Conditional Waiver for Rice and Rice Pesticides Program

2009 Annual Monitoring Report Sacramento River Drainage Basin

Volume 1

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Prepared by
CH2MHILL

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Acronyms and Abbreviations

µmhos/cm	micromhos per centimeter
ACP	agricultural civil penalties
AMR	Annual Monitoring Report
Basin Plan	Water Quality Control Plan for the Sacramento and San Joaquin River Basins
BMP	Best Management Practice
CAC	County Agricultural Commissioner
CDEC	California Data Exchange Center
CDFG	California Department of Fish and Game
CDPH	California Department of Public Health
COC	chain of custody
CRC	California Rice Commission
CTR	California Toxics Rule
CVRWQCB	Central Valley Regional Water Quality Control Board
CWFR	Conditional Waiver for Rice
DOC	dissolved organic carbon
DO	dissolved oxygen
DPR	California Department of Pesticide Regulation
DWR	California Department of Water Resources
EC	electrical conductivity
EMA	Environmental Micro Analysis, Inc.
gpm	gallons per minute
K	potassium
LCS	lab control spike
L	liter
mg/L	milligrams per liter
MS/MSD	matrix spike and matrix spike duplicate

MCL	maximum contaminant level
MDL	minimum detection limit
MRL	minimum reportable limit
MRP	Monitoring and Reporting Program
MRP Order	Monitoring and Reporting Program Order No. R5-2003-0826
N	nitrogen
ND	non-detect
NOA	Notice of Applicability or Notice of Application
NOI	Notice of Intent
NTU	nephelometric turbidity unit
P	phosphorus
ppb	parts per billion
PUR	Pesticide Use Report
QAO	quality assurance objective
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
ROD	record of decision
RPD	relative percent difference
RPP	Rice Pesticides Program
SWRCB	State Water Resources Control Board
TDS	total dissolved solids
TOC	total organic carbon
TIE	toxicity identification evaluation
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Administration
UCCE	University of California Cooperative Extension
UC IPM	University of California Integrated Pest Management
WQO	water quality objective
WET	whole effluent toxicity
Zn	zinc

CHAPTER 1

Introduction

The California Rice Commission (CRC) is a statutory organization representing about 2,500 rice farmers who farm approximately 500,000 acres of California farmland. Rice is one of the top 20 crops produced in California, and adds nearly a half billion dollars in revenue and thousands of jobs vital to the state's economy. The California rice industry contributes significantly to the foundation of many rural economies and the positive balance of international trade. Rice produced in the United States provides 1.5 to 2 percent of global production, competes in the global market, and constitutes a large proportion of internationally traded medium-grain (north Asian) rice.

The CRC implements water quality monitoring and reporting activities in compliance with two programs of the Central Valley Regional Water Quality Control Board (CVRWQCB). The CRC implements Conditional Waiver for Rice (CWFR) monitoring and reporting, pursuant to the Monitoring and Reporting Program (MRP) issued under the CVRWQCB's *Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands*. The CRC also implements the Rice Pesticides Program (RPP), pursuant to the Conditional Prohibition of Discharge requirements specified in the *Water Quality Control Plan for the Sacramento and San Joaquin River Basins* (Basin Plan).

This report serves as the 2009 Annual Monitoring Report (AMR) for both the CWFR and RPP efforts, and describes the CRC-conducted program activities for the calendar year 2009.

Key CWFR activities include the following:

- Reporting of rice acreage information
- Reporting of rice pesticide use information
- Water quality monitoring
- Toxicity testing
- Laboratory coordination
- Laboratory analysis and reporting
- Data validation and review
- Coordination of early-season data submittals between the County Agricultural Commissioners (CACs) and the California Department of Pesticide Regulation (DPR)
- Interaction with pesticide registrants to support the development of reduced-risk pesticides
- Annual reporting and review

Key RPP activities include the following:

- Reporting of rice acreage information
- Reporting of rice pesticide use information
- Water quality monitoring
- Laboratory coordination
- Laboratory analysis and reporting
- Data validation and review
- Coordination of early-season data submittals between the CACs and the DPR
- Pesticide use compliance inspections and enforcement
- Communications with the City of Sacramento and City of West Sacramento, enhanced through the activities of the Storm Event Work Group
- Interaction with pesticide registrants to support the development of reduced-risk pesticides
- Triennial reporting and review

Program Administration

The CRC has long been recognized by the CVRWQCB as an entity with the authority and capacity to implement RPP activities to achieve water quality protection. The CRC is a statutory organization with authorities and restrictions as established in the California Food and Agricultural Code. In July 2003, the CRC was issued a Notice of Applicability (NOA) as a watershed coalition under the CVRWQCB's Conditional Waiver for Discharges from Irrigated Lands and has implemented rice-specific program activities since then.

Kleinfelder was contracted by the CRC to collect water samples at specified sites to obtain data that would help characterize water quality. CH2M HILL prepared this AMR under contract to the CRC.

California Rice

Rice is grown in nine Sacramento Valley counties (Butte, Colusa, Glenn, Placer, Sacramento, Sutter, Tehama, Yolo, and Yuba). Rice is also farmed in counties outside the Sacramento Valley; however, the acreages are generally small and rice is not the dominant crop in these areas. For the purposes of the rice-specific MRP, the monitoring area is defined as the nine rice-producing counties in the Sacramento Valley.

Rice fields provide numerous environmental and commercial advantages that no alternative land use would, including a variety of upland and shallow aquatic habitat. In their quest to reduce rice straw burning and to improve wildlife habitat, rice farmers routinely flood their fields in the winter (when no rice is present) to degrade the straw and reduce the need for rice straw burning.

Rice farming requires flooded field conditions that contribute to favorable habitat conditions. More than 235 species of wildlife and millions of migratory waterfowl thrive in California rice fields. In 2003, California rice lands were designated as shorebird habitat of international significance by the Manomet Center for Conservation Sciences in partnership with the Western Hemisphere Shorebird Reserve Network.

In 2009, between 552,000 (as reported by the National Agricultural Statistics Service) and 569,320 acres of rice (as reported by the CACs) were planted in the nine rice-growing counties of the Sacramento Valley. The CAC acreage numbers are usually higher than actual planted acres due to accounting through pesticide applications; multiple applications on single acres can result in double counting of acreage under the CAC method. Figure 1-1 shows the distribution of acreage within the Sacramento Valley (as reported by the CACs).

Rice Farming's Influence on Water Quality

Because rice is farmed in standing water, the importance of good farming practices to water quality is evident. However, water quality problems associated with other crops and locales, such as soil erosion and sediment transport, saline drainage waters, and high concentrations of trace elements in subsurface drainage, are typically not problems associated with rice drainage. The generally slow rate of flow through rice fields and the controlled rate of water release tend to minimize significant soil erosion. With regard to salinity, much of the water used to irrigate rice fields initially has a low salt concentration and there is little possibility for salt accumulation in a continuously flooded system, so salt concentration in return flows is usually relatively low.

History of Rice Water Quality Efforts

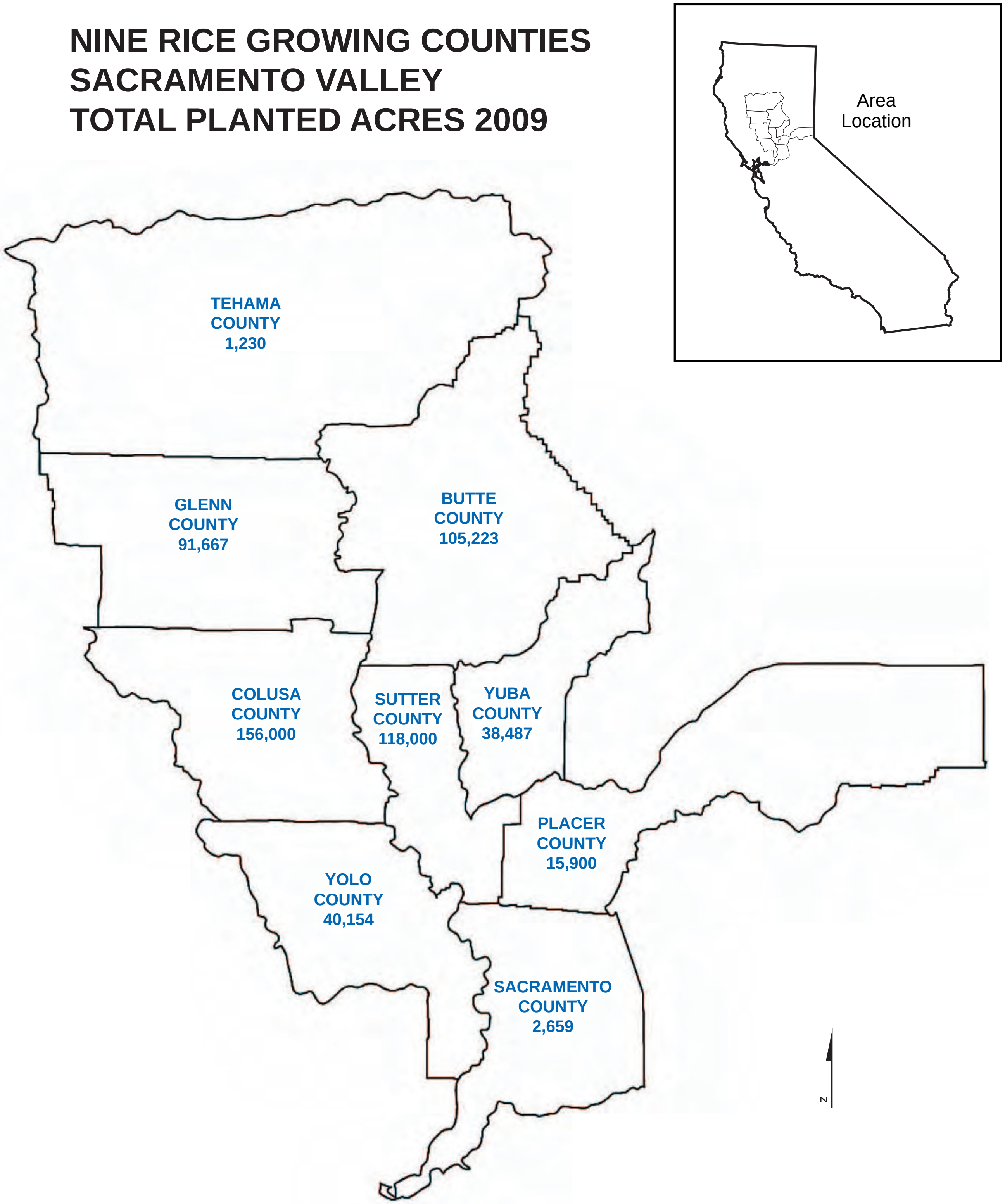
The CRC has undertaken water quality management activities since the 1980s. The efforts began under the RPP and, beginning in 2004, included efforts under the CWFR.
A description of the historical context of rice water quality management efforts in the Sacramento Valley follows.

RPP

A rice pesticide regulatory program has been in place since the 1980s. Implementation of the program included a proactive, industry-led effort to meet water quality objectives. The rice industry not only met the challenge, but also created an example for other commodity groups and coalitions to follow.

In the early 1980s, fish losses occurred in Sacramento Valley agricultural drains dominated by rice drainage. Because of these losses, the California Department of Fish and Game (DFG) conducted investigations that indicated molinate poisoning caused the fish losses.
In response, increased in-field holding times for irrigation waters containing molinate were implemented, and no additional fish losses have been documented since June 1983.
At approximately the same time, monitoring studies found that thiobencarb concentrations as low as 1 microgram per liter (µg/L) at the city intakes resulted in increases in water taste complaints from people whose drinking water was supplied by the Sacramento River downstream of agricultural drain inputs.

NINE RICE GROWING COUNTIES
SACRAMENTO VALLEY
TOTAL PLANTED ACRES 2009



Note: Acreage totals based on preliminary data provided by the County Agricultural Commissioners

FIGURE 1-1
Sacramento Valley Rice Acres, 2009
CRC 2009 Annual Monitoring Report

CVRWQCB monitoring studies in the early 1980s determined that molinate, carbofuran, malathion, and methyl parathion were present in agricultural drains dominated by rice drainage. As a result of studies and chemical monitoring in the early 1980s, the rice industry worked collaboratively with the registrants, CACs, Rice Research Board, University of California (UC) at Davis, UC Cooperative Extension, DFG, CVRWQCB, State Water Resources Control Board (SWRCB), and the California Department of Food and Agriculture (now DPR) initiated the Rice Pesticide Control program, the precursor to today's RPP, in 1984 to manage and regulate the discharge of pesticides from rice fields.

Findings by DFG and the CVRWQCB further moved the SWRCB to contract for scientific studies to develop a toxicity database and to suggest limits for pesticide levels in the Sacramento Valley's rivers and agricultural drains.

A review of information on toxicity of molinate and thiobencarb was conducted by the SWRCB (1984). This review was used to develop specific water quality criteria and performance goals for those pesticides. In 1990, the CVRWQCB amended the Basin Plan for the Central Valley Region to include a conditional prohibition of discharge for irrigation return flows containing molinate, thiobencarb, carbofuran, malathion, and methyl parathion unless a CVRWQCB-approved management practice is followed. Proposed management practices are intended to control pesticide concentrations in return flows from rice fields so that specific performance goals are met.

Environmental monitoring in the RPP has been among the most intense ever undertaken by California's agricultural producers and has resulted in a substantial knowledge base regarding the movement of rice pesticides in the Sacramento Valley. Through the implementation of industry-wide Best Management Practices (BMPs), the rice industry has been very successful in meeting water quality performance goals set by the CVRWQCB.

The RPP undergoes annual CVRWQCB review, at which time the CVRWQCB considers re-certifying the program through Board approval of management practices. Annual reports are due to the CVRWQCB each December.

This is the third year that the CRC has submitted a single report combining information for the CWFR and RPP programs.

Conditional Waiver of Waste Discharge Requirements for Rice

The CRC was granted an NOA to serve as a watershed coalition group under the CVRWQCB Resolution R5-2003-0105, *Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands within the Central Valley* (Irrigated Lands Conditional Waiver) and Monitoring and Reporting Program Order No. R5-2003-0826 (MRP Order).

In October 2004, the CRC submitted a technical report entitled *Basis for Water Quality Monitoring Program: Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands for Rice* (CWFR) to the CVRWQCB. The report served as the basis for the CVRWQCB's rice-specific MRP. The report presented mapping information, including subwatersheds and drainages, rice acreage, and hydrography (lakes, reservoirs, rivers, creeks, canals, and drains); an overview of rice cultural practices; information on the usage and a review of historical data for pesticides and nutrients; a discussion of other potential constituents of concern; a proposed future rice-specific sampling program, including sample locations, sample parameters, and sample timing; and a discussion of the framework for future program review. The geographic and historical data were analyzed and employed to select appropriate water quality monitoring sites. Specifically, the report included information on the following subjects:

- Study area
- Rice pesticide use and water quality data
- Nutrient use and water quality data
- Copper use and water quality data
- Proposed future sampling
- Framework for program review and update

AMR Requirements

The AMR for the CWFR program is to be submitted by December 31 of each year. The AMR is to include the following components:

1. Title page
2. Table of contents
3. Description of the watershed
4. Monitoring objectives
5. Sample site descriptions
6. Location map of sampling sites and land use
7. Tabulated results of analyses
8. Sampling and analytical methods used
9. Copy of chains of custody
10. Associated laboratory and field quality control sample results
11. Summary of precision and accuracy
12. Pesticide use information
13. Data interpretation, including an assessment of data quality objectives
14. Summary of management practices used
15. Actions taken to address water quality impacts identified, including but not limited to revised or additional management practices to be implemented
16. Communication reports
17. Conclusions and recommendations

Table 1-1 shows the location of each piece of the required above listed information within this report.

TABLE 1-1
Location of Required AMR Information in this Report

Required Information	Location in this Report
Table of contents	Page iii
Description of the watershed	Chapter 2
Monitoring objectives	Chapter 4
Sample site descriptions	Chapter 4
Location map of sampling sites and land use	Appendix A
Tabulated results of analyses	Chapter 5
Sampling and analytical methods used	Chapter 4
Copies of chains of custody	Appendixes B and C
Associated laboratory and field quality control sample results	Appendixes B and C
Summary of precision and accuracy	Chapter 6
Pesticide use information	Chapter 2
Data interpretation, including an assessment of data quality objectives	Chapter 5
Summary of management practices used	Chapter 3
Actions taken to address water quality impacts identified, including but not limited to revised or additional management practices to be implemented	Chapter 3
Communication reports	The information herein supersedes the communication reports.
Conclusions and recommendations	Chapter 7
Field documentation	Appendixes B and C
Laboratory original data	Appendixes B and C
Summary of field conditions, including a description of the weather, rainfall, stream flow, color of the water, odor, and other relevant information that can help in data interpretation	Chapter 2

CHAPTER 2

Growing Season, Hydrology, and Applied Materials

The rice water quality monitoring programs are based on a thorough understanding of how rice is grown in the Sacramento Valley, including key events such as irrigation, drainage, and runoff, and an understanding of when and how products such as pesticides and nutrients are applied. Hydrological conditions during the year can also influence the timing of key events. This chapter includes descriptions of the "typical" Sacramento Valley rice farming calendar and the 2009 rice growing season (including 2009 Sacramento River hydrology), and includes data on the materials applied to rice during the 2009 growing season.

Rice Farming in the Sacramento Valley

Most California rice is produced by direct seeding into standing water, and a continuous flood is maintained for most of the season. Limited acreage is drill seeded (planted with ground equipment), which also uses permanent flood after stand establishment. Key events in the rice farming cycle are:

- Field preparation
- Planting
- Fertilizer application
- Pesticide application
- Irrigation
- Drainage
- Harvest
- Winter flood-up
- Winter drainage

Figure 2-1 illustrates the timeline for these key events.

Hydrology

Seasonal rainfall and weather conditions influence rice planting and rice pesticide application. The 2009 rice farming year was relatively typical. Fields were planted in mid-April, and fall drainage occurred during August and September. Flow data for the Sacramento River and Butte Slough were acquired from the California Data Exchange Center (CDEC), and precipitation data for a sensor in Colusa were obtained from the University of California Integrated Pest Management (UC IPM) California Weather Database. Data were collected for the period January 1, 2009, through October 1, 2009.

The California Department of Water Resources (DWR) provides flow data (station COL) and the UC IPM California Weather Database provides precipitation and air temperature data for a station near the Sacramento River at Colusa (station COL.A). Flow and precipitation data for the 2009 growing season are shown in Figure 2-2, and minimum and maximum air temperatures are shown in Figure 2-3.

Applied Materials

Agricultural use of pesticides in California is regulated by DPR. Growers, pesticide applicators, pest control advisors, and pest control operators report pesticide use to CACs for inclusion in the DPR Pesticide Use Report (PUR). DPR provides the CRC with early review/draft PUR data and enforcement data for inclusion in the CRC's annual report. Data presented in the following discussions of pesticide use and nutrient application are usage data for the Sacramento Valley rice growing counties.

Pesticide Use

The pesticides with acreage increases in 2009 were bensulfuron-methyl (+15,341 ac), bispyribac-sodium (+21,319 ac), propanil (+65,371 ac), and triclopyr TEA (+36,819 ac).

The pesticides with acreage decreases in 2009 were carfentrazone ethyl (-914 ac), clomazone (-23,871 ac), cyhalofop-butyl (-7,242 ac), molinate (-3,248 ac), penoxsulam (-3,578 ac), and thiobencarb (-1,561 ac).

Treated acreage has a direct correlation to pounds of active ingredient applied. Planted acreage in 2009 (569,320 acres [CACs]) decreased by 2,667 acres or approximately 0.5 percent from 2008 (571,987 acres).

Tables 2-1 and 2-2 show the Sacramento Valley rice acres treated and pounds applied, respectively, with herbicides. Tables 2-3 and 2-4 show the Sacramento Valley rice acres treated and pounds applied, respectively, with insecticides. Tables 2-5 and 2-6 show the Sacramento Valley rice acres treated and pounds applied, respectively, with fungicides. Sacramento Valley acres treated with molinate and thiobencarb for the time period 2006 through 2009 are listed in Table 2-7, and pounds of molinate and thiobencarb applied during this same time are listed in Table 2-8.

Source: University of California Cooperative Extension and grower input

FIGURE 2-1
Key Events in a Typical Rice Year

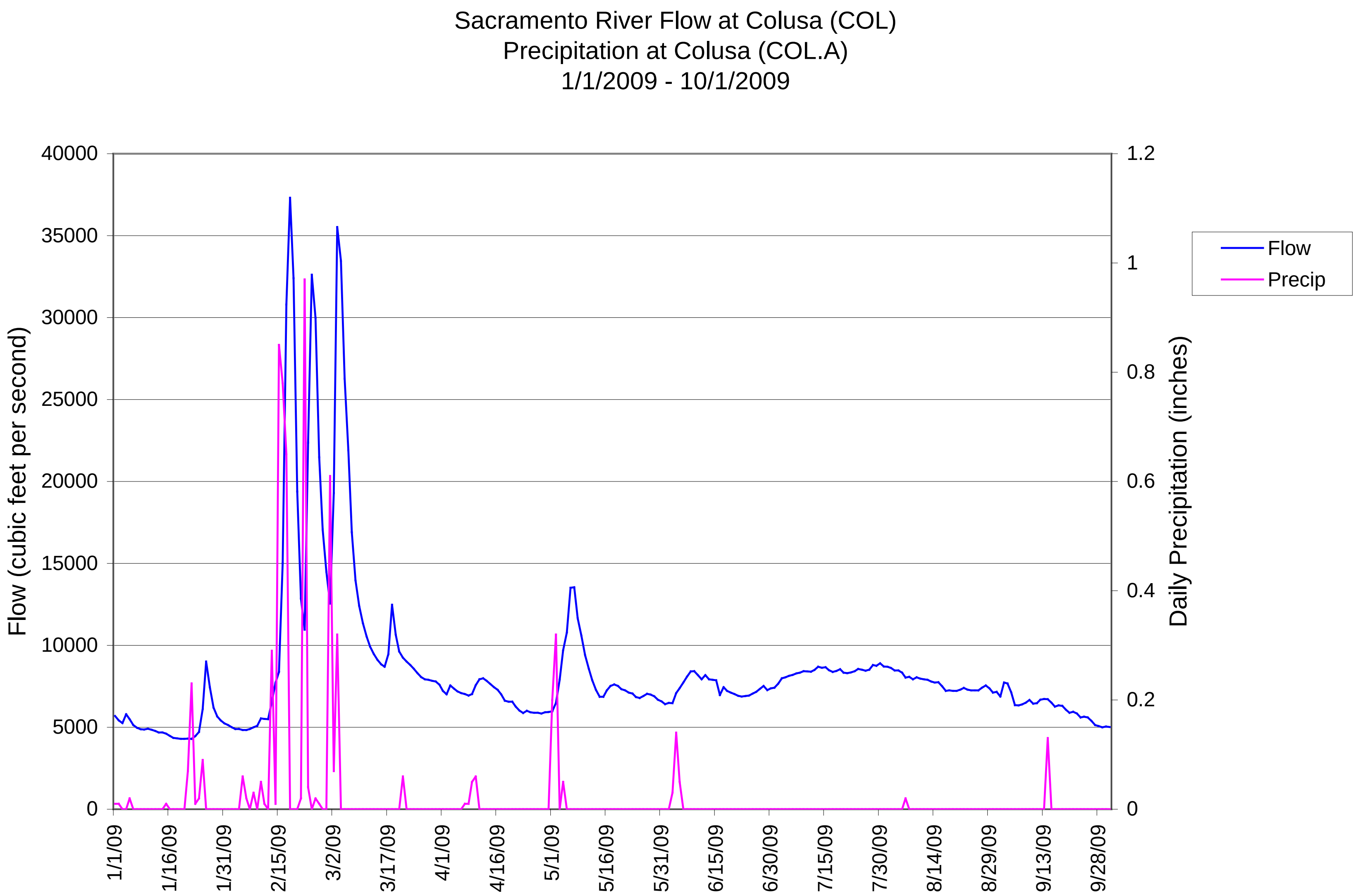


FIGURE 2-2
2009 Flow and Precipitation Data

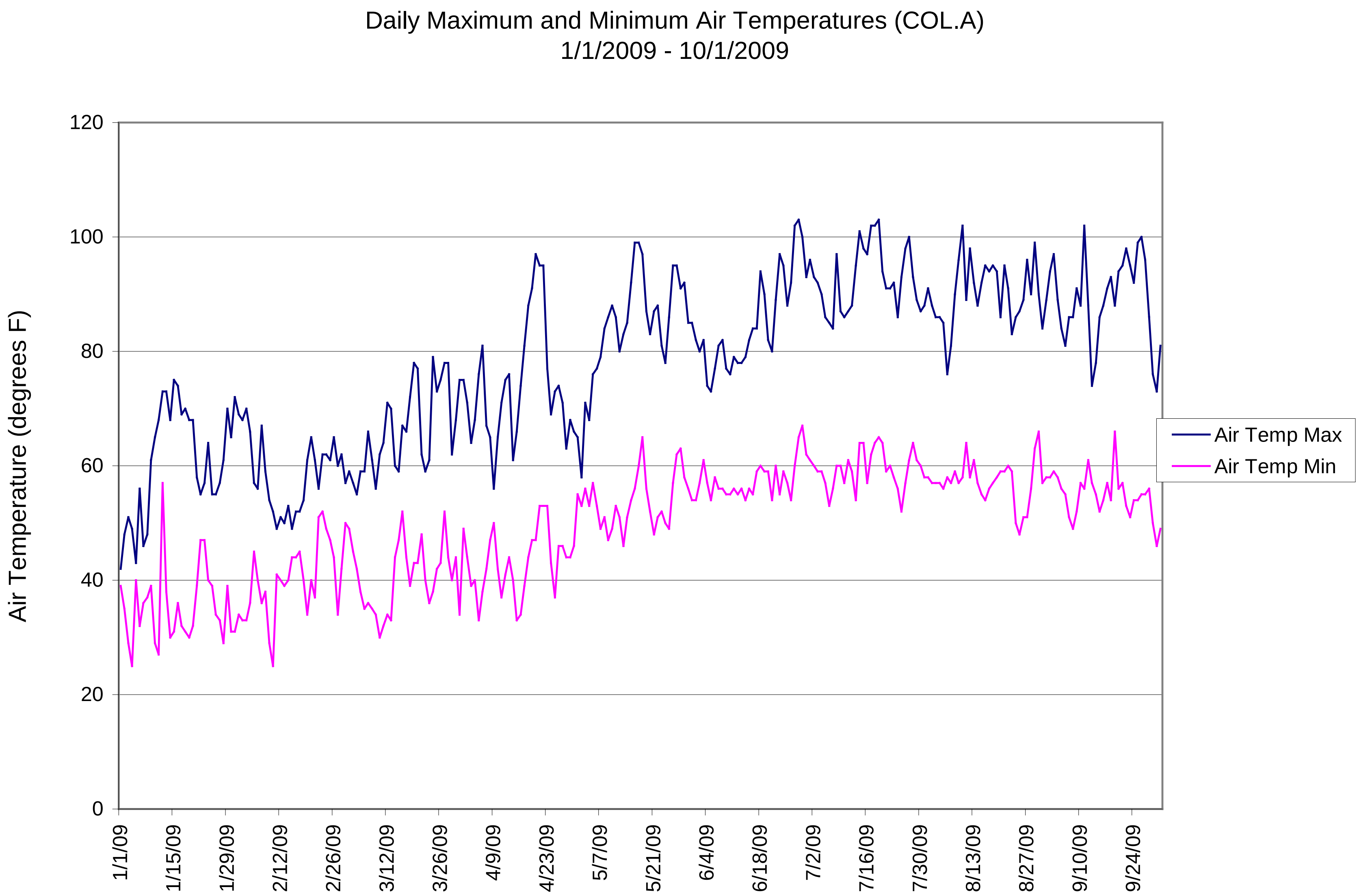


FIGURE 2-3
2009 Daily Maximum and Minimum Air Temperatures

Nutrient Use

Like most other farmland, rice acreage is fertilized annually. Fertilizer suppliers are the best source of information regarding the rates of fertilizer application. Suppliers were consulted to determine the range of fertilizer rates commonly applied to rice in the Sacramento Valley. The information obtained from the suppliers is summarized in Table 2-9. The table shows that fertilizer may be applied to rice before planting (granular starter, aqua ammonia, zinc) and later in the season (topdressing). The totals for the high and low ends of the reported range are shown for each element in the lower section of Table 2-9.

Nitrogen (N) is essential for all commercial rice production in California. The general rate is 120 to 150 pounds per acre. Specific N requirements vary with soil type, variety, cropping history, planting date, herbicide used, and the kind and amount of crop residue incorporated during seedbed preparation. Winter flooding for straw decomposition and waterfowl management has greatly reduced N use in some rice fields. Most N is applied preplant and either soil incorporated or injected 2 to 4 inches before flooding. Some N may be topdressed mid-season (panicle differentiation) to correct deficiencies and maintain plant growth and yield.

Phosphorus (P) is applied at a rate of 18 to 26 pounds per acre and is incorporated into the seedbed before flooding. Most rice fields are above a critical need for P and do not require repeated use of this fertilizer. Phosphate fertilizer may also be topdressed when a deficiency occurs, usually in the early seedling stage.

Potassium (K) is generally unnecessary in California.

Zinc (Zn) deficiency or “alkali disease” is common in alkaline soils and areas where topsoil has been removed. If Zn is used, the rate is 2 to 16 pounds per acre at preflood, and it is not incorporated into the soil. Zinc deficiencies most commonly occur in cool weather during stand establishment (early season).

Iron deficiency is rare in California and can usually be corrected by lowering the soil pH.

TABLE 2-1
Herbicides: Acres Treated, Sacramento Valley, 2009

	Acres Treated									
County	Bensulfuron-methyl	Bispyribac-sodium	Carfentrazone-ethyl	Clomazone	Cyhalofop-butyl	Molinate	Penoxsulam	Propanil	Thiobencarb	Triclopyr TEA
Butte	6,387	4,729	1,063	11,171	2,340	45	4,053	26,488	1,923	14,871
Colusa	4,573	21,014	2,877	37,317	46,458	40	18,525	109,996	35,201	102,886
Glenn	4,205	18,794	1,749	54,102	9,544	520	8,559	60,302	4,660	48,094
Placer	1,299	402	0	6,718	0	45	2,284	2,324	0	2,344
Sacramento	0	1,199	30	300	361	0	368	2,232	0	1,717
Sutter	2,094	13,715	806	3,933	4,318	174	6,216	57,001	859	48,019
Tehama	150	0	0	150	296	0	894	270	0	120
Yolo	451	3,966	453	2,593	8,154	0	5,719	30,978	14,698	27,827
Yuba	3,583	4,803	4,583	24,072	1,865	0	14,420	20,973	3,092	6,817
Total acres	**22,742**	**68,622**	**11,561**	**140,356**	**73,336**	**824**	**61,038**	**310,564**	**60,433**	**252,695**

TABLE 2-2
Herbicides: Pounds Applied, Sacramento Valley, 2009

	Pounds Applied									
County	Bensulfuron-methyl	Bispyribac-sodium	Carfentrazone-ethyl	Clomazone	Cyhalofop-butyl	Molinate	Penoxsulam	Propanil	Thiobencarb	Triclopyr TEA
Butte	357	153	127	5,208	752	180	126	127,236	7,265	2,115
Colusa	217	587	134	18,264	14,004	160	575	586,962	137,420	18,020
Glenn	190	589	174	28,422	3,283	1,563	273	333,597	17,806	7,382
Placer	71	7	0	3,535	0	180	82	10,258	0	413
Sacramento	0	38	2	135	88	0	11	11,346	0	508
Sutter	92	376	38	1,842	1,437	661	205	295,897	2,843	10,180
Tehama	9	0	0	60	100	0	36	1,337	0	16
Yolo	15	133	30	1,126	3,466	0	196	153,103	58,152	5,907
Yuba	171	115	558	9,678	454	0	519	106,404	9,868	1,409
Total pounds	**1,122**	**1,998**	**1,063**	**68,270**	**23,584**	**2,744**	**2,023**	**1,626,140**	**233,354**	**45,950**

TABLE 2-3
Insecticides: Acres Treated, Sacramento Valley, 2009

	Acres Treated			
County	**Diflubenzuron**	**(s)-Cypermethrin**	**Lambda Cyhalothrin**	**Malathion**
Butte	0	663	6,460	0
Colusa	15	5,704	21,397	0
Glenn	53	16,726	8,814	0
Placer	0	385	6,238	0
Sacramento	0	0	67	0
Sutter	0	3,144	2,112	0
Tehama	0	34	0	0
Yolo	0	0	4,869	60
Yuba	803	5,096	10,748	0
Total acres	**871**	**31,752**	**60,704**	**60**

TABLE 2-4
Insecticides: Pounds Applied, Sacramento Valley, 2009

	Pounds Applied			
County	**Diflubenzuron**	**(s)-Cypermethrin**	**Lambda Cyhalothrin**	**Malathion**
Butte	0	22	188	0
Colusa	1	173	693	0
Glenn	6	473	265	0
Placer	0	8	146	0
Sacramento	0	0	2	0
Sutter	0	68	60	0
Tehama	0	1	0	0
Yolo	0	0	134	86
Yuba	151	192	280	0
Total pounds	**158**	**937**	**1,768**	**86**

TABLE 2-5
Fungicides: Acres Treated, Sacramento Valley, 2009

	Acres Treated		
County	**Azoxystrobin**	**Propiconazole***	**Trifloxystrobin***
Butte	28,395	120	120
Colusa	65,235	7,179	7,179
Glenn	56,865	721	721
Placer	0	0	0
Sacramento	1,876	0	0
Sutter	27,897	4,525	4,525
Tehama	270	0	0
Yolo	13,747	0	0
Yuba	12,452	229	229
Total acres	**206,737**	**12,774**	**12,774**

NOTE:
*Propiconazole and trifloxystrobin constitute the product Stratego

TABLE 2-6
Fungicides: Pounds Applied, Sacramento Valley, 2009

	Pounds Applied		
County	**Azoxystrobin**	**Propiconazole***	**Trifloxystrobin***
Butte	3,849	20	20
Colusa	10,326	1,020	1,020
Glenn	9,609	327	327
Placer	0	0	0
Sacramento	466	0	0
Sutter	4,979	593	593
Tehama	50	0	0
Yolo	2,310	0	0
Yuba	2,302	34	34
Total pounds	**33,891**	**1,994**	**1,994**

NOTE:
*Propiconazole and trifloxystrobin constitute the product Stratego

TABLE 2-7
Acres Treated with Molinate and Thiobencarb, 2006 through 2009

County	Acres Treated							
	Molinate				Thiobencarb			
	2006	2007	2008	2009	2006	2007	2008	2009
Butte	21,571	10,965	2,528	45	20,353	13,099	11,113	1,923
Colusa	880	340	0	40	24,384	24,094	22,714	35,201
Glenn	1,845	701	100	520	4,952	1,140	472	4,660
Placer	2,173	437	462	45	367	813	456	0
Sacramento	0	0	0	0	1,158	0	0	0
Sutter	4,675	2,036	506	174	17,359	13,018	18,544	859
Tehama	0	148	0	0	0	148	261	0
Yolo	414	666	0	0	6,200	8,321	7,518	14,698
Yuba	0	0	476	0	656	1,194	916	3,092
Total treated acres	**31,588**	**15,293**	**4,072**	**824**	**75,429**	**61,827**	**61,994**	**60,433**
Total planted acres	**526,000**	**522,000**	**571,987**	**569,320**	**526,000**	**522,000**	**571,987**	**569,320**

TABLE 2-8
Pounds of Molinate and Thiobencarb Applied, 2006 through 2009

County	Pounds Applied							
	Molinate				Thiobencarb			
	2006	2007	2008	2009	2006	2007	2008	2009
Butte	92,930	47,730	11,527	180	81,722	51,149	43,655	7,265
Colusa	3,551	1,467	0	160	96,106	95,684	89,641	137,420
Glenn	7,631	2,839	405	1,563	18,611	4,201	1,866	17,806
Placer	9,978	1,690	1,727	180	1,114	2,694	1,664	0
Sacramento	0	0	0	0	4,243	0	0	0
Sutter	20,545	9,188	2,286	661	66,765	49,199	71,773	2,843
Tehama	0	525	0	0	0	450	783	0
Yolo	1,561	2,937	0	0	24,761	33,315	29,562	58,152
Yuba	0	0	2,148	0	2,480	4,483	2,853	9,868
Total pounds	**136,196**	**66376**	**18,093**	**2,744**	**295,802**	**241,175**	**241,797**	**233,354**
Total planted acres	**526,000**	**522,000**	**571,987**	**569,320**	**526,000**	**522,000**	**571,987**	**569,320**

TABLE 2-9
Range of Fertilizer Components Applied to Rice

	Pounds per Acre		
Material/Element	**Low**	**High**	**Form and Method**
N	80	120	Injected aqua
16-20	150	200	
N	24	32	Solid 16-20-0-13 starter
P	30	40	Solid 16-20-0-13 starter
K	0	0	Solid 16-20-0-13 starter
S	19.5	26	Solid 16-20-0-13 starter
Zn	1	5	Metallic
NH_4SO_4	0	200	Topdressed
N	0	42	Topdressed
S	0	49	Topdressed
Totals			
N	104	194	Total for all application methods
P	30	40	Total for all application methods
K	0	0	Total for all application methods
S	20	75	Total for all application methods
Zn*	1	5	Total for all application methods

NOTE:
*Seldom applied

CHAPTER 3

Management Practices

Management practices are a key component of the rice water quality programs. During the early phases of the RPP, management practices were developed to increase efficacy and ultimately to protect water quality. The cornerstone of rice management practices is a thorough understanding of the rice calendar, including the application methods and timing of pesticide use.

Management practices include field-level management of rice pesticides and discharges, CAC enforcement programs, grower education efforts, and communication programs. This chapter includes the pesticide use calendar, general information on rice water quality management practices, and specific 2009 enforcement data.

Pesticide Use Calendar

The following tables depict the season or timing of pesticide applications to rice. Included are separate tables for herbicide applications (Table 3-1), tank mix combinations (Table 3-2), insecticide applications (Table 3-3), and sequential herbicide applications (Table 3-4). A "sequential" is the application of an herbicide followed by another herbicide with a different mode of action. Sequential applications are used to achieve better coverage and efficacy for weed control. The second application usually occurs in the next growth stage of the rice plant. For example, clomazone is applied at germination. A sequential application of bispyribac-sodium is applied at tiller initiation. Figure 3-1 provides illustrations of rice's growth stages.

Rice pesticide applications are timed for specific growth stages of the rice plant. To simplify the rice growth schedule, the following tables group pre-flood and germination into early season; tiller initiation and tillering are mid-season, and panicle initiation and flower are late season.

This calendar of applications provides information that is useful for understanding potential water quality concerns relative to particular times during the year.

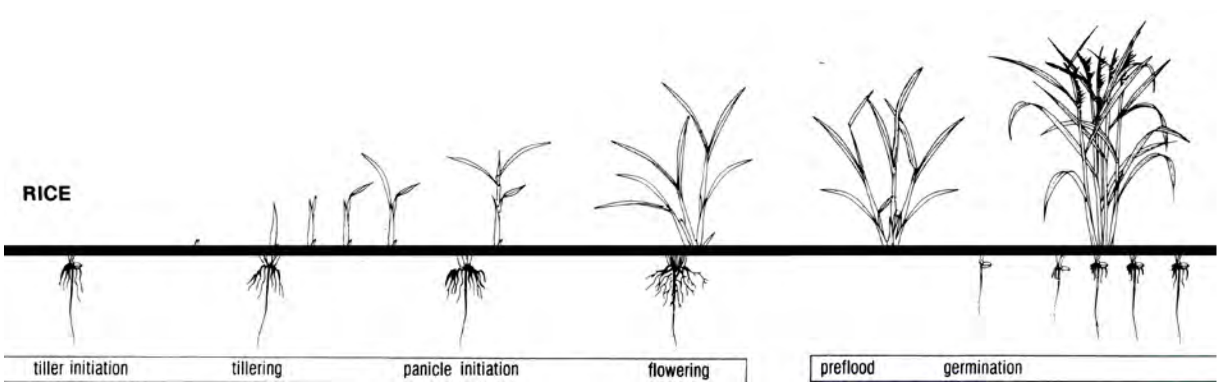


FIGURE 3-1
Rice Growth Stages

TABLE 3-1
Timing of Specific Rice Herbicide Applications

<table>
<tr><th colspan="2">Early Season
(March–April)</th><th colspan="2">Mid Season
(May–June)</th><th colspan="2">Late Season
(June–July)</th></tr>
<tr><th>Pre-Flood</th><th>Germination</th><th>Tiller Initiation</th><th>Tillering</th><th>Panicle Initiation</th><th>Flowering</th></tr>
<tr><td></td><td>Bensulfuron-methyl
Permanent flood</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>Bensulfuron-methyl
Pinpoint flood</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>Bispyribac-sodium
Pinpoint flood</td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Carfentrazone-ethyl
Permanent flood
5-day static; 30-day release</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Clomazone
Permanent flood
14-day water hold</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Cyhalofop-butyl
Pinpoint flood
7-day water hold</td><td></td><td></td></tr>
<tr><td></td><td>Molinate
Permanent flood
28-day water hold</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>Propanil
Pin-point flood</td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Thiobencarb (Bolero and Abolish)
Permanent flood
30-day water hold</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Triclopyr TEA
Pinpoint flood
20-day water hold</td><td></td><td></td></tr>
</table>

TABLE 3-2
Timing of Herbicide Tank Mix Combinations

Early Season (March–April)		**Mid Season (May–June)**		**Late Season (June–July)**	
Pre-Flood	**Germination**	**Tiller Initiation**	**Tillering**	**Panicle Initiation**	**Flowering**
		Bispyribac-sodium/Thiobencarb (Abolish) Pinpoint flood 30-day water hold Propanil/Thiobencarb (Abolish) Permanent flood 30-day water hold			

TABLE 3-3
Timing of Specific Rice Insecticide Applications

Early Season (March–April)		**Mid Season (May–June)**		**Late Season (June–July)**	
Pre-Flood	**Germination**	**Tiller Initiation**	**Tillering**	**Panicle Initiation**	**Flowering**
	Lambda cyhalothrin Border treatment 7-day water hold (s)-cypermethrin Border treatment 7-day water hold				Lambda cyhalothrin Border treatment 7-day water hold (s)-cypermethrin Border treatment 7-day water hold

TABLE 3-4
Timing of Sequential Rice Herbicide Applications

<table>
<tr><th colspan="2">Early Season
(March–April)</th><th colspan="2">Mid Season
(May–June)</th><th colspan="2">Late Season
(June–July)</th></tr>
<tr><th>Pre-Flood</th><th>Germination</th><th>Tiller Initiation</th><th>Tillering</th><th>Panicle Initiation</th><th>Flowering</th></tr>
<tr><td></td><td colspan="2">Bispyribac-sodium, Thiobencarb (Bolero)
30-day water hold
Permanent Flood</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Bispyribac-sodium, Propanil
Pinpoint flood</td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Clomazone, Bensulfuron-methyl
14-day water old
Permanent flood</td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="3">Clomazone, Bispyribac-sodium
14-day water hold
Permanent flood</td><td></td><td></td></tr>
<tr><td></td><td colspan="3">Clomazone, Carfentrazone-ethyl
up to 30-day water hold
Permanent flood</td><td></td><td></td></tr>
<tr><td></td><td colspan="3">Clomazone, Propanil
14-day water hold
Permanent flood</td><td></td><td></td></tr>
<tr><td></td><td colspan="3">Clomazone, Propanil/Triclopyr TEA
20-day water hold</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Cyhalofop-butyl, Bensulfuron-methyl
7-day water hold
Pinpoint flood</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Cyhalofop-butyl, Bispyribac-sodium
7-day water hold
Pinpoint flood</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Cyhalofop-butyl, Propanil
7-day water hold
Pinpoint flood</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Propanil, Cyhalofop-butyl
7-day water hold
Pinpoint flood</td><td></td><td></td></tr>
<tr><td></td><td colspan="3">Carfentrazone-ethyl, Cyhalofop-butyl
30-day water hold, 7-day water hold
Pinpoint flood</td><td></td><td></td></tr>
</table>

Role of Management Practices in Attaining Water Quality Protection

Over the years, BMPs such as water hold requirements, grower information meetings, and inspection/enforcement were implemented to ensure compliance with performance goals and attainment of water quality objectives and maximum contaminant level (MCLs) for the RPP. The water holds, which are specified on pesticide use labels and through permit conditions, were developed to provide for in-field degradation of pesticides prior to the release of treated water to drains and other surface waters. For 2009, required water holds were the same as those required during the 2005 to 2008 growing seasons.

Water Holds

The primary field-level water quality management practice is the water hold. The nature of rice farming, which requires standing water during the growing season, provides rice farmers with a unique opportunity to manage water flow. Water hold durations vary based on the persistence of specific registered rice pesticides in the environment, and are used to provide time for the applied product to degrade in the field. The goal of this strategy is to discharge rice drainage water that meets Basin Plan Performance Goals or other benchmarks.

