dpr

Paul E. Helliker
Director

Department of Pesticide Regulation

Gray Davis
Governor

Winston H. Hickox
Secretary, California Environmental Protection Agency

MEMORANDUM

TO: Kean S. Goh, Ph.D.
Agriculture Program Supervisor IV
Environmental Monitoring Branch

FROM: Sheryl Gill, M.S.
Associate Environmental Research Scientist
Surface Water Protection Program
(916) 324-5144

DATE: August 9, 2002

SUBJECT: OVERVIEW OF SURFACE WATER MONITORING ALTERNATIVES

I. Purpose of Memo

This memo defines different monitoring options for the Department of Pesticide Regulation's (DPR) Surface Water Protection Program. It gives examples of what information can be gathered with different types of studies and provides example study objectives. It also outlines the regulatory role of different monitoring study types. Budget information for relative workload costs of different projects is provided.

II. Background

California is a state of amazing physical diversity. No other state in the nation possesses such a wide range of topography, soils, and climate. These characteristics support an agricultural industry that is a complex and unique mosaic that produces over 250 agricultural products, worth over 29 billion dollars in 1999. California also sustains a 2.5 billion dollar flower, foliage and nursery crop industry, which supplies plants to the homes, parks, and golf courses for the 34 million people that now call California home (Scheuring, 1983; CFBF, 2002).

The wide variety of growing conditions results in a broad range of plant and insect pests as well as plant pathogens and diseases. More than 11,500 pest control products representing 890 active ingredients are currently registered in California for controlling these pests (DPR, 2002). Regulating pesticide use in California is the responsibility of DPR.

The California Food and Agriculture Code (FAC) authorizes DPR's pesticide regulatory program and mandates that the department "protect the environment from environmentally harmful pesticides by prohibiting, regulating, or ensuring proper stewardship of those pesticides" (FAC, Section 11501 [b]). Within the charge of protecting the environment lies the department's responsibility to protect surface water from pesticide contamination. The goal of DPR's Surface

Water Protection Program is to characterize pesticide residues in surface water bodies, identify where the contamination originated, determine the transport mechanisms involved, and develop mitigation or regulatory measures to keep the pesticides out of surface water. These goals are achieved primarily through surface water monitoring to identify locations and concentrations of pesticides in surface water, and through research to characterize the factors that lead to off site movement and subsequent surface water contamination (Federighi, 2001).

Federal water quality laws dictate that individual states are responsible for establishing ambient water quality standards that maintain the "chemical, physical, and biological integrity of the Nation's waters" (CWA, PL 92-500). Section 303 (d) of the Clean Water Act requires states to establish Total Maximum Daily Loads (TMDLs) for pollutants to assure water quality and to determine if water quality standards are being met. The California Water Code (CWC) stipulates that the State and Regional Water Quality Control Boards are responsible for the coordination and control of activities related to water quality.

The overlapping authorities of the FAC and the CWC have necessitated the implementation of a Management Agency Agreement (MAA) between the Water Boards and DPR. The agreement contains a four-stage approach to minimize the potential for pesticide movement to surface water. The first stage involves prevention of pesticide contamination. The remaining three stages hinge on correcting and mitigating for pesticides detected in surface waters. This is where DPR's Surface Water Protection Program monitoring studies play a key role. The MAA dictates that DPR will conduct ongoing monitoring that helps identify the water surface quality impairment that may result from pesticides in surface water (DPR, 1997a).

Pesticide Detections

DPR's Surface Water Database (SURF) was developed in 1997. It contains results from over 30 different monitoring studies conducted by state, federal, and local agencies as well private industry and environmental groups over the eleven year period of 1991-2001. The database contains over 94,000 analytical records including approximately 8,400 detections of pesticides in surface waters of California. Nearly 100 different active ingredients and breakdown products have been detected in rivers, creeks, urban streams, agricultural drains, and urban storm water runoff throughout the state (DPR, 1997b). Some pesticides have exceeded narrative water quality standards and also levels that cause aquatic toxicity.

