPLICATE FOR LIMS 40900071

COMPOUND NAME	SPIKE ADDED	SAMPLE CONC.	MSD CONC.	MSD % REC.	QC LIMITS
GAMMA-BHC (LINDANE)	30.8		25	81 %	46-127
HEPTACHLOR	30.8		27	86 %	35-130
ALDRIN	30.8		25	80 %	34-132
DIELDRIN	61.7		49	80 %	31-134
ENDRIN	61.7		55	90 %	42-139
4,4'-DDD	61.7		41	67 %	23-134

MISC. ENVIRONMENTAL ANALYSIS

MATRIX SPIKE DUPLICATE OF SAMPLE #40900071

COMPOUND NAME	SPIKE ADDED UG/KG	SAMPLES RESULTS UG/KG	MSD RESULTS UG/KG	MSD % REC.
2,4-D	1800	0.0	1700	94 %
2,4,5-TP	360	0.0	260	72.2%

SAMPLE NUMBER: 40900074

SOIL: KELLY FARM SOIL REP 4; 8/26/94, MATRIX SPIKE SPIKE
PROJECT NO. 201.34

MISC. ENVIRONMENTAL ANALYSIS (CONTINUED)

2,4,5-T	360	0.0	340	94 %

METHOD REFERENCES

ORGANOPHOSPHATE PESTICIDES
"ORGANOPHOSPHOROUS PESTICIDES," 40CFR 455, METHOD 622, OCTOBER 4, 1985.
"ORGANOPHOSPHOROUS PESTICIDES," *TEST METHODS FOR EVALUATING SOLID WASTE SW846*, 3RD EDITION, METHODS 8140 AND 8141, DECEMBER 1987.

GC PESTICIDE/PCB FRACTION
U.S. EPA METHOD 608 (FEDERAL REGISTER, VOLUME 49, NO. 209, PG. 43321-43336, OCTOBER 26, 1984).
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHOD 8080, U.S. EPA, WASHINGTON, DC (REVISED APRIL, 1984).

APPENDIX 4. STATE MUSSEL WATCH DATA

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data															
Metals, ppm dry weight (unless labeled wet weight)															
Station Name	Date	Type	% Mois	Alumi-num	Ar-senic	Cad-mium	Chro-mium	Cop-per	Lead	Mang-ganese	Mer-cury	Nick-el	Selen-ium	Silver	Zinc
Standards:															
EDL 85 (1977-1987)[a], ppm dry weight				693		12	3	38	2	66	0.31			0.31	169
EDL 95 (1977-1987)[a], ppm dry weight				1551		15	9	71	5	121	0.37			0.38	187
EDL 85 (1977-1993)[a], ppm wet weight				206	0.90	0.92	2.0	8.8	0.21	9.6	0.04	1.0	0.43	0.03	19.4
EDL 95 (1977-1993)[a], ppm wet weight				446	0.93	1.26	3.1	15	0.39	16.9	0.05	1.4	0.46	0.04	25.1
Median International Standard, ppm, wet weight					1.4	1.0	1.0	20	2.0		0.5		0.3		70
[a] Transplanted freshwater clams															
Aptos Creek	10/25/90			600	11	2.5	10	77	0.38	110	0.25	na	2.5	0.06	150
Kelly Farm cell 3	Jan. 91			920	11	3.9	10	89	0.59	80	0.51	5.4	3	0.18	280
Laguna @ Stony Point Rd.	1/30/91			360	7.8	2	2.3	61	0.33	65	0.33	na	2.1	0.03	150
Laguna @ Wohler	1/30/91			570	8.2	3	3.3	70	0.49	31	0.29	na	2.4	0.05	160
SRC @Willowside	1/30/91			890	11	2.4	3.3	73	1.1	120	0.32	na	2.4	0.04	190
Aptos Cr. (Control)	12/19/91			1900	13	5.1	61	160	0.36	37	0.21	na	5.3	0.41	150
Kelly Farm cell 1	Dec. 91			542.64	3.62	7.49	91.73	68.48	<1.29	122.74	<0.65	126.61	<0.65	<1.29	206.72
Kelly Farm cell 3	Dec. 91			213.11	4.92	4.59	36.07	100	14.75	196.72	1.97	52.46	1.48	<1.64	245.9
Kelly Farm control	Dec.91			201.68	11.13	<2.10	21.01	128.15	<2.10	31.51	<1.05	27.31	1.89	<2.10	203.78
Laguna @ Stony Point Rd.	3/6/92			1300	9.4	3.4	17	170	1	46	0.47	4.1	4.8	0.36	150
Laguna @ Wohler	3/6/92			900	4.8	3.2	6.7	98	0.66	46	0.46	4	4	0.19	170
MWC @ Slusser Rd.	3/6/92			1000	7.1	6.6	9.3	120	0.35	50	0.32	4.3	5.5	0.28	130
Russian @ Hacienda Br.	3/6/92			1900	12	5.4	20	170	0.81	55	0.36	10	6.1	0.41	150
Russian below Ukiah	3/6/92			8000	7.9	4	26	130	1.7	190	0.34	22	4.4	0.32	170
Russian West Fork	3/6/92			4900	8.9	3.6	21	35	1	68	0.28	9.6	4.8	0.43	120
Windsor @ MW Sta. Rd.	3/6/92			2500	6.8	4.1	13	110	0.96	270	0.87	7.9	4	0.18	190
Russian @ Wohler	4/7/92			5700	9.3	5.5	28	150	1.5	120	0.37	26	5.2	0.3	180
Windsor @ MW Sta. Rd.	1/1/93			800	11	0.45	19	44	0.023	44	0.15	17	2	0.085	100
Laguna @ Stony Pt.	1/1/94			420	15	1.1	1.3	57	0.54	52	0.27	2.6	1.5	0.092	130
Laguna @ Wohler	1/1/94			460	14	1.3	1.8	66	0.24	57	0.22	2.4	1.3	0.13	160
MWC @ Slusser Rd.	1/1/94			350	13	0.83	14	45	0.21	36	0.25	12	1.4	0.1	150
Russian @ Hacienda	1/1/94			790	15	1.3	3.3	71	0.36	73	0.26	3.9	1.4	0.14	160
Russian @ Wohler	1/1/94			670	12	0.75	1.9	51	0.5	70	0.21	3	1.1	0.088	140
SRC @ Willowside	1/1/94			610	13	1.1	14	62	1.2	63	0.3	12	1.4	0.098	160
Estero Americana	10/11/94	RCM	85	770	12	10	2.4	7.2	0.9	12	0.25	2.9	1.9	0.073	180
Estero Americana	10/11/94	Std Dev	0.33	31	0.58	1.4	0.058	0.57	0.096	0	0.056	0.21	0.12	0.0084	15
Mark West CK/Slusser Rd	10/11/94	TFC	88	350	13	0.83	14	45	0.21	36	0.25	12	1.4	0.1	150
Mark West CK/Slusser Rd	10/11/94	Std Dev	1	40	1.2	0.1	12	3	0.057	2	0.05	9.1	0.21	0.0064	10
Santa Rosa Ck/Willowside Rd	10/11/94	TFC	87	610	13	1.1	14	62	1.2	63	0.3	12	1.4	0.098	160
Santa Rosa Ck/Willowside Rd	10/11/94	Std Dev	0.6	74	0.58	0.058	9	2.6	0.1	15	0.0058	6.1	0.058	0.014	5.8
Laguna De Santa Rosa/Stoney Pt	10/11/94	TFC	89	420	15	1.1	1.3	57	0.54	52	0.27	2.6	1.5	0.092	130
Laguna De Santa Rosa/Stoney Pt	10/11/94	Std Dev	0.36	70	1.2	0.15	0.25	1.5	0.1	5.1	0.075	0.15	0.15	0.0072	5.8
Russian River/Wohler Rd Br	10/11/94	TFC	85	670	12	0.75	1.9	51	0.5	70	0.21	3	1.1	0.088	140
Russian River/Wohler Rd Br	10/11/94	Std Dev	1.3	78	1.5	0.2	0.5	5	0.023	8.1	0.025	0.56	0.13	0.01	12

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data															
Metals, ppm dry weight (unless labeled wet weight)															
Station Name	Date	Type	% Mois	Aluminum	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc
Laguna De Santa Rosa/Wohler Rd	10/11/94	TFC	72	460	14	1.3	1.8	66	0.24	57	0.22	2.4	1.3	0.13	160
Laguna De Santa Rosa/Wohler Rd	10/11/94	Std Dev	4.6	30	1.2	0.058	0.17	4	0.04	3.6	0.085	0.1	0.21	0.032	17
Russian River/Hacienda Br	10/11/94	TFC	79	790	15	1.3	3.3	71	0.36	73	0.26	3.9	1.4	0.14	160
Russian River/Hacienda Br	10/11/94	Std Dev	0.39	340	0.58	0.17	0.87	3.1	0.055	9.7	0.012	1.2	2E-08	0	5.8
Estero Americana	2/26/93	RMC		660	11	9.3	4.9	8.1	0.61	14	0.15	5.7	2.7	0.095	160
Estero Americana	2/26/93	Std Dev		86	0.11	1.6	1.3	0.8	0.076	5.8	0.038	1.4	0.22	0.027	11
Mark West CK/Slusser Rd	3/30/93	TFC		560	12	0.48	17	46	0.26	26	0.1	14	2.1	0.067	98
Mark West CK/Slusser Rd	3/30/93	Std Dev		61	2.6	0.04	2.8	3	0.036	0.85	0.016	2.2	0.1	0.0062	10
Windsor Creek/Mark West St	3/30/93	TFC		600	11	0.45	19	44	0.23	44	0.15	17	2	0.065	100
Windsor Creek/Mark West St	3/30/93	Std Dev		230	1	0.032	10	5.1	0.062	16	0.068	7.9	0.41	0.014	9.9
Santa Rosa Ck/Willowside Rd	3/30/93	TFC		590	12	0.64	1.9	83	0.61	33	0.075	1.9	2.2	0.12	140
Santa Rosa Ck/Willowside Rd	3/30/93	Std Dev		460	1.7	0.13	1	52	0.57	12	0.023	0.91	0.035	0.08	47
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC		400	12	0.48	9	46	0.36	33	0.14	7.6	2.8	0.057	110
Laguna De Santa Rosa/Stoney Pt	3/30/93	Std Dev		110	1.1	0.078	1.2	1.7	0.072	2.3	0.022	1.4	0.69	0.0074	2.5
Russian River/Wohler Rd Br	3/30/93	TFC		970	10	0.38	11	44	0.34	50	0.23	8.2	2	0.069	110
Russian River/Wohler Rd Br	3/30/93	Std Dev		140	0.32	0.046	9.7	2.7	0.029	6.6	0.037	5.1	0.32	0.0085	4.3
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC		2400	14	0.52	9.4	51	0.54	56	0.18	9.8	2.3	0.12	100
Laguna De Santa Rosa/Wohler Rd	3/30/93	Std Dev		590	0.89	0.067	4.1	4.1	0.11	8.9	0.026	3.2	0.25	0.01	0.86
Russian River/Hacienda Br	3/30/93	TFC		1500	NA	0.57	25	63	0.38	47	0.18	NA	NA	0.11	120
Russian River/Hacienda Br	3/30/93	Std Dev		380	NA	0.061	8	5.5	0.097	5.9	0.019	NA	NA	0.0058	8.9
(Wet Weight)															
Estero Americana	2/26/93	RMC		110	1.7	1.5	0.78	1.3	0.097	2.3	0.024	0.9	0.43	0.015	26
Mark West CK/Slusser Rd	3/30/93	TFC		65	1.4	0.056	2	5.3	0.03	3	0.011	1.6	0.25	0.0078	11
Windsor Creek/Mark West St	3/30/93	TFC		79	1.5	0.06	2.4	5.6	0.03	5.8	0.019	2.2	0.26	0.0085	13
Santa Rosa Ck/Willowside Rd	3/30/93	TFC		78	1.6	0.084	0.25	11	0.081	4.4	0.0099	0.25	0.29	0.016	19
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC		49	1.5	0.059	1.1	5.7	0.044	4	0.017	0.9	0.34	0.007	14
Russian River/Wohler Rd Br	3/30/93	TFC		140	1.5	0.055	1.6	6.4	0.049	7.2	0.034	1.2	0.29	0.01	16
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC		240	1.4	0.052	0.93	5.1	0.053	5.6	0.018	1	0.23	0.012	10
Russian River/Hacienda Br	3/30/93	TFC		350	NA	0.13	5.8	15	0.089	11	0.041	NA	NA	0.026	28
(Dry Weight)															
Big Sulfur Creek	3/30/93	TFC		880	NA	0.54	4.3	57	0.13	26	0.15	NA	NA	0.06	110
Estero De San Antonio	2/26/93	TCM		1000	NA	8.9	20	9.6	1.2	18	0.26	NA	NA	0.02	200
Russian River/Mouth	2/25/93	TCM		1200	NA	6.5	15	10	0.74	20	0.22	NA	NA	0.04	190
Russian River/near Moscow	3/30/93	TFC		600	NA	0.5	12	43	0.18	22	0.08	NA	NA	0.04	83
Green Valley Creek 1	3/30/93	TFC		410	NA	0.48	14	52	0.24	23	0.07	NA	NA	0.05	110
Green Valley Creek 2	3/30/93	TFC		420	NA	0.48	15	47	0.28	22	0.12	NA	NA	0.08	110
(Wet Weight)															
Big Sulfur Creek	3/30/93	TFC		100	NA	0.06	0.5	6.7	0.02	3	0.02	NA	NA	0.007	13
Estero De San Antonio	2/26/93	TCM		130	NA	1.1	2.5	1.2	0.15	2.3	0.03	NA	NA	0.002	25
Russian River/Mouth	2/25/93	TCM		180	NA	0.96	2.2	1.5	0.11	2.9	0.03	NA	NA	0.006	28