The management practices developed under the RPP have been the foundation for development and implementation of water hold requirements for other pesticides. Over the years, water holds have become standard practice to address aquatic toxicity, taste complaints, environmental fate, and product efficacy. Water holds were developed with input from technical resources such as the University of California Cooperative Extension (UCCE) and pesticide registrants. In the early 1980s, when the RPP began, water holds were generally not a pesticide-use label requirement. Over time, rice-specific registrations of pesticides were developed to require specified water holds as a condition of the permitted use of these products. Additionally, DPR and the CACs have the authority to impose additional water hold requirements necessary to protect water quality.

Water hold requirements for thiobencarb and molinate are pesticide-use permit conditions under the RPP. Table 3-5 specifies the water hold requirements for the four currently registered pesticides regulated under the CVRWQCB's RPP Conditional Prohibition of Discharge. These water hold requirements are the same as those required during the 2005 to 2008 growing seasons. Table 3-6 lists the water holds for other products registered for use on rice.

Actions Taken to Address Identified Water Quality Impacts

The CACs are the local enforcement agencies working with DPR to enforce the California Food and Agricultural Code and the California Code of Regulations pertinent to pesticide use. CACs issue restricted materials permits to growers purchasing and using California-restricted materials in their respective counties. Molinate and thiobencarb are restricted materials with additional use restrictions (permit conditions) not found on the registered product label. The most common permit conditions for molinate and thiobencarb are water holds. The thiobencarb permit conditions for 2009 remained in place during 2004 to 2008. Since 2003, the CVRWQCB RPP authorizing resolutions have included thiobencarb permit conditions that required increased inspections for seepage control; buffer zones during application; a pre-season mandatory meeting for growers, pest control advisors, and applicators; and formation of a Storm Event Work Group.

TABLE 3-5
Water Hold Requirements in Days for Molinate, Thiobencarb, Methyl Parathion, and Malathion (RPP Pesticides)

	Molinate		Thiobencarb			
Release Type	**Ordram® 15-GM**	**Ordram® 8-E**	**Bolero® 15-G**	**Abolish™ 8EC**	**Methyl Parathion**	**Malathion**
Single field	28	4	30	19	24	4[a]
Single field southern area only[b]	—	—	19	—	—	—
Release into tailwater recovery system or pond onto fallow field (except southern area)[b]	28	4	14[c]	14[c]	—	—
Multi-growers and district release onto closed recirculating systems	8	4	6	6	—	—
Multi-growers and district release onto closed recirculating systems in southern area	—	—	6	—	—	—
Release into areas that discharge negligible amounts to perennial streams	12	4	19	6[d]	—	—
Pre-flood application: release onto tailwater recovery system	4	4	—	—	—	—
Emergency release of tailwater	11	—	19	19	—	—
Commissioner verifies the hydrologic isolation of the fields	—	—	6	6	—	—

NOTES:

[a] Voluntary hold
[b] Sacramento–San Joaquin Valley defined as south of the line defined by Roads E10 and 116 in Yolo County and the American River in Sacramento County
[c] Thiobencarb permit condition allowed Bolero® 15-G label hold period of 14 days
[d] Applies to verified hydrologically isolated fields

TABLE 3-6
Hold Times for Insecticides, Fungicides, and Herbicides Not Covered by RPP

Active Ingredient	Trade Name	Water Hold Time	Provisions
Insecticides			
Diflubenzuron	Dimlin® Insect Growth Regulator	14 days	None
(s)-cypermethrin	Mustang® 1.5 EW Insecticide	7 days	None
Lambda-cyhalothrin	Warrior® Insecticide	7 days	None
Fungicides			
Azoxystrobin	Quadris® Flowable Fungicide	14 days	None
Herbicides			
Carfentrazone-ethyl	Shark®	5-day static 30-day release	None
Clomazone	Cerano™	14 days	Less if closed system
Cyhalofop-butyl	Clincher™	7 days	None
Propanil	Stam™ 80 EDF	7 days	None
Triclopyr TEA	Grandsand™ CA Herbicide	20 days	Less if closed system

The restricted materials permits require the CACs to keep records of pesticides applied to rice acreage, while full use reporting documents all agricultural use pesticides. The CACs meet the notification requirements by utilizing the Notice of Intent (NOI) and NOA process. Rice growers or pest control operators submit NOIs to the CACs at least 24 hours prior to application so that CAC staff can observe applications. NOAs are reported 24 hours after an application occurs so that water holding times can be recorded, inspected, and tracked.

Compliance with pesticide-use restrictions is a critical component of the RPP's ability to achieve water quality protection. A range of label restrictions and permit conditions apply to the use of rice pesticides, including mix/load, application, and water hold requirements. CACs perform inspections to enhance compliance with each of the label restrictions and permit conditions. Mix/load inspections are performed primarily for worker protection and to evaluate whether proper handling and containment of pesticides is being implemented to prevent releases to the environment. Application inspections are performed to evaluate label and permit condition application restrictions such as buffer zones, adherence to rate and wind speed and other local requirements, and water management. Seepage inspections evaluate the efficacy of farm water management levees to hold water in-field throughout the duration of water holds.

Release Inquiries and Emergency Releases

In 2009, there were two release inquiries and one reported emergency release. The release inquiries occurred in Colusa and Sutter Counties, and the reported emergency release occurred in Colusa County.

Seepage Control and Inspections

Seepage is a concern because rice field water can move laterally through levees bordering rice fields, especially when levees are constructed in a manner that does not prevent water seepage. Often, levee borrow pits, commonly called “sweat ditches,” are used to contain this water. When water gets high enough, it can flow into local agricultural drainage conveyances. The CVRWQCB expressed concern that seepage was a contributing factor to increased thiobencarb concentrations in the Sacramento River in the past.

Current program recommendations require securing weir boxes in rice fields with a soil barrier to a depth higher than the water level. At rice pesticide permit issuance, the CACs provide rice growers with a handout entitled *Closed Rice Water Management Systems*, prepared by the U.S. Department of Agriculture (USDA) and the UCCE. In addition, the CACs provide the growers a brochure entitled *Seepage Water Management – Voluntary Guidelines for Good Stewardship in Rice Production*, cooperatively developed by the UC Davis Department of Agronomy and Range Science, DPR, and UCCE. The brochure is also distributed at the thiobencarb mandatory meetings. The brochure explains the causes of seepage and identifies voluntary management activities that growers should use to minimize and prevent seepage.

For several years, the CRC has contracted with the CACs to fund CAC “off duty” enforcement activity on weekends and holidays during the molinate and thiobencarb use season. The CRC continued this practice during the 2009 growing season.

In 1998, DPR and the CACs implemented a Prioritization Plan and a Negotiated Work Plan. One component of both plans was to negotiate a number of water hold inspections. The plans allow the counties to set priorities within the Pesticide Use Enforcement Program Standard Compendium under the Restricted Materials and Permitting manual. All rice pesticide water holding requirements are ranked as high-priority inspections when rice pesticides are used as restricted materials.

Some pre-flood inspections were per grower request, while most inspections were in response to an NOI filed at the CAC office. Some permits were denied due to seepage conditions upon inspection. Information was gathered from the CACs on number of inspections, types of inspections, violations, agricultural civil penalties (ACPs), and water seepage inspection activities in 2009. The CRC provided the CAC offices with weekly updates of the rice herbicide monitoring results in order to coordinate water quality protection activities.

CACs conducted seepage inspections, as summarized in Table 3-7. Based on the inspection data provided to the DPR by the CAC, 907 molinate and thiobencarb use sites were inspected. Of these inspected sites, 877 sites reported no discharge, and 30 had reported discharges of less than 5 gallons per minute (gpm). These 30 sites constitute 1.5 percent of inspected sites. Of the 907 sites inspected, none had reported discharges of greater than 5 gpm; therefore, no enforcement actions were issued.

TABLE 3-7
Molinate and Thiobencarb Water Seepage Inspections in 2009

County	Chemical	Seepage Inspections	Sites with No Seepage	Sites with Less than 5 gpm Seepage	Sites with More than 5 gpm Seepage	Enforcement Actions
Butte	Molinate	7	7	0	0	0
	Thiobencarb	234	231	3	0	0
Colusa	Molinate	0	0	0	0	0
	Thiobencarb	211	195	16	0	0
Glenn	Molinate	10	10	0	0	0
	Thiobencarb	67	63	4	0	0
Placer	Molinate	0	0	0	0	0
	Thiobencarb	0	0	0	0	0
Sacramento	Molinate	0	0	0	0	0
	Thiobencarb	7	7	0	0	0
Sutter	Molinate	7	7	0	0	0
	Thiobencarb	334	327	7	0	0
Tehama	Molinate	0	0	0	0	0
	Thiobencarb	0	0	0	0	0
Yolo	Molinate	0	0	0	0	0
	Thiobencarb	0	0	0	0	0
Yuba	Molinate	0	0	0	0	0
	Thiobencarb	30	30	0	0	0
Totals		**907**	**877**	**30**	**0**	**0**

Application and Mix/Load Inspections

CACs conducted application and mix/load inspections, as summarized in Table 3-8. Based on the inspection data the CACs provided to the DPR, a total of 25 mix/load events were inspected. The CACs performed 24 application inspections. No enforcement actions were issued.

Water Hold Inspections

CACs conducted water hold inspections of 1,036 molinate and thiobencarb use sites in 2009 (Table 3-8). Reporting was recorded for two formulations of each product. No enforcement actions were issued for any of the 1,036 sites.

TABLE 3-8
Molinate and Thiobencarb Water Hold, Application, and Mix/Load Inspections in 2009

County	Chemical	Water Hold Inspections	Release Inquiries	Emergency Releases	Application Inspections	Mix-Load Inspections	ACPs
Butte	Ordram 15GM	7	0	0	0	0	0
	Ordram 8E	0	0	0	0	0	0
	Bolero 15G	234	0	0	4	2	0
	Abolish EC	0	0	0	0	0	0
	County Total	*241*	*0*	*0*	*4*	*2*	*0*
Colusa	Ordram 15GM	0	0	0	0	0	0
	Ordram 8E	0	0	0	0	0	0
	Bolero 15G	150	1	1	2	4	0
	Abolish EC	61	0	0	5	5	0
	County Total	*211*	*1*	*1*	*7*	*9*	*0*
Glenn	Ordram 15GM	10	0	0	1	1	0
	Ordram 8E	0	0	0	0	0	0
	Bolero 15G	67	0	0	1	1	0
	Abolish EC	0	0	0	0	0	0
	County Total	*77*	*0*	*0*	*2*	*2*	*0*
Placer	Ordram 15GM	0	0	0	0	0	0
	Ordram 8E	0	0	0	0	0	0
	Bolero 15G	2	0	0	0	0	0
	Abolish EC	0	0	0	0	0	0
	County Total	*2*	*0*	*0*	*0*	*0*	*0*
Sacramento	Ordram 15GM	0	0	0	0	0	0
	Ordram 8E	0	0	0	0	0	0
	Bolero 15G	42	0	0	0	0	0
	Abolish EC	0	0	0	0	0	0
	County Total	*42*	*0*	*0*	*0*	*0*	*0*
Sutter	Ordram 15GM	7	0	0	1	1	0
	Ordram 8E	0	0	0	0	0	0
	Bolero 15G	320	1	0	4	6	0
	Abolish EC	14	0	0	0	0	0
	County Total	*341*	*1*	*0*	*5*	*7*	*0*
Tehama	Ordram 15GM	0	0	0	0	0	0
	Ordram 8E	0	0	0	0	0	0
	Bolero 15G	0	0	0	1	0	0
	Abolish EC	0	0	0	0	0	0
	County Total	*0*	*0*	*0*	*1*	*0*	*0*

TABLE 3-8
Molinate and Thiobencarb Water Hold, Application, and Mix/Load Inspections in 2009

County	Chemical	Water Hold Inspections	Release Inquiries	Emergency Releases	Application Inspections	Mix-Load Inspections	ACPs
Yolo	Ordram 15GM	0	0	0	0	0	0
	Ordram 8E	0	0	0	0	0	0
	Bolero 15G	90	0	0	3	3	0
	Abolish EC	2	0	0	1	1	0
	County Total	*92*	*0*	*0*	*4*	*4*	*0*
Yuba	Ordram 15GM	0	0	0	0	0	0
	Ordram 8E	0	0	0	0	0	0
	Bolero 15G	28	0	0	0	0	0
	Abolish EC	2	0	0	1	1	0
	County Total	*30*	*0*	*0*	*1*	*1*	*0*
Total		**1,036**	**2**	**1**	**24**	**25**	**0**

CHAPTER 4

Monitoring and Reporting Requirements

The monitoring and reporting requirements for the CWFR are specified in the MRP Order R5-2009-0809 (CRC MRP), under Resolution No. R5-2006-0053 and amended by R5-2006-0077. Additional requirements and guidance are provided in Executive Order letters, issued under the authority granted in the Resolution. Monitoring and reporting requirements for the 2009 RPP are specified in CVRWQCB Resolution No. R5-2007-0018. This chapter provides an overview of the monitoring and reporting requirements of each program, including the overall purpose and objectives, the sites, the program administration, sampling procedures, and analytical labs and methods used to assess water quality.

Monitoring Purpose and Objectives

Although similar, the CWFR and RPP programs each have different purposes and objectives for monitoring and reporting.

CWFR

The purpose of the CRC MRP is to monitor the discharge of wastes in irrigation return flows and stormwater from irrigated rice lands. CRC MRP Attachment B, Section B, Item 4 lists the objectives of the CRC MRP. These objectives are consistent with the Nonpoint Source (NPS) Policy and include the following:

1. Determine whether the discharge of waste from irrigated lands within the Coalition Group boundaries causes or contributes to exceedances of applicable water quality standards or causes nuisance.
2. Provide information about the Coalition Group area characteristics, including but not limited to land use, crops grown, and chemicals used.
3. Monitor the effectiveness of management practices implemented to address exceedances of applicable water quality standards.
4. Determine which management practices are most effective in reducing wastes discharged to surface waters from irrigated lands.
5. Specify details about monitoring periods, parameters, protocols, and quality assurance.
6. Support the development and implementation of the CWFR.
7. Verify the adequacy and effectiveness of the CWFR's conditions.
8. Evaluate the Coalition Group's compliance with the terms and conditions of the CWFR.

RPP

The purpose of the RPP is to achieve attainment of Performance Goals established in the Basin Plan. Monitoring is conducted under the RPP for to determine attainment of those Performance Goals. Similar to the CWFR, though not specifically stated in regulatory documents, the purposes of the monitoring under the RPP are:

a. Assess the impacts of the rice pesticides regulated under the Basin Plan.

b. Determine the degree of implementation of rice pesticides management practices.

c. Monitor the effectives of management practices and strategies to attain Performance Goals.

d. Determine concentration of Basin Plan rice pesticides at specific sites.

e. Evaluate compliance with Performance Goals to determine whether additional management practices are necessary to improve and/or protect water quality.

Overview of Requirements

The CWFR and RPP programs have different requirements. The CWFR requirements are specified in the rice-specific MRP. The RPP requirements are specified in CVRWQCB Resolution R5-2007-0018.

CWFR

In January 2008, the CVRWQCB adopted Order No. R5-2008-0005 (January 2008 Coalition MRP), an MRP that requires Coalition Groups to revise their MRP Plans. The CRC MRP was developed to be functionally equivalent to the January 2008 Coalition MRP.

The MRP requires that the following types of monitoring and evaluation be conducted:

- **Toxicity testing.** The stated purpose of the toxicity testing is to evaluate compliance with the Basin Plan's narrative toxicity objective, to identify the causes of observed toxicity, and to determine the sources of identified toxicants.

- **Water quality and flow monitoring.** The stated purpose of the water quality and flow monitoring is to assess the sources of wastes and loads in discharges from irrigated lands to surface waters, and to evaluate the performance of management practice implementation efforts. Monitoring data are to be compared to existing numeric and narrative water quality objectives.

- **Pesticide use evaluation.** The stated purpose of the pesticide use evaluation is to provide information regarding the usage of pesticide relative to monitoring sites, including changes in pesticide use.

- **Management practice evaluation.** The stated purpose of this requirement is to evaluate the effectiveness of management practices and track levels of implementation in the watershed.

Consistent with the approach outlined in the MRP, the CRC's approach for its monitoring program includes three types of monitoring:

- Assessment monitoring to determine the condition of a water body
- Core monitoring for to track trends
- Special project monitoring for source identification and other problem solving

Assessment and core monitoring are to be conducted according to a 3-year cycle. Core monitoring is conducted at a subset of core sites considered to be representative of the Coalition Group's area, and for a reduced set of parameters. Assessment monitoring is to include an expanded suite of parameters and may include an expanded list of sites, including assessment sites and core sites. The purposes of the expanded suite are to confirm that core monitoring continues to adequately characterize water quality conditions or identify changed conditions and to provide the technical basis for use of core sites.

Special project monitoring includes monitoring and reporting implemented pursuant to approved and proposed management plans, as well as other focused investigations that may assist in addressing data gaps or other technical evaluations. Table 4-1 provides the sequential schedule for assessment and core monitoring.

TABLE 4-1
Assessment and Core Monitoring Cycle[a]

Monitoring Type	Year 1 (2009)	Year 2 (2010)	Year 3 (2011)
Assessment[b]	X		
Core[c]		X	X

NOTES:
[a] Repeat cycle every 3 years, or as specified in an approved MRP Plan.
[b] Assessment monitoring is conducted at core sites and assessment sites. Site-specific monitoring requirements may be included.
[c] Core monitoring is conducted only at core sites.

Assessment Monitoring

Assessment monitoring is to be used to provide supporting data for sites that a Coalition Group wishes to select as core monitoring sites for trends. Supporting data may also allow consideration for the use of some monitoring sites to be representative of other locations within the CRC study area.

The January 2008 Coalition MRP describes the technical requirements of the proposed assessment monitoring. These requirements fall into the following categories:

- Focus on a diversity of monitoring sites across the Coalition Group's area (hydrology, size, and flow).
- Evaluate different types of water bodies for assessment.
- Include a sufficient number of sampling sites to assess the entire Coalition Group area and all drainages.

- Propose the approach, including schedule, to sampling assessment monitoring sites.
- Include sampling sites in areas of known water quality impairments, even if they are not currently identified on the Clean Water Act (CWA) 303(d) listing.
- Include sampling sites that are compliance monitoring sites for total maximum daily loads (TMDLs), where implementation is conducted by the Coalition Group.
- Provide scientific rationale for the site selection process based on historical and/or ongoing monitoring, drainage size, crop types and distribution, and topography and land use.
- Discuss the criteria for the selection of each monitoring site.
- Conduct the initial focus of monitoring on water bodies that carry agricultural drainage or are dominated by agricultural drainage.
- Identify priorities with respect to work on specific watersheds, subwatersheds, and water quality parameters.
- In conjunction with core monitoring for trends and special projects focused on specific problems, demonstrate the effectiveness of management practices, and identify locations for implementation of new management practices, as needed.
- Include the requirements provided in Parts I through III of the MRP Order.

Three assessment sites, shown in Table 4-2 and described in the following sections, are included in the 2009 MRP.

Core Monitoring

Core monitoring sites are to be used to measure trends at the selected representative sites over extended periods of time. The core monitoring component of the monitoring strategy will:

- Focus on a diversity of monitoring sites across the Coalition Group’s area (hydrology, size, and flow).
- Include sites that through assessment monitoring or other information have been shown to be characteristic of key crop types, topography, and hydrology within the Coalition Group’s boundaries.
- Provide scientific rationale for the site selection process based on the assessment monitoring, existing monitoring projects, or historical information.
- Discuss the criteria for the selection of each monitoring site.
- Propose the approach, including schedule, to sampling core monitoring sites.
- Include water bodies that carry agricultural drainage, are dominated by agricultural drainage, or are otherwise affected by other irrigated agriculture activities.
- Have management practice information provided in order to establish relationships (status and trends) with water quality monitoring information.

- In conjunction with assessment monitoring, demonstrate the effectiveness of management practices and implement new management practices as needed.
- Use data generated from the core monitoring sites to establish trend information about the effectiveness of the Coalition Group's efforts to reduce or eliminate the impact of irrigated agriculture on surface waters.

The 2009 MRP includes monitoring at the four core sites monitored in previous Irrigated Lands Regulatory Program monitoring efforts.

Special Project Monitoring

Special project monitoring is to be established on water bodies where waste-specific monitoring or targeted source identification studies are needed. The CRC's Algae Management Plan is considered special project monitoring.

RPP

The RPP requires that the following types of monitoring and evaluation be conducted:

- Field water quality monitoring
- Molinate and thiobencarb water quality monitoring
- Pesticide use reporting

Monitoring Sites

Monitoring under both the CWFR and the RPP is conducted at specific sites. Table 4-2 lists site names, locations, and drainage area for each of the sites under the CWFR and RPP monitoring programs. Figure 4-1 shows the locations of the CWFR assessment and core monitoring sites, and the locations of the RPP monitoring sites.

TABLE 4-2
2009 CWFR and RPP Monitoring Sites

Site Code	Site Name	Latitude	Longitude	Estimated Rice Area Captured by Station (acres)	Program(s)	Site Type
CBD1	Colusa Basin Drain above Knights Landing	38.8125 N	-121.7731 W	171,165	CWFR, RPP	Core monitoring
CBD5	Colusa Basin Drain #5	39.1833 N	-122.0500 W	156,000	CWFR, RPP	Core monitoring
BS1	Butte Slough at Lower Pass Road	39.1875 N	-121.9000 W	183,617	CWFR, RPP	Core monitoring
SSB	Sacramento Slough Bridge near Karnak	38.7850 N	-121.6533 W	24,549	CWFR, RPP	Core monitoring
F	Lurline Creek; upstream site of CBD5	39.2184 N	-122.1512 W	--	CWFR	Assessment
G	Cherokee Canal; upstream site for BS1*	39.3611 N	-121.8675 W	--	CWFR	Assessment

TABLE 4-2
2009 CWFR and RPP Monitoring Sites

Site Code	Site Name	Latitude	Longitude	Estimated Rice Area Captured by Station (acres)	Program(s)	Site Type
H	Obanion Outfall at DWR PP on Obanion Road	39.0258 N	-121.7272 W	--	CWFR	Assessment
SR1	Sacramento River at Village Marina/ Crawdads Cantina	38.6039 N	-121.5189 W	~500,000	RPP	River

NOTES:
* If there is no flow at the specified site, a site on Butte Slough will be sampled.

DWR PP = California Department of Water Resources pumping plant

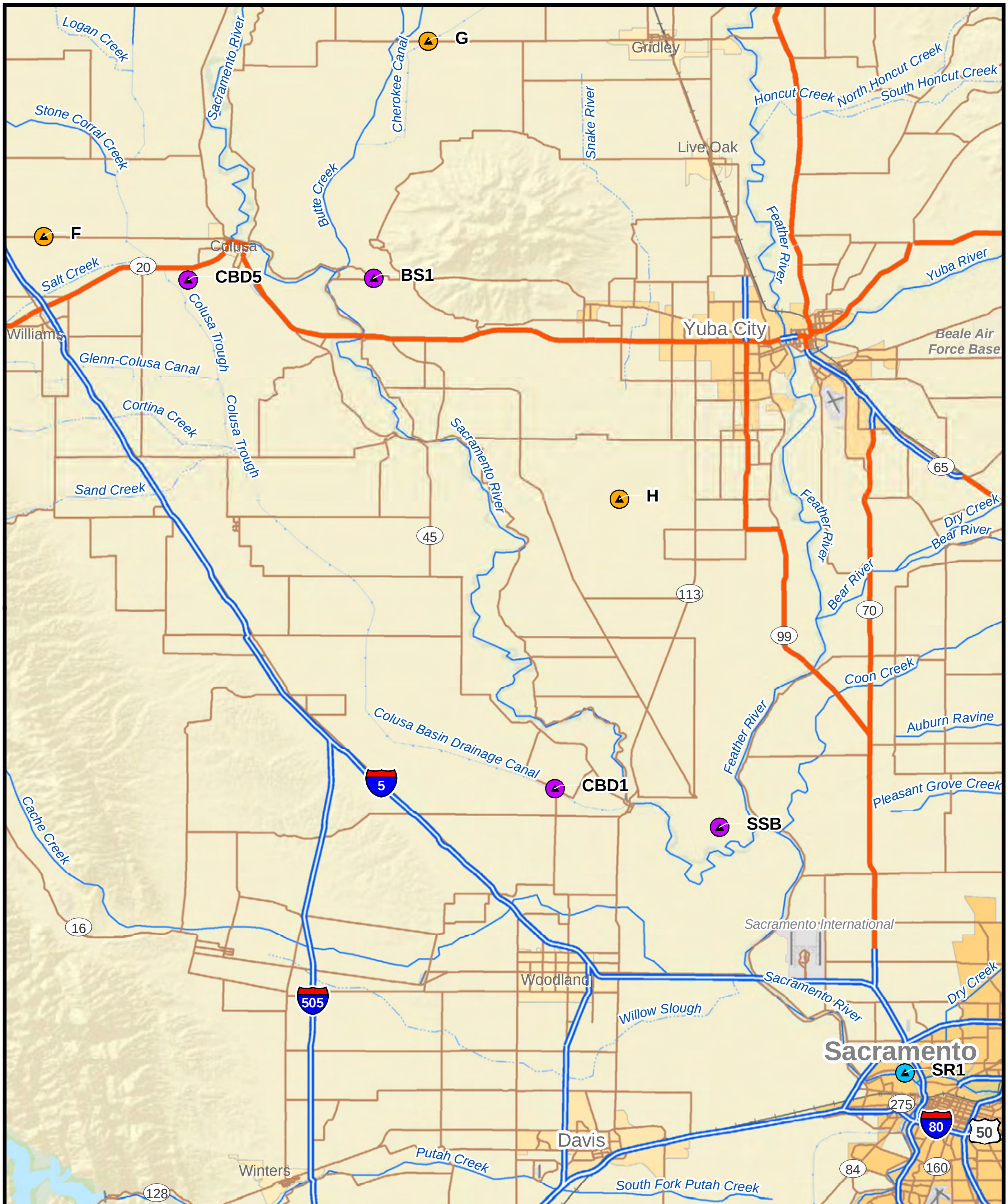
CWFR Sites

In 2009, the monitoring strategy for the CWFR was altered to include different types of monitoring. These include assessment monitoring for the condition of the water body and core monitoring for trends. The core monitoring sites identified in the MRP Order are sites previously monitored by the CRC during the last 4 years. These core sites collectively capture approximately 90 percent of the rice field drainage in the Sacramento River Basin. Using core monitoring sites to monitor trends in rice water quality is appropriate because of the uniformity of rice farming practices across the valley. The same set of field preparation, irrigation, and harvest practices are available to these growers. Additionally, the same set of water hold requirements are in place for all growers in the valley, leaving little variation in the methods of rice farming in one drainage versus another. Core monitoring sites continue to be monitored annually.

The assessment monitoring sites will initially provide data on water bodies representing a wide range of hydrologic conditions, provide data to develop correlations between assessment and core sites, provide upstream data on new generation pesticides, and allow for monitoring of water quality in drainages with a high percentage of land farmed in rice. Assessment sites included in the 2009 MRP Plan were selected following a technical analysis of historical information, including reviews of the geographic information system (GIS) analysis conducted in 2004 and historical DPR and CRC water quality data (CH2M HILL, 2004). The 83 sites monitored under the historical programs were evaluated to better understand monitoring that has taken place concurrently at upstream and core sites. The selected assessment sites represent relatively smaller drainages that are tributary to the core sites. Theoretically, these sites capture a higher proportion of rice drainage than the other candidate sites, and therefore may be representative of more concentrated rice drainage. Assessment sites may be required to be monitored every 3 years, or as specified in an approved MRP Plan. The monitoring sites are sufficiently representative to generally characterize water quality for surface waters of the state that may be affected by river discharges.

RPP Sites

Under the RPP, the CRC performs water quality and flow monitoring at five sites. Four of these sites (CBD1, CBD5, BS1, and SSB) are also monitored under the CWFR, while the fifth site (SR1) is monitored only under the RPP. Figure 4-1 shows the five RPP monitoring sites.



Legend

- CWFR Assessment Sites
- CWFR & RPP Core Sites
- RPP River Site

FIGURE 4-1

MONITORING SITES

RICE PESTICIDES PROGRAM

CALIFORNIA RICE COMMISSION

\\ZION\SACGIS\PROJ\RICECOMMISION_343599\MAPFILES\MONITORING_SITES_SB_FEB09.MXD MONITORING_SITES_SB_FEB09.PDF CARCHER 2/3/2009 10:09:28

CBD1

CBD1 is located on the Colusa Basin Drain. Water samples at CBD1 were collected from the middle of the bridge along Road 99E as it crosses Colusa Basin Drainage Canal near Road 108 west of Knights Landing. CBD1 is monitored under both the CWFR (core) and the RPP.

PHOTO 1
CBD1: Colusa Basin Drain #1

CBD5

CBD5 is located on the Colusa Basin Drain within the Colusa National Wildlife Refuge. Water samples at CBD5 were collected from the middle of the second bridge at the Colusa National Wildlife Refuge south of Highway 20. CBD5 is monitored under both the CWFR (core) and the RPP.

PHOTO 2
CBD5: Colusa Basin Drain #5

BS1

BS1 is located on Butte Slough. Water samples at BS1 were collected from the middle of the bridge along Lower Pass Road, which crosses Butte Sough northeast of Meridian, California. In 1995 and 1996, samples were collected at the west end of the washed out bridge. Sampling at the new bridge site started in 1997. BS1 is monitored under both the CWFR (core) and the RPP.

PHOTO 3
BS1: Butte Slough #1

SSB

The RPP historically monitored Sacramento Slough at a location known as Sacramento Slough 1 (SS1), which was located at the California Department of Water Resources (DWR) gauging station downstream of the Karnak pumps. Beginning in 2006, the monitoring site for Sacramento Slough was moved slightly upstream to a location named Sacramento Slough Bridge (SSB) to provide improved safety for field technicians accessing the site. SSB is monitored under both the CWFR (core) and the RPP.

PHOTO 4
SSB: Sacramento Slough Bridge

F

Site F is located on Lurline Creek. Water samples on Site F were collected from the middle of the bridge located along Lurline Avenue between San Jose Road and Two Mile Road, northwest of Colusa, east of Interstate 5. This site serves as the upstream assessment site for core site CBD5. Site F is monitored under the CWFR (assessment).

PHOTO 5
F: Lurline Creek

G

Site G is located on Cherokee Canal. Water samples on Site G were collected from the middle of the bridge located along Colusa Highway, west of Hatch Road and east of Gridley Road and Butte Creek. This site serves as the upstream assessment site for ore site BS1. Site G is monitored under the CWFR (assessment).

PHOTO 6
G: Cherokee Canal

H

Site H is located at the Obanion Outfall at DWR pumping plant (DWR PP) on Obanion Road. Water samples on Site H were collected from the middle of the bridge along Obanion Road west of Boulton Road and immediately east of the Sutter Bypass levee. Site H is monitored under the CWFR (assessment).

PHOTO 7
H: Obanion Outfall

SR1

SR1 is located on the Sacramento River. Water samples at SR1 were collected from the Sacramento River at the Village Marina along the Garden Highway in Sacramento. The SR1 water samples were collected from the edge of a floating dock near the entrance of a restaurant along the east bank of the Sacramento River. Kleinfelder noted the river level on a staff gauge located along a middle dock between the sampling point and the riverbank. SR1 is monitored under only the RPP.

PHOTO 8
SR1: Sacramento River Village Marina

Constituents

CWFR

The MRP specifies the constituents for which field monitoring and laboratory analysis are to be conducted. Table 4-3 presents the constituents for which monitoring was required during 2009, which is considered Year 5 of the CWFR program.

The "irrigation season" for this monitoring program is defined as April through September. In an effort to evaluate the impacts of rice field discharges during the irrigation season, the CRC monitors throughout the defined irrigation season. In addition to monitoring for the purpose of characterizing irrigation season drainage, the MRP also required monitoring to evaluate water quality during February or March and October 2004 to 2008, which are considered the two most significant periods of discharge outside of irrigation season. In February and March, rice growers drain their fields in preparation for the rice planting season. Unlike farming methods used for field, row, and tree crops, rice fields can capture and hold rainfall in the field, and drainage throughout the valley can be a controlled/managed event. In October, rice growers typically flood their fields to begin winter straw decomposition. Monitoring during the rice field drainage periods of February or March and October produced no negative impacts from rice, so the CRC MRP was revised by the CVRWQCB staff to require monitoring only during April to September 2009. The rationale for the revision was that winter flood up and drainage produced no negative impacts in February or March. Adjusting the October monitoring date to September was more representative of actual field drainage for harvest preparation.

TABLE 4-3
CWFR Monitoring and Reporting Requirements, 2009

Constituent	Units	Sample Type	Type of Monitoring	Irrigation Season Sampling Frequency (April to September)	Reporting Frequency
Flow	cfs	Field[a]	Core and assessment	Monthly	Annually
pH	pH units	Field	Core and assessment	Monthly	Annually
Electrical conductivity	µmhos/cm	Field	Core and assessment	Monthly	Annually
Dissolved oxygen	mg/L	Field	Core and assessment	Monthly	Annually
Temperature	degrees C	Field	Core and assessment	Monthly	Annually
Turbidity	NTUs	Field	Core and assessment	Monthly	Annually
Total dissolved solids[b]	mg/L	Field	Core and assessment	Monthly	Annually
Aquatic toxicity[c]	% survival / %growth[d]	Grab	Assessment	Monthly	Annually
CWFR Pesticides[e]	µg/L	Grab	Core and assessment	Monthly	Annually
Algae Management Plan – Triclopyr	µg/L	Grab	Core	May, June	Annually
Algae Management Plan – Propanil	µg/L	Grab	Core	June, July	Annually
Hardness	mg/L	Grab	Core and assessment	Monthly	Annually
Copper[f]	µg/L	Grab	Core and assessment	Monthly	Annually
Sediment toxicity[g]	% survival	Grab	Assessment	September	Annually
Sediment pesticides[g]	ng/g	Grab	As needed; Assessment	See note g	Annually
Sediment TOC	mg/kg	Grab	Assessment	September	Annually

Notes:

[a] Flow may also be obtained from DWR monitoring stations, where available.

[b] Calculated from electrical conductivity field measurements.

[c] Acute toxicity testing shall be conducted using the invertebrate, *Ceriodaphnia dubia*, and the larval fathead minnow, *Pimephales promelas*, according to standard U.S. Environmental Protection Administration (USEPA) acute toxicity test methods. In addition, to identify toxicity caused by herbicides, 96-hour toxicity tests with the green algae S*elanastrum capricornutum* shall be conducted.

[d] To be reported as percent survival, as compared to the control for *C. dubia and P. promelas*, and as % growth for *S. capricornutum*.

[e] CWFR pesticides are determined annually based on available water quality data, current usage trends, and aquatic toxicity considerations. These pesticides are formally included in the CRC's MRP requirement through Executive Officer communication or Board Resolution. In 2009, CWFR pesticides to be monitored are carfentrazone ethyl, clomazone, glyphosate, pendimethalin, and penoxsulam.

[f] Copper monitoring is required in conjunction with CWFR pesticides study.

[g] Sediment samples that show statistically significant toxicity to *Hyalella azteca* at the end of an acceptable test, and that exhibit ≥ 20% reduction in organism survival as compared to the control, require pesticide analysis of the same sample to determine the possible cause of toxicity. The sample is to be analyzed for lambda cyhalothrin and s-cypermethrin.

ng/g = nanograms(s) per gram
TOC = total organic carbon

RPP

Monitoring for the RPP is conducted during the 10-week period of peak rice pesticide use. Monitoring is conducted once per week for the first 3 weeks, then is increased to twice per week for the following 4 weeks (corresponding with peak usage), and is then decreased to once per week for the final 3 weeks. Field parameters are recorded, and samples are taken for molinate and thiobencarb analysis. The constituents and their monitoring requirements are shown in Table 4-4.

TABLE 4-4
RPP Monitoring and Reporting Requirements, 2009

Constituent	Units	Sample Type	Sampling Frequency			Reporting Frequency
			Weeks 1–3	Weeks 4–7	Weeks 8–10	
pH	pH units	Field	Weekly	Biweekly	Weekly	Annually
Electrical conductivity	µmhos/cm	Field	Weekly	Biweekly	Weekly	Annually
Dissolved oxygen	mg/L	Field	Weekly	Biweekly	Weekly	Annually
Temperature	degrees C	Field	Weekly	Biweekly	Weekly	Annually
Turbidity	NTUs	Field	Weekly	Biweekly	Weekly	Annually
Molinate	µg/L	Grab	Weekly	Biweekly	Weekly	Annually
Thiobencarb	µg/L	Grab	Weekly	Biweekly	Weekly	Annually

Administration and Execution

For both the CWFR and the RPP, the CRC contracted with Kleinfelder to collect water samples and coordinate with laboratories. Following each monitoring event, field data sheets, chain-of-custody (COC) forms, and calibration logs were scanned and e-mailed to CH2M HILL. Kleinfelder was the primary contact for all laboratory services. After analysis, the labs submitted data to Kleinfelder, which then forwarded the data to CH2M HILL for review and analysis.

Sampling Procedures

Sampling was conducted pursuant to the procedures described in the CWFR and RPP Quality Assurance Project Plan (CH2M HILL, 2009), unless otherwise noted.

Field Measurements

Field water quality parameters for the CWFR and RPP, provided in Tables 4-3 and 4-4, respectively, were measured prior to sample collection at each site, and flow was measured after samples were collected. At each site, a water quality sheet was completed; this documented the surface water level, width of the waterway, sample depth at the middle of the water column, total depth to sediment, general weather observations, time arrived on site, and field water quality measurements. Unless otherwise noted, field measurements were taken at a depth equal to approximately half the water column.

Flow

Flow is measured only under the CWFR. Measurements are taken at 10 cross-sections at each site. The wetted width of the water body was measured, recorded, and divided by 10 to determine the width of each cross-section. The midpoint of each cross-section was calculated by dividing the cross-section width in half. Velocity was measured at the midpoint of each cross-section at 0.2 and 0.8 of the total depth from the water surface, and then averaged. Flow was then calculated using the following equation:

$$Q = \sum_{n=1}^{10} W_n D_n V_n$$

Where:

Q	=	estimated flow at the site (cfs)
W	=	section width (feet)
D	=	depth of measurement (feet)
V	=	velocity (feet per second)

Electrical Conductivity, Dissolved Oxygen, Temperature, and pH

Electrical conductivity (EC), dissolved oxygen (DO), temperature, and pH measurements are taken for both the CWFR and RPP monitoring programs. These parameters were measured using a multiprobe instrument that was lowered directly into the water column. The meter was allowed to equilibrate for at least 90 seconds before data were recorded. The meter was calibrated at the beginning of the sampling day. Calibration logs for the CWFR monitoring events are included in Appendix B-1 and the logs for the RPP monitoring events are included in Appendix C-1.

Turbidity

Turbidity was measured using a turbidity meter. Turbidity measurements were recorded for both the CWFR and the RPP.

Total Dissolved Solids

EC is measured in the field using the multiprobe instrument as described above. These measurements are then converted to a total dissolved solids (TDS) result by using the following equation:

$$TDS = 0.77 \times EC + 36.46$$

Where:

TDS	=	Total dissolved solids (milligrams per liter [mg/L])
EC	=	electrical conductivity measurement (micromhos per centimeter [µmhos/cm])

Grab Samples

For both the CWFR and the RPP, grab samples were collected by a qualified and trained crew of Kleinfelder technicians. The water grab samples were collected using a Kemmerer water sampler (either stainless steel and Teflon model or clear acrylic and PVC model; approximately 1.5-liter volume) at a depth equal to one-half the water column. The

Kemmerer was emptied into a stainless steel container and the process repeated until the appropriate volume of water was acquired to split into the required number of samples. This process allowed for homogenization as additional sample volume was added to the container. Certified sample containers were filled with the composite sample using a stainless steel funnel, with an additional bottle filled to be held in sample control as a back-up sample.

Non-disposable equipment used in sample collection was decontaminated after each use by rinsing thoroughly with distilled water. The sample equipment was also rinsed at each site with water from the middle of the water column before sample collection. Clean sampling equipment was not allowed to touch the ground, and field personnel wore clean, disposable gloves. New, clean sample bottles and jars were provided by the analytical laboratories or purchased from a supply company.

Sample containers were labeled at the time of sample collection with a unique sample ID number. The label also contained the following information:

- Sample ID
- Sample location
- Date and time of sample collection
- Kleinfelder project number
- Sampling technician identification

Samples were held on wet or blue ice at 4°C until delivered to the laboratory for analysis.

Sample Custody and Documentation

For both the CWFR and the RPP, custody of samples was maintained and documented from the time of sample collection to completion of analysis. Each sample was considered to be in the sampler's custody, and the sampler was responsible for the care and custody of the samples until they were delivered to the laboratory. Field data sheets and copies of COC forms were maintained in the project file for samples collected during each event.

A COC form, sample labels, and field documentation were crosschecked to verify sample identification, type of analyses, sample volume, and number and type of containers.

Field data sheets, COC forms, and calibration forms were scanned by Kleinfelder and submitted to CH2M HILL. CWFR and RPP COC forms are included in Appendixes B-1 and C-1, respectively.

Sample Delivery and Analysis

For both the CWFR and the RPP, after each sampling event, Kleinfelder submitted the samples under COC to the laboratories. Sample shipments were accompanied by the original COC form, which identified contents. Samples were transported after sample collection to the lab for analysis within the sample holding time. The laboratories performing the analyses and the methods used are listed in Table 4-5.

TABLE 4-5
Analytical Laboratories and Methods, 2009

Laboratory	Analytes/Analytical Method(s)	Analytical Method(s) Standard Operating Procedures	Notes
McCampbell Analytical, Inc. 1534 Willow Pass Road Pittsburg, CA 94565 main@mccampbell.com (925) 252-9262	Pesticides (water)	EPA 525.2, HPLC (penoxsulam)	
	Glyphosate	EPA 547	
	Copper and hardness	EPA 200.8 and SM2340B	
	TDS	EPA 160.1/SM2540C	
	Pesticides (sediment)	EPA 8270	
	TOC (sediment)	SM5310B	
AQUA-Science 17 Arboretum Drive Davis, CA 95616 aquasci@aol.com (530) 753-5456	Fathead minnow acute bioassay	Acute 96-Hour Percent Survival Static non-renewal, static renewal, or LC50 Test (EPA 821-R-02-012; 5th ed.) SOP #503.3	AQUA-Science performed all aquatic toxicity tests with the exception of the sediment toxicity tests
	C. dubia acute bioassay	Acute 96-Hour Percent Survival Static non-renewal, static renewal, or LC50 Test (EPA 821-R-02-012; 5th ed.) SOP #503.3	
	Algae chronic bioassay	Chronic Freshwater Algae (S*elanastrum capricornutum)* Static non-renewal Growth Test (EPA 821-R-02-013; 4th ed.) SOP #510. NO EDTA.	
Nautilus Environmental San Diego Bioassay Laboratory 5550 Morehouse Drive, Suite 150 San Diego, CA 92121	Sediment toxicity – *Hyalella azteca* 10-day bioassay	10-Day Freshwater Sediment Invertebrate (*Hyalella azteca*) Survival Test (based on EPA 823-B-98-004; EPA 600-R-99-064). SOP #518	Nautilus Environmental is a subcontractor to AQUA-Science
Environmental Micro Analysis, Inc. (EMA) 40 N. East Street, Suite B Woodland, CA 95776	Thiobencarb and Molinate	EPA 8141A	Analyzed under the RPP
Valent Dublin Laboratory (Registrant Laboratory) 6560 Trinity Court Dublin, CA 94568	Thiobencarb	Registrant method	Analyzed under the RPP
Syngenta Crop Protection, Inc. (Registrant Laboratory) 410 Swing Road Greensboro, NC 27419	Molinate	Registrant method	Analyzed under the RPP

CHAPTER 5

2009 Monitoring

The 2009 CWFR and RPP monitoring season information and results are provided separately according to the relevant required information for each program. CWFR monitoring information is provided in the following manner:

- Sampling schedule
- Field parameter results
- 2009 flow data
- Copper and hardness analysis
- Aquatic toxicity testing
- Algae management plan (AMP)
- Pesticide analysis
- Sediment toxicity and total organic carbon analysis
- Propanil testing
- UC Davis edge-of-field monitoring

RPP monitoring information is provided in this manner:

- RPP Performance Goals
- Water holds
- Pesticides monitored
- Sampling schedule
- Sampling collection, delivery, and analysis
- Results

CWFR Monitoring

Monitoring is conducted under the CWFR according to the MRP. Monitoring at the four core and three assessment sites included measurement of general field parameters and laboratory analysis of aquatic toxicity, sediment toxicity, and CWFR pesticides. The 2009 CWFR monitoring requirements and results follow.

Sampling Schedule

The MRP specifies the general calendar for monitoring. Based on the understanding of the rice growing season, a rice-specific monitoring calendar was developed to characterize the April through August "irrigation season," with events in August and September to characterize typical drainage events. In 2009, sampling was conducted as shown in Table 5-1, which lists regularly scheduled monitoring. No resampling was required in 2009.