The current 303(d) impaired water-body list for California includes over 1,400 water body/pollutant combinations requiring the development and implementation of over 800 TMDLs. Nearly 100 water body/pesticide (currently registered) combinations are listed for state waterways. These include approximately 60 waterways on the 303(d) list for diazinon, 11 for chlorpyrifos, and 22 for the general category "pesticides." Other pesticides named in the 303(d) list are carbofuran, malathion, and methyl parathion (SWRCB, 1998).

California Water
California has 149 river basins that have been grouped into 9 regions by state water agencies (DWR, 1998; CERES, 1999). All regions but one, Region 1, have waterways on the 303(d) list for pesticides (SWRCB, 1998). Most data have been collected from a limited number of river basins, and most monitoring has been focused on organophosphates, particularly diazinon and chlorpyrifos. These two insecticides account for more than 2000 of the pesticide detections in SURF. In general, sampling for pesticides has historically been concentrated in areas of known pesticide impairment. The tributaries and main stems of the Sacramento and San Joaquin Rivers have been the focus of most monitoring activities conducted by DPR, U.S. Geological Survey (USGS) and the Central Valley Regional Board (DPR, 1997b; Spurlock, 2002). The Alamo River in Region 7 has also been frequently sampled. One DPR study additionally sampled the Salinas and Russian Rivers (Ganapathy et al., 1997).

Rationales for Monitoring
DPR is mandated to protect the environment from the adverse effects of pesticides (FAC Sec. 11501 [b]). Water quality monitoring is the most accurate and direct method used to characterize the presence and concentration of pesticide residues in surface water, and to thereby assess their impact on the environment. Monitoring provides a crucial component of a sound scientific basis for the surface water protection program.

III. Monitoring Options

Overview of study types
For the purposes of this memorandum, surface water monitoring studies are grouped into five general types. Each type addresses specific objectives and plays a unique role in DPR's regulatory pesticide water quality program.

Targeted monitoring studies
Targeted monitoring studies are typically conducted to determine the frequency and concentration of known pesticide contaminants in surface waters. These studies may be conducted in areas and/or seasons of the year that lack monitoring data.

Monitoring network studies
Monitoring networks are typically designed to track long-term trends in surface water pesticide concentrations and may also provide data to evaluate the success of regulatory programs and mitigation measures.

Source identification studies
Source identification studies determine the geographic origin of pesticide loadings into main stem rivers or other water bodies. Such studies may help to distinguish between urban and agricultural sources, or may be used to identify which tributaries contribute to pesticide loading. Source

identification studies are an important part of the TMDL's development process and will help steer mitigation, outreach and regulatory efforts.

Designed research studies
In an effort to meet water quality standards for known pesticide water contaminants, mitigation measures may be adopted voluntarily or through regulatory actions to reduce the amount of pesticides entering surface water. Designed research studies are scientific investigations that statistically test the effectiveness of mitigation measures.

Surface water protection list monitoring
Surveys for pesticides with (a) a high potential to contaminate surface water and (b) that have little or no previous monitoring history fall into the surface water protection monitoring category.

A comment on aquatic toxicity testing
The presence or absence of numerous constituents may contribute to or cause toxicity in aquatic toxicity tests, including pesticides, metals, ammonia, or lack of dissolved oxygen. Therefore, aquatic toxicity testing is generally nonspecific, and inclusion of aquatic toxicity testing in a study design may significantly reduce resources available for sampling and chemical analysis while providing little or no additional information directly relevant to study objectives. For this reason, use of aquatic toxicity testing should be carefully considered in the context of the specific objectives of each study.

If aquatic toxicity testing is to be included in a study, as much ancillary relevant water quality data as possible should also be included in sample analysis, including ammonia, dissolved oxygen, temperature, and electrical conductivity measurements. In addition, analysis for organophosphate insecticides should always be included with aquatic testing in a study because of their frequent significant contribution to aquatic toxicity in agriculturally dominated water bodies. Finally, an additional consideration is that toxicity testing results may be difficult or impossible to interpret if pesticide analyte reporting limits are greater than toxicity threshold concentrations.