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data															
Metals, ppm dry weight (unless labeled wet weight)															
Station Name	Date	Type	% Mois	Aluminum	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Zinc
Russian River/near Moscow	3/30/93	TFC		80	NA	0.07	1.6	5.8	0.02	2.9	0.01	NA	NA	0.005	11
Green Valley Creek 1	3/30/93	TFC		67	NA	0.08	2.3	8.5	0.04	3.7	0.01	NA	NA	0.008	18
Green Valley Creek 2	3/30/93	TFC		55	NA	0.06	2	6.2	0.04	2.9	0.02	NA	NA	0.011	15
(Dry Weight)															
Estero Americana	3/5/92	RMC		890	6.3	7	1.8	8.3	0.46	12	0.11	2.5	2.6	0.07	110
Mark West CK/Slusser Rd	4/7/92	TFC		1000	7.1	6.6	9.3	120	0.35	50	0.32	4.3	5.5	0.28	130
Windsor Creek/Mark West St	4/7/92	TFC		2500	6.8	4.1	13	110	0.96	270	0.87	7.9	4	0.18	190
Laguna De Santa Rosa/Stoney Pt	4/7/92	TFC		1300	9.4	3.4	17	170	1	46	0.47	4.1	4.8	0.36	150
Russian River/Wohler Rd Br	4/7/92	TFC		5700	9.3	5.5	28	150	1.5	120	0.37	26	5.2	0.3	180
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC		900	4.8	3.2	6.7	98	0.66	46	0.46	4	4	0.19	170
Russian River/Hacienda Br	4/7/92	TFC		1900	12	5.4	20	170	0.81	55	0.36	10	6.1	0.41	150
(Wet Weight)															
Estero Americana	3/5/92	RMC		180	1.2	1.4	0.35	1.6	0.09	2.4	0.02	0.5	0.51	0.014	22
Mark West CK/Slusser Rd	4/7/92	TFC		61	0.4	0.4	0.57	7.3	0.02	3.1	0.02	0.3	0.34	0.017	8
Windsor Creek/Mark West St	4/7/92	TFC		190	0.5	0.3	0.99	8.4	0.07	21	0.07	0.6	0.3	0.014	14
Laguna De Santa Rosa/Stoney Pt	4/7/92	TFC		110	0.8	0.3	1.5	15	0.09	3.9	0.04	0.3	0.41	0.031	13
Russian River/Wohler Rd Br	4/7/92	TFC		350	0.6	0.3	1.7	9.3	0.09	7.4	0.02	1.6	0.32	0.019	11
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC		82	0.4	0.3	0.61	8.9	0.06	4.2	0.04	0.4	0.36	0.017	15
Russian River/Hacienda Br	4/7/92	TFC		69	0.6	0.3	1.1	9	0.04	2.9	0.02	0.5	0.32	0.022	8
(Dry Weight)															
Big Sulfur Creek	1/29/91	TFC		630	NA	5.7	43	250	1.4	140	1.8	NA	NA	0.16	470
Estero Americana	1/29/91	RMC		580	7.6	14	2	7.9	0.64	8.7	0.2	NA	1.5	0.13	140
Willowside Road	1/30/91	TFC		890	11	2.4	3.3	73	1.1	120	0.32	NA	2.4	0.04	190
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC		360	7.8	2	2.3	61	0.33	65	0.33	NA	2.1	0.03	150
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC		570	8.2	3	3.3	70	0.49	31	0.29	NA	2.4	0.05	160
(Wet Weight)															
Big Sulfur Creek	1/29/91	TFC		110	NA	1	7.3	42	0.24	24	0.3	NA	NA	0.03	79
Estero Americana	1/29/91	RMC		110	1.4	2.6	0.37	1.5	0.12	1.6	0.04	NA	0.28	0.02	26
Willowside Road	1/30/91	TFC		75	0.9	0.2	0.28	6.1	0.09	10	0.03	NA	0.2	ND	16
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC		40	0.9	0.2	0.26	6.8	0.04	7.2	0.04	NA	0.23	ND	17
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC		50	0.7	0.3	0.29	6.1	0.04	2.7	0.03	NA	0.21	ND	14

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data																		
Pesticide Concentrations (ng/g = ppb, dry weight)																		
Station Name	Date	Type	% Moist	% Lipid	Aldrin	Chloro-benside	alpha chlordane	cis-chlordane	gamma chlordane	trans-chlordane	cis-nonachlor	trans-nonachlor	oxy-chlordane	Total Chlordane	chlor-pyrifos	dacthal	o,p'-DDD	p,p'-DDD
Standards (ppb, wet weight):																		
EDL 85 (1977-1993), transplanted freshwater clams					0.7	ND	1.5	13	1.1	9.5	2.8	9.2	0.7	35.1	40	137.5	46	165
EDL 95 (1977-1993), transplanted freshwater clams					1.5	ND	2.8	26.7	3.1	18.4	12.2	18.6	1.7	79	72	378	120.6	396.4
USAFDA Action Level					300													
NAS Recommended Maximum Concentration																		
(Dry weight)																		
Estero Americana	10/11/94	RCM	84.3	0.256	ND	ND	ND	1.48	ND	1.32	ND	ND	ND	2.8	ND	ND	ND	ND
Mark West CK/Slusser Rd	10/11/94	TFC	87.4	2.08	ND	ND	ND	ND	ND	ND	ND	8.2	ND	8.2	99.1	ND	4.3	9.89
Santa Rosa Ck/Willowside Rd	10/11/94	TFC	87.8	5.2	ND	ND	3.61	10	5.05	7.89	2.48	36.1	1.95	67.08	37.8	8.02	ND	3.92
Laguna De Santa Rosa/Stoney Pt	10/11/94	TFC	88.6	1.22	ND	ND	2.98	6.74	2.81	6.87	5.33	22.3	ND	47.03	21.9	ND	ND	6.9
Russian River/Wohler Rd Br	10/11/94	TFC	84.8	1.75	ND	ND	2.92	16.8	3.07	16.3	10.5	32.3	3.13	85.02	30.3	14.9	13.2	28.8
Laguna De Santa Rosa/Wohler Rd	10/11/94	TFC	78	3.79	ND	ND	ND	ND	ND	1.53	1	9.57	ND	12.1	6.36	ND	ND	12.8
(Dry weight)																		
Estero Americana	2/27/93	RCM	84.22		ND		ND	3.1	ND	2.8	ND	2.3	ND	8.2	ND	ND	ND	ND
Mark West CK/Slusser Rd	3/30/93	TFC	88.56		ND		ND	10	ND	5.9	5.6	5.6	ND	27.1	15	6.2	7.9	22
Windsor Creek/Mark West St	3/30/93	TFC	88.45		ND		ND	16	1.5	10	5.3	6.3	2.2	41.3	81	9.3	8.9	21
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC	87.8		ND		3.3	25	5.8	20	10	15	3.4	82.5	28	9.5	ND	14
Russian River/Wohler Rd Br	3/30/93	TFC	85.2		ND		3	36	4	23	14	19	5.4	104.4	58	22	11	21
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC	89.74		ND		ND	7.3	ND	6	4.6	4.7	2.2	24.8	19	ND	5.6	18
(Wet weight)																		
Estero Americana	2/27/93	RCM	84.22		ND		ND	0.5	ND	0.4	ND	0.4	ND	1.3	ND	ND	ND	ND
Mark West CK/Slusser Rd	3/30/93	TFC	88.56		ND		ND	1.1	ND	0.7	0.7	0.6	ND	3.1	1.8	0.7	0.9	2.5
Windsor Creek/Mark West St	3/30/93	TFC	88.45		ND		ND	1.8	0.2	1.2	0.6	0.7	0.3	4.8	9.4	1.1	1	2.5
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC	87.8		ND		0.4	3.1	0.7	2.5	1.2	1.9	0.4	10.2	3.5	1.2	ND	1.7
Russian River/Wohler Rd Br	3/30/93	TFC	85.2		ND		0.4	5.3	0.6	3.4	2.1	2.8	0.8	15.4	8.7	3.3	1.7	3.1
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC	89.74		ND		ND	0.7	ND	0.6	0.5	0.5	0.2	2.5	1.9	ND	0.6	1.8
(Dry weight)																		
Big Sulfur Creek	3/30/93	TFC			ND	NA	ND	4.1	ND	4.6	3.2	4.4	ND	16.3	ND	ND	ND	12
(Wet weight)																		
Big Sulfur Creek	3/30/93	TFC			ND	NA	ND	0.5	ND	0.5	0.4	0.5	ND	1.9	ND	ND	ND	1.4
(Dry Weight)																		
Estero De San Antonio	2/26/93	TCM			ND	NA	ND	3.8	ND	1.8	ND	1.1	ND	6.7	ND	ND	ND	ND
Russian River/Mouth	2/25/93	TCM			ND	NA	ND	6.2	ND	3.7	ND	2.9	2.5	15.3	ND	ND	ND	4.7
Russian River/near Moscow	3/30/93	TFC			ND	NA	ND	5.7	ND	4.6	3.8	4.4	1	19.5	18	5.5	5.3	13
Green Valley Creek 1	3/30/93	TFC			ND	NA	ND	4.3	ND	4.3	3.7	3.5	ND	15.8	31	ND	ND	13
Green Valley Creek 2	3/30/93	TFC			ND	NA	ND	8.8	ND	5.7	5.1	5.4	5.3	30.3	290	ND	100	81
(Wet Weight)																		
Estero De San Antonio	2/26/93	TCM			ND	NA	ND	0.6	ND	0.3	ND	0.2	ND	1.1	ND	ND	ND	ND
Russian River/Mouth	2/25/93	TCM			ND	NA	ND	0.9	ND	0.5	ND	0.4	0.3	2.1	ND	ND	ND	0.7
Russian River/near Moscow	3/30/93	TFC			ND	NA	ND	0.7	ND	0.6	0.5	0.6	0.1	2.5	2.2	0.7	0.7	1.7
Green Valley Creek 1	3/30/93	TFC			ND	NA	ND	0.7	ND	0.7	0.6	0.6	ND	2.6	5	ND	ND	2
Green Valley Creek 2	3/30/93	TFC			ND	NA	ND	1.1	ND	0.7	0.6	0.7	0.7	3.8	35	ND	12	10
(Dry Weight)																		
Estero Americana	3/5/92	RMC			ND	NA	ND	2.3	ND	1.6	ND	1.9	2	7.8	ND	ND	ND	ND
Windsor Creek/Mark West St	4/7/92	TFC			ND	NA	ND	20	3.1	11	7.5	29	1.9	72.5	6.9	ND	19	24
Russian River/Wohler Rd Br	4/7/92	TFC			ND	NA	ND	2.5	ND	2	1.9	5.5	ND	11.9	4.4	ND	ND	ND
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC			ND	NA	2.7	48	4.2	52	14	66	6.8	193.7	37	29	12	43
Russian River/Hacienda Br	4/7/92	TFC			ND	NA	ND	13	ND	4.5	5	12	ND	34.5	ND	7.9	12	18
(Wet Weight)																		
Estero Americana	3/5/92	RMC			ND	NA	ND	0.5	ND	0.3	ND	0.4	0.4	1.6	ND	ND	ND	ND
Windsor Creek/Mark West St	4/7/92	TFC			ND	NA	ND	1.3	0.2	0.7	0.5	1.8	0.1	4.6	0.4	ND	1.2	1.5
Russian River/Wohler Rd Br	4/7/92	TFC			ND	NA	ND	0.1	ND	0.1	0.1	0.3	ND	0.6	0.2	ND	ND	ND
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC			ND	NA	0.2	3.7	0.3	4	1.1	5	0.5	14.8	2.8	2.2	0.9	3.3
Russian River/Hacienda Br	4/7/92	TFC			ND	NA	ND	0.6	ND	0.2	0.2	0.6	ND	1.6	ND	0.4	0.6	0.9

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data Pesticide Concentrations (ng/g=ppb, dry weight) Station Name	Date	Type	o,p'-DDE	p,p'-DDE	o,p'-DDT	p,p'-DDT	p,p'-DDMS	p,p'-DDMU	Total DDT	diazinon	dichloro-benzo-phenone	dicofol	dieldrin	endosulfan I	endosulfan II	endosulfan sulfate	Total Endosulfan
Standards (ppb, wet weight):																	
EDL 85 (1977-1993), transplanted freshwater clams			9.2	376.9	41.9	217.4	ND	15.1	911	ND	ND	40.1	110.4	22.7	24.9	37.8	74.6
EDL 95 (1977-1993), transplanted freshwater clams			20.8	1019.8	126.2	665.1	7.8	34.4	2493.7	23.2	4.6	107.4	196.9	190.5	111.4	86.3	294.4
USAFDA Action Level													300				
NAS Recommended Maximum Concentration									1,000								
(Dry weight)																	
Estero Americana	10/11/94	RCM	ND	6.81	ND	ND		ND	6.81	ND	ND	ND	6.71	ND	ND	ND	ND
Mark West CK/Slusser Rd	10/11/94	TFC	4.3	75.9	ND	ND		ND	94.39	ND	ND	ND	4.04	ND	ND	ND	ND
Santa Rosa Ck/Willowside Rd	10/11/94	TFC	4	71.4	ND	4.77		ND	84.09	ND	ND	ND	7.91	ND	ND	ND	ND
Laguna De Santa Rosa/Stoney Pt	10/11/94	TFC	3.02	67.3	ND	ND		ND	77.22	ND	ND	ND	1.78	ND	ND	ND	ND
Russian River/Wohler Rd Br	10/11/94	TFC	ND	70	ND	4.24		ND	114.24	51.7	ND	ND	11.8	ND	ND	ND	ND
Laguna De Santa Rosa/Wohler Rd	10/11/94	TFC	5.83	110	ND	ND		ND	128.63	ND	ND	ND	ND	ND	ND	ND	ND
(Dry weight)																	
Estero Americana	2/27/93	RCM	ND	11	ND	ND	ND	ND	11		ND		11	ND	ND	ND	ND
Mark West CK/Slusser Rd	3/30/93	TFC	7.4	110	ND	17	ND	18	182.3		ND		4.6	ND	ND	ND	ND
Windsor Creek/Mark West St	3/30/93	TFC	6.2	87	ND	19	ND	22	164.1		ND		6.2	ND	ND	8.8	8.8
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC	6.2	85	ND	7.1	ND	24	136.3		ND		4.4	ND	ND	ND	ND
Russian River/Wohler Rd Br	3/30/93	TFC	5.1	93	ND	21	ND	40	191.1		ND		15	ND	ND	ND	ND
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC	8.1	100	ND	14	ND	12	157.7		ND		ND	ND	ND	ND	ND
(Wet weight)																	
Estero Americana	2/27/93	RCM	ND	1.7	ND	ND	ND	ND	1.7		ND		1.7	ND	ND	ND	ND
Mark West CK/Slusser Rd	3/30/93	TFC	0.9	12	ND	2	ND	2.1	20.4		ND		0.5	ND	ND	ND	ND
Windsor Creek/Mark West St	3/30/93	TFC	0.7	10	ND	2.2	ND	2.5	18.9		ND		0.7	ND	ND	1	1
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC	0.8	10	ND	0.9	ND	2.9	16.3		ND		0.5	ND	ND	ND	ND
Russian River/Wohler Rd Br	3/30/93	TFC	0.8	14	ND	3	ND	6	28.6		ND		2.1	ND	ND	ND	ND
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC	0.8	11	ND	1.4	ND	1.2	16.8		ND		ND	ND	ND	ND	ND
(Dry weight)																	
Big Sulfur Creek	3/30/93	TFC	7	92	ND	ND	ND	7	118	NA	ND	NA	ND	ND	ND	ND	ND
(Wet weight)																	
Big Sulfur Creek	3/30/93	TFC	0.8	10	ND	ND	ND	0.8	13	NA	ND	NA	ND	ND	ND	ND	ND
(Dry Weight)																	
Estero De San Antonio	2/26/93	TCM	ND	5.5	ND	ND	ND	ND	5.5	NA	ND	NA	8.7	ND	ND	ND	ND
Russian River/Mouth	2/25/93	TCM	ND	33	ND	10	ND	ND	47.7	NA	ND	NA	11	ND	ND	ND	ND
Russian River/near Moscow	3/30/93	TFC	7.1	100	ND	5.7	ND	7.1	138.2	NA	ND	NA	ND	ND	ND	ND	ND
Green Valley Creek 1	3/30/93	TFC	8.9	120	ND	ND	ND	7.7	149.6	NA	31	NA	ND	ND	ND	ND	ND
Green Valley Creek 2	3/30/93	TFC	16	320	25	130	ND	16	688	NA	ND	NA	8.1	ND	ND	3.1	3.1
(Wet Weight)																	
Estero De San Antonio	2/26/93	TCM	ND	0.9	ND	ND	ND	ND	0.9	NA	ND	NA	1.5	ND	ND	ND	ND
Russian River/Mouth	2/25/93	TCM	ND	4.6	ND	1.5	ND	ND	6.8	NA	ND	NA	1.5	ND	ND	ND	ND
Russian River/near Moscow	3/30/93	TFC	0.9	13	ND	0.7	ND	0.9	17.9	NA	ND	NA	ND	ND	ND	ND	ND
Green Valley Creek 1	3/30/93	TFC	1.4	19	ND	ND	ND	1.2	23.6	NA	4.9	NA	ND	ND	ND	ND	ND
Green Valley Creek 2	3/30/93	TFC	1.9	39	3.1	17	ND	2	85	NA	ND	NA	1	ND	ND	0.4	0.4
(Dry Weight)																	
Estero Americana	3/5/92	RMC	ND	11	ND	ND	ND	ND	11	NA	ND	NA	8.6	ND	ND	ND	ND
Windsor Creek/Mark West St	4/7/92	TFC	ND	99	10	100	ND	ND	252	NA	ND	NA	3.5	ND	ND	15	15
Russian River/Wohler Rd Br	4/7/92	TFC	ND	69	ND	ND	ND	ND	69	NA	ND	NA	1.9	ND	ND	ND	ND
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC	ND	97	ND	44	ND	ND	196	NA	ND	NA	17	ND	ND	ND	ND
Russian River/Hacienda Br	4/7/92	TFC	ND	140	ND	67	ND	ND	237	NA	ND	NA	16	ND	ND	ND	ND
(Wet Weight)																	
Estero Americana	3/5/92	RMC	ND	2.2	ND	ND	ND	ND	2.2	NA	ND	NA	1.7	ND	ND	ND	ND
Windsor Creek/Mark West St	4/7/92	TFC	ND	6.3	0.7	6.4	ND	ND	16.1	NA	ND	NA	0.2	ND	ND	1	1
Russian River/Wohler Rd Br	4/7/92	TFC	ND	3.6	ND	ND	ND	ND	3.6	NA	ND	NA	0.1	ND	ND	ND	ND
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC	ND	7.3	ND	3.3	ND	ND	14.8	NA	ND	NA	1.3	ND	ND	ND	ND
Russian River/Hacienda Br	4/7/92	TFC	ND	6.7	ND	3.2	ND	ND	11.4	NA	ND	NA	0.8	ND	ND	ND	ND