Field Parameter Results

The following field parameters were measured as part of the 2009 sampling effort: temperature, DO, pH, EC, turbidity, and flow.

TABLE 5-1
2009 Sampling and Resampling Calendar

Event Type	Month	Date	Field	Copper	Hardness	CWFR Pesticides	AMP Pesticides	*C. dubia* Toxicity Tests	Minnow Toxicity Tests	*Selenastrum* Toxicity Tests	QC Samples
Irrigation	April	4/28/09 (assessment), 4/29/09 (core)	✓	✓	✓	✓		Assessment sites only			
Irrigation	May	5/12/09 (assessment), 5/13/09 (core)	✓	✓	✓	✓	Triclopyr–core sites only	Assessment sites only		All sites	CBD5
Irrigation	June	6/2/09 (core), 6/3/09 (assessment)	✓	✓	✓	✓	Triclopyr and Propanil—core sites only	Assessment sites only		All sites	
Irrigation	July	7/7/09 (core), 7/8/09 (assessment)	✓	✓	✓	✓	Propanil—core sites only	Assessment sites only		All sites	BS1
Drainage	August	8/25/09 (assessment), 8/26/09 (core)	✓	✓	✓	✓		Assessment sites only			SSB
Drainage	September	9/15/09	✓	✓	✓	✓		Assessment sites only			
Drainage	September	9/22/09	Sediment toxicity and total organic carbon (TOC) at assessment sites only.*								

NOTES:
No resampling due to toxicity was required during the 2009 monitoring season.
CWFR pesticides include: carfentrazone ethyl, clomazone, glyphosate, pendimethalin, and penoxsulam.
*Sediment samples that show statistically significant toxicity to *Hyalella azteca* at the end of an acceptable test, and that exhibit ≥ 20% reduction in organism survival as compared to the control will require pesticide analysis of the same sample to determine the possible cause of toxicity. The sample is to be analyzed for lambda cyhalothrin and s-cypermethrin.

Temperature Measurements

Temperature measurements were taken during field sampling using the multiprobe instrument. Figure 5-1 shows the field temperature results taken during the 2009 season. Temperatures in water bodies are typically lowest in the winter and highest in the summer; in 2009, peak temperatures were observed during the July sampling event, with a high of 76.8°F. As seen in previous years, water temperature in these water bodies essentially tracks with ambient air temperatures. During this time of the year, these bodies of water are clearly not coldwater fisheries, although they may provide coldwater habitat during other times of the year.

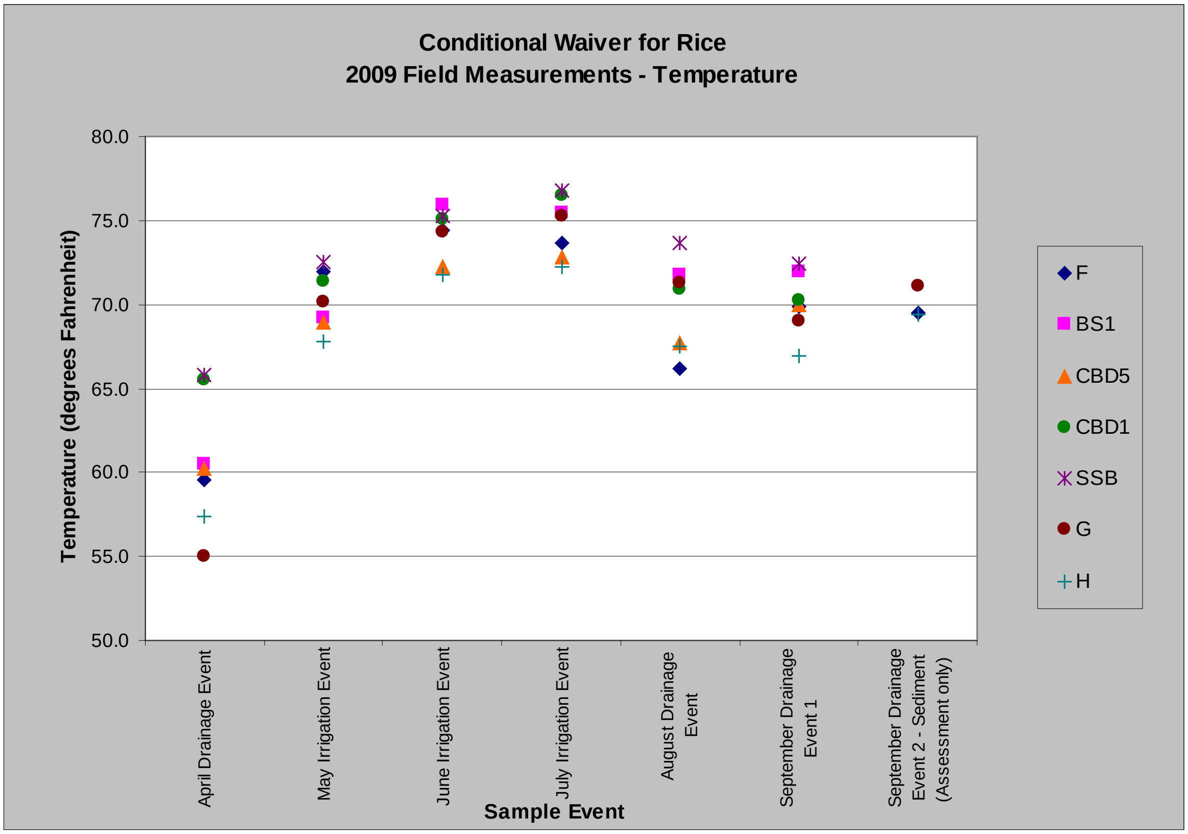


FIGURE 5-1
Field Temperature Measurements, 2009

Table 5-2 presents tabulated temperature results and basic summary information, including site minimum, maximum, mean, and median observed temperature, as well as event minimum, maximum, mean, and median observed temperatures. Table 5-2 also includes an evaluation of the number of times and the frequency with which the observed field temperature exceeded 68°F, which is the Basin Plan water quality objective (WQO) for the lower Sacramento River.

TABLE 5-2
Field Temperature Measurements—Tabulated Results, 2009

Event	Date	Temperature (°F)							Event Low	Event Mean	Event Median	Event High	Event Variance	Event Standard Deviation	N
		BS1	CBD5	CBD1	SSB	H	G	F							
April Irrigation Event	4/28/09 (assessment), 4/29/09 (core)	60.5	60.2	65.5	65.8	57.4	55.0	59.5	55.0	60.6	60.2	65.8	15.7	4.0	7
May Irrigation Event	5/12/09 (assessment), 5/13/09 (core)	69.2	68.9	71.4	72.5	67.8	70.1	71.9	67.8	70.3	70.1	72.5	3.0	1.7	7
June Irrigation Event	6/2/09 (core), 6/3/09 (assessment)	76.0	72.3	75.1	75.3	71.7	74.3	74.4	71.7	74.2	74.4	76.0	2.5	1.6	7
July Irrigation Event	7/7/09 (core), 7/8/09 (assessment)	75.5	72.8	76.5	76.8	72.3	75.3	73.7	72.3	74.7	75.3	76.8	3.2	1.8	7
August Drainage Event	8/25/09 (assessment), 8/26/09 (core)	71.7	67.7	71.0	73.7	67.5	71.3	66.2	66.2	69.9	71.0	73.7	7.5	2.7	7
September Drainage Event 1	9/15/2009 (assessment), 9/16/2009 (core)	72.0	70.0	70.3	72.5	66.9	69.0	69.8	66.9	70.1	70.0	72.5	3.40	1.84	7
September Drainage Event 2 - Sediment (Assessment only)	9/22/2009	NA	NA	NA	NA	69.4	71.1	69.5	69.4	70.0	69.5	71.1	0.91	0.95	3
Site Low		**60.53**	**60.24**	**65.48**	**65.80**	**57.36**	**54.99**	**59.52**							
Site Mean		**70.81**	**68.65**	**71.61**	**72.75**	**67.56**	**69.44**	**69.30**							
Site Median		**71.84**	**69.44**	**71.17**	**73.09**	**67.77**	**71.06**	**69.84**							
Site High		**75.97**	**72.79**	**76.50**	**76.78**	**72.27**	**75.29**	**74.44**							
Site Variance		**31.73**	**20.70**	**15.13**	**14.40**	**24.54**	**45.58**	**26.36**							
Site Standard Deviation		**5.63**	**4.55**	**3.89**	**3.79**	**4.95**	**6.75**	**5.13**							
N		**6**	**6**	**6**	**6**	**7**	**7**	**7**							
Number of obs. Temp >68°F		**5**	**4**	**5**	**5**	**3**	**6**	**5**							
Number of obs. Temp <68°F		**1**	**2**	**1**	**1**	**4**	**1**	**2**							
Percent of obs. where Temp >68°F		**83%**	**67%**	**83%**	**83%**	**43%**	**86%**	**71%**							
Percent of obs. where temp <68°F		**17%**	**33%**	**17%**	**17%**	**57%**	**14%**	**29%**							

DO Measurements

The multiprobe instrument was used to take DO measurements in the field. Figure 5-2 shows the results of DO measurements taken during the 2009 monitoring season. Table 5-3 presents tabulated DO results and basic summary information, including site minimum, maximum, mean, and median observed DO, as well as event minimum, maximum, mean, and median observed DO. Table 5-3 also includes an evaluation of the number of times and the frequency with which the observed field DO values were less than 5 mg/L, 6 mg/L, and 7 mg/L. The WQO for DO is 7 mg/L.

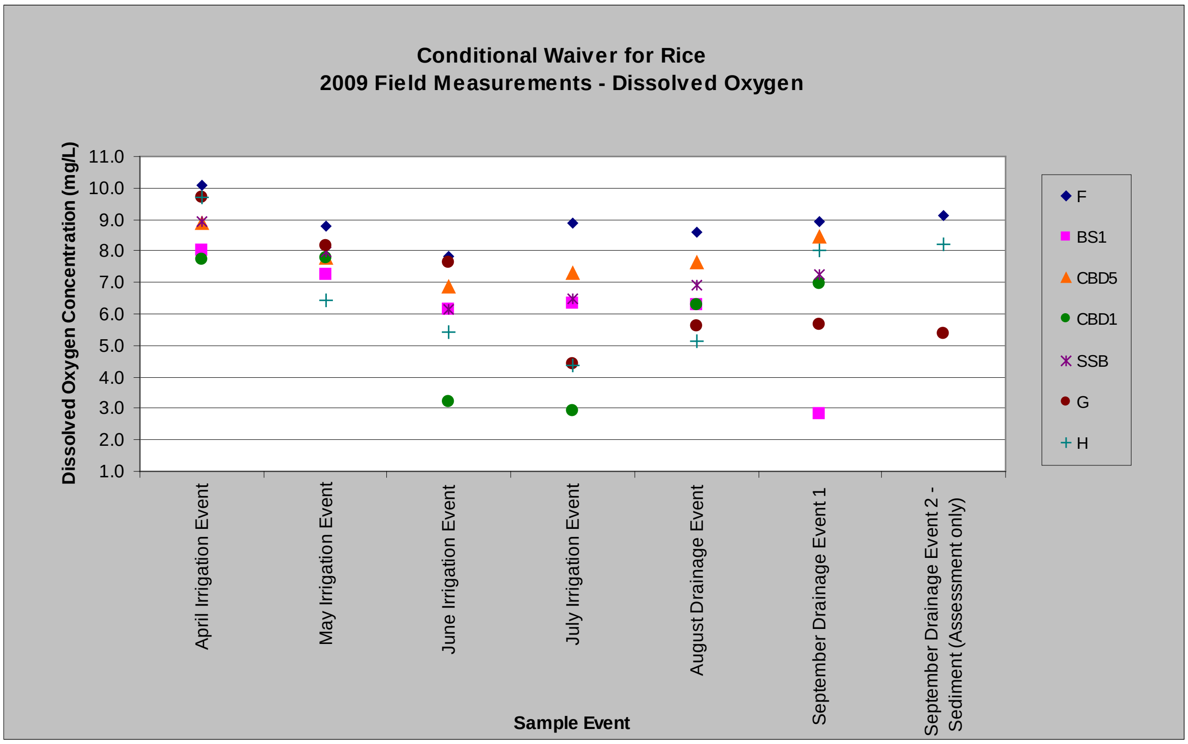


FIGURE 5-2
Dissolved Oxygen Field Measurements, 2009

DO values of less than 6 mg/L were observed at H, G, BS1, and CBD1 (Table 5-3). All these sites also had at least one DO reading of less than 5 mg/L during the 2009 sampling season.

Low DO (<6 mg/L) was observed during more than one monitoring event at the H, G, and CBD1 monitoring sites. Low DO began at sites H and CBD1 in June, and at site G in July. CBD1 historically has had low DO throughout the summer months. In 2008, low DO at CBD1 persisted through August. This improved in 2009, with low DO only present during the June and July events. This is the first year during which DO monitoring has been conducted at assessment sites. The BS1 location had only one instance of low DO (<6 mg/L), at the September monitoring event. Site BS1 has typically had low DO later in the season, with the September event typically having the lowest DO reading (reading of 1.69 mg/L in 2008). The mean DO concentration at the CBD1 site was 5.81 mg/L, at site H it was 6.77 mg/L, and at site G it was 6.65 mg/L. All three sites experienced their lowest DO concentration during the July sampling event (CBD1 = 2.91 mg/L, H = 4.38 mg/L, and G = 4.39 mg/L).

Factors that may contribute to low DO include in-stream biological oxygen demand from high organic loads and productive algal communities (resulting from available nutrients) and the resulting diurnal oxygen depletion resulting from nighttime algae uptake and/or uniform channel character that limits natural aeration.

Warm water temperatures can also contribute to low DO values. As temperature increases, oxygen solubility decreases and approaches the WQO of 7 mg/L DO. This means that biological activity (such as from microorganisms breaking down detritus or other organic matter) can easily consume enough oxygen to depress DO below the WQO, particularly under warmer conditions. Figure 5-3 shows oxygen solubility as a function of temperature. Oxygen solubilities on the graph are approximate because additional factors, such as salinity, influence oxygen solubility.

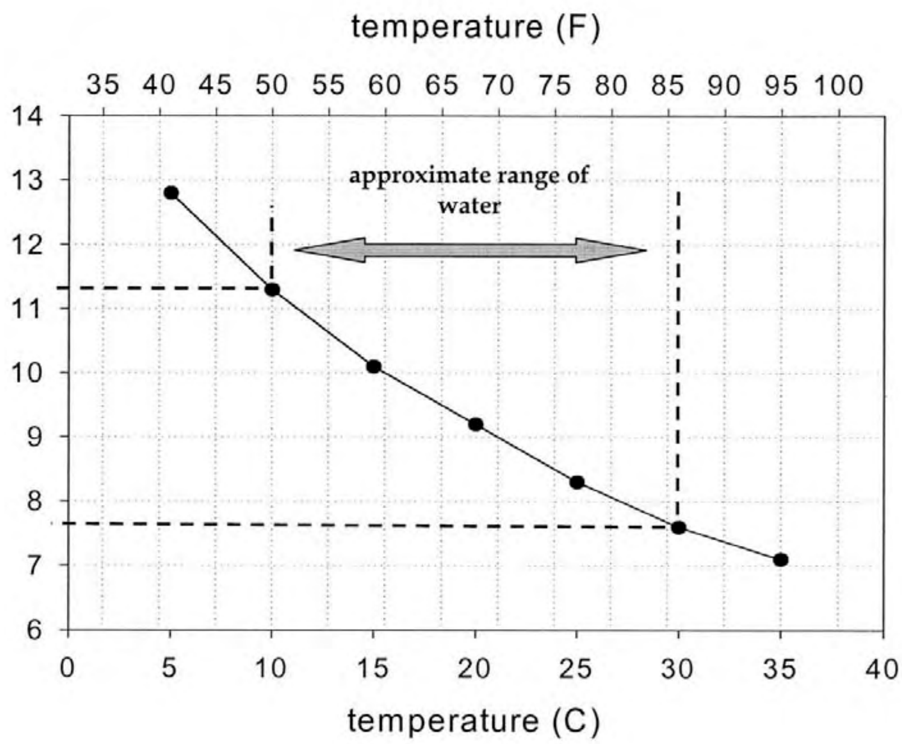


FIGURE 5-3
Oxygen Solubility as a Function of Temperature

TABLE 5-3
Dissolved Oxygen Field Measurements—Tabulated Results, 2009

Event	Date	Dissolved Oxygen Concentration (mg/L)							Event Low	Event Mean	Event Median	Event High	Event Variance	Event Standard Deviation	N	Number of obs. DO<7	Number of obs. DO<6	Number of obs. DO<5	Percent of obs. DO<7	Percent of obs. DO<6	Percent of obs. DO<5
		BS1	CBD5	CBD1	SSB	H	G	F													
April Irrigation Event	4/28/09 (assessment), 4/29/09 (core)	8.02	8.88	7.74	8.93	9.71	9.71	10.10	7.74	9.01	8.93	10.10	0.80	0.89	7	0	0	0	0%	0%	0%
May Irrigation Event	5/12/09 (assessment), 5/13/09 (core)	7.26	7.78	7.76	7.96	6.42	8.15	8.80	6.42	7.73	7.78	8.80	0.55	0.74	7	1	0	0	14%	0%	0%
June Irrigation Event	6/2/09 (core), 6/3/09 (assessment)	6.15	6.86	3.20	6.14	5.45	7.63	7.85	3.20	6.18	6.15	7.85	2.47	1.57	7	5	2	1	71%	29%	14%
July Irrigation Event	7/7/09 (core), 7/8/09 (assessment)	6.36	7.30	2.91	6.48	4.38	4.39	8.87	2.91	5.81	6.36	8.87	4.14	2.03	7	5	3	3	71%	43%	43%
August Drainage Event	8/25/09 (assessment), 8/26/09 (core)	6.30	7.64	6.30	6.93	5.15	5.61	8.60	5.15	6.65	6.30	8.60	1.41	1.19	7	5	2	0	71%	29%	0%
September Drainage Event 1	9/15/2009 (assessment), 9/16/2009 (core)	2.82	8.48	6.98	7.27	8.04	5.68	8.92	2.82	6.88	7.27	8.92	4.35	2.09	7	3	2	1	43%	29%	14%
September Drainage Event 2 - Sediment (Assessment only)	9/22/2009	NA	NA	NA	NA	8.23	5.37	9.11	5.37	7.57	8.23	9.11	3.83	1.96	3	1	1	0	33%	33%	0%
Site Low		**2.82**	**6.86**	**2.91**	**6.14**	**4.38**	**4.39**	**7.85**													
Site Mean		**6.15**	**7.82**	**5.81**	**7.28**	**6.77**	**6.65**	**8.89**													
Site Median		**6.33**	**7.71**	**6.64**	**7.10**	**6.42**	**5.68**	**8.87**													
Site High		**8.02**	**8.88**	**7.76**	**8.93**	**9.71**	**9.71**	**10.10**													
Site Variance		**3.18**	**0.56**	**4.88**	**1.05**	**3.76**	**3.56**	**0.45**													
Site Standard Deviation		**1.78**	**0.75**	**2.21**	**1.03**	**1.94**	**1.89**	**0.67**													
N		**6**	**6**	**6**	**6**	**7**	**7**	**7**													
Number of obs. DO<7		**4**	**1**	**4**	**3**	**4**	**4**	**0**													
Number of obs. DO<6		**1**	**0**	**2**	**0**	**3**	**4**	**0**													
Number of obs. DO<5		**1**	**0**	**2**	**0**	**1**	**1**	**0**													
Percent of obs. DO<7		**67%**	**17%**	**67%**	**50%**	**57%**	**57%**	**0%**													
Percent of obs. DO<6		**17%**	**0%**	**33%**	**0%**	**43%**	**57%**	**0%**													
Percent of obs. DO<5		**17%**	**0%**	**33%**	**0%**	**14%**	**14%**	**0%**													

pH Measurements

The multiprobe instrument was used to take pH measurements in the field. Figure 5-4 shows the results of pH measurements taken during the 2009 monitoring season. Table 5-4 presents tabulated pH results and basic summary information, including site minimum, maximum, mean, and median observed pH, as well as event minimum, maximum, mean, and median observed pH. Table 5-4 also includes an evaluation of the number of times and the frequency with which the observed field pH was less than 6.5 or greater than 8.5 (WQOs). There were no observations that fell outside the 6.5 to 8.5 pH range in 2009; all samples showed achievement of water quality standards.

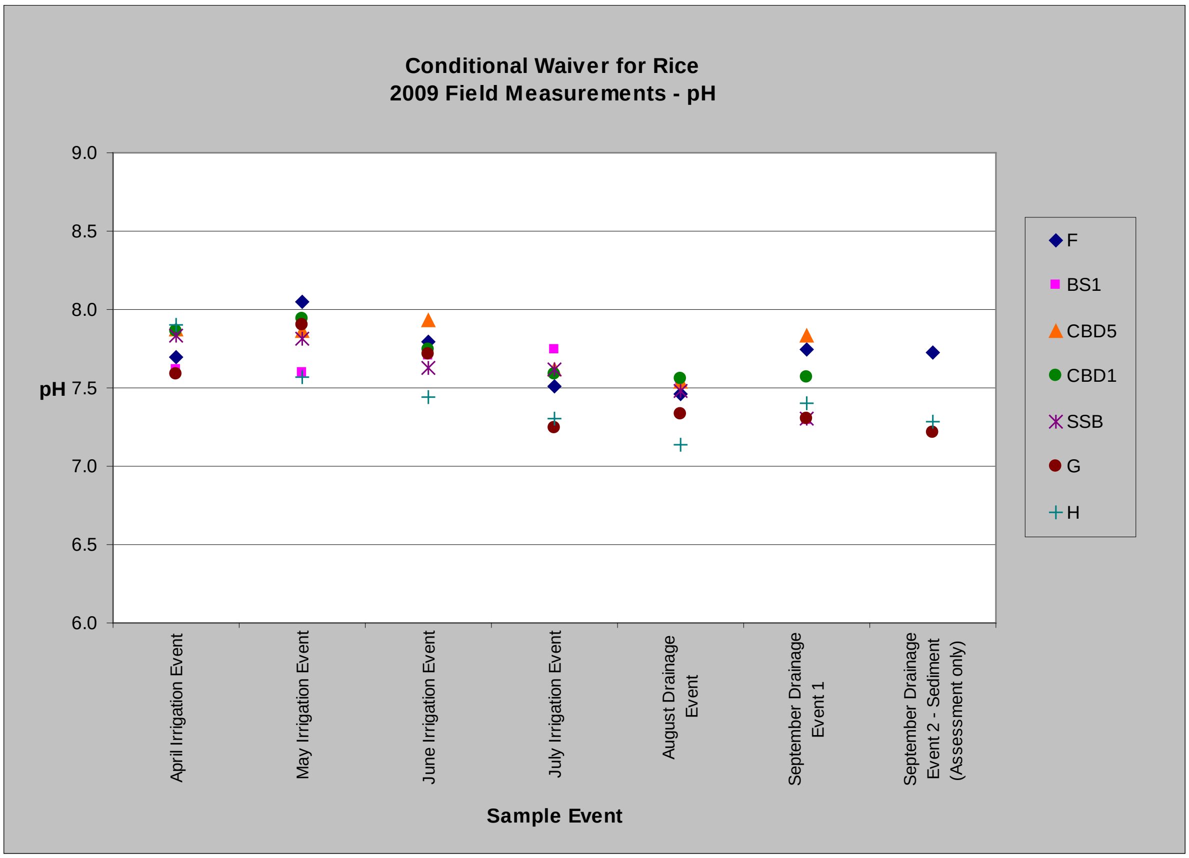


FIGURE 5-4
pH Field Measurements, 2009

TABLE 5-4
pH Field Measurements—Tabulated Results, 2009

Event	Date	pH							Event Low	Event Mean	Event Median	Event High	Event Variance	Event Standard Deviation	N	Number of obs. pH<6.5	Number of obs. pH>8.5	Percent of obs. pH<6.5	Percent of obs. pH>8.5
		BS1	CBD5	CBD1	SSB	H	G	F											
April Irrigation Event	4/28/09 (assessment), 4/29/09 (core)	7.62	7.87	7.86	7.83	7.90	7.59	7.70	7.59	7.77	7.83	7.90	0.02	0.13	7	0	0	0%	0%
May Irrigation Event	5/12/09 (assessment), 5/13/09 (core)	7.60	7.86	7.94	7.81	7.57	7.91	8.05	7.57	7.82	7.86	8.05	0.03	0.18	7	0	0	0%	0%
June Irrigation Event	6/2/09 (core), 6/3/09 (assessment)	7.71	7.93	7.75	7.63	7.44	7.72	7.79	7.44	7.71	7.72	7.93	0.02	0.15	7	0	0	0%	0%
July Irrigation Event	7/7/09 (core), 7/8/09 (assessment)	7.75	7.62	7.59	7.62	7.30	7.25	7.51	7.25	7.52	7.59	7.75	0.03	0.18	7	0	0	0%	0%
August Drainage Event	8/25/09 (assessment), 8/26/09 (core)	7.55	7.54	7.56	7.48	7.14	7.33	7.46	7.14	7.44	7.48	7.56	0.02	0.15	7	0	0	0%	0%
September Drainage Event 1	9/15/2009 (assessment), 9/16/2009 (core)	7.29	7.84	7.57	7.30	7.40	7.31	7.75	7.29	7.49	7.40	7.84	0.05	0.23	7	0	0	0%	0%
September Drainage Event 2 Sediment (Assessment only)	9/22/2009	NA	NA	NA	NA	7.28	7.22	7.73	7.22	7.41	7.28	7.73	0.08	0.28	3	0	0	0%	0%
Site Low		**7.29**	**7.54**	**7.56**	**7.30**	**7.14**	**7.22**	**7.46**											
Site Mean		**7.59**	**7.78**	**7.71**	**7.61**	**7.43**	**7.47**	**7.71**											
Site Median		**7.61**	**7.85**	**7.67**	**7.63**	**7.40**	**7.33**	**7.73**											
Site High		**7.75**	**7.93**	**7.94**	**7.83**	**7.90**	**7.91**	**8.05**											
Site Variance		**0.03**	**0.02**	**0.03**	**0.04**	**0.06**	**0.07**	**0.04**											
Site Standard Deviation		**0.16**	**0.16**	**0.16**	**0.20**	**0.25**	**0.27**	**0.19**											
N		**6**	**6**	**6**	**6**	**7**	**7**	**7**											
Number of obs. pH<6.5		**0**	**0**	**0**	**0**	**0**	**0**	**0**											
Number of obs. pH>8.5		**0**	**0**	**0**	**0**	**0**	**0**	**0**											
Percent of obs. pH<6.5		**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**											
Percent of obs. pH>8.5		**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**											

Electrical Conductivity Measurements

The multiprobe instrument was used to take electrical conductivity (EC) measurements in the field. Figure 5-5 shows the results of EC measurements collected during the 2009 monitoring season. Table 5-5 presents tabulated EC results and basic summary information, including site minimum, maximum, mean, and median observed EC, as well as event minimum, maximum, mean, and median observed EC. Table 5-5 also includes an evaluation of the number of times and the frequency with which the observed field EC exceeded 700 µmhos/cm, which has been cited by CVRWQCB as a threshold for reporting. This threshold is based on the citation in Recommended Numerical Limits to Translate Water Quality Objectives, 19 May 2004, and is an agricultural water quality value (Ayers and Westcot, 1985). Inclusion of this reference value is for screening purposes only and does not imply that the CRC recognizes this value as an adopted salinity WQO. Management of salinity with the Sacramento Valley should be undertaken in the context of the CALFED Record of Decision (ROD). The 2009 sampling season yielded no samples with an EC greater than 700 µmhos/cm. During previous sampling seasons, several samples with EC values greater than 700 µmhos/cm were collected. These samples were typically collected during storm event sampling (which was not continued for the 2009 monitoring season).

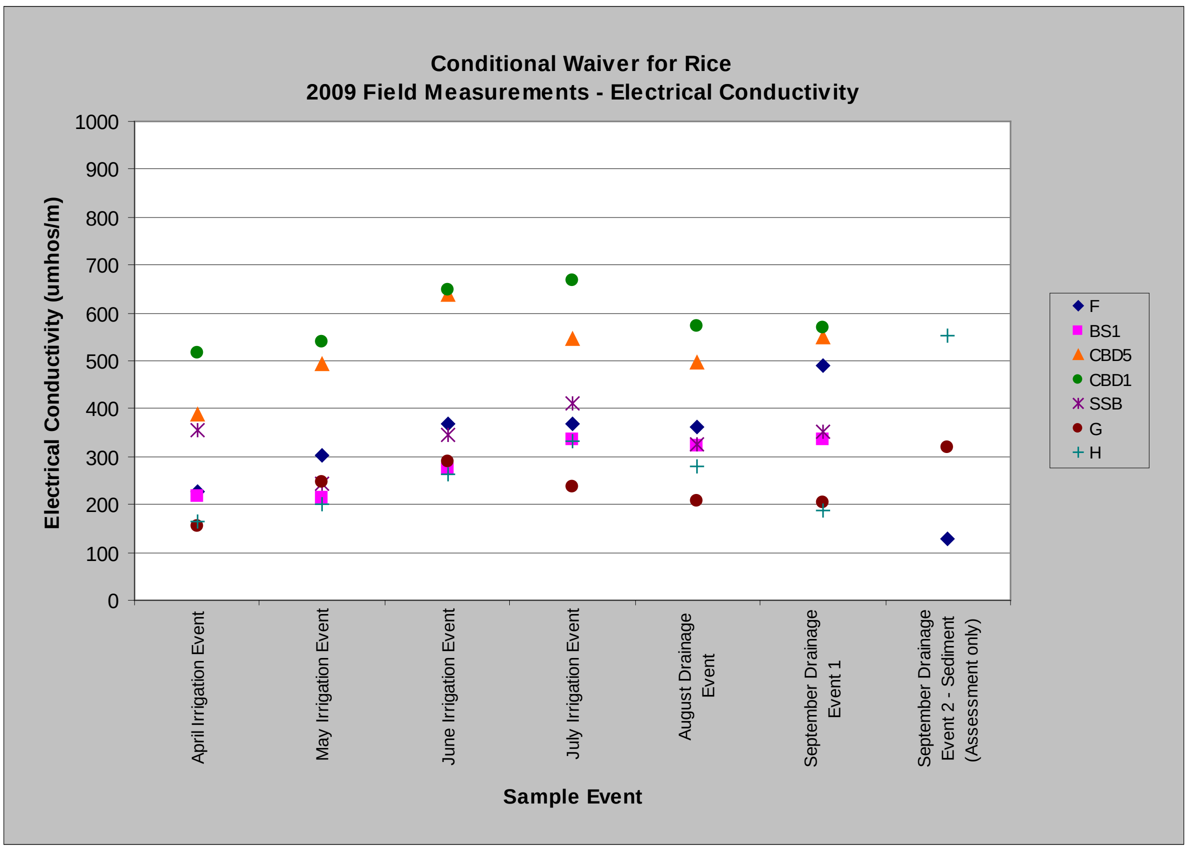


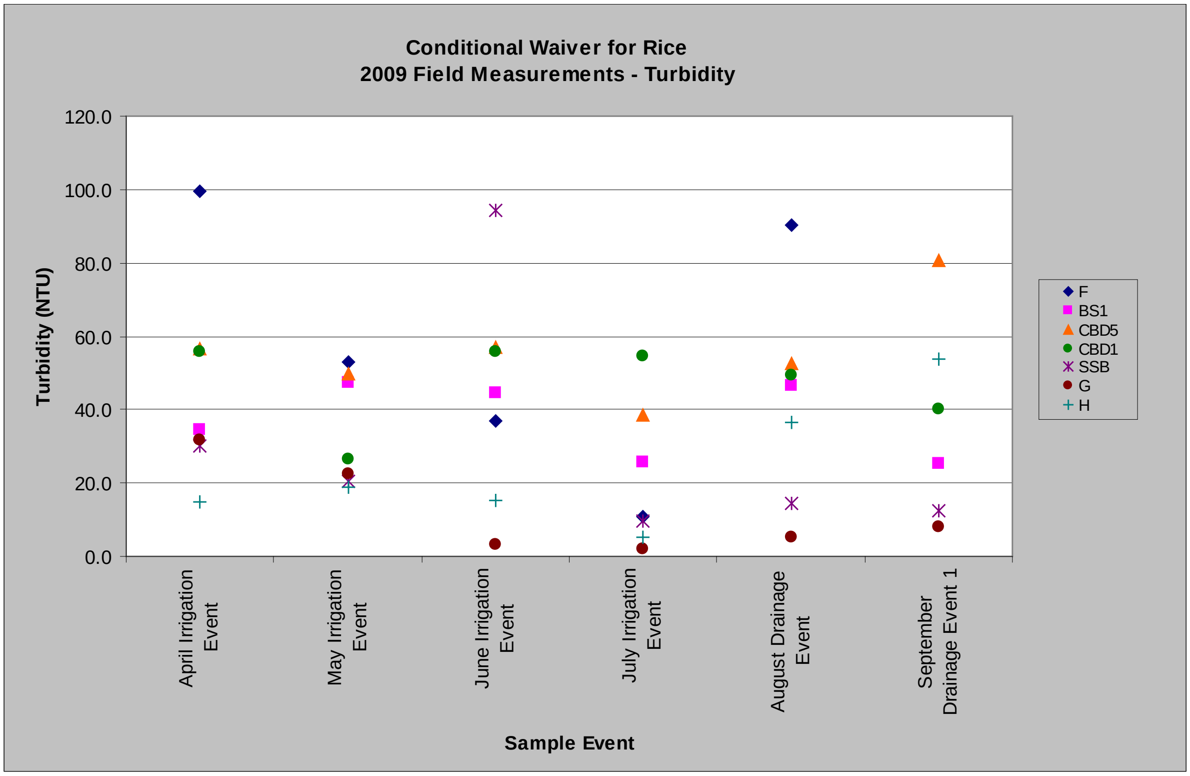
FIGURE 5-5
Electrical Conductivity Field Measurements, 2009

TABLE 5-5
Electrical Conductivity Field Measurements—Tabulated Results, 2009

Event	Date	Electrical Conductivity (µS/cm)							Event Low	Event Mean	Event Median	Event High	Event Variance	Event Std. Deviation	N	Number of obs. EC>700	Percent of obs. EC>700
		BS1	CBD5	CBD1	SSB	H	G	F									
April Irrigation Event	4/28/09 (assessment), 4/29/09 (core)	217	387	515	355	166	153	228	153	289	228	515	17928	134	7	0	0%
May Irrigation Event	5/12/09 (assessment), 5/13/09 (core)	215	495	539	243	200	246	303	200	320	246	539	19297	139	7	0	0%
June Irrigation Event	6/2/09 (core), 6/3/09 (assessment)	273	638	649	347	263	290	370	263	404	347	649	28204	168	7	0	0%
July Irrigation Event	7/7/09 (core), 7/8/09 (assessment)	336	545	667	411	333	236	368	236	414	368	667	21271	146	7	0	0%
August Drainage Event	8/25/09 (assessment), 8/26/09 (core)	324	498	571	327	281	208	361	208	367	327	571	15823	126	7	0	0%
September Drainage Event 1	9/15/2009 (assessment), 9/16/2009 (core)	355	548	570	352	189	204	489	189	384	352	570	24384	156.2	7	0	0%
September Drainage Event 2 - Sediment (Assessment only)	9/22/2009	NA	NA	NA	NA	554	320	128	128	334	320	554	45516	213.3	3	0	0%
Site Low		**215**	**387**	**515**	**243**	**166**	**153**	**128**									
Site Mean		**283**	**519**	**585**	**339**	**284**	**237**	**321**									
Site Median		**299**	**522**	**570**	**349**	**263**	**236**	**361**									
Site High		**336**	**638**	**667**	**411**	**554**	**320**	**489**									
Site Variance		**3255**	**6824**	**3654**	**3004**	**17642**	**3126**	**13415**									
Site Std. Deviation		**57.0**	**82.6**	**60.5**	**54.8**	**132.8**	**55.9**	**115.8**									
N		**6**	**6**	**6**	**6**	**7**	**7**	**7**									
Number of obs. EC>700		**0**	**0**	**0**	**0**	**0**	**0**	**0**									
Percent of obs. EC>700		**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**									

Turbidity

Turbidity measurements are taken in the field using the multiprobe instrument. Figure 5-6 shows the results of turbidity measurements taken during the 2009 monitoring season. Table 5-6 presents tabulated turbidity results and basic summary information, including site minimum, maximum, mean, and median observed turbidity, as well as event minimum, maximum, mean, and median observed turbidity.



NOTE:
NTU = nephelometric turbidity unit

FIGURE 5-6
Turbidity Field Measurements, 2009

TABLE 5-6
Turbidity Field Results—Tabulated Results, 2009

Event	Date	Turbidity (NTU)							Event Low	Event Mean	Event Median	Event High	Event Variance	Event Standard Deviation	N
		BS1	CBD5	CBD1	SSB	H	G	F							
April Irrigation Event	4/28/09 (assessment), 4/29/09 (core)	34.37	56.78	55.61	30.22	15.00	31.75	99.64	15.00	46.20	34.37	99.64	772.31	27.79	7
May Irrigation Event	5/12/09 (assessment), 5/13/09 (core)	47.16	49.90	26.30	20.50	18.69	22.36	53.14	18.69	34.01	26.30	53.14	233.96	15.30	7
June Irrigation Event	6/2/09 (core), 6/3/09 (assessment)	44.49	56.93	55.95	94.48	15.27	3.41	36.86	3.41	43.91	44.49	94.48	897.06	29.95	7
July Irrigation Event	7/7/09 (core), 7/8/09 (assessment)	25.60	38.42	54.66	9.63	5.25	2.15	10.95	2.15	20.95	10.95	54.66	381.88	19.54	7
August Drainage Event	8/25/09 (assessment), 8/26/09 (core)	46.67	52.52	49.47	14.61	36.48	5.27	90.44	5.27	42.21	46.67	90.44	777.36	27.88	7
September Drainage Event 1	9/15/2009 (assessment), 9/16/2009 (core)	25.34	80.54	40.19	12.58	53.96	8.16	133.30	8.16	50.58	40.19	133.30	1956.68	44.23	7
September Drainage Event 2 – Sediment	9/22/2009	NA	NA	NA	NA	NR	NR	NR	0.00	0.00	0.00	0.00	0.00	0.00	0
Site Low		**25.34**	**38.42**	**26.30**	**9.63**	**5.25**	**2.15**	**10.95**							
Site Mean		**37.27**	**55.85**	**47.03**	**30.34**	**24.11**	**12.18**	**70.72**							
Site Median		**39.43**	**54.65**	**52.07**	**17.56**	**16.98**	**6.72**	**71.79**							
Site High		**47.16**	**80.54**	**55.95**	**94.48**	**53.96**	**31.75**	**133.30**							
Site Variance		**105.04**	**192.38**	**138.77**	**1040.51**	**318.05**	**145.61**	**2033.90**							
Site Standard Deviation		**10.25**	**13.87**	**11.78**	**32.26**	**17.83**	**12.07**	**45.10**							
N		**6**	**6**	**6**	**6**	**6**	**6**	**6**							

NOTES:
NA = not applicable
NR = not recorded

2009 Flow Data

Table 5-7 contains the flow data collected during the 2009 monitoring season. Flow measurements were taken at 10 cross-sections at each CWFR core and assessment monitoring site. The wetted width of the waterbody was measured, recorded, and divided by 10 to determine the width of each cross-section. The midpoint of each cross-section was calculated by dividing the cross-section width in half. Velocity was measured at the midpoint of each cross-section at 0.2 and 0.8 of the total depth from the water surface, and then averaged. Field measurements were documented on field sheets contained in Appendix B-1. The flow measurements for 2009 are shown in Table 5-7.

In 2009, several instances of zero flow were reported at sites BS1, CBD1, SSB, H, and G. Pictures of these events are included as Appendix B-6. During QC review, it was determined that the reported zero flow at core sites was likely a measurement error, as general system understanding and past experience has shown flow at these sites.

The DWR California Data Exchange Center (CDEC) site was queried for stations correlating with the CWFR monitoring sites. CDEC site “BSL” is located in the vicinity of BS1; no other CDEC sites correlated with the CWFR sites. Flow measurements for CDEC site “BSL” are reported in Table 5-7.

Following identification of the measurement error, the Field Project Manager met with the field crew to review field procedures. The field crew reported that the velocity meter appeared to be operating and had not noted equipment malfunction during the monitoring. The Field Project Manager then sent the flow meter and deployment system to the manufacturer for diagnosis. The manufacturer reported that the deployment system had degraded over the past few seasons and wasn't allowing the unit to hold at the proper angle to the stream flow. The manufacturer suggested an alternate deployment scenario that should alleviate the "perceived no-flow" problem.

The Field Project Manager has reported that in the event that of “zero” readings in the future, even with implementation of suggested field corrections, the field crew has been instructed to use the flow estimation method (i.e., "orange" method) of floating something and timing it for the width of the bridge. The unit will then be sent to the manufacturer for repairs before the next event.

TABLE 5-7
Flow Data for the 2009 Monitoring Season

Month	Sample Date	Estimated Flow (cubic feet per second)						
		BS1	CBD5	CBD1	SSB	H	G	F
April	4/28/09 (assessment), 4/29/09 (core)	55	230	[a]	141	1.4	65	36
May	5/12/09 (assessment), 5/13/09 (core)	44	129	[a]	55	1.7	28	6.8
June	6/2/09 (core), 6/3/09 (assessment)	342[b]	32	[a]	19	[a]	[a]	55
July	7/7/09 (core), 7/8/09 (assessment)	266[b]	161	[a]	[a]	[a]	[a]	34
August	8/25/09 (assessment), 8/26/09 (core)	223[b]	797	204	[a]	[a]	[a]	69
September	9/15/09 (assessment), 9/16/09 (core)	299[b]	311	135	532	[a]	[a]	36

NOTES:
[a] Velocity measurement of “0 cfs” reported on field sheet
[b] Flow values from DWR CDEC gage BSL

Copper and Hardness Analysis

Samples were collected for copper and hardness analysis at the same sites and events as the pesticide sampling, in accordance with the MRP. Samples were analyzed for copper using EPA Method 200.8, and hardness using EPA Method 200.8 and calculation SM2340B. Results are shown in Table 5-8.

TABLE 5-8
2009 Copper and Hardness Results

		Total Copper Concentration (µg/L)							Total Hardness as $CaCO_3$ (mg/L)						
Month	**Date**	**CBD5**	**BS1**	**CBD1**	**SSB**	**F**	**G**	**H**	**CBD5**	**BS1**	**CBD1**	**SSB**	**F**	**G**	**H**
April	4/28/09 (assessment), 4/29/09 (core)	8.6	3.9	5.6	3.9	35[a]	4.2	2.7	120[b]	100	170	170	92	73	85
May	5/12/09 (assessment), 5/13/09 (core)	10	4.8	4.0	3.5	26[a]	17[a]	3.8	160	92	160	93	86	110	100
June	6/2/09 (core), 6/3/09 (assessment)	11	7.6	8.2	5.5	11	6.6	5.8	180	120	200	140	94	140	130
July	7/7/09 (core), 7/8/09 (assessment)	6.4	5.2	5.5	5.3	5.0	3.2	3.8	190	150	210	170	120	110	160
August	8/25/09 (assessment), 8/26/09 (core)	4.6	4.9	5.9	2.5	6.0	1.9	3.3	180	140	210	140	110	95	120
September	9/15/09 (assessment), 9/16/09 (core)	5.4	2.9	4.1	2.1	7.5	1.6	5.1	195	140	190	140	160	99	92

NOTES:

[a] Copper concentration above the 1-hr hardness-adjusted copper water quality criteria.
The California Toxics Rule (CTR) 1-hour maximum criterion for copper is:
1-hour maximum dissolved copper concentration (µg/L) = $e^{0.9422[\ln(\text{hardness})]-1.700}$
The CTR requires dissolved copper results. Because the 2009 monitoring included total copper monitoring, it is not appropriate to use the results in the CTR equation.

[b] Estimated value due to low surrogate recovery, caused by matrix interference.

Copper results will be evaluated against algae toxicity in the following section to determine whether a discernable relationship exists between copper concentration and algae toxicity.

Aquatic Toxicity Testing

Aquatic toxicity analyses were conducted in accordance with MRP requirements. For 2009, the MRP only required toxicity at assessment sites. Acute and chronic aquatic toxicity tests were performed on three test species:

- Fathead minnow (*Pimephales promelas*)
- Water flea (*Ceriodaphnia dubia*)
- Green algae (*Selenastrum capricornutum*)

The aquatic toxicity tests are performed on samples collected at each station, concurrently with tests on control samples.

The following discussion explains the methodology used to perform the required test, and then provides details and summary results for each species-specific toxicity test.