1. Targeted Monitoring

Purpose
Historically, many of the monitoring studies conducted by the surface water program have been targeted monitoring projects, designed to survey the occurrence and concentration levels of pesticides in surface waters that may be toxicologically important in aquatic systems. Examples include recent sampling for the synthetic pyrethroids permethrin and esfenvalerate (Starner, 2002; Bacey, 2001) and a survey for oryzalin (Guo, 2000). Data from targeted monitoring projects may be used to quantify spatial and temporal distributions of pesticides in surface water, and studies may be initiated based on events such as a major shift in use patterns, registration of new products, or surface water detections in other studies, by

other agencies, or in other states. Targeted projects may also be used to survey for known surface water contaminants in river basins with a lack of monitoring data.

Seasonality and site selection
The time of year and location of monitoring for targeted studies is determined primarily by pesticide use patterns and climactic factors, ideally chosen such that both pesticide use and the likelihood of runoff events are maximized. In some cases historic sampling sites may be used if targeted compounds are direct replacements for analytes previously detected. An example is DPR's recent dormant season monitoring for esfenvalerate and permethrin at sites of historically high diazinon concentrations. Esfenvalerate and permethrin are used as direct replacements for diazinon in the dormant season.

Sampling frequency
A targeted study is usually designed with high intensity sampling over a relatively short time frame of weeks to months, determined largely by the seasonality of pesticide use. Sampling during storm events would be appropriate if runoff is the suspected transport mechanism. For pesticides applied during the dry season, sampling could be timed to irrigation events or to irrigation water releases to agricultural drains such as during the rice growing season.

Analytical and toxicity testing considerations
Chemical analysis will include the targeted analyte, and usually one or two analytical screens that reflect known contaminants of concern. Currently the analytical screens most commonly used by DPR are the organophosphate screen, the carbamate screen, and the herbicide screen. If additional information concerning associated acute toxicity is needed, then inclusion of some of these analytical pesticide screens may be necessary to help identify possible causes of aquatic toxicity.

Example Objectives for targeted monitoring studies
Determine if concentrations of esfenvalerate and permethrin are present in dormant season storm runoff in the San Joaquin and Sacramento River Basins.

Determine if summer-use cotton pesticides are present in surface waters of the San Joaquin River Basin.

Example Budget

Scenarios	Two multi-residue screens [1]	Four multi-residue screens [1]
Hourly sampling for one 10 hour storm event at one site		
Near (example Sacramento or San Joaquin River)	$7,727	$14,327
Mid (example Salinas River)	$8,439	$15,039
Far (example Alamo River)	$9,532	$16,132
For acute toxicity bioassay analysis add	$5,000	$5,000
Hourly sampling for two 10 hour storm events at four sites		
4 near sites	$61,816	$114,616
4 mid sites	$67,512	$120,312
For acute toxicity bioassay analysis add	$40,000	$40,000
Method development and validation add	$15,000	$15,000

1. Includes all personnel and operating expenses and chemical analysis.

2. <u>Monitoring Networks</u>

Purpose

Monitoring networks are typically designed to evaluate potential long-term detection or concentration trends for a fixed suite of analytes through the collection of time-series pesticide concentration data at fixed locations. A second related objective of monitoring networks may be to test whether pesticide concentrations are in compliance with water quality goals or objectives. One example of a network program is DPR's rice pesticide monitoring program, in which monitoring has been conducted at fixed sites in the Sacramento Valley rice growing season since the mid-1980s (Newhart, 2002). Data from the rice monitoring program have provided an on-going effectiveness measure for mandatory rice pesticide management practices (water holding times).

Seasonality and site selection
Statistical analysis of trend monitoring data is most powerful if the occurrence of non-detections is minimized. Therefore, monitoring in main stem rivers at DPR's current detection levels would generally be of limited use due to the generally low concentration of most common pesticides relative to reporting limits. Consequently, many years of data would be required to determine the presence of any statistically significant concentration trends if such trends could be identified at all. Trend analysis would generally be more powerful if monitoring efforts were focused on smaller waterways such as tributaries where pesticide concentrations are generally higher.

While it is not necessary to sample throughout the year in a network design, in each year sampling should bracket the pesticide use period or pesticide use type (e.g. dormant spray insecticide applications) of interest. The ultimate goal is to provide a representative sample of concentrations at the chosen sites for a fixed time period that includes the use period of interest.

Sampling frequency
In a network monitoring study to determine trends, sampling frequency is extremely important. Analysis of pesticide concentration data has shown that, due to the high variability of data, sampling weekly may require a minimum of five to ten years of data or more to show statistically significant trend information. Sampling at monthly intervals or longer would probably be useless for trend analysis.