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data																				
Pesticide Concentrations (ng/g = ppb, dry weight)																Penta-Chloro-		Tetra-Chloro-		
Station Name	Date	Type	endrin	ethion	alpha HCH	beta HCH	delta HCH	gamma HCH	heptachlor	heptachlor epoxide	hexachloro-benzene	methoxychlor	ethyl parathion	methyl parathion	oxadiazon	Phenol	Phenol	Phenol	tetradifon	toxaphene
Standards (ppb, wet weight):																				
EDL 85 (1977-1993), transplanted freshwater clams			17	ND	0.1	ND	ND	0.6	ND	0.6	1.3	ND	ND	ND	26.2				ND	603.2
EDL 95 (1977-1993), transplanted freshwater clams			29.3	ND	0.4	ND	ND	0.9	0.3	2.6	2.9	ND	ND	ND	61.8				ND	2374.4
USAFDA Action Level			300						300	300										
NAS Recommended Maximum Concentration																				
(Dry weight)																				
Estero Americana	10/11/94	RCM	ND	ND	1.46	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND				ND	ND
Mark West CK/Slusser Rd	10/11/94	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	21				ND	ND
Santa Rosa Ck/Willowside Rd	10/11/94	TFC	ND	ND	ND	ND	ND	ND	1.04	ND	1.06	ND	ND	ND	700				ND	ND
Laguna De Santa Rosa/Stoney Pt	10/11/94	TFC	ND	ND	ND	ND	ND	ND	ND	ND	1.18	ND	ND	ND	370				ND	ND
Russian River/Wohler Rd Br	10/11/94	TFC	ND	ND	ND	ND	ND	1.32	ND	1.68	ND	ND	ND	ND	420				ND	ND
Laguna De Santa Rosa/Wohler Rd	10/11/94	TFC	ND	ND	ND	ND	ND	ND	ND	ND	1.05	ND	ND	ND	8.02				ND	ND
(Dry weight)																				
Estero Americana	2/27/93	RCM	ND	ND	1	ND	ND	0.8	ND	1	ND	ND			ND					ND
Mark West CK/Slusser Rd	3/30/93	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			57					ND
Windsor Creek/Mark West St	3/30/93	TFC	ND	ND	ND	ND	ND	ND	ND	1	ND	ND			240					ND
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC	ND	ND	ND	ND	ND	ND	3.9	3	1.5	ND			190					ND
Russian River/Wohler Rd Br	3/30/93	TFC	ND	ND	1.7	ND	ND	ND	ND	2.8	1.2	ND			190					ND
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND					ND
(Wet weight)																				
Estero Americana	2/27/93	RCM	ND	ND	0.2	ND	ND	0.1	ND	0.2	ND	ND			ND					ND
Mark West CK/Slusser Rd	3/30/93	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			6.6					ND
Windsor Creek/Mark West St	3/30/93	TFC	ND	ND	ND	ND	ND	ND	ND	0.1	ND	ND			28					ND
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC	ND	ND	ND	ND	ND	ND	0.5	0.4	0.2	ND			23					ND
Russian River/Wohler Rd Br	3/30/93	TFC	ND	ND	0.3	ND	ND	ND	ND	0.4	0.2	ND			29					ND
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND					ND
(Dry weight)																				
Big Sulfur Creek	3/30/93	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	ND	NA	NA	NA	NA	ND
(Wet weight)																				
Big Sulfur Creek	3/30/93	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	ND	NA	NA	NA	NA	ND
(Dry Weight)																				
Estero De San Antonio	2/26/93	TCM	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	ND	NA	NA	NA	NA	ND
Russian River/Mouth	2/25/93	TCM	ND	ND	2.4	1.4	ND	ND	ND	2.5	ND	ND	NA	NA	ND	NA	NA	NA	NA	ND
Russian River/near Moscow	3/30/93	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	18	NA	NA	NA	NA	ND
Green Valley Creek 1	3/30/93	TFC	ND	ND	ND	ND	ND	3.7	ND	1.9	ND	ND	NA	NA	ND	NA	NA	NA	NA	ND
Green Valley Creek 2	3/30/93	TFC	ND	ND	ND	ND	1.3	5.3	ND	ND	0.8	ND	NA	NA	16	NA	NA	NA	NA	ND
(Wet Weight)																				
Estero De San Antonio	2/26/93	TCM	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	ND	NA	NA	NA	NA	ND
Russian River/Mouth	2/25/93	TCM	ND	ND	0.3	0.2	ND	ND	ND	0.3	ND	ND	NA	NA	ND	NA	NA	NA	NA	ND
Russian River/near Moscow	3/30/93	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	2.3	NA	NA	NA	NA	ND
Green Valley Creek 1	3/30/93	TFC	ND	ND	ND	ND	ND	0.6	ND	0.3	ND	ND	NA	NA	ND	NA	NA	NA	NA	ND
Green Valley Creek 2	3/30/93	TFC	ND	ND	ND	ND	0.2	0.7	ND	ND	0.1	ND	NA	NA	2	NA	NA	NA	NA	ND
(Dry Weight)																				
Estero Americana	3/5/92	RMC	ND	ND	3.5	ND	ND	0.9	ND	ND	ND	ND	NA	NA	ND	NA	NA	NA	NA	ND
Windsor Creek/Mark West St	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	98	NA	NA	NA	NA	ND
Russian River/Wohler Rd Br	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	13	NA	NA	NA	NA	ND
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC	ND	ND	1.8	ND	ND	9.1	ND	ND	ND	ND	NA	NA	140	NA	NA	NA	NA	ND
Russian River/Hacienda Br	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	30	NA	NA	NA	NA	ND
(Wet Weight)																				
Estero Americana	3/5/92	RMC	ND	ND	0.7	ND	ND	0.2	ND	ND	ND	ND	NA	NA	ND	NA	NA	NA	NA	ND
Windsor Creek/Mark West St	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	6.2	NA	NA	NA	NA	ND
Russian River/Wohler Rd Br	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	0.7	NA	NA	NA	NA	ND
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC	ND	ND	0.1	ND	ND	0.7	ND	ND	ND	ND	NA	NA	11	NA	NA	NA	NA	ND
Russian River/Hacienda Br	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	1.4	NA	NA	NA	NA	ND

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data																		
Pesticide Concentrations (ng/g=ppb, dry weight)																		
Station Name	Date	Type	Duration	% Water	Length	%Lipid	PCB 1248	PCB 1254	PCB 1260	PCT 5460	Total PCB	PCB 1650	Aroclor 48	Aroclor 54	Aroclor 60	Aroclor Total	PCB 6	PCB 18
Standards (ppb, wet weight):																		
EDL 85 (1977-1993), transplanted freshwater clams							4.1	59.8	ND	ND	78							
EDL 95 (1977-1993), transplanted freshwater clams							13.4	151.6	9.4	ND	151.6							
USAFDA Action Level											200							
NAS Recommended Maximum Concentration											500							
(Dry weight)																		
Estero Americana	10/11/94	RCM					ND	ND	ND	ND	0							
Mark West CK/Slusser Rd	10/11/94	TFC					ND	56.3	ND	ND	56.3							
Santa Rosa Ck/Willowside Rd	10/11/94	TFC					ND	130	28.6	ND	158.6							
Laguna De Santa Rosa/Stoney Pt	10/11/94	TFC					ND	86.7	22.7	ND	109.4							
Russian River/Wohler Rd Br	10/11/94	TFC					ND	64.6	19.2	ND	83.8							
Laguna De Santa Rosa/Wohler Rd	10/11/94	TFC					ND	60.8	21.2	ND	82							
(Dry weight)																		
Estero Americana	2/27/93	RCM					ND	17	ND	ND	17							
Mark West CK/Slusser Rd	3/30/93	TFC					ND	110	ND	ND	110							
Windsor Creek/Mark West St	3/30/93	TFC					76	96	ND	ND	172							
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC					150	74	ND	ND	224							
Russian River/Wohler Rd Br	3/30/93	TFC					ND	76	ND	ND	76							
Laguna De Sante Rosa/Wohler Rd	3/30/93	TFC					ND	130	ND	ND	130							
(Wet weight)																		
Estero Americana	2/27/93	RCM					ND	2.7	ND	ND	2.7							
Mark West CK/Slusser Rd	3/30/93	TFC					ND	12	ND	ND	12							
Windsor Creek/Mark West St	3/30/93	TFC					8.7	11	ND	ND	19.7							
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC					18	9	ND	ND	27							
Russian River/Wohler Rd Br	3/30/93	TFC					ND	11	ND	ND	11							
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC					ND	13	ND	ND	13							
(Dry weight)																		
Big Sulfur Creek	3/30/93	TFC	0.9	88.6	32.7	1.3	ND	110	ND	ND	110							
(Wet weight)																		
Big Sulfur Creek	3/30/93	TFC	0.9	88.6	32.7	1.3	ND	13	ND	ND	13							
(Dry Weight)																		
Estero De San Antonio	2/26/93	TCM	4.2	83.1	55.1	0.4	ND	26	ND	ND	26							
Russian River/Mouth	2/25/93	TCM	4.2	85.9	56.6	0.8	ND	38	ND	ND	38							
Russian River/near Moscow	3/30/93	TFC	0.9	87.2	31.1	1.8	ND	100	ND	ND	100							
Green Valley Creek 1	3/30/93	TFC	0.9	84.1	33.1	2.4	ND	120	ND	ND	120							
Green Valley Creek 2	3/30/93	TFC	0.9	87.6	32.5	1.8	38	110	ND	ND	150							
(Wet Weight)																		
Estero De San Antonio	2/26/93	TCM	4.2	83.1	55.1	0.4	ND	4.4	ND	ND	4.4							
Russian River/Mouth	2/25/93	TCM	4.2	85.9	56.6	0.8	ND	5.4	ND	ND	5.4							
Russian River/near Moscow	3/30/93	TFC	0.9	87.2	31.1	1.8	ND	13	ND	ND	13							
Green Valley Creek 1	3/30/93	TFC	0.9	84.1	33.1	2.4	ND	19	ND	ND	19							
Green Valley Creek 2	3/30/93	TFC	0.9	87.6	32.5	1.8	4.8	14	ND	ND	19							
(Dry Weight)																		
Estero Americana	3/5/92	RMC	NA	80.3	58	0.88	ND	ND	ND	ND	ND							
Windsor Creek/Mark West St	4/7/92	TFC	3.3	93.6	19.9	0.5	ND	99	ND	ND	99							
Russian River/Wohler Rd Br	4/7/92	TFC	1.1	94.7	22.7	0.34	ND	37	140	ND	177							
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC	1.1	92.4	22.8	0.67	ND	78	78	ND	156							
Russian River/Hacienda Br	4/7/92	TFC	1.1	95.3	26.7	0.49	ND	120	250	ND	370							
(Wet Weight)																		
Estero Americana	3/5/92	RMC	NA	80.3	58	0.88	ND	ND	ND	ND	ND							
Windsor Creek/Mark West St	4/7/92	TFC	3.3	93.6	19.9	0.5	ND	6.3	ND	ND	6.3							
Russian River/Wohler Rd Br	4/7/92	TFC	1.1	94.7	22.7	0.34	ND	2	7.3	ND	9.3							
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC	1.1	92.4	22.8	0.67	ND	6	5.9	ND	12							
Russian River/Hacienda Br	4/7/92	TFC	1.1	95.3	26.7	0.49	ND	5.8	12	ND	18							

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data																																
Pesticide Concentrations (ng/g = ppb, dry weight)																																
			PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB
Station Name	Date	Type	25	26	28	29	44	45	63	89	96	114	118	137	138	141	149	151	153	158	176	177	179	180	185	189	191	193	194	197	198	199
Standards (ppb, wet weight):																																
EDL 85 (1977-1993), transplanted freshwater clams																																
EDL 95 (1977-1993), transplanted freshwater clams																																
USAFDA Action Level																																
NAS Recommended Maximum Concentration																																
(Dry weight)																																
Estero Americana	10/11/94	RCM																														
Mark West CK/Slusser Rd	10/11/94	TFC																														
Santa Rosa Ck/Willowside Rd	10/11/94	TFC																														
Laguna De Santa Rosa/Stoney Pt	10/11/94	TFC																														
Russian River/Wohler Rd Br	10/11/94	TFC																														
Laguna De Santa Rosa/Wohler Rd	10/11/94	TFC																														
(Dry weight)																																
Estero Americana	2/27/93	RCM																														
Mark West CK/Slusser Rd	3/30/93	TFC																														
Windsor Creek/Mark West St	3/30/93	TFC																														
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC																														
Russian River/Wohler Rd Br	3/30/93	TFC																														
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC																														
(Wet weight)																																
Estero Americana	2/27/93	RCM																														
Mark West CK/Slusser Rd	3/30/93	TFC																														
Windsor Creek/Mark West St	3/30/93	TFC																														
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC																														
Russian River/Wohler Rd Br	3/30/93	TFC																														
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC																														
(Dry weight)																																
Big Sulfur Creek	3/30/93	TFC																														
(Wet weight)																																
Big Sulfur Creek	3/30/93	TFC																														
(Dry Weight)																																
Estero De San Antonio	2/26/93	TCM																														
Russian River/Mouth	2/25/93	TCM																														
Russian River/near Moscow	3/30/93	TFC																														
Green Valley Creek 1	3/30/93	TFC																														
Green Valley Creek 2	3/30/93	TFC																														
(Wet Weight)																																
Estero De San Antonio	2/26/93	TCM																														
Russian River/Mouth	2/25/93	TCM																														
Russian River/near Moscow	3/30/93	TFC																														
Green Valley Creek 1	3/30/93	TFC																														
Green Valley Creek 2	3/30/93	TFC																														
(Dry Weight)																																
Estero Americana	3/5/92	RMC																														
Windsor Creek/Mark West St	4/7/92	TFC																														
Russian River/Wohler Rd Br	4/7/92	TFC																														
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC																														
Russian River/Hacienda Br	4/7/92	TFC																														
(Wet Weight)																																
Estero Americana	3/5/92	RMC																														
Windsor Creek/Mark West St	4/7/92	TFC																														
Russian River/Wohler Rd Br	4/7/92	TFC																														
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC																														
Russian River/Hacienda Br	4/7/92	TFC																														