Whole Effluent Test Methodology

Whole effluent toxicity (WET) tests, or bioassays, are one approach for evaluating the quality of discharged water and its potential to adversely affect biota in receiving waters. WET tests are laboratory toxicity studies in which standard test species are exposed to field-collected water samples by using standardized protocols, and the resulting toxicity (or absence of toxicity) is observed. Suter et al. (2000) identified strengths and weaknesses of bioassays. Strengths of bioassays include the following:

- Realistic representation of the form and bioavailability of the contaminants
- Effects due to multiple contaminants or contaminants that lack toxicity data may be evaluated
- The spatial distribution of toxicity can be determined by testing multiple locations

Weaknesses of bioassays include the following:

- Test media may be modified by collection and preparation for toxicity testing
- Forms and concentrations of chemicals may be modified by sample collection and processing
- Samples may be unrepresentative
- Most media toxicity tests have short durations and test species may not adequately represent species in the field
- If toxicity is observed, the cause of the toxicity is unknown

These limitations do not negate the considerable advantages of media toxicity testing. The first three limitations can be avoided to a considerable degree by exercising care in the collection and handling of samples and in the conduct of the tests. The fourth limitation requires analysis and interpretation of the results. The fifth limitation requires additional testing to identify which components of the contaminant mixture are responsible, a process called toxicity identification evaluation (TIE) (EPA, 1998a and 1998b). In the TIE process, the toxic components of a mixture are identified by removing components of a mixture and testing the residue, fractionating the mixture and testing the fractions, or adding components of the mixture to a background medium and testing the artificially contaminated medium.

Control and reference media both should be tested along with the contaminated media. Control media are laboratory media known to be appropriate for the test species. That is, control media support the maximal rates of survival, growth, and reproduction of the test species. The characteristics of control media are usually prescribed in standard test protocols. Reference media are media that come from near the site, and are physically and chemically similar to the test media except that they do not contain the site contaminants. The control tests determine whether the test was conducted properly using healthy organisms. The local reference tests provide the basis for determining how much toxicity the site adds to proximate media. If a separate clean reference is used, it provides the basis for determining whether the differences from controls are due to contaminants or to properties of the media, such as pH.

Standard toxicity tests have been developed for determining the acceptability of aqueous effluents and are widely used in effluent permitting in the United States. These tests are unique in the extent to which they have been validated against biosurvey data (Dickson et al., 1992; Grothe et al., 1996). In numerous studies, the 7-day fathead minnow and *Ceriodaphnia dubia* tests have been found to be predictive of reductions in the species richness of aquatic communities. As a result of this intensive development and validation, these tests are widely used.

In accordance with the MRP Order, acute and chronic toxicity tests were performed on three test species:

- Fathead minnow, *Pimephales promelas*
- Water flea, *Ceriodaphnia dubia*
- Green algae, *Selenastrum capricornutum*

Tests are performed on samples collected at each station and are performed concurrently with tests on control samples.

Fathead Minnow (*Pimephales promelas*)

The MRP includes toxicity tests using the test species *Pimephales promelas* to detect toxicity to fish species. This minnow is considered a sensitive test species, and toxicity to *P. promelas* can indicate a water quality concern.

2009 *P. promelas* Toxicity Testing. Toxicity testing on *P. promelas* was required only at assessment sites during the 2009 monitoring season. AQUA-Science Laboratories performed the 2009 *P. promelas* toxicity tests; the detailed results of these tests are shown in Table 5-9. These tabulated results provide the sample date, the lab report that summarizes the test results, and the test organisms' percent survival (as compared to the control). For all the analyses conducted during Year 5, there was no statistically significant observed toxicity to fathead minnow, and no resamples were triggered. These results indicate that sampled waters were not toxic to fish species.

Water Flea (*Ceriodaphnia dubia*)

The MRP includes toxicity tests using the test species *Ceriodaphnia dubia* to detect toxicity to invertebrates. *C. dubia* is considered a sensitive test species, and toxicity to *C. dubia* can indicate a water quality concern.

2009 *C. dubia* Toxicity Testing

Toxicity testing on *C. dubia* was only required at assessment sites during the 2009 monitoring season. AQUA-Science performed the 2009 *C. dubia* toxicity tests; the detailed results of these tests are shown in Table 5-10. These tabulated results provide the sample date, the lab report that summarizes the test results, the test organisms' percent survival (as compared to the control), whether resampling was triggered, and the results of any resampling. As with the fathead minnow, for all of the analyses conducted during Year 5, there was no statistically significant observed toxicity to the water flea, and no resamples were triggered. These results indicate that samples waters were not toxic to invertebrates.

TABLE 5-9
2009 Minnow Toxicity Test Summary Results (Assessment sites only during 2009)

Month	Event	Sample Date	Appendix Reference	Minnow 96-Hour Percent Survival as Compared to Control			Resample Triggered?		
				F	G	H	F	G	H
April	Original	4/28/09	5/13/09; AQUA-Science	100%	100%	100%	N	N	N
May	Original	5/12/09	6/1/09; AQUA-Science	97.5%	100%	100%	N	N	N
June	Original	6/3/09	6/11/09; AQUA-Science	100%	100%	100%	N	N	N
July	Original	7/8/09	7/15/09; AQUA-Science	97.5%	100%	100%	N	N	N
August	Original	8/25/09	9/4/09; AQUA-Science	100%	100%	100%	N	N	N
September	Original	9/15/09	10/8/09; AQUA-Science	100%	100%	100%	N	N	N

NOTE:
N = resample was not triggered

TABLE 5-10
2009 *Ceriodaphnia* dubia Toxicity Test Summary Results (Assessment sites only during 2009)

Month	Event	Sample Date	Appendix Reference	*C. dubia* 96-Hour Percent Survival as Compared to Control			Resample Triggered?		
				F	G	H	F	G	H
April	Original	4/28/09	5/13/09; AQUA-Science	100%	95%	100%	N	N	N
May	Original	5/12/09	6/1/09; AQUA-Science	100%	100%	100%	N	N	N
June	Original	6/3/09	6/11/09; AQUA-Science	95%	100%	100%	N	N	N
July	Original	7/8/09	7/15/09; AQUA-Science	95%	100%	100%	N	N	N
August	Original	8/25/09	9/4/09; AQUA-Science	100%	100%	100%	N	N	N
September	Original	9/15/09	10/8/09; AQUA-Science	100%	95%	100%	N	N	N

NOTE:
N = resample was not triggered

Green Algae (*Selenastrum capricornutum*)

The MRP includes toxicity tests using the test species *Selenastrum capricornutum* to detect toxicity to aquatic plants. *Selenastrum* is a green algae species and is considered the most sensitive test species. Toxicity to *Selenastrum* can indicate a water quality concern.

2009 *Selenastrum* Toxicity Testing. *Selenastrum* toxicity testing was required at assessment sites under the MRP, and at core sites during the May, June, and July events under the AMP. *Selenastrum* toxicity tests were performed by AQUA-Science; the detailed results of the *Selenastrum* toxicity tests are shown in Table 5-11. These tabulated results provide the sample date, the lab report that summarizes the results of the tests, the test organisms' percent growth (as compared to the control), whether resampling was triggered, and the results of any resampling. Resampling is triggered if the percent growth as compared to the control is 50 percent or less. The results of the 2009 CWFR (MRP and AMP) *Selenastrum* toxicity testing are summarized as follows:

MRP—Only one site sampled under the MRP testing had lower percent growth than the control. This was the April site G sample, which yielded a growth of 15 percent less than the control. This did not trigger resampling. The remainder of the events had growth beyond the control, indicating that the sample water was a better growth source than the control water.

AMP—Two sites sampled under the AMP testing had lower percent growth than the control. These were the May site CBD1 and site SSB samples. These samples yielded a growth of 16 percent and 12 percent less than the control, respectively. Neither of these results triggered resampling (resampling for algae is triggered at a reduction of 50 percent or greater as compared to the control). The remainder of the events had growth beyond the control, indicating that the sample water was a better growth source than the control water.

TABLE 5-11
2009 *Selenastrum* Toxicity Test Summary Results

Month	Event	Sample Date	Appendix Reference	*Selanastrum* 96-Hour Percent Growth as Compared to Control (% Control[a])						
				BS1	CBD5	CBD1	SSB	F	G	H
April	Original	4/28/09	5/13/09; AQUA-Science	–	–	–	–	0%	**-15%[b]**	+1%
May	Original	5/12/09 (assessment), 5/13/09 (core)	6/1/09; AQUA-Science	+2%	+8%	**-16%[b]**	**-12%[b]**	+9%	0%	+2%
June	Original	6/2/09 (core), 6/3/09 (assessment)	6/11/09; AQUA-Science	+145%	+255%	+62%	+76%	+98%	+326%	+556%
July	Original	7/7/09 (core), 7/8/09 (assessment)	7/15/09; AQUA-Science	+411%	+579%	+273%	+45%	+956%	+753%	+526%
August	Original	8/25/09 (assessment)	9/4/09; AQUA-Science	–	–	–	–	+505%	+125%	+308%
September	Original	9/15/09 (assessment)	10/8/09; AQUA-Science	–	–	–	–	+380%	+206%	+170%

NOTES:
[a] percent control = (sample absorbance) / (control absorbance) * 100
[b] Statistically significant toxicity observed

Comparison of Algae Toxicity with Copper Results

Sampling for copper analyses occurred during the same events as the algae toxicity sampling to determine whether copper contributes to algae toxicity. Lab results show that copper was present in all the samples; however, there does not seem to be a relationship between copper presence/concentration and algae toxicity. Copper levels at sites with statistically significant toxicity varied, and sites with higher copper concentrations were not necessarily those with higher toxicity. This indicates that copper is not a factor in algae toxicity in these samples.

Algae Management Plan

CVRWQCB Resolution No. R5-2006-0077 requires that Coalitions implementing water quality control program under the Conditional Waiver submit management plans when monitoring results show two or more observed "exceedances" over a three-year period.

The CRC has implemented water quality monitoring and reporting pursuant to the CVRWQCB's approved MRP for rice discharges.

Results obtained during CRC's Year 1 (2005) through Year 4 (2008) monitoring showed aquatic toxicity for *Selenastrum capricornutum*, an algae specified by the U.S. Environmental Protection Agency (EPA) to determine chronic aquatic toxicity of receiving waters, triggering the submittal of a Management Plan. The AMP attached as Appendix B-5 fulfills this requirement. Background information on monitoring during Years 1 through 4 is provided here; refer to Appendix B-5 for more information.

Background. Monitoring conducted in Year 1 and Year 2 of the CWFR monitoring program identified *Selenastrum* reductions as an ongoing occurrence. TIEs performed in Year 1 and Year 2 were not conclusive in determining the causal agents contributing to toxicity, although "short-lived non-polar organic herbicides" were often indicated based on the effectiveness of SPE-18 treatments in removing the toxicity. Follow-on chemistry conducted on elute derived from the SPE-18 columns resulted in a series of non-detects for various rice herbicides and non-rice products.

In 2007, an alternative study plan, included in the AMP, was proposed by the CRC and was endorsed by CVRWQCB staff. In an effort to improve the effectiveness of the study plan in determining the causal agent contributing to the *Selenastrum* reductions, the CRC proposed, in lieu of TIEs, to submit samples for herbicides and copper analysis concurrently with the initiation of the *Selenastrum* toxicity tests. This approach provided the benefit of including immediate analysis of original samples (the prior approach involved waiting for determination of toxicity prior to submitting samples for herbicide analysis). In addition, because previous TIEs had been unsuccessful in advancing the understanding of the causal agent beyond the determination of "short-lived non-polar organic herbicides," this approach was deemed more economical because it would provide up-front chemistry aimed at assessing specific herbicides and it would provide numeric results for detected pesticides.

In addition to the additional herbicide analysis, resampling is required at any site with an observed toxicity reduction of 50 percent or more (less than 50 percent survival as compared to the control).

Based on a review of previous *Selenastrum* toxicity studies conducted by the CRC and by UC Davis and the CVRWQCB, the CVRWQCB staff, CH2M HILL, and the CRC consulted on the list of herbicides to be analyzed in 2007 and 2008. This list of herbicides was reduced in 2009 to herbicides that were detected during the 2007 and 2008 sampling, and the timing of the herbicides analysis altered to coincide with the May through July herbicide use period. Therefore, the 2009 AMP herbicides analysis was conducted for clomazone, propanil, and triclopyr at all core sites during primary months of herbicide usage.

The 2009 MRP already required monitoring the following pesticides at the four core and three assessment sites: carfentrazone ethyl, clomazone, glyphosate, pendimethalin, and penoxsulam. In addition, the MRP required monitoring for hardness and copper. Because the MRP already required clomazone analysis, the AMP portion of the monitoring was limited to triclopyr and propanil. Complete results of the herbicide analyses are included in Appendix B-2.

Pesticide Analysis

Samples were collected for pesticide analysis under the MRP and the AMP, as described above. Table 5-12 gives the list of pesticides analyzed, the EPA methods, method reporting limits, and additional information regarding the usage of these products on rice. Results of the pesticide analysis are presented in Table 5-13. Only the July and August monitoring events yielded non-detect (below the MRL) results for all pesticides tested. Each of the other events had at least one detect per sampling site. Clomazone, propanil, and triclopyr were the only pesticides detected during the 2009 monitoring season. The most commonly detected pesticide was clomazone, detected above the MRL in 17 out of 42 samples. Clomazone was detected in nearly every sample with a detect (only 21 of the samples had detects). Clomazone is solely a rice pesticide, so these detections can be attributed to applications on rice. Complete results of the pesticide analyses are included in Appendix B-2.

TABLE 5-12
Herbicides Identified for Analysis under the 2009 MRP and Algae Management Plan

Herbicide	Program	EPA Method	Detection (MRL)*	Application Period	Sequential Application	Water Hold Period	Use	Rice Herbicide?	Used for Other Crops?
Carfentrazone ethyl	MRP	E525.2	0.10 µg/L	April–June	Yes	5-day static, 30-day release	Herbicide	Yes	Yes
Clomazone	MRP, AMP	E525.2	1.0 µg/L	April–May	No, 120-day PHI	14 day	Herbicide	Yes	No
Glyphosate	MRP	E547	5.0 µg/L	March, if rice preplant	NA	None (preplant)	Herbicide	Yes	Yes
Pendimethalin	MRP	E525.2	0.20 µg/L	March–April	No	None (preplant)	Herbicide	Yes	Yes
Penoxsulam	MRP	HPLC	20.0 µg/L	April–June	No	None	Herbicide	Yes	No
Propanil	AMP	E525.2	0.05 µg/L	May–July	Yes	7 day	Herbicide	Yes	No
Triclopyr	AMP	E525.2	0.05 µg/L	May–June	Yes	20 day	Herbicide	Yes	Yes

NOTES:
* Estimated minimum reportable limit (MRL), based on the result sheets received from the lab (Appendix B-2). The actual detection and reportable limits are to be provided by the analytical laboratory as part of QA/QC.

TABLE 5-13
2009 Pesticide Monitoring Results

Event Type	Month	Date	BS1	CBD5	CBD1	SSB	H	G	F
Irrigation 1	April	4/28/09 (assessment), 4/29/09 (core)	Clomazone 0.39 J	Clomazone 0.51 J	ND	ND	ND	Clomazone 0.75 J	Clomazone 0.23 J
Irrigation 2	May	5/12/09 (assessment), 5/13/09 (core)	Clomazone 2.3	Clomazone 6.9 J	Clomazone 2.8	Clomazone 1.7	Clomazone 0.84 J	Clomazone 2.5	Clomazone 5.6 J
Irrigation 3	June	6/2/09 (core), 6/3/09 (assessment)	Clomazone 2.5	Clomazone 2.6, Propanil 1.9, Triclopyr 0.71	Clomazone 4.0	Clomazone 1.8 J	Clomazone 3.8 J	Clomazone 2.9 J	Propanil 47
Irrigation 4	July	7/7/09 (core), 7/8/09 (assessment)	ND	Propanil 0.38	Propanil 0.065	Propanil 0.25	ND	ND	ND
Drain 1	August	8/25/09 (assessment), 8/26/09 (core)	ND	ND	ND	ND	ND	ND	ND
Drain 2	September	9/15/09 (assessment), 9/16/09 (core)	ND	ND	ND	ND	ND	ND	ND

NOTES:
ND = non-detect
J = laboratory “J-flagged” indicating laboratory quality control notes indicate analyte below quantitation limits.

Algae Management Plan Pesticides and Algae Toxicity

Although concentrations of the targeted pesticides listed in Table 5-12 were found in several samples taken during the 2009 monitoring season, there was no apparent relationship between pesticide presence and algae toxicity. Only 3 days with algae toxicity were recorded; concentrations of detected pesticides on these days were actually lower than on days with high algae growth. A more widespread monitoring of toxicity and pesticides may be necessary to fully determine whether there is a correlation between toxicity and the target AMP pesticides.

Sediment Toxicity and Total Organic Carbon Testing

The MRP requires sediment toxicity testing using the test species *Hyalella azteca* to detect toxicity to benthic organisms. *Hyalella azteca* is considered a sensitive test species, and toxicity can indicate a sediment quality concern. As required, sediment toxicity tests were performed on assessment site samples collected in late September.

Methods

Sediment samples that show statistically significant toxicity to *Hyalella azteca* and that exhibit a ≥ 20 percent reduction in organism survival compared to the control require pesticide analysis for the same sample to determine a possible cause of toxicity. When sediment samples are collected for toxicity analysis, additional volume sufficient for the recommended chemical and physical analyses must be collected. This additional sample volume must be held in frozen storage until the results of the toxicity analysis are available. If the sample is not toxic to the test species, the additional sample can be discarded.

In addition, all sediment samples for assessment monitoring must be analyzed for total organic carbon (TOC). Analysis for TOC is necessary to evaluate the expected magnitude of toxicity to the test species. If the toxicity criterion described above is exceeded, then the additional sample volume must also be analyzed for lambda-cyhalothrin and cypermethrin, the only two pyrethoids used in rice operations. Analysis at practical reporting limits of 1 ng/g on a dry weight basis for each pesticide is required to allow comparison to established lethal concentrations of these chemicals to the test species. This follow-up analysis must begin within 5 business days of receipt of results indicating that the toxicity criterion described above is exceeded.

Results

H. azteca toxicity tests performed on samples collected at assessment sites in September showed no statistically significant effects. In fact, they had better survival than the control (95 to 100 percent survival, as compared to the control, ranging 85 to 100 percent survival). No resampling or pesticide analysis was required. September *Hyalella* results are detailed in Table 5-14.

TABLE 5-14
September *H. azteca* Sediment Toxicity Results, 2009

Site	Mean Percent Survival	Percent Survival Compared to Control
Control	93%	-
F	98%	+5%
G	98%	+5%
H	95%	+2%

Levels of TOC in the assessment sediment samples ranged from approximately 3000 to 10,000 mg/kg, as shown in Table 5-15. This information was not utilized because pesticide testing was not required.

TABLE 5-15
September Sediment Total Organic Carbon Results, 2009

Site	TOC (mg/kg)
F	3,100
G	10,000
H	7,000

Propanil Testing

The 2009 AMP required propanil testing at core sites during the June and July events. In addition, the supplemental propanil testing initiated in 2006 (with results provided in the 2008 AMP) was continued in 2009. Water samples were collected from each of the core monitoring locations on a weekly basis from the beginning of June to the middle of July, which is the common application period for propanil (Table 5-12). Supplemental samples were also collected from assessment sites during the CWFR events (June 3 and July 8). Field sheets for the propanil sampling are located in Appendix B-1, and results for the propanil sampling are located in Appendix B-2.

Eight consecutive weeks of propanil sampling were completed in 2009 (Table 5-16). Although several of the samples had ND results, many others had levels of propanil above 1.0 µg/L. The highest measuring samples were from the June event at site F (47 µg/L), and the July event at site SSB (12 µg/L). The June 9 and 16 sampling events had the most detections, with concentrations above the detection limit at every site sampled. Only one of the sampling weeks (7/21/09) had no detections at any of the sampling locations.

TABLE 5-16
2009 Propanil Monitoring Results

Sampling Date	Sampling Event	Monitoring Results (µg/L) (*Detection Limit for McCampbell Analytical <0.05 µg/L)*						
		CBD5	**BS1**	**CBD1**	**SSB**	**F**	**G**	**H**
6/2/09	AMP	1.9	ND	ND<0.10	ND<0.25	-	-	-
6/3/09	AS	-	-	-	-	47	ND<0.25	ND<0.25
6/9/09	AS	11	1.7	3.5	0.36	-	-	-
6/16/09	AS	3.1	1.3	2.0	0.76	-	-	-
6/23/09	AS	0.64	0.66	0.26	ND	-	-	-
6/30/09	AS	ND<0.10	ND<0.10	ND<0.25	ND<0.10	-	-	-
7/7/09	AMP	0.38	ND	0.065	0.25	-	-	-
7/8/09	AS	-	-	-	-	ND	ND	ND
7/14/09	AS	ND	ND	ND	12	-	-	-
7/21/09	AS	ND	ND	ND	ND	-	-	-

NOTES:
Concentrations are reported in µg/L (parts per billion)
AMP = Algae Management Plan
AS = Additional sampling
ND = Not detected above laboratory reporting limits

Propanil results for 2009 were fairly typical when compared to the 2006 and 2007 results, but were overall higher than the 2008 results (Table 5-17). In 2008, there were fewer detections than in previous years, with the highest detection (4.18 µg/L) occurring in July. The 2009 season resembled previous seasons, with many more detections over 1.0 ug/L than observed during the same time period in 2008. Field sheets and results for the 2006, 2007, and 2008 propanil events were included as Appendix B-5 in the 2008 AMR.

TABLE 5-17
2006-2009 Propanil Results (concentrations in µg/L)

Sample Date	Year	CBD5	BS1	CBD1	SSB	SR1
6/7	2006	0.08	ND	0.06	ND	ND
6/21	2006	31.2	1.36	3.30	ND	0.18
6/23	2006	0.35	0.45	0.67	ND	ND
6/28	2006	0.24	0.88	0.18	ND	ND
7/6	2006	ND	0.79	ND	ND	ND
7/12	2006	0.07	0.46	0.23	ND	ND
6/6	2007	2.42	0.46	1.60	ND	-
6/13	2007	0.85	1.08	0.64	0.20	-
6/20	2007	0.20	0.37	0.13	0.08	-
6/27	2007	0.14	0.14	0.11	0.29	-
7/4	2007	0.36	0.37	0.06	0.05	-
7/11	2007	ND	0.11	ND	ND	-
7/18	2007	ND	ND	0.08	ND	-
7/24	2007	ND	ND	ND	ND	-
6/4	2008	ND	ND	ND	ND	ND
6/11	2008	ND	ND	ND	ND	ND
6/18	2008	1.34	1.29	ND	ND	ND
6/25	2008	0.24	0.16	ND	ND	ND
7/2	2008	ND	ND	ND	ND	ND
7/16	2008	0.31	0.14	0.35	ND	0.23
7/23	2008	ND	ND	ND	4.18	ND
6/2	2009	1.9	ND	ND	ND	-
6/9	2009	11	1.7	3.5	0.36	-
6/16	2009	3.1	1.3	2.0	0.76	-
6/23	2009	0.64	0.66	0.26	ND	-
6/30	2009	ND	ND	ND	ND	-
7/7	2009	0.38	ND	0.065	0.25	-
7/14	2009	ND	ND	ND	12	-
7/21	2009	ND	ND	ND	ND	-

NOTE:
SR1 was not tested for propanil in 2007 and 2009.

Propanil Guidance

Propanil RED. The EPA amended propanil reregistration eligibility decision (RED), finalized in March 2006, set new water holding periods for permanent flood rice in California. The initial RED recommendation required that rice paddy water containing newly applied propanil be held for a minimum of 30 days before being released. The amended RED, determined by modeling propanil degredation, set a water hold period of 7 days for permanent flood rice in California, with an assumed application rate of one or two applications of 4 lbs active ingredient (a.i.)/acre (maximum seasonal application of 8 lbs a.i./acre). The water hold mitigation measure was expected to reduce the off-field concentrations of propanil to levels such that concentrations of propanil would be below levels of concern for aquatic organisms.

Potential risks to fish and invertebrates are expected to be prevented if the holding periods are fully implemented; however, acute risks have been estimated for birds, small mammals, freshwater invertebrates, and nontarget aquatic plants, and chronic risks have been identified for small mammals and freshwater fish and invertebrates.

To reduce the exposure to propanil, the EPA has determined concentrations of concern to endangered and nonendangered species of fish and aquatic invertebrates (Table 5-18) based on the most sensitive toxicity endpoints (Table 5-19), and the minimum water-holding periods in rice fields that would reduce predicted exposure to these organisms (Table 5-20) (EPA, 2006). The EPA's review of propanil resulted in a determination that propanil will have "no effect" on threatened and endangered aquatic species from the use on rice, with the implementation of the water holding periods (discharge intervals) in rice paddies.

Review of Propanil Endpoints. Dr. Lenwood Hall prepared a report that compared the toxicity of propanil and 3,4 – DCA (the primary metabolite) using ecological toxicity data from similar aquatic species and similar measurement endpoints and applied a probabilistic approach for analyzing the distribution of propanil using the 2006-2008 core site data (Hall, 2009). This report is being reviewed by CVRWQCB staff.

TABLE 5-18
Environmental Concentrations of Concern for Freshwater Aquatic Species (based on Propanil RED Table 18[a])

Test Species	Acute Exposure Concentration of Concern (ppb)[b]	Chronic Exposure Concentration of Concern (ppb)[c]
Freshwater Fish	115	9.1
Freshwater Invertebrate	60	86

NOTES:
[a] Please see the Propanil RED for more information.
[b] Acute concentration of concern = risk quotient level of concern * most sensitive LC50
[c] Chronic concentration of concern = risk quotient level of concern * most sensitive NOAEL (No Observed Adverse Effect Level).

TABLE 5-19
Toxicity Values Used to Calculate Target Environmental Concentrations (based on Propanil RED Table 19)

Test Species	Exposure Type	Most Sensitive Species (Surrogate)	Toxicity
Freshwater Fish	Acute	Rainbow trout	LC50 = 2,300 ppb
Freshwater Invertebrate		Daphnia magna	EC50 = 1,200 ppb
Freshwater Fish	Chronic	Fathead minnow	NOAEC = 9.1 ppb
Freshwater Invertebrate		Daphnia magna	NOAEC = 86 ppb

TABLE 5-20
Required Holding Periods (days) to Reduce Acute Risk for Aquatic Organisms Based on EPA Modeling (based on Propanil RED Table 20)

Rice Production Method (Location)	Freshwater Invertebrate (2/1 apps)*	Freshwater Fish (2/1 apps)*
Water seeded (California)	7/7	1/1

NOTE:
* Based on Level of Concern = 0.05 for risk to endangered species because there are known endangered freshwater fish and invertebrates.

Comparison of Propanil RED Targets to Measured Concentrations. Two events during the 2009 sampling season had a concentration of propanil above the chronic exposure target for freshwater fish. Site F had a propanil concentration of 47 µg/L (ppb) during the 6/3/09 monitoring event, and site SSB had a propanil concentration of 12 µg/L (ppb) during the 7/14/09 monitoring event. If propanil holds were followed, EPA propanil modeling shows that the propanil concentrations should not have been this high (Table 5-20). All of this information is being considered as part of the development of the 2010 MRP requirements.

UC Davis Edge-of-Field Monitoring

The MRP requirements incorporate reporting of monitoring conducted under UC Davis CALFED Grant 384. The grant was approved for funding by the SWRCB on June 17, 2004 (Resolution No. 2004-0035) and contains four study components producing data to be submitted by UC Davis (UCD) to the CVRWQCB.

The grant contract is entitled "The Regents of the University of California, University of California Davis—State Water Resources Control Board Grant Agreement No. 04-183-555-0." UC Davis, with significant input and oversight by CVRWQCB staff, developed a monitoring plan that specifies the parameters of monitoring activities to be conducted under the grant. On behalf of the SWRCB, the grant is managed by a CVRWQCB staff person.

Due to the State's budget crisis, in 2008, all state grants and contracts funded by General Obligations Bonds were suspended due to lack of State funding. This suspension of funding has delayed UC Davis' ability to produce the final technical report evaluating the collected data. In lieu of the UC Davis report, a brief analysis of available data is included herein, to meet the intent of the monitoring requirement specified in the MRP. It is assumed that all of the data have been collected; preliminary data and an assessment will be presented here as a way to complete the MRP reporting responsibility outside of grant funding constraints.

Descriptions of each study component's purpose and parameters follow.

Study Component 1 – Organic Carbon, Salinity, and Turbidity in Rice Field Outflows

Study Component 1 is focused on the evaluation of total organic carbon and dissolved organic carbon (TOC/DOC), TDS and EC, and turbidity of outflows from rice fields cultivated under differing straw decomposition and winter flood practices. This component includes the evaluation of a minimum of four fields with two plots per field.

Study Component 2 – Organic Carbon, Salinity, and Turbidity in Peripheral Canals

Study Component 2 is designed to measure the amount and transport of TOC and DOC, TDS and EC, and turbidity in rice field peripheral drains. Peripheral drain sites are to be located downstream of the fields used in Study Component 1.

Study Component 3 - Impact of Alternative Seeding Methods on pest management and Pesticide Outflows

Study Component 3 is designed to determine the impact of alternative seeding methods on pest management and pesticide outflows from rice fields, including a water seeded and a conventionally farmed field, and a dry-seeded and conventionally farmed rice field. Data from this portion of the study are not included because they have not been through the UCD quality control process at this time.

Study Component 4 – Nitrogen and Phosphorus Concentrations in Rice Field Outflows

Study Component 4 is to measure the impact of alternative rice-seeding methods and irrigation management on nitrogen and phosphorus outflows from rice fields, including outflows from a water seeded and a conventionally farmed field, and a dry-seeded and conventionally farmed rice field.

Summary of Sampling

Sampling was typically performed every one to two weeks during the sampling seasons over the course of two years, May 2006 through April 2008. Sampling was scheduled to characterize discharges during two seasons, the growing season and the winter season, with three subseasons during each season: early, mid, and final. Table 5-21 shows the general definition of the seasons and subseasons.

Several fields were included the study. The fields were managed under either straw burning or flooded decomposition. Some fields used only one straw management approach for the entire study period, while others incorporated both approaches. Data from nine fields determined by UCD to have the most robust datasets were selected for analysis. Table 5-22 shows the field numbers and their rice straw management type for each period of the study.

The specific months defining each field's seasons depended on the grower's planting and harvest schedule, and vary by field, season and year. A more detailed calendar of the sampling dates for each season and subseason is shown in Figure 5-7.

Analysis for TOC, DOC, EC, TDS, turbidity, nitrogen and phosphorus were all conducted in Dr. Johan Six's laboratory at UCD. The potassium analysis was conducted at the UCD soil testing lab. Sampling and analysis was conducted according to a QAPP developed by UCD for the grant project.

TABLE 5-21
UC Davis Edge-of-Field Monitoring Seasons

Seasons and Subseasons	Months
Growing Season	
Early Subseason	June - July
Mid-Subseason	July - August
Final Drain Subseason	August - September
Winter Season	
Early Subseason	November - December
Mid-Subseason	November - February
Final Drain Subseason	January - March

TABLE 5-22
Study FIelds, Seasons, and Rice Straw Management Approach

Field Number	Season	Year	Rice Straw Management Approach
3	Growing	1	Incorporated
	Winter	1	Burned
	Growing	2	Burned
	Winter	2	Incorporated
5	Growing	1	Incorporated
	Winter	1	Incorporated
	Growing	2	Incorporated
	Winter	2	Incorporated
6	Growing	1	Burned
	Winter	1	Burned
	Growing	2	Burned
	Winter	2	Burned
7	Growing	1	Incorporated
	Winter	1	-
	Growing	2	-
	Winter	2	-
8	Growing	1	Burned
	Winter	1	-
	Growing	2	Burned
	Winter	2	Burned
9	Growing	1	Incorporated
	Winter	1	Incorporated
	Growing	2	Incorporated
	Winter	2	Incorporated
10	Growing	1	Burned
	Winter	1	Burned
	Growing	2	Burned
	Winter	2	Incorporated
11	Growing	1	-
	Winter	1	Incorporated
	Growing	2	Incorporated
	Winter	2	Incorporated
12	Growing	1	-
	Winter	1	-
	Growing	2	Incorporated
	Winter	2	Incorporated

Year 1, Season 1

Field Number	Year	Season	Subseason	Dates
3	1	1	1	6/1/06
			2	7/21/06 - 8/25/06
			3	UNK
5	1	1	1	6/2/06 - 6/9/06
			2	7/18/06 - 8/11/06
			3	9/3/06
6	1	1	1	6/2/06 - 6/9/06
			2	7/11/06 - 7/18/06
			3	8/4/06 - 8/11/06
7	1	1	1	UNK - 7/28/06
			2	8/4/06 - 8/11/06
			3	UNK
8	1	1	1	UNK
			2	7/21/06 - 8/11/06
			3	UNK
9	1	1	1	-
			2	8/25/06
			3	9/3/06
10	1	1	1	-
			2	8/4/06
			3	8/25/06
11	1	1	1	-
			2	-
			3	-
12	1	1	1	-
			2	-
			3	-

Year 1, Season 2

Field Number	Year	Season	Subseason	Dates
3	1	2	1	11/17/06 - 12/11/06
			2	12/18/06 - 2/12/07
			3	2/14/07 - 3/2/07
5	1	2	1	10/19/06 - 11/8/06
			2	11/17/06 - 1/17/07
			3	1/29/07 - 2/28/07
6	1	2	1	-
			2	12/13/06 - 2/28/07
			3	-
7	1	2	1	-
			2	-
			3	-
8	1	2	1	-
			2	-
			3	-
9	1	2	1	11/12/2006
			2	12/11/06 - 12/18/06
			3	2/1/07 - 2/28/07
10	1	2	1	-
			2	-
			3	2/12/07 - 2/16/07
11	1	2	1	UNK
			2	UNK
			3	2/14/07 - 3/2/07
12	1	2	1	-
			2	-
			3	-

Year 2, Season 1

Field Number	Year	Season	Subseason	Dates
3	2	1	1	6/20/07 - 7/18/07
			2	8/9/2007
			3	9/12/2007
5	2	1	1	5/18/07 - 6/1/07
			2	7/2/07 - 8/13/07
			3	8/15/07 - 8/17/07
6	2	1	1	4/20/07 - 5/10/07
			2	5/24/07 - 7/30/07
			3	8/13/07 - 8/22/07
7	2	1	1	-
			2	-
			3	-
8	2	1	1	5/1/07 - 5/2/07
			2	6/8/07 - 7/27/07
			3	8/21/07 - 8/31/07
9	2	1	1	-
			2	-
			3	8/27/07 - 9/3/07
10	2	1	1	-
			2	-
			3	8/27/07 - 8/31/07
11	2	1	1	UNK - 7/20/07
			2	7/20/07 - 8/29/07
			3	9/12/2007
12	2	1	1	5/1/07 - 6/8/07
			2	6/28/07 - 8/13/07
			3	8/21/07 - 8/24/07

Year 2, Season 2

Field Number	Year	Season	Subseason	Dates
3	2	2	1	11/1/07 - 11/17/07
			2	12/12/07 - 2/7/2008
			3	2/22/08 - 2/25/08
5	2	2	1	10/15/07 - 11/7/07
			2	11/17/07 - 1/28/08
			3	1/30/08 - 2/11/08
6	2	2	1	-
			2	12/19/07 - 2/4/08
			3	-
7	2	2	1	-
			2	-
			3	-
8	2	2	1	-
			2	1/7/08 - 2/4/08
			3	2/8/08 - 2/13/08
9	2	2	1	10/25/07 - 11/17/07
			2	12/7/07 - 2/4/08
			3	2/13/08 - 2/25/08
10	2	2	1	12/7/2007
			2	2/1/08 - 2/13/08
			3	2/18/08 - 2/25/08
11	2	2	1	12/19/07 - 1/11/08
			2	1/24/08 - 2/7/08
			3	2/22/08 - UNK
12	2	2	1	12/07/07 - 1/7/08
			2	1/24/08 - 2/4/08
			3	2/6/08 - 2/13/08

NOTES:

Season 1 = growing season. Season 2 = winter season.

Subseason 1 = early season, Subseason 2 = mid season, Sub Season 3 = final drain

FIGURE 5-7
Detailed Calendar of Sampling, 2006-2008

Results

Sampling results were grouped into growing and winter seasons, which were each further subdivided into early subseason, mid-subseason, and final drain subseason, as described above.

Study Component 1 – Organic Carbon, Salinity, and Turbidity in Rice Field Outflows

The summary of the initial results for Component 1, focused on the evaluation of TOC, DOC, TDS, EC, and turbidity of rice field outflows, are included in Table 5-23.

TABLE 5-23
Summary of Data for Organic Carbon, Salinity, and Turbidity Rice Field Outflow

	TOC	DOC	EC (uS)*	TDS (ppm)*	Turbidity (NTU)
Number of Observations	*457*	*457*	*444*	*442*	*448*
Minimum	0.80	0.01	2.09	6.84	0.26
Maximum	84.82	77.34	1677.00	849.00	1440.00
Average	15.45	13.34	299.20	149.94	63.76
Median	11.46	9.28	195.75	97.85	20.35
Standard Deviation	12.94	11.67	253.16	126.59	127.28
Variance	167.3	136.3	64088.4	16025.5	16199.2

* Revised dataset, as described below.

Raw Results Analysis

TOC and DOC

Figure 5-8 is a plot of TOC vs. DOC. As would be anticipated, the TOC and DOC results generally track with one another, and a linear regression ($R^2 = 0.92$) can characterize the relationship between the two parameters. As a percentage, the dissolved fraction (DOC) comprises between 44 and 100% of the total measured organic carbon, and averages 82%. During the majority of the monitoring, over 70% of the total measured carbon was made up of the dissolved fraction.

Figures 5-9 and 5-10 show scatter plot and histogram results of TOC measurements, respectively. Figures 5-11 and 5-12 show the scatter plot and histogram results of DOC measurements, respectively. Results were also plotted by month, as shown in Figure 5-13, to assess the range of organic carbon results observed over time. The following observations, specifically for TOC and applying generally to DOC, can be made from these data:

- Over 40% of TOC results are below 10 mg/L, with an additional 50% falling between 10 mg/L and 40 mg/L, and only 5% above 40 mg/L.
- The TOC results over 40 mg/L are substantially from Field 5 during the winter season.

- Concentrations of organic carbon appear to peak in the early part of each subseason, and rapidly decrease as the subseason progresses. As shown in Figure 5-13, October and November demonstrated the highest concentrations, with concentrations in all other months generally below 40 mg/L.