One method to determine sampling frequency for a network study is to analyze historical data. For example, organophosphate concentration time-series data for the both the San Joaquin River (diazinon) and Orestimba Creek (chlorpyrifos) during winter and spring months in the 1990s demonstrated significant autocorrelation for lag periods of up to 3-6 days (Spurlock, 2001).
The data suggest that, for sampling intervals greater than 3-6 days, there may be a substantial loss of concentration information, thereby compromising any study objectives relating to characterizing concentration. Therefore, sampling for these compounds should probably occur at a minimum of twice a week.

Analytical considerations
For trend analysis, pesticides with relatively high detection frequencies are the most easily characterized. Diazinon, chlorpyrifos, diuron, and simazine are the four best candidates based on this criterion as all are found frequently, at least at certain times of the year. Of these pesticides, diazinon and chlorpyrifos are currently of greatest regulatory concern due to their relatively high aquatic toxicity to daphnids.

Additional comments
Due to the relatively high cost of chemical analyses needed for determining pesticide concentrations in surface water, long-term fixed site monitoring studies are generally very expensive. Further, the high variability and seasonality of the many causative factors that affect

surface water pesticide concentrations may require many years of data to detect any significant trends. Obtaining trend data or verifying compliance with water quality objectives/goals are the two primary objectives of network monitoring. Therefore, such long-term fixed site monitoring is inappropriate for most other sampling objectives, such as identifying new contaminants or the geographic extent of existing contamination episodes.

If acquisition of trend data is determined to be a priority by DPR; for example, to provide baseline data and a subsequent evaluation of the success of DPR's regulatory dormant spray program, then the most cost-effective monitoring option at this time would be to continue DPR's annual dormant spray runoff monitoring studies. Five years of monitoring data have already been collected for dormant season organophosphates (OP) and triazine herbicides in two major river basins (the Sacramento River Basin and the San Joaquin River Basin) that are prioritized for diazinon TMDL implementation. The five years of recent monitoring would provide a substantial portion of data required for evaluating trends in surface water OP concentrations in the basins, and would bring DPR that much closer to providing the baseline data needed to evaluate the effects of any future regulatory actions.

Other options for network monitoring might include having one or two sampling sites in the major river basins throughout the state, such as the Sacramento, San Joaquin, Salinas, Russian, and Alamo River Basins. Another option would be to concentrate on one basin, with multiple sites within the basin, such as the five major tributaries of the San Joaquin River Basin. A continuation of DPR's dormant spray project as it has been previously conducted would involve two sites in the San Joaquin Basin and two or three in the Sacramento Basin.

All options for monitoring networks have some limitations. For instance, with only one or two sites per basin, it is impossible to find monitoring sites that are characteristic of the entire basin and representative of the cropping patterns, pesticide use, and runoff mechanism of the basin. Consequently, network monitoring objectives must be clearly and precisely specified at the beginning of a network study and will have the highest likelihood of success if carefully limited in scope.

Example objectives for monitoring networks
Determine if dormant season surface water concentrations of OP are changing over time in the main tributaries of the San Joaquin, Sacramento and Feather Rivers.

Determine the seasonal compliance with rice herbicide water quality objectives.

Example Budget

Scenarios	**Weekly Sampling** [1]	**Total**
Year round with one monitoring site		
Near (example Sacramento or San Joaquin River)	$108,080	
Mid (example Salinas River)	$153,301	
Far (example Alamo River)	$204,658	
For toxicity samples add	$26,000	
Year round with five monitoring sites in one basin		
Five nearby sites (ex. five sites San Joaquin River)	$540,401	
Five mid sites (ex. five sites Salinas River)	$766,505	
For acute toxicity bioassay analysis add	$130,000	
Year round with ten monitoring sites in five different river basins		
Example- two sites each in Sac, San Joaquin, Russian, Salinas, Alamo Rivers. Comprised of four near sites, four mid sites, one far site.	$1,250,182	
For acute toxicity bioassay analysis add	$260,000	
Continuation of dormant OP monitoring program [2]		
Example- Two sites San Joaquin and three sites Sacramento River- Samples taken Dec- March		$249,360
For acute toxicity bioassay analysis add		$60,000

1. Includes all personnel and operating expenses and chemical analysis for four multi-residue suites.
2. Based on sampling frequency and chemical analyses used in DPR's 5-year dormant spray studies.