Station Name	Date	Type	PCB 201	PCB 205	PCB 206	PCB 207	PCB 5	PCB 7	PCB 15	PCB 16	PCB 19	PCB 22	PCB 27	PCB 31	PCB 33	PCB 40	PCB 41	PCB 46	PCB 47	PCB 49	PCB 52	PCB 56	PCB 59	PCB 66	PCB 67	PCB 70	PCB 74	PCB 82	PCB 83	PCB 84	PCB 87	PCB 91
Mussel Chemistry Data																																
Pesticide Concentrations (ng/g=ppb, dry weight)																																
Standards (ppb, wet weight):																																
EDL 85 (1977-1993), transplanted freshwater clams																																
EDL 95 (1977-1993), transplanted freshwater clams																																
USAFDA Action Level																																
NAS Recommended Maximum Concentration																																
(Dry weight)																																
Estero Americana	10/11/94	RCM																														
Mark West CK/Slusser Rd	10/11/94	TFC																														
Santa Rosa Ck/Willowside Rd	10/11/94	TFC																														
Laguna De Santa Rosa/Stoney Pt	10/11/94	TFC																														
Russian River/Wohler Rd Br	10/11/94	TFC																														
Laguna De Santa Rosa/Wohler Rd	10/11/94	TFC																														
(Dry weight)																																
Estero Americana	2/27/93	RCM																														
Mark West CK/Slusser Rd	3/30/93	TFC																														
Windsor Creek/Mark West St	3/30/93	TFC																														
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC																														
Russian River/Wohler Rd Br	3/30/93	TFC																														
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC																														
(Wet weight)																																
Estero Americana	2/27/93	RCM																														
Mark West CK/Slusser Rd	3/30/93	TFC																														
Windsor Creek/Mark West St	3/30/93	TFC																														
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC																														
Russian River/Wohler Rd Br	3/30/93	TFC																														
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC																														
(Dry weight)																																
Big Sulfur Creek	3/30/93	TFC																														
(Wet weight)																																
Big Sulfur Creek	3/30/93	TFC																														
(Dry Weight)																																
Estero De San Antonio	2/26/93	TCM																														
Russian River/Mouth	2/25/93	TCM																														
Russian River/near Moscow	3/30/93	TFC																														
Green Valley Creek 1	3/30/93	TFC																														
Green Valley Creek 2	3/30/93	TFC																														
(Wet Weight)																																
Estero De San Antonio	2/26/93	TCM																														
Russian River/Mouth	2/25/93	TCM																														
Russian River/near Moscow	3/30/93	TFC																														
Green Valley Creek 1	3/30/93	TFC																														
Green Valley Creek 2	3/30/93	TFC																														
(Dry Weight)																																
Estero Americana	3/5/92	RMC																														
Windsor Creek/Mark West St	4/7/92	TFC																														
Russian River/Wohler Rd Br	4/7/92	TFC																														
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC																														
Russian River/Hacienda Br	4/7/92	TFC																														
(Wet Weight)																																
Estero Americana	3/5/92	RMC																														
Windsor Creek/Mark West St	4/7/92	TFC																														
Russian River/Wohler Rd Br	4/7/92	TFC																														
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC																														
Russian River/Hacienda Br	4/7/92	TFC																														

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Station Name	Date	Type	PCB 97	PCB 99	PCB 101	PCB 105	PCB 107	PCB 110	PCB 122	PCB 128	PCB 129	PCB 134	PCB 135	PCB 136	PCB 146	PCB 156	PCB 170	PCB 172	PCB 173	PCB 174	PCB 183	PCB 187	PCB 195	PCB 196		PAHs anthracene	dibenz(a,h) anthracene	biphenyl
Mussel Chemistry Data																												
Pesticide Concentrations (ng/g = ppb, dry weight)																												
Standards (ppb, wet weight):																												
EDL 85 (1977-1993), transplanted freshwater clams																												
EDL 95 (1977-1993), transplanted freshwater clams																												
USAFDA Action Level																												
NAS Recommended Maximum Concentration																												
(Dry weight)																												
Estero Americana	10/11/94	RCM																								ND	ND	ND
Mark West CK/Slusser Rd	10/11/94	TFC																								ND	ND	ND
Santa Rosa Ck/Willowside Rd	10/11/94	TFC																								ND	ND	ND
Laguna De Santa Rosa/Stoney Pt	10/11/94	TFC																								ND	ND	12
Russian River/Wohler Rd Br	10/11/94	TFC																								ND	ND	ND
Laguna De Santa Rosa/Wohler Rd	10/11/94	TFC																								ND	ND	ND
(Dry weight)																												
Estero Americana	2/27/93	RCM																								ND	ND	ND
Mark West CK/Slusser Rd	3/30/93	TFC																								ND	ND	ND
Windsor Creek/Mark West St	3/30/93	TFC																								ND	ND	ND
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC																								ND	ND	ND
Russian River/Wohler Rd Br	3/30/93	TFC																								ND	ND	ND
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC																								ND	ND	ND
(Wet weight)																												
Estero Americana	2/27/93	RCM																								ND	ND	ND
Mark West CK/Slusser Rd	3/30/93	TFC																								ND	ND	ND
Windsor Creek/Mark West St	3/30/93	TFC																								ND	ND	ND
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC																								ND	ND	ND
Russian River/Wohler Rd Br	3/30/93	TFC																								ND	ND	ND
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC																								ND	ND	ND
(Dry weight)																												
Big Sulfur Creek	3/30/93	TFC																								ND	10	ND
(Wet weight)																												
Big Sulfur Creek	3/30/93	TFC																								ND	1.2	ND
(Dry Weight)																												
Estero De San Antonio	2/26/93	TCM																										
Russian River/Mouth	2/25/93	TCM																										
Russian River/near Moscow	3/30/93	TFC																										
Green Valley Creek 1	3/30/93	TFC																										
Green Valley Creek 2	3/30/93	TFC																										
(Wet Weight)																												
Estero De San Antonio	2/26/93	TCM																										
Russian River/Mouth	2/25/93	TCM																										
Russian River/near Moscow	3/30/93	TFC																										
Green Valley Creek 1	3/30/93	TFC																										
Green Valley Creek 2	3/30/93	TFC																										
(Dry Weight)																												
Estero Americana	3/5/92	RMC																								ND	ND	ND
Windsor Creek/Mark West St	4/7/92	TFC																								ND	ND	ND
Russian River/Wohler Rd Br	4/7/92	TFC																								ND	ND	ND
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC																								ND	ND	ND
Russian River/Hacienda Br	4/7/92	TFC																								ND	ND	ND
(Wet Weight)																												
Estero Americana	3/5/92	RMC																								ND	ND	ND
Windsor Creek/Mark West St	4/7/92	TFC																								ND	ND	ND
Russian River/Wohler Rd Br	4/7/92	TFC																								ND	ND	ND
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC																								ND	ND	ND
Russian River/Hacienda Br	4/7/92	TFC																								ND	ND	ND

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data															
Pesticide Concentrations (ng/g = ppb, dry weight)															
Station Name	Date	Type	chrysene	fluoranthene	benzo(b) fluoranthene	benzo(k) fluoranthene	fluorene	naphthalene	1-methyl-naphthalene	2-methyl-naphthalene	2,6-dimethyl-naphthalene	2,3,5-trimethyl-naphthalene	Naphthene	perylene	benzo(ghi) perylene
Standards (ppb, wet weight):															
EDL 85 (1977-1993), transplanted freshwater clams															
EDL 95 (1977-1993), transplanted freshwater clams															
USAFDA Action Level															
NAS Recommended Maximum Concentration															
(Dry weight)															
Estero Americana	10/11/94	RCM	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
Mark West CK/Slusser Rd	10/11/94	TFC	15	44	ND	ND	ND	51	21	30	14	12		ND	ND
Santa Rosa Ck/Willowside Rd	10/11/94	TFC	110	180	47	10	10	32	20	25	14	20		ND	28
Laguna De Santa Rosa/Stoney Pt	10/11/94	TFC	130	250	53	13	25	34	50	61	41	44		ND	23
Russian River/Wohler Rd Br	10/11/94	TFC	41	93	ND	ND	10	22	ND	11	ND	ND		ND	ND
Laguna De Santa Rosa/Wohler Rd	10/11/94	TFC	13	12	ND	ND	ND	14	ND	11	11	12		ND	ND
(Dry weight)															
Estero Americana	2/27/93	RCM	ND	ND	ND	ND	ND	17	ND	15	ND	ND		ND	ND
Mark West CK/Slusser Rd	3/30/93	TFC	ND	61	ND	ND	ND	20	ND	12	ND	ND		ND	ND
Windsor Creek/Mark West St	3/30/93	TFC	16	130	13	ND	12	83	61	68	1.6	17		ND	ND
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC	43	270	30	ND	33	17	21	27	ND	36		ND	11
Russian River/Wohler Rd Br	3/30/93	TFC	26	120	20	ND	ND	15	10	11	ND	ND		ND	ND
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC	ND	37	ND	ND	ND	19	ND	12	ND	ND		ND	ND
(Wet weight)															
Estero Americana	2/27/93	RCM	ND	ND	ND	ND	ND	2.7	ND	2.4	ND	ND		ND	ND
Mark West CK/Slusser Rd	3/30/93	TFC	ND	6.9	ND	ND	ND	2.3	ND	1.3	ND	ND		ND	ND
Windsor Creek/Mark West St	3/30/93	TFC	1.9	16	1.5	ND	1.4	9.5	7.1	10	1.7	2		ND	ND
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC	5.2	33	3.6	ND	4.1	2	2.6	3.2	ND	4.5		ND	1.3
Russian River/Wohler Rd Br	3/30/93	TFC	3.7	18	2.9	ND	ND	2.3	1.5	1.6	ND	ND		ND	ND
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC	ND	3.7	ND	ND	ND	1.9	ND	1.2	ND	ND		ND	ND
(Dry weight)															
Big Sulfur Creek	3/30/93	TFC	ND	30	ND	ND	ND	16	ND	14	ND	ND	ND	ND	ND
(Wet weight)															
Big Sulfur Creek	3/30/93	TFC	ND	3.4	ND	ND	ND	1.8	ND	1.6	ND	ND	ND	ND	ND
(Dry Weight)															
Estero De San Antonio	2/26/93	TCM													
Russian River/Mouth	2/25/93	TCM													
Russian River/near Moscow	3/30/93	TFC													
Green Valley Creek 1	3/30/93	TFC													
Green Valley Creek 2	3/30/93	TFC													
(Wet Weight)															
Estero De San Antonio	2/26/93	TCM													
Russian River/Mouth	2/25/93	TCM													
Russian River/near Moscow	3/30/93	TFC													
Green Valley Creek 1	3/30/93	TFC													
Green Valley Creek 2	3/30/93	TFC													
(Dry Weight)															
Estero Americana	3/5/92	RMC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Windsor Creek/Mark West St	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Russian River/Wohler Rd Br	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC	57	81	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Russian River/Hacienda Br	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
(Wet Weight)															
Estero Americana	3/5/92	RMC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Windsor Creek/Mark West St	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Russian River/Wohler Rd Br	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC	4.3	6.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Russian River/Hacienda Br	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data													
Pesticide Concentrations (ng/g = ppb, dry weight)													
				1-methyl-		benzo[a]	benzo[e]	indeno[1,2,3-cd]	ace-	ace-	benz[a]	dibenzo[ghi]	Total
Station Name	Date	Type	phenanthrene	phenanthrene	pyrene	pyrene	pyrene	pyrene	naphthylene	naphthene	anthracene	perylene	PAH
Standards (ppb, wet weight):													
EDL 85 (1977-1993), transplanted freshwater clams													
EDL 95 (1977-1993), transplanted freshwater clams													
USAFDA Action Level													
NAS Recommended Maximum Concentration													
(Dry weight)													
Estero Americana	10/11/94	RCM	12	ND	ND	ND	ND	ND	ND		ND		12
Mark West CK/Slusser Rd	10/11/94	TFC	32	ND	40	ND	ND	ND	ND		ND		259
Santa Rosa Ck/Willowside Rd	10/11/94	TFC	82	ND	200	12	43	24	ND		19		876
Laguna De Santa Rosa/Stoney Pt	10/11/94	TFC	90	ND	300	11	57	18	ND		28		1240
Russian River/Wohler Rd Br	10/11/94	TFC	37	ND	85	ND	20	ND	ND		ND		319
Laguna De Santa Rosa/Wohler Rd	10/11/94	TFC	37	ND	ND	ND	ND	ND	ND		ND		110
(Dry weight)													
Estero Americana	2/27/93	RCM	27	ND	ND	ND	ND	ND	ND	ND	ND	ND	59
Mark West CK/Slusser Rd	3/30/93	TFC	49	21	29	ND	ND	ND	ND	ND	ND	ND	192
Windsor Creek/Mark West St	3/30/93	TFC	87	27	100	ND	ND	ND	ND	ND	ND	ND	635.5
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC	170	83	230	ND	35	ND	ND	ND	26	ND	1032
Russian River/Wohler Rd Br	3/30/93	TFC	53	18	110	ND	18	ND	ND	ND	13	ND	413
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC	45	12	19	ND	ND	ND	ND	ND	ND	ND	144
(Wet weight)													
Estero Americana	2/27/93	RCM	4.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.3
Mark West CK/Slusser Rd	3/30/93	TFC	5.6	2.4	3.3	ND	ND	ND	ND	ND	ND	ND	21.8
Windsor Creek/Mark West St	3/30/93	TFC	10	3.1	12	ND	ND	ND	ND	ND	ND	ND	75.2
Laguna De Santa Rosa/Stoney Pt	3/30/93	TFC	21	10	27	ND	4.3	ND	ND	ND	3.2	ND	124.9
Russian River/Wohler Rd Br	3/30/93	TFC	7.8	2.6	16	ND	2.7	ND	ND	ND	1.9	ND	61
Laguna De Santa Rosa/Wohler Rd	3/30/93	TFC	4.8	1.3	2	ND	ND	ND	ND	ND	ND	ND	14.7
(Dry weight)													
Big Sulfur Creek	3/30/93	TFC	42	ND	28	ND	ND	ND	ND		ND		140
(Wet weight)													
Big Sulfur Creek	3/30/93	TFC	4.7	ND	3.2	ND	ND	ND	ND		ND		15.9
(Dry Weight)													
Estero De San Antonio	2/26/93	TCM											
Russian River/Mouth	2/25/93	TCM											
Russian River/near Moscow	3/30/93	TFC											
Green Valley Creek 1	3/30/93	TFC											
Green Valley Creek 2	3/30/93	TFC											
(Wet Weight)													
Estero De San Antonio	2/26/93	TCM											
Russian River/Mouth	2/25/93	TCM											
Russian River/near Moscow	3/30/93	TFC											
Green Valley Creek 1	3/30/93	TFC											
Green Valley Creek 2	3/30/93	TFC											
(Dry Weight)													
Estero Americana	3/6/92	RMC	ND	ND	ND	ND	ND	ND	ND		ND		0
Windsor Creek/Mark West St	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND		ND		0
Russian River/Wohler Rd Br	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND		ND		0
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC	39	ND	92	ND	27	ND	ND		ND		296
Russian River/Hacienda Br	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND		ND		0
(Wet Weight)													
Estero Americana	3/6/92	RMC	ND	ND	ND	ND	ND	ND	ND		ND		0
Windsor Creek/Mark West St	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND		ND		0
Russian River/Wohler Rd Br	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND		ND		0
Laguna De Santa Rosa/Wohler Rd	4/7/92	TFC	2.9	ND	7	ND	2	ND	ND		ND		22.3
Russian River/Hacienda Br	4/7/92	TFC	ND	ND	ND	ND	ND	ND	ND		ND		0