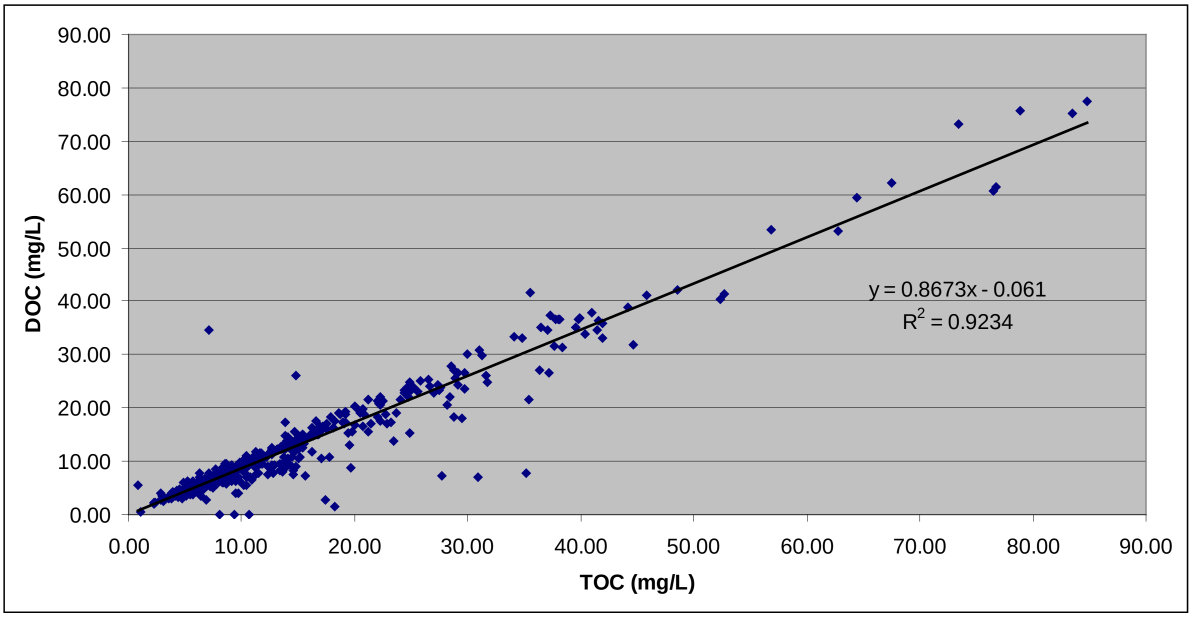


FIGURE 5-8
Regression Analysis of TOC and DOC Edge-of-Field Results

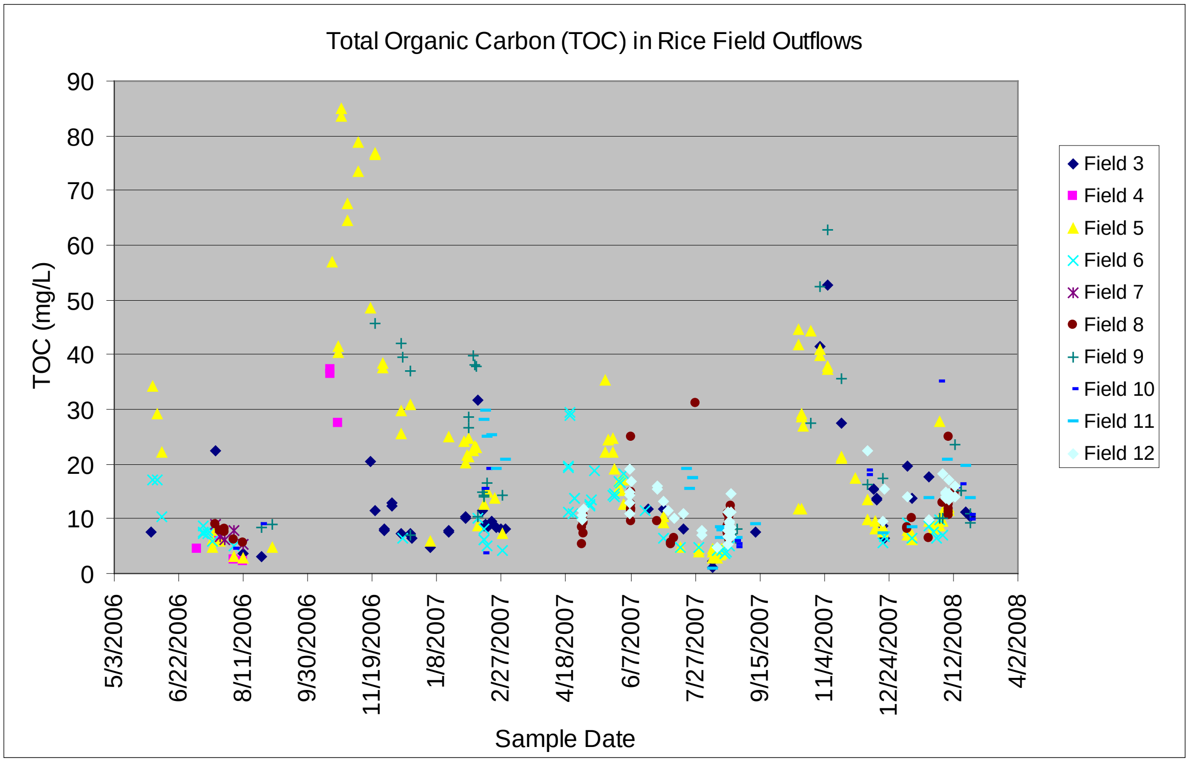


FIGURE 5-9
TOC in Rice Field Outflows

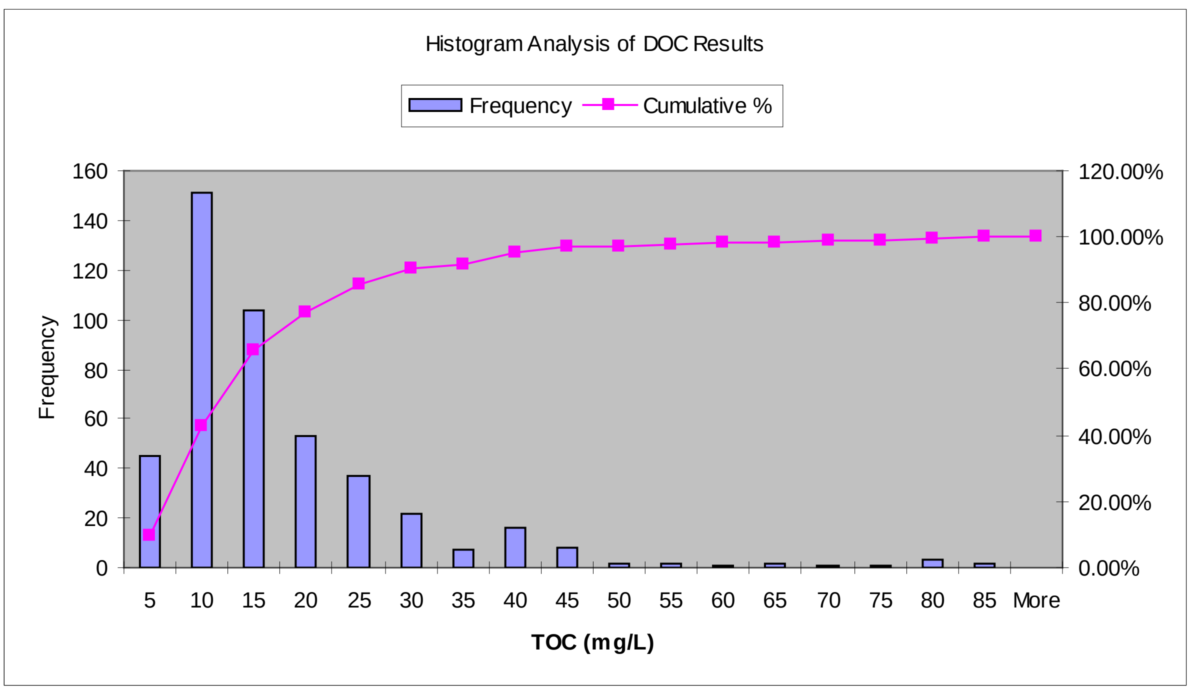


FIGURE 5-10
Histogram Analysis of TOC in Rice Field Outflows

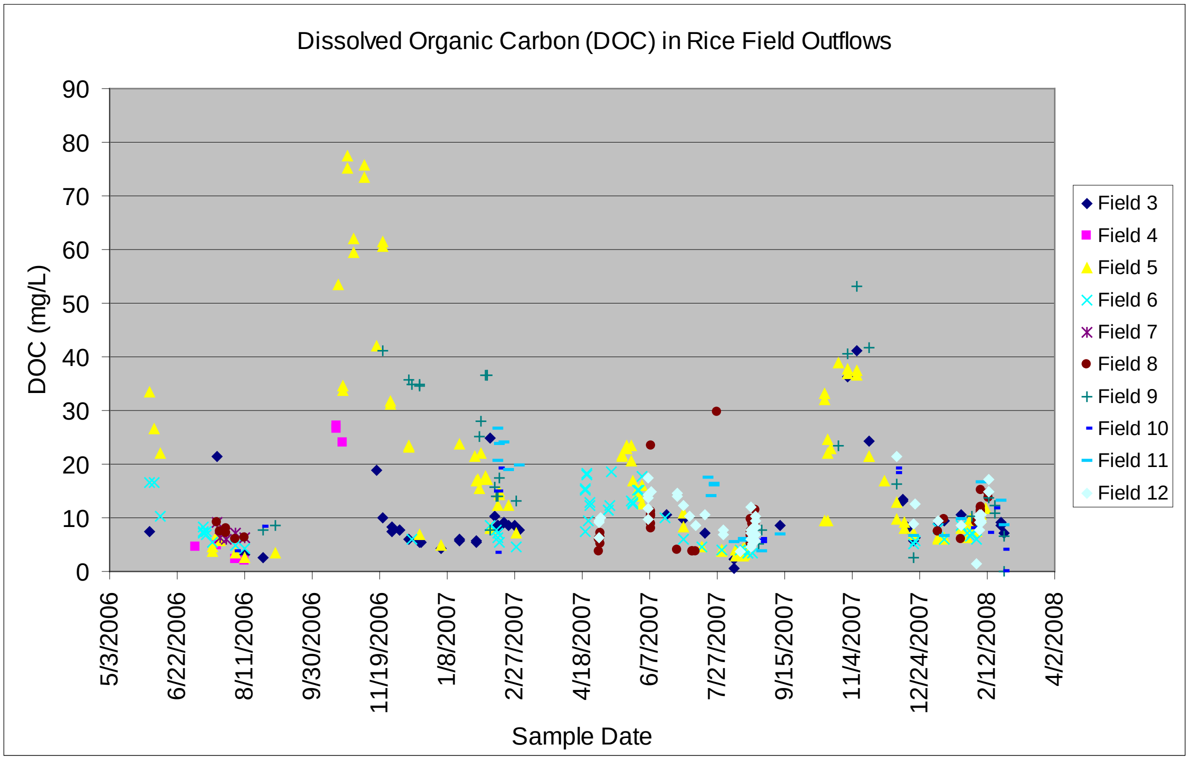


FIGURE 5-11
DOC in Rice Field Outflows

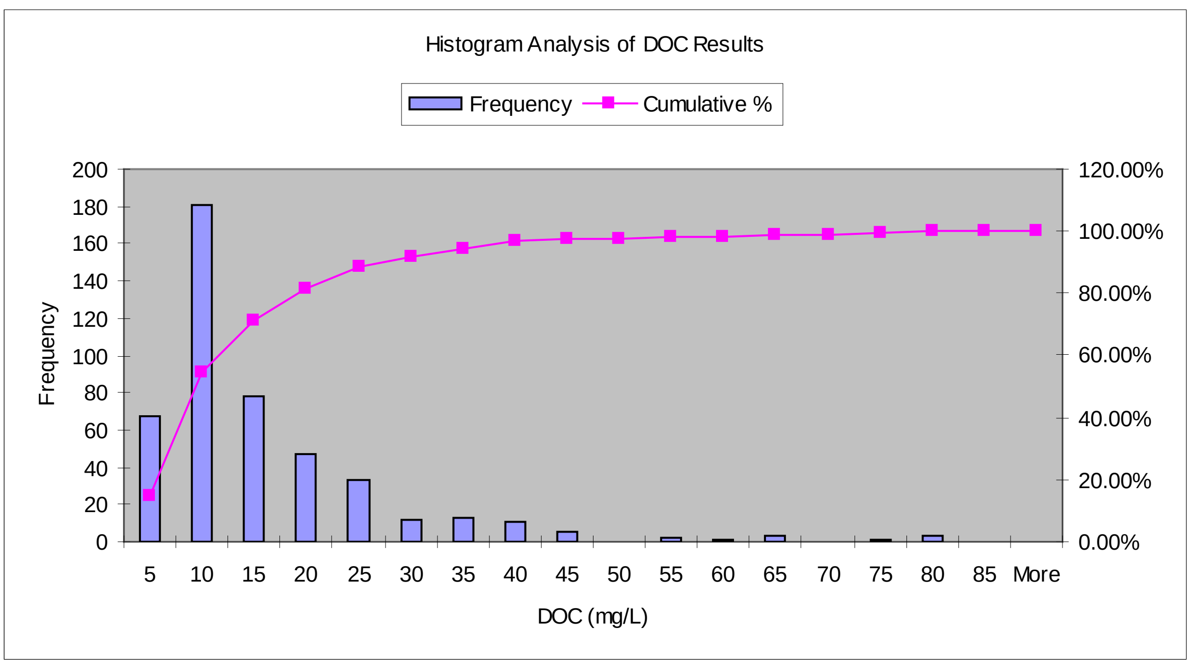


FIGURE 5-12
Histogram Analysis of DOC in Rice Field Outflows

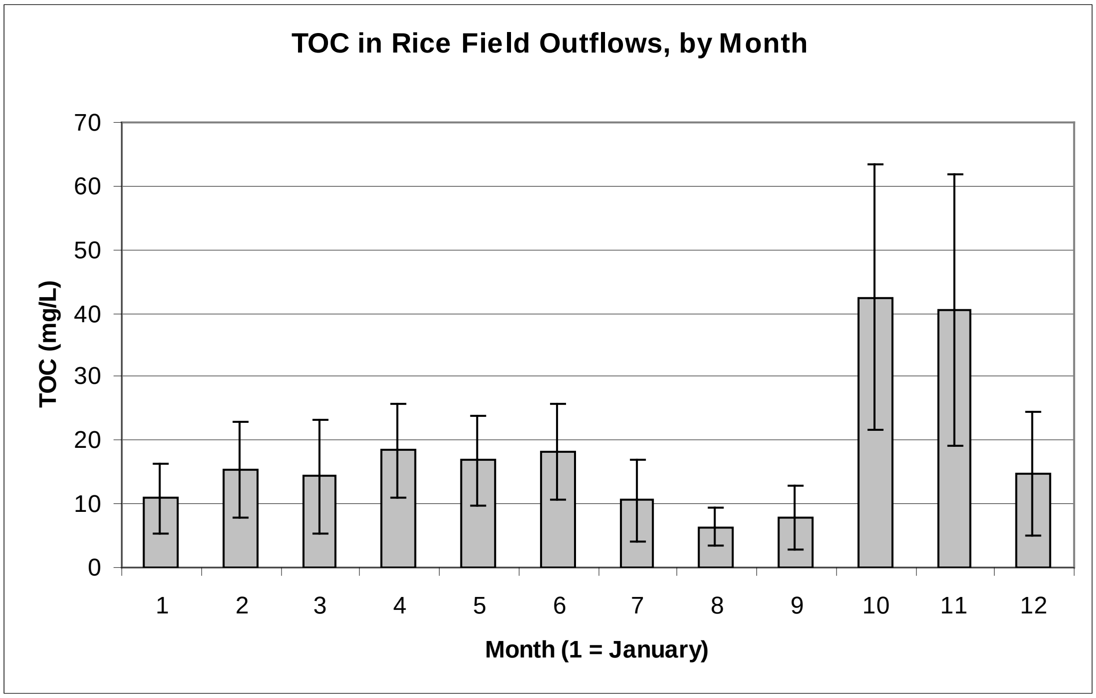


FIGURE 5-13
TOC in Rice Field Outflows, By Month (error bars show ±1 standard deviation)

EC and TDS

Figure 5-14 includes a plot of EC vs. TDS, which was developed as a means of checking data quality. EC and TDS should typically result in a linear regression with a high R^2 value. As shown, several values fall well off the regression line, and their inclusion results in an R^2 of 0.84. These values were deemed to be outliers and were removed from the EC/TDS dataset. The regression of this revised dataset is shown in Figure 5-15, and results in an R^2 of 0.995.

Figures 5-16 and 5-17 show the scatter plot and histogram results of TDS measurements, respectively. Figures 5-18 and 5-19 show the scatter plot and histogram results of EC measurements, respectively. Results were also plotted by month, as shown in Figure 5-20, to assess the range of TDS observed over time.

The following observations apply to TDS and EC results:

- The relationship between edge-of-field EC and TDS can be described by the equation EC = (0.4977 x TDS) + 1.1.
- Monthly average TDS ranged from 93 mg/L to 475 mg/L.
- Over 90% of the sites/dates had TDS values of less than 300 mg/L.
- Nearly 94% of the sites/dates had EC values of less than 700 µmhos. Results above 700 µmhos were typically associated with Field 12.
- June exhibited peak TDS concentrations. This appears to be substantially attributable to results from Fields 8 and 12 in 2007.

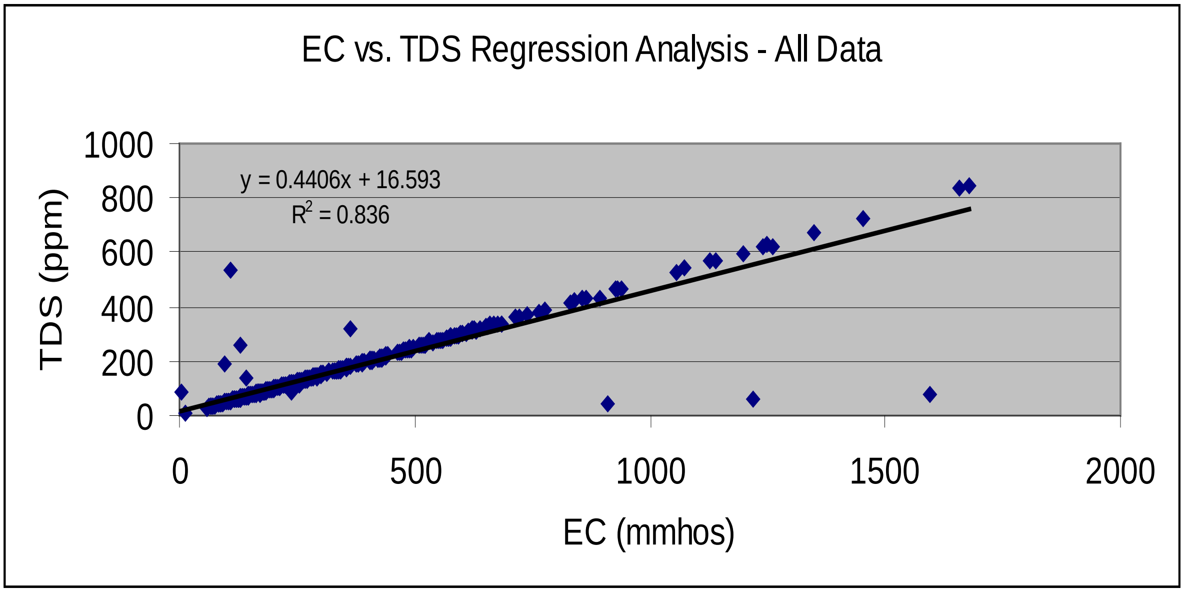


FIGURE 5-14
EC vs. TDS Regression – All Data

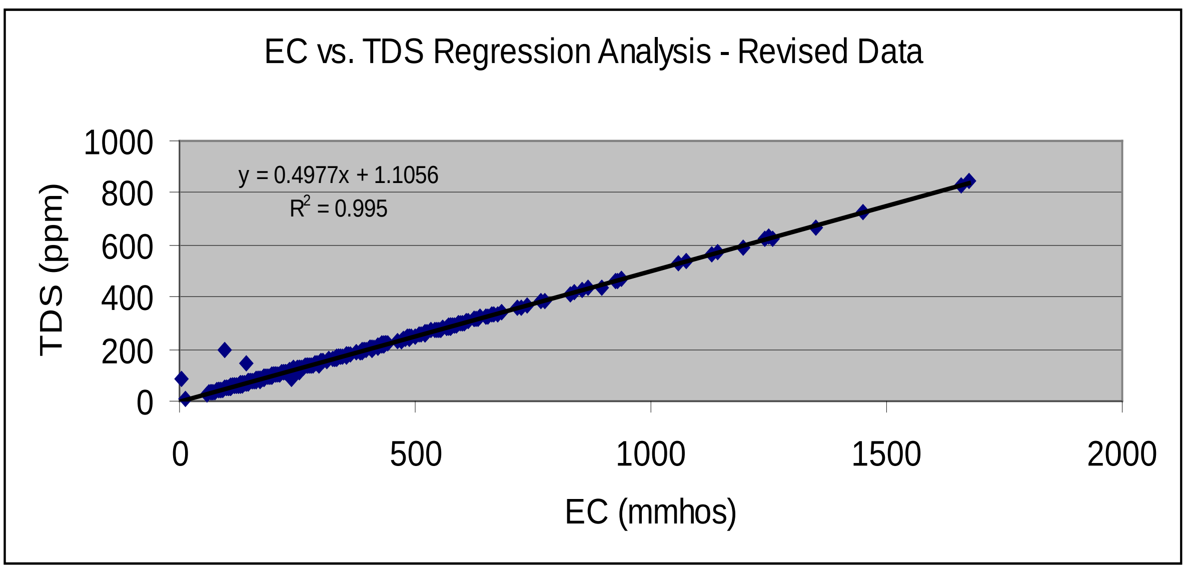


FIGURE 5-15
EC vs. Regression - Revised Data

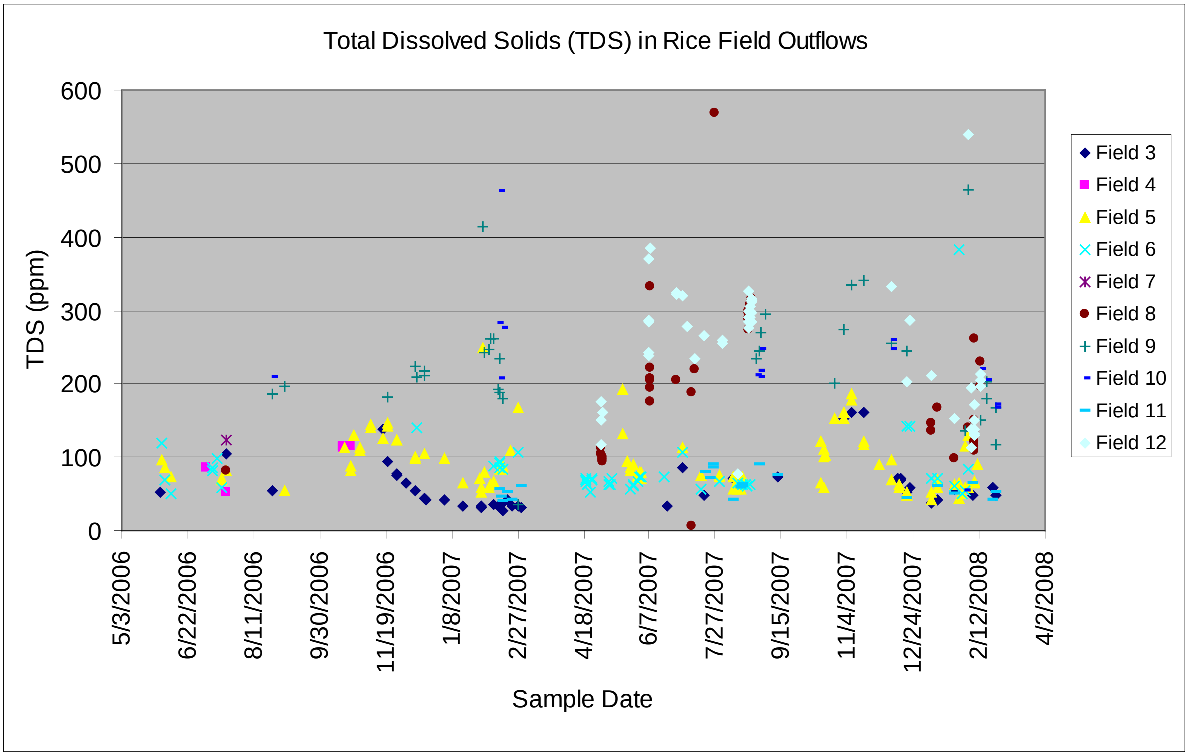


FIGURE 5-16
Total Dissolved Solids (TDS) in Rice Field Outflows

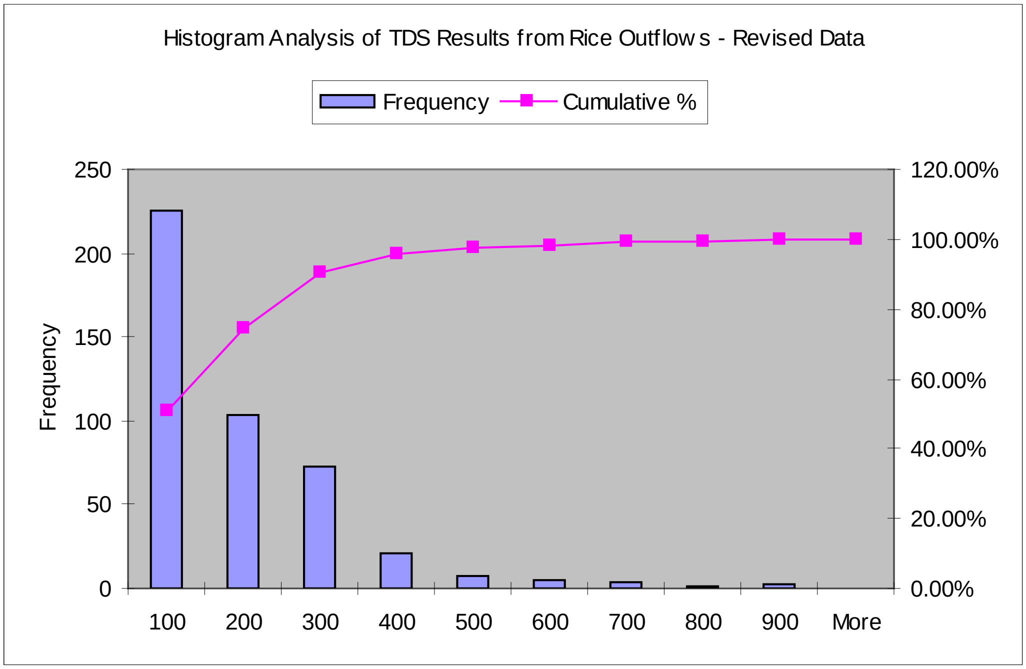


FIGURE 5-17
Histogram Analysis of TDS in Rice Field Outflows

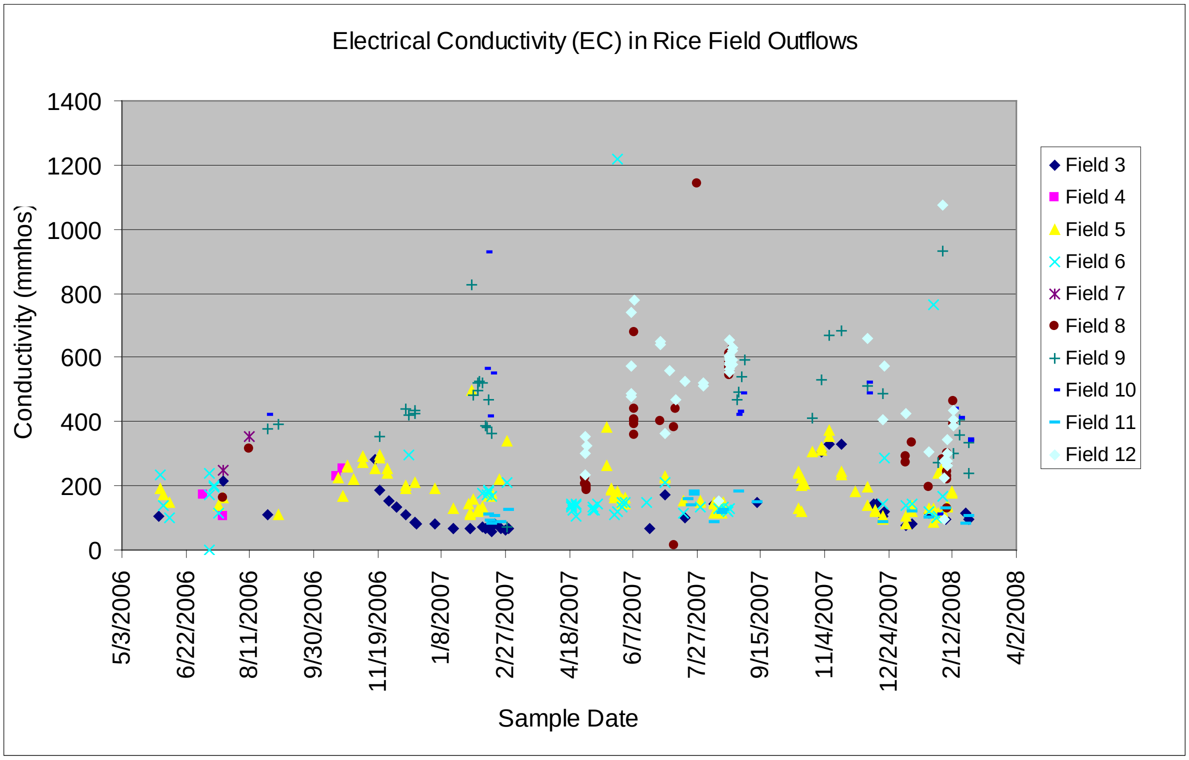


FIGURE5-18
Electrical Conductivity (EC) in Rice Field Outflows

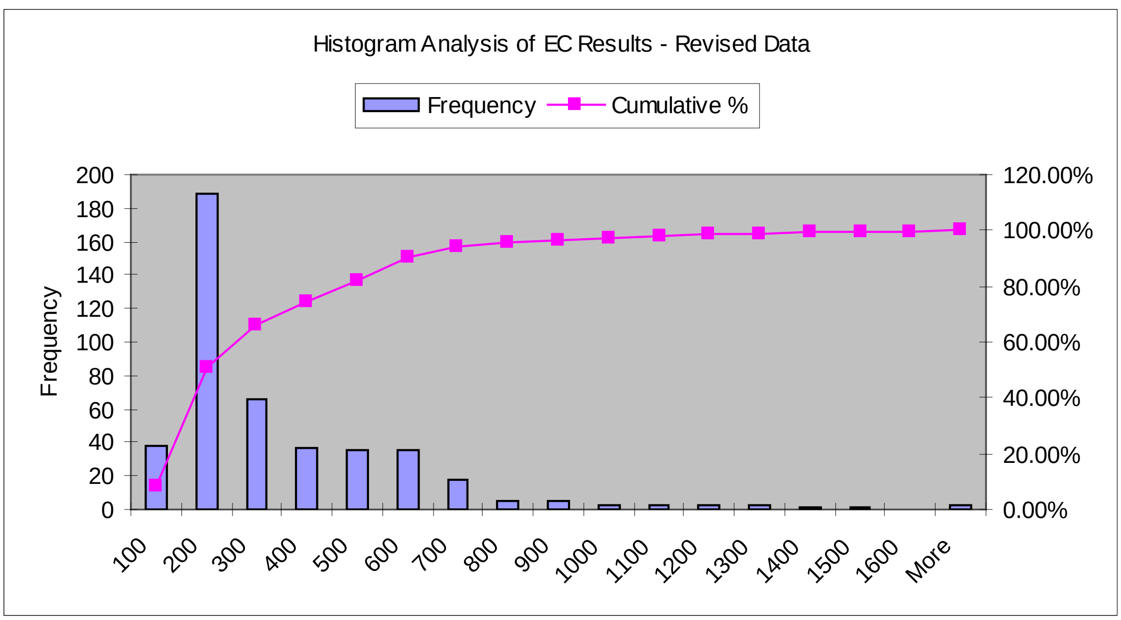


FIGURE 5-19
Histogram Analysis of EC in Rice Field Outflows

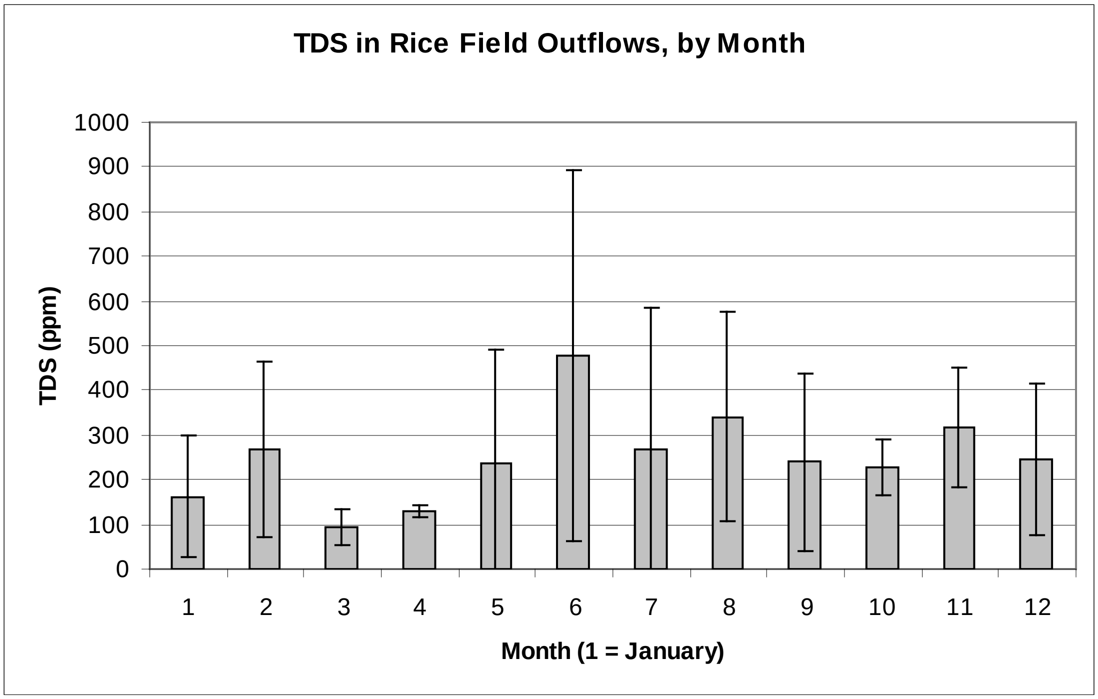


FIGURE 5-20
TDS in Rice Field Outflows, By Month (error bars show ±1 standard deviation)

Turbidity

Figures 5-21 and 5-22 show the scatter plot and histogram results of turbidity measurements, respectively. Results were also plotted by month, as shown in Figure 5-23, to assess the range of TDS observed over time.

The following observations apply to turbidity results:

- Over 80% of the sites/dates had a turbidity of less than 100 NTU. An additional 10% of the results ranged from 100 to 200 NTU. About 7% of the results showed turbidity greater than 200 NTU.
- Average monthly turbidity ranged from 9 to 219 NTU.
- Peak observations occurred in December through February, and were generally associated with fields 3 and 12.
- The highest average turbidity occurred in samples collected in April.

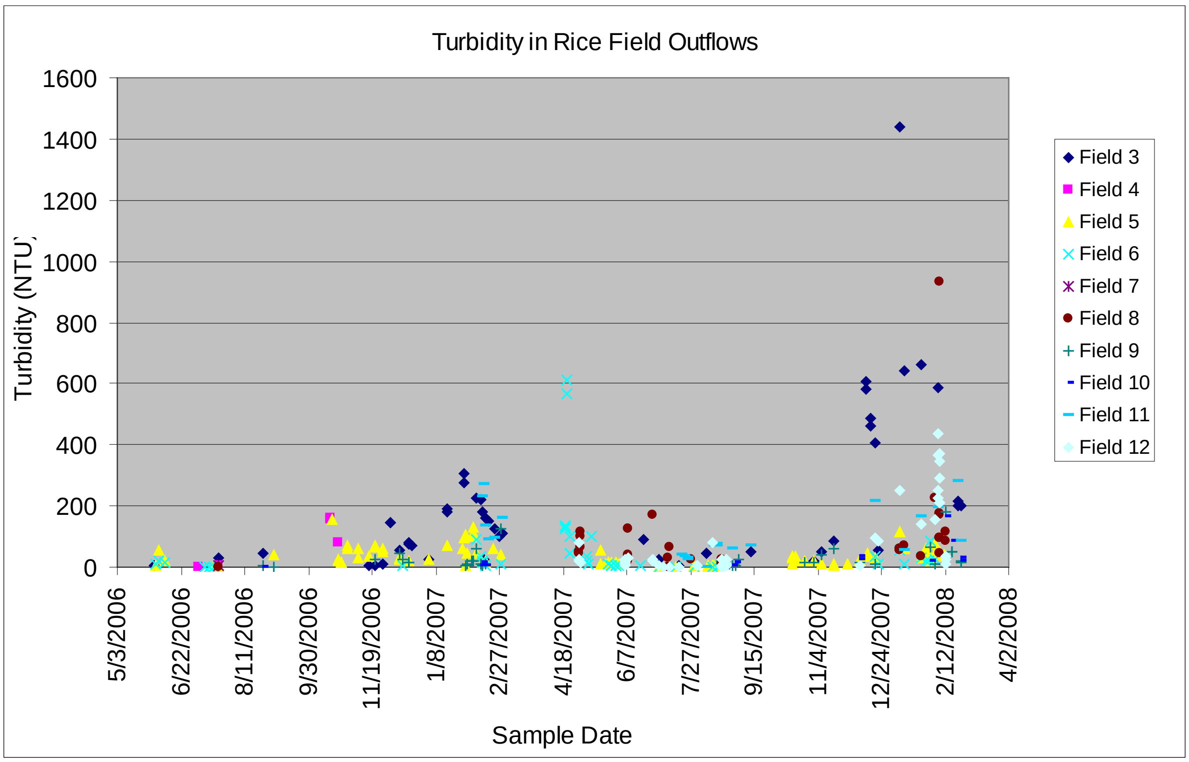


FIGURE 5-21
Turbidity in Rice Field Outflows

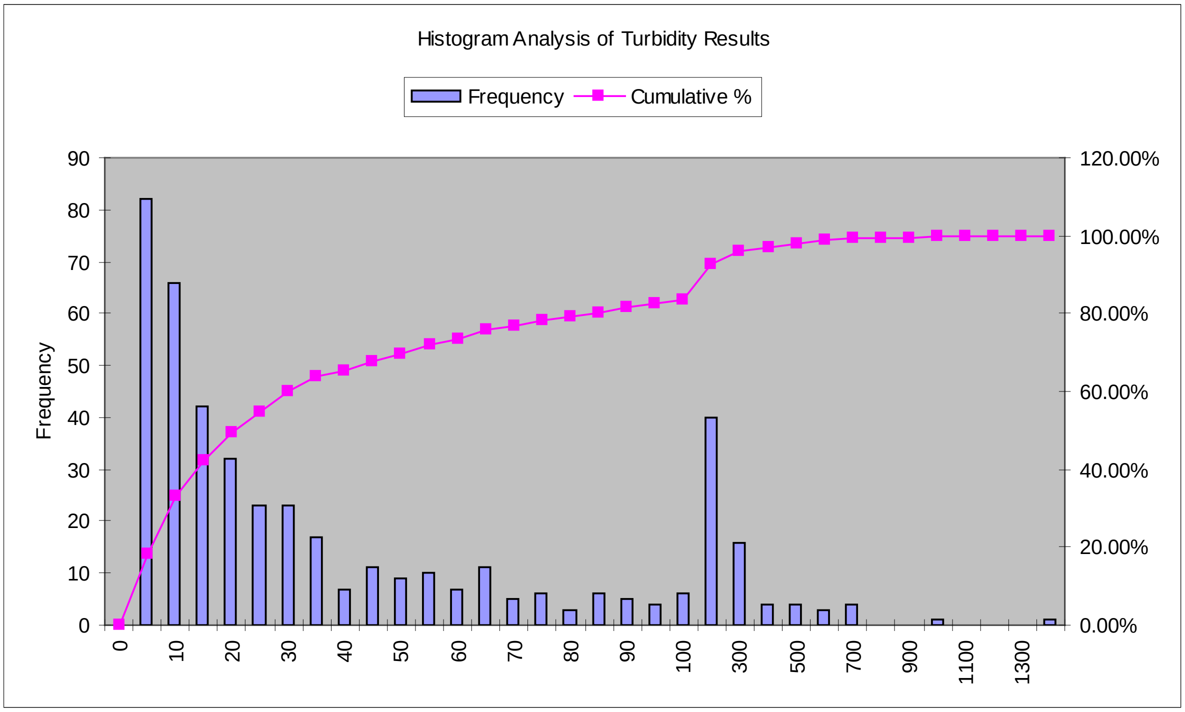


FIGURE 5-22
Histogram Analysis of Turbidity in Rice Field Outflows

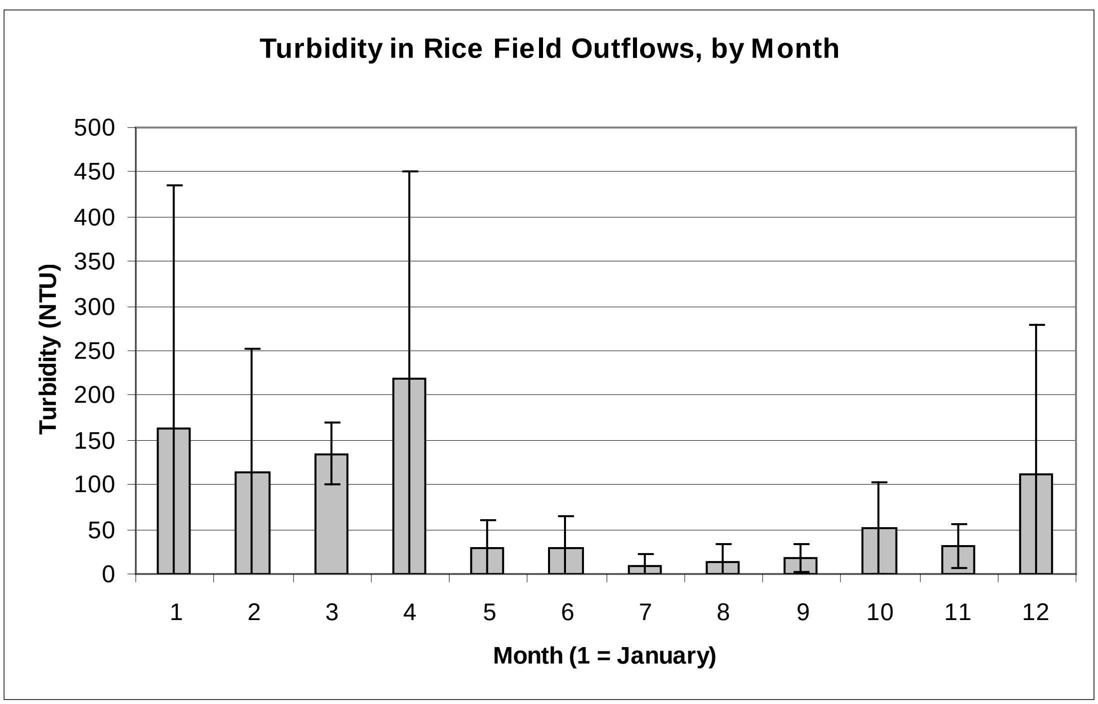


FIGURE 5-23
Turbidity in Rice Field Outflows, By Month (error bars show ±1 standard deviation)

Flow-Weighted Results

In addition to presentation of the raw scatterplot data, flow-weighted results were compiled to compare water quality results from the incorporated rice straw management fields and the burned fields, and to compare the results among seasons. These flow-weighted plots were prepared for DOC and TDS, which both specify their measurement in terms of mass.

DOC

Figure 5-24 shows the seasonal and straw management comparisons of edge-of-field DOC. The following summarizes initial observations about these data:

- In both the growing season and winter season, early subseason discharges of DOC were the highest.
- Winter season DOC results trended higher than growing season results.
- Burned field DOC discharges were generally lower during the early growing season than incorporated field discharges, but are similar during the mid- and final-subseasons of the growing season. Burned field DOC discharges were generally lower than incorporated field discharges in all subseasons of the winter season.

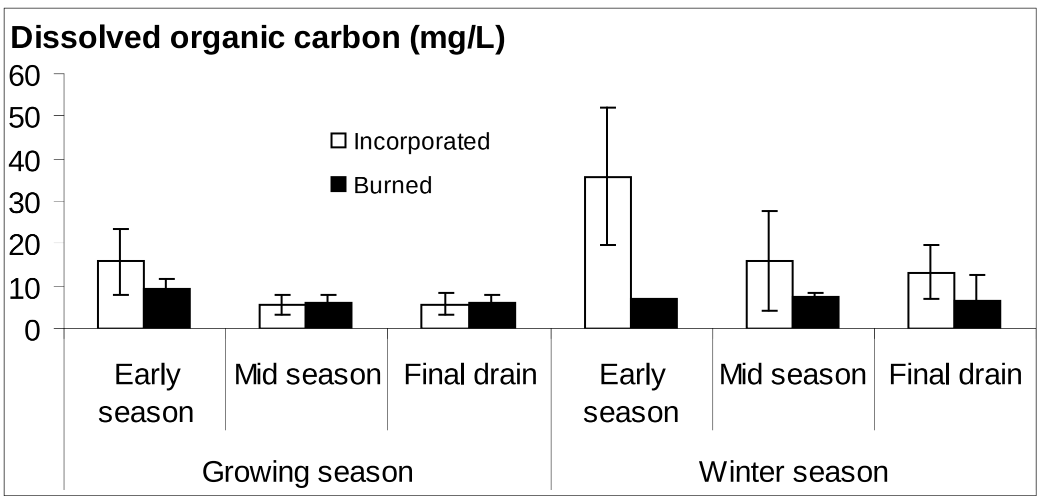


FIGURE 5-24
Comparison of Seasonal and Subseasonal DOC Flow-Weighted Edge-of-Field Results

TDS

Figure 5-25 shows the seasonal and straw management comparisons of edge-of-field TDS. The following summarizes initial observations about these data:

- Fields utilizing incorporated straw management generally had higher EC concentrations, though mid-subseason results are comparable.
- For incorporated fields, average dissolved solids discharges were relatively consistent among the subseasons, for both growing and winter seasons.
- Burned fields generally had lower TDS values than incorporated fields.

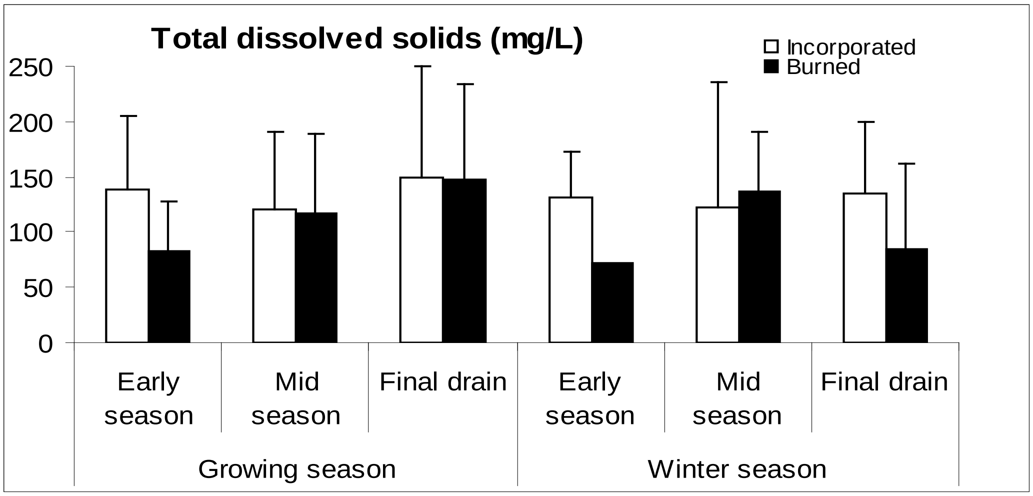


FIGURE 5-25
Comparison of Seasonal and Subseasonal TDS Flow-Weighted Edge-of-Field Results

Inlet vs. Outlet

Samples were collected at the water supply intakes to each of the fields (inlet samples). These samples are compared to edge-of-field samples (outlet samples) as a means of assessing overall contribution of rice fields to each of the parameters. Results of inlet and outlet measurements of DOC, TSS, and TDS are presented in Figure 5-26. As would be expected for these parameters, discharge concentrations are typically greater than supply concentrations.

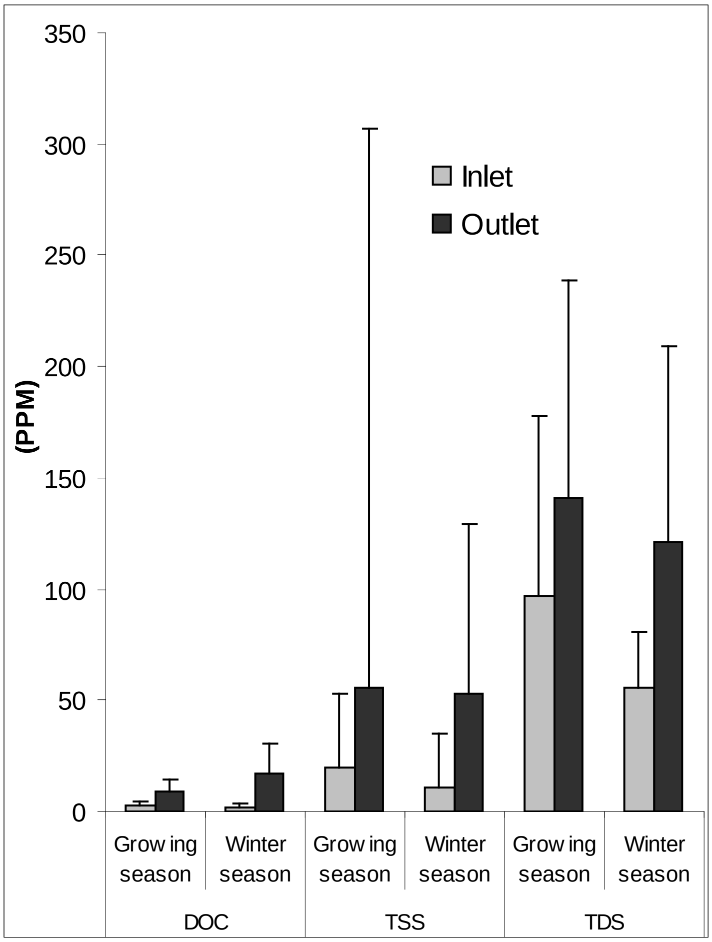


FIGURE 5-26
Comparison of Inlet and Outlet DOC, TSS, and TDS Concentrations

Study Component 2 – Organic Carbon, Salinity, and Turbidity in Peripheral Canals

The initial results for Component 2, focused on the evaluation of TOC, DOC, TDS, EC, turbidity in rice field peripheral drains, are included in Figures 5-27 through 5-38 and summarized in Table 5-24. Peripheral drains were defined by CVRWQCB to include drains immediately downstream of rice discharges. These drains typically convey only rice drainage (or storm runoff), and are typically constructed and maintained features designed to convey discharges to larger main drains, which in turn discharge to creeks, sloughs, or rivers.

TABLE 5-24
Summary of Peripheral Drain Water Quality Data

	TOC (mg/L)	DOC (mg/L)	TDS (ppm)	EC (μmhos)	Turbidity (NTU)
n	1279	1278	1222	1232	1220
min	0.005	0.005	0.87	1.71	0
max	107.2	84.89	1900	3260	1440
average	11.8	9.9	143.0	281.7	50.8
median	8.8	7.3	85.4	167.5	23.5
std dev	11.9	10.0	151.9	290.9	95.1
var	142.1	100.3	23086.9	84593.9	9052.9

Comparison of Edge-of-Field to Associated Peripheral Drain (100 feet Downstream)

The following comparisons can be drawn from the edge of field data to the peripheral drain data:

- Discharges of EC and TDS are generally assimilated in receiving drains.
- EC and TDS in canal are steady across seasons & subseasons.
- The highest increase in TDS is observed during the final subseason of the growing seasaon. This is likely a result of longer holding times during the final subseason of growing season, which result in greater evaporation and concentration of salts in the discharge water.
- Turbidity higher in canals, especially during the middle of each season.
- TOC concentrations are generally cyclical, tending to decrease during the mid subseason of both seasons. This same pattern is observed in both outlet & peripheral canal samples.
- TOC concentrations are similar in outlet and peripheral canal samples during growing season, but outlet concentrations are higher during winter season.
- DOC varied across seasons & subseasons, and generally higher concentrations are observed during winter.

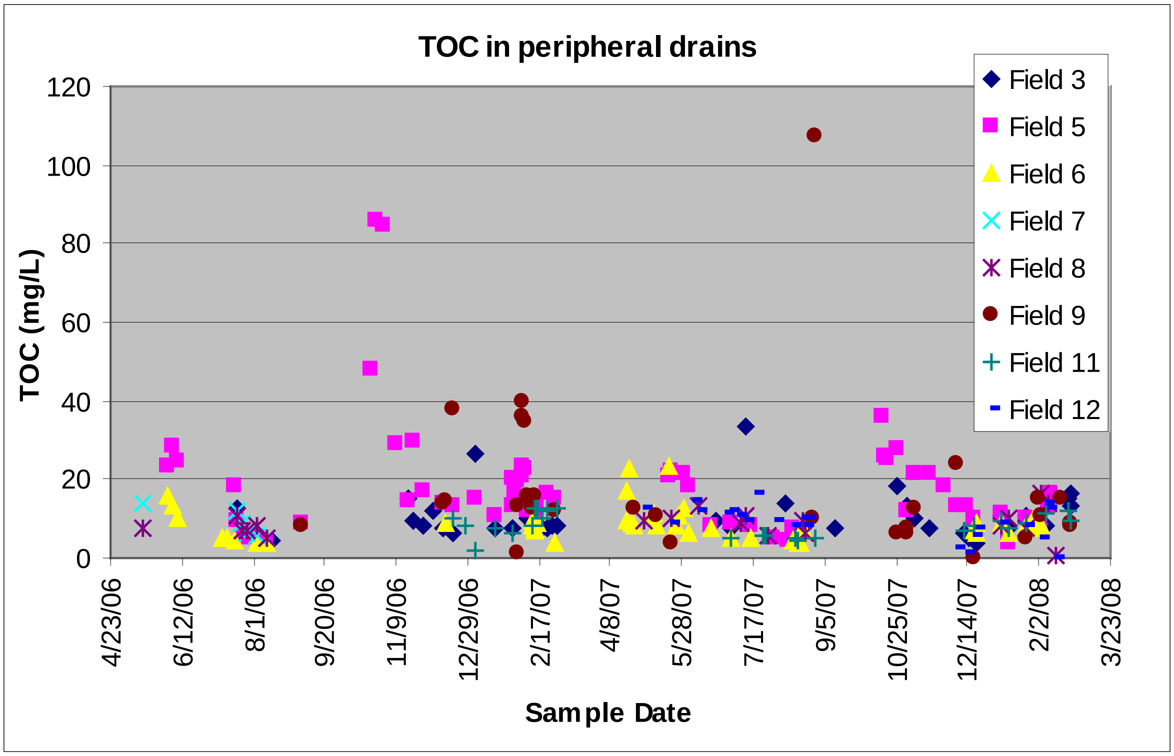


FIGURE 5-27
Total Organic Carbon (TOC) in Peripheral Drain Samples

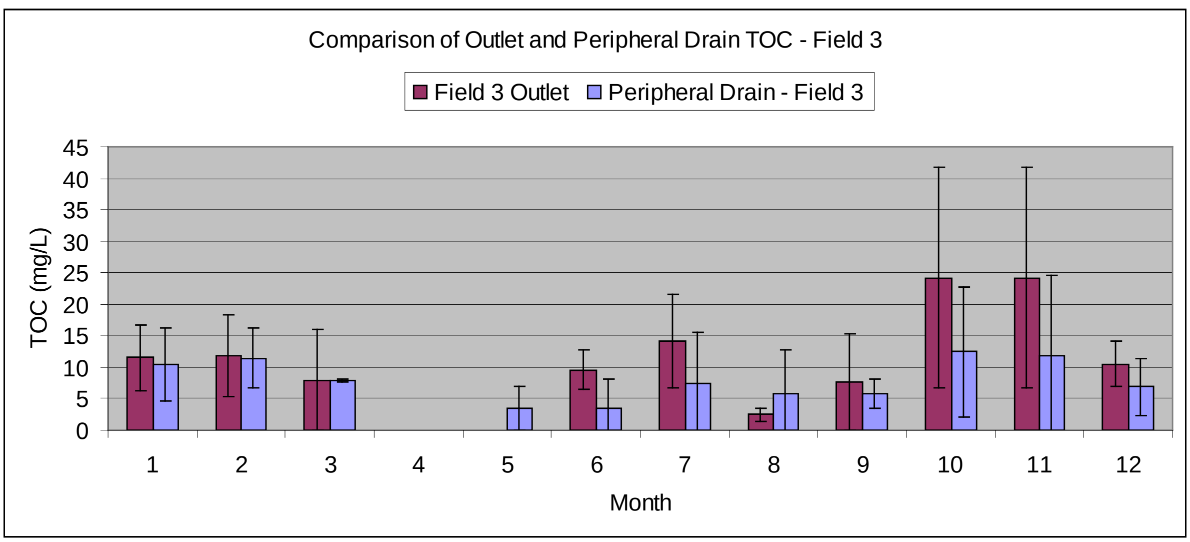


FIGURE 5-28
Comparison of Outlet and Peripheral Drain TOC – Field 3

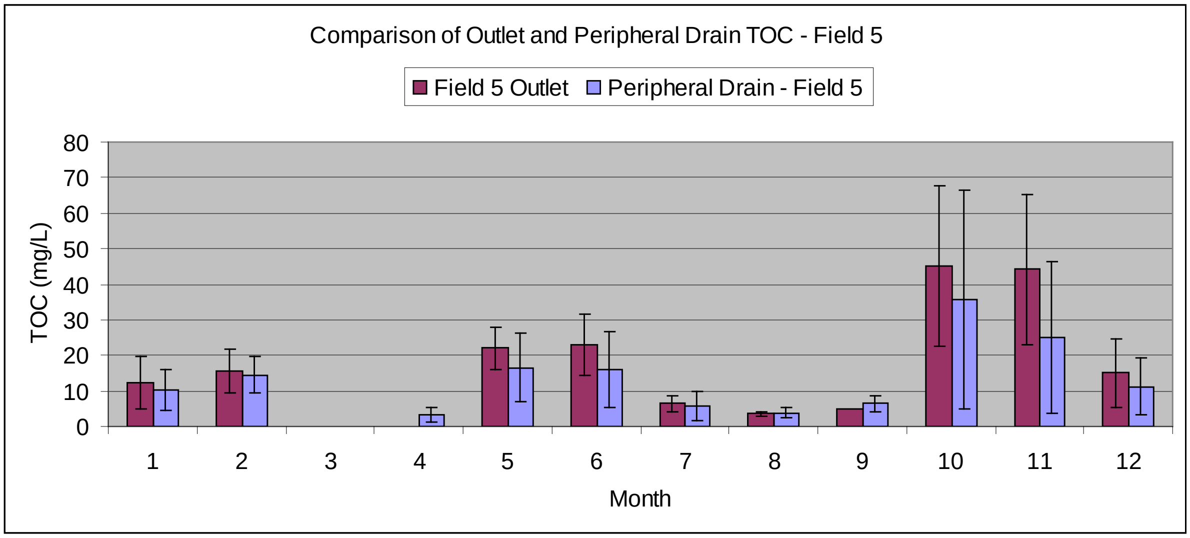


FIGURE 5-29
Comparison of Outlet and Peripheral Drain TOC – Field 5

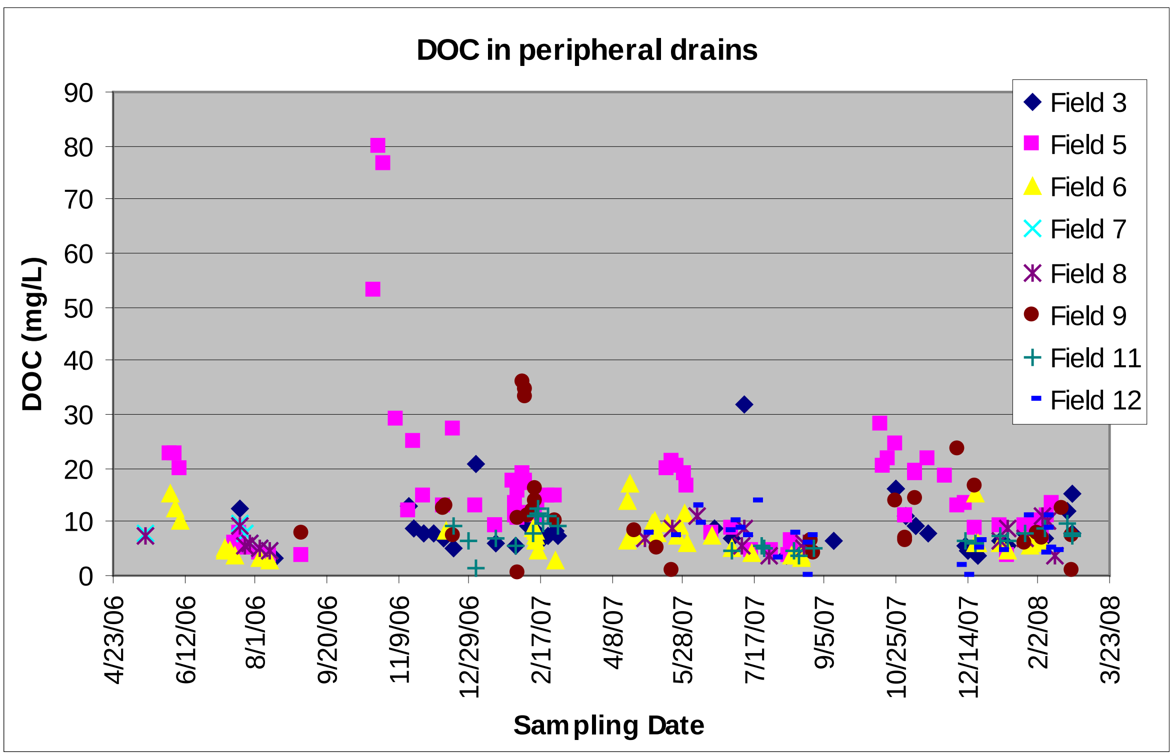


FIGURE 5-30
Dissolved Organic Carbon (DOC) in Peripheral Drain Samples

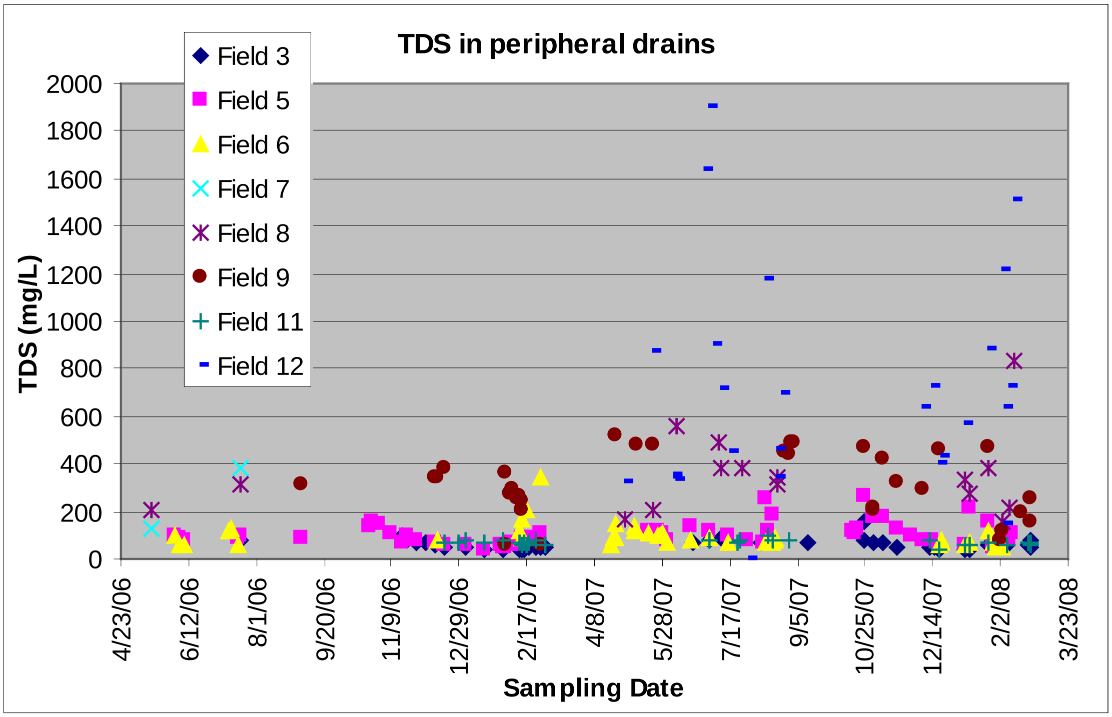


FIGURE 5-31
Total Dissolved Solids (TDS) in Peripheral Drain Samples

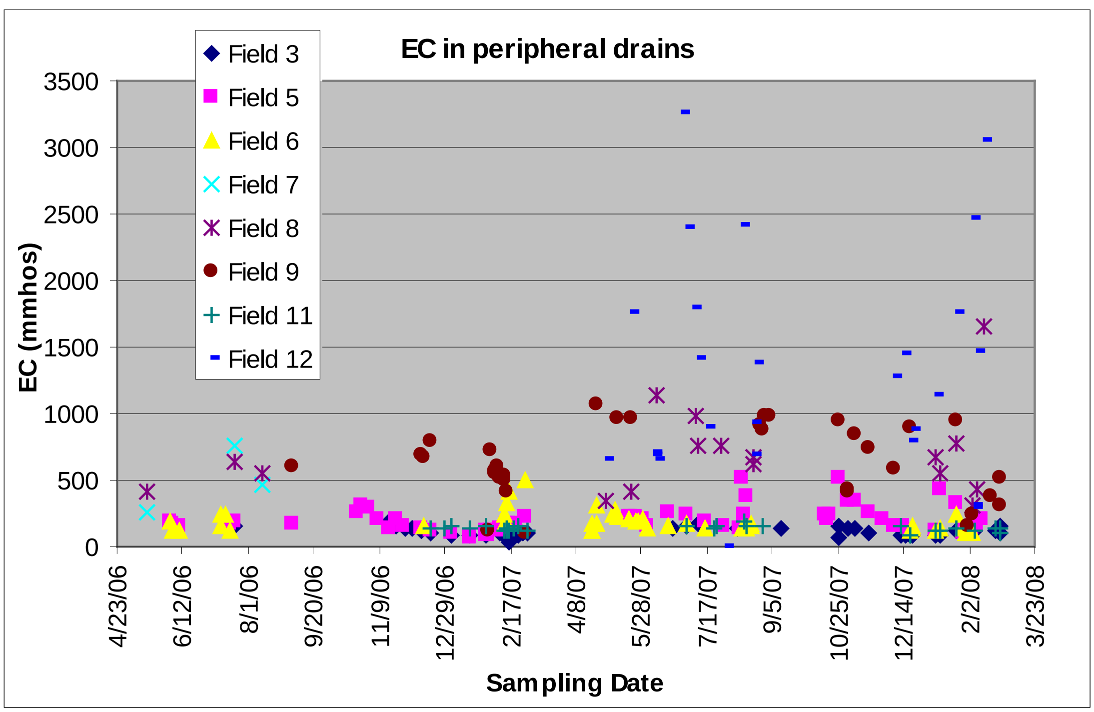


FIGURE 5-32
Electrical Conductivity in Peripheral Drain Samples

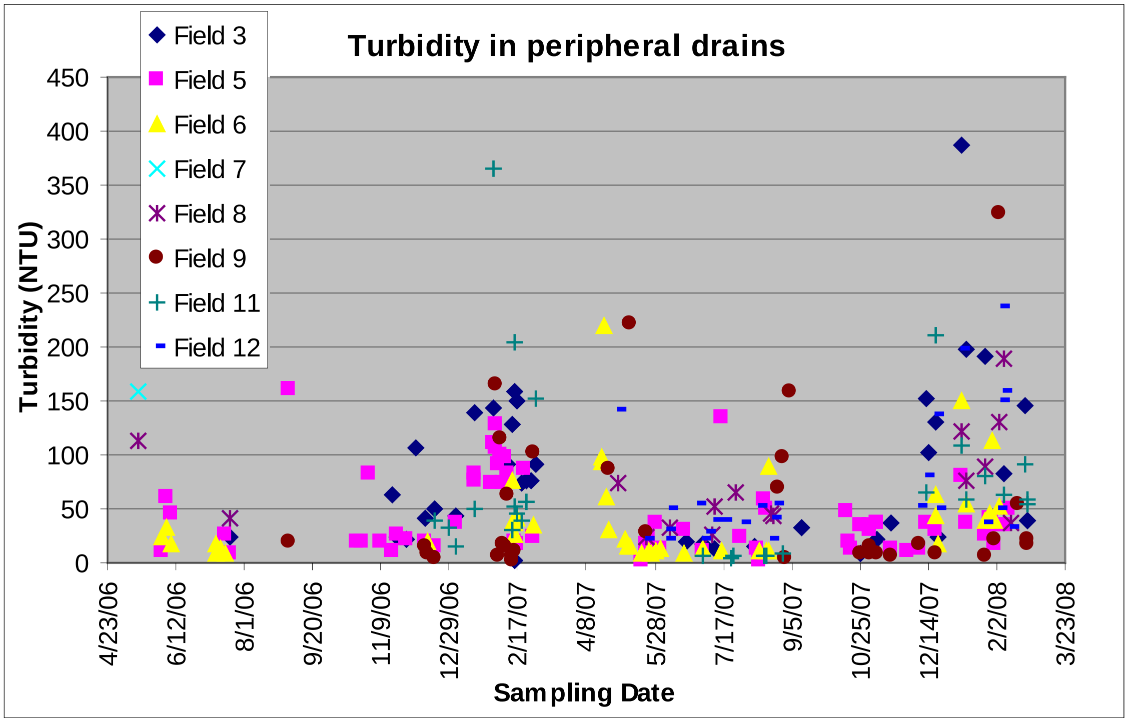


FIGURE 5-33
Turbidity in Peripheral Drain Samples

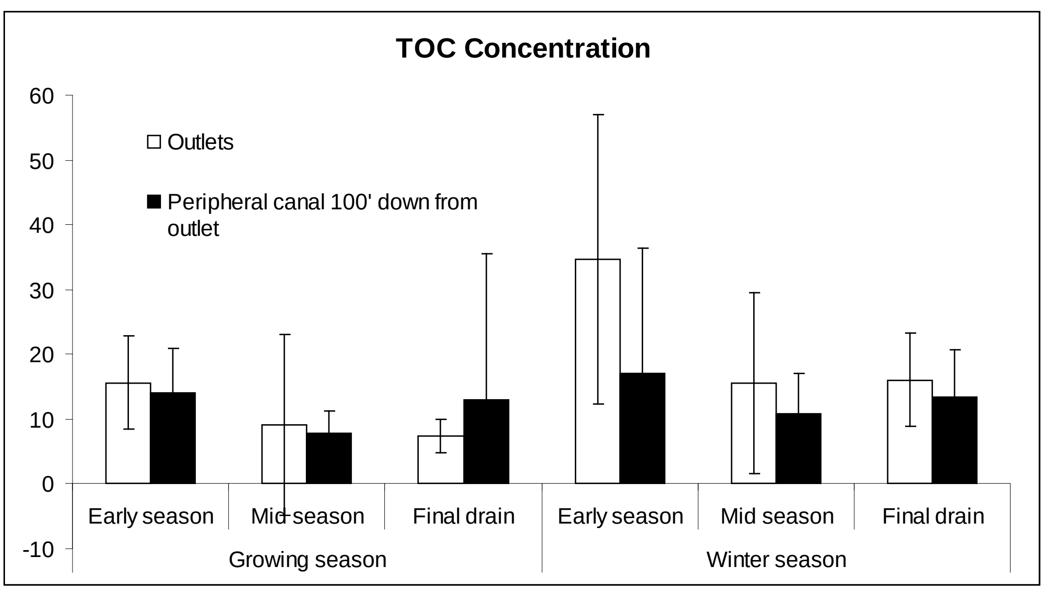


FIGURE 5-34
Comparison of Outlet and Peripheral Drain TOC – Field 3

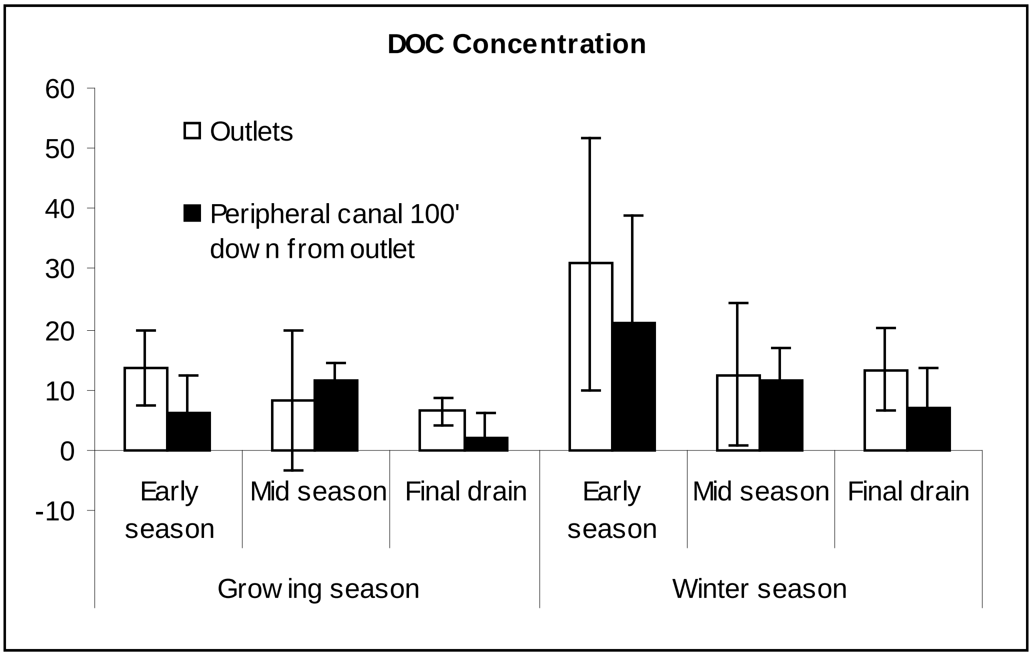


FIGURE 5-35
Comparison of Outlet and Peripheral Drain DOC

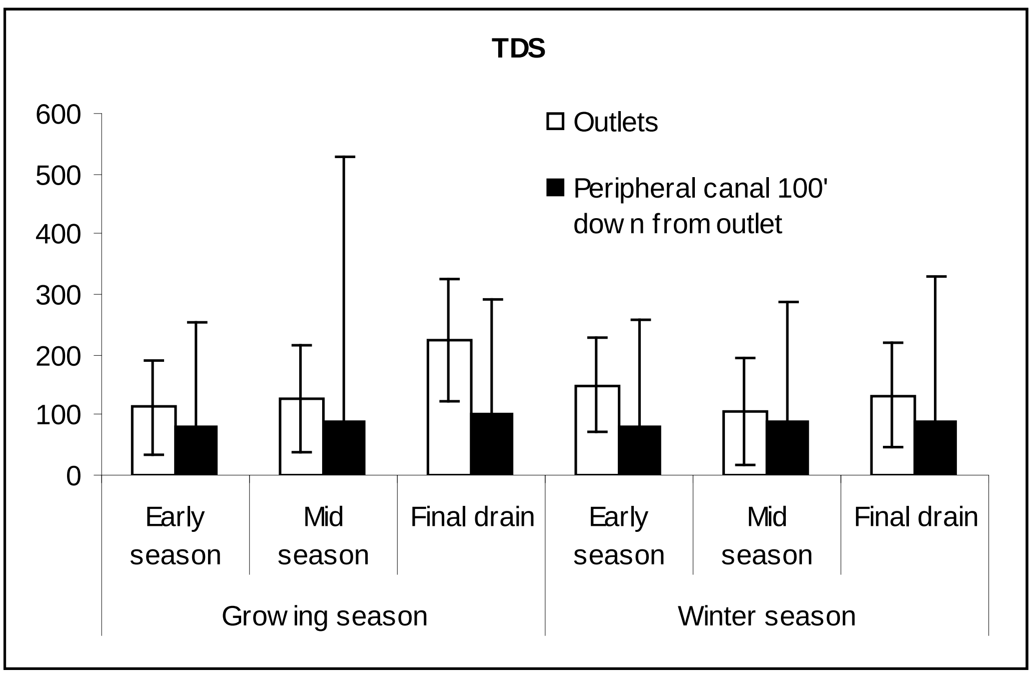


FIGURE 5-36
Comparison of Outlet and Peripheral Drain TDS

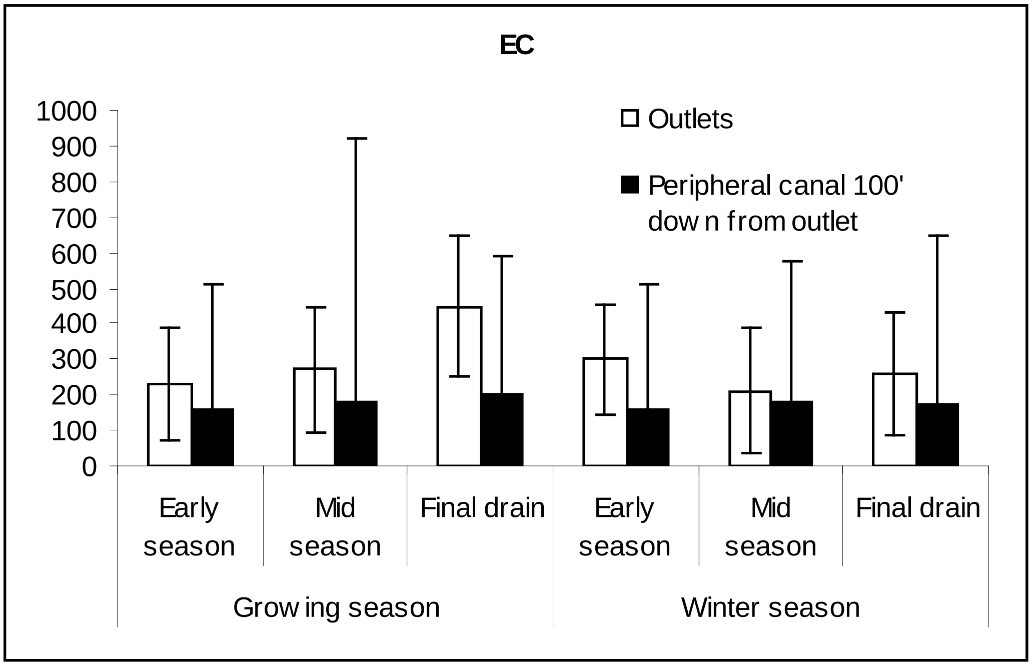


FIGURE 5-37
Comparison of Outlet and Peripheral Drain EC

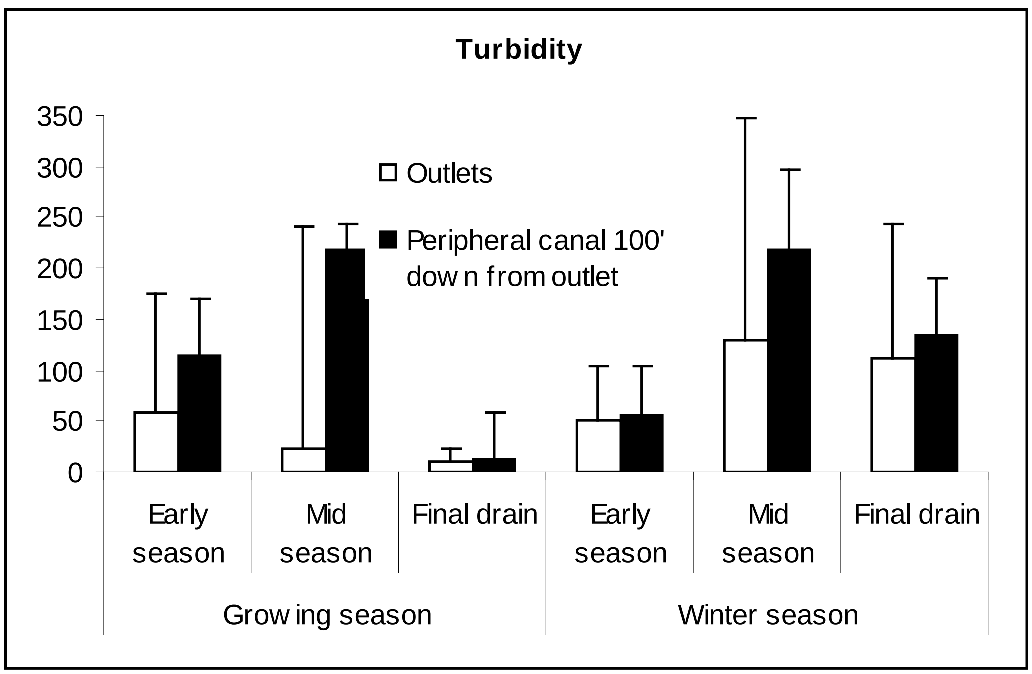


FIGURE 5-38
Comparison of Outlet and Peripheral Drain Turbidity

Study Component 3

Results not included because these data have not yet been through the UCD quality control process for their release.

Study Component 4 – Nitrogen and Phosphorus Concentrations in Rice Field Outflows

The initial summary data for Component 4, focused on nitrogen and phosphorus outflows from rice fields, is included in Table 5-25 and presented in Figures 5-39 through 5-43. The initial study design proposed that Component 4 sampling be conducted at the Rice Experiment Station; however, due to accessibility issues, sampling was instead conducted on the fields sampled under Component 1. Study parameters for this component included:

- Ammonia – NH4-N
- Nitrate – NO3-N
- Dissolved Inorganic Nitrogen – DIN-N
- Dissolved Phosphorus – P
- Potassium – K

TABLE 5-25
Summary of Nitrogen and Phosphorus Rice Field Data

	NH4-N (ppm)	NO3-N (ppm)	DIN-N (ppm)	DP-P (ppm)	K (ppm)
Number of Observations	*346*	*335*	*378*	*344*	*371*
Minimum	0.01	0.01	0.00	0.01	0.05
Maximum	3.61	9.52	9.54	4.10	27.55
Average	0.10	0.12	0.20	0.09	3.56
Median	0.03	0.01	0.05	0.03	2.32
Standard Deviation	0.27	0.71	0.72	0.27	3.82
Variance	0.1	0.5	0.5	0.1	14.6

The following summarizes the results of the nutrient sampling:

- Approximately 98% of all NH4-N results were below 0.5 ppm. Above 0.5 ppm, there were six observations between 0.5 and 2.5 ppm and one observation of 3.61 ppm.
- Approximately 97% of all NO3-N results were below 0.5 ppm. Above 0.5 ppm, there were six observations between 0.5 and 1 ppm, one observation of 2.5 and one observation of 9.52.
- Approximately 93% of all DIN-N results were below 0.5 ppm. Above 0.5 ppm, there were 22 observations between 0.5 and 2.5 ppm, one observation each of 3.64, 4.55, 7.27, 9.54.

- Approximately 98% of all DP-P results were below 0.5 ppm. Above 0.5 ppm, there were six observations between 0.5 and 1 ppm, one observation of 2.5 and one observation of 4.5.
- Approximately 78% of all K results were below 5 ppm. Above 0.5 ppm, over 20% of results were between 5 and 20 ppm, and the remaining 1% (4 observations) ranged from 35 to 27 ppm. The K results demonstrate much more variation, both among fields and seasonally.

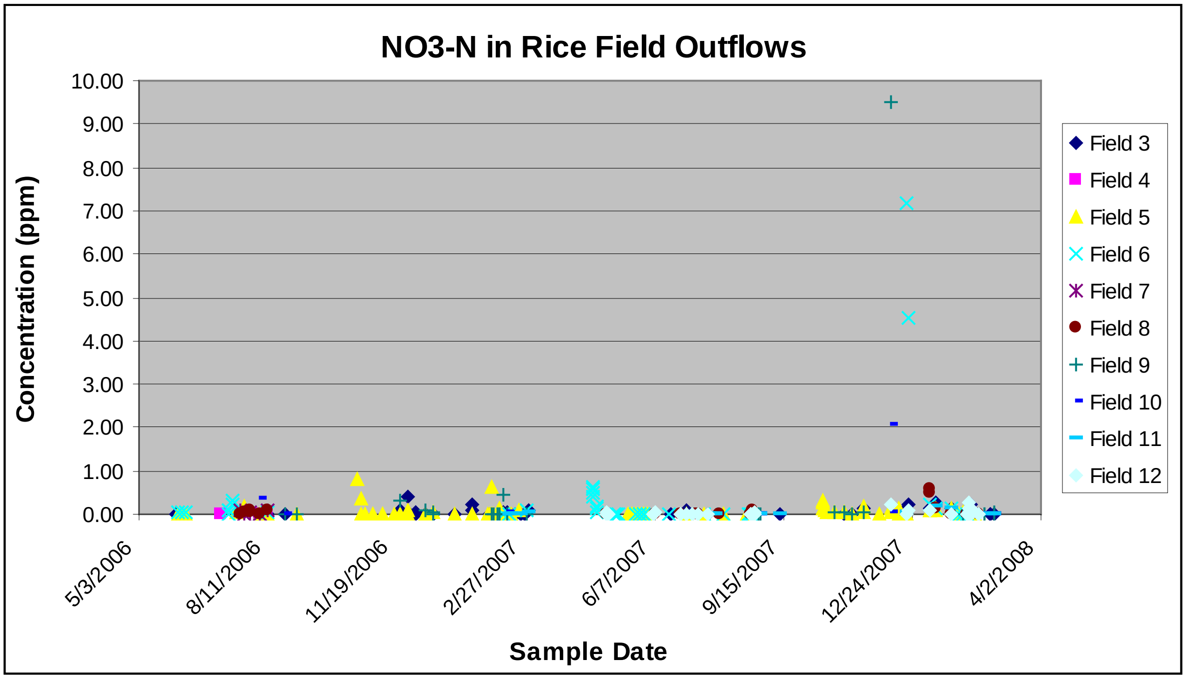


FIGURE 5-39
NO3-N in Rice Field Outflows

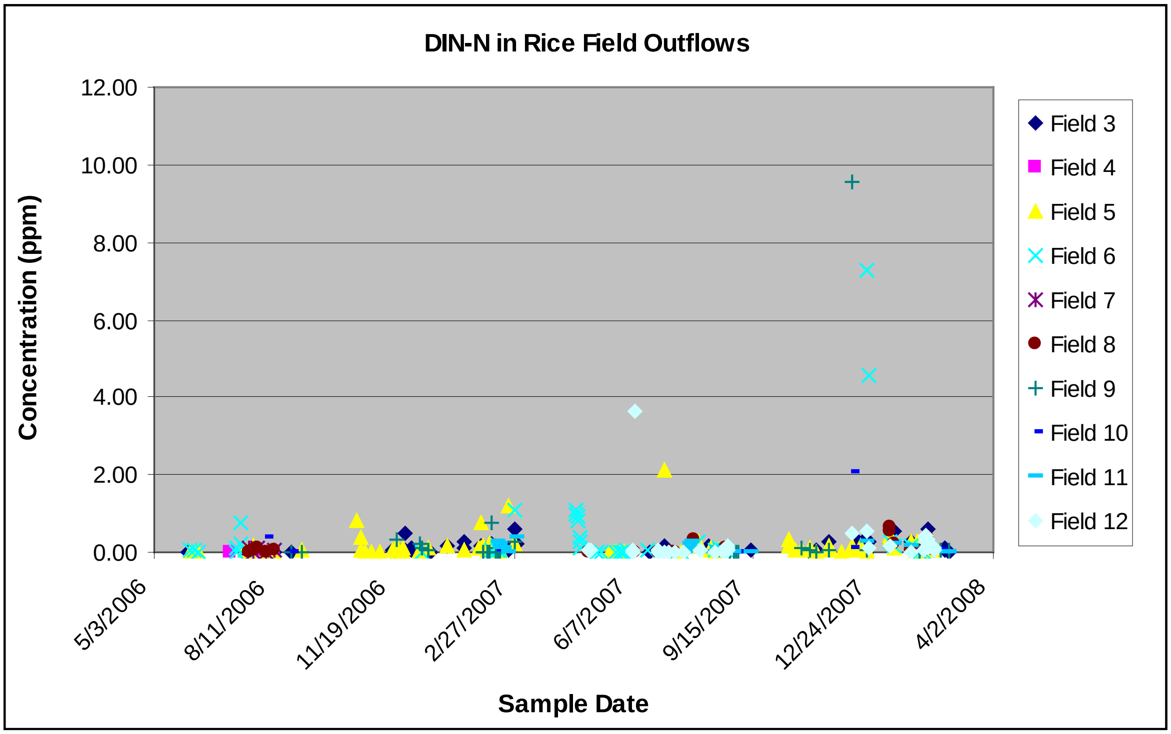


FIGURE 5-40
DIN-N in Rice Field Outflows

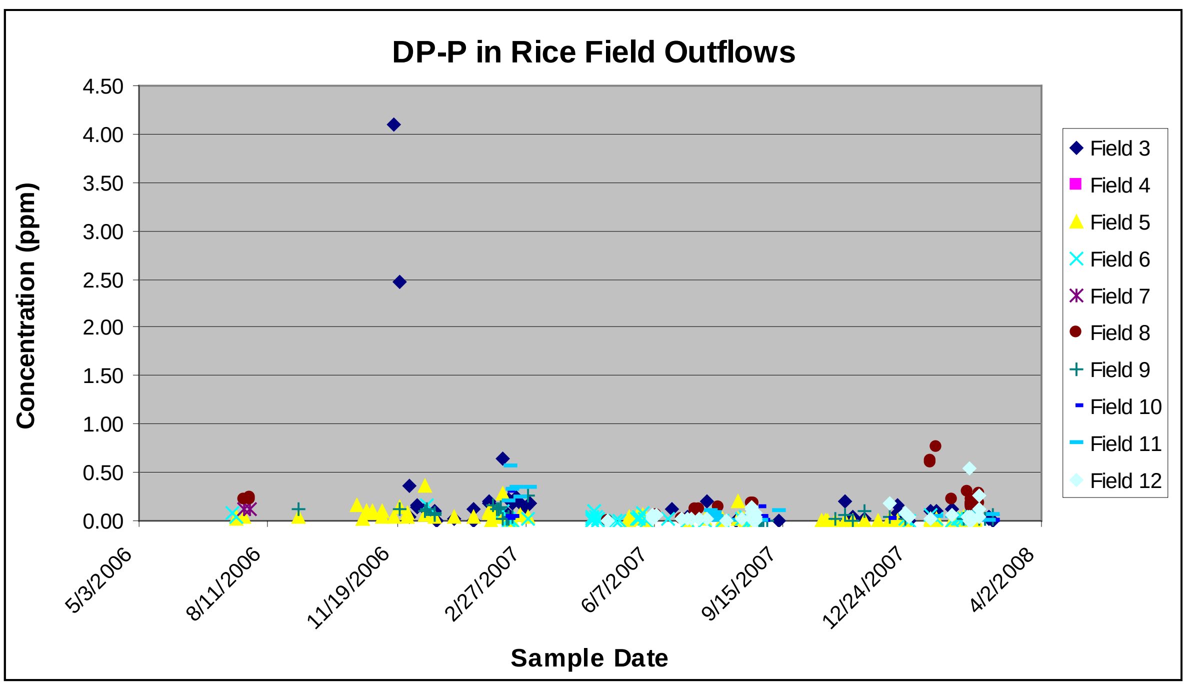


FIGURE 5-41
DP-P in Rice Field Outflows

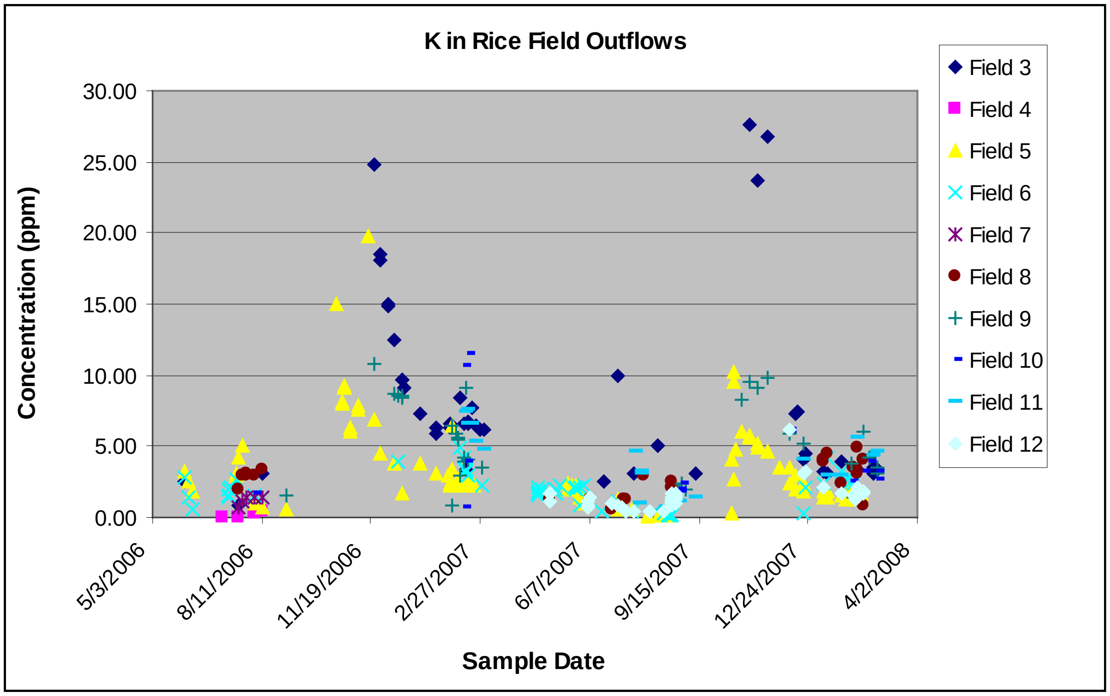


FIGURE 5-42
K in Rice Field Outflows

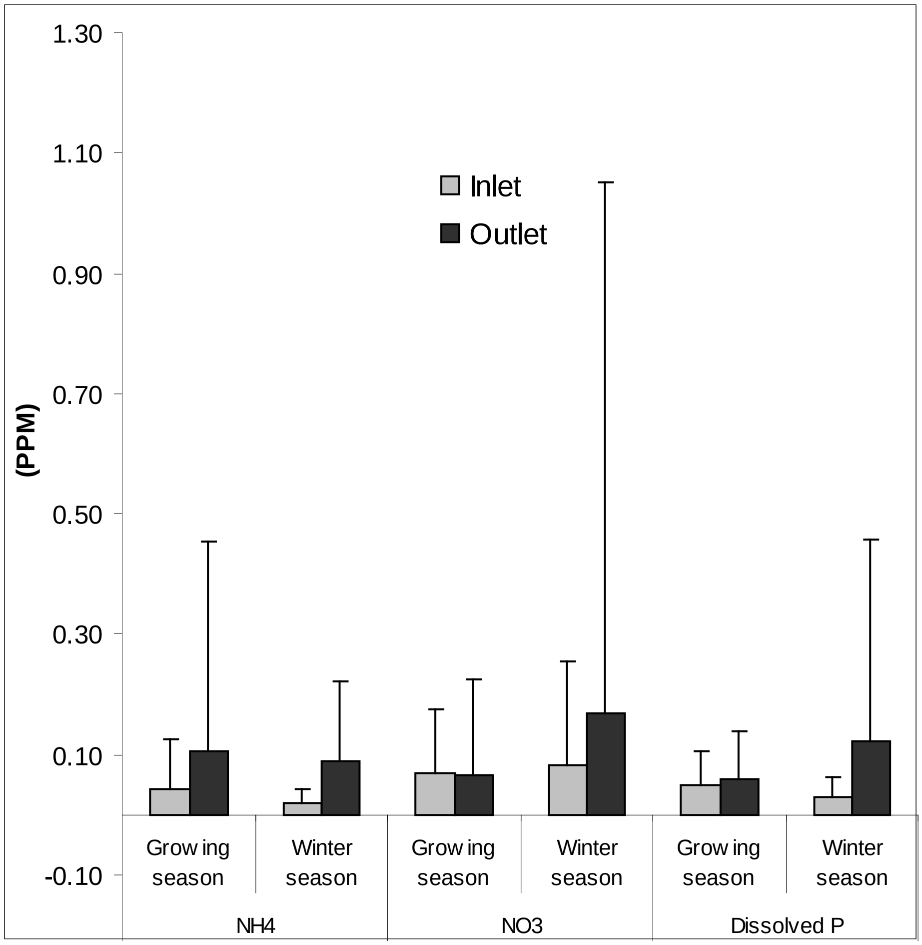


FIGURE 5-43
Comparison of Inlet and Outlet Nutrient Results

RPP Monitoring

Monitoring is conducted under the RPP according the CVRWQCB Resolution No. R5-2007-0018. Monitoring at the five RPP sites included measurement of general field parameters and laboratory analysis of the chemicals molinate and thiobencarb.

The RPP is reviewed triennially by the CVRWQCB, which has authority to authorize the program or use another regulatory approach to achieve water quality protection, including attainment of Performance Goals established in the Basin Plan. The RPP has achieved substantial improvements in water quality and an increased understanding of rice water quality concerns and serves as a model of grower engagement and follow through.

RPP Performance Goals

Since 1990, Sacramento Valley rice farmers have operated pursuant to water quality regulations that prohibit the discharge of irrigation return flows containing carbofuran, malathion, methyl parathion, molinate, and thiobencarb unless the discharger is following management practices approved by the CVRWQCB. The Basin Plan requires that practices only be approved if implementation of such practices can be expected to result in compliance with adopted numeric performance goals and narrative toxicity standards. The Basin Plan was amended to establish performance goals for the five pesticides. The goals were established to be protective of the aquatic ecosystem. The established performance goals for the five pesticides regulated under the conditional prohibition of discharge are shown in Table 5-26.

TABLE 5-26
Basin Plan Performance Goals for the Five RPP Pesticides

Pesticide	Basin Plan Performance Goal
Molinate	10.0 ppb
Thiobencarb	1.5 ppb
Malathion	0.1 ppb
Methyl parathion	0.13 ppb
Carbofuran	0.4 ppb

NOTE:
ppb = parts per billion

In addition to achieving the Basin Plan performance goals, molinate and thiobencarb levels in drinking water delivered to municipal customers must meet enforceable MCLs. MCLs are enforceable drinking water standards set by the EPA and the California Department of Public Health (CDPH, formerly the California Department of Health Services). Primary MCLs are health-based standards, and secondary MCLs are based on aesthetic properties such as taste, color, odor, and appearance. The primary MCL for thiobencarb is 70.0 ppb (toxicity), and the secondary MCL is 1.0 ppb (off-taste). The MCL for molinate is 20.0 ppb.

Water Holds

Over the years, best management practices such as water hold requirements, grower information meetings, and inspection and enforcement were implemented to ensure compliance with performance goals and attainment of water quality objectives and MCLs. The water holds, which are specified in the Department of Pesticide Regulation (DPR) permit conditions, were developed to provide for in-field degradation of pesticides prior to the release of treated water to drains and other surface waters. For 2009, thiobencarb and molinate water hold requirements were the same as during the 2005, 2006, 2007 and 2008 growing seasons.

Pesticides Monitored

RPP samples were analyzed for thiobencarb and molinate during the 2009 monitoring season. As in recent years past, samples were *not* analyzed for carbofuran, malathion, and methyl-parathion because of registration cancellation, decrease in use, and no reportable applications to rice. Specifically, carbofuran is no longer registered for use on rice and has had no reportable use since 2000. Malathion has not been monitored since 2003 because of a dramatic decrease in its use. Historical information indicates that the maximum rice acreage treated with malathion was 9,278 acres in 1991. Annual malathion use on rice has been less than 1,000 acres since 2001. The preliminary 2009 DPR PUR documented 60 acres of malathion usage. This small area of application is too small to warrant water quality monitoring under the RPP monitoring program.

Sampling Schedule

The sampling calendar was developed based on historical data, rice pesticide use and drainage patterns, and actual 2009 conditions. Sampling was conducted for 10 weeks according to the schedule listed in Table 5-27. Kleinfelder initiated sampling on April 28, 2009, at sites SR1, CBD1, CBD5, BS1, and SSB.

Weekly samples were collected on Tuesdays during weeks 1-3 and 8-10. During weeks 4, 5, 6, and 7, samples were collected on Tuesdays and Thursdays. The CVRWQCB requested this sampling frequency to monitor attainment of water quality performance goals established for rice pesticides; this sampling frequency provides a sound technical basis for screening for water quality concerns in order to inform prompt followup.

TABLE 5-27
RPP Sampling Schedule, 2009

Date	Event
4/28/09	W1
5/5/09	W2
5/12/09	W3
5/19/09	W4D1
5/21/09	W4D2
5/26/09	W5D1
5/28/09	W5D2
6/2/09	W6D1
6/04/09	W6D2
6/09/09	W7D1
6/11/09	W7D2
6/16/09	W8D1
6/23/09	W9
6/30/09	W10

Sample Collection, Delivery, and Analysis

During the 2009 sampling season, Kleinfelder collected water samples to detect whether water quality performance goals were being attained. Sample analysis was conducted by registrant laboratories, with additional samples collected and analyzed by a third-party laboratory. Performance goals were established in the Basin Plan with additional conditions in CVRWQCB Resolution No. R5-2007-0018.

Water samples were collected from specified surface water locations within the Sacramento River Basin. Each site serves as an end-of-basin drainage point designed to trigger further study and potential scrutiny, should measured conditions indicate an impact to existing (non-toxic event) in-stream habitat suitability. Sites included one river site and four drain sites, as shown on Figure 4-2. Samples were collected, split if necessary, and submitted under chain of custody directly to the analytical laboratories for thiobencarb and molinate analysis. Detailed maps of each station are included in Appendix A; field sheets and COCs are included in Appendix C-1.

Thiobencarb analyses were performed by the registrant laboratory Valent Dublin Laboratory. Molinate analyses were performed by the registrant laboratory Syngenta Crop Protection, Inc. Environmental Micro Analysis (EMA), Inc. was used as a secondary laboratory for both thiobencarb and molinate analysis. Contact information for these laboratories is included in Chapter 4, and full laboratory results are included in Appendixes C-2 through C-4.

Results

The 2009 RPP water quality results and City results are summarized in Table 5-28. In 2009, there were three measured exceedances of thiobencarb and no measured exceedances of molinate performance goals or MCLs at the five primary monitoring locations and the City drinking water intakes. Field data sheets and COC forms are presented in Appendix C-1, and laboratory data sheets are presented in Appendixes C-2 through C-4.

TABLE 5-28
Summary of Detections (RPP and City Monitoring), 2009

	Molinate			Thiobencarb		
Site	**Detections**	**Detections Greater than Performance Goal**	**Range of Detected Concentrations**	**Detections**	**Detections Greater than Performance Goal**	**Range of Detected Concentrations**
CBD5[a]	0	0	ND	12	0	ND – 1.24 µg/L
BS1[a]	0	0	ND	6	0	ND – 0.50 µg/L
CBD1[a]	1	0	ND – 1.56 µg/L	10	3	ND – 1.84 µg/L
SSB[a]	0	0	ND	5	0	ND – 0.24 µg/L
SR1[a]	0	0	ND	2	0	ND – 0.31 µg/L
SRR[b]	0	0	ND	2	0	ND – 0.29 µg/L
WSR[c]	0	0	ND	3	0	ND – 0.68 µg/L
Totals	**1**	**0**	**–**	**40**	**3**	**–**

NOTES:
ND = non-detect (below the method reporting limit)
[a]RPP site
[b]City of Sacramento intake site (as reported by the City)
[c]City of West Sacramento intake site (as reported by the City)

RPP Molinate Results

During the 10 weeks of sampling, molinate detections were far below the 10.0 µg/L water quality performance goal. The highest measured concentration, which occurred at CBD1 on May 28, 2009, was 1.56 µg/L, similar to the high concentrations in 2007 and 2008 (2007 - BS1, May 22, 2007, 1.92 µg/L; 2008 - BS1, June 12, 2008, 1.73 µg). This 2009 high concentration was actually the only concentration above the method detection that was observed (the rest of the events and sites had non-detect results). The average concentration (counting non-detects as equivalent to zero) for the period of monitoring in 2009 was similar to 2008, at 0.02 µg/L (2008 average was also 0.02 µg/L). The average concentration in 2007 was 0.14 µg/L. Graphical results are shown in Figure 5-44, and tabulated results are shown in Table 5-29.

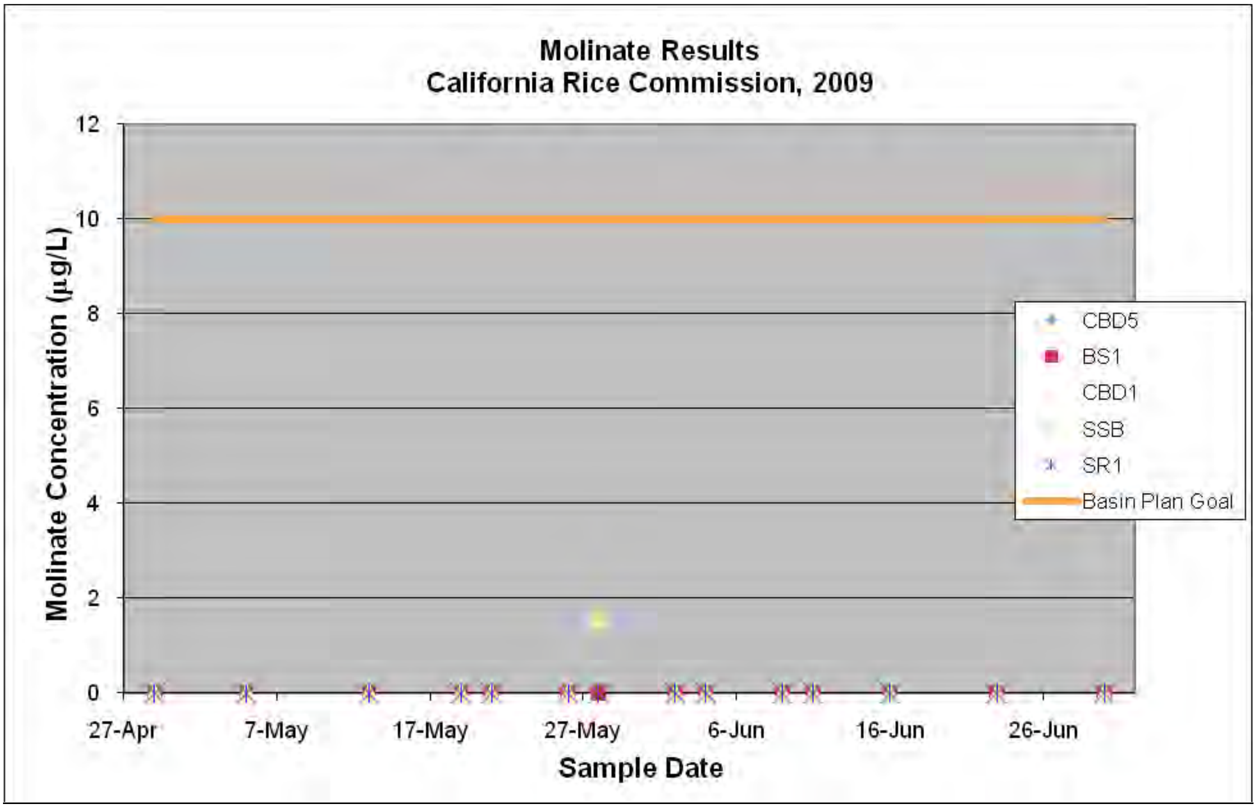


FIGURE 5-44
Molinate Results, RPP 2009
Non-detects are shown as zero (0) on the graph.

TABLE 5-29
Molinate Monitoring Results, RPP 2009

Sampling Dates	Concentrations at Monitoring Sites µg/L (ppb)				
	CBD5	BS1	CBD1	SSB	SR1
April 29	ND	ND	ND	ND	ND
May 5	ND	ND (Syngenta) ND (EMA)	ND	ND	ND
May 13	ND	ND	ND	ND	ND
May 19	ND	ND	ND	ND	ND (Syngenta) ND (EMA)
May 21	ND	ND	ND	ND	ND
May 26	ND	ND	ND (Syngenta) ND (EMA)	ND	ND
May 28	ND	ND	1.56	ND	ND
June 2	ND	ND	ND	ND	ND
June 4	ND	ND	ND	ND (Syngenta) ND (EMA)	ND
June 9	ND	ND (Syngenta) ND (EMA)	ND	ND	ND
June 11	ND	ND	ND	ND	ND
June 16	ND (Syngenta) ND (EMA)	ND	ND	ND	ND
June 23	ND	ND	ND	ND	ND (Syngenta) ND (EMA)
June 30	ND	ND	ND	ND	ND

NOTES:
ND = not detected above laboratory reporting limits
If a sample was tested at the primary and secondary laboratories, each result is provided with the respective laboratory's name.
The Syngenta ND limit is <1.00 µg/L
The EMA ND limit is <0.5 µg/L
The Basin Plan performance goal for molinate is 10 µg/L (ppb)

RPP Thiobencarb Results

During the 10 weeks of sampling, thiobencarb was observed 35 times. Three detections above the 1.5 µg/L performance goal were observed, one at CBD1 on May 19, another at CBD1 on May 26, and the last at CBD1 on May 28. The highest measured concentration, which occurred at CBD1 on May 26, was 1.84 µg/L. This was lower than the highest measured concentration in 2008 (BS1, May 27, 2008, 1.99 µg/L), but higher than the highest measured concentration in 2007 (CBD1, May 22, 2007, 0.76 µg/L). The average concentration (counting non-detects equivalent to zero) was 0.30 µg/L for the period of monitoring, which was the same as in 2008, and higher than the 2007 average of 0.09 µg/L. Graphical results are shown in Figure 5-45, and tabulated results are shown in Table 5-30.

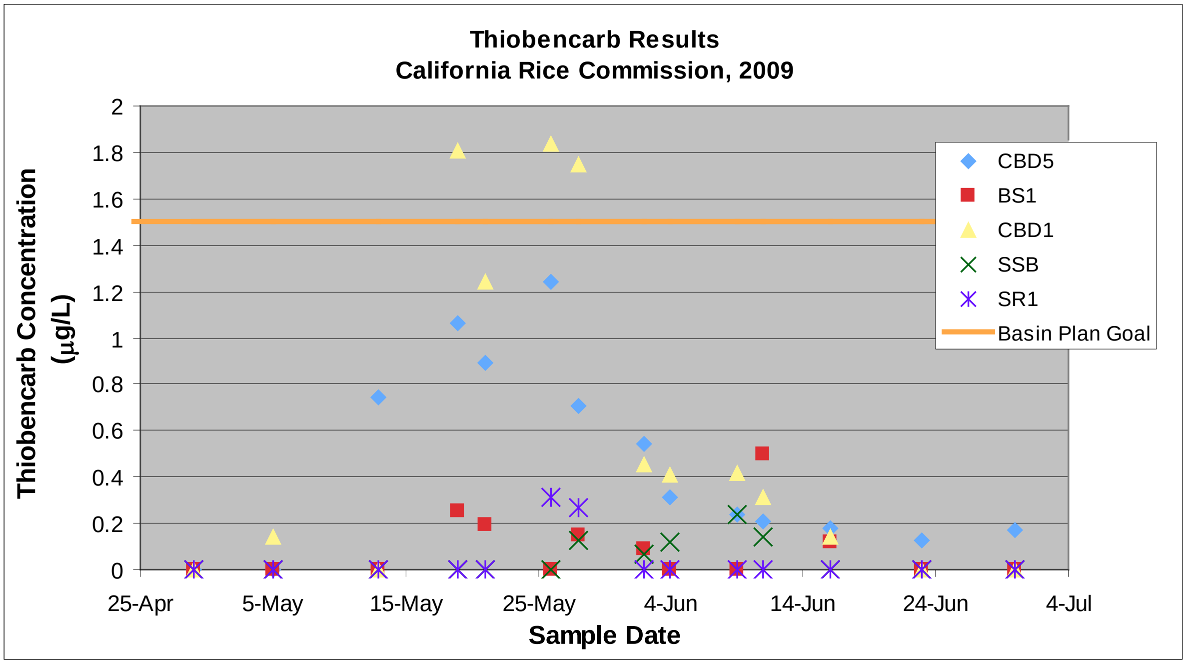


FIGURE 5-45
Thiobencarb Results, RPP, 2009
Non-detects are shown as zero (0) on the graph, and only the highest value of a reported duplicate sample is shown

TABLE 5-30
Thiobencarb Monitoring Results, RPP 2009

Sampling Dates	Concentrations at Monitoring Sites µg/L (ppb)				
	CBD5	**BS1**	**CBD1**	**SSB**	**SR1**
April 29	ND	ND	ND	ND	ND
May 5	ND	ND (Valent), ND (EMA)	0.14	ND	ND
May 13	0.74	ND	ND	ND	ND
May 19	1.06	0.25	**1.81**	ND	ND (Valent), ND (EMA)
May 21	0.89	0.19	1.24	ND	ND
May 26	1.24	ND	**1.54 (Valent) 1.84 (EMA)**	ND	0.31
May 28	0.71	0.15	**1.75**	0.13	0.27
June 2	0.54	0.09	0.45	0.07	ND
June 4	0.31	ND	0.41	0.12 (Valent), ND (EMA)	ND
June 9	0.24	ND (Valent), ND (EMA)	0.42	0.24	ND
June 11	0.21	0.50	0.31	0.14	ND
June 16	0.18 (Valent), ND (EMA)	0.12	0.14	ND	ND
June 23	0.13	ND	ND	ND	ND (Valent), ND (EMA)
June 30	0.17	ND	ND	ND	ND

NOTES:
ND = not detected above laboratory reporting limits
If a sample was tested at the primary and secondary laboratories, each result is provided with the respective laboratory's name
The Valent ND limit is <0.5 µg/L
The EMA ND limit is <0.5 µg/L
The Basin Plan performance goal for thiobencarb is 1.5 µg/L (ppb)

The cause of the three thiobencarb exceedances is unclear; however, this year it is unlikely that the exceedances were due to high winds or a significant rain event, both of which have triggered early/emergency water releases in the past (Moran, 2009). The most likely cause of the exceedances is use of the new Bolero formulation (Bolero Ultramax). Bolero Ultramax was approved for use in the 2008 growing season. The 2009 growing season was the first full season of use for this pesticide, which releases thiobencarb into the water column at higher concentrations after initial application than the previous Bolero formulation (Moran, 2009). Because of this formulation change, drift, emergency releases, and possibly seepage could have created higher surface water thiobencarb concentrations in 2008-2009 than in previous years (Moran, 2009).

Once exceedances were reported by the labs to the CRC, the CRC immediately implemented a communication strategy that included notification of the Cities and CVRWQCB, and immediate notification of the CRC membership. Grower meetings were used to inform growers of the exceedances, discuss potential causes of the exceedances, renew the growers' andoperators' knowledge of emergency release and water holding requirements, and reinforce the importance of CAC coordination in cases requiring emergency releases. In addition, on June 3, 2009, the CRC sent letters to the County Agricultural Commissioners bringing the problem to their attention and requesting their assistance in investigating and enforcing thiobencarb hold times (Appendix C-5). The CRC sent letters to all growers on June 5, 2009, asking for their assistance in remedying this problem. The grower letter included complete pesticide regulation information, including water hold information for Bolero UltraMax (Appendix C-5). Quick action by the CRC and grower responsiveness protected water quality for the remainder of 2009. Aggressive outreach and education will be implemented prior to the start of the 2010 growing season, as a means of enhancing grower awareness before the Bolero use season.

City Intake Results

The City of Sacramento provided the CRC with analytical results for drinking water intake sampling for Sacramento and West Sacramento. The cities of Sacramento and West Sacramento monitor at two separate locations:

- **SRR:** Sacramento River at the intake to the water treatment facility in Sacramento, California, approximately 0.3 kilometer downstream from the confluence with the American River in Sacramento County
- **WSR:** Sacramento River at the intake to the water treatment facility in West Sacramento, California, approximately 100 yards west of Bryte Bend Bridge in West Sacramento

City sampling was performed from April 23 through June 11, 2009. The intake results for thiobencarb and molinate, as provided to the CRC, are detailed in Table 5-31.

TABLE 5-31
Cities of Sacramento and West Sacramento Molinate and Thiobencarb Results, 2009

Sample Date	Thiobencarb Concentration (µg/L)		Molinate Concentration (µg/L)		Percent Sacramento River Water at SRR[a]
	WSR	SRR	WSR	SRR	
April 23	<0.20[b]	<0.20[b]	<0.20[b]	<0.20[b]	82.0
April 30	<0.10	<0.10	<0.10	<0.10	53.8
May 7	<0.10	<0.10	<0.10	<0.10	69.7
May 14	<0.10	<0.10	<0.10	<0.10	75.2
May 21	0.11	<0.10	<0.10	<0.10	77.8
May 25	0.68*	0.29	<0.10*	<0.10	77.9
May 28	0.22	0.18	<0.10	<0.10	83.8
June 4	<0.10	<0.10	<0.10	<0.10	80.5
June 11	<0.10	<0.10	<0.10	<0.10	87.5

NOTES:
Monitoring Site Locations:
SRR = Sacramento River Water Treatment Plant Intake
WSR = Bryte Bend Water Treatment plant Intake (except for * = sample taken at Crawdad's Marina, slightly downstream from the water treatment plant)
[a] The sampling location SRR, which is located on the Sacramento River at the City of Sacramento's municipal water treatment intake, is downstream of the confluence of the Sacramento River and the American River. Based on the daily flows of the two rivers, the sample taken at SRR will represent varying proportions of Sacramento and American river water. This column represents the City of Sacramento's reported information regarding the blending ration of Sacramento River and American River water on the day of sampling
[b] Analysis done by TestAmerica

SRR Results. Prior to the City of Sacramento drinking water intake, some water mixing occurs from the American River at the Sacramento River confluence. Concentrations of thiobencarb and molinate continued to be less than 1 µg/L at SRR; in 2009, only two of the nine SRR sampling events resulted in a detection, and those detections were below the RPP Basin Plan Performance Goals and the drinking water MCLs. These results demonstrate achievement of both the RPP Basin Plan Performance Goals and the drinking water MCLs.

WSR Results. WSR is located upstream from the confluence of the American River, so the mixing and dilution prior to the drinking water intake that occurs at the City of Sacramento water intake (SRR) does not occur at WSR. Concentrations of thiobencarb and molinate continued to be less than 1 µg/L at the City of West Sacramento drinking water intake. Of the five sampling events in 2009, no molinate detections were measured, and three thiobencarb detections were measured. The highest measured concentration of thiobencarb was 0.68 µg/L on May 25, 2009. These results demonstrate achievement of both the RPP Basin Plan Performance Goals and the drinking water MCLs.

CHAPTER 6

Review of Quality Assurance/Quality Control

The validity of water quality monitoring results relies on defining and rigorously following a Quality Assurance/Quality Control (QA/QC) Program. QA/QC requirements are specified in a Monitoring Quality Assurance Project Plan (QAPP), and the laboratory QA/QC requirements are specified in QA/QC plans for each lab.

QA/QC requirements for the CWFR sampling are specified in a QAPP submitted June 2009. QA/QC requirements for the RPP sampling are specified in the same QAPP. Project schedules (sampling dates, parameters, and sites) specified for each program are revised at the beginning of each monitoring year based on actual weather conditions and grower schedules. The sampling calendars for CWFR and RPP monitoring are included in Chapter 5 (Table 5-1).

The QAPPs were prepared in accordance with Attachment C (Quality Assurance Project Plan Guidelines for California Rice Commission) of the Monitoring and Reporting Program under amended order no R5-2006-0053.

The QAPP specifies several types of QA/QC samples, including:

- Field QA/QC samples
  - Field blanks
  - Field duplicates
- Lab QA/QC samples:
  - Method blanks
  - Matrix spikes and matrix spike duplicates (MS/MSDs)
  - Laboratory control spikes (LCSs)
  - Surrogate samples

The QAPP also specifies numeric QA/QC objectives for precision, accuracy, representativeness, comparability, and completeness.

This section describes the QA/QC samples and their purposes, presents the quality assurance objectives, and then evaluates the 2009 CWFR and RPP QA/QC results against the objectives.

Internal QC

Internal QC is achieved by collecting and analyzing a series of duplicate, blank, spike, and spike duplicate samples to confirm that analytical results are within the specified QC objectives. The QC sample results are used to qualify precision and accuracy, and to identify any problem or limitation in the associated sample results. The internal QC components of a sampling and analysis program ensure that data of known quality are produced and documented.

Field QA/QC Samples

Field QA/QC samples are used to assess the influence of sampling procedures and equipment used in sampling. The results from these samples are examined to ensure that field procedures yield acceptable results. Two types of field quality control samples were used during the 2009 sampling, field blanks and field duplicates.

Field Blanks

A field blank is a bottle of reagent water that is exposed to sampling conditions, returned to the laboratory, and treated as an environmental sample. This blank is used to provide information about contaminants that may be introduced during sample collection, storage, and transport.

Field Duplicates

Field duplicates, or split samples, consist of an additional bottle of sample collected at a randomly selected sample location. The results from the duplicate sample are compared to the results from the primary sample; if the relative percent difference (RPD) between the samples is greater than 35 percent, a thorough evaluation of the samples will be performed to determine whether to take corrective action (to either report the data or resample). Duplicate samples provide precision information for the entire measurement system, including sample acquisition, homogeneity, handling, shipping, storage, laboratory sample preparation, and laboratory analysis.

Laboratory QA/QC Samples

Laboratory QA/QC samples are prepared to ensure that the required level of laboratory accuracy is being achieved. Four types of quality control samples are used to determine laboratory accuracy: method blanks, matrix spikes, LCSs, and surrogate standards.

Method Blanks

Method blanks consist of deionized water that is run through all of the same steps as the environmental samples at the lab. These samples are used to determine the existence of any laboratory sources of contamination.

Matrix Spikes and Matrix Spike Duplicates

(MS/MSD samples are collected at the same time as the environmental samples and are spiked at the laboratory with known concentrations of the analyte(s) to be measured. These samples are used to evaluate the effect a particular sample matrix has on the accuracy of the measurement. The MSD sample serves as another check of accuracy and allows calculation of the analysis method's precision. The difference in the measured concentrations of the original sample and the spiked sample is compared with the spike concentration, and a percent recovery (the concentration that the laboratory measures divided by the known concentration of a spiked sample multiplied by 100) of the spiked concentration is reported.

Laboratory Control Spikes

(LCSs consist of known concentrations of a constituent in distilled water. The measured concentrations are compared with the spike concentration, and a percent recovery can be determined. Results are acceptable if the percent recovery falls within a predetermined range.

Surrogate Standards

Surrogate standards are samples that have been spiked with an organic compound that is chemically similar to the analyte of interest, but is not expected to occur in the environmental sample. The recovery of the surrogate standard is used to monitor for errors, unusual effects, and other anomalies. Surrogate recovery is evaluated by comparing the measured concentration with the amount added to the sample.

Quality Assurance Objectives

Quality assurance objectives (QAOs) are the detailed QC specifications for precision, accuracy, representativeness, comparability, and completeness. QAOs are used as comparison criteria during data quality review to evaluate if the minimum requirements have been met and the data can be used as planned. The basis for assessing each element of data quality for this project is discussed in the following subsections.

Precision

Precision is a measure of the reproducibility of analyses under a given set of conditions. Precision will be assessed by replicate measurements of field and laboratory duplicate samples. The routine comparison of precision is measured by the RPD between duplicate sample measurements. The overall precision of a sampling event is determined by a sampling component and an analytical component.

The following formula determines the RPD between two samples:

$$RPD = \frac{|D1 - D2|}{(D1 + D2)/2} x100$$

Where:

RPD = relative percent difference
D1 = first sample value
D2 = second sample value (duplicate)

The maximum acceptable RPD for this project is 35 percent.

Accuracy

Accuracy is a determination of how close the measurement is to the true value. Accuracy can be assessed using MS/MSD, LCS, calibration standard, and spiked environmental samples. The accuracy of the data submitted for this project will be assessed in the following manner:

- The percent recovery of LCS, MS/MSD, and spiked surrogates will be calculated and evaluated against established laboratory recovery limits. **Acceptable laboratory recovery limits for this project are 75 to 120 percent.**

Laboratory method blanks will be tested to determine levels of target compounds. If a target compound is found above the method detection limit (MDL) in the method blank corresponding to a batch of samples, and the same target compound is found in a sample, then the data will not be background subtracted but will be flagged to indicate the result in the blank.

Accuracy is presented as percent recovery. Because accuracy is often evaluated from spiked samples, laboratories commonly report accuracy using this formula:

$$\% \text{ Recovery} = R / S * 100$$

Where:

S = spiked concentration
R = reported concentration

The laboratory shall monitor accuracy by reviewing MS/MSD, LCS, calibration standard, and surrogate spike recovery results.

Representativeness

Representativeness refers to the degree to which sample data accurately and precisely describe the characteristics of a population of samples, parameter variations at a sampling point, or environmental conditions. Representativeness is a qualitative parameter that is primarily concerned with the proper design of the sampling program or of the subsampling of a given sample. Representativeness will be assessed by the use of duplicate field and laboratory samples because they provide information pertaining to both precision and representativeness.

Samples that are not properly preserved or are analyzed beyond acceptable holding times will not be considered to provide representative data. Also, detection limits above applicable MCLs or screening criteria will not be considered representative.

Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Sample data should be comparable for similar samples collected under like conditions. This goal is achieved through the use of standard techniques to collect and analyze representative samples and reporting analytical results with appropriate units.

Comparability is limited by other analytical control parameters; therefore, only when precision and accuracy are known can data sets be compared with confidence. Using standard operating procedures (SOPs) promotes comparability.

Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that was expected to be obtained under normal conditions. To be considered complete, the data set must contain all analytical results and data specified for the project. In addition, all data are compared to project requirements to ensure that specifications are met. Completeness is evaluated by comparing the project objectives to the quality and quantity of the data collected to assess if any deficiencies exist. Missing data can result from any number of circumstances ranging from sample acquisition and accessibility problems to sample breakage and rejection of analytical data because of quality control deficiencies. Completeness is quantitatively assessed as the percent of controlled QC parameters that are within limits. Percent completeness for each set of samples for each individual method can be calculated as follows:

$$Completeness = \frac{\text{valid data obtained}}{\text{total data analyzed}} \times 100\%$$

Where:

Valid data are defined as those data points that are not qualified as rejected.

The requirement for completeness is 90 percent for each individual analytical method for all QC parameters except holding times. These QC parameters will include:

- Initial calibration
- Continuing calibrations
- LCS percent recovery
- MS/MSD
- Field duplicate RPDs
- Surrogate percent recoveries

The requirement for holding times will be 100 percent. Any deviations are reported in the report narrative.

CWFR QA/QC Sample Results and Analysis

In 2009, one "QC set" was required for each analytical method batch per sampling event. One QC set is used for core and assessment samples, which are collected on consecutive days. The minimum required samples for chemical analysis were:

1. Field blank
2. Field duplicate
3. MS/MSD
4. LCS and laboratory control spike duplicate (LCSD)
5. Laboratory blank
6. Laboratory duplicate (MS/MSD or LS/LSD pair may serve this function)

The minimum required samples for toxicity analysis were:

1. Field duplicate
2. Negative control
3. Reference toxicant (one reference toxicant per species per month)

Field QA/QC Samples

Field CWFR QA/QC samples collected during 2009 sampling included field blanks and field duplicates. The dates, events, and sites of these samples are shown in Table 6-1. Results for field QA/QC samples are provided below.

TABLE 6-1
CWFR Field QA/QC Samples, 2009

Date	Event	QA/QC Sample Type(s)
4/28/09	April Assessment	Toxicity Duplicate at F
4/29/09	April Core	Field Blank at CBD5 Field Duplicate at CBD5
5/12/09	May Assessment	Toxicity Duplicate at G
5/13/09	May Core	Field Blank at CBD1 Field Duplicate at CBD1
6/02/09	June Core	Field Blank at SSB Field Duplicate at SSB
6/03/09	June Assessment	Toxicity Duplicate at H
7/07/09	July Core	Field Blank at BS1 Field Duplicate at BS1
7/8/09	July Assessment	Toxicity Duplicate at F
8/25/09	August Assessment	Toxicity Duplicate at G
8/26/09	August Core	Field Blank at SSB Field Duplicate at SSB
9/15/09	September Assessment	Toxicity Duplicate at H
9/16/09	September Core	Field Duplicate at CBD5 Field Duplicate at CBD5

Field Blanks

Field blank samples were collected and analyzed for the same constituents as the environmental samples (Table 6-2). In most cases, the field blanks had a result of ND (not detected above the MDL). Two samples, from the July and August events, had a small, but measurable amount of TDS. The water used in the field blanks is reagent water direct from McCampbell Analytical, and it should be completely pure. It is assumed that dust must have entered the samples during sampling, as the field crew opens the field blank jars at the sampling location to account for any environmental factors. Dust entering the jars could contribute a small amount of TDS without contributing to other sampled analytes. The level of TDS was just above the MRL, and was much lower than the level typically found in the environmental samples.

Field Duplicates

Field duplicate samples were collected and analyzed for the same constituents as the primary environmental samples, including toxicity. Results between primary and duplicate samples were similar, as was expected (Tables 6-3 and 6-4).

TABLE 6-2
2009 CWFR Field Blank Results

		Results Sampling Event and Site					
Analyte	**MRL (µg/L)**	**April (CBD5)**	**May (CBD1)**	**June (SSB)**	**July (BS1)**	**August (SSB)**	**September (CBD5)**
Carfentrazone Ethyl	0.1	ND	ND	ND	ND	ND	ND
Clomazone	1.0	ND	ND	ND	ND	ND	ND
Pendimethalin	0.2	ND	ND	ND	ND	ND	ND
Triclopyr	0.05	x	ND	ND	x	x	X
Propanil	x	x	x	ND	ND	x	X
Glyphosate	5.0	ND	ND	ND	ND	ND	ND
Hardness	1.0 mg $CaCO_3$/L	ND	ND	ND	ND	ND	ND
Copper	0.5	ND	ND	ND	ND	ND	ND
Penoxsulam	20	ND	ND	ND	ND	ND	ND
TDS	10 mg/L	ND	ND	ND	**12.0**	**10.0**	ND

TABLE 6-3
2009 CWFR Primary and Duplicate Sample Results, Chemistry

Chemical	MRL (µg/L)	April Event (CBD5)		May Event (CBD1)		June Event (SSB)		July Event (BS1)		August Event (SSB)		September Event (CBD5)	
		Primary	*Duplicate*	*Primary*	*Duplicate*	*Primary*	*Duplicate*	*Primary*	*Duplicate*	*Primary*	*Duplicate*	*Primary*	*Duplicate*
Carfentrazone Ethyl	0.1	ND	ND	ND<0.20	ND<0.20	ND<0.50	ND<0.50	ND	ND	ND<1.0	ND<1.0	ND<0.20	ND<0.20
Clomazone	1.0	0.51J	0.49J	2.8	3.4	1.8J	1.8J	ND	ND	ND<10	ND<10	ND<0.20	ND<0.20
Pendimethalin	0.2	ND	ND	ND<0.40	ND<0.40	ND<1.0	ND<1.0	ND	ND	ND<2.0	ND<2.0	ND<0.40	ND<0.40
Triclopyr	0.05	x	x	ND<0.10	ND<0.10	ND<0.25	ND<0.25	x	x	x	x	x	x
Propanil	x	x	x	x	x	ND<0.25	ND<0.25	ND	ND	x	x	x	x
Glyphosate	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hardness	1.0*	120	130	160	160	140	150	150	140	140	140	190	200
Copper	0.5	8.6	8.1	4.0	3.7	5.5	5.8	5.2	4.4	2.5	2.7	4.7	6.1
Penoxsulam	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TDS	10#	239	246	303	302	223	224	211	186	174	207	306	341

NOTES:
* mg CaCO3/L
\# mg/L
J = analyte detected below quantitation limits

TABLE 6-4
2009 CWFR Primary and Duplicate Sample Results , Toxicity

Sample Event	Test Site	Sample	*C. dubia* (% survival)	FHM (% survival)	Algae (% control)
April	F	Primary	100	100	+0%
		Duplicate	100	100	-3%
May	G	Primary	100	100	+0%
		Duplicate	100	100	+1%
June	H	Primary	100	100	+556
		Duplicate	100	100	+587
July	F	Primary	100	100	+956
		Duplicate	95	97.5	+871
August	G	Primary	100	100	+125%
		Duplicate	100	100	+143%
September	H	Primary	100	100	+170%
		Duplicate	100	100	+116%

Laboratory QA/QC Samples

The laboratory QA/QC samples included method blanks, matrix spikes, LCSs, and surrogate standard samples; the results for each follow.

Method Blank

Method blank samples were prepared by the laboratory and tested for the same analytes as the environmental samples. The results of all the method blank samples were below the MRL (non-detect) for these analytes (Table 6-5).

MS/MSD

MS and MSD samples were prepared and analyzed for every sampling event during the 2009 season (Table 6-6). Miscommunication at the lab led to MS/MSD samples only being prepared and analyzed for glyphosate, hardness, copper, and penoxsulam during the April, May, June, and July events. Full sets of MS/MSD samples were prepared and analyzed for the August and September events (including carfentrazone ethyl, clomazone, and pendimethalin, along with the above constituents). The majority of the recoveries and RPD values were within the acceptable range, with the exception of the copper recovery from the April event, and the pendimethalin recoveries during the September events. All of these recovery values were above the acceptable limits. All RPD values were within the acceptable range for MS/MSD samples.

LCS

LCS samples were prepared and analyzed for every sampling event during the 2009 season. The RPD percentages for all of the samples were within the acceptable limits (Table 6-7). The majority of the recoveries were also within acceptable limits, with the exception of: pendimathalin and clomazone from the August event, and pendimathalin from the September event. All three of these recoveries were above the acceptable limit.

Surrogate Standard

Surrogate standard samples were prepared for analysis for each of the environmental samples. All the surrogate standards except for two fell within the QAPP recovery limits (Table 6-8). The two samples outside of the QAPP recovery limits were the April method 200.7 surrogates for sites BS1 and CBD5-Dup. According to McCampbell, both samples were outside the recovery limits because of matrix interference with the surrogate. The results for the environmental samples corresponding to these two surrogate samples were J-flagged in the SWAMP datasheet submitted to the Regional Board.

TABLE 6-5
2009 CWFR Method Blank Results

		Chemical (MRL)								
Month	**Event**	**Carfentrazone Ethyl (0.1 µg/L)**	**Clomazone (0.2 µg/L)**	**Pendimethalin (0.2 µg/L)**	**Glyphosate (5.0 µg/L)**	**Hardness (1.0 mg $CaCO_3$/L)**	**Copper (0.1 µg/L)**	**Penoxsulam (30 µg/L)**	**Triclopyr (0.05 µg/L)**	**Propanil (0.05 µg/L)**
April	Assessment	ND	ND	ND	ND	ND	ND	ND	NA	NA
	Core	ND	ND	ND	ND	ND	ND	ND	NA	NA
May	Assessment	ND	ND	NR	ND	ND	ND	ND	NA	NA
	Core	ND	ND	ND	ND	ND	ND	ND	ND	NA
June	Assessment	ND	ND	ND	ND	ND	ND	ND	NA	NA
	Core	ND	ND	ND	ND	ND	ND	ND	ND	ND
July	Assessment	ND	ND	ND	ND	ND	ND	ND	NA	NA
	Core	ND	ND	ND	ND	ND	ND	ND	NA	ND
Aug	Assessment	ND	ND	ND	ND	ND	ND	ND	NA	NA
	Core	ND	ND	ND	ND	ND	ND	ND	NA	NA
Sept	Assessment	ND	ND	ND	ND	ND	ND	ND	NA	NA
	Core	ND	ND	ND	ND	ND	ND	ND	NA	NA

NOTES:
ND = non-detect at the MRL
NA = not scheduled during that sampling event
NR = no value reported

TABLE 6-6
2009 Laboratory MS/MSD Samples

Month	Event	Analyte	Spike Level (µg/L)	Matrix Result (µg/L)	SPK Recovery (%)	DUP Recovery (%)	Recovery Limits	RPD (%)	RPD Limits
April	Core/Assessment	Glyphosate	200	ND	95.9	95.3	75-120	0.632	35
	Core/Assessment	Hardness	29.1	150	NR	NR	75-120	NR	35
	Core	Copper	10	16	**127**	88.2	75-120	14.3	35
	Assessment	Copper	10	13	98.7	95	75-120	1.66	35
	Core/Assessment	Penoxsulam	100	ND	115	111	75-120	4.15	35
May	Core/Assessment	Glyphosate	200	ND	110	111	75-120	0.964	35
	Core/Assessment	Hardness	29.1	150	NR	NR	75-120	NR	35
	Core	Copper	10	9.1	96.5	93.5	75-120	1.61	35
	Assessment	Copper	10	10	99.8	99.8	75-120	0	35
	Core/Assessment	Penoxsulam	100	ND	111	111	75-120	0	35
June	Core	Glyphosate	200	ND	87.9	89.6	75-120	1.92	35
	Assessment	Glyphosate	200	ND	95.6	91.2	75-120	4.78	35
	Core	Hardness	29.1	ND	96.2	96.2	75-120	0	35
	Assessment	Hardness	29.1	110	NR	NR	75-120	NR	35
	Core	Copper	10	ND	95.4	102	75-120	6.90	35
	Assessment	Copper	10	ND	105	107	75-120	1.89	35
	Core/Assessment	Penoxsulam	100	ND	108	103	75-120	4.50	35

TABLE 6-6
2009 Laboratory MS/MSD Samples

Month	Event	Analyte	Spike Level (µg/L)	Matrix Result (µg/L)	SPK Recovery (%)	DUP Recovery (%)	Recovery Limits	RPD (%)	RPD Limits
July	Core/Assessment	Glyphosate	200	ND	97.1	96.8	75-120	0.272	35
	Core/Assessment	Hardness	29.1	110	NR	NR	75-120	NR	35
	Core	Copper	10	17	109	107	75-120	0.675	35
	Assessment	Copper	10	18	101	103	75-120	0.771	35
	Core/Assessment	Penoxsulam	100	ND	110	110	75-120	0	35
August	Core	Carfentrazone Ethyl	0.5	ND	112	111	75-120	1.04	35
	Assessment	Carfentrazone Ethyl	0.5	ND	119	117	75-120	1.21	35
	Core	Clomazone	0.5	ND	119	110	75-120	7.87	35
	Assessment	Clomazone	0.5	ND	**121**	**126**	75-120	3.84	35
	Core	Pendimethalin	0.5	ND	116	98.4	75-120	16.7	35
	Assessment	Pendimethalin	0.5	ND	**121**	**122**	75-120	0.58	35
	Core/Assessment	Glyphosate	200	ND	96.1	92.1	75-120	4.24	35
	Core	Hardness	29.1	ND	96.2	96.2	75-120	0	35
	Assessment	Hardness	29.1	110	NR	NR	75-120	NR	35
	Core	Copper	10	ND	100	105	75-120	4.86	35
	Assessment	Copper	10	10	101	101	75-120	0	35
	Core/Assessment	Penoxsulam	100	ND	116	113	75-120	2.48	35

TABLE 6-6
2009 Laboratory MS/MSD Samples

Month	Event	Analyte	Spike Level (µg/L)	Matrix Result (µg/L)	SPK Recovery (%)	DUP Recovery (%)	Recovery Limits	RPD (%)	RPD Limits
September	Core	Carfentrazone Ethyl	0.50	ND	95.1	92.8	75-120	2.42	35
	Assessment	Carfentrazone Ethyl	0.50	ND	86.0	97.5	75-120	12.5	35
	Core	Clomazone	0.50	ND	110	115	75-120	4.34	35
	Assessment	Clomazone	0.50	ND	**124**	**130**	75-120	4.45	35
	Core	Pendimethalin	0.50	ND	**128**	**122**	75-120	5.19	35
	Assessment	Pendimethalin	0.50	ND	**121**	**130**	75-120	6.89	35
	Core/Assessment	Glyphosate	200	ND	102	106	75-120	3.89	35
	Core/Assessment	Hardness	29.1	ND	96.2	96.2	75-120	0	35
	Assessment	Copper	10	ND	91.8	90.5	75-120	1.43	35
	Core/Assessment	Penoxsulam	100	ND	110	111	75-120	0.521	35

NOTES:
Bold indicates values that do not meet acceptable recovery limits.

ND = non-detect at the MRL
NR = no value reported

TABLE 6-7
2009 CWFR Lab Control Spikes (LCS)

Month	Event	Analyte	Spike Level (µg/L)	SPK Recovery (Percent)	DUP Recovery (Percent)	Recovery Limits	RPD (Percent)	RPD Limit
April	Core/Assessment	Carfentrazone Ethyl	0.50	109	110	75-120	1.18	35
	Core/Assessment	Clomazone	0.50	115	111	75-120	2.81	35
	Core/Assessment	Pendimethalin	0.50	120	118	75-120	1.68	35
	Core/Assessment	Glyphosate	200	101	98.7	75-120	2.07	35
	Core/Assessment	Hardness	29.1	99.7	99.7	75-120	0.0	35
	Core	Copper	10	103	104	75-120	0.775	35
	Assessment	Copper	10	114	112	75-120	1.77	35
	Core/Assessment	Penoxsulam	100	110	113	75-120	2.24	35
May	Core/Assessment	Carfentrazone Ethyl	0.50	110	109	75-120	0.768	35
	Core/Assessment	Clomazone	0.50	118	118	75-120	0	35
	Core	Pendimethalin	0.50	120	106	75-120	12.7	35
	Core	Triclopyr	0.50	105	100	75-120	4.50	35
	Core/Assessment	Glyphosate	200	110	110	75-120	0	35
	Core	Hardness	29.1	110	99.7	75-120	9.84	35
	Assessment	Hardness	2.91	99.7	99.7	75-120	0	35
	Core	Copper	10	99.9	98.1	75-120	1.86	35
	Assessment	Copper	10	107	108.0	75-120	1.39	35
	Core/Assessment	Penoxsulam	100	101	104	75-120	2.46	35

TABLE 6-7
2009 CWFR Lab Control Spikes (LCS)

Month	Event	Analyte	Spike Level (µg/L)	SPK Recovery (Percent)	DUP Recovery (Percent)	Recovery Limits	RPD (Percent)	RPD Limit
June	Core	Carfentrazone Ethyl	0.5	109	112	75-120	2.72	35
	Core	Clomazone	0.5	106	110	75-120	3.65	35
	Core	Pendimethalin	0.5	84.5	90.7	75-120	7.16	35
	Core	Propanil	0.5	96	101	75-120	5.01	35
	Core	Triclopyr	0.5	88.4	90.7	75-120	2.55	35
	Core	Glyphosate	200	94	95	75-120	1.02	35
	Assessment	Glyphosate	200	92.6	94.4	75-120	1.95	35
	Core	Hardness	29.1	99.7	99.7	75-120	0	35
	Assessment	Hardness	29.1	99.7	110	75-120	9.84	35
	Core	Copper	10	89.3	92.2	75-120	3.18	35
	Assessment	Copper	10	104	105	75-120	1.34	35
	Core/Assessment	Penoxsulam	100	109	109	75-120	0	35
July	Core/Assessment	Carfentrazone Ethyl	0.50	83.9	83.5	75-120	0.422	35
	Core/Assessment	Clomazone	0.50	85.5	87.4	75-120	2.22	35
	Core/Assessment	Pendimethalin	0.50	97.5	97.5	75-120	0	35
	Core	Propanil	0.50	96.5	98.2	75-120	1.75	35
	Core/Assessment	Glyphosate	200	98.1	96.5	75-120	1.66	35
	Core/Assessment	Hardness	29.1	110	99.7	75-120	9.84	35
	Core	Copper	10	94.3	93.8	75-120	0.500	35
	Assessment	Copper	10	105	106	75-120	1.23	35
	Core/Assessment	Penoxsulam	100	107	106	75-120	1.17	35

TABLE 6-7
2009 CWFR Lab Control Spikes (LCS)

Month	Event	Analyte	Spike Level (µg/L)	SPK Recovery (Percent)	DUP Recovery (Percent)	Recovery Limits	RPD (Percent)	RPD Limit
August	Core/Assessment (BS1, CBD5, CBD1)	Carfentrazone Ethyl	0.50	99.3	95	75-120	4.46	35
	Assessment (SSB, SSB-Dup, SSB-FBL)	Carfentrazone Ethyl	0.50	115	105	75-120	8.55	35
	Core/Assessment (BS1, CBD5, CBD1)	Clomazone	0.50	**123**	119	75-120	3.35	35
	Assessment (SSB, SSB-Dup, SSB-FBL)	Clomazone	0.50	**124**	**125**	75-120	0.896	35
	Core/Assessment (BS1, CBD5, CBD1)	Pendimethalin	0.50	113	115	75-120	1.50	35
	Assessment (SSB, SSB-Dup, SSB-FBL)	Pendimethalin	0.50	**128**	**129**	75-120	0.925	35
	Core/Assessment	Glyphosate	200	99.1	96.3	75-120	2.90	35
	Core	Hardness	29.1	99.7	96.2	75-120	3.51	35
	Assessment	Hardness	29.1	99.7	99.7	75-120	0	35
	Core	Copper	10	97.6	99.5	75-120	1.91	35
	Assessment	Copper	10	105	107	75-120	1.79	35
	Core/Assessment	Penoxsulam	100	115	112	75-120	1.80	35

TABLE 6-7
2009 CWFR Lab Control Spikes (LCS)

Month	Event	Analyte	Spike Level (µg/L)	SPK Recovery (Percent)	DUP Recovery (Percent)	Recovery Limits	RPD (Percent)	RPD Limit
September	Core	Carfentrazone Ethyl	0.50	85.5	86.8	75-120	1.52	35
	Assessment	Carfentrazone Ethyl	0.50	88.2	91	75-120	3.16	35
	Core	Clomazone	0.50	111	112	75-120	0.864	35
	Assessment	Clomazone	0.50	108	112	75-120	3.58	35
	Core	Pendimethalin	0.50	114	114	75-120	0	35
	Assessment	Pendimethalin	0.50	**128**	**130**	75-120	1.49	35
	Core/Assessment	Glyphosate	200	103	104	75-120	0.912	35
	Core	Hardness	29.1	96.2	96.2	75-120	0	35
	Assessment	Hardness	29.1	92.8	96.2	75-120	3.64	35
	Assessment	Copper	10	92	91	75-120	1.13	35
	Core/Assessment	Penoxsulam	100	111	111	75-120	0	35

NOTE:
Bold indicates values that do not meet acceptable recovery limits.

TABLE 6-8
2009 CWFR Surrogate Standard Sample Results

			Surrogate Recovery Results (Percent)		
Sampling Month	Sampling Event	Sample Location	4-Terphenyl-d14 (EPA 525.2) (65-135)[a]	Confidential (EPA 200.7) (65-135)[a]	Confidential (EPA 200.8) (65-135)[a]
April	Core	BS1	119	**43**[b]	104
		CBD5	117	86	101
		CBD5-Dup	112	**135**[c]	102
		CBD5-FBL	99	102	102
		CBD1	91	107	106
		SSB	103	70	100
	Assessment	H	97	-	102
		G	97	-	106
		F	118	-	108
May	Core	BS1	93	-	109
		CBD5	109	-	110
		CBD1	84	-	110
		CBD1-Dup	87	-	107
		CBD1-FBL	90	-	104
		SSB	89	-	103
	Assessment	H	92	106	107
		G	100	107	105
		F	#	107	106
June	Core	BS1	71	120	109
		CBD5	74	115	107
		CBD1	90	104	106
		SSB	105	-	109
		SSB-Dup	98	-	107
		SSB-FBL	81	-	105
		SSB-MS/MSD	103	-	-
	Assessment	H	101	-	105
		G	114	-	101
		F	See note d	-	106
July	Core	BS1	70	-	111
		BS1-Dup	79	-	112
		BS1-FBL	80	-	106
		CBD5	72	-	110
		CBD1	71	-	111
		SSB	71	-	115
	Assessment	H	70	104	104
		G	71	107	107
		F	70	114	106

TABLE 6-8
2009 CWFR Surrogate Standard Sample Results

			Surrogate Recovery Results (Percent)		
Sampling Month	Sampling Event	Sample Location	4-Terphenyl-d14 (EPA 525.2) (65-135)[a]	Confidential (EPA 200.7) (65-135)[a]	Confidential (EPA 200.8) (65-135)[a]
August	Core	BS1	87	-	105
		CBD5	73	-	102
		CBD1	72	-	106
		SSB	80	-	104
		SSB – Dup	84	-	103
		SSB – FBL	91	-	100
	Assessment	H	85	-	110
		G	73	-	108
		F	70	-	111
September	Core	BS1	71	-	106
		CBD5	70	-	104
		CBD5 – Dup	71	-	108
		CBD5 – FBL	73	-	103
		CBD1	75	-	106
		SSB	77	-	106
	Assessment	H	106	-	105
		G	100	-	106
		F	115	-	105

NOTES:
[a] Control limits
[b] Estimated value due to low surrogate recovery, caused by matrix interference
[c] Estimated value due to high surrogate recovery, cause by matrix interference
[d] Surrogate diluted out of range or surrogate coelutes with another peak

Analysis of Precision

Field duplicate samples were collected during the June, July, and September sampling events for each matrix and analyzed for each primary analyte. Duplicate results were found to be consistent with the original matrix results. Field duplicate results are presented in Tables 6-3 and 6-4.

MS/MSD sample sets were prepared for every sampling event during the 2009 season. All of the sample sets had acceptable RPD limits for all analytes. MS/MSD results and RPD values are presented in Table 6-6.

LCS samples were prepared and analyzed for every sampling event during the 2009 season. The RPD percentages for all of the samples were within the acceptable limits. LCS results and RPD values are presented in Table 6-7.

Analysis of Accuracy

Field blank samples were utilized during each sampling event, and were analyzed for each primary analyte. Two field blank samples were found to have levels of TDS just above the MRLs; this was assumed to be due to traffic in the sampling area contributing dust to the samples. All other samples had analyte levels below the MRLs. Field blank results are presented in Table 6-2.

Method blank samples were run with every batch of analytical samples. All method blank samples were found to have analyte levels below the MRLs. Method blank results are presented in Table 6-5.

MS and MSD samples were prepared and analyzed for every sampling event during the 2009 season. The majority of the MS/MSD results were within the acceptable recovery limits. Three events had analyte recoveries outside the limits - copper from the April event, pendimethalin and clomazone from the August assessment event, clomazone from the September assessment event, and Pendimethalin from the September core and assessment events. In all cases, the spike recovery was above the recovery limit. MS/MSD results and recovery limits are presented in Table 6-6.

LCS samples were prepared and analyzed for every sampling event during the 2009 season. The majority of the LCS results were within the acceptable recovery limits. Two events had analyte recoveries outside the limits - clomazone and pendimethalin from the August event, and pendimethalin from the September event. The August clomazone and pendimethalin spike and spike duplicate recoveries were above the recovery limits, and the September pendimethalin spike and spike duplicate recoveries were also above the acceptable recovery limits. LCS results and recovery limits are presented in Table 6-7.

Surrogate standard samples were prepared for analysis with the environmental samples. All of the surrogate standards except for two fell within the required recovery limits (Table 6-8). The two samples outside of the required recovery limits were the April method 200.7 surrogates for sites BS1 and CBD5-Dup. According to McCampbell, both samples were outside of the recovery limits because of matrix interference with the surrogate. Surrogate standard results and recovery limits are presented in Table 6-8.

Analysis Summary

The following summarizes the results of the QA/QC analysis performed on the CWFR data:

- Two of the field blank samples had levels of TDS just above the MRL; these samples were from the July and August events. The TDS were attributed to dust entering the sample bottles from passing traffic on the road during sampling.
- Field duplicate sample results were consistent with primary sample results.
- Method blank samples had results below the MRLs for all analytes.
- MS/MSD samples had RPD values within acceptable limits. Three events had analyte recoveries outside of acceptable levels: copper from the April event, clomazone and pendimethalin from the August assessment event, clomazone from the September and clomazone and pendimethalin form the September event.

- LCS samples had RPD values within acceptable limits. Two events had analyte recoveries outside of acceptable levels: clomazone and pendimethalin from the August event, and pendimethalin from the September event.
- Two of the surrogate standard samples had recoveries outside of the acceptable recovery limits: the April 200.7 surrogates for sites BS1 and CBD5-Dup. These samples had results outside the recovery limits because of matrix interference with the surrogate.

RPP QA/QC Sample Results and Analysis

As described in Chapter 5, RPP molinate samples are analyzed by the Syngenta Crop Protection, Inc. registrant laboratory, and thiobencarb samples are analyzed by the Valent Dublin Laboratory registrant laboratory. In addition, the CRC submits QA/QC samples to Environmental Micro Analysis Inc. (EMA) throughout the monitoring season.

During each QC sampling event, two sets of samples were collected. One set was sent to the analyte-specific laboratory (Syngenta or Valent), and the other set was sent to the EMA laboratory for comparison.

The field RPP QA/QC samples are shown in Table 6-9. In addition to the field QA/QC samples, analytical laboratories typically perform method blank, LCS, and surrogate standard analyses with each event.

TABLE 6-9
QA/QC Samples, RPP 2009

Date	Event	QA/QC Sample Type
5/5/09	W2D1	Duplicate at BS1
5/19/09	W4D1	Duplicate at SR1
5/21/09	W4D2	Blind spikes
5/26/09	W5D1	Duplicate at CBD1
5/26/09	W5D2	Rinse blank at CBD5
6/4/09	W6D2	Duplicate at SSB
6/9/09	W7D1	Duplicate at BS1
6/11/09	W7D2	Blind spikes
6/16/09	W8D1	Rinse blank at SSB
		Duplicate at CBD5
6/23/2009	W9D1	Duplicate at SR1

Field QA/QC Samples

Field QA/QC samples included rinse blank, field duplicate, and MS/MSD samples; the results for each follow.

Rinse Blank

Rinse blank samples were collected twice during the sampling season, at the W5D2 and W8D1 sampling events. The results for all rinse blank samples were below the MDLs for thiobencarb and molinate (Table 6-10).

TABLE 6-10
2009 RPP Comparison of Rinse Blank Samples to Primary Samples

Date	Sample Event	Monitoring Site	Sample Type	Thiobencarb (µg/L)	Molinate (µg/L)
5/28/09	W5D2	CBD5	Primary*	0.71	<1.0
			Rinse*	<0.50	<0.50
6/16/09	W8D1	SSB	Primary*	<0.50	<1.0
			Rinse*	<0.50	<0.50

NOTE:
*Primary thiobencarb samples analyzed at Valent Laboratories, primary molinate samples analyzed at Syngenta Laboratories, and rinse samples analyzed at EMA Laboratories.

Field Duplicate

Field duplicate samples were collected during 7 weeks of RPP sampling (Table 6-11). Although the primary and duplicate samples are analyzed at two different labs, the majority of the sample pairs yielded similar results for the primary and duplicate samples.

TABLE 6-11
2009 RPP Field Duplicate Results

Date	Sample Event	Monitoring Site	Sample Type	Thiobencarb (µg/L)	Molinate (µg/L)
5/5/09	W2D1	BS1	Primary*	<0.5	<1.0
			Duplicate*	<0.5	<0.5
5/19/09	W4D1	SR1	Primary*	<0.5	<1.0
			Duplicate*	<0.5	<0.5
5/26/09	W5D1	CBD1	Primary*	1.54	<1.0
			Duplicate*	1.84	<0.5
6/4/09	W6D2	SSB	Primary*	0.12	<1.0
			Duplicate*	<0.5	<0.5
6/9/09	W7D1	BS1	Primary*	<0.5	<1.0
			Duplicate*	<0.5	<0.5

TABLE 6-11
2009 RPP Field Duplicate Results

Date	Sample Event	Monitoring Site	Sample Type	Thiobencarb (µg/L)	Molinate (µg/L)
6/16/09	W8D1	CBD5	Primary*	0.18	<1.0
			Duplicate*	<0.5	<0.5
6/23/09	W9D1	SR1	Primary*	<0.5	<1.0
			Duplicate*	<0.5	<0.5

NOTES:
*Duplicate samples analyzed at EMA laboratories, primary thiobencarb samples analyzed at Valent laboratories, and primary molinate samples analyzed at Syngenta laboratories.
EMA and Valent reporting limit is 0.5 µg/L
Syngenta reporting limit is 1.0 µg/L

Samples collected during W5D1 had a detectable level of thiobencarb; the results from the two different labs are remarkably similar. This shows good correlation between the two labs used for this analysis. Thiobencarb was again detected in the primary sample from W8D1; however, the detection was at a level below the EMA method detection limit for the duplicate sample.

MS/MSD

Matrix (environmental) spike samples were collected during the W4D2 and W7D2 sampling events. These samples were spiked by Kleinfelder and submitted to the laboratory with fictitious sample site identification. The samples were then analyzed for thiobencarb and molinate (Table 6-12).

TABLE 6-12
Matrix Spike Sample Results, RPP 2009

Date	Sample Event	Sample Location	Laboratory	Analyte	Spike Level (µg/L)	SPK Result (µg/L)	SPK Recovery (Percent)	Recovery Limits
5/21/09	W4D2	CRC1*	EMA	Thiobencarb	1.5	1.37	91.3	75–120
			EMA	Molinate	10.0	8.17	81.7	75–120
			Valent	Thiobencarb	1.5	1.67	111.3	75–120
			Syngenta	Molinate	10.0	11.0	110	75-120
6/11/09	W7D2	CRC1*	EMA	Thiobencarb	1.0	1.04	104	75–120
			EMA	Molinate	5.0	3.53	**70.6**	75–120
			Valent	Thiobencarb	1.0	1.27	**127**	75–120
			Syngenta	Molinate	5.0	5.25	105	75–120

NOTES:
Bold indicates values that do not meet acceptable recovery limits.
EMA and Valent reporting limit = 0.5 µg/L.
Syngenta reporting limit = 1.0 µg/L.
*CRC1 is a fictitious sample location name given to the spike samples for laboratory analysis.

An RPD value could not be calculated for these samples because the two sets of values for each analyte were spiked and analyzed at different laboratories.

Two samples had recovery percentages outside of the acceptable range for recovery limits. Those samples included the Valent thiobencarb from the W7D2 event, and the EMA molinate from the W7D2 event. The EMA molinate sample resulted in a percent recovery below the acceptable recovery range, and the Valent thiobencarb sample resulted in a percent recovery above the acceptable recovery range.

Laboratory QA/QC Samples

The laboratory QA/QC samples included method blanks, laboratory control spikes (LCS), and surrogate standard samples; the results for each follow.

Method Blank

Method blank samples were prepared and tested for the same analytes as the environmental samples. The values below are for the EMA laboratory analysis. All samples had values below the MRLs for molinate and thiobencarb (Table 6-13).

TABLE 6-13
Method Blank Results (EMA), RPP 2009

Sample Date	Event	Molinate (RL = 0.50)	Thiobencarb (RL = 0.50)
5/5/09	W2D1	ND	ND
5/19/09	W4D1	ND	ND
5/21/09	W4D2	ND	ND
5/26/09	W5D1	ND	ND
5/28/09	W5D2	ND	ND
6/4/09	W6D2	ND	ND
6/09/09	W7D1	ND	ND
6/11/09	W7D2	ND	ND
6/16/09	W8D1	ND	ND
6/23/09	W9D1	ND	ND

Laboratory Control Spikes (LCS)

LCS samples were utilized at all three analytical laboratories as an internal QC for the data. The results of all three laboratories' LCS samples are included in Tables 6-14, 6-15, and 6-16.

EMA Laboratories. LCS samples were analyzed at EMA laboratories for selected sampling events. The RPD percentages for all samples were within acceptable limits (Table 6-14); however, several samples had recovery limits outside the acceptable range. These samples included thiobencarb from the W6D2 sampling event, and molinate from W8D1 and W9D1 (samples were run in same batch, and therefore had the same LCS sample).

Valent Laboratories. LCS samples were spiked with thiobencarb and analyzed at Valent laboratories for selected sampling events. The RPD percentages and recovery limits for all samples were within acceptable limits (Table 6-15).

Syngenta Laboratories. LCS samples were spiked with molinate and analyzed at Syngenta laboratories for selected sampling events. The recovery limits for all samples were within acceptable limits (Table 6-16).

TABLE 6-14
EMA Molinate and Thiobencarb LCS Sample Results, RPP 2009

Sample Event/Date	Analyte	Spike Level (µg/L)	SPK Recovery (Percent)	DUP Recovery (Percent)	Recovery Limits	RPD (Percent)	RPD Limit
W2D1 5/5/09	Molinate				75–120		35
	Thiobencarb				75–120		35
W4D1 5/19/09	Molinate				75-120		35
	Thiobencarb				75-120		35
W4D2 5/21/09	Molinate				75–120		35
	Thiobencarb				75–120		35
W5D1 5/26/09	Molinate	5	99.3	99.4	75–120	0.10	35
	Thiobencarb	5	109.4	106.7	75–120	2.50	35
W5D2 5/28/09	Molinate	5	82.1	113.6	75–120	32.2	35
	Thiobencarb	5	94.3	115.1	75–120	19.9	35
W6D2 6/4/09	Molinate	5.00	96.7	118.0	75–120	19.8	35
	Thiobencarb	10.0	**130.0**	**122.4**	75–120	6.02	35
W7D2 6/9/09	Molinate	0.5	83.8	90.4	75–120	7.58	35
	Thiobencarb	5.0	97.0	114.0	75–120	16.1	35
W8D1 6/16/09	Molinate	5	**63.0**	**71.9**	75–120	13.2	35
	Thiobencarb	5	94.5	101.9	75–120	7.54	35
W9D1 6/23/09	Molinate	5	**63.0**	**71.9**	75–120	13.2	35
	Thiobencarb	5	94.5	101.9	75–120	7.54	35

NOTES:
Bold indicates values that do not meet acceptable recovery limits.
Samples from W8D1 and W9D1 were run in the same batch, and therefore had the same LCS.

RPD = 100 * (Sample - Duplicate) / [(Sample + Duplicate) /2]

TABLE 6-15
Valent Thiobencarb LCS Sample Results, RPP 2009

Sample Event/Date	Spike Level (µg/L)	SPK Result (µg/L)	DUP Result (µg/L)	SPK Recovery (Percent)	DUP Recovery (Percent)	Recovery Limits	RPD (Percent)	RPD Limits
W1D1 4/29/09	1.0	0.987	1.011	98.7	101.1	75–120	2.40	35
W2D1 5/5/09	1.0	0.977	0.954	97.7	95.4	75–120	2.38	35
W3D1 5/14/09	1.0	0.973	0.973	97.3	97.3	75–120	0	35
W4D1 5/19/09	1.0	0.990	0.998	99.0	99.8	75–120	0.80	35
W5D1 5/26/09	1.0	1.007	0.999	100.7	99.9	75–120	0.80	35
W6D1 6/4/09	1.0	0.961	0.977	96.1	97.7	75–120	1.65	35
W7D1 6/9/09	1.0	1.016	1.042	101.6	104.2	75–120	2.53	35
W8D1 6/16/09	1.0	1.012	1.012	101.2	101.2	75–120	0	35
W9D1 6/23/09	1.0	1.002	0.978	100.2	97.8	75-120	2.42	35
W10D1 6/30/09	1.0	0.935	1.019	93.5	101.9	75-120	8.60	35

TABLE 6-16
Syngenta Molinate LCS Sample Results, RPP 2009

Analysis Date	Spike Level (µg/L)	SPK Recovery (Percent)	Recovery Limits
5/13/09	1.0	94.0	75–120
5/18/09	1.0	102	75–120
5/27/09	1.0	102	75–120
6/1/09	1.0	98.0	75–120
6/8/09	1.0	101	75–120
6/15/09	1.0	102	75–120
6/22/09	1.0	102	75–120
7/6/09	1.0	99.0	75-120
5/13/09	5.0	101	75–120
5/18/09	5.0	103	75–120
5/27/09	5.0	101	75–120
6/1/09	5.0	103	75–120

TABLE 6-16
Syngenta Molinate LCS Sample Results, RPP 2009

Analysis Date	Spike Level (µg/L)	SPK Recovery (Percent)	Recovery Limits
6/8/09	5.0	105	75–120
6/15/09	5.0	102	75–120
6/22/09	5.0	102	75–120
7/6/09	5.0	100	75-120

Surrogate Standard

Surrogate standard samples were prepared by EMA for analysis with the environmental samples. All sample results were within the required recovery limits with the exception of the SSB sample on 6/16/09 (Table 6-17).

TABLE 6-17
Surrogate Standard Results (EMA), RPP 2009

		Surrogate Recovery Results (Percent)	
Sample Date	Sample Location	Triphenylphosphate (65–135)[a]	Tributylphosphate (65-135)[a]
5/5/09	BS1	128	NA
5/19/09	SR1	NA	118
5/21/09	CRC1	NA	108
5/26/09	CBD1	NA	130
5/28/09	CBD5	NA	130
6/4/09	SSB	NA	111
6/9/09	BS1	NA	117
6/11/09	CRC1	NA	125
6/16/09	SSB	NA	136[b]
	CBD5	NA	126
6/23/09	SR1	NA	129

NOTES:
NA = not analyzed
Both Triphenylphosphate and Tributylphosphate were surrogates for EPA 8141 at 2.0 µg/L.

[a] Control limits
[b] Surrogate level above laboratory control limits due to matrix interference. Sample ran on two systems with similar results. Because no target compounds were detected, no further action was taken.

Analysis of Precision

Duplicates for the RPP sampling were uniquely processed, with the primary and duplicate samples analyzed at different laboratories (primary samples at Valent or Syngenta, duplicate samples at EMA). Although this prevents a direct comparison of results from within a site, it allows a comparison of laboratories.

A field duplicate sample was collected nearly every week of sampling, with the exception of weeks 1 and 3. Although the primary and duplicate samples were analyzed at two different labs, the majority of the sample pairs yielded similar results for the primary and duplicate samples.

Samples collected during W5D1 had a detectable level of thiobencarb; the results from the two different labs are remarkably similar. This shows good correlation between the two labs used for this analysis. Thiobencarb was again detected in the primary samples from W6D2 and W8D1; however, the detection was at a level below the method detection limit. No detection was reported for the duplicate sample from that event. Field duplicate results are presented in Table 6-11.

MS/MSD samples were utilized for each matrix during the W4D2 and W7D2 sampling events. Although two samples for each analyte were taken at each event, the samples were spiked and analyzed at different laboratories, making an RPD comparison inappropriate. MS/MSD results are presented in Table 6-12.

LCS samples were prepared at EMA for the W2D1, W4D1, W4D2, W5D1, W5D2, W6D2, W7D2, W8D1, and W9D1 sampling events. All samples from all dates were within RPD limits for both analytes. LCS sample results and RPD values are presented in Table 6-14.

LCS samples were analyzed at Valent for all analysis dates. All samples from all dates were within RPD limits for thiobencarb. LCS sample results and RPD values are presented in Table 6-15.

LCS samples were analyzed at Syngenta for all analysis dates. Duplicates were not run, so an RPD cannot be calculated for molinate samples from this lab. LCS sample results are presented in Table 6-16.

Analysis of Accuracy

Rinse blank samples were collected twice during the 2009 sampling season, at the W5D1 and W8D1 sampling events. All rinse blank samples were found to have analyte levels below the method reporting limits. Rinse blank results are presented in Table 6-10.

Method blank samples were run with every batch of analytical samples. All method blank samples were found to have analyte levels below the method reporting limits. Method blank results are presented in Table 6-11.

MS/MSD samples were prepared for the W4D2 and W7D2 sampling events. The majority of the samples were within the acceptable recovery limits. The results from two samples fell outside the recovery limits; the EMA molinate sample from W7D2 had a spike recovery of 70.6, which is lower than acceptable, and the Valent thiobencarb sample from the same event had a spike recovery of 127.0, which is higher than acceptable. MS results and recovery limits are presented in Table 6-12.

LCS samples were prepared at EMA laboratories for nine sampling events; W2D1, W4D1, W4D2, W5D1, W5D2, W6D2, W7D2, W8D1, and W9D1. Several of the LCS samples had recovery limits outside the acceptable range. These samples included the thiobencarb spikes from W6D2, and the molinate spikes from W8D1 and W9D1 (samples were run in the same batch, and therefore had the same LCS sample). LCS results and recovery limits are presented in Table 6-14.

LCS samples for all analysis dates were analyzed at Valent. All samples from all dates were within the acceptable recovery limits for thiobencarb. LCS sample results and recovery limit values are presented in Table 6-15.

LCS samples for all analysis dates were analyzed at Syngenta. All samples from all dates were within the acceptable recovery limits for molinate. LCS sample results and recovery limits values are presented in Table 6-16.

Surrogate standards were evaluated with the analytical samples at the EMA laboratory. All of the sample results were within the acceptable recovery limits with the exception of the SSB sample from 6/16/09. The recovery from this sample was above acceptable limits; lab results state that this is because of matrix interference. Surrogate standard results and recovery limits are presented in Table 6-17.

Analysis Summary

The following summarizes the results of the QA/QC analysis performed on the RPP data:

- Primary and duplicate samples were analyzed at two different laboratories, making a comparison for RPD inappropriate.
- MSD samples were not submitted for analysis to each laboratory in conjunction with MS samples. Rather, the submittal of MS samples to EMA provided an in-lieu MSD for the MS samples submitted to Valent and Syngenta.
- Two MS samples had results outside the acceptable recovery limits: the EMA molinate sample from W7D2, and the Valent thiobencarb sample from the same event.
- Several LCS samples had recovery limits outside the acceptable range. These samples included thiobencarb from W6D2, and molinate from W8D1 and W9D1 (samples were run in the same batch, and therefore had the same LCS sample).
- Surrogate standard samples were run at EMA Laboratories. All samples had recoveries within acceptable limits with the exception of one sample from 6/16/09.

Chains of Custody

Chains of custody were utilized to document sample possession from the time of field sampling until the time of laboratory analysis. A chain-of-custody (COC) form was completed after sample collection at each sample event and prior to sample shipment or release. The COC record forms were completed with indelible ink. Unused portions of the form were crossed out and initialed by the sampler. The COC form, sample labels, and field documentation were cross-checked to verify sample identification, type of analyses, sample volume, and number and type of containers.

COC forms for the CWFR and RPP monitoring programs are included in Appendixes B-1 and C-1, respectively.

CHAPTER 7

Summary and Conclusions

This year was the fifth full year in which the CRC conducted water quality monitoring and reporting activities under the requirements of the CVRWQCB's *Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands*. This effort included monitoring at core and assessment sites, as well as implementation of additional monitoring under an Algae Management Plan (AMP). The CRC also conducted monitoring and reporting activities under the requirements of the Rice Pesticides Program, as required under the CVRWQCB Resolution No. R5-2007-0018. Summaries of the 2009 program implementation follow.

CWFR and AMP

CWFR and AMP monitoring included field assessment of temperature, DO, pH, and EC. Lab analyses were conducted as required for total copper, hardness, aquatic toxicity, and pesticides.

Temperature: Temperature results indicate warm water conditions May through September. Core and assessment site temperatures were consistent with results observed in previous years. Water temperatures track with observed air temperatures. Peak temperatures were observed during the July monitoring event, with a high of 76.8°F.

DO: DO results were generally consistent with observations in previous years. DO typically trended above the 6 mg/L warm water standard. Low DO (less than the WARM WQO of 5 mg/L) was observed as follows: BS1 (September), CBD1 (June and July), H (July), and G (July).

pH: There were no observations outside the 6.5 to 8.5 WQO range during 2009.

EC: The 2009 sampling season yielded no samples with an EC greater than 700 µmhos/cm.

Copper and Hardness: Samples from all sites during all events were analyzed for hardness and total copper, in accordance with the MRP. The California Toxics Rule hardness-adjusted copper criteria rely on use of dissolved copper results; therefore, hardness-adjusted copper was not calculated. Future monitoring will specify dissolved copper analysis.

Pesticide Analysis: The MRP included assessment and core site analysis for carfentrazone ethyl, clomazone, glyphosate, pendimethalin, and penoxsulam. The AMP included assessment and core site analysis for clomazone, propanil, and triclopyr. The QAPP-specified method detection limits are substantially below the identified ecological toxicity endpoints, providing sufficient assurance that levels of concern would be detected if present in sample waters. The following summarizes the results of the CWFR and AMP pesticide analyses:

- Clomazone was detected at the majority of core and assessment sites during the April, May, and June monitoring events. These detections were two to three orders of magnitude below the lowest identified ECOTOX 96-hour LC50 value and, based on available information, do not indicate aquatic ecology water quality concerns.

- Propanil was detected in June and July, with four detections at core sites and a single detection at an assessment site. The propanil detection at the assessment site is the same order of magnitude as the lowest identified ECOTOX EC50 value, and as a result may indicate additional monitoring or management implementation.
- Triclopyr was detected once at CBD5. The detection is four orders of magnitude less than the identified ECOTOX EC50 value and, based on available information, does not indicate an aquatic ecology water quality concern.
- There were no detections of the following pesticides: carfentrazone ethyl, glyphosate, pendimethalin, or penoxsulam.

Aquatic Toxicity Testing: For 2009, aquatic toxicity testing was conducted as required at the assessment monitoring sites. Acute and chronic toxicity tests were performed on three test species. The results of the testing are as follows:

- **Fathead minnow (*Pimephales promelas*):** For all the analyses conducted during Year 5, there was no statistically significant observed toxicity to fathead minnow, and no resamples were triggered. These results indicate that sampled waters were not toxic to representative fish species.
- **Water flea (*Ceriodaphnia dubia*):** As with the fathead minnow, for all the analyses conducted during Year 5, there was no statistically significant observed toxicity to the water flea, and no resamples were triggered. These results indicate that sampled waters were not toxic to representative invertebrates.
- **Green algae (*Selenastrum capricornutum*):** *Selenastrum* toxicity testing was conducted under both the MRP and the AMP (AMP required monitoring at core sites during May, June, and July). One site sampled under the MRP testing had a lower percent growth than the control (April site G sample, growth of 15% less than the control); however, the result did not trigger resampling. Two sites sampled under the AMP testing had lower percent growth than the control (May site CBD1 and site SSB samples, growth of 16% and 12% less than the control, respectively); however, the results did not trigger resampling. The remainder of the MRP and AMP events had growth beyond the control, indicating that that sample waters were not toxic to *Selenastrum* and that algae grown in the sample water demonstrated better growth as compared to algae grown in the control water.

Comparison of Algae Toxicity with Copper Results: Sampling for copper analyses occurred during the same events as the algae toxicity sampling. Lab results show copper present in all samples; however, a relationship between copper presence/concentration and algae toxicity was not identified. Copper concentrations at sites with statistically significant toxicity varied, and sites with higher copper concentrations were not necessarily those with higher toxicity. This indicates that copper was not a factor in algae toxicity in these samples.

Algae Management Plan Pesticides Analysis: An AMP was established in 2007 to provide a framework for additional testing to identify the presence or non-detection of rice herbicides concurrent with algae toxicity test results. The list of specified herbicides requiring monitoring was modified in 2009 to include herbicides that were detected during the 2007 and 2008 sampling, and the timing of the herbicide analysis refined to coincide with the primary months of herbicide usage. The 2009 AMP included May, June, and July core event clomazone analysis, May and June core event triclopyr analysis, and June and July core event propanil analysis.

Algae Management Plan Pesticides and Algae Toxicity: Although monitored pesticides were detected during the 2009 monitoring season, no apparent relationship between pesticide presence and algae toxicity could be confirmed. Three days with algae toxicity were recorded, and concentrations of detected pesticides on these days were lower than on days with high algae growth.

Assessment of the 2009 CWFR Program and AMP

This year represents the fifth full year of the CWFR program. The key successes and challenges faced during 2009 program implementation are summarized as follows:

- Monitoring and assessment were conducted in accordance with the requirements of the MRP, AMP, and RPP. Regularly scheduled CWFR sampling was conducted as required under the MRP. This sampling included core and assessment site analysis for field parameters (temperature, DO, pH, electrical conductivity, and flow), AMP pesticides and toxicity, and assessment site toxicity (fathead minnow, water flea, and green algae).
- CWFR water quality monitoring was conducted at four core sites and three assessment sites. This effort satisfies the MRP requirement for implementation of a phased core/assessment monitoring regime, which includes assessment monitoring on a 3-year cycle.
- The CRC developed and implemented a SWAMP-compliant electronic data submittal system, including laboratory prepared SWAMP-compliant Electronic Data Reports for chemistry and aquatic toxicity analyses. The CRC submitted results to the CVRWQCB on a regular basis to provide for real-time discussion of results, their potential implications, and appropriate management actions.
- A SWAMP-compliant QAPP was developed and implemented. As part of the SWAMP submittal, lab Method Detection Limit studies for modified USEPA analysis methods were submitted to the CVRWQCB. The MDL studies provide technical confirmation of the detection limits reported by McCampbell.
- Review of field and laboratory QA/QC samples indicates substantial achievement of quality objectives.
  - Field blanks for all pesticides, hardness, and copper achieved quality objectives, while two TDS samples showed detections where none would be expected. These detections are attributed to field contamination of blank water standards. Field duplicate sample results were consistent with primary sample results.
  - Field duplicate samples for algae toxicity tests all coincided with samples exhibiting growth, as compared to the control. The majority of the duplicate results for these samples show a relatively substantial percent difference, ranging from -3 percent to +85 percent. It is hypothesized that samples showing substantial growth as

compared to the control may exhibit greater variability in growth, and results may also be skewed by clumping or other factors that influence measurement. While this range in duplicate reporting cannot be directly extrapolated to samples exhibiting growth less than the control, it does demonstrate the extreme variability that the algae toxicity tests may show under growth conditions.

– Laboratory QA/QC substantially achieved data quality objectives. Method blanks achieved data quality objectives, with all results nondetect, as expected. MS/MSD samples substantially achieved data quality objectives. Five spike recoveries and four coinciding duplicate recoveries exceeded the target range, indicating an overprediction. Four lab control spikes (two for clomazone and two for pendimethalin) and three coinciding duplicate recoveries (clomazone and pendimathalin) exceeded the target range, indicating an overprediction. Two early season surrogate recovery results were estimated results, due to matrix interference. The remainder of the surrogate recovery results met the data quality objectives.

- Pesticide analysis included analysis of core site samples for carfentrazone ethyl, clomazone, glyphosate, pendimethalin, and penoxsulam. The AMP included analysis of assessment and core site samples for clomazone, propanil, and triclopyr. Pesticide results substantially indicated that management practices are effectively protecting water quality, with results either nondetect or two to four orders of magnitude below identified laboratory ecological toxicity thresholds. One exception is propanil; 2009 propanil results indicate that implementation of additional monitoring and management may be appropriate during 2010.
- Core monitoring sites for trend monitoring of rice water quality impacts continue to be appropriate because of the uniformity of rice farming practices across the valley. Rice water management and rice water quality management practices are relatively consistent throughout the valley: The same set of field preparation, irrigation, and harvest practices are available to growers. Additionally, the water hold requirements apply to all rice growers, leaving little variation in the methods of rice farming from the various drainage areas.
- Fathead minnow, *C. daphnia*, and *H. azteca* toxicity testing at assessment sites showed no toxicity. This indicates that rice water quality management practices are effectively protecting indicator species.
- *Selenastrum* toxicity testing at assessment sites showed statistically significant algae reductions at three different sites during 2009, ranging from 12 percent to 16 percent reduction, as compared to the control. This reduction is substantially below the 50 percent reduction threshold that would have triggered resampling.
- Herbicide and copper analysis conducted concurrent with the AMP testing did not support a determination of the toxicants associated with these algae reductions. However, detections of propanil concurrent with algae results that showed no toxicity indicate there is a certain threshold at which propanil may not contribute to toxicity.
- The CRC implemented DO monitoring in coordination with the UC Davis CALFED grant during 2007 in an effort to increase the understanding of rice discharges and the

effects on DO. These data, along with the UC Davis study data are included in this report to conform to the reporting requirements of the MRP.

- Implementation of management practices continued in 2009, including water hold requirements; education and outreach (newsletters and grower meetings); stakeholder involvement with enforcement activities; and coordination with the UC Cooperative Extension, UC Davis, and the Rice Research Board. Additionally, the CRC has the ability to directly contact each of its members and is committed to using its outreach capabilities to address water quality concerns when they are identified.
- The CRC continues to be engaged in the CVRWQCB's efforts to refine the irrigated lands conditional waiver program through its regular consultation with CVRWQCB staff and through its participation in the CVRWQCB's Technical Issues Committee, CV-SALTS Salinity Coalition, Central Valley Pesticide Total Maximum Daily Load and Basin Plan Amendment, and Drinking Water Policy Workgroup.

CWFR Recommendations for 2010

- The CRC's 2009 assessment monitoring satisfies the MRP requirements for a phased monitoring regime that includes assessment monitoring on a 3-year cycle. It is recommended that monitoring in 2010 and 2011 include core monitoring parameters at core sites.
- It is recommended the results of the AMP be evaluated collaboratively with CVRWQCB staff, to develop an appropriate recommendation for the assessment of algae reductions.
- The field crew must implement backup measures for monitoring of flow to ensure that flow data are accurately recorded. The QAPP Standard Operating Procedure for flow measurement should be revised to include a backup method, and include immediate submittal of the flow meter for service should it not measure velocity at any site where the alternative method indicates flow. Where zero flow is reported on the field sheets, the Field Project Manager should immediately contact the Quality Assurance Officer to discuss the followup plan.
- The field crew should consider using blind naming conventions for spike, duplicate, and rinse blank samples. This would ensure that the laboratories are unaware of expected results.
- For future monitoring seasons that incorporate core and assessment site monitoring, it is recommended that assessment site monitoring be conducted on the first day, and core site monitoring be conducted on the second day of each monitoring event. This would provide downstream data more closely aligned with the upstream data, and could assist with interpretation of data.
- Close consultation with CVRWQCB staff regarding the program should continue in an effort to refine the program to focus on identified water quality concerns and appropriate implementation actions, if warranted.

RPP

The results of all monitoring conducted by the Cities of Sacramento and West Sacramento showed thiobencarb and molinate concentrations below the drinking water maximum contaminant level and Basin Plan Performance Goals. At the CRC's CBD1 drain site, there were three measured exceedances of the 1.5 µg/L Basin Plan Performance Goals for thiobencarb and no measured exceedances for molinate during the 2009 monitoring season. The thiobencarb exceedances were all at site CBD1, and occurred on May 19, May 26, and May 28.

Immediately upon receipt of these results, the CRC initiated its communication strategy, which includes outreach to its grower membership, CVRWQCB staff, the Cities of Sacramento and West Sacramento, and the CACs. The CRC sent letters to all growers and the rice CACs on June 5, 2009, as notification of the exceedances and asking for their assistance in remedying the problem. The grower letter included complete pesticide regulation information, including water hold information for Bolero UltraMax. Following the aggressive outreach to grower membership, no further exceedances were detected.

Assessment of the 2009 RPP Program

- The RPP continues to be an example of an effective agricultural water quality regulatory program. The RPP implements an aggressive monitoring schedule designed to focus sampling activities during the 10 weeks of peak pesticide use and on high-use products that are regulated under the Basin Plan's Conditional Prohibition of Discharge.

- The CRC's RPP monitoring schedule continues to provide a rigorous sampling regime designed to rapidly assess attainment of rice pesticides regulated under the Basin Plan Prohibition of Discharge, and to monitor achievement of water quality performance goals and protection of water quality.

- The CRC assessed the potential causes of the thiobencarb exceedances. In past years, detections near threshold values have been attributed to high winds (overtopping), significant rains, and the associated emergency releases that such conditions may trigger. This year, however, such weather conditions did not occur, and it is surmised that the new Bolero formulation (Bolero UltraMax), approved for use in 2008 and more widely used in 2009, could be a contributing factor. The new formulation releases thiobencarb into the water column at higher concentrations after initial application than the previous Bolero formulation. In addition, the registrant launched BoleroMax with a proposed reduction in the water hold requirement. Some confusion may exist as to the correct water hold requirement for Bolero UltraMax. The CRC's outreach efforts focused on the Bolero requirements to achieve water quality protection.

- Water holds and other management practices implemented by rice growers and the CRC continue to be critical to protect water quality.

RPP Recommendations for 2010

- The CRC has already launched efforts to implement additional, aggressive industry outreach and education to growers, pest control advisors (PCAs), and applicators early in the 2010 season. Examples of the CRC outreach and education include the following:

  - Continuance of the mandatory thiobencarb stewardship meetings
  - Outreach in the CRC newsletter
  - Maintenance of the ongoing relationships with applicators and PCAs
  - The outreach is to focus on management practices for new formulation of Bolero,
  - Implementation of measures to effectively manage thiobencarb discharges, as detailed in the CVRWQCB Resolution and the DPR Permit Conditions
  - The outreach is to focus on management practices for the new formulation of Bolero.
  - This outreach and education is critical to 2010 water quality protection efforts.
- The CRC should consider use of an alternate QA/QC lab for RPP pesticide analysis. The current lab, which is used as third-party confirmation of pesticide registrant labs, provides data of lesser quality than the registrant labs and does not report when its result do not achieve QA/QC metrics.
- It is recommended that the CRC continue to implement RPP water quality monitoring and reporting activities consistent with the program implemented during 2008 and approved through 2010.
- The CRC will utilize the stakeholder process in gaining collaboration from DPR, the CVRWQCB, and the city utilities on the RPP recommendations through 2010.

CHAPTER 8

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