3. <u>Surface Water Protection List Monitoring</u>

Purpose
Another monitoring option is the development of a surface water protection list of pesticides based on physical chemical properties and use patterns similar to the methodology used to develop the ground water protection list (Troiano et al., 2001; Johnson, 1991). Studies that monitor pesticides with (a) a high potential to contaminate surface water and (b) that have little or no previous monitoring history fall into the surface water protection monitoring category.

In addition to physical-chemical properties, the surface water program could use Pesticide Use Report (PUR) data and information about aquatic toxicity to develop a protection list of pesticides that have a high potential to move off site to surface water. PUR data supplies information about where, when, and to what extent agricultural pesticides are used and can facilitate determining monitoring site location. Toxicity data provides clues to the potential impairment of aquatic ecosystems if the pesticides end up in surface water and helps indicate at what concentration compounds might cause aquatic toxicity.

Seasonality and site selection

Studies would be developed to look specifically for compounds on the priority list at the time and place they are most likely to be found. If compounds on the list are detected in surface water, they may be subjected to more in-depth monitoring projects, such as source identification and load characterization studies.

Sampling frequency

Sampling frequency would likely be high intensity sampling over a short time frame, determined by the seasonality of pesticide use. Sampling during storm events would be appropriate if runoff is the suspected transport mechanism. For some compounds, sampling could be timed to irrigation events or to irrigation water releases to agricultural drains.

Since its creation in 1992, the 6800(b) list has contained more than 50 active ingredients (Troiano et al., 2001). Resources were available to sample for only a few active ingredients per year, so a method of further prioritizing pesticides on the list was necessary. That process would likely be needed, for a surface water protection list as well, considering that the list could potentially contain hundreds of candidates.

Analytical considerations

Projects would be designed to look specifically for compounds on the priority list. Therefore, only one or two analytical methods would be needed. If information about associated acute toxicity is needed, then more chemical screens may be necessary to help identify other possible causes of aquatic toxicity.

Additional comments

While PUR data and physical chemical properties are good indicators of runoff potential and are tools that can facilitate DPR's attempts to identify surface water contaminants, they are not fail safe. Monitoring projects based on a surface water protection list designation would be an important component in the further development of the surface water program. They should not, however, be used as the sole monitoring method.

Sample Objectives for Surface Water Protection List (SWPL) studies
Determine if detectable concentrations of "pesticide number 1" from the SWPL are present in surface waters within areas where the material is used.

Example Budget

	Cost	
Env. Scientist ($25/hr)	$7,500	300 hrs
Senior & Supervision ($32/ hr)	$640	20 hrs
Staff Benefits (31%)	$2,524	
Scientific Aides ($11/hr)	$3,300	300 hrs
Staff Benefits (10.73%)	$354	
Admin. on Personnel Services (31.15%)	$4,461	
Total Personnel Expenses	$18,779	
Transportation ($.34/ mile)	$2,040	6000 miles
Chemical Screens ($300/ screen)	$48,000	160 samples
Field Supplies	$500	
Total Operating Expenses	$50,540	
Total	$69,319	
For method development and validation add	$15,000	
For acute toxicity samples add	$25,000	

Based on 4 mid distance monitoring sites, sampling 1 time/week for 3 months, 3 chemical screens

4. Research Studies: Mitigation Measure Evaluation

Purpose
Part of DPR's responsibility as outlined in the MAA, and part of the Surface Water Protection Program's mission, is to characterize factors that lead to off site movement of pesticides and to develop site specific use practices that will keep pesticides out of surface waters (Federighi, 2001; DPR, 1997a). As TMDLs are developed and implemented, information on the effectiveness of mitigation measures will be required to document regulatory progress of water quality protection programs.

Mitigation measures may range from changes in label language and additional permit requirements to voluntary, in-field pesticide use practices. Measures will also vary greatly depending on the pesticide mitigated and the off site transport mechanism.