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data																		
Pesticide Concentrations (ng/g=ppb, dry weight)																		
Station Name	Date	Type	% Moist	% Lipid	Aldrin	Chloro- benside	alpha chlordene	cis- chlordane	gamma chlordene	trans- chlordane	cis- nonachlor	trans- nonachlor	oxy- chlordane	Total Chlordane	chlor- pyrifos	dacthal	o,p'-DDD	p,p'-DDD
(Dry Weight)																		
Willowside Road	1/30/91	TFC			ND	ND	3.8	46	6	34	24	48	2	163.8	5.3	ND	6.5	17
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC			ND	ND	.1.1	12	1	9.1	6.9	11	ND	41.1	ND	ND	ND	7.5
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC			ND	ND	ND	390	ND	240	160	290	ND	1080	ND	ND	110	300
(Wet Weight)																		
Willowside Road	1/30/91	TFC			ND	ND	0.3	3.9	0.5	2.9	2	4	0.2	13.8	0.4	ND	0.5	1.4
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC			ND	ND	0.1	1.3	0.1	1	0.8	1.2	ND	4.5	ND	ND	ND	0.8
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC			ND	ND	ND	35.1	ND	21.6	14.4	26.1	ND	97.2	ND	ND	9.9	27
(Dry Weight)																		
Estero Americana	2/6/90	RMC			ND	ND	ND	3.6	ND	1.8	ND	1.8	1.2	8.3	ND	ND	ND	ND
Willowside Road	3/20/90	TFC			ND	ND	3.2	58.9	5.3	57.9	37.9	37.9	3.2	204.2	ND	ND	ND	36.8
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC			ND	ND	4.1	18	4.1	18	13.9	15.6	ND	73.8	ND	ND	ND	7.4
Russian River/Wohler Rd Br	3/20/90	TFC			ND	ND	ND	3.4	ND	3.4	4.5	9.1	ND	20.5	ND	ND	ND	6.8
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC			ND	ND	2.7	28.6	2.7	28.6	21.4	25.9	1.8	111.6	8	ND	ND	27.7
Russian River/Hacienda Br	3/20/90	TFC			ND	ND	ND	13.8	ND	6.9	16.2	15.4	ND	52.3	ND	ND	ND	23.1
(Wet Weight)																		
Estero Americana	2/6/90	RMC			ND	ND	ND	0.6	ND	0.3	ND	0.3	0.2	1.4	ND	ND	ND	ND
Willowside Road	3/20/90	TFC			ND	ND	0.3	5.6	0.5	5.5	3.6	3.6	0.3	19.4	ND	ND	ND	3.5
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC			ND	ND	0.5	2.2	0.5	2.2	1.7	1.9	ND	9	ND	ND	ND	0.9
Russian River/Wohler Rd Br	3/20/90	TFC			ND	ND	ND	0.3	ND	0.3	0.4	0.8	ND	1.8	ND	ND	ND	0.6
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC			ND	ND	0.3	3.2	0.3	3.2	2.4	2.9	0.2	12.6	0.9	ND	ND	3.1
Russian River/Hacienda Br	3/20/90	TFC			ND	ND	ND	1.8	ND	0.9	2.1	2	ND	6.8	ND	ND	ND	3
(Dry Weight)																		
Russian river	1/17/84	RCM			ND	ND	NA	10	NA	6.6	NA	ND	ND	16.6	ND	ND	ND	6.5
Russian River (Moscow)	11/26/85	FWC			ND	ND	NA	6.6	NA	5.2	2	7.2	ND	21	ND	ND	ND	6.9
(Wet Weight)																		
Russian river	1/17/84	RCM			ND	ND	NA	1.11	NA	0.73	NA	ND	ND	1.84	ND	ND	ND	0.72
Russian River (Moscow)	11/26/85	FWC			ND	ND	NA	0.47	NA	0.37	0.14	0.51	ND	1.49	ND	ND	ND	0.49
Control																		
Aptos	1/31/90				ND	ND	ND	14.9	ND	14	9.6	14.9	1.8	55.3	ND	ND	ND	16.7
Aptos	10/25/90	TFC			ND	ND	ND	1.9	ND	1.4	ND	4.3	ND	7.6	ND	ND	ND	9.2
Lake Isabella	2/9/93	RFC			ND	ND	ND	0.5	ND	0.5	0.4	0.5	ND	1.9	ND	0.7	ND	1.3
average 1990								8.4		7.7		9.6		31.45				12.95
average control								5.766666667		5.3	5	6.566666667	1.8	21.6		0.7		9.066666667

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data Pesticide Concentrations (ng/g=ppb, dry weight) Station Name	Date	Type	o,p'-DDE	p,p'-DDE	o,p'-DDT	p,p'-DDT	p,p'-DDMS	p,p'-DDMU	Total DDT	diazinon	dichloro-benzo-phenone	dicofol	dieldrin	endosulfan I	endosulfan II	endosulfan sulfate	Total Endosulfan
(Dry Weight)																	
Willowside Road	1/30/91	TFC	ND	35	ND	12	ND	ND	70.5	ND	ND	ND	3	ND	NA	NA	ND
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC	ND	32	ND	7.1	ND	ND	46.6	ND	ND	ND	ND	ND	NA	NA	ND
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC	ND	1100	ND	140	ND	ND	1650	ND	ND	ND	76	ND	ND	ND	ND
(Wet Weight)																	
Willowside Road	1/30/91	TFC	ND	2.9	ND	1	ND	ND	5.9	ND	ND	ND	0.3	ND	NA	NA	ND
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC	ND	3.5	ND	0.8	ND	ND	5.1	ND	ND	ND	ND	ND	NA	NA	ND
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC	ND	99	ND	12.6	ND	ND	148.5	ND	ND	ND	6.8	ND	ND	ND	ND
(Dry Weight)																	
Estero Americana	2/6/90	RMC	ND	6.5	ND	ND	ND	ND	6.5	ND	ND	ND	7.7	ND	NA	NA	ND
Willowside Road	3/20/90	TFC	ND	64.2	ND	72.6	ND	ND	173.7	ND	ND	ND	7.4	ND	ND	ND	ND
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC	ND	61.5	ND	9.8	ND	ND	78.7	ND	ND	ND	ND	ND	ND	ND	ND
Russian River/Wohler Rd Br	3/20/90	TFC	ND	84.1	ND	23.9	ND	ND	114.8	ND	ND	ND	ND	ND	ND	ND	ND
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC	ND	107.1	ND	30.4	ND	ND	165.2	ND	ND	ND	2.7	ND	ND	ND	ND
Russian River/Hacienda Br	3/20/90	TFC	ND	100	ND	20	ND	ND	143.1	ND	ND	ND	3.8	ND	ND	ND	ND
(Wet Weight)																	
Estero Americana	2/6/90	RMC	ND	1.1	ND	ND	ND	ND	1.1	ND	ND	ND	1.3	ND	NA	NA	ND
Willowside Road	3/20/90	TFC	ND	6.1	ND	6.9	ND	ND	16.5	ND	ND	ND	0.7	ND	ND	ND	ND
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC	ND	7.5	ND	1.2	ND	ND	9.6	ND	ND	ND	ND	ND	ND	ND	ND
Russian River/Wohler Rd Br	3/20/90	TFC	ND	7.4	ND	2.1	ND	ND	10.1	ND	ND	ND	ND	ND	ND	ND	ND
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC	ND	12	ND	3.4	ND	ND	18.5	ND	ND	ND	0.3	ND	ND	ND	ND
Russian River/Hacienda Br	3/20/90	TFC	ND	13	ND	2.6	ND	ND	18.6	ND	ND	ND	0.5	ND	ND	ND	ND
(Dry Weight)																	
Russian river	1/17/84	RCM	ND	24	ND	ND	ND	ND	30.5	ND	ND	ND	20	ND	NA	NA	ND
Russian River (Moscow)	11/26/85	FWC	ND	28	ND	ND	ND	ND	34.9	ND	ND	ND	ND	ND	NA	NA	ND
(Wet Weight)																	
Russian river	1/17/84	RCM	ND	2.66	ND	ND	ND	ND	3.39	ND	ND	ND	2.22	ND	NA	NA	ND
Russian River (Moscow)	11/26/85	FWC	ND	1.99	ND	ND	ND	ND	2.48	ND	ND	ND	ND	ND	NA	NA	ND
Control																	
Aptos	1/31/90		5.3	80.7	ND	21.1	ND	ND	123.7	ND	ND	ND	ND	ND	NA	NA	ND
Aptos	10/25/90	TFC	ND	36	ND	ND	ND	ND	45.2	ND	ND	ND	ND	ND	ND	ND	ND
Lake Isabella	2/8/93	RFC	0.8	11	ND	ND	ND	1	14.1	NA	ND	NA	ND	ND	ND	ND	ND
average 1990				58.35					84.45								
average control			3.05	42.56666667		21.1		1	61								

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data																				
Pesticide Concentrations (ng/g = ppb, dry weight)																				
Station Name	Date	Type	endrin	ethion	alpha HCH	beta HCH	delta HCH	gamma HCH	heptachlor	heptachlor epoxide	hexachloro-benzene	methoxychlor	ethyl parathion	methyl parathion	oxadiazon	Penta-Chloro-Phenol	Phenol	Tetra-Chloro-Phenol	tetradifon	toxaphene
(Dry Weight)																				
Willowside Road	1/30/91	TFC	ND	ND	ND	ND	ND	ND	1.5	1.7	2.1	ND	ND	ND	ND	NA	NA	NA	ND	ND
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	54	NA	NA	NA	ND	ND
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC	ND	ND	ND	ND	ND	120	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	ND	ND
(Wet Weight)																				
Willowside Road	1/30/91	TFC	ND	ND	ND	ND	ND	ND	0.1	0.1	0.2	ND	ND	ND	ND	NA	NA	NA	ND	ND
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.9	NA	NA	NA	ND	ND
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC	ND	ND	ND	ND	ND	10.8	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	ND	ND
(Dry Weight)																				
Estero Americana	2/6/90	RMC	ND	ND	3.6	3.6	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND
Willowside Road	3/20/90	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND
Russian River/Wohler Rd Br	3/20/90	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC	ND	ND	ND	ND	ND	1.8	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND
Russian River/Hacienda Br	3/20/90	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND
(Wet Weight)																				
Estero Americana	2/6/90	RMC	ND	ND	0.6	0.6	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND
Willowside Road	3/20/90	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND
Russian River/Wohler Rd Br	3/20/90	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC	ND	ND	ND	ND	ND	0.2	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND
Russian River/Hacienda Br	3/20/90	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND
(Dry Weight)																				
Russian river	1/17/84	RCM	ND	ND	6.8	ND	ND	1	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	ND	ND
Russian River (Moscow)	11/26/85	FWC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	ND	ND
(Wet Weight)																				
Russian river	1/17/84	RCM	ND	ND	0.75	ND	ND	0.11	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	ND	ND
Russian River (Moscow)	11/26/85	FWC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	ND	ND
Control																				
Aptos	1/31/90		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		NA	NA	ND	ND
Aptos	10/25/90	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	1.2	ND	ND	ND
Lake Isabella	2/9/93	RFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	ND	ND	NA	ND	ND	ND
average 1990																				
average control																				

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data																		
Pesticide Concentrations (ng/g=ppb, dry weight)														Aroclor	Aroclor	Aroclor	Aroclor	PCB
Station Name	Date	Type	Duration	% Water	Length	%Lipid	PCB 1248	PCB 1254	PCB 1260	PCT 5460	Total PCB	PCB 1650	48	54	60	Total	6	18
(Dry Weight)																		
Willowside Road	1/30/91	TFC	2.8	91.6	22.2	0.76	ND	120	ND	ND	120							
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC	2.8	89.1	21.9	0.99	ND	65	ND	ND	65							
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC	2.8	91	22.3	0.89	ND	3400	ND	ND	3400							
(Wet Weight)																		
Willowside Road	1/30/91	TFC	2.8	91.6	22.2	0.76	ND	10.1	ND	ND	10.1							
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC	2.8	89.1	21.9	0.99	ND	7.1	ND	ND	7.1							
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC	2.8	91	22.3	0.89	ND	306	ND	ND	306							
(Dry Weight)																		
Estero Americana	2/6/90	RMC		83.2	53.9	0.8	ND	ND	ND		ND							
Willowside Road	3/20/90	TFC	1.4	90.5	19.4	0.98	ND	115.79	ND		115.79							
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC	1.4	87.8	21.1	1.2	ND	76.23	ND		79.23							
Russian River/Wohler Rd Br	3/20/90	TFC	1.4	91.2	19.5	0.69	ND	93.18	ND		93.18							
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC	1.4	88.8	20.4	0.88	ND	98.21	ND		98.21							
Russian River/Hacienda Br	3/20/90	TFC	1.4	87	20.4	1.16	ND	107.69	ND		107.69							
(Wet Weight)																		
Estero Americana	2/6/90	RMC		83.2	53.9	0.8	ND	ND	ND		ND		ND	ND	ND	0	ND	ND
Willowside Road	3/20/90	TFC	1.4	90.5	19.4	0.98	ND	11	ND		11		ND	11	ND	11	ND	ND
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC	1.4	87.8	21.1	1.2	ND	9.3	ND		9.3		ND	9.3	ND	9.3	ND	ND
Russian River/Wohler Rd Br	3/20/90	TFC	1.4	91.2	19.5	0.69	ND	8.2	ND		8.2		ND	8.2	ND	8.2	ND	ND
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC	1.4	88.8	20.4	0.88	ND	11	ND		11		ND	11	ND	11	ND	ND
Russian River/Hacienda Br	3/20/90	TFC	1.4	87	20.4	1.16	ND	14	ND		14		ND	14	ND	14	ND	ND
(Dry Weight)																		
Russian river	1/17/84	RCM																
Russian River (Moscow)	11/26/85	FWC																
(Wet Weight)																		
Russian river	1/17/84	RCM					ND	ND	ND		ND							
Russian River (Moscow)	11/26/85	FWC					ND	ND	ND		ND							
Control																		
Aptos	1/31/90												ND	12	4.8	16.8	ND	ND
Aptos	10/25/90	TFC																
Lake Isabella	2/9/93	RFC					ND	13	ND	ND	13							
average 1990																		
average control																		