Mitigation measure evaluation studies have been conducted by DPR in dormant peach orchards, citrus orchards, alfalfa crops, and nurseries. Studies tested the effectiveness of using cover crops, mechanical incorporation, pesticide formulation, and vegetative filters to reduce pesticide runoff (Ross et al., 1997; Troiano and Garretson, 1998; Spurlock et al., 1997; Kim, 2000).

Analytical considerations
Mitigation measure projects are usually applied, designed research studies that take place in test blocks in orchards or fields. They could require the cooperation of growers or university farms and the involvement of surface water stewardship programs. Chemical analyses may be limited to one analyte.

Sample objectives for designed research studies
Determine if vegetation between tree rows in orchards can significantly reduce diazinon runoff during the rainy season in the Central Valley.

Determine the effect of formulation on diazinon runoff potential.

Example Budget
Costs vary greatly depending on scale of project and type of mitigation measure evaluated. This estimate is for a runoff study at a mid distance site.

	Cost	
Env. Scientist ($25/hr)	$5,000	200hrs
Senior & Supervision ($32/hr)	$640	20hrs
Staff Benefits (31%)	$1,748	
Scientific Aides ($11/hr)	$2,200	200hrs
Staff Benefits (10.73%)	$236	
Overtime	$750	20hrs
Admin. on Personnel Services (31.15%)	$3,294	
Total Personnel Services	$13,868	
Per Diem & Lodging	$1,050	
Transportation ($0.34/mi)	$1,020	25 trips Yuba City
Chemical Analysis ($300/screen plus 10% QC for 200 samples)	$60,000	200 samples
Field Supplies/Equipment rental	$3,000	cover crop seeds, grass plugs, chemicals, equip rental etc.
Plot Rental	$1,000	
Total Operating Expenses	$65,170	
Total	$79,038	

5. <u>Source Identification Studies</u>

Purpose
Source identification studies are used to identify sources of pesticide detections in surface water. Studies may be designed to trace sources of pesticide contamination in local watersheds or in entire hydrologic basins. Source identification studies are an important component of TMDL development. The TMDL process requires that all sources of pollution and all aspects of a

watershed's drainage system be reviewed (SWRCB, 2000). When new compounds are detected in surface water, source identification studies may be needed to determine where they originated.

Information gathered in source identification studies help to identify where pesticides in surface water originated and may be used for directing future outreach, mitigation, and enforcement efforts. Data from these studies can also be used to calibrate computer simulation runoff models.

Local-scale source identification studies are designed to determine relative contributions by different transport mechanisms that are responsible for the off site movement of pesticides. Such studies may help to identify which agricultural, commercial, and residential practices contribute to pesticide presence in surface water. An example of a local-scale project is DPR's urban runoff study that was designed to determine the proportional importance of residential and commercial sources of diazinon and chlorpyrifos to total influent loads in the Central Contra Costa Sanitation District (Singhasemanon et al., 1998).

On a larger scale, source identification studies can be used to determine which tributaries contribute to pesticide loading of main stem rivers. An example of a larger scale project is a USGS monitoring study done in conjunction with DPR and the Sacramento River Watershed Program. It was designed to determine the quantity of diazinon transported to the Sacramento River from selected sub-basins within the watershed (USGS, 2002).

Seasonality and site selection
Local scale studies may take place in small areas such as residential or commercial sewer systems, where inputs are well known. Basin scale studies are more likely to be event-based studies conducted when detections and concentrations were expected to be highest. Many sampling sites are typically needed. The USGS study monitored at 17 different sampling sites.

Sampling frequency
Sampling would likely be high intensity over a short time frame such as daily sampling for several weeks or hourly sampling during storm events.

Analytical considerations
Projects would be designed to determine sources of specific analytes. Therefore, only one or two analytical methods would be needed. If information about associated acute toxicity is needed then more chemical screens may be necessary to help identify other possible causes of aquatic toxicity.

Sample objectives for source identification studies
Determine the relative contribution of various tributaries to diazinon loadings in the San Joaquin River.

Example Budget

Scenario	**Cost**	
Environmental Research Scientist ($25/hr)	$7,500	300 hrs
Senior & Supervision ($32/hr)	$640	20 hrs
Staff Benefits (31%)	$2,524	
Scientific Aides ($11/hr)	$3,300	300 hrs
Staff Benefits (10.73%)	$355	
Administrative Personnel Services (31.15%)	$4,460	
Total Personnel Services	$18,779	
Transportation ($0.34/mi)	$1,000	2800 miles
Chemical Analysis ($300/screen plus 10% QC)	$92,400	280 samples
Field Supplies/Equipment	$1,000	
Total Operating Expenses	$94,400	
Total	$113,179	

Daily sampling for 1 week per month for 4 months, five near sites, two chemical screens.

IV. Conclusion

The following table summarizes the types, regulatory role, and relative cost of various monitoring options.

	Description	Roll	Cost
Targeted Monitoring	Studies designed to survey the occurrence and concentration levels of known surface water contaminants for which additional data are needed.	Further quantify spatial and temporal distributions of surface water concentrations of known water contaminants, new AI's etc.	Relatively inexpensive. Short term studies. Basic projects begin at $70,000.
Network Monitoring	Monitoring network to determine trends in water quality or compliance with water quality goals/objectives.	Gauge effectiveness of regulatory program.	Most expensive option. Range- simplest design $120,000 up to several million per year. Ongoing, requires multiple years of data collection.
Designed Research Studies	Designed research studies to statistically test the effectiveness of pesticide management practices.	Mitigation measure evaluation.	Costs vary greatly based on scope of project. Basic projects begin at $80,000.
Source Identification Studies	Studies used to identify sources of pesticide detections in surface water. Studies may be designed to trace sources of pesticide contamination in local watersheds or in entire hydrologic basins.	Identify sources of pesticide detections in surface water.	Large cost range. Local scale studies may require only a few sampling sites. Hydrologic basin scale studies typically require many sampling sites. Basic projects begin at $100,000.
Surface Water Protection List	Physical-chemical parameters for different pesticides used to create a priority list of compounds that have a high potential to move to surface water and for which there is little or no monitoring data.	A systematic method to identify potential contaminants.	Potentially least expensive option-requires one or two chemical screens per study and projects will likely be short term. Basic projects begin at $60,000.

V. References

Bacey, N. (2001). Protocol for monitoring the occurrence and typical concentration of esfenvalerate and permethrin pyrethroids. California Department of Pesticide Regulation EHAP Study Protocol No. 205. Available at http://www.cdpr.ca.gov/docs/empm/pubs/protocol.htm.

California Food and Agriculture Code. Section 11501 (a-f). Available at http://www.leginfo.ca.gov/calaw.html.

California Water Code. Available at http://www.leginfo.ca.gov/calaw.html.

CFBF (2002). California Farm Bureau Federation. Facts and stats: top California commodities. Available at http://www.cfbf.com/info/agfacts3.asp.

CERES (1999). Watershed information by hydrologic region. The California Environmental Resources Evaluation System. Available at http://www.ceres.ca.gov.

CWA (1972). Federal Water Pollution Control Act and Amendments. Available at http://www.epa.gov/region5/water/cwa.htm.

Dow AgroSciences LLC (1998). A monitoring study to characterize chlorpyrifos concentrations and ecological risk in an agriculturally dominated tributary of the San Joaquin River. Study No. ENV96055.

DPR (1997a). California pesticide management plan for water quality. An implementation plan for the management agency agreement between the Department of Pesticide Regulation and the State Water Resources Control Board.

DPR (1997b). Surface water database. California Department of Pesticide Regulation. Available at http://www.cdpr.ca.gov/docs/surfwatr/surfdata.htm.

DPR (1999). Budget change proposal (007) for fiscal year 1999-2000. Environmental Monitoring and Pest Management Branch. Department of Pesticide Regulation.

DPR (2002). DPR approves 22 new chemicals; 9 are reduced risk. Press release (02-06) March 1, 2002.

DWR (1998). California Water Plan. California Department of Water Resources Bulletin 160-98. Available at http://rubicon.water.ca.gov.

Federighi, V. *ed.* (2001). Regulating pesticides: the California story. Department of Pesticide Regulation Publication 203. www.cdpr.ca.gov.

Ganapathy, C., *C. Nordmark ,K. Bennett, and A. Bradley* (1997). Temporal distribution of insecticide residues in four California rivers. California Department Pesticide Regulation, Environmental Hazards Assessment Program Report EH97-06. December 1997.