Appendix 4. 1990-1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data																																
Pesticide Concentrations (ng/g=ppb, dry weight)																																
			PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB
Station Name	Date	Type	25	26	28	29	44	45	63	89	96	114	118	137	138	141	149	151	153	158	176	177	179	180	185	189	191	193	194	197	198	199
(Dry Weight)																																
Willowside Road	1/30/91	TFC																														
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC																														
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC																														
(Wet Weight)																																
Willowside Road	1/30/91	TFC																														
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC																														
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC																														
(Dry Weight)																																
Estero Americana	2/6/90	RMC																														
Willowside Road	3/20/90	TFC																														
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC																														
Russian River/Wohler Rd Br	3/20/90	TFC																														
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC																														
Russian River/Hacienda Br	3/20/90	TFC																														
(Wet Weight)																																
Estero Americana	2/6/90	RMC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Willowside Road	3/20/90	TFC	ND	ND	ND	ND	0.6	0.7	ND	0.4	ND	ND	1.2	ND	1	ND	0.8	0.2	4.2	ND	ND	ND	ND	0.4	ND	ND	ND	ND	ND	ND	ND	ND
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC	ND	ND	ND	ND	0.3	ND	ND	0.3	ND	ND	1.2	ND	1.1	ND	0.8	0.3	5.1	ND	ND	0.2	ND	0.5	ND	ND	ND	ND	ND	ND	ND	ND
Russian River/Wohler Rd Br	3/20/90	TFC	ND	ND	ND	ND	0.2	ND	ND	0.3	ND	ND	0.9	ND	1	ND	0.6	0.2	4.3	ND	ND	ND	ND	0.4	ND	ND	ND	ND	ND	ND	ND	ND
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC	ND	ND	ND	ND	0.3	ND	ND	0.6	ND	ND	1.4	ND	1.4	ND	1	0.4	5.9	ND	ND	0.2	ND	0.6	ND	ND	ND	ND	ND	ND	ND	ND
Russian River/Hacienda Br	3/20/90	TFC	ND	ND	ND	ND	0.3	ND	ND	0.3	ND	ND	0.8	ND	0.5	ND	0.4	0.2	2.5	ND	ND	ND	ND	0.3	ND	ND	ND	ND	ND	ND	ND	ND
(Dry Weight)																																
Russian river	1/17/84	RCM																														
Russian River (Moscow)	11/26/85	FWC																														
(Wet Weight)																																
Russian river	1/17/84	RCM																														
Russian River (Moscow)	11/26/85	FWC																														
Control																																
Aptos	1/31/90		ND	ND	ND	ND	0.3	ND	ND	0.8	ND	ND	1.3	ND	1.5	ND	1.1	1.9	7	0.3	ND	0.2	ND	0.7	ND	ND	ND	ND	ND	ND	ND	ND
Aptos	10/25/90	TFC																														
Lake Isabella	2/9/93	RFC																														
average 1990																																
average control																																

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data																																
Pesticide Concentrations (ng/g=ppb, dry weight)																																
			PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB
Station Name	*Date*	*Type*	201	205	206	207	5	7	15	16	19	22	27	31	33	40	41	46	47	49	52	56	59	66	67	70	74	82	83	84	87	91
(Dry Weight)																																
Willowside Road	1/30/91	TFC																														
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC																														
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC																														
(Wet Weight)																																
Willowside Road	1/30/91	TFC																														
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC																														
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC																														
(Dry Weight)																																
Estero Americana	2/6/90	RMC																														
Willowside Road	3/20/90	TFC																														
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC																														
Russian River/Wohler Rd Br	3/20/90	TFC																														
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC																														
Russian River/Hacienda Br	3/20/90	TFC																														
(Wet Weight)																																
Estero Americana	*2/6/90*	*RMC*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2	ND	ND	ND
Willowside Road	3/20/90	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.2	ND	0.4	ND	ND	ND	0.2	1	ND	0.4	ND	ND	ND	0.9	0.3	ND
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.5	ND	ND	ND	ND	ND	0.3	0.2	ND
Russian River/Wohler Rd Br	3/20/90	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.5	ND	ND	ND	ND	ND	ND	ND	ND
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.7	ND	ND	ND	ND	ND	ND	0.2	ND
Russian River/Hacienda Br	3/20/90	TFC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.4	ND	ND	ND	ND	ND	ND	ND	ND
(Dry Weight)																																
Russian river	1/17/84	RCM																														
Russian River (Moscow)	11/26/85	FWC																														
(Wet Weight)																																
Russian river	1/17/84	RCM																														
Russian River (Moscow)	11/26/85	FWC																														
Control																																
Aptos	1/31/90		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.7	ND	0.2	ND	ND	0.2	1	0.4	ND
Aptos	10/25/90	TFC																														
Lake Isabella	2/9/93	RFC																														
average 1990																																
average control																																

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data																									PAHs		
Pesticide Concentrations (ng/g=ppb, dry weight)																											
			PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB	PCB			dibenz[a,h]	
Station Name	Date	Type	97	99	101	105	107	110	122	128	129	134	135	136	146	156	170	172	173	174	183	187	195	196		anthracene	anthracene	biphenyl
(Dry Weight)																												
Willowside Road	1/30/91	TFC																								ND	ND	ND
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC																								ND	ND	ND
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC																								ND	ND	ND
(Wet Weight)																												
Willowside Road	1/30/91	TFC																								ND	ND	ND
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC																								ND	ND	ND
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC																								ND	ND	ND
(Dry Weight)																												
Estero Americana	2/6/90	RMC																								ND	ND	ND
Willowside Road	3/20/90	TFC																								ND	ND	ND
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC																								ND	ND	ND
Russian River/Wohler Rd Br	3/20/90	TFC																								ND	ND	ND
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC																								ND	ND	ND
Russian River/Hacienda Br	3/20/90	TFC																								ND	ND	ND
(Wet Weight)																												
Estero Americana	2/6/90	RMC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
Willowside Road	3/20/90	TFC	0.4	1.4	1	ND	0.2	0.7	ND	0.2	ND	ND	1	ND	0.8	0.3	ND	ND	ND	ND	ND	0.3	ND	ND		ND	ND	ND
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC	0.3	0.7	0.8	ND	0.2	0.6	ND	ND	ND	ND	1.1	ND	0.4	0.4	0.2	ND	ND	ND	0.2	0.6	ND	ND		ND	ND	ND
Russian River/Wohler Rd Br	3/20/90	TFC	0.3	0.3	0.6	ND	ND	0.5	ND	ND	ND	ND	0.8	ND	0.3	0.3	ND	ND	ND	ND	ND	0.4	ND	ND		ND	ND	ND
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC	0.3	0.9	0.9	ND	0.2	0.7	ND	ND	0.3	ND	1	ND	0.7	0.5	0.2	ND	ND	ND	0.2	0.6	ND	0.2		ND	ND	ND
Russian River/Hacienda Br	3/20/90	TFC	0.2	0.4	0.4	ND	ND	0.4	ND	ND	ND	ND	0.3	ND	0.4	0.2	ND	ND	ND	ND	ND	0.3	ND	ND		ND	ND	ND
(Dry Weight)																												
Russian river	1/17/84	RCM																										
Russian River (Moscow)	11/26/85	FWC																										
(Wet Weight)																												
Russian river	1/17/84	RCM																										
Russian River (Moscow)	11/26/85	FWC																										
Control																												
Aptos	1/31/90		0.4	1	1.2	ND	ND	0.8	ND	0.3	0.3	ND	0.6	ND	0.7	0.6	0.3	ND	ND	ND	0.2	0.8	ND	0.2	58.6	ND	ND	ND
Aptos	10/25/90	TFC																										
Lake Isabella	2/9/93	RFC																										
average 1990																												
average control																												

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data															
Pesticide Concentrations (ng/g=ppb, dry weight)															
					benzo[b]	benzo[k]			1-methyl-	2-methyl-	2,6-dimethyl-	2,3,5-trimethyl-			benzo[ghi]
Station Name	Date	Type	chrysene	fluoranthene	fluoranthene	fluoranthene	fluorene	naphthalene	naphthalene	naphthalene	naphthalene	naphthalene	Naphthene	perylene	perylene
(Dry Weight)															
Willowside Road	1/30/91	TFC	220	91	54	40	ND	22	ND	ND	ND	ND	ND	ND	ND
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC	99	120	ND	10	ND	26	ND	ND	ND	ND	ND	ND	ND
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC	48	59	ND	ND	ND	46	ND	ND	ND	ND	ND	ND	ND
(Wet Weight)															
Willowside Road	1/30/91	TFC	18.48	7.64	4.54	3.36	ND	1.85	ND	ND	ND	ND	ND	ND	ND
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC	10.79	13.08	ND	1.09	ND	2.83	ND	ND	ND	ND	ND	ND	ND
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC	4.32	5.31	ND	ND	ND	4.32	ND	ND	ND	ND	ND	ND	ND
(Dry Weight)															
Estero Americana	2/6/90	RMC	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND
Willowside Road	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND
Russian River/Wohler Rd Br	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND
Russian River/Hacienda Br	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND
(Wet Weight)															
Estero Americana	2/6/90	RMC	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND
Willowside Road	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND
Russian River/Wohler Rd Br	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND
Russian River/Hacienda Br	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND
(Dry Weight)															
Russian river	1/17/84	RCM													
Russian River (Moscow)	11/26/85	FWC													
(Wet Weight)															
Russian river	1/17/84	RCM													
Russian River (Moscow)	11/26/85	FWC													
Control															
Aptos	1/31/90		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aptos	10/25/90	TFC													
Lake Isabella	2/9/93	RFC													
average 1990															
average control															

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data													
Pesticide Concentrations (ng/g=ppb, dry weight)													
Station Name	Date	Type	phenanthrene	1-methyl-phenanthrene	pyrene	benzo[a] pyrene	benzo[e] pyrene	indeno[1,2,3-cd] pyrene	ace-naphthylene	ace-naphthene	benz[a] anthracene	dibenzo[ghi] perylene	Total PAH
(Dry Weight)													
Willowside Road	1/30/91	TFC	29	19	200	60	67	ND	ND		40		842
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC	43	21	170	ND	25	ND	ND		17		531
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC	33	14	110	ND	15	ND	ND		ND		327
(Wet Weight)													
Willowside Road	1/30/91	TFC	2.44	1.6	16.8	5.04	5.63	ND	ND		3.36		70.74
Laguna De Santa Rosa/Stoney Pt	1/30/91	TFC	4.69	2.29	18.53	ND	2.72	ND	ND		1.85		57.87
Laguna De Santa Rosa/Wohler Br	1/30/91	TFC	2.97	1.26	9.9	ND	1.35	ND	ND		ND		29.43
(Dry Weight)													
Estero Americana	2/6/90	RMC	ND	ND	ND	NA	ND	ND	ND		ND		0
Willowside Road	3/20/90	TFC	ND	ND	ND	NA	1263.16	ND	ND		ND		1263.16
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND		ND		0
Russian River/Wohler Rd Br	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND		ND		0
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND		ND		0
Russian River/Hacienda Br	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND		ND		0
(Wet Weight)													
Estero Americana	2/6/90	RMC	ND	ND	ND	NA	ND	ND	ND		ND		0
Willowside Road	3/20/90	TFC	ND	ND	ND	NA	120	ND	ND		ND		120
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND		ND		0
Russian River/Wohler Rd Br	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND		ND		0
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND		ND		0
Russian River/Hacienda Br	3/20/90	TFC	ND	ND	ND	NA	ND	ND	ND		ND		0
(Dry Weight)													
Russian river	1/17/84	RCM											
Russian River (Moscow)	11/26/85	FWC											
(Wet Weight)													
Russian river	1/17/84	RCM											
Russian River (Moscow)	11/26/85	FWC											
Control													
Aptos	1/31/90		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
Aptos	10/25/90	TFC											
Lake Isabelle	2/9/93	RFC											
average 1990													
average control													

Appendix 4. 1990 -1991 and 1991-1992 State Mussel Watch (metals ppm dry wt.; organics ppb dry wt.)

Mussel Chemistry Data															
Metals, ppm dry weight (unless labeled wet weight)															
				Alumi-	Ar-	Cad-	Chro-	Cop-		Mang-	Mer-	Nick-	Selen-		
Station Name	Date	Type	% Mois	num	senic	mium	mium	per	Lead	ganese	cury	el	ium	Silver	Zinc
(Dry Weight)															
Big Sulfur Creek	3/21/90	TFC		1053	NA	2.35	16.19	81.14	1.38	32.01	NA	NA	NA	0.067	140.53
Estero Americana	2/6/90	RMC		308.63	9.4	8.24	1.8	8.14	0.53	7.66	0.168	2.25	2.27	0.054	143.74
Willowside Road	3/20/90	TFC		732.25	7.87	1.71	10.32	53.12	2.08	55.63	0.426	6.17	2.9	0.033	203.4
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC		1055.4	7.65	2.09	10.06	58.26	1.62	177.59	0.325	6.63	3.25	0.031	156.45
Russian River/Wohler Rd Br	3/20/90	TFC		1250.5	9.23	2.29	16.3	67.61	0.86	74.66	0.308	11.39	3.43	0.043	299.39
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC		976.57	7.95	1.83	11.4	54.83	1.16	136.32	0.329	4.55	3.1	0.054	137.59
Russian River/Hacienda Br	3/20/90	TFC		779.86	8.03	1.84	12.37	54.74	0.67	47.23	0.204	7.85	3.23	0.053	143.67
(Wet Weight)															
Big Sulfur Creek	3/21/90	TFC		314.84	NA	0.7	4.84	24.26	0.41	9.57	NA	NA	NA	0.02	42.018
Estero Americana	2/6/90	RMC		54.63	1.66	1.46	0.32	1.44	0.09	1.36	0.03	0.4	0.4	0.01	25.442
Willowside Road	3/20/90	TFC		74.69	0.8	0.17	1.05	5.42	0.21	5.67	0.043	0.63	0.3	0.003	20.747
Laguna De Santa Rosa/Stoney Pt	3/20/90	TFC		122.42	0.89	0.24	1.17	6.76	0.19	20.6	0.038	0.77	0.38	0.004	18.032
Russian River/Wohler Rd Br	3/20/90	TFC		105.04	0.78	0.19	1.37	5.68	0.07	6.27	0.026	0.96	0.29	0.004	25.149
Laguna De Santa Rosa/Wohler Br	3/20/90	TFC		109.38	0.89	0.2	1.28	6.14	0.13	15.27	0.037	0.51	0.35	0.006	15.41
Russian River/Hacienda Br	3/20/90	TFC		99.82	1.03	0.24	1.58	7.01	0.09	6.05	0.026	1	0.41	0.007	18.39
(Dry Weight)															
Russian river	1/17/84	RCM		605.67	NA	5.3	4.73	8.03	2.2	21.1	0.354	NA	NA	0.076	191.37
Russian River Mouth	12/9/86	RCM		296.15	NA	9.74	2.12	2.12	6.49	3.33	11.93	NA	NA	0.038	70.55
Russian River Mouth	11/26/85	FWC		1583.3	NA	14.61	14.61	8.71	43.04	2.06	54.27	NA	NA	0.374	161.35
Russian River Mouth	12/9/86	FWC		177.15	NA	6.11	6.11	3.11	17.22	0.17	20.79	NA	NA	0.209	109.25
(Wet Weight)															
Russian river	1/17/84	RCM		84.9	NA	0.74	0.66	1.12	0.31	2.93	0.049	NA	NA	0.011	26.6
Russian River Mouth	12/9/86	RCM		71.08	NA	2.34	0.51	1.56	0.8	2.86	0.042	NA	NA	0.009	16.93
Russian River Mouth	11/26/85	FWC		68.08	NA	0.63	0.37	1.85	0.09	2.33	0.014	NA	NA	0.016	6.94
Russian River Mouth	12/9/86	FWC		19.49	NA	0.67	0.34	1.89	0.02	2.29	0.026	NA	NA	0.023	12.02