Guo, L. (2000). Protocol for monitoring the occurrence and concentrations of oryzalin in the San Joaquin River Basin. California Department of Pesticide Regulation EHAP Study Protocol No. 202. Available at http://www.cdpr.ca.gov/docs/empm/pubs/protocol.htm.

Johnson, B. (1991). Setting revised specific numerical values. California Department of Pesticide Regulation Publication EH 91-06.

Kim, D. (2000). Pesticide and Nutrient Removal from Nursery Runoff Using A Vegetative Buffer Strip**.** California Department of Pesticide Regulation EHAP Study Protocol No. 198. Available at http://www.cdpr.ca.gov/docs/empm/pubs/protocol.htm.

National Research Council (2001). Assessing the TMDL approach to water quality management. Committee to assess the scientific basis of the total maximum daily load approach to water pollution reduction, Water Science and Technology Board, National Research Council. Available at http://www.nap.edu/catalog/10146.html.

Newhart, K. (2002). Rice Pesticides Program Monitoring Protocol. California Department of Pesticide Regulation EHAP Study Protocol No. 206. Available at http://www.cdpr.ca.gov/docs/empm/pubs/protocol.htm.

Ross L., K. Bennett, K. Kim, K. Hefner, and J. Hernandez. (1997). Reducing dormant spray runoff from orchards. California Department of Pesticide Regulation Publication EH 97-03.

Sanders, TG. *ed.* (1983). Design of networks for monitoring water quality. Water Resources Publications, LLC. Highlands Ranch, Colorado.

Scheuring, AF. *ed.* (1983). A guidebook to California agriculture. University of California Press, Berkeley, CA.

Singhasemanon, N., C. Nordmark, and T. Barry (1998). Diazinon and chlorpyrifos in the Central Contra Costa Sanitary District Sewer System, Summer 1996. California Department of Pesticide Regulation Publication EH 98-05.

Spurlock, F., C. Garretson, and J. Troiano (1997). Runoff from citrus orchard middles: Comparison of three herbicides and effect of organosilicon surfactant. California Department Pesticide Regulation Publication 97-02.

Spurlock, FC (2002). Analysis of diazinon and chlorpyrifos surface water monitoring and acute toxicity bioassay data 1991-2001. California Department of Pesticide Regulation Publication EH 01-01.

Starner, K. (2002). Monitoring surface waters of the San Joaquin River Basin for selected summer-use pesticides. California Department of Pesticide Regulation EHAP Study Protocol No. 207. Available at http://www.cdpr.ca.gov/docs/empm/pubs/protocol.htm.

SWRCB (1998). Impaired water bodies 303(d) list for California. Available at http://www.swrcb.ca.gov/tmdl/303d_lists.html.

SWRCB (2000). TMDL information: Background. Available at http://www.swrcb.ca.gov/tmdl/background.html#background.

Troiano, J and C. Garretson (1998). Movement of simazine in runoff from citrus orchard row middles as affected by mechanical incorporation. J. Environ. Qual. 27:448

Troiano, J, D. Weaver, J. Marade, F. Spurlock, M. Pepple, C. Nordmark, and D. Bartkowiak (2001). Summary of well water sampling in California to detect pesticide residues resulting from nonpoint- source applications. J. Environ. Qual. 30:448-459, 2001.

USGS (2002). Occurrence and transport of diazinon in the Sacramento River, California, and selected tributaries during three winter storms, January- February 2000. United States Geological Survey Water Resources Investigations Report 02-4101. Sacramento, CA 2002.

Document Review and Approval
Environmental Hazards Assessment Program
Department of Pesticide Regulation
1001 I Street
Sacramento, CA 95812

Document Title: OVERVIEW OF SURFACE WATER MONITORING ALTERNATIVES

Author(s): Sheryl Gill, M.S.

Document Date: August 12, 2002

APPROVED: ______________________ Date: 8/13/02
Frank Spurlock, Ph.D.
Senior Environmental Research Scientist

APPROVED: ______________________ Date: 8/13/02
Kean Goh, Ph.D.
Agriculture Program Supervisor IV

APPROVED: ______________________ Date: 8/14/02
John Sanders, Ph.D.
Branch Chief