APPENDIX 5. TOXIC SUBSTANCES MONITORING PROGRAM DATA

Appendix 5. Toxic Substances Monitoring Program Data

Trace Elements in Fish and Invertebrates		ppm wet weight		* = ND, number to left is half the reporting limit												
Station #	Station Name	Species	Tissue	Date	AS		CD		CR		CU		PB		HG	
		Code			ppm		ppm		ppm		ppm		ppm		ppm	
114.11.16	Russian R/Odd Fellows Pk Brd	COR	W	7/11/78	0.54		0.16		1.1		4.2		0.05	*		
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	7/11/78											0.41	
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	L	7/11/78	0.05	*	0.2		0.12		1.8					
114.11.16	Russian R/Odd Fellows Pk Brd	PACI	W	7/11/79	0.2		0.01		0.01	*	9.9		0.05	*		
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	7/11/79											0.24	
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	L	7/11/79	0.2		0.1		0.01	*	1.9		0.05	*		
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	8/6/80											0.36	
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	L	8/6/80	0.1		0.15		0.01	*	0.8		0.05	*		
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	8/14/81											0.27	
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	L	8/14/81	0.1		0.12		0.01	*	1.1		0.1			
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	8/26/85											0.23	
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	L	8/26/85	0.2											
114.11.23	Russian R/Wohler Brd	TFC	W	12/30/87	0.77		0.52		0.79		6.6		0.05	*	0.05	
114.21.10	Laguna De Santa Rosa/Stony Point	TFC	W	12/30/87	0.88		0.72		0.14		3.7		0.05	*	0.04	
114.11.12	Russian R/Hacienda Brg	TFC	W	12/30/87	0.7		0.68		0.41		4.8		0.2		0.03	
114.22.90	Santa Rosa Cr/Willowside Rd	TFC	W	12/30/87	0.84		0.68		0.4		4.6		0.1		0.08	
114.11.16	Russian R/Odd Fellows Pk Brd	SMB	L	10/4/89	0.16		0.37		0.01	*	2		0.05	*		
114.11.16	Russian R/Odd Fellows Pk Brd	SMB	F	10/4/89											0.4	
114.23.00	Mark West Creek	BG	F	10/4/89											0.4	
114.23.00	Mark West Creek	BG	L	10/4/89	0.16		0.24		0.01	*	1.8		0.1			
114.26.00	Big Sulfur Creek	SMB	L	10/4/89											0.22	
114.26.00	Big Sulfur Creek	SMB	F	10/4/89	0.16		0.02		0.15		1.6		0.05	*		
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	9/7/90											0.54	
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	L	9/7/90			0.17		0.01	*	2.3		0.05	*		
114.23.00	Mark West Creek	BG	F	9/7/90											0.22	
114.11.05	Russian R/Duncans Mills	PCP	W	7/17/91	0.16		0.005	*	0.09		1		0.05	*	0.26	
115.30.02	Estero de San Antonio	PCP	F	7/16/91											0.29	
115.30.02	Estero de San Antonio	PCP	L	7/16/91	0.4		0.02		0.01	*	3.2		0.05	*		
115.30.04	Estero Americano	STG	W	7/16/91							2				0.06	
115.30.04	Estero Americano	STG	W	7/16/91							2.4				0.06	
201.12.01	Walker Creek	STG	W	7/16/91	0.3		0.005	*	0.21		2.3		0.05	*	0.16	
114.23.00	Mark West Creek	WCR	W	9/8/93	0.09		0.01		0.1		0.72		0.05	*	0.07	
206.31.14	Petaluma R/Petaluma	GSF	W	8/25/93	0.08		0.005	*	0.07		0.62		0.05	*	0.14	

Appendix 5. Toxic Substances Monitoring Program Data

201.12.01	Walker Creek	RBT	F	8/25/93	0.34		0.005	*							0.33	
201.12.01	Walker Creek	RBT	L	8/25/93					0.01	*	20		0.05	*		
114.11.05	Russian R/Duncans Mills	PCP	W	7/22/92	0.19		0.005	*	0.07		0.92		0.05	*	0.29	
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	W	7/23/92	0.07		0.005	*	0.25		0.94		0.05	*	0.19	
114.11.23	Russian R/Wohler Brd	SMB	W	10/8/92	0.12		0.005	*	0.11		0.71		0.05	*	0.24	
114.23.00	Mark West Creek	SKR	W	10/8/92	0.14		0.02		1.1		1.1		0.2		0.04	
114.26.00	Big Sulfur Creek	SQF	F	10/7/92											0.01	*
114.26.00	Big Sulfur Creek	SQF	L	10/7/92	0.025	*	0.02		0.01	*	27		0.05	*		
115.30.02	Estero de San Antonio	SSP	W	10/22/92	0.6		0.02		0.28		1.4		0.05	*	0.02	
115.30.04	Estero Americano	STB	W	10/22/92	0.35		0.005	*	0.18		4.5		1.05	*	0.07	
201.12.01	Walker Creek	STB	W	7/27/92	0.42		0.01		0.2		2.9		0.05	*	0.19	
Station #	Station Name	Species	Tissue	Date	AS		CD		CR		CU		PB		HG	
		Code			ppm		ppm		ppm		ppm		ppm		ppm	
114.11.12	Russian R/Hacienda Brg	TFC	W	12/30/87	0.7		0.68		0.41		4.8		0.2		0.03	
114.11.16	Russian R/Odd Fellows Pk Brd	COR	W	7/11/78	0.54		0.16		1.1		4.2		0.1*	*		
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	7/11/78											0.41	
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	L	7/11/78	.1*	*	0.2		0.12		1.8					
114.11.16	Russian R/Odd Fellows Pk Brd	PACI	W	7/11/79	0.2		0.01		0.02*	*	9.9		0.1*	*		
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	7/11/79											0.24	
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	L	7/11/79	0.2		0.1		0.02*	*	1.9		0.1*	*		
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	8/6/80											0.36	
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	L	8/6/80	0.1		0.15		0.02*	*	0.8		0.1*	*		
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	8/14/81											0.27	
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	L	8/14/81	0.1		0.12		0.02*	*	1.1		0.1			
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	8/26/85											0.23	
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	L	8/26/85	0.2											
114.11.23	Russian R/Wohler Brd	TFC	W	12/30/87	0.77		0.52		0.79		6.6		0.1*	*	0.05	
114.21.10	Laguna De Santa Rosa/Stony Point	TFC	W	12/30/87	0.88		0.72		0.14		3.7		0.1*	*	0.04	
114.22.90	Santa Rosa Cr/Willowside Rd	TFC	W	12/30/87	0.84		0.68		0.4		4.6		0.1		0.08	
114.11.16	Russian R/Odd Fellows Pk Brd	SMB	L	10/4/89	0.16		0.37		0.02*	*	2		0.1*	*		
114.11.16	Russian R/Odd Fellows Pk Brd	SMB	F	10/4/89											0.4	
114.23.00	Mark West Creek	BG	F	10/4/89											0.4	
114.23.00	Mark West Creek	BG	L	10/4/89	0.16		0.24		0.02*	*	1.8		0.1			
114.26.00	Big Sulfur Creek	SMB	L	10/4/89											0.22	
114.26.00	Big Sulfur Creek	SMB	F	10/4/89	0.16		0.02		0.15		1.6		0.1*	*		

Appendix 5. Toxic Substances Monitoring Program Data

114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	9/7/90										0.54	
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	L	9/7/90			0.17		0.02*	*	2.3	0.1*	*		
114.23.00	Mark West Creek	BG	F	9/7/90										0.22	
115.30.02	Estero de San Antonio	PCP	F	7/16/91										0.29	
115.30.02	Estero de San Antonio	PCP	L	7/16/91	0.4		0.02		0.02*	*	3.2	0.1*	*		
115.30.04	Estero Americano	STG	W	7/16/91							2			0.06	
115.30.04	Estero Americano	STG	W	7/16/91							2.4			0.06	
201.12.01	Walker Creek	STG	W	7/16/91	0.3		.01*	*	0.21		2.3	0.1*	*	0.16	
114.11.05	Russian R/Duncans Mills	PCP	W	7/17/91	0.16		.01*	*	0.09		1	0.1*	*	0.26	
114.11.05	Russian R/Duncans Mills	PCP	W	7/22/92	0.19		.01*	*	0.07		0.92	0.1*	*	0.29	
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	W	7/23/92	0.07		.01*	*	0.25		0.94	0.1*	*	0.19	
114.26.00	Big Sulfur Creek	SQF	F	10/7/92										.02*	*
114.26.00	Big Sulfur Creek	SQF	L	10/7/92	.05*	*	0.02		0.02*	*	27	0.1*	*		
114.11.23	Russian R/Wohler Brd	SMB	W	10/8/92	0.12		.01*	*	0.11		0.71	0.1*	*	0.24	
114.23.00	Mark West Creek	SKR	W	10/8/92	0.14		0.02		1.1		1.1	0.2		0.04	
115.30.02	Estero de San Antonio	SSP	W	10/22/92	0.6		0.02		0.28		1.4	0.1*	*	0.02	
115.30.04	Estero Americano	STB	W	10/22/92	0.35		.01*	*	0.18		4.5	0.1*	*	0.07	
201.12.01	Walker Creek	STB	W	7/27/92	0.42		0.01		0.2		2.9	0.1*	*	0.19	
206.31.14	Petaluma R/Petaluma	GSF	W	8/25/93	0.08		.01*	*	0.07		0.62	0.1*	*	0.14	
201.12.01	Walker Creek	RBT	F	8/25/93	0.34		.01*	*						0.33	
201.12.01	Walker Creek	RBT	L	8/25/93					0.02*	*	20	0.1*	*		
114.23.00	Mark West Creek	WCR	W	9/8/93	0.09		0.01		0.1		0.72	0.1*	*	0.07	
Maximum Tissue Residue Levels					0.2		0.64							1	
NAS Guidelines (whole fish)														0.5	
FDA action levels (edible portion)														1	
Median International Standards (freshwater fish)					1.5		0.3		1		20	2		0.5	
TSMP EDL 85 (freshwater fish filets)					0.15		<0.01		<0.02		0.68	<0.10		0.8	
TSMP EDL 95 (freshwater fish filets)					0.33		<0.01		<0.02		0.73	<0.10		1.7	
TSMP EDL 85 (whole freshwater fish)					0.44		0.08		0.23		3.4	0.2		0.1	
TSMP EDL 95 (whole freshwater fish)					0.92		0.15		0.48		4.34	0.5		0.19	
TSMP EDL 85 (freshwater fish livers)					0.22		0.36		0.03		14	0.1		insuf. data	
TSMP EDL 95 (freshwater fish livers)					0.7		0.99		0.07		33	0.2		insuf. data	
	MTRIs, NAS and FDA guidelines, and MIS from 1991 TSMP data report														
	EDLs calculated using 1978-1993 data unpublished TSMP rept - Del Rasmussed SWQCB														

NI		SE		AG		ZN
ppm		ppm		ppm		ppm
1.1				0.04		18
0.35	*			0.02	*	18
0.05	*			0.02		13
0.1				0.02		24
0.05	*			0.01	*	
0.05	*			0.01	*	13
1.7		0.51		0.02		13
0.3		0.57		0.02		12
1.4		0.48		0.02		15
0.9		0.54		0.02		14
0.05	*			0.01	*	16
		0.34				
		0.28				
0.05	*			0.01	*	19
		0.3				
0.05	*			0.01	*	13
		0.16				
0.05	*			0.01	*	17
1.2		0.21		0.01	*	5.6
0.05	*			0.01	*	35
0.2		0.24		0.01	*	12
0.05	*	0.17		0.01	*	26
0.1		0.22		0.01	*	26

0.05	*	0.18				
				0.14		28
0.05	*	0.23		0.01	*	15
0.29		0.33		0.01	*	22
0.05	*	0.3		0.01	*	21
0.97		0.25		0.01	*	19
		0.34				
0.05	*			0.08		21
0.1		0.27		0.01	*	17
0.2		0.26		0.01	*	35
0.2		0.28		0.02		30
NI		SE		AG		ZN
ppm		ppm		ppm		ppm
1.4		0.48		0.02		15
1.1				0.04		18
0.7*	*			.04*	*	18
0.1*	*			0.02		13
0.1				0.02		24
0.1*	*			.02*	*	
0.1*	*			.02*	*	13
1.7		0.51		0.02		13
0.3		0.57		0.02		12
0.9		0.54		0.02		14
0.1*	*			.02*	*	16
		0.34				
		0.28				
0.1*	*			.02*	*	19
		0.3				
0.1*	*			.02*	*	13

		0.16			
0.1*	*		.02*	*	17
0.1*	*		.02*	*	35
0.2		0.24	.02*	*	12
1.2		0.21	.02*	*	5.6
0.1*	*	0.23	.02*	*	15
0.29		0.33	.02*	*	22
		0.34			
0.1*	*		0.08		21
0.1*	*	0.3	.02*	*	21
0.97		0.25	.02*	*	19
0.1		0.27	.02*	*	17
0.2		0.26	.02*	*	35
0.2		0.28	0.02		30
0.1		0.22	.02*	*	26
0.1*	*	0.18			
			0.14		28
0.1*	*	0.17	.02*	*	26
28					
		2			45
<0.10		1.1	<0.02		16.5
<0.10		1.84	<0.02		30.25
0.2		1.4	0.03		40
0.56		1.86	0.05		49
<0.10		3.39	0.25		28
0.2		5.22	0.76		38

Appendix 5. Toxic Substances Monitoring Program Data

Organic Chemicals in Fish and Invertebrates		ppb wet weight			* = ND, number to left is half the reporting limit											
Station #	Station Name	Species	Tissue	Date	Aldrin		Alpha-Chl		cis-chlordan		gamma-Chlor		trans-Chlorda		cis-Nonachlo	
		Code			ppb		ppb		ppb		ppb		ppb		ppb	
114.11.16	Russian R/Odd Fellows Pk Brd	COR	W	7/11/78	2.5	*			2.5	*			2.5	*		
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	7/11/78	2.5	*			2.5	*			2.5	*		
114.11.16	Russian R/Odd Fellows Pk Brd	SSKR	F	7/11/78	2.5	*			2.5	*			2.5	*		
114.11.16	Russian R/Odd Fellows Pk Brd	PACI	W	7/11/79	2.5	*			2.5	*			2.5	*		
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	7/11/79	2.5	*			2.5	*			2.5	*		
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	8/14/81	2.5	*	1	*	2.5	*	1	*	2.5	*	15	*
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	8/26/85	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*
114.11.12	Russian R/Hacienda Brg	TFC	W	12/30/87	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*
114.11.23	Russian R/Wohler Brd	TFC	W	12/30/87	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*
114.21.10	Laguna De Santa Rosa/Stony Point	TFC	W	12/30/87	2.5	*	2.5	*	5.1		2.5	*	5.1		2.5	*
114.22.90	Santa Rosa Cr/Willowside Rd	TFC	W	12/30/87	2.5	*	2.5	*	12		2.5	*	9.2		2.5	*
114.11.16	Russian R/Odd Fellows Pk Brd	SMB	F	10/4/89	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*
114.23.00	Mark West Creek	BG	F	10/4/89	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*
201.12.01	Walker Creek	STG	W	7/16/91	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*
114.11.05	Russian R/Duncans Mills	PCP	W	7/17/91	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*
114.11.05	Russian R/Duncans Mills	PCP	W	7/22/92	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	W	7/23/92	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*
201.12.01	Walker Creek	STB	W	7/27/92	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*
206.30.07	Petaluma R/Lakeville	YFG	F	7/28/92	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*
114.26.00	Big Sulfur Creek	SQF	F	10/7/92	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*
114.11.23	Russian R/Wohler Brd	SMB	W	10/8/92	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*
114.23.00	Mark West Creek	SKR	W	10/8/92	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*
Maximum Tissue Residue Levels					0.05											
NAS Guidelines (whole fish)					100											
FDA action levels (edible portion)					300											
TSMP EDL 85 (freshwater fish filets)					<5.0		<5.0		13		<5.0		8		6	
TSMP EDL 95 (freshwater fish filets)					<5.0		<5.0		38		<2.0		21		18	
TSMP EDL 85 (whole freshwater fish)					<5.0		<5.0		38.2		<5.0		22		18	
TSMP EDL 95 (whole freshwater fish)					<5.0		5.1		60.8		9.9		38.2		30	
	MTRIs, NAS and FDA guide lines from 1991 data report															
	EDLs calculated using 1978-1993 data unpublished TSMP rept - Del Rasmussed SWQCB															

trans-Nonach		Oxychlordan		Total Chlorda		Chlorpyrifos		Dacthal		Dieldrin		o,p'DDD		p,p'DDD		o,p'DDE		p,p'DDE		o,p'DDT		p,p'DDT	
ppb		ppb		ppb		ppb		ppb		ppb		ppb		ppb		ppb		ppb		ppb		ppb	
2.5	*	2.5	*	ND		5	*	2.5	*	2.5	*	5	*	13		5	*	11		5	*	12	
2.5	*	2.5	*	ND		5	*	2.5	*	2.5	*	5	*	2.5	*	5	*	2.5	*	5	*	2.5	*
2.5	*	2.5	*	ND		5	*	2.5	*	2.5	*	5	*	5		5	*	14		5	*	7	
		5	*	ND		5	*	5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*
		5	*	ND		5	*	5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*	2.5	*
2.5	*	2.5	*	ND		5	*	2.5	*	2.5	*	5	*	5	*	5	*	2.5	*	5	*	5	*
2.5	*	2.5	*	ND		5	*	2.5	*	2.5	*	5	*	5	*	5	*	2.5	*	5	*	5	*
2.5	*	2.5	*	ND		5	*	2.5	*	2.5	*	5	*	5	*	5	*	11		5	*	5	*
2.5	*	2.5	*	ND		5	*	2.5	*	2.5	*	5	*	5	*	5	*	11		5	*	5	*
2.5	*	2.5	*	10.2		5	*	11		6.2		5	*	5	*	5	*	8.4		5	*	5	*
10		2.5	*	31.2		12		2.5	*	6.2		5	*	5	*	5	*	11		5	*	5	*
2.5	*	2.5	*	ND		5	*	2.5	*	2.5	*	5	*	5	*	5	*	2.5	*	5	*	5	*
2.5	*	2.5	*	ND		5	*	2.5	*	2.5	*	5	*	5	*	5	*	2.5	*	5	*	5	*
2.5	*	2.5	*	ND		5	*	2.5	*	2.5	*	5	*	5	*	5	*	2.5	*	5	*	5	*
2.5	*	2.5	*	ND		5	*	2.5	*	2.5	*	5	*	5	*	5	*	16		5	*	5	*
5.1		2.5	*	5.1		5	*	2.5	*	2.5	*	5	*	5	*	5	*	19		5	*	5	*
2.5	*	2.5	*	ND		5	*	2.5	*	2.5	*	5	*	5	*	5	*	24		5	*	5	*
2.5	*	2.5	*	ND		5	*	2.5	*	2.5	*	5	*	5	*	5	*	2.5	*	5	*	5	*
2.5	*	2.5	*	ND		5	*	2.5	*	2.5	*	5	*	5	*	5	*	2.5	*	5	*	5	*
2.5	*	2.5	*	ND		5	*	2.5	*	2.5	*	5	*	5	*	5	*	8.7		5	*	5	*
2.5	*	2.5	*	ND		5	*	2.5	*	2.5	*	5	*	5	*	5	*	15		5	*	5	*
2.5	*	2.5	*	ND		5	*	2.5	*	2.5	*	5	*	5	*	5	*	14		5	*	5	*
				1.1						0.65													
				100						100													
				300						300													
18		<5.0		41.8		<10.0		12		10		11.8		85		<10.0		570		<10.0		28	
44		<5.0		119		19		338		34.7		35.9		250		24		2000		17		109.5	
50		10		144.8		26.2		95.6		49.4		50.2		292		17		1800		50.2		142	
69.8		17		204.8		73.6		426		473.5		162		994		48		3580		146		402	

p,p'DDMU		p,p'DDMS		Total DDT		Dicofol		Diazinon		Endosulfan I		Endosulfan II		Endosulfan S		Total Endos		Endrin		alpha-HCH		beta-HCH	
ppb		ppb		ppb		ppb		ppb		ppb		ppb		ppb		ppb		ppb		ppb		ppb	
2.5	*	2.5	*	35		50	*	62.5	*	2.5	*					ND		7.5	*	1	*	5	*
2.5	*	2.5	*	ND		50	*	62.5	*	2.5	*					ND		7.5	*	1	*	5	*
2.5	*	2.5	*	26		50	*	62.5	*	2.5	*					ND		7.5	*	1	*	5	*
2.5	*	2.5	*	ND		50	*	62.5	*	5	*					ND		7.5	*	1	*	5	*
2.5	*	2.5	*	ND		50	*	62.5	*	5	*					ND		7.5	*	1	*	5	*
7.5	*	15	*	ND		50	*	25	*	2.5	*					ND		7.5	*	1	*	5	*
7.5	*	15	*	ND		50	*	25	*	2.5	*					ND		7.5	*	1	*	5	*
7.5	*	15	*	11		50	*	25	*	2.5	*					ND		7.5	*	1	*	5	*
7.5	*	15	*	11		50	*	25	*	2.5	*					ND		7.5	*	1	*	5	*
7.5	*	15	*	8.4		50	*	25	*	2.5	*					ND		7.5	*	1	*	5	*
7.5	*	15	*	11		50	*	25	*	2.5	*					ND		7.5	*	1	*	5	*
7.5	*	15	*	ND		50	*	25	*	2.5	*	35	*	42.5	*	ND		7.5	*	1	*	5	*
7.5	*	15	*	ND		50	*	25	*	2.5	*					ND		7.5	*	1	*	5	*
7.5	*	15	*	ND		50	*	25	*	2.5	*	35	*	42.5	*	ND		7.5	*	1	*	5	*
7.5	*	15	*	16		50	*	25	*	2.5	*	35	*	42.5	*	ND		7.5	*	1	*	5	*
7.5	*	15	*	19		50	*	25	*	2.5	*	35	*	42.5	*	ND		7.5	*	1	*	5	*
7.5	*	15	*	24		50	*	25	*	2.5	*	35	*	42.5	*	ND		7.5	*	1	*	5	*
7.5	*	15	*	ND		50	*	25	*	2.5	*	35	*	42.5	*	ND		7.5	*	1	*	5	*
7.5	*	15	*	ND		50	*	25	*	2.5	*	35	*	42.5	*	ND		7.5	*	1	*	5	*
7.5	*	15	*	8.7		50	*	25	*	2.5	*	35	*	42.5	*	ND		7.5	*	1	*	5	*
7.5	*	15	*	15		50	*	25	*	2.5	*	35	*	42.5	*	ND		7.5	*	1	*	5	*
7.5	*	15	*	14		50	*	25	*	2.5	*	35	*	42.5	*	ND		7.5	*	1	*	5	*
				32												250		3000		0.5		1.8	
				1000												100		100					
				5000														300					
<5.0		<30.0		764.9		<100.0		<50.0		<5.0		<70.0		<85.0		Below dl		<15.0		<2.0		<10.0	
41.9		<30.0		2461.3		<100.0		<50.0		23.7		83.8		120		52		<15.0		<2.0		<10.0	
60.2		<30.0		2479.2		<100.0		<50.0		8.6		<70.0		95		56.1		<15.0		<2.0		<10.0	
164		<30.0		5358.2		<100.0		66.2		51		80		240		328		37.2		<2.0		<10.0	

delta-HCH		Gamma-HCH		Total HCH		Heptachlor		Heptachlorep		Hexachlorob		Methoxychlor		Oxadiathon		Ethylparathio		MethylParat		PCB 1248		PCB 1254	
ppb		ppb		ppb		ppb		ppb		ppb		ppb		ppb		ppb		ppb		ppb		ppb	
1	*	1	*	ND		2.5	*	2.5	*	1	*	25	*			12.5	*			25	*	25	*
1	*	1	*	ND		2.5	*	2.5	*	1	*	25	*			12.5	*			25	*	25	*
1	*	1	*	ND		2.5	*	2.5	*	1	*	25	*			12.5	*			25	*	25	*
1	*	1	*	ND		2.5	*	2.5	*	1	*	25	*			12.5	*			25	*	25	*
1	*	1	*	ND		2.5	*	2.5	*	1	*	25	*			12.5	*			25	*	25	*
1	*	1	*	ND		2.5	*	2.5	*	1	*	15	*			5	*			25	*	25	*
2.5	*	1	*	ND		2.5	*	2.5	*	1	*	7.5	*			5	*			25	*	25	*
2.5	*	1	*	ND		2.5	*	2.5	*	1	*	7.5	*			5	*			25	*	25	*
2.5	*	1	*	ND		2.5	*	2.5	*	1	*	7.5	*			5	*			25	*	25	*
2.5	*	1	*	ND		2.5	*	2.5	*	1	*	7.5	*			5	*			25	*	25	*
2.5	*	1	*	ND		2.5	*	2.5	*	1	*	7.5	*			5	*			25	*	25	*
2.5	*	2.7		2.7		2.5	*	2.5	*	1	*	7.5	*	5	*	5	*	5	*	25	*	25	*
2.5	*	2		2		2.5	*	2.5	*	1	*	7.5	*	5	*	5	*	5	*	25	*	25	*
2.5	*	1	*	ND		2.5	*	2.5	*	1	*	7.5	*	5	*	5	*	5	*	25	*	25	*
2.5	*	1	*	ND		2.5	*	2.5	*	1	*	7.5	*	5	*	5	*	5	*	25	*	25	*
2.5	*	1	*	ND		2.5	*	2.5	*	1	*	7.5	*	5	*	5	*	5	*	25	*	25	*
2.5	*	1	*	ND		2.5	*	2.5	*	1	*	7.5	*	5	*	5	*	5	*	25	*	25	*
2.5	*	1	*	ND		2.5	*	2.5	*	1	*	7.5	*	5	*	5	*	5	*	25	*	25	*
2.5	*	1	*	ND		2.5	*	2.5	*	1	*	7.5	*	5	*	5	*	5	*	25	*	25	*
2.5	*	1	*	ND		2.5	*	2.5	*	1	*	7.5	*	5	*	5	*	5	*	25	*	25	*
2.5	*	1	*	ND		2.5	*	2.5	*	1	*	7.5	*	5	*	5	*	5	*	25	*	25	*
2.5	*	1	*	ND		2.5	*	2.5	*	1	*	7.5	*	5	*	5	*	5	*	25	*	25	*
		2.5				1.8		0.8		6													
		100				100		100															
						300		300															
<2.0		<2.0		Below dl		<5.0		<5.0		<2.0		<15.0		<5.0		<10.0		<10.0		<50.0		<50.0	
<2.0		3.1		4.6		<5.0		<5.0		5.3		<15.0		9.6		<10.0		<10.0		<50.0		160	
<5.0		3.3		4		<5.0		<5.0		4		<15.0		240		<10.0		<10.0		<50.0		140	
<5.0		9.1		9.6		<5.0		11.4		9.7		<15.0		1140		<10.0		<10.0		<50.0		374	

PCB 1260		Total PCB		Toxaphene		Chemical Group A		
ppb		ppb		ppb		ppb		
25	*	ND		200	*			
25	*	ND		200	*	ND		
25	*	ND		200	*	ND		
25	*	ND		125	*	ND		
25	*	ND		125	*			
25	*	ND		50	*	ND		
25	*	ND		50	*	ND		
25	*	ND		50	*			
25	*	ND		50	*			
25	*	ND		50	*			
25	*	ND		50	*			
25	*	ND		50	*	2.7		
25	*	ND		50	*	2		
25	*	ND		50	*	ND		
25	*	ND		50	*	ND		
25	*	ND		50	*	5.1		
25	*	ND		50	*	ND		
25	*	ND		50	*	ND		
25	*	ND		50	*	ND		
25	*	ND		50	*	ND		
25	*	ND		50	*	ND		
25	*	ND		50	*	ND		
		2.2		8.8				
		500		100				
		2000		5000				
61.2		130		236		400		
184		358		1000		1220.9		
82.2		240		1100		1686.6		
160		600.6		2300		3498.7		

Appendix 5. Toxic Substance Monitoring Program Data

Lipid Data in Fish		ppb,lipid weight		ND=not detected, NA=not analyzed						
Station #	Station Name	Species Code	Tissue	Date	Aldrin ppb	Alfa-Chlor ppb	cis-chlordan ppb	gamma-Chlor ppb	trans-Chlorda ppb	cis-Nonachlo ppb
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	8/14/81	ND	ND	ND	ND	ND	ND
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	F	8/26/85	ND	ND	ND	ND	ND	ND
114.31.10	Russian R/Russian R Estates	SKR	F	9/9/87	NA	NA	NA	NA	NA	NA
114.11.16	Russian R/Odd Fellows Pk Brd	SMB	F	10/4/89	ND	ND	ND	ND	ND	ND
114.23.00	Mark West Creek	BG	F	10/4/89	ND	ND	ND	ND	ND	ND
114.11.05	Russian R/Duncans Mills	PCP	W	7/17/91	ND	ND	ND	ND	ND	ND
201.12.01	Walker Creek	STG	W	7/16/91	ND	ND	ND	ND	ND	ND
114.11.05	Russian R/Duncans Mills	PCP	W	7/22/92	ND	ND	ND	ND	ND	ND
114.11.16	Russian R/Odd Fellows Pk Brd	GSF	W	7/23/92	ND	ND	ND	ND	ND	ND
114.11.23	Russian R/Wohler Brd	SMB	W	10/8/92	ND	ND	ND	ND	ND	ND
114.23.00	Mark West Creek	SKR	W	10/8/92	ND	ND	ND	ND	ND	ND
114.26.00	Big Sulfur Creek	SQF	F	10/7/92	ND	ND	ND	ND	ND	ND
201.12.01	Walker Creek	STB	W	7/27/92	ND	ND	ND	ND	ND	ND
206.30.07	Petaluma R/Lakeville	YFG	F	7/28/92	ND	ND	ND	ND	ND	ND

Appendix 5. Toxic Substance Monitoring Program Data

trans-Nonach	Oxychlordan	Total Chlorda	Chlorpyrifos	Dacthal	Dieldrin	o,p'DDD	p,p'DDD	o,p'DDE	p,p'DDE	o,p'DDT	p,p'DDT
ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	252	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
87.8	ND	87.8	ND	ND	ND	ND	ND	ND	327	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	676.1	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	471.7	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	979	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	587.8	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Appendix 5. Toxic Substance Monitoring Program Data

p,p'DDMU	p,p'DDMS	Total DDT	Dicofol	DBP	Diazinon	Endosulfan I	Endosulfan II	Endosulfan S	Total Endos	Endrin	alpha-HCH
ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND
ND	ND	252	ND	NA	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND
ND	ND	327	ND	NA	ND	ND	ND	ND	ND	ND	ND
ND	ND	676.1	ND	NA	ND	ND	ND	ND	ND	ND	ND
ND	ND	471.7	ND	NA	ND	ND	ND	ND	ND	ND	ND
ND	ND	979	ND	NA	ND	ND	ND	ND	ND	ND	ND
ND	ND	587.8	ND	NA	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND

beta-HCH	delta-HCH	Gamma-HCH	Total HCH	Heptachlor	Heptachlorep	Hexachlorob	Methoxychlor	Oxadiazon	Ethylparathio	MethylPara	PCB 1248
ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ND	ND	540	540	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	909.1	909.1	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

PCB 1254	PCB 1260	Total PCB	Toxaphene	Chemical Group A
ppb	ppb	ppb	ppb	ppb
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
NA	NA	NA	NA	NA
ND	ND	ND	ND	540
ND	ND	ND	ND	909.1
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND