Conditional Waiver for Rice

2006 Annual Monitoring Report
Sacramento River Drainage Basin

Prepared for

California Rice Commission

December 2006

CH2MHILL

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Executive Summary

The California Rice Commission (CRC) conducted Conditional Waiver for Rice (CWFR) program activities for the calendar year 2006. Key CFWR activities include:

- reporting of rice acreage information
- reporting of rice pesticide use information
- water quality monitoring
- toxicity testing and follow-up toxicity identification evaluations
- 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.

Purpose

This report fulfills the reporting requirements of the 2006 CFWR, a conditional waiver issued by the Central Valley Regional Water Quality Control Board (CVRWQCB).

Regulatory Program

The current requirements of the CWFR are specified in CVRWQCB's Resolution No. R5-2003-0105, and monitoring and reporting requirements specific to rice are specified in Monitoring and Reporting Program (MRP) Order No. R5-2004-0839.

Program Authority

The CRC has long been recognized by the CVRWQCB as an entity with the authority and capacity to implement Program 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. The CRC was issued a Notice of Applicability as a watershed Coalition under the CVRWQCB's Conditional Waiver for Discharges from Irrigated Lands in July of 2003, and has implemented CWFR program activities since that time.

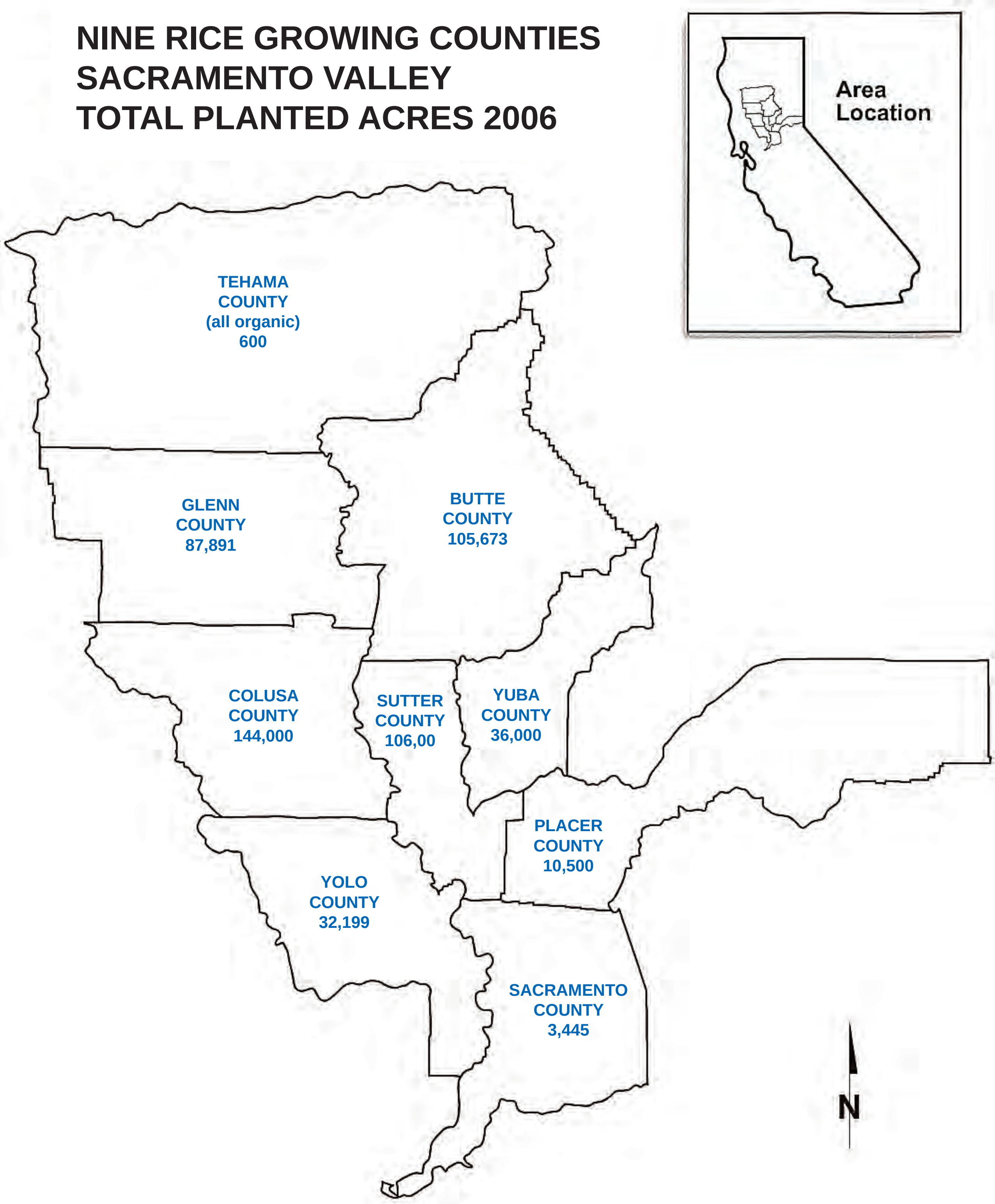

FIGURE ES-1
Rice Growing Region
California Rice Commission

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Acreage and Planting Season

Growers in the Sacramento Valley planted over 526,000 acres of rice during calendar year 2006. This is a reduction of 2,000 acres from 2005. The planting date this year was substantially delayed due to late season rains and runoff that left many rice lands inundated until early May. The Sutter and Yolo Bypasses, drainage channels for much of the rice growing area, remained inundated late into the spring. Record high temperatures in July reduced yield of early planted rice.

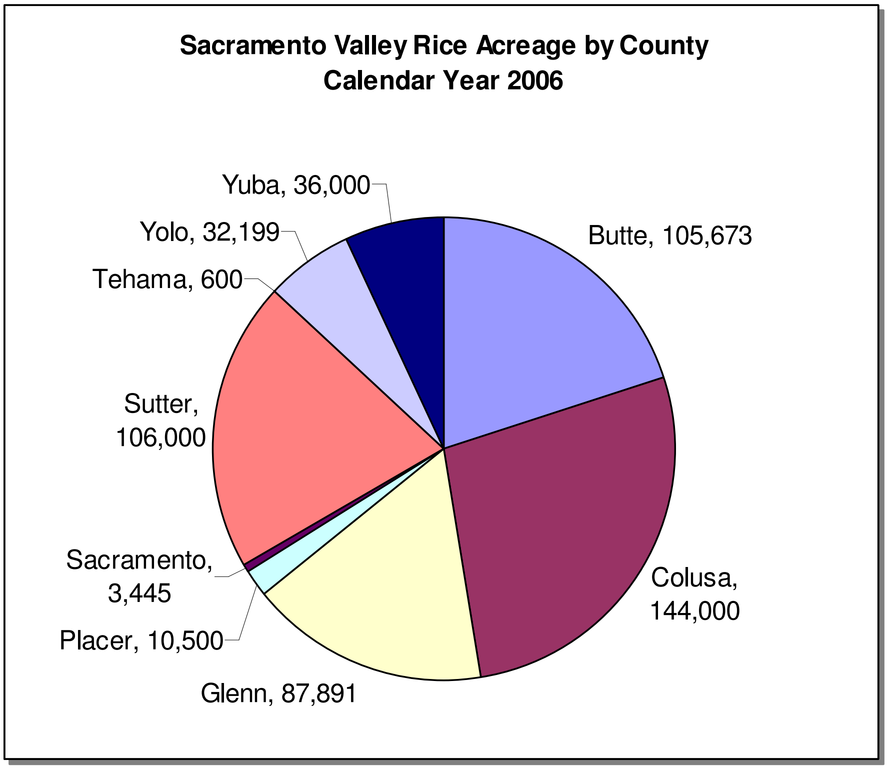

Figure ES-2. Sacramento Valley Rice Acreage by County, 2006

Pesticide Use

Growers, pesticide applicators, and pest control advisors report pesticide use to the CACs for inclusion in the DPR Pesticide Use Report (PUR). DPR provides the CRC with early-review/draft PUR and enforcement data for inclusion in the CRC's Rice Pesticides Program annual report, from which a list of pesticides that were used on rice within the Sacramento Valley is compiled. Among these pesticides, there was a reported increase in use of seven (7) pesticides and a decrease in use of nine (9) pesticides. The two monitored rice pesticides were among the products for which a reduction in use was reported, and this year saw no reported usage of malathion or methyl-parathion. Usage data by county are provided in Section 2.3 of the main report.

DPR issued a press release on November 14, 2006. DPR reported "Major crops or sites with decreased pounds applied included rice (1.5 million pounds), fresh tomatoes (700,000 pounds), strawberries (420,000 pounds), and lemons (370,000 pounds)". Based on the draft PUR data, in 2006, rice pesticide useage went up by 118,955 treated acres (noting that many planted acres are planted and counted twice), but the amount of active ingredient applied was down by 66,624 pounds. The reduction in active ingredient applied to rice is the result of the industry's efforts to pursue reduced-risk pesticides. These newer pesticides, effective at low application rates and with a shorter half-life, are designed to have less total impact on the environment.

Pesticide Use Compliance Inspections and Enforcement

Compliance with pesticide use restrictions is a critical component to achieve water quality protection. A range of label restrictions and permit conditions apply to the use of rice pesticides, including mixing and loading, application, and water hold requirements. County agricultural commissioners perform inspections to enhance compliance with each type of label or permit restriction. Mixing and loading inspections are performed primarily for worker protection, but also to ensure that proper handling and containment of pesticides is being implemented to prevent releases to the environment. Application inspections are performed to evaluate conformance with label and permit application restrictions such as buffer zones; adherence to rate, wind speed, and water management restrictions, and other local requirements. Seepage inspections evaluate the efficacy of farm water management levees to hold water on fields throughout the duration of required water holds.

In 2006, the CACs performed 1,222 thiobencarb and molinate water-hold inspections, resulting in the issuance of one (1) enforcement action. The CACs conducted 22 mix/load inspections and 67 application inspections for thiobencarb and molinate. The inspections results in no compliance actions for mix/load, and the issuance of four compliance actions for applications. The CACs performed 1,222 water hold inspections, resulting in the issuance of five agricultural civil penalties. County-level data are provided in Section 3.1.2 of the main report.

In 2006, there were no release inquiries and no reported emergency releases.

Rice Season Highlights

Notable highlights of the 2006 rice-growing season were:

- Planted acreage decreased only 2,000 acres from 2005.
- The acres treated with the pesticides in this report increased by 118,955 acres (noting that planted acres are counted once for each pesticide applied).
- The amount of applied pesticide active ingredient in the scope of this report decreased by 65,624 pounds.
- Herbicide resistance continues to be a problem with a limited number of herbicides registered for rice in California and, an even more limited selection due to similar modes of action that could exacerbate development of resistance.
- Surveillance and seepage inspections continue to increase.

- Late spring storms and cool weather were responsible for delays in planting and related decreases in yields.
- Record high temperatures in July caused yield decreases in the early-planted rice.
- Operations of the NCMWC/RD 1000 system were altered so that it is no longer managed as a closed system.

Monitoring

Monitoring was conducted at five sites, as shown in Table ES-1.

Table ES-1. 2006 Sampling Sites

Site Code	Site Name	LAT (N)	LON (W)	Estimated Rice Area Captured by Station (acres)	Site Type
CBD1	Colusa Basin Drain above Knights Landing	38.8125 N	-121.7731 W	171,165	Main
CBD5	Colusa Basin Drain #5	39.1833 N	-122.0500 W	156,000	Main
BS1	Butte Slough at Lower Pass Road	39.1875 N	-121.9000 W	183,617	Main
SSB	Sacramento Slough Bridge near Karnak	38.7850 N	-121.6533 W	24,549	Main
LCC	Lower Coon Creek[a]	38.8715 N	-121.5808 W	20,764	Rotating, Year 2

[a] Coon Creek @ Striplin Road (west of Power Line Road)

The MRP specifies the general calendar for monitoring. This year, sampling was conducted as shown in Table ES-2. Table ES-2 lists the regularly scheduled monitoring, as well as re-sampling that was required.

Water Quality

Water quality monitoring was implemented at five sites[1], as shown on Figure ES-1. This monitoring season, water quality sampling commenced on March 7, 2006 and concluded on October 25, 2006. The March event was considered a "winter storm event", April through September is considered the "irrigation season", and the October event is considered a "fall drainage event". The sampling calendar was developed based on historic data, rice cultural practices, pesticide use and drainage patterns, and actual 2006 conditions. The key events that occur during a rice season are shown in Figure ES-2. Monitoring activities are conducted by consultant teams who provide field crews, coordinate with laboratories, and report data. Sample analysis is conducted by certified laboratories.

[1] The five sites monitoring under the 2006 program were: Colusa Basin Drain #5 (CBD5), Butte Slough #1 (BS1), Colusa Basin Drain #1 (CBD1), Sacramento Slough Bridge #1 (SSB), Sacramento River Village Marina (SR1).

Table ES-2. 2006 Sampling and Re-Sampling Calendar

Event Type	Month	Date	Field	Metals	Hardness and Color	Specified Pesticides[1]	Daphnia Toxicity Tests	Minnow Toxicity Tests	Selanastrum Toxicity Tests	Hyalella Toxicity Tests	QC Samples
Winter Drainage	March	03/07/2006	✓	✓	✓		✓	✓	✓		
Irrigation	April	04/25/2006	✓	✓	✓	✓	✓	✓	✓		yes
Irrigation	May	05/30/2006	✓	✓	✓	✓	✓	✓	✓		
Irrigation	June	06/13/2006	✓	✓	✓	✓	✓	✓	✓		yes
June Re-Sample	“	06/22/2006	✓	✓	✓			✓	✓ (TIES)		
Irrigation/Drainage	July	07/25/2006	✓	✓	✓	✓	✓	✓	✓	✓	
July Re-Sample	“	08/01/2006	✓	✓	✓				✓ (TIES)		
Irrigation/Drainage	August	08/22/2006	✓	✓	✓	✓	✓	✓	✓		yes
Irrigation/Drainage	September	09/20/2006	✓	✓	✓	✓	✓	✓	✓ (TIES)	✓	
September Re-Sample	“	09/27/2006	✓	✓	✓				✓		
Winter Flood-Up	October	10/25/2006	✓	✓	✓		✓	✓	✓		

[1] Year 2 (2006) specified pesticides were carfentrazone-ethyl and bispyribac-sodium.

[2] Re-sample requirements are based on the outcome of toxicity tests performed on sample collected during regularly scheduled monthly monitoring events.

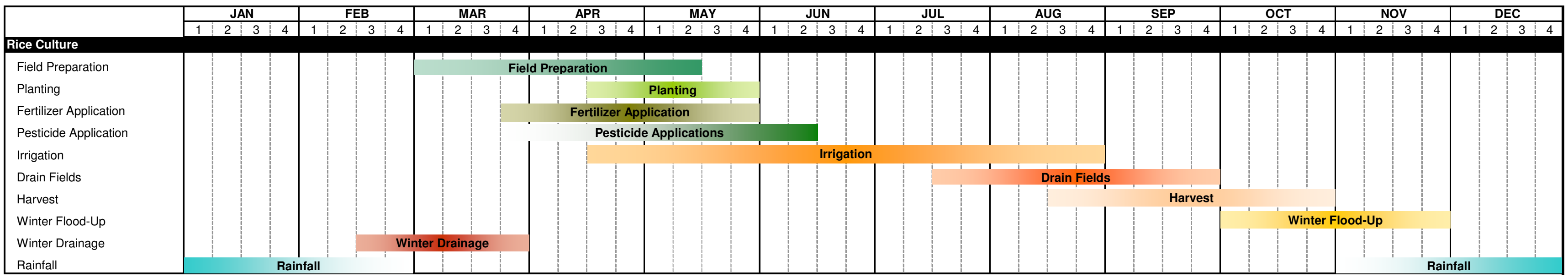

Figure ES-2. Typical Rice Year.
Source: UCCE, Grower input.

Metals

The following summarizes the results of the metals analysis:

- **Arsenic:** One sample, the 14 ug/L concentration measured at LCC, exceeded the drinking water primary MCL of 10 ug/L. No other samples exceed the drinking water MCL. It is noted that pesticides containing arsenic are no longer registered for use, and further, such chemicals have never historically been applied to rice.

- **Boron:** There is no aquatic ecosystem boron limit specified within the Regional Board's Water Quality Goals report. The maximum detected concentration of boron was 0.32 ug/L. L.

- **Cadmium:** All samples were non-detect for cadmium.

- **Copper:** Copper water quality results were compared to the hardness-adjusted aquatic ecosystem 1-hour maximum criterion. Compared to this threshold, one sample, taken in March at LCC, exceeded copper criterion. The measured hardness for the sample was 72 mg/L as CaCO3, which resulted in a CTR hardness-adjusted criterion of 10.3. The copper concentration of the sample was 12 ug/L, or 1.7 ug/L greater than the criterion. For the March sample event, stormwater runoff dominated the flows at LCC.

- **Lead:** All sample results for lead were non-detect.

- **Nickel:** Nickel water quality results were compared to the hardness-adjusted aquatic ecosystem 1-hour maximum criterion. All samples were significantly below the hardness-adjusted one-hour maximum criteria.

- **Selenium:** All sample results for selenium were non-detect.

- **Zinc:** All sample were non-detect.

Specified Pesticides

Two pesticides were monitored during Year 2 (2006). These include carfentrazone-ethyl (Shark) and bispyribac-sodium (Regiment). Results for the entire year were non-detect.

Aquatic Toxicity Testing

In accordance with the MRP, acute and chronic toxicity tests were performed on three test species. Tests are performed on samples collected at each station and are performed concurrent with tests on control samples. The three test species are:

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

Where toxicity tests resulted in significant effects and fell below specified triggers, re-sampling and/or Toxicity Identification Evaluations (TIEs) were performed. Re-sampling is performed to monitor the persistence of toxicity, while TIEs are intended to identify the specific toxicant(s) contributing to toxicity.

Fathead Minnow

- There was no statistically significant observed toxicity to minnows for any of the samples collected during 2006.
- The tests performed on the June samples had a laboratory control failure. Based on the failure of the lab control, the CRC performed re-sampling, the results of which showed no statistically significant toxicity to minnows.

c. Daphnia

- There was no statistically significant observed toxicity to daphnia for the samples collected March through September.
- There was statistically significant toxicity to daphnia observed in the BS1 sample collected in October, with a survival of 15% as compared to the control. However, due to miscommunication between within the CRC/consultant team, no re-sampling was performed, and no formal TIEs were conducted. This error in communication is being addressed to prevent the failure of the consultant to perform follow-up monitoring and appropriate communication with the CRC and the CVRWQCB.

Selanstrum

- Statistically significant *Selanastrum* toxicity was observed in samples collected in June, July, September, and October.
- Re-sampling was triggered in June and July. Re-sampling was triggered at four of the five sites in June. The CRC elected to perform re-sampling for all sites in June. Based on the results of re-sampling, TIEs were triggered at BS1, CBD1, CBD5, and SSB.
- The results of the June TIEs implicated non-polar organic pesticides, but follow-up chemistry did not confirm a specific causative toxicant.
- Re-sampling was triggered for all sites in July and TIEs were triggered for all sites. Again, non-polar organic pesticides were implicated in the toxicity, but follow-up chemistry did not identify the causative agent.
- TIEs were performed on original sample for the September event because sufficient sample volume existed to perform the tests on the original sample. Again, non-polar organic pesticides were implicated in the toxicity, but follow-up chemistry did not identify the causative agent.
- Statistically significant toxicity was observed on samples collected in October. However, due to miscommunication within the CRC/consultant team no re-sampling was performed, and no formal TIEs were conducted. This error in communication is being addressed to prevent future failures to perform follow-up monitoring and appropriate communication with the CRC and CVRWQCB.
- Algae toxicity was the focus of a significant amount of effort during the 2006 CWFR program. Throughout the course of the year, approaches were developed in an attempt determine the causative toxicant to this test organism. The CRC submitted

samples for additional chemistry analysis to determine whether the algae toxicity was caused by rice pesticides. Yet more analyses were performed to screen for herbicides (simazine, glyphosate and diuron) used by other agricultural commodities, counties, and agricultural districts for roadside and aquatic weed control . The results of the additional chemistry were non-detect for all herbicides analyzed. This is likely due to the short-lived nature of the causative toxicant, and to the timing of this chemical analysis relative to sample collection.

- Revisions to the procedure have been proposed for 2007. The revisions include chemistry analysis for pesticides at the initiation of toxicity tests, rather than at the conclusion. It is hoped that this revision will improve the ability to identify the algae toxicant.

Sediment Toxicity Testing

Sediment toxicity tests, using the test species *Hyalella azteca,* were performed on samples collected in July and September.

- *Hyalella* toxicity tests performed on samples collected in July showed no statistically significant effects (94% to 97% survival).
- Some samples containers, filled on 9/19/2006, were broken during shipment to the sediment toxicity testing lab. One of the jars from BS1 and both of the jars from CBD1 broke. There was adequate sediment remaining the intact BS1 jar to conduct the sediment toxicity test. The CRC consultant re-sampled CBD1 on 9/27/2006 and submitted the replacement sample to the lab. All other sample jars arrived intact at the lab.
- *Hyalella* toxicity tests performed on samples collected in September showed no statistically significant effects (92% to 99% survival).

Assessment of the 2006 CWFR Program

The 2006 sampling year was the second full year of the CWFR program. During 2006, the CRC invested significant staff and financial resources to comply with the requirements and intent of the CWFR and its associated MRP. In addition, the CRC has continued to educate its members about water quality protection, and further developed the capacity of its technical consultant team, while providing timely reporting to the CVRWQCB when water quality concerns are identified.

The following summarizes the key successes and challenges faced during 2006 program implementation:

- Water quality program actions continued to be implemented, including water-holds, education and outreach (newsletters and grower meetings), enforcement activities, and coordination with the UC Cooperative Extension. 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.

- No new management practices were triggered as a result of the 2006 water quality monitoring results.

- Regularly scheduled sampling was conducted as required under the MRP. This sampling included analysis for field parameters (temperature, D.O., pH, electrical conductivity/total dissolved solids, flow), metals (arsenic, boron, cadmium, copper, lead, nickel, selenium, and zinc), specified pesticides (carfentrazone-ethyl and bispyribac-sodium), and toxicity (fathead minnow, water flea, and green algae).

- Low dissolved oxygen, particularly at BS1 and LCC sites, was consistently measured. Low D.O. was prevalent during the hot summer months. The CRC is implementing D.O. 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 D.O.

- Based on the results of *Selanastrum* toxicity tests, re-sampling was triggered in June, July, September, and October. Re-sampling was conducted in June, July, and September. Re-sampling was not conducted in October, as noted below.

- No fathead minnow toxicity was observed.

- Daphnia toxicity was observed in October (a month in which rice growers do not use pesticides). Daphnia toxicity was not detected in any other month.

- *Selanastrum* toxicity was observed during several months. The CRC implemented re-sampling and TIEs, as required by the MRP; however, this technical process did not result in a definitive determination of the causative agent. Through the TIEs , the laboratories were able to determine that toxicity is caused by a "non-polar organic herbicide with a short half life". Unfortunately, follow-up chemistry analysis for rice herbicides and other suspect herbicides did not provide information to aid in the definitive identification of the toxicant (all results were non-detect). By the end of the season, it was determined that the technical design of the program could be improved with regard to the ability to identify a short-lived herbicide. One way to achieve this would be the inclusion of an additional of herbicide analysis at the initiation of the toxicity tests. Though this will be more costly, the CRC is hopeful that this technical modification of the program will help to identify specific toxicants. The additional herbicide analysis will include rice herbicides, as well as suspect herbicides that are utilized within the sampling period.

- The identification S*elanastrum* toxicity and of a "non-polar organic herbicide with a short half life" as the causative toxicant is an advance in the scientific understanding of agricultural drain water quality.

- Communications reports were submitted on all results.

- The application of the tributary rule to drain sites may not be appropriate, though it is recognized that protection of existing beneficial uses is an important part of water quality protection.

- Confusion during early 2006 over the interpretation of the re-sampling triggers and the requirements to perform TIEs resulted in significant consultation with CVRWQCB staff. As a result of consultation, the CRC/consultant team developed improved communication processes to rapidly identify re-sample and/or TIE requirements. The CRC conducted re-sampling and TIEs, as required for all months, except for the month of October, when a communication lapse resulted in a failure to perform a TIE and re-sample.

- Communication lapses within the CRC/consultant team posed some challenges in program implementation. Specifically, communication regarding toxicity results and failed laboratory control tests during the first half of the season resulted in a decision to switch to another aquatic toxicity laboratory to address concerns over failed laboratory controls. Additionally, in October, a communication lapse resulted in a failure to perform a Toxicity Identification Evaluation and resample. Though rice growers do not use pesticides in October, the MRP nonetheless calls for re-sampling based on defined triggers. The CRC is working with its consultant team to develop improved procedures and tools to prevent this type of lapse in the future.

- As part of its TIE efforts, the CRC analyzed for pesticides that were used on rice as well as other potential toxicants used within the watershed. This exceeds the requirements of the MRP.

- Additional tools, such as focused investigations, will continue to be sought, particularly where the current CWRP program does not provide necessary information to identify water quality problems and their causes. Additionally, program elements that provide consistent, but inconclusive results, may be replaced or dropped. Such changes will be proposed to the CVRWQCB along with suitable justification.

- 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.

1. Background and Introduction

1.1 Background

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 half a 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 is the basis for cuisine that spans the globe: sushi, risotto, and pilaf. California rice supports cultural diversity by connecting heritage, religion, ancestry, and language through this most universal food.

Rice is grown in nine Sacramento Valley counties (Butte, Colusa, Glenn, Placer, Sacramento, Sutter, Tehama, Yolo, and Yuba). For the purposes of the rice-specific Monitoring and Reporting Program (MRP), the study area is defined as the nine rice producing counties in the Sacramento Valley. 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. Specifically, about 13,000 acres of rice are grown in the San Joaquin Valley and receive coverage under local coalition groups. Wild rice is actually a distinct plant species and crop, and therefore does not receive Conditional Waiver coverage by the CRC. All wild rice growers must sign up for Conditional Waiver coverage under a local coalition group.

The CRC conducted Conditional Waiver for Rice (CWFR) program activities for the calendar year 2006. Key CFWR activities include:

- reporting of rice acreage information
- reporting of rice pesticide use information
- water quality monitoring
- toxicity testing and follow-up toxicity identification evaluations
- 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.

1.2 Report Purpose

This report fulfills the rice-specific reporting requirements of the 2006 Conditional Waiver of Waste Discharge, a conditional waiver of the Central Valley Regional Water Quality Control Board (CVRWQCB). The purpose of this report is to inform interested stakeholders of CFWR 2006 activities, including the results of water quality monitoring.

1.3 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 are not the dominant crops 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 offer a number of environmental advantages not provided by any other land use. Rice fields provide a number of 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 is cultivated on over 500,000 acres annually and provides a substantial benefit to the State's farm economy. Rice produced in the United States provides 1.5-2 percent of global production and competes in the global market, and comprises a large proportion of internationally traded medium-grain (north Asian) rice.

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 ricelands 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 2006, the nine rice growing counties of the Sacramento Valley farmed about 526,000 acres of rice, as shown on Figure 1.

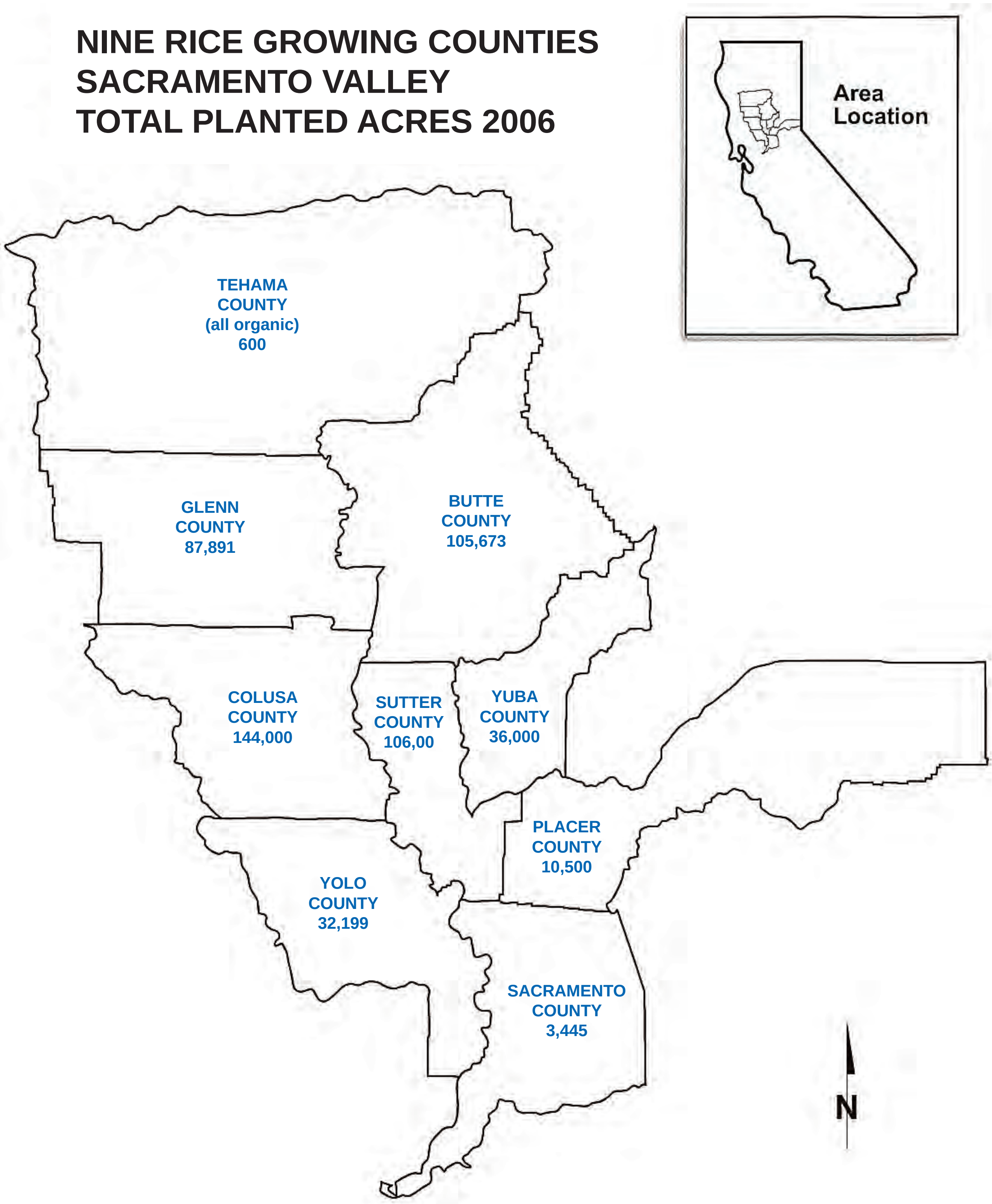

FIGURE 1
Rice Growing Region
California Rice Commission

1.4 Role of Management Practices in Attaining Water Quality Protection

Over the years, best management practices 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). 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 2006, all required water-hold were the same as required during the 2005 growing season. Table 1 lists the pesticides for which Basin Plan performance goals are specified and which require water holds.

Table 1. Water Hold Requirements for RPP Rice Pesticides

Product	Water Hold (days)
Molinate (Ordram®)	28*
Thiobencarb (Bolero®)	30*
Thiobencarb (Abolish™)	19*
Methyl parathion	24
Malathion	4

* Reduced water-holds for molinate and thiobencarb are allowed when these products are applied in water-short areas, when closed water management systems are used, and in hydrologically isolated fields that do not enter adjacent waterways.

In 2006, of the pesticides covered under the conditional prohibition of discharge, only molinate and thiobencarb were used by Sacramento Valley rice growers.

1.5 Program Administration

The CRC has long been recognized by the Regional Water Quality Control Board as an entity with the authority and capacity to implement Rice Pesticides Program (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. . The CRC was issued a Notice of Applicability as a watershed Coalition under the CVRWQCB's Conditional Waiver for Discharges from Irrigated Lands in July of 2003 and has implemented rice-specific program activities since that time.

Kleinfelder was contracted to collect water samples at specified sites to obtain data to characterize water quality. CH2M HILL prepared this Annual Monitoring Report under contract to the CRC.

1.6 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 avoid significant soil erosion. Also, because 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, salt concentration in return flows are usually relatively low.

1.7 History of Rice Water Quality Efforts

1.7.1 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.

Beginning in May 1980, and on a yearly basis through 1983, over 65,000 carp, catfish, black bas, and crappie died in Sacramento Valley agricultural drains dominated by rice drainage (Hill et al., 1991). At approximately the same time, monitoring studies found that thiobencarb concentrations as low as 1 ug/L resulted in increases in water taste complaints from people whose drinking water was supplied by the Sacramento River downstream of agricultural drain inputs.

As a result of the fish kill events in the early 1980s, the California Department of Fish and Game (CDFG) conducted investigations that indicated that the fish losses resulted from molinate poisoning (SWRCB, 1990). By implementation of increased in-field holding times for irrigation waters containing molinate, no additional fish losses have been documented since June 1983.

Monitoring studies in the early 1980s by the CVRWQCB determined that molinate, carbofuran, malathion, and methyl parathion were present in agricultural drains dominated by rice drainage. The concentrations of these chemicals were determined to pose a threat to aquatic life. As a result of the fish kills and the chemical monitoring through the early 1980s, the California Department of Food and Agriculture (now DPR) initiated the Rice Pesticide Control program in 1984 to manage and regulate the discharge of pesticides from rice fields.

Findings by CDFG 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 Valley's rivers and agricultural drains.

A review of information on toxicity of molinate and thiobencarb was conducted by the SWRCB (1990). This review was used to developed specific water quality criteria and performance goals for those pesticides. In 1990, the CVRWQCB amendment 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 contractions 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 RWQCB.

The RPP undergoes annual RWQCB review, at which time the RWQCB considers re-certifying the program. Annual reports are due to the RWQCB each December.

Concurrent with the submission of this report, a separate report was submitted to the CVRWQCB that documents the results of the RPP in comparison to the water quality goals, management practices, and enforcement activities.

1.7.2 Conditional Waiver of Waste Discharge Requirements for Rice

The CRC was granted a Notice of Applicability 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 historic 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 historic data are analyzed and employed to select appropriate water quality monitoring sites. Specifically the report included information on:

- 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

2. Description of the Sacramento River Watershed

2.1 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) and also uses permanent flood after stand establishment. Key events in the rice farming cycle, as shown in Figure 2, include:

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

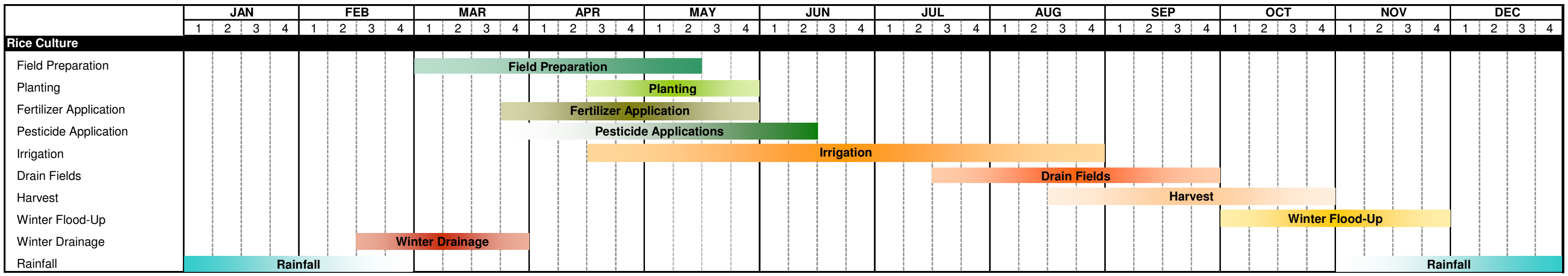

Figure 2. Typical Rice Year.

Source: UCCE, Grower input.

2.2 Weather Conditions

Weather conditions influence the planting of rice and application of rice pesticides. During 2006, crops were late due to extended inundation of the Sutter and Yolo Bypasses, and inundation of a substantial proportion of rice farmland. 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 UC IPM California Weather Database. Data were collected the period 1 January 2006 through 11 July 2006.

Sacramento River Flow and Regional Precipitation

The Department of Water Resources (DWR) provides flow and precipitation data for the Sacramento River at Colusa (COL). Flow and precipitation data are shown in Figure 3.

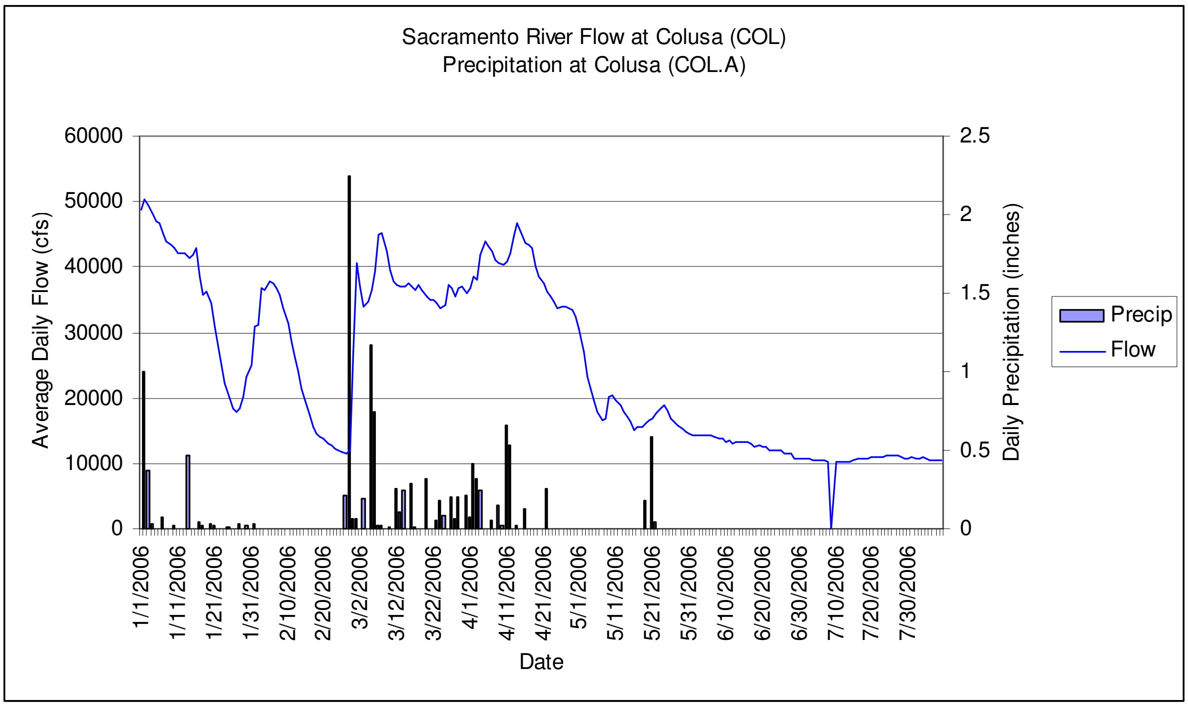

Figure 3. Flow and Precipitation Data

2.3 Applied Materials

2.3.1 Pesticide Use

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. Rice pesticide use for 2006 is reported in the CRC's RPP Annual Report, submitted to the CVRWQCB concurrent with this report.

The pesticides with acreage increases were, (s)-cypermethrin (18,308), carfentrazone-ethyl (8,764), clomazone (53,347), cyhalofop-butyl (28,828), penoxsulam (3,607), propanil (11,004) and triclopyr TEA (13,405). No reportable uses for malathion and methyl parathion in 2006. Tables 2 and 3 show the rice acres treated and pounds applied, respectively, with herbicides.

The pesticides with acreage decreases were thiobencarb (25,142), molinate (6,997), bensulfuron-methyl (1,778), bispyribac-sodium (4,055), carfentrazone-ethyl (19,888), diflubenzuron (656), carbaryl (997), and lambda cyhalothrin (11,175)

Treated acreage has a direct correlation to pounds of active ingredient applied. Planted acres similar in 2006 to 2005. The total acres treated increased due to differences in pest pressures. However, total pounds of active ingredient went down because of decreases in use of higher application rate products. The rice industry is experiencing an expansion of reduced-risk[2] products with lower per acre use rates.

Three (3) insecticides, diflubenzuron, (s)-cypermethrin, and lambda cyhalothrin, were used on Sacramento Valley rice. All three of these products have very low per acre application rates. Less than 1,300 acres were treated with diflubenzuron, with nearly 40,000 acres treated with (s)-cypermethrin, and an additional 40,000 acres treated with lambda cyhalothrin.

On November 14, 2006, DPR issued a press release announcing the availability of the 2005 PUR. DPR reported "Major crops or sites with decreased pounds applied included rice (1.5 million pounds), fresh tomatoes (700,000 pounds), strawberries (420,000 pounds), and lemons (370,000 pounds)". Based on the draft PUR data, in 2006, rice pesticides usage went up 118,955 treated acres, but the total pounds applied were down 66,624. The shift in less pounds of active ingredient applied to rice is the result of the industry's efforts to pursue reduced-risk pesticides. These newer pesticides are highly active, low use rate products with a shorter half-life, designed to have less total impact on the environment.

Tables 2 and 3 show the rice acres treated and pounds applied, respectively, with herbicides. Tables 4 and 5 show the rice acres treated and pounds applied, respectively, with insecticides.

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[2] The USEPA designates pesticides as reduced-risk based the following criteria: low-impact on human health, low toxicity to non-target organisms (birds, fish, and plants), low potential for groundwater contamination, lower use rates, low pest resistance potential and compatibility with Integrated Pest Management.

Table 2. Herbicides, Acres Treated, 2006

County	Acres Treated									
	Bensulfuron-methyl	**Bispyribac-sodium**	**Carfentrazone-ethyl**	**Clomazone**	**Cyhalofop-butyl**	**Molinate**	**Penoxsulam**	**Propanil**	**Thiobencarb**	**Triclopyr TEA**
Butte	3,305	7,288	13,086	28,199	12,536	21,571	11,089	53,230	20,353	37,868
Colusa	2,122	22,779	678	13,491	40,497	880	10,895	79,360	24,384	79,890
Glenn	2,988	6,993	5,173	50,044	9,845	1,845	6,885	57,173	4,952	42,170
Placer	0	379	486	1,464	1,136	2,173	2,204	5,186	367	3,996
Sacramento	0	246	0	246	30	0	920	3,628	1,158	2,358
Sutter	3,024	6,562	9,093	15,941	23,066	4,675	33,515	71,354	17,359	57,395
Yolo	904	2,267	0	313	6,816	414	4,195	10,008	6,200	7,455
Yuba	45	2,590	3,474	0	8,247	0	110	15,630	656	2,137
Total Acres	**12,388**	**49,104**	**31,990**	**109,698**	**102,173**	**31,558**	**69,813**	**295,569**	**75,429**	**233,269**

Table 3. Herbicides, Pounds Applied, 2006

County	Pounds Applied									
	Bensulfuron-methyl	**Bispyribac-sodium**	**Carfentrazone-ethyl**	**Clomazone**	**Cyhalofop-butyl**	**Molinate**	**Penoxsulam**	**Propanil**	**Thiobencarb**	**Triclopyr TEA**
Butte	103	217	2,436	13,458	3,748	92,930	380	243,600	81,722	6,272
Colusa	96	697	55	7,048	12,033	3,551	382	395,213	96,106	14,521
Glenn	148	166	638	28,619	3,237	7,631	681	291,184	18,611	6,404
Placer	0	12	63	623	352	9,978	81	23,184	1,114	604
Sacramento	0	8	0	117	10	0	21	14,979	4,243	361
Sutter	150	209	1,473	7,056	7,555	20,545	1157	315,469	66,765	9,639
Yolo	50	64	0	128	1,996	1,561	152	43,447	24,761	1,330
Yuba	3	91	650	0	2,375	0	4	482	2,480	356
Total Pounds	**550**	**1,464**	**5,315**	**57,049**	**31,306**	**136,196**	**2,858**	**1,327,558**	**295,802**	**39,487**

Table 4. Insecticides, Acres Treated, 2006

County	Acres Treated		
	Diflubenzuron	**(s)-Cypermethrin**	**Lambda Cyhalothrin**
Butte	418	7,124	10,537
Colusa	308	8,303	7,933
Glenn	447	11,969	1,436
Placer	0	1,613	1,155
Sacramento	0	0	182
Sutter	86	7,143	10,894
Yolo	0	1,410	1,394
Yuba	0	562	5,710
Total Acres	**1,259**	**38,124**	**39,241**

Table 5. Insecticides, Pounds Applied, 2006

County	Pounds Applied		
	Diflubenzuron	**(s)-Cypermethrin**	**Lambda Cyhalothrin**
Butte	55	531	350
Colusa	39	384	217
Glenn	52	733	44
Placer	0	65	33
Sacramento	0	0	5
Sutter	22	310	325
Yolo	0	55	42
Yuba	0	26	149
Total Pounds	**168**	**2,104**	**1,165**

2.3.2 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 with 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 6. The table shows that fertilizer may be applied to rice pre-planting (granular starter, aqua ammonia, zinc), and later in the season (topdressing). The total for the high and low ends of the reported range are shown for each element in the lower section of Table 6.

Table 6. 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
NH4SO4	0	200	Topdressed
N	0	42	Topdressed
S	0	49	Topdressed
Total			
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.

* Seldom applied.

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 have 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 18 to 26 pounds per acres and 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 high pH, acidic soils and areas where topsoil has been removed. If Zn is used, the rate is 2 to 16 pounds per acre at preflood, and 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.

3. Management Practices

Because rice is farmed in standing water, management practices that provide for water quality protection can be implemented. Water-holding requirements for thiobencarb and molinate are permit conditions under the RPP. 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, for example, water-holds have become standard practice to address aquatic toxicity, taste complaints, environmental fate, and product efficacy. Table 7 lists pesticides and water-hold requirements for products that are not covered by the RPP.

Table 7. Hold times for Insecticides, Fungicides, and Herbicides Not Covered by the RPP

Active Ingredient	Trade Name	Water-hold Time	Provisions
INSETICIDES			
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

Table 8 shows water-holds for the products covered under the RPP's conditional prohibition of discharge.

Table 8. Water-Holds for RPP Products

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

[a] 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
[b] Thiobencarb permit condition allowed Bolero® 15-g label hold period of 14-days.
[c] See hydrologically isolated fields.
[d] Voluntary hold.

3.1.1 Known Management Programs Addressing Water Quality

The following tables depict the season or timing of pesticide applications to rice. Included are separate tables for insecticide applications, tank mix combinations and sequential herbicide applications. A "sequential" is the application of an herbicide followed by another herbicide with a different mode of action to provide better coverage and efficacy for weed control. The second application usually takes place 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.

Rice pesticide applications take place during 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 in understanding potential water quality concerns, relative to time of the year.

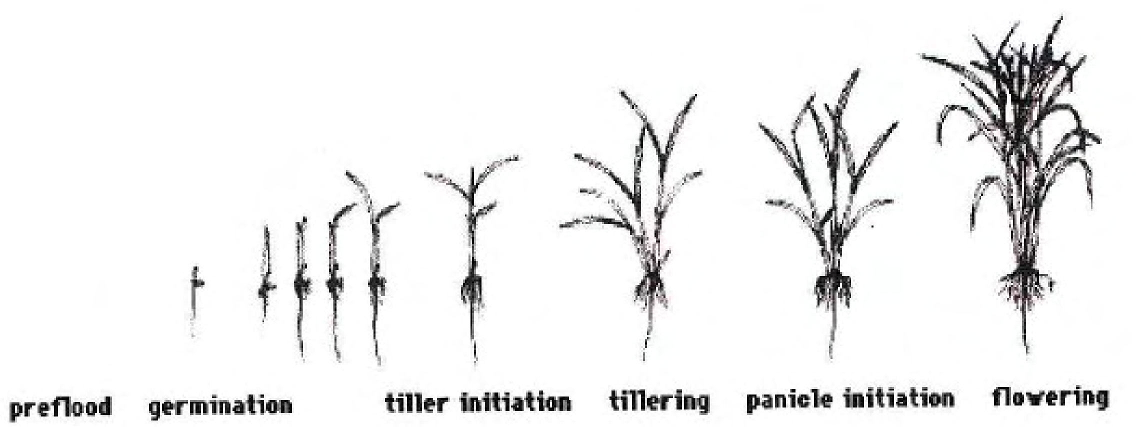

Table 9. Timing of Specific Rice Herbicide Applications

Early Season (March-April)		Mid Season (May-June)		Late Season (June-July)	
Pre-Flood	**Germination**	**Tiller Initiation**	**Tillering**	**Panicle Initiation**	**Flowering**
	Bensulfuron-methyl Permanent flood 7-day water-hold				
		Bensulfuron-methyl Pin-point flood 7-day water-hold			
		Bispyribac-sodium Pin-point flood			
	Carfentrazone-ethyl Permanent Flood 5-day static; 30-day release				
	Clomazone Permanent Flood 14-day water-hold				
		Cyhalofop-butyl Pin-point Flood 7-day water-hold			
	Molinate Permanent Flood				

	28-day water-hold				
		Propanil Pin-point Flood			
	Thiobencarb (Bolero and Abolish) Permanent Flood Bolero 30-day/Abolish 19-day				
		Triclopyr TEA Pin-point Flood 20-day water-hold			

Table 10. 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) Pin-point flood 19-day water-hold			
		Propanil/Thiobencarb (Abolish) Permanent Flood 19-day water-hold			

Table 11. 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 Boarder treatment 7-day water-hold				Lambda cyhalothrin Boarder treatment 7-day water-hold
	(s)-cypermethrin Boarder treatment 7-day water-hold				(s)-cypermethrin Boarder treatment 7-day water-hold

Table 12. 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
Pin-point 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
Pin-point Flood</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Cyhalofop-butyl, Bispyribac-sodium
7-day water-hold
Pin-point Flood</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Cyhalofop-butyl, Propanil
7-day water-hold
Pin-point Flood</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Propanil, Cyhalofop-butyl
7-day water-hold
Pin-point 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
Pin-point flood</td><td></td><td></td></tr>
</table>

3.1.2 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. Each CAC issues restricted materials permits to growers purchasing and using

California restricted materials in their county. Both molinate and thiobencarb qualify as 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 2003 remained in place during 2004, 2005 and 2006. 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.

The restricted materials permits require the CACs in rice growing counties of the Sacramento Valley Basin to keep records of specific pesticides applied to rice acreage. The CACs meet the notification requirements by utilizing the Notices of Intent (NOIs) and Notices of Application (NOAs) 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 in order that water-holding times can be recorded, inspected and tracked.

Compliance with pesticide use restrictions is a critical component of the ability of the RPP 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. County agricultural commissioners 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 2006, there were no release inquiries and no reported emergency releases.

Seepage Control and Inspections

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

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 USDA with the UCCE. Another brochure the CACs provide to rice growers entitled: *Seepage Water Management-Voluntary Guidelines for Good Stewardship in Rice Production*, was cooperatively developed by the UCD Department of Agronomy and Range Science, DPR and UCCE. In addition, the brochure is 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.

The CRC continues to contract with and fund CAC "off duty" inspections for rice growing activities in 2005. As a result, the CACs increase seepage and pre-flood inspections in 2006, including weekends and Memorial Day. In addition, DPR and the CACs implemented both a Prioritization Plan and a Negotiated Work Plan in 1998. One component of both plans was to negotiate a number of water hold inspections. The plans allow the counties to set priorities within the standard enforcement guidelines. All rice pesticide water holding requirements are ranked 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 a notice of intent (NOI) filed at the CAC office. Some permits were denied due to seepage conditions upon inspection. Tables 13 through 15, present enforcement activities, water-hold and seepage inspections. Information was gathered from the CACs on number of inspections, types of inspections, violations, agricultural civil penalties (ACP) and water seepage inspections. The CRC provided the CAC offices weekly updates of the rice herbicide monitoring results, in order to coordinate water quality protection activities.

CACs conduct seepage inspections, as summarized in Table 13. Based on the inspection data provided to the DPR by the CAC, a total of 1,221 molinate and thiobencarb use sites were inspected, out of a total reported 2,382 sites. Of the 1,221 sites inspected, 46 had reported discharges of less than 5 gallons per minute (gpm). These 46 sites comprise 4% of inspected sites. Of the 1,221 sites inspected, 9 had reported discharges of greater than 5 gpm. These 9 sites comprise just under 1% of inspected sites. One enforcement action was issued.

Application and Mix/Load Inspections

CACs conducted application and mix/load inspections, as summarized in Table 14. Based on the inspection data provided to the DPR by the CACs, a total of 22 mix/load events were inspected and no enforcement actions were issued. The CACs performed 67 application inspections, resulting in four compliance actions.

Water Hold Inspections

CACs conduct water hold inspections, as summarized in Table 15. A total of 1,222 molinate and thiobencarb use sites were inspected. Reporting was recorded for two formulations of each product. Of the 1,222 sites inspected, 5 were issued enforcement actions.

Table 13. Molinate and Thiobencarb Water Seepage Inspections, 2006

County	Chemical	Number of Seepage Inspections	Number of Sites w/No Seepage	Number of Sites w/Less than 5 gpm	Number of Sites w/More than 5 gpm	Enforcement Actions
Butte	Molinate	118	112	6	0	0
	Thiobencarb	197	196	1	0	0
Colusa	Molinate	1	1	0	0	0
	Thiobencarb	197	197	0	0	0
Glenn	Molinate	79	68	9	2	0
	Thiobencarb	85	56	27	2	0
Placer	Molinate	5	0	0	0	0
	Thiobencarb	2	2	0	0	0
Sacramento	Molinate	0	0	0	0	0
	Thiobencarb	82	82	0	0	0
Sutter	Molinate	82	78	2	2	0
	Thiobencarb	279	276	0	3	1
Tehama	Molinate	3	3	0	0	0
	Thiobencarb	2	2	0	0	0
Yolo	Molinate	4	4	0	0	0
	Thiobencarb	52	51	1	0	0
Yuba	Molinate	0	0	0	0	0
	Thiobencarb	33	33	0	0	0
TOTALS	**Total Molinate**	**292**	**266**	**17**	**4**	**0**
	Total Thiobencarb	**929**	**895**	**29**	**5**	**1**
	Total	**1221**	**1161**	**46**	**9**	**1**

Table 14. Molinate and Thiobencarb Application and Mix/Load Inspections by County, 2006

Counties	Chemicals	Application Inspections (Compliance Actions)	Mix/Load Inspections
Butte	Ordram 15 GM	5 (1)	3
	Ordram 8E	1	0
	Bolero 15 G	4	3
	Abolish EC	2	2
	County Total	12	8
Colusa	Ordram 15 GM	0	0
	Ordram 8E	0	0
	Bolero 15G	9	6
	Abolish EC	2	2
	County Total	11	8
Glenn	Ordram 15 GM	0	0
	Ordram 8E	0	0
	Bolero 15G	3 (3)	0
	Abolish EC	1	1
	County Total	4	1
Placer	Ordram 15 GM	19	0
	Ordram 8E	3	0
	Bolero 15G	0	0
	Abolish EC	8	0
	County Total	30	0
Sacramento	Ordram 15 GM	0	0
	Ordram 8E	0	0
	Bolero 15G	0	0
	Abolish EC	0	0
	County Total	0	0
Sutter	Ordram 15 GM	1	1
	Ordram 8E	0	0
	Bolero 15G	3	3
	Abolish EC	0	0
	County Total	4	4
Tehama	Ordram 15 GM	0	0
	Ordram 8E	0	0
	Bolero 15G	0	0
	Abolish EC	0	0
	County Total	0	0
Yolo	Ordram 15 GM	1	1
	Ordram 8E	0	0
	Bolero 15G	5	0
	Abolish EC	0	0
	County Total	6	1
Yuba	Ordram 15 GM	0	0
	Ordram 8E	0	0
	Bolero 15G	0	0
	Abolish EC	0	0
	County Total	0	0
Total		67 (4)	22

Table 15. Molinate and Thiobencarb Water Hold Inspections by County, 2006

Counties	Chemicals	Number of Water Hold inspections	Release Inquires	Emergency Releases
Butte	Ordram 15 GM	118	0	0
	Ordram 8E	0	0	0
	Bolero 15 G	175	0	0
	Abolish EC	22	0	0
	County Total	315	0	0
Colusa	Ordram 15 GM	1	0	0
	Ordram 8E	0	0	0
	Bolero 15G	180 (1)	0	0
	Abolish EC	17	0	0
	County Total	198	0	0
Glenn	Ordram 15 GM	79	0	0
	Ordram 8E	0	0	0
	Bolero 15G	82 (2)	0	0
	Abolish EC	3	0	0
	County Total	164	0	0
Placer	Ordram 15 GM	5	0	0
	Ordram 8E	0	0	0
	Bolero 15G	0	0	0
	Abolish EC	2	0	0
	County Total	7	0	0
Sacramento	Ordram 15 GM	0	0	0
	Ordram 8E	0	0	0
	Bolero 15G	77	0	0
	Abolish EC	5	0	0
	County Total	82	0	0
Sutter	Ordram 15 GM	80 (1)	0	0
	Ordram 8E	0	0	0
	Bolero 15G	267 (1)	0	0
	Abolish EC	15	0	0
	County Total	362	0	0
Tehama	Ordram 15 GM	3	0	0
	Ordram 8E	0	0	0
	Bolero 15G	2	0	0
	Abolish EC	0	0	0
	County Total	5	0	0
Yolo	Ordram 15 GM	4	0	0
	Ordram 8E	0	0	0
	Bolero 15G	52	0	0
	Abolish EC	0	0	0
	County Total	56	0	0
Yuba	Ordram 15 GM	0	0	0
	Ordram 8E	0	0	0
	Bolero 15G	33	0	0
	Abolish EC	0	0	0
	County Total	33	0	0
Total		**1,222 (5)**	**0**	**0**

( ) = Agricultural Civil Penalties

4. Monitoring and Reporting Requirements

4.1 Purpose and Objectives, per MRP

The purpose of the MRP is to monitor the discharge of wastes in irrigation return flows and Stormwater from irrigated rice lands.

As specified Part (I) of the MRP, the purposes of monitoring conducted under the MRP are to:

a. Assess the impacts of waste discharges from irrigated lands to surface water
b. Determine the degree of implementation of management practices to reduce discharges of waste that impact water quality
c. Determine the effectives of management practices and strategies to reduce discharge of wastes that impact water quality
d. Determine concentration and load of waste in these discharges to surface waters
e. Evaluate compliance with existing narrative and numeric water quality objectives to determine if additional implementation of management practices is necessary to improve and/or protect water quality

The monitoring and reporting requirements of the 2006 (Year 2) CWFR program are specified in CVRWQCB Monitoring and Reporting Program Order No. R5-2004-0839 under Resolution No. R5-2003-0105. Additional requirements and guidance are provided in Executive Order letters, issued under the authority granted in the Resolution.

4.2 Overview of Requirements

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's 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 is 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.

- Evaluation of the effectiveness of management practices and tracking levels of implementation in the watershed.

4.3 Constituents

The MRP specifies the constituents for which field monitoring and laboratory analysis are to be conducted. Table 16 presents the constituents for which monitoring was required during 2006, which is considered Year 2 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 irrigation season rice field discharges, the CRC is required to monitor as follows:

In addition to monitoring to characterize irrigation season drainage, the MRP also requires monitoring to evaluate water quality during February and October, which are considered the two most significant periods of discharge outside of irrigation season. In February, 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 flood their fields to begin winter straw decomposition.

Table 16. Year 2 Monitoring and Reporting Requirements

Constituent	Units	Type of Sample	Irrigation Season (April through September) Sampling Frequency	Non-Irrigation Season Sampling Frequency	Reporting Frequency
Flow	cfs	Field[1]	Monthly	February, October	Annually
pH	pH units	Field	Monthly	February, October	Annually
Electrical Conductivity	umhos/cm	Field	Monthly	February, October	Annually
Dissolved Oxygen	mg/L	Field	Monthly	February, October	Annually
Temperature	degrees C	Field	Monthly	February, October	Annually
Color	ADMI	Field	Monthly	February, October	Annually
Turbidity	NTUs	Field	Monthly	February, October	Annually
Total dissolved solids[2]	mg/L	Field	Monthly	February, October	Annually
Aquatic Toxicity[3]	% surivival[4]	Grab	Monthly	February, October	Annually
Sediment Toxicity	% surivival[4]	Grab	July, September	February[6]	Annually
Specified Pesticides[5]	ug/L	Grab	Monthly	n/a	Annually
Hardness	mg/L as $CaCO_3$	Grab	Monthly	February, October	Annually
Cadmium	ug/L	Grab	Monthly	February, October	Annually
Copper	ug/L	Grab	Monthly	February, October	Annually
Lead	ug/L	Grab	Monthly	February, October	Annually
Nickel	ug/L	Grab	Monthly	February, October	Annually
Zinc	ug/L	Grab	Monthly	February, October	Annually
Selenium	ug/L	Grab	Monthly	February, October	Annually
Arsenic	ug/L	Grab	Monthly	February, October	Annually
Boron	ug/L	Grab	Monthly	February, October	Annually

1 Flow may also be obtained from Department of Water Resources monitoring stations, where available.

2 Calculated from EC field measurements.

3 Acute toxicity testing shall be conducted using the invertebrate, *Ceriodaphnia dubia*, and the larval fathead minnow, *Pimephales promelas*, according to standard USEPA acute toxicity test methods. In addition, to identify toxicity caused by herbicides, 96-hr toxicity tests with the green algae, *selanastrum capricornutum*, shall be conducted.

4 To be reported as "% survival, as compared to the control" (CVRWQCB, date)

5 Specified pesticides are determined annually, based on available water quality data, current usage trends, aquatic toxicity considerations. These pesticides are formally included in the CRC's MRP requirement through Executive Officer communication or Board Resolution.
Start-Up Monitoring (2004): specified pesticides were: Lambda cyhalothrin, s-cypermethrin (CVRWQCB, 2004)
Year 1 (2005) specified pesticides were: Lambda cyhalothrin, s-cypermethrin (CVRWQCB, 2004)
Year 2 (2006) specified pesticides were: Carfentrazone-ethyl, bispyribac-sodium (CVRWQCB, 2005)
Year 3 (2007) specified pesticides are to include: Cyhalofop-butyl and azoxystrobin (CVRWQCB, 2006)

6 Sediment toxicity required in February only if toxicity is found in both the previous irrigation season sampling events (July and September).

4.4 Sites

The MRP requires that the CRC perform water quality and flow monitoring at six (6) sites per year. These six sites are shown in Table 17. Each year, monitoring must be conducted at four main sites and one rotating site. In 2006, the rotating site LCC.

The five sites were selected because, collectively, they are estimated to capture drainage from 90% of the acres planted in rice. BS1, CBD1, CBD5, and SSB are historic sites.

Table 17. Monitoring Sites, CWFR, 2006

Site Code	Site Name	LAT (N)	LON (W)	Estimated Rice Area Captured by Station (acres)	Site Type
CBD1	Colusa Basin Drain above Knights Landing	38.8125 N	-121.7731 W	171,165	Main
CBD5	Colusa Basin Drain #5	39.1833 N	-122.0500 W	156,000	Main
BS1	Butte Slough at Lower Pass Road	39.1875 N	-121.9000 W	183,617	Main
SSB	Sacramento Slough Bridge near Karnak	38.7850 N	-121.6533 W	24,549	Main
JS	Jack Slough Site [b]	39.1804 N	-121.5711 W	27,741	Rotating, Year 1
LCC	Lower Coon Creek[a]	38.8715 N	-121.5808 W	20,764	Rotating, Year 2

[a] Coon Creek @ Striplin Road (west of Power Line Road)
[b] Jack Slough @ Jack Slough Road (near Kimball Lane)

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.

Photo 1: *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 that crosses Butte Sough northeast of Meridian. In 1995 and 1996, samples were previously collected at the west end of the washed out bridge. Sampling at the new bridge site started in 1997.

Photo 2: *BS1 – Butte Slough #1*

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.

Photo 3: *CBD1 – Colusa Basin Drain #1*

SSB

The RPP historically monitored Sacramento Slough at a location known as Sacramento Slough 1 (SS1), which was located at the 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) in order to provide improved safety for field technicians accessing the site. This year, during Weeks 1 through 3, the bridge was inundated was not accessible so sampling was conducted from the gauging station upstream of the Karnak pumps. Beginning in Week 4, sampling was conducted from the bridge location, SSB.

Photo 4: *SSB – Sacramento Slough Bridge*

LCC

LLC is located on Lower Coon Creek. Water samples at LCC

were collected from the middle of the Striplin Road Bridge.

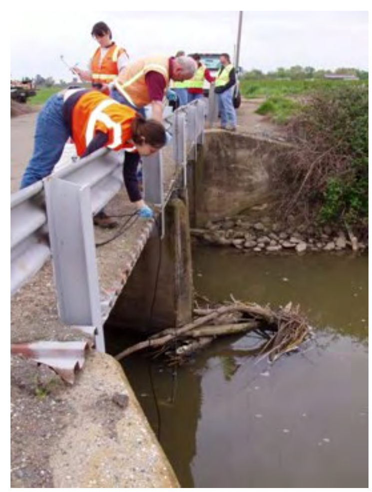

Photo 5: *LCC – Lower Coon Creek*

4.5 Reporting Requirements

The CWFR program requires a rigorous set of reporting protocols designed to promptly inform the CVRWQCB staff of water quality exceedances and follow-up actions.

4.5.1 Communication Reports

When monitoring data indicate that water quality objectives are exceeded at a monitoring site, the CRC is to submit a Communication Report "describing how it will evaluate the effectiveness of one or more management practice(s) at preventing discharges of constituents of concern (COCs) to surface waters. The selection of management practice evaluation projects shall include consideration of the contribution of target COCs to known water quality impairments, potential application of the management practices over a broad geographic area that addresses rice discharges and ease and immediacy of possible implementation. Project need not involve new practices, but can involve quantification of benefits of existing practices. Several Communication Reports may be submitted for each proposed, implemented, or completed project and shall include, at a minimum: description of management practice(s) being evaluated, target chemical(s), reasons for selecting the specific project, methodology for evaluation evaluating the effectiveness of the practice (including sampling and QA/QC plans), and involvement by stakeholders and agencies in developing, implementing and evaluating the project. If projects are completed, Communication Reports shall present the conclusion(s) of the evaluation project. Submission of Communication Reports is an ongoing process."

4.5.2 Exceedance Reports

The CRC is to "immediately notify CVRWQCB staff, via email or fax, that an exceedance of any water quality objective has occurred. The CRC shall submit a written Communication Report within one week of the notification sing forth the process the CRC will follow to investigate the source of toxicity, such as conducting a toxicity identification evaluation (TIE) and communicating with local agricultural commissioners. The CRC shall submit follow-up Communication Reports, as needed, that outline further steps the CRC is taking to address the exceedance(s) of water quality objectives (i.e. grower outreach and management practice implementation)."

4.5.3 Annual Report

The Annual Report 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 samples results
11. Summary of precision and accuracy
12. Pesticide Use Information
13. Data interpretation including and assessment of data quality objectives
14. Summary of management practices used
15. Actions take to address water quality impacts identified, including but not limited to, revised or additional management practices to be implemented
16. Communications Reports
17. Conclusions and Recommendations

Table 18 shows the location of each piece of the above listed information within this report:

Table 18. Location of Required AMR Information within this Report

Required Information	Location of Information within this Report
Table of contents	Page i
Description of the watershed	Section 2
Monitoring objectives	Section 4
Sample site descriptions	Section 4.4
Location map of sampling sites and land use	Appendix A
Tabulated results of analyses	Section 5
Sampling and analytical methods used	Section 4.7
Copies of chains of custody	Appendix B
Associated laboratory and field quality control samples results	Appendices C, D, and E
Summary of precision and accuracy	Section
Pesticide Use Information	Section 2.3
Data interpretation including and assessment of data quality objectives	Section 5
Summary of management practices used	Section 3
Actions take to address water quality impacts identified, including but not limited to, revised or additional management practices to be implemented	Section 3
Communications Reports	Previously submitted to the Regional Board. The information herein supersedes the communication reports.
Conclusions and Recommendations	Section 6
Field documentation	Appendix B
Laboratory original data	Appendices C, D, and E
Perspective on field conditions including a description of the weather, rainfall, stream flow, color of the water, odor, and other relevant inform that can help in data interpretation	Section 2

4.6 Administration and Execution

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 emailed to CH2M HILL. Kleinfelder was the primary contact for all laboratory services. Labs submitted data to Kleinfelder, which then forwarded the data to CH2M HILL for review and analysis.

4.7 Sampling Procedures

Sampling was conducted pursuant to the procedures described in the CWFR Quality Assurance Project Plan (Kleinfelder, 2004), unless otherwise noted.

4.7.1 Field Measurements

Field water quality parameters, listed in Table 16, were measured prior to sample collection at each site, and flow was measured after samples were collected. A water quality sheet was completed at each site documenting 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

Measurements are taken at 10 cross-sections along at each site. The waterbody's wetted width was measured, record and divided by 10 to determine the width of each cross-section. The mid-point of each cross-section was calculated by dividing the cross section width in half. Velocity was measured at the mid-point 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 (cubic feet per second)
W	=	section width (feet)
D	=	depth of measurement (feet)
V	=	velocity (feet per second)

Electrical Conductivity, Dissolved Oxygen, Temperature, and pH

EC, D.O., temperature, and pH 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 are included in the Appendix.

Turbidity

Turbidity was measured using a turbidity meter.

TDS

Was calculated using the following equation:

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

Where:

TDS = Total dissolved solids (mg/L)

EC = electrical conductivity measurement (umhos/cm)

4.7.2 Grab Samples

Grab samples are collected by a qualified and trained crew of Kleinfelder technicians. The water grab samples were collected using a Kemmerer water sampler (stainless steel and Teflon model, approximately 1.5 liter volume) at a depth equal to one-half the water column. The sample was emptied from the Kemmerer to a stainless steel container and the samples were collected until approximately 13 liters of sample. The composite sample was homogenized and then split, using a stainless steel funnel, into the follow:

- Ten (10) 1-L amber glass bottles for toxicity analysis ***
- Two (2) 1-L amber glass bottles for pesticide analysis
- One (1) 1-L amber glass bottle for the color analysis

Non-disposable equipment used in the collection of the samples was cleaned after each use by rinsing with distilled water. The sampling equipment was also rinsed at each site with river, slough, or drain water from the middle of the water column before sample collection. Clean sampling equipment was not placed on the ground prior to use. Field personnel wore clean, disposable gloves. New, clean sample bottles and jars were provided by the analytical laboratories or purchased from a supply company.

Samples were identified with a unique number to properly report and interpret the results. Sample containers were labeled at the time of sample collection with 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 (4 degrees C) until delivered to the laboratories.

4.7.3 Sample Custody and Documentation

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 responsible for the care and custody of the samples until they were delivered to the laboratory. Field data sheets and copies of chain-of-custody (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.

4.7.4 Sample Delivery and Analysis

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 transports after sample collection to the lab for analysis within the sample holding time. The laboratories were as shown in Table 19.

Table 19. Analytical Laboratories and Methods

Laboratory	Analytical Method(s)	Analytical Method(s) Standard Operating Procedures	Notes
Block Environmental Service 2451 Estand Way Pleasant Hill, CA 94523-3911	Fathead Minnow 5th edition Screen	Acute 96-Hour Percent Survival Static non-renewal, static renewal, or LC50 Test (EPA 821-R-02-012) SOP #503.3	BES performed toxicity tests and TIEs (when required) on samples collected March through June.
	c. dubia 5th ed. Screen	Acute 96-Hour Percent Survival Static non-renewal, static renewal, or LC50 Test (EPA 821-R-02-012) SOP #503.3	
	Algae Chronic Screen	Chronic Freshwater Algae (*selenastrum capricornutum)* Static non-renewal Growth Test SOP #510	
	Sediment Toxicity	10-Day Freshwater Sediment Invertebrate (*Hyalella azteca*) Survival Test SOP #518	
AquaScience 17 Arboretum Dr. Davis, CA 95616 aquasci@aol.com 530-753-5456	Fathead Minnow 5th edition Screen and	Acute 96-Hour Percent Survival Static non-renewal, static renewal, or LC50 Test (EPA 821-R-02-012) SOP #503.3	AquaScience performed aquatic toxicity tests and TIEs (when required) on samples collected July through October.
	c. dubia 5th ed. Screen	Acute 96-Hour Percent Survival Static non-renewal, static renewal, or LC50 Test (EPA 821-R-02-012) SOP #503.3	
	Algae Chronic Screen	Chronic Freshwater Algae (*selenastrum capricornutum)* Static non-renewal Growth Test SOP #510	

Laboratory	Analytical Method(s)	Analytical Method(s) Standard Operating Procedures	Notes
Nautilus Environmental San Diego Bioassay Laboratory 5550 Morehouse Drive, Suite 150 San Diego, CA 92121	Sediment Toxicity	10-Day Freshwater Sediment Invertebrate (*Hyalella azteca*) Survival Test SOP #518	AquaScience performed sediment toxicity tests on samples collected July through October.
Environmental Micro Analysis , Inc. (EMA) 40 N. East Street, Suite E Woodland, CA 95776	Carfentrazone-ethyl	EPA 8081A (s); (MRL = 0.02 ng/uL)	Specified pesticide. Analyzed as part of TIE follow-up.
	Bispyribac-sodium		Specified pesticide.
	Bensulfuron-methyl	EPA 8081A (s); (MRL = 0.02 ng/uL)	Analyzed as part of TIE follow-up.
	Clomazone	EPA 8141A (s); (MRL = 0.1 ng/uL)	Analyzed as part of TIE follow-up.
	Cyhalofop-butyl	EPA 8081A (s); (MRL = 005 ng/uL)	Analyzed as part of TIE follow-up.
	Diflubenzuron	Specific HPLC; (MRL = 0.1 ng/uL)	Analyzed as part of TIE follow-up.
	Diuron	Specific HPLC; (MRL = 0.1 ng/uL)	Not a rice pesticide. Analyzed as part of TIE follow-up.
	Halosulfuron	EPA 8081A (s); (MRL = 0.05 ng/uL)	Analyzed as part of TIE follow-up.
	Lambda cyhalothrin	EPA 8081A (s); (MRL = 0.05 ng/uL)	Analyzed as part of TIE follow-up.
	Molinate	EPA 8141A (s); (MRL = 0.05 ng/uL)	Analyzed as part of TIE follow-up.
	Pendimethalin	EPA 8081A (s); (MRL = 0.01 ng/uL)	Analyzed as part of TIE follow-up.
	Propanil	EPA 8081A (s); (MRL = 0.05 ng/uL)	Analyzed as part of TIE follow-up.
	Thiobencarb	EPA 8141A (s); (MRL = 0.05 ng/uL)	Analyzed as part of TIE follow-up.
	Trifloxystrobin	EPA 8081A (s); (MRL = 0.02 ng/uL)	Analyzed as part of TIE follow-up.
	Zeta-cypermethrin	EPA 8081A (s); (MRL = 0.05 ng/uL)	Analyzed as part of TIE follow-up.
	Diuron		Not a rice pesticide. Analyzed as part of TIE follow-up.
	Simazine		Not a rice pesticide. Analyzed as part of TIE follow-up.

Laboratory	Analytical Method(s)	Analytical Method(s) Standard Operating Procedures	Notes
California Laboratory Services (CLS) 3249 Fitzgerald Road Rancho Cordova, CA 95742	Arsenic	EPA 6020/70	
	Boron	EPA 6010B	
	Cadmium	EPA 6020/70	
	Copper	EPA 6020/70	
	Lead	EPA 6020/70	
	Nickel	EPA 6020/70	
	Selenium	EPA 6020/70	
	Zinc	EPA 6020/70	
	Color	EPA 110.2	
	Hardness	SM 2340B	

5. 2006 Monitoring

5.1 Monitoring Calendar

The MRP specifies the general calendar for monitoring. This year, sampling was conducted as shown in Table 20. Table 20 lists the regularly scheduled monitoring, as well as re-sampling that was required.

Table 20. 2006 Sampling and Re-Sampling Calendar

Event Type	Month	Date	Field	Metals	Hardness and Color	Specified Pesticides[1]	Daphnia Toxicity Tests	Minnow Toxicity Tests	Selanastrum Toxicity Tests	Hyalella Toxicity Tests	QC Samples
Winter Drainage	**March**	**03/07/2006**	✓	✓	✓		✓	✓	✓		
Irrigation	**April**	**04/25/2006**	✓	✓	✓	✓	✓	✓	✓		**yes**
Irrigation	**May**	**05/30/2006**	✓	✓	✓	✓	✓	✓	✓		
Irrigation	**June**	**06/13/2006**	✓	✓	✓	✓	✓	✓	✓		**yes**
June Re-Sample	"	**06/22/2006**	✓	✓	✓			✓	✓ **(TIES)**		
Irrigation/Drainage	**July**	**07/25/2006**	✓	✓	✓	✓	✓	✓	✓	✓	
July Re-Sample	"	**08/01/2006**	✓	✓	✓				✓ **(TIES)**		
Irrigation/Drainage	**August**	**08/22/2006**	✓	✓	✓	✓	✓	✓	✓		**yes**
Irrigation/Drainage	**September**	**09/20/2006**	✓	✓	✓	✓	✓	✓	✓ **(TIES)**	✓	
September Re-Sample	"	**09/27/2006**	✓	✓	✓				✓		
Winter Flood-Up	**October**	**10/25/2006**	✓	✓	✓		✓	✓	✓		

[1] Year 2 (2006) specified pesticides were carfentrazone-ethyl and bispyribac-sodium.

[2] Re-sample requirements are based on the outcome of toxicity tests performed on sample collected during regularly scheduled monthly monitoring events.

5.2 Field Parameters

5.2.1 Temperature

Temperature measurements are taken during field sampling. Figure 4 shows the temperature field measurements. As shown, temperature in the waterbodies is typically lowest in the winter and highest in the summer. This year, peak temperatures were observed during the July sampling event, and approached 90°F, essentially tracking with ambient air temperatures. During this time of the year, these waterbodies are clearly not coldwater fisheries, though they may provide coldwater habitat during other times of the year.

Table 21 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 temperature. Table 21 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 for the lower Sacramento River.

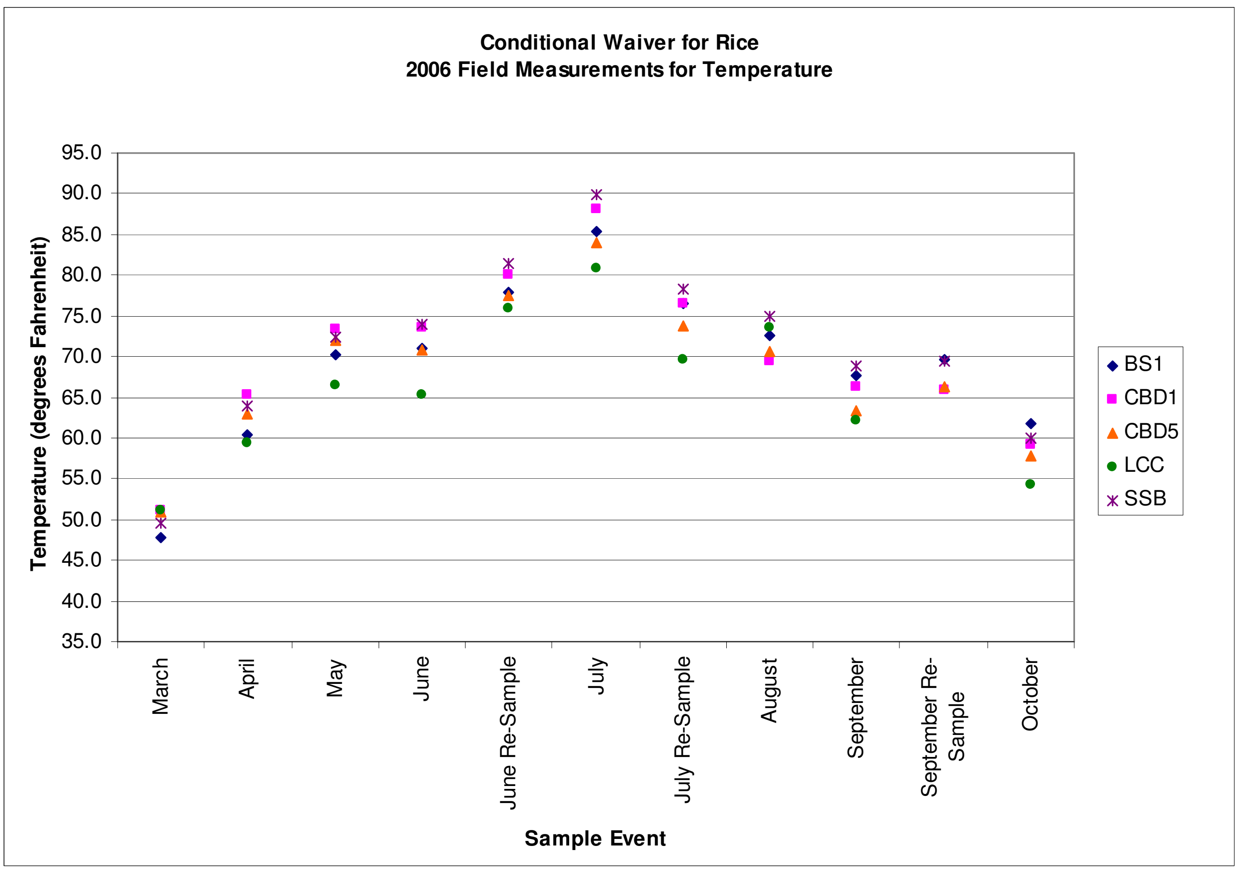

Figure 4. Temperature Field Measurements, 2006

Table 21. Temperature Field Measurements Tabulated Results, 2006

Event	Date	BS1	CBD1	CBD5	LCC	SSB	event low	event mean	event median	event high	event variance	event std. deviation	n	number of obs Temp >68F	number of obs Temp <68F	% of obs. where Temp >68F	% of obs. where temp <68F
		Temperature (degrees F)															
March	3/7/2006	47.696	51.062	51.008	51.08	49.604	47.70	50.09	51.01	51.08	2.18	1.48	5	0	5	0%	100%
April	4/25/2006	60.296	65.246	63.014	59.45	63.86	59.45	62.37	63.01	65.25	5.93	2.44	5	0	5	0%	100%
May	5/30/2006	70.286	73.364	72.068	66.452	72.428	66.45	70.92	72.07	73.36	7.48	2.74	5	4	1	80%	20%
June	6/13/2006	71.042	73.49	70.736	65.354	73.976	65.35	70.92	71.04	73.98	11.74	3.43	5	4	1	80%	20%
June Re-Sample	6/22/2006	77.81	80.078	77.54	76.01	81.446	76.01	78.58	77.81	81.45	4.68	2.16	5	5	0	100%	0%
July	7/25/2006	85.388	88.16	83.984	80.906	89.888	80.91	85.67	85.39	89.89	12.40	3.52	5	5	0	100%	0%
July Re-Sample	8/1/2006	76.496	76.46	73.85	69.62	78.332	69.62	74.95	76.46	78.33	11.43	3.38	5	5	0	100%	0%
August	8/22/2006	72.554	69.332	70.538	73.616	74.966	69.33	72.20	72.55	74.97	5.19	2.28	5	5	0	100%	0%
September	9/20/2006	67.676	66.218	63.338	62.24	68.864	62.24	65.67	66.22	68.86	7.93	2.82	5	1	4	20%	80%
September Re-Sample	9/27/2006	69.566	65.966	66.272		69.386	65.97	67.80	67.83	69.57	3.78	1.94	4	2	2	50%	50%
October	10/25/2006	61.718	59.162	57.866	54.212	59.918	54.21	58.58	59.16	61.72	7.89	2.81	5	0	5	0%	100%
	site low	47.70	51.06	51.01	51.08	49.60											
	site mean	69.14	72.55	70.31	66.98	72.79											
	site median	70.29	73.49	72.07	66.45	73.98											
	site high	85.39	88.16	83.98	80.91	89.89											
	site variance	100.53	138.71	113.48	99.15	169.48											
	site std. deviation	10.03	10.13	9.23	9.50	10.88											
	n	11	11	11	10	11											
	number of obs Temp >68F	7	6	6	4	8											
	number of obs Temp <68F	4	5	5	6	3											
	% of obs. where Temp >68F	64%	55%	55%	40%	73%											
	% of obs. where temp <68F	36%	45%	45%	60%	27%											

5.2.2 Dissolved Oxygen

Dissolved oxygen (D.O.) measurements are taken in the field. Figure 5 shows the results of all D.O. measurements taken during 2006. Table 22 presents tabulated D.O. results and basic summary information, including site minimum, maximum, mean, and median observed D.O., as well as event minimum, maximum, mean, and median observed D.O. Table 22 also includes an evaluation of the number of times and the frequency with which the observed field D.O. exceeded 5 mg/L, 6 mg/L, and 7 mg/L.

D.O. less than 6 mg/L was observed at all sites, and D.O. less than 5 mg/L was observed at BS1, CBD1, and LCC.

Low D.O. was consistently observed at LCC beginning in April (<6 mg/L), when flows in the creek were substantially dominated by stormwater runoff. Low D.O. at LCC persisted through August. Results in September showed D.O. concentrations at LCC to be just over 7 mg/L, though low D.O. conditions returned in October (<2 mg/L). For samples collected in 2006, D.O. at LCC averaged 5.57 mg/L. Low was also consistently observed at BS1, with a site low of 3.61 mg/L (occurring in September) and a 2006 average of 6.09 mg/L.

Factors that may contribute to low D.O. 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 night-time algae uptake, and/or uniform channel character that limits natural aeration.

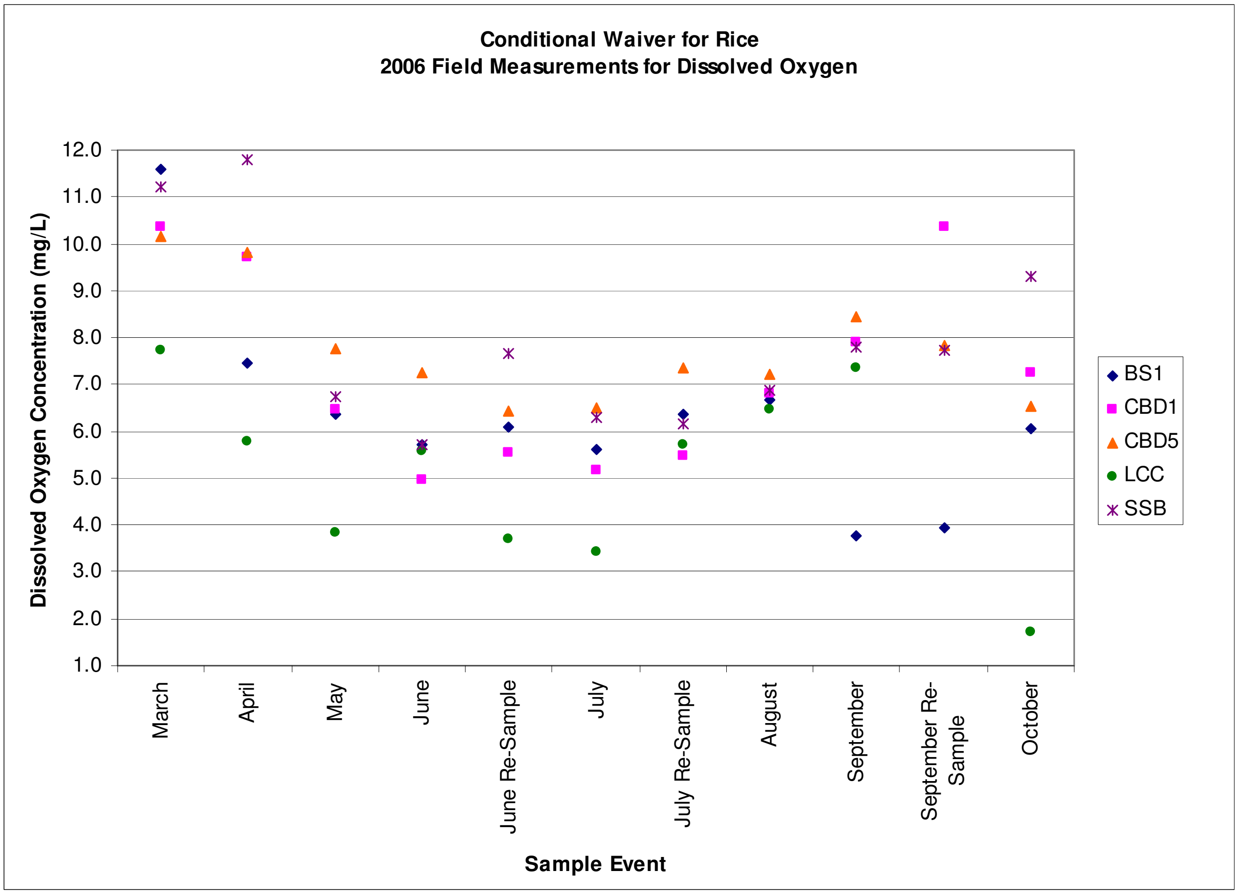

Figure 5. Dissolved Oxygen Field Measurements, 2006

Table 22. Dissolved Oxygen Field Measurements Tabulated Results, 2006

Dissolved Oxygen Concentration (mg/L)

Event	Date	BS1	CBD1	CBD5	LCC	SSB	event low	event mean	event median	event high	event variance	event std. deviation	n	number of obs. DO<7	number of obs. DO<6	number of obs. DO<5	% of obs. where DO<7	% of obs. where DO<6	% of obs. where DO<5
March	3/7/2006	11.59	10.35	10.17	7.73	11.23	7.73	10.21	10.35	11.59	2.28	1.51	5	0	0	0	0%	0%	0%
April	4/25/2006	7.47	9.7	9.81	5.77	11.8	5.77	8.91	9.70	11.80	5.43	2.33	5	1	1	0	20%	20%	0%
May	5/30/2006	6.35	6.46	7.75	3.82	6.74	3.82	6.22	6.46	7.75	2.11	1.45	5	4	1	1	80%	20%	20%
June	6/13/2006	5.73	4.95	7.24	5.57	5.71	4.95	5.84	5.71	7.24	0.71	0.84	5	4	4	1	80%	80%	20%
June Re-Sample	6/22/2006	6.09	5.56	6.42	3.7	7.67	3.70	5.89	6.09	7.67	2.10	1.45	5	4	2	1	80%	40%	20%
July	7/25/2006	5.61	5.18	6.51	3.44	6.28	3.44	5.40	5.61	6.51	1.49	1.22	5	5	3	1	100%	60%	20%
July Re-Sample	8/1/2006	6.36	5.48	7.34	5.7	6.17	5.48	6.21	6.17	7.34	0.52	0.72	5	4	2	0	80%	40%	0%
August	8/22/2006	6.67	6.8	7.21	6.45	6.88	6.45	6.80	6.80	7.21	0.08	0.28	5	4	0	0	80%	0%	0%
September	9/20/2006	3.76	7.9	8.46	7.34	7.79	3.76	7.05	7.79	8.46	3.54	1.88	5	1	1	1	20%	20%	20%
September Re-Sample	9/27/2006	3.94	10.36	7.83		7.72	3.94	7.46	7.78	10.36	7.00	2.65	4	1	1	1	25%	25%	25%
October	10/25/2006	6.06	7.24	6.53	1.71	9.31	1.71	6.17	6.53	9.31	7.76	2.79	5	3	1	1	60%	20%	20%

	BS1	CBD1	CBD5	LCC	SSB
site low	3.76	4.95	6.42	1.71	5.71
site mean	6.33	6.81	7.89	5.10	7.94
site median	6.09	5.56	7.34	5.57	6.74
site high	11.59	10.36	10.17	7.73	11.80
site variance	4.24	5.08	2.28	2.38	6.35
site std. deviation	2.06	2.05	1.27	1.90	2.03
n	11	11	11	10	11
number of obs DO<7	9	6	3	8	5
number of obs DO<6	4	4	0	7	1
number of obs DO<5	2	1	0	4	0
% of obs. where DO<7	82%	55%	27%	80%	45%
% of obs. where DO<6	36%	36%	0%	70%	9%
% of obs. where DO<5	18%	9%	0%	40%	0%

Analysis and Trends

Two years of data is typically not considered sufficient upon which to base long-term conclusions; however, with respect to drain habitat, it is typically recognized that low D.O. conditions are widespread, particularly during the summer months.

Per the Basin Plan, the dissolved oxygen (D.O.) Water Quality Objective (WQO) for waterbodies designated SPWN/COLD is 7.0 mg/L units. According to CVRWQCB staff, application of the "tributary rule" results in the application of Sacramento River and/or Feather River beneficial uses and WQOs to the five agriculturally dominated sampling stations

At the LCC station, the consistently low D.O. may be attributable to low flow and stagnant conditions in the creek. It is noted that the April measurement also showed a D.O. level below the SPWN/COLD objective coupled with relatively high flow and that the creek flow in April of this year was attributable to spring runoff, not agricultural drainage. However, at other stations, low flow is not a likely contributing factor to depressed D.O. conditions.

Factors that may contribute to low D.O. 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 night-time algae uptake, and/or uniform channel character that limits natural aeration.

5.2.3 pH

pH measurements are taken in the field. Figure 6 shows the results of all pH measurements taken during 2006. Table 23 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 23 also includes an evaluation of the number of times and the frequency with which the observed field pH exceeded 6.5 and 8.5. One observation of less than 6.5 pH was observed in March at LCC. The March event represented stormwater runoff conditions.

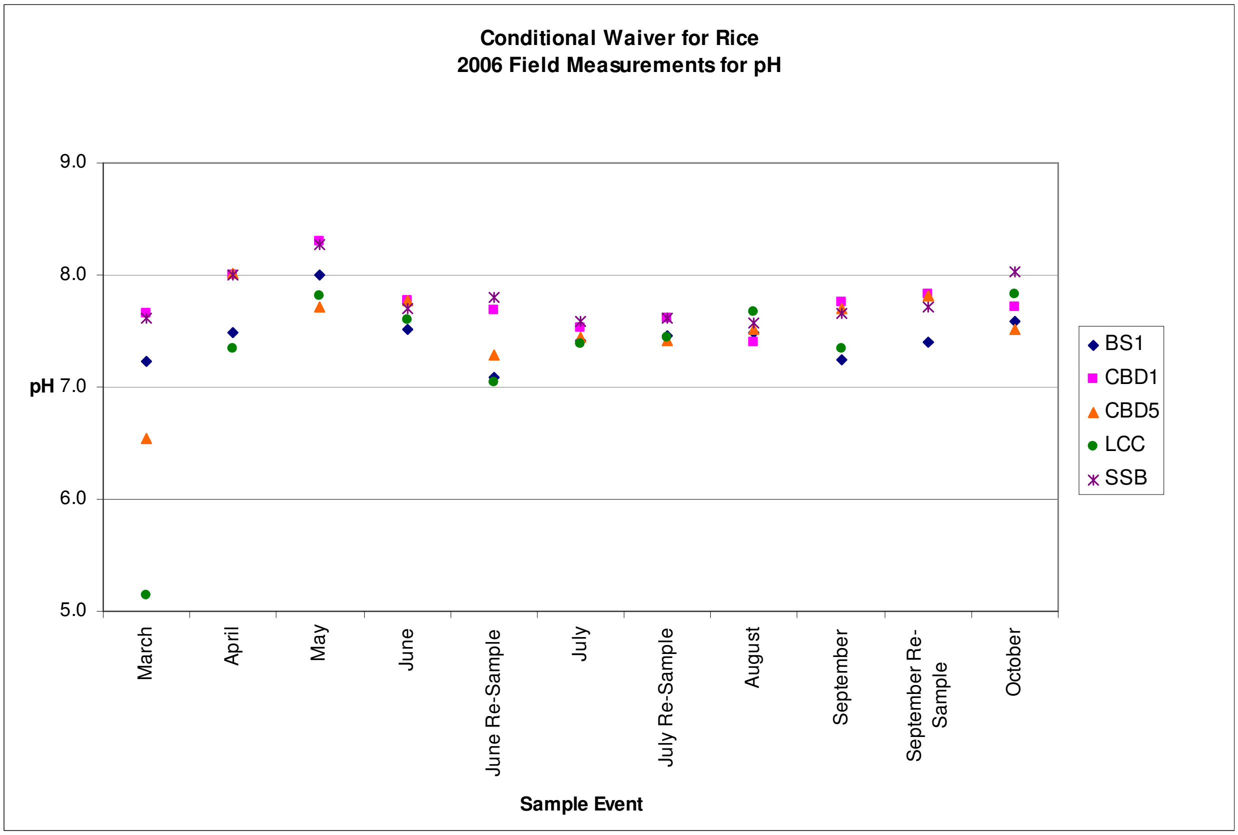

Figure 6. pH Field Measurements, 2006

Table 23. pH Field Measurements Tabulated Results, 2006

Event	Date	BS1	CBD1	CBD5	LCC	SSB	event low	event mean	event median	event high	event variance	event std. deviation	n	number of obs pH<6.5	number of obs pH>8.5	% of obs. where pH<6.5	% of obs. where pH>8.5
March	3/7/2006	7.23	7.66	6.54	5.14	7.61	5.14	6.84	7.23	7.66	1.10	1.05	5	1	0	0	20%
April	4/25/2006	7.48	8	8.02	7.34	8	7.34	7.77	8.00	8.02	0.11	0.33	5	0	0	0	0%
May	5/30/2006	8	8.3	7.71	7.82	8.27	7.71	8.02	8.00	8.30	0.07	0.26	5	0	0	0	0%
June	6/13/2006	7.52	7.77	7.77	7.6	7.7	7.52	7.67	7.70	7.77	0.01	0.11	5	0	0	0	0%
June Re-Sample	6/22/2006	7.08	7.68	7.29	7.04	7.8	7.04	7.38	7.29	7.80	0.12	0.35	5	0	0	0	0%
July	7/25/2006	7.42	7.53	7.45	7.38	7.58	7.38	7.47	7.45	7.58	0.01	0.08	5	0	0	0	0%
July Re-Sample	8/1/2006	7.46	7.61	7.41	7.44	7.62	7.41	7.51	7.46	7.62	0.01	0.10	5	0	0	0	0%
August	8/22/2006	7.48	7.4	7.51	7.67	7.57	7.40	7.53	7.51	7.67	0.01	0.10	5	0	0	0	0%
September	9/20/2006	7.25	7.76	7.7	7.35	7.65	7.25	7.54	7.65	7.76	0.05	0.23	5	0	0	0	0%
September Re-Sample	9/27/2006	7.4	7.83	7.81		7.71	7.40	7.69	7.76	7.83	0.04	0.20	4	0	0	0	0%
October	10/25/2006	7.58	7.71	7.52	7.83	8.03	7.52	7.73	7.71	8.03	0.04	0.20	5	0	0	0	0%
	site low	7.08	7.40	6.54	5.14	7.57											
	site mean	7.45	7.79	7.46	7.11	7.80											
	site median	7.46	7.68	7.45	7.38	7.70											
	site high	8.00	8.30	8.02	7.83	8.27											
	site variance	0.06	0.07	0.22	0.81	0.06											
	site std. deviation	0.24	0.24	0.39	0.78	0.23											
	n	11	11	11	10	11											
	number of obs pH<6.5	0	0	0	1	0											
	number of obs pH>8.5	0	0	0	0	0											
	% of obs. where pH<6.5	0%	0%	0%	10%	0%											
	% of obs. where pH>8.5	0%	0%	0%	0%	0%											

5.2.4 EC/TDS

Electrical conductivity measurements are taken in the field. Figure 7 shows the results of all EC measurements taken during 2006. Table 24 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 24 also includes an evaluation of the number of times and the frequency with which the observed field EC exceeded 700 umhos/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. This value is an agricultural water quality value cited from the paper Ayers, R. S. and D. W. Westcot, Water Quality for Agriculture , Food and Agriculture Organization of the United Nations - Irrigation and Drainage Paper No. 29, Rev. 1, Rome (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 water quality objective. Management of salinity with the Sacramento Valley should be undertaken in the context of the CALFED ROD. Three samples, all collected in May, were greater than 700 umhos/cm.

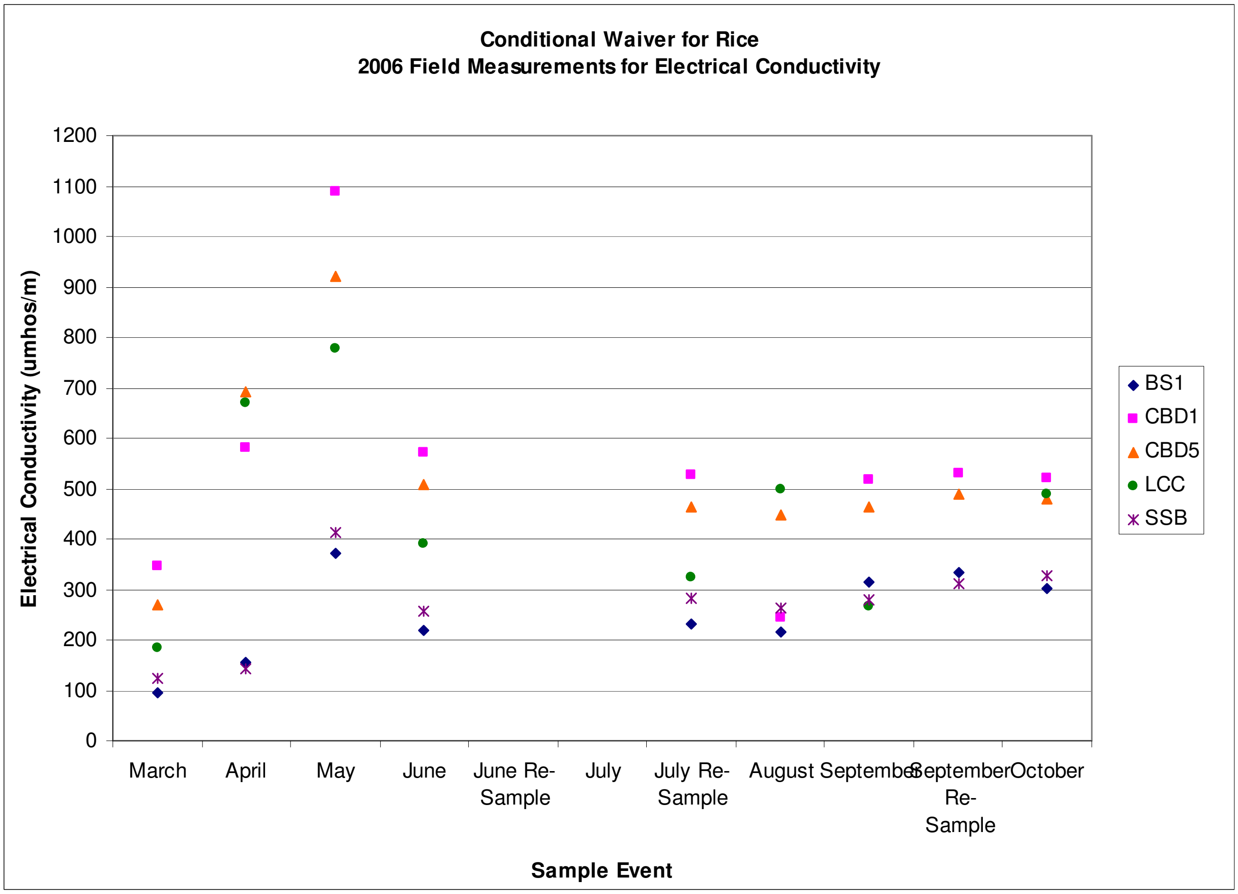

Figure 7. EC Field Measurements, 2006

Table 24. EC Water Quality Results 2006

Electrical Conductivity (umhos/cm)

Event	Date	BS1	CBD1	CBD5	LCC	SSB	event low	event mean	event median	event high	event variance	event std. deviation	n	number of obs EC>700	% of obs. where EC>700
March	3/7/2006	94	347	270	183	124	94.00	203.60	183.00	347.00	10936.30	104.58	5	0	0%
April	4/25/2006	156	581	692	669	144	144.00	448.40	581.00	692.00	75936.30	275.57	5	0	0%
May	5/30/2006	371	1090	921	778	413	371.00	714.60	778.00	1090.00	99142.30	314.87	5	3	60%
June	6/13/2006	218	572	507	391	258	218.00	389.20	391.00	572.00	23454.70	153.15	5	0	0%
June Re-Sample	6/22/2006						0.00	#DIV/0!	#NUM!	0.00	#DIV/0!	#DIV/0!	0	0	#DIV/0!
July	7/25/2006						0.00	#DIV/0!	#NUM!	0.00	#DIV/0!	#DIV/0!	0	0	#DIV/0!
July Re-Sample	8/1/2006	233	526	462	324	282	233.00	365.40	324.00	526.00	15330.80	123.82	5	0	0%
August	8/22/2006	216	246	447	499	265	216.00	334.60	265.00	499.00	16605.30	128.86	5	0	0%
September	9/20/2006	313	519	464	268	280	268.00	368.80	313.00	519.00	13195.70	114.87	5	0	0%
September Re-Sample	9/27/2006	334	531	490		312	312.00	416.75	412.00	531.00	12079.58	109.91	4	0	0%
October	10/25/2006	303	522	480	490	328	303.00	424.60	480.00	522.00	10237.80	101.18	5	0	0%
	site low	94.00	246.00	270.00	183.00	124.00									
	site mean	248.67	623.20	570.40	469.00	244.20									
	site median	233.00	572.00	507.00	391.00	258.00									
	site high	371.00	1090.00	921.00	778.00	413.00									
	site variance	8012.50	77009.70	60929.30	61096.50	13650.20									
	site std. deviation	89.51	231.66	182.71	201.18	88.82									
	n	9	9	9	8	9									
	number of obs EC>700	0	1	1	1	0									
	% of obs. where EC>700	0%	11%	11%	13%	0%									

5.2.5 Turbidity

Turbidity measurements are taken in the field. Figure 8 shows the results of all turbidity measurements taken during 2006. Table 25 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.

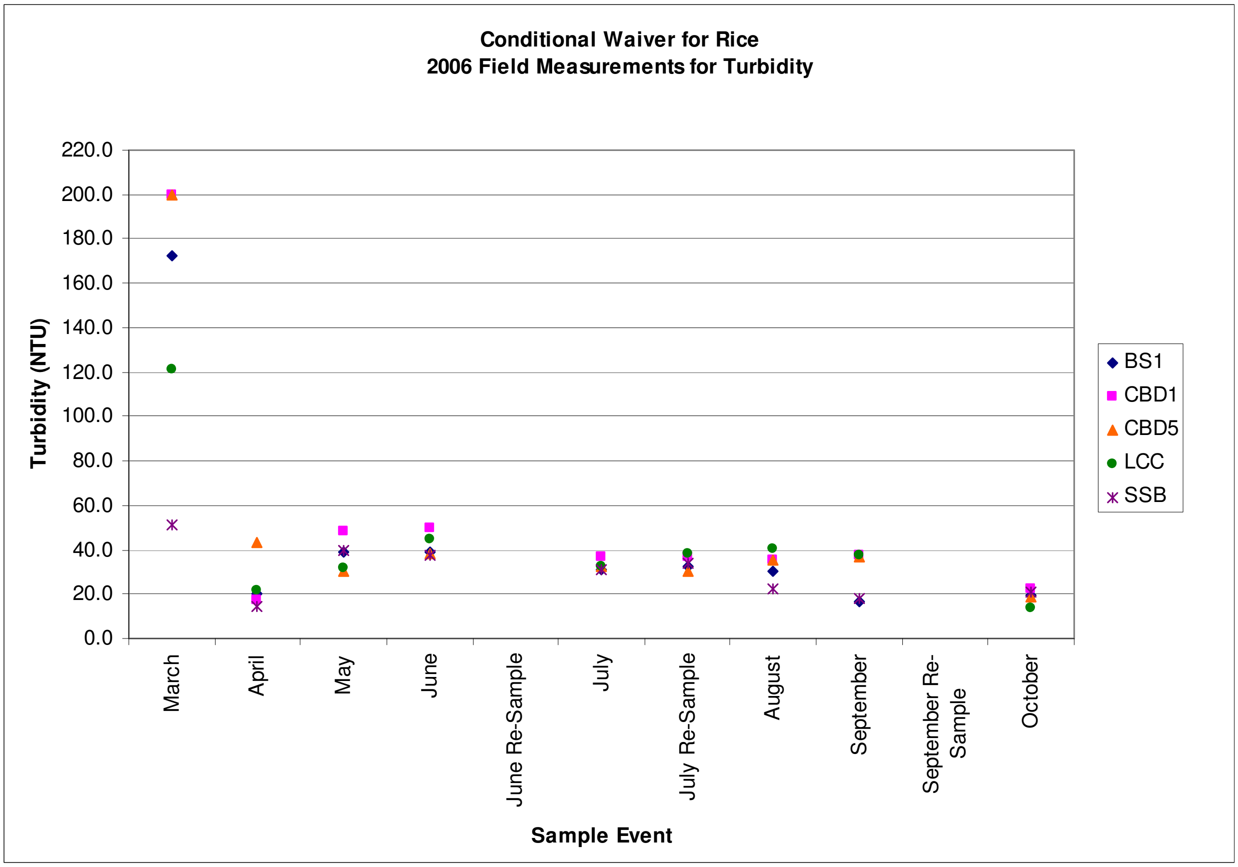

Figure 8. Turbidity Field Measurements, 2006

Table 25. Turbidity Field Results Tabulated Results, 2006

Event	Date	Turbidity (NTU) BS1	CBD1	CBD5	LCC	SSB	event low	event mean	event median	event high	event variance	event std. deviation	n
March	3/7/2006	172.2	>200	>200	121.4	50.9	50.90	148.90	172.20	200.00	4031.39	63.49	5
April	4/25/2006	20.4	17.3	43.2	21.4	14.45	14.45	23.35	20.40	43.20	130.59	11.43	5
May	5/30/2006	39.2	48.6	30.3	31.6	39.4	30.30	37.82	39.20	48.60	53.96	7.35	5
June	6/13/2006	38.6	50.1	38.2	44.4	37.4	37.40	41.74	38.60	50.10	29.55	5.44	5
June Re-Sample	6/22/2006												0
July	7/25/2006	31.1	36.8	32.2	32.2	31.1	31.10	32.68	32.20	36.80	5.61	2.37	5
July Re-Sample	8/1/2006	32.4	36.9	30	38.5	33.8	30.00	34.32	33.80	38.50	11.69	3.42	5
August	8/22/2006	30.5	35.3	35.3	40.2	22.7	22.70	32.80	35.30	40.20	43.64	6.61	5
September	9/20/2006	16.3	37.8	36.9	37.2	18.1	16.30	29.26	36.90	37.80	121.71	11.03	5
September Re-Sample	9/27/2006												0
October	10/25/2006	19.2	22.4	19	13.4	20.6	13.40	18.92	19.20	22.40	11.37	3.37	5
	site low	16.30	17.30	19.00	13.40	14.45							
	site mean	44.43	64.95	62.32	48.25	34.51							
	site median	31.10	42.75	35.20	35.35	35.60							
	site high	172.20	200.00	200.00	121.40	50.90							
	site variance	2363.53	4515.22	4576.04	1343.31	143.09							
	site std. deviation	48.62	55.80	56.03	31.21	11.83							
	n	9	9	9	9	9							

5.3 Metals

Samples were analyzed for the metals listed in Table 26. Results typically are available within one month of sample collection, and are provided electronically by the laboratory to Kleinfelder, which forwards the results to CH2M HILL and the CRC for review and reporting.

Table 26. Hardness Water Quality Results, 2006

		Hardness (mg/L as $CaCO_3$)				
		BS1	**CBD1**	**CBD5**	**LCC**	**SSB**
March	3/7/2006	44	120	98	72	56
April	4/25/2006	70	190	230	300	65
May	5/30/2006	86	170	160	150	93
June	6/13/2006	94	170	150	160	110
July	7/25/2006	110	180	170	160	140
August	8/22/2006	110	200	180	120	140
September	9/20/2006	120	160	150	91	110
October	10/25/2006	120	160	150	200	130

5.3.1 Arsenic

Samples collected March through October were analyzed for arsenic using EPA preparation method 3020A and EPA analysis method EPA 6020/7000 (reporting limit 5 ug/L). The 2006 arsenic results are shown in Table 27. At BS1, one sample (September) contained a measurable concentration of arsenic, with concentrations ranging from non-detect to 5.7 ug/L and averaging 2.9 ug/L (assuming the concentration of non-detects is equal to ½ the reporting limit, or 2.5 ug/L). At CBD1, one sample (May) contained a measurable concentration of arsenic, with concentrations ranging from non-detect to 5.4 ug/L and averaging 2.86 ug/L. At CBD5, all samples were non-detect. At LCC, measurable concentrations of arsenic were detected in two of eight months, with concentrations ranging from 5.3 to 14 ug/L, and averaging 4.29 ug/L. At SSB, one sample (July) contained a measurable concentration of arsenic, with concentrations ranging from non-detect to 5.1 ug/L and averaging 2.83 ug/L

Marshack reports a drinking water primary MCL of 10 ug/L. One sample, the 14 ug/L concentration measured on LCC in October, exceeded the drinking water MCL.

It is noted that pesticides containing arsenic are no longer registered for use, and further, such chemicals have never historically been applied to rice.

Table 27. Arsenic Water Quality Results, 2006

		Arsenic Concentration (ug/L)				
		BS1	**CBD1**	**CBD5**	**LCC**	**SSB**
March	3/7/2006	ND	ND	ND	ND	ND
April	4/25/2006	ND	ND	ND	ND	ND

May	5/30/2006	ND	5.4	ND	ND	ND
June	6/13/2006	ND	ND	ND	5.3	ND
July	7/25/2006	ND	ND	ND	ND	5.1
August	8/22/2006	ND	ND	ND	ND	ND
September	9/20/2006	5.7	ND	ND	ND	ND
October	10/25/2006	ND	ND	ND	14	ND

5.3.2 Boron

Samples collected March through October were analyzed for boron using EPA preparation method 3010A and EPA analysis method 6010B (reporting limit of 0.05 mg/L). The 2006 boron results are shown in Table 28. At BS1, boron was detected in two of eight months, with measured concentration of 0.058 and 0.052 mg/L in September and October, respectively, with an average of 0.016 mg/L (assuming non-detects are equal to ½ the reporting limit). At CBD1, boron was detected in all samples, with concentrations ranging from 0.088 and 0.32 mg/L, and averaging 0.0226 mg/L. At CBD5, boron was detected in all samples collected, with concentrations ranging from 0.051 to 0.25 mg/L, and averaging 0.168 mg/L. At LCC, boron was detected in six of eight months, with concentrations ranging from non-detect to 0.11 mg/L, and averaging 0.053 mg/L. At SSB, boron was detected in two of eight months, with concentrations ranging from non-detect to 0.053, and averaging 0.021 mg/L.

Marshack does not specify aquatic ecosystem boron limits.

Table 28. Boron Water Quality Results, 2006

		Boron Concentration (mg/L)				
	Date	BS1	CBD1	CBD5	LCC	SSB
March	3/7/2006	ND	0.19	0.11	0.074	ND
April	4/25/2006	ND	0.26	0.25	ND	ND
May	5/30/2006	ND	0.32	0.19	0.069	ND
June	6/13/2006	ND	0.3	0.25	0.054	0.052
July	7/25/2006	ND	0.28	0.21	0.11	0.053
August	8/22/2006	ND	0.088	0.051	ND	ND
September	9/20/2006	0.058	0.18	0.14	0.056	ND
October	10/25/2006	0.052	0.19	0.14	0.059	0.05

5.3.3 Cadmium

Samples collected March through October were analyzed for cadmium using EPA preparation method 3010A and EPA analysis method EPA 6020/7000 (reporting limit 0.05 ug/L). All sample results for cadmium were non-detect, as shown in Table 29.

Table 29. Cadmium Water Quality Results, 2006

		Cadmium Concentration (ug/L)				
		BS1	CBD1	CBD5	LCC	SSB
March	3/7/2006	ND	ND	ND	ND	ND
April	4/25/2006	ND	ND	ND	ND	ND
May	5/30/2006	ND	ND	ND	ND	ND

June	6/13/2006	ND	ND	ND	ND	ND
July	7/25/2006	ND	ND	ND	ND	ND
August	8/22/2006	ND	ND	ND	ND	ND
September	9/20/2006	ND	ND	ND	ND	ND
October	10/25/2006	ND	ND	ND	ND	ND

5.3.4 Copper

Samples collected March through October were analyzed for copper using EPA preparation method 3020A and EPA analysis method EPA 6020/7000 (reporting limit of 2.0 ug/L). The 2006 copper results are shown in Table 30. At BS1, copper concentrations ranged from 2.1 to 7.1 ug/L, and averaged 5.3 ug/L. At CBD1, copper concentrations ranged from 4.1 to 9.3 ug/L, and averaged 6.5 ug/L. At CBD5, copper concentrations ranged from 4.7 to 12 ug/L, and averaged 8 ug/L. At LCC, copper concentrations ranged from 3.3 to 12 ug/L, and averaged 6.8 ug/L. At SSB, copper concentrations ranged from 2.4 to 6.3 ug/L, and averaged 4.5 ug/L.

The CTR 1-hour maximum criterion for copper is:

$$1\text{ - hour maximum copper concentration (ug/L)} = e^{0.9422[\ln(\text{hardness})]-1.700}$$

The hardness-adjusted copper criteria, based on the actual hardness measured for the sample location and date, are shown in Table 31. One sample, taken in March at LCC, exceeded the copper criterion. The measured hardness for the sample was 72 mg/L as $CaCO_3$, which resulted in a CTR hardness-adjusted criterion of 10.3. The copper concentration of the sample was 12 ug/L, or 1.7 ug/L greater than the criterion. For the March sample event, stormwater runoff dominated the flows at LCC.

Table 30. Copper Water Quality Results, 2006

		Copper Concentration (ug/L)				
	Date	BS1	CBD1	CBD5	LCC	SSB
March	3/7/2006	6.5	7.9	11	**12**	3.7
April	4/25/2006	3.6	4.6	5.8	4.6	3
May	5/30/2006	6.1	6.7	11	5	5.6
June	6/13/2006	6.1	9.3	12	12	6.1
July	7/25/2006	7.1	8.7	8.3	7.4	6.3
August	8/22/2006	4.5	5.4	4.7	4.4	4.3
September	9/20/2006	2.1	4.1	5.3	5.8	2.4
October	10/25/2006	6.7	5.2	6.2	3.3	4.4

Table 31.Hardness-Adjusted CTR Copper Water Quality Criteria (1-hour maximum)

		Hardness-Adjusted CTR Copper Water Quality Criteria (ug/L)				
	Date	BS1	CBD1	CBD5	LCC	SSB
March	3/7/2006	6.5	16.6	13.7	10.3	8.1
April	4/25/2006	10.0	25.6	30.7	39.4	9.3
May	5/30/2006	12.1	23.1	21.8	20.5	13.1

June	6/13/2006	13.2	23.1	20.5	21.8	15.3
July	7/25/2006	15.3	24.4	23.1	21.8	19.2
August	8/22/2006	15.3	26.9	24.4	16.6	19.2
September	9/20/2006	16.6	21.8	20.5	12.8	15.3
October	10/25/2006	15.3	21.8	20.5	26.9	17.9

5.3.5 Lead

Samples collected March through October were analyzed for lead using EPA preparation method 3010A and EPA analysis method EPA 6020/7000 (reporting limit 0.05 ug/L). All sample results for lead were non-detect, as shown in Table 32.

Table 32. Lead Water Quality Results, 2006

		Cadmium Concentration (ug/L)				
		BS1	**CBD1**	**CBD5**	**LCC**	**SSB**
March	3/7/2006	ND	ND	ND	ND	ND
April	4/25/2006	ND	ND	ND	ND	ND
May	5/30/2006	ND	ND	ND	ND	ND
June	6/13/2006	ND	ND	ND	ND	ND
July	7/25/2006	ND	ND	ND	ND	ND
August	8/22/2006	ND	ND	ND	ND	ND
September	9/20/2006	ND	ND	ND	ND	ND
October	10/25/2006	ND	ND	ND	ND	ND

5.3.6 Nickel

Samples collected March through October were analyzed for nickel using EPA preparation method 3020A and EPA analysis method EPA 6020/7000 (reporting limit 2.0 ug/L). The 2006 nickel results are shown in Table 33. At BS1, nickel concentrations ranged from non-detect to 11 ug/L, and averaged 5 ug/L (assuming non-detects are ½ the reporting limit, or 1 ug/L). At CBD1, concentrations ranged from non-detect to 15 ug/L, and averaged 7.2 ug/L. At CBD5, concentrations ranged from non-detect to 13 ug/L, and averaged 7 ug/L. At LCC, concentration ranged from non-detect to 16 ug/L and averaged 7.1 ug/L. At SSB, nickel concentrations ranged from non-detect to 9.1, and averaged 4.3 ug/L.

The CTR 1-hour maximum criterion for nickel is:

$$1\text{ - hour maximum nickel concentration (ug/L)} = e^{-0.8460[\ln(\text{hardness})]+2.255}$$

The hardness-adjusted nickel criteria, based on the actual hardness measured for the sample location and date, are shown in Table 34. One sample, taken in March at LCC, exceeded the copper criterion. All samples were significantly below the hardness-adjusted one-hour maximum criteria.

Table 33. Nickel Water Quality Results, 2006

		Nickel Concentration (ug/L)				
		BS1	**CBD1**	**CBD5**	**LCC**	**SSB**
March	3/7/2006	3.9	7.8	7.9	5.8	2.1
April	4/25/2006	3.9	6.8	8	8.4	2.7
May	5/30/2006	3.4	5.5	4.4	4.9	4.2
June	6/13/2006	3.6	5.8	6.3	7.9	3.8
July	7/25/2006	9	15	13	9	9.1
August	8/22/2006	4.1	6.3	4.4	4	3.4
September	9/20/2006	ND	ND	ND	ND	ND
October	10/25/2006	11	9.2	11	16	8.1

Table 34. Hardness-Adjusted CTR Nickel Water Quality Criteria (1-hour maximum)

		Hardness-Adjusted CTR Nickel Water Quality Criteria (ug/L)				
		BS1	CBD1	CBD5	LCC	SSB
March	3/7/2006	230	550	460	360	290
April	4/25/2006	350	810	950	1190	330
May	5/30/2006	410	740	700	660	440
June	6/13/2006	450	740	660	700	510
July	7/25/2006	510	770	740	700	620
August	8/22/2006	510	840	770	550	620
September	9/20/2006	550	700	660	430	510
October	10/25/2006	550	700	660	840	590

5.3.7 Selenium

Samples collected March through October were analyzed for selenium using EPA preparation method 3010A and EPA analysis method EPA 6020/7000 (reporting limit 5.0 ug/L). All sample results for selenium were non-detect, as shown in Table 35.

Table 35. Selenium Water Quality Results, 2006

		Selenium Concentration (ug/L)				
		BS1	**CBD1**	**CBD5**	**LCC**	**SSB**
March	3/7/2006	ND	ND	ND	ND	ND
April	4/25/2006	ND	ND	ND	ND	ND
May	5/30/2006	ND	ND	ND	ND	ND
June	6/13/2006	ND	ND	ND	ND	ND
July	7/25/2006	ND	ND	ND	ND	ND
August	8/22/2006	ND	ND	ND	ND	ND
September	9/20/2006	ND	ND	ND	ND	ND
October	10/25/2006	ND	ND	ND	ND	ND

5.3.8 Zinc

Samples collected March through October were analyzed for zinc using EPA preparation method 3010A and EPA analysis method EPA 6020/7000 (reporting limit 20 ug/L). All sample results for zinc were non-detect, as shown in Table 36.

Table 36. Zinc Water Quality Results, 2006

		Zinc Concentration (ug/L)				
		BS1	CBD1	CBD5	LCC	SSB
March	3/7/2006	ND	ND	ND	ND	ND
April	4/25/2006	ND	ND	ND	ND	ND
May	5/30/2006	ND	ND	ND	ND	ND
June	6/13/2006	ND	ND	ND	ND	ND
July	7/25/2006	ND	ND	ND	ND	ND
August	8/22/2006	ND	ND	ND	ND	ND
September	9/20/2006	ND	ND	ND	ND	ND
October	10/25/2006	ND	ND	ND	ND	ND

5.4 Toxicity Testing

In accordance with the MRP, acute and chronic toxicity tests were performed on three test species. Tests are performed on samples collected at each station and are performed concurrent with tests on control samples. The three test species are:

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

5.4.1 Overview - Whole Effluent Tests (Bioassays)

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

- 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 include:

- 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 can be avoided to a considerable extent by care in the collection and handling of samples and in the conduct of the tests. The fourth point requires analysis and interpretation of the results. The fifth problem requires that additional tests be done to identify which components of the contaminant mixture are responsible, a process called TIE (EPA 1991a; EPA 1993f). In TIE, 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 background medium and testing the artificially contaminated medium. Extension of the TIE process to include other properties of tested media could solve the sixth problem.

Both control and reference media should be tested along with the contaminated media. Control media are laboratory media that are 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 the vicinity of 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 U.S. 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 a number of 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. Tests are performed on samples collected at each station and are performed concurrent with tests on control samples. The three test species are:

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

This year, the toxicity testing and re-sample requirements were as shown in Figure 9.

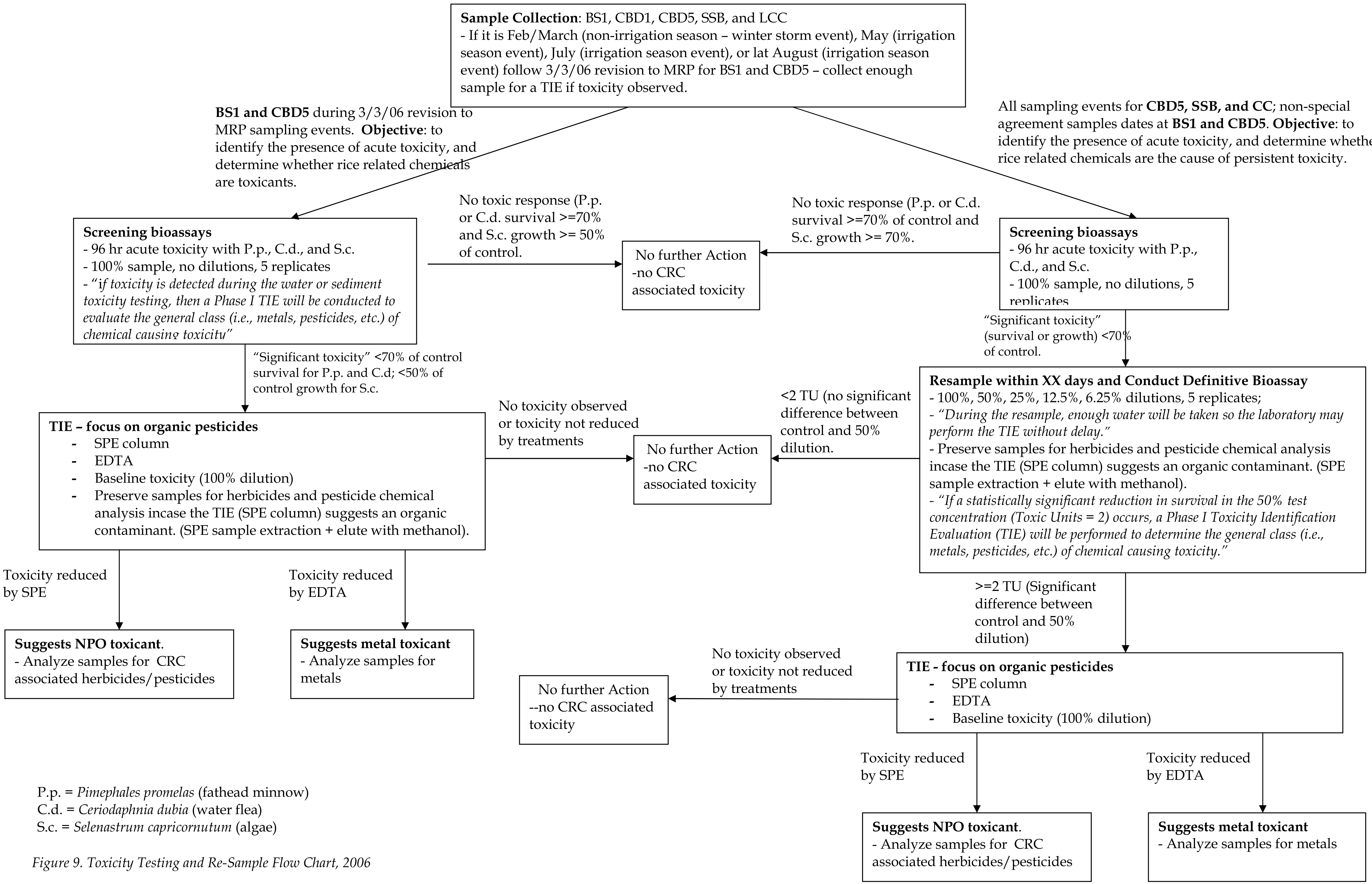

Figure 9. Toxicity Testing and Re-Sample Flow Chart, 2006

5.4.2 *Pimephales promelas*

Overview

The MRP includes toxicity tests using the test species *Pimephales promelas* (hereafter "minnow") to detect toxicity to fish species. *Pimephales promelas* is considered a sensitive test species, and toxicity to *c. daphnia* can indicate a water quality concern.

2006 Fathead Minnow Toxicity Testing

Fathead minnow toxicity tests were performed on samples collected March through October. For the samples collected March through June, toxicity testing was conducted by Block Environmental Science (BES). For the samples collected July through October, toxicity testing was conducted by AquaScience.

The results of the minnow toxicity tests are shown in Table 37. These tabulated results provide the sample date (or re-sample date), the lab report that summarizes the results of the tests, the percent survival (as compared to the control) of the test organisms, whether re-sampling was triggered, and the results of any re-sampling. The following summarizes the results of the 2006 CWFR fathead minnow toxicity testing:

March, April, May, July, August, September, and October:

- Fathead minnow toxicity tests performed on samples collected in March, April, May, July, August, September, and October showed no statistically significant effects.

June

- During the fathead minnow toxicity tests performed during June, there was a failure of the laboratory control samples to meet test criteria. The lab control samples failed the minimum survival criteria with only 55% of the fish surviving. BES staff concluded that the fish were probably stressed during shipping from the supplier since their concurrent reference toxicant test also failed acceptability criteria. Normally, BES uses fish that are cultured in-house for the acute tests, but they did not have adequate in-house supply at the time of analysis of the CRC samples. Due to the failure of the control samples, results cannot be reported as a percent difference from the control.

- The tests performed on the field samples resulted in the following percent survivals:

    - BS1, 75%
    - CBD1, 100%
    - CBD5, 40%
    - LCC, 80%
    - SSB, 80%

- Based on the failure of the June laboratory control samples to meet survival, the CRC initiated re-sampling.

- The fathead minnow toxicity tests performed on the June re-samples showed no statistically significant effects.

5.4.3 C. Daphnia

Overview

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

2006 C. Daphnia Toxicity Testing

C. daphnia toxicity tests were performed on samples collected March through October. For the samples collected March through June, toxicity testing was conducted by BES. For the samples collected July through October, toxicity testing was conducted by AquaScience.

The results of the daphnia toxicity tests are shown in Table 38. These tabulated results provide the sample date (or re-sample date), the lab report that summarizes the results of the tests, the percent survival (as compared to the control) of the test organisms, whether re-sampling was triggered, and the results of any re-sampling. The following summarizes the results of the 2006 CWFR *c. daphnia* toxicity testing:

March, April, May, June, July, August, and September

- *C. daphnia* toxicity tests performed on samples collected in March, April, May, June, July, August, and September showed no statistically significant toxicity.

October

- There was statistically significant toxicity to daphnia observed in the BS1 sample collected in October, with a survival of 15% as compared to the control. *C. daphnia* toxicity tests performed on CBD1, CBD5, LCC, and SSB samples collected in March showed no statistically significant toxicity.
- However, due to miscommunication between the lab and CRC's consultant team, no re-sampling was performed at BS1, and no formal TIE was conducted on the BS1 sample. This error in communication is being addressed to prevent the failure of the consultant team to perform follow-up monitoring and appropriate communication with between the CRC and the CVRWQCB and its staff. It is noted that there are no applications of rice pesticides during the month of October; therefore, it is not likely that the *c. daphnia* toxicity is attributable to rice pesticide use.

5.4.4 *Selenastrum capricornutum*

Overview

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

2006 *Selanastrum* Testing

Selanastrum toxicity tests were performed on samples collected March through October. For the samples collected March through June, toxicity testing was conducted by BES. For the samples collected July through October, toxicity testing was conducted by AquaScience.

The results of the *selanastrum* toxicity tests are shown in Table 39. These tabulated results provide the sample date (or re-sample date), the lab report that summarizes the results of the tests, the percent survival (as compared to the control) of the test organisms, whether re-sampling was triggered, and the results of any re-sampling. The following summarizes the results of the 2006 CWFR *selanastrum* toxicity testing:

March

- During the *selanastrum* toxicity tests performed during March, there was a failure of the laboratory control samples to meet test criteria. According the lab, "Laboratory documentation identified the cause of the control failure to a misprepared nutrient solution." The laboratory reported the control failure to the CRC and the CRC consultant team via email on March 15, 2006. Samples had been collected on March 7, 2006, toxicity testing was initiated on March 8, 2006, and the duration of the standard algae toxicity test is 96 hours (4 days). BES issued a Corrective Action Report (CAR), as is required under the QAPP. The CAR called for retraining of staff.

- No re-test of the original sample was conducted, nor was any re-sampling was conducted. Follow-up consultation with CVRWQCB staff resulted in a decision to more proactively manage communications with the toxicity laboratory and to perform re-testing and/or re-sampling in the event of the failure of *selanastrum* lab controls. It is noted that the CVRWQCB Technical Issues Committee (TIC) is developing recommendations regarding the failure of laboratory controls in the performance of toxicity tests.

April

- *Selanastrum* toxicity tests performed on samples collected in April showed growth at increased levels as compared to the control samples. Control samples met the test criteria.

May

- *Selanastrum* toxicity tests performed on BS1, CBD5, and LCC samples collected in May showed no statistically significant effects.

- *Selanastrum* toxicity tests performed on CBD1 and SSB samples collected in May showed statistically significant effects. The CBD1 sample resulted in 65% survival, as compared to the control, and the SSB sample resulted in 73% survival, as compared to the control.

- Re-sampling and/or initiation of a TIE were *not* triggered for BS1 because growth was not reduced more than 50%. Re-sampling and/or initiation of a TIE were *not* triggered for SSB because growth was not reduced more than 30% in that sample.

June

- *Selanastrum* toxicity tests performed on the LCC sample collected in May showed no statistically significant effects.

- *Selanastrum* toxicity tests performed on BS1, CBD1, CBD5, and SSB samples collected in June showed statistically significant effects. Percent survival, as compared to the control, for the four sites with statistically significant toxicity ranged from 28% to 64%, triggering re-sampling for these four sites. The percent survival for the BS1 and CBD5 samples was greater than 50%; therefore, TIEs were not initiated on original sample, though re-sampling was conducted at these two sites.

- Re-sampling was conducted on June 22, 2006, which was within one week of the date of the original June sampling.

- Toxicity tests using dilutions of 12.5%, 25%, 50%, 75%, and 100% were performed on the four re-samples. These tests showed statistically significant toxicity in the CBD1, CBD5, and LCC re-samples. The statistically significant *selanastrum* effects observed in the BS1, CBD1, and CBD5 re-samples triggered TIEs.

- In addition, the test performed on the SSB re-sample showed statistically significant toxicity in the 50% dilution, but not in any of the other dilutions. Based on the statistically significant toxicity in the 50% SSB dilution, the CRC elected to have a TIE performed on this re-sample as well.

- The procedures and outcome of the TIEs are discussed in Appendix F. A "non-polar organic herbicide with a short half-life" was identified as the probable toxicant.

July

- For the July sampling event, a decision was made by the CRC to utilize the toxicity testing lab Aqua Science for toxicity testing.

- *Selanastrum* toxicity tests performed on all five samples (BS1, CBD1, CBD5, LCC, and SSB) in May showed statistically significant effects. Percent survival, as compared to the control, for the four sites with statistically significant toxicity ranged from 36% to 64%.

- Based on the re-sample triggers, re-sampling was triggered at four sites: CBD1, CBD5, LCC, and SSB. Though not required, the CRC elected to perform re-sampling at BS1. Re-sampling was conducted on August 1, 2006, which was within one week of the date of the original July sampling and two days following the conclusion of the original sampling.

- Toxicity tests using dilutions of 12.5%, 25%, 50%, 75%, and 100% were performed on the five re-samples. These tests showed statistically significant toxicity in the CBD1, LCC, and SBB re-samples. The statistically significant *selanastrum* toxicity observed these re-samples triggered TIEs.

- The procedures and outcome of the TIEs are discussed in Appendix F. A "non-polar organic herbicide with a short half-life" was identified as the probable toxicant.

August

- *Selanastrum* toxicity tests performed on all five samples (BS1, CBD1, CBD5, LCC, and SSB) in May showed no statistically significant effects.

- No re-sampling was triggered, and no TIEs were triggered.

September

- *Selanastrum* toxicity tests performed on the LCC sample collected in September showed no statistically significant effects.

- *Selanastrum* toxicity tests performed on BS1, CBD1, CBD5, and SSB samples collected in September showed statistically significant effects. Percent survival, as compared to the control, for the four sites with statistically significant toxicity ranged from 7% to 37%.

- Based on the TIE/re-sample triggers, re-sampling was triggered at four sites: BS1, CBD1, CBD5, and SSB. Sufficient sample was collected at these four sites to perform TIEs on original sample.

- The procedures and outcome of the TIEs are discussed in Appendix F. Again, a "non-polar organic herbicide with a short half-life" was identified as the probable toxicant.

October

- *Selanastrum* toxicity tests performed on the LCC sample collected in October showed no statistically significant effects.

- *Selanastrum* toxicity tests performed on BS1, CBD1, CBD5, and SSB samples collected in October showed statistically significant effects. Percent survival, as compared to the control, for the four sites with statistically significant toxicity ranged from 54% to 77%.

- Due to communications failure within the CRC/consultant team, the results of the tests were not known to the team until early December. No re-sampling was performed, and no formal TIEs were conducted. This error in communication is being addressed to prevent the failure of the consultant to perform follow-up monitoring and appropriate communication with between the CRC and CVRWQCB and its staff. It is noted that rice pesticides are not used during the month of October.

5.4.5 Hyalella azteca Toxicity Testing (Sediment Toxicity Testing)

Overview

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

2006 *Hyalella* Toxicity Testing

July

- *Hyalella* toxicity tests performed on samples collected in July showed no statistically significant effects (94% to 97% survival).

October

- Some samples, collected on 9/19/2006, were broken during shipment to the sediment toxicity testing lab. One of the jars from BS1 and both of the jars from CBD1 broke. There was adequate sediment remaining the intact BS1 jar to conduct the sediment toxicity test. The CRC consultant re-sampled CBD1 on 9/27/2006 and submitted the replacement sample to the lab. All other sample jars arrived at the lab in-tact.

- *Hyalella* toxicity tests performed on samples collected in October showed no statistically significant effects (92% to 99% survival).

Table 37. Minnow Toxicity Results Summary, 2006

Month	Date	Minnow Toxicity Tests	Appendix Reference	Minnow 96-Hour % Survival, as compared to control (control survival)					Re-Sample Triggered?					Re-Sample Toxicity Information					TIE Performed (O = original sample, R = re-sample)				
				BS1	**CBD1**	**CBD5**	**LCC**	**SSB**	**BS1**	**CBD1**	**CBD5**	**LCC**	**SSB**	**BS1**	**CBD1**	**CBD5**	**LCC**	**SSB**	**BS1**	**CBD1**	**CBD5**	**LCC**	**SSB**
March	03/07/2006	✓	BES Report dated 3/15/2006	100%	100%	100%	100%	100%	no	no	no	no	no	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
April	04/25/2006	✓	BES Report dated 5/1/2006	100%	100%	100%	100%	100%	no	no	no	no	no	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
May	05/30/2006	✓	BES Report dated 6/5/2006	100%	100%	95%	100%	100%	no	no	no	no	no	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
June	06/13/2006	✓	BES Report dated 6/20/2006	75% (55)	100% (55%)	40% (55%)	80% (55%	80% (55%)	Based on lab control failure and one site with 96-hr survival<70%, the CRC initiated re-sampling.					95%	95%	90%	100%	100%	n/a	n/a	n/a	n/a	n/a
				Lab control failure. See BES reported dated _______.										Percent survival for lab controls reported as 100%.									
“	6/22/2006	✓	BES Report dated 7/3/2006	95% (100%)	95% (100%)	90% (100%)	100% (100%)	100% (100%)	no	no	no	no	no	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
July	07/25/2006	✓	AquaScience Report Dated 10/10/2006	100%	100%	100%	100%	100%															
“	08/01/2006		N/A																				
August	08/22/2006	✓	AquaScience Report Dated 10/25/2006	100%	100%	100%	100%	100%	no	no	no	no	no	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
September	09/19/2006	✓	AquaScience Report Dated 11/17/2006	100%	100%	100%	100%	100%	no	no	no	no	no	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
“	09/27/2006																						
October	10/24/2006	✓	AquaScience Report Dated 12/7/2006	100%	100%	100%	100%	100%	no	no	no	no	no	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 38. C. Daphnia Toxicity Test Results Summary, 2006

Month	Date	Daphnia Toxicity Tests	Appendix Reference	Daphnia 96-Hour % Survival, as compared to control (control survival)					Daphnia Toxicity Results Triggered Re-sample?					Re-Sample Toxicity Information					TIE Performed? (O = original sample, R = re-sample)				
				BS1	**CBD1**	**CBD5**	**LCC**	**SSB**	**BS1**	**CBD1**	**CBD5**	**LCC**	**SSB**	**BS1**	**CBD1**	**CBD5**	**LCC**	**SSB**	**BS1**	**CBD1**	**CBD5**	**LCC**	**SSB**
March	03/07/2006	✓	BES Report dated 3/15/2006	95%	100%	95%	95%	100%	no	no	no	no	no	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
April	04/25/2006	✓	BES Report dated 5/1/2006	100%	100%	100%	100%	100%	no	no	no	no	no	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
May	05/30/2006	✓	BES Report dated 6/5/2006	100%	100%	95%	100%	100%	no	no	no	no	no	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
June	06/13/2006	✓	BES Report dated 6/20/2006	100% (95%)	100% (95%)	100% (95%)	100% (95%)	100% (95%)	no	no	no	no	no	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
“	06/22/2006		N/A																				
July	07/25/2006	✓	AquaScience Report Dated 10/10/2006	95%	100%	95%	100%	100%	no	no	no	no	no	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
“	08/01/2006		N/A																				
August	08/22/2006	✓	AquaScience Report Dated 10/25/2006	100%	100%	100%	100%	100%	no	no	no	no	no	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
September	09/19/2006	✓	AquaScience Report Dated 11/17/2006	100%	100%	100%	100%	100%	no	no	no	no	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
“	09/27/2006																						
October	10/24/2006	✓	AquaScience Report Dated 12/7/2006	15%	100%	100%	100%	95%	yes	no	no	no	no										

Table 39. Selanastrum Toxicity Test Results, 2006

			Appendix Reference	Selanastrum 96-Hour Survival % Survival, as compared to control					Re-Sample Triggered?					Re-Sample Toxicity Information					TIE Performed (O = original sample, R = re-sample)				
Month	**Date**	**Selanastrum Toxicity Tests**		**BS1**	**CBD1**	**CBD5**	**LCC**	**SSB**	**BS1**	**CBD1**	**CBD5**	**LCC**	**SSB**	**BS1**	**CBD1**	**CBD5**	**LCC**	**SSB**	**BS1**	**CBD1**	**CBD5**	**LCC**	**SSB**
March	03/07/2006	✓	BES Report dated 3/15/2006	Lab control failure.																			
April	04/25/2006	✓	BES Report dated 5/1/2006	Growth>control					no	no	no	no	no	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
May	05/30/2006	✓	BES Report dated 6/5/2006	94%	65%	107%	87%	73%	no	no	no	no	no						None, %reduction <-30% (note)				
June	06/13/2006	✓	BES Report dated 6/20/2006	54%	48%	64%	76%	28%	yes	yes	yes	no	yes						R	R	R	R	R
“	06/22/2006	✓ (TIES)	BES Report Dated 8/7/2006											8 TUs	>8TUs	4 TU		1 TU***					
July	07/25/2006	✓	AquaScience Report Dated 10/10/2006	64%	44%	37%	36%	60%	yes	yes	yes	yes	yes										
“	08/01/2006	✓ (TIES)	AquaScience Report Dated 10/10/2006																R	R	R	R	R
August	08/22/2006	✓	AquaScience Report Dated 10/25/2006	89%	91%	90%	92%	91%	no	no	no	no	no	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
September	09/19/2006	✓ (TIES)	AquaScience Report Dated 11/17/2006	10%	37%	33%	101%	7%	yes	yes	yes	yes	yes	TIE Triggered	TIE Triggered	TIE Triggered		TIE Triggered	O	O	O		O
“	09/27/2006		AquaScience Report Dated 11/17/2006											>4TUs, dilution series testing performed at 25, 50, 75, and 100% concentrations.									
October	10/24/2006	✓	AquaScience Report Dated 12/7/2006	77%	61%	54%	104%	78%	yes	yes	yes	no	yes										

5.5 Pesticides

5.5.1 Specified Pesticides

Two pesticides were monitored during Year 2 (2006). These include carfentrazone-ethyl (Shark) and bispyribac-sodium (Regiment). Results for the entire year were non-detect. The raw lab results are included in the Appendices

5.5.2 Additional (elective) Pesticide Analyses Performed for TIE Follow-Up

This year, in an effort to determine the causes of aquatic toxicity identified through the toxicity tests, the CRC elected to perform some additional analysis for pesticides beyond that required by the MRP. These included the active ingredients listed in Table 40.

Table 40. Pesticides Analyzed as part of TIE Follow-Up

Parameter	Reporting Limit	Units	Notes
Bensulfuron-methyl	0.02	ng/uL	
Carfentrazone	0.02	ng/uL	
Clomazone	0.1	ng/uL	
Cyhalofop-butyl	0.05	ng/uL	
Diflubenzuron	0.1	ng/uL	
Diuron	0.1	ng/uL	Not used on rice.
Glyphosate			Not used on rice.
Halosulfuron	0.05	ng/uL	
Lambda cyhalothrin	0.05	ng/uL	
Molinate	0.05	ng/uL	
Pendimethalin	0.01	ng/uL	
Propanil	0.05	ng/uL	
Simazine			Not used on rice.
Thiobencarb	0.05	ng/uL	
Trifloxystrobin (Flint)	0.02	ng/uL	
Zeta-cypermethrin	0.05	ng/uL	

5.6 UC Davis Edge of Field Monitoring

5.6.1 Overview of Requirements

The University of California at Davis (UC Davis) CALFED grant #384, approved for funding by the SWRCB on June 17, 2004 (Resolution No. 2004-0035), contains four study components producing data that is to be submitted by the CRC 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” A monitoring plan was developed by UC Davis with significant input and oversight by CVRWQCB staff. This monitoring plan specifies the monitoring requirements, monitoring locations, etc. to be conducted under the grant. On behalf of the SWRCB, the grant is managed by a CVRWQCB staff person.

Study Component #1

Study Component #1 is focused on the evaluation of Total Organic Carbon/ Dissolved Organic Carbon (TOC/DOC), TDS/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. The MRP specifies the Study Component #1 monitoring.

Study Component #2

Study Component #2 is designed to measure the amount and transport of TOC/DOC, TDS/EC, and turbidity in rice field "peripheral drains". Peripheral drain sites are to be located downstream of the fields used in Study Component #1. Monitoring as specified in the MRP is to be conducted as part of Component #2.

Study Component #3

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/conventionally farmed field and a dry seeded/conventionally farmed rice field. Monitoring for Component #3 is to be conducted as specified in the MRP.

Study Component #4

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/conventionally farmed field and a dry seeded/ conventionally farmed rice field. Monitoring for Component #3 is to be conducted as specified in the MRP.

The following are the preliminary results of the UC Davis edge of field monitoring being conducted under the CALFED grant. These results are considered preliminary and are subject to revision.

5.6.2 Measurements

Measurements of dissolved organic carbon (DOC) concentration, total organic carbon (TOC) concentration, electrical conductivity (EC), total dissolved solids (TDS), turbidity, and total suspended solids (TSS) are reported on water collected from grower rice field inlets and outlets and in lateral/peripheral drains upstream and downstream of the rice field outlet. Measurements of pesticide concentrations are reported on water collected from the Rice Experiment Station. The University is currently working on preparing the data for all nitrogen, phosphorus, potassium, and copper concentrations as well as all carbon, nutrient, and metal flux. The DOC and TOC concentrations reported herein represent the concentrations at one point in time. The DOC concentration can be affected by many environmental variables, including water flow; consider this when interpreting these data.

Site Descriptions

Table 41.Description of straw management for farmer field sites (na = information not applicable)

Grower ID	Field #	Straw Management 2005/06 Winter	2006 Growing Season	2006/07 Winter
MAT	3	Incorporate	Flooding with maintenance flow	Burn- Flooding with maintenance flow
MAT	4	Burn	Flooding with maintenance flow	--
MAT	11	--	--	Incorporate- Flooding with no outflow
MEY	5	Incorporate	Flooding with maintenance flow	Incorporate- Flooding with maintenance flow
MEY	6	Burn	Flooding with maintenance flow	Burn- No flooding
TIB	7	Incorporate	Flooding with maintenance flow (Leathers' method)	--
TIB	8	Burn	Flooding with maintenance flow (Leathers' method)	Burn- No flooding
TIB	12	--	--	Not burned or incorporated- No flooding
MAB	9	Incorporate	Flooding with no maintenance flow	Incorporate- Flooding with no outflow
MAB	10	Incorporate	Flooding with no maintenance flow	Burn- No flooding

Two fields, MAT 4 and TIB 7 will be replaced at the end of the 2006 growing season due to alterations in straw management and crop rotation, respectively. The new fields will be monitored beginning October 1, 2006.

5.6.3 Results

Farmer Fields

Table 42. Within-growing season DOC concentration, TOC concentration, EC, TDS, Turbidity, and TSS from INLETS. Water levels at both MAT fields were adjusted throughout the growing season, leading to intermittent periods of outflow.

Grower ID	Field	Date	DOC	TOC	EC	TDS	Turbidity	TSS
			mg L^{-1}		µS cm^{-1}	mg L^{-1}	NTU	mg L^{-1}
MAT	3	06/23/06	0.6	0.5	59.4	30.2	2.4	37.9
		07/06/06	1.3	0.8	120.0	60.0	0.3	1.8
		07/21/06	1.5	1.5	66.1	33.0	1.3	2.0
		08/04/06	0.0	0.0	65.0	32.6	2.2	25.8
		08/11/06	0.0	0.0	66.4	33.1	1.4	14.7
MAT	4	05/08/06	1.5	1.9	51.5	25.8	9.0	24.8
		06/09/06	0.4	0.4	50.3	24.9	3.8	6.5
		06/23/06	0.6	0.9	53.7	28.8	15.1	209
		07/06/06	2.0	1.1	119	59.3	6.4	9.6
		07/21/06	1.6	2.1	67.0	33.5	12.0	15.8

		08/04/06	0.0	0.0	64.1	31.8	1.7	22.4
		08/11/06	0.0	0.1	66.2	33.1	1.7	12.1
MEY	5	05/12/06	2.1	2.6	33.8	67.7	13.1	25.0
		05/25/06	1.1	2.4	48.4	24.1	1.8	4.3
		06/02/06	2.8	2.9	62.8	31.6	7.4	7.6
		06/05/06	3.1	3.4	68.1	34.0	8.5	12.4
		06/09/06		1.3	66.0	33.1	7.8	6.1
		07/06/06	2.1	1.7	124	61.8	2.9	5.3
		07/18/06	0.0	0.1	72.4	35.6	7.8	8.0
		07/21/06	2.5	2.9	74.4	37.2	5.4	8.2
		07/24/06	1.6	1.5	69.7	34.3	5.9	70.8
		08/04/06	0.8	0.9	73.9	36.7	5.8	56.4
		08/11/06	0.9	1.1	75.5	37.9	0.8	69.2
MEY	6	05/08/06	2.6	2.3	72.4	36.0	9.4	7.9
		06/02/06	2.9	2.7	65.7	33.1	6.9	12.5
		06/05/06	3.1	3.1	67.1	33.7	5.7	7.5
		06/09/06	1.1	1.1	65.7	32.7	8.1	9.7
		06/23/06	1.1	1.3	67.1	62.5	6.0	91.0
		07/06/06	1.8	0.3	125	62.8	2.3	6.7
		07/11/06	2.2	1.5	130	64.8	3.7	7.0
		07/11/06	1.7	1.8	132	65.8	4.5	6.8
		07/11/06	7.4	7.6	165	82.4	1.0	1.9
		07/14/06	2.0	1.5	129	65.2	4.2	6.5
		07/18/06	0.0	0.0	71.9	36.0	5.4	8.8
		08/04/06	0.8	1.0	74.2	36.9	5.2	59.5
		08/11/06	0.8	1.2	76.3	38.0	5.0	58.5
TIB	7	05/12/06	1.7	1.8	124	62.2	19.4	30.2
		05/20/06	4.3	4.7	118	58.7	37.4	77.5
		07/21/06	5.4	6.2	299	150	33.8	50.7
		07/24/06	2.6	3.4	273	140	36.2	523
		07/28/06	2.7	3.2	273	135	30.0	415
		08/04/06	2.5	3.6	261	131	37.3	451
		08/11/06	3.0	2.9	268	133	36.1	542
TIB	8	05/12/06	1.7	1.6	123	61.7	16.6	23.0
		05/19/06	1.3	2.0	121	60.6	24.7	40.4
		07/21/06	5.5	6.9	298	149	35.4	46.9
		07/24/06	2.7	3.5	296	141	32.3	520
		07/28/06	2.6	3.2	273	138	28.9	391
		08/04/06	1.9	3.7	533	265	76.9	447
		08/11/06	2.6	2.8	262	133	32.8	547
MAB	9	06/20/06	5.7	5.7	298	149	10.2	16.6
		07/06/06	2.7	2.8	432	212	5.0	12.7
		07/21/06	6.4	6.7	255	127	8.2	18.4
		08/04/06	3.8	5.2	293	145	16.5	253
		08/11/06	3.1	3.8	291	144	10.7	169
MAB	10	05/25/06	0.8	0.9	308	154	15.0	26.4
		06/20/06	4.6	5.1	315	157	15.2	21.0
		07/06/06	2.8	2.0	435	215	8.7	22.2
		07/21/06	6.9	6.7	27.9	140	12.3	19.2
		08/04/06	3.7	4.6	287	145	14.0	185

	08/11/06	3.2	3.6	290	144	8.9	117
MIN		0.0	0.0	27.9	24.1	0.3	1.8
MAX		7.4	7.6	533	265	76.9	547
MEDIAN		2.0	2.0	119	61.7	8.1	22.4

- The DOC and TOC concentrations of inlet water were typically low, rarely exceeding 5 mg L^{-1} during any sampling.

Table 43. Within-growing season DOC concentration, TOC concentration, EC, TDS, Turbidity, and TSS from OUTLETS.

Grower ID	Field	Date	DOC	TOC	EC	TDS	Turbidity	TSS
			mg L^{-1}		µS cm^{-1}	mg L^{-1}	NTU	mg L^{-1}
MAT	3	07/21/06	21.4	22.5	21.3	105	31.2	20.3
		08/11/06	3.0	3.6	125	62.8	39.3	187.2
		08/25/06	2.4	3.0	110	55.0	43.3	217.7
MAT	4	06/01/06	7.3	7.5	104	52.0	2.5	3.3
		07/06/06	4.7	4.5	170	85.1	0.5	0.9
		07/21/06	4.8	6.1	107	53.2	4.1	4.1
		08/04/06	2.3	2.4	102	51.5	8.9	63.4
		08/11/06	2.0	2.3	107	53.8	9.6	63.3
MEY	5	06/02/06	33.4	34.1	191	96.6	3.3	3.0
		06/05/06	26.6	29.1	171	85.4	53.5	4.1
		06/09/06	22.0	22.3	146	73.2	18.7	6.0
		07/18/06	4.6	6.2	138	69.2	2.6	3.9
		07/18/06	3.8	4.7	140	70.2	2.6	4.7
		07/21/06	6.9	7.9	165	82.2	1.7	4.2
		07/24/06	5.7	6.0	150	74.1	3.2	51.2
		08/04/06	3.4	3.0	106	52.6	5.3	116
		08/11/06	2.7	2.9	99	49.7	2.1	22.6
		09/03/06	3.5	4.7	110	55.0	39.6	1044
MEY	6	06/02/06	16.5	17.2	236	120	10.6	5.8
		06/05/06	16.5	17.0	139	69.5	21.7	3.7
		06/09/06	10.2	10.2	98.1	49.2	14.1	4.3
		07/11/06	7.1	7.4	164	81.9	1.6	2.8
		07/11/06	8.4	8.7	172	86.4	1.5	2.7
		07/14/06	7.0	7.3	199	98.9	0.8	2.0
		07/14/06	7.5	7.8	196	97.8	1.8	11.7
		07/18/06	5.5	5.9	115	57.7	0.7	1.0
		08/04/06	4.8	5.2	123	61.5	2.8	25.9
		08/11/06	4.4	5.3	135	67.4	4.1	59.8
TIB	7	07/21/06	9.2	9.1	247	123	3.3	3.6
		07/24/06	6.3	6.7	246	122	3.0	27.5
		07/28/06	6.1	6.2	278	139	2.1	35.6
		08/04/06	7.1	7.8	306	154	6.0	14.1
		08/11/06	6.2	5.2	352	175	5.0	61.6
TIB	8	07/21/06	9.1	8.9	162	80.9	1.6	1.8
		07/24/06	7.5	7.9	197	99.7	1.1	14.0
		07/28/06	7.6	7.8	227	113	2.6	30.1

		08/04/06	5.9	6.1	623	312	67.8	24.1
		08/11/06	6.2	5.7	316	158	1.3	34.9
MAB	9	05/19/06	13.2	16.9	249	125	2.7	11.0
		08/25/06	7.6	8.4	376	187	2.9	84.6
		09/03/06	8.7	9.0	390	196	2.0	37.1
MAB	10	08/25/06	8.3	9.0	420	210	1.0	25.3
MIN			2.0	2.3	21.3	49.2	0.5	0.9
MAX			33.4	34.1	623.0	312.0	67.8	1043.9

- DOC concentrations of outlet water were typically greater earlier in the growing season compared to later.
- Only eight outlet samples had DOC concentrations greater than 10 mg L^{-1}.
- The DOC concentrations in the first outflows were two-fold greater from the incorporated field (5) compared to the burn field (6)

Table 44. Within-growing season DOC concentration and TOC concentration from lateral or peripheral drains UPSTREAM and DOWNSTREAM of the outlet.

			UPSTREAM		DOWNSTREAM	
Grower ID	Field	Date	DOC	TOC	DOC	TOC
			mg L^{-1}		mg L^{-1}	
MAT	3	07/21/06	8.0	8.5	12.7	12.8
		08/14/06	4.2	9.3	3.4	4.5
MEY	5	06/02/06	17.9	18.5	22.4	23.1
		06/05/06	21.1	27.5	22.4	28.3
		06/09/06			20.0	24.7
		07/18/06	3.0	6.5	5.8	18.5
		07/21/06	10.5	12.6	7.7	9.2
		07/24/06	6.5	8.3	4.9	5.3
		08/04/06	5.3	5.8	4.2	4.9
		08/11/06	4.0	4.5	3.7	3.7
		09/03/06	5.7	7.3	3.8	8.6
MEY	6	06/02/06	14.2	16.5	15.0	16.0
		06/05/06	11.2	14.4	12.3	13.3
		06/09/06	9.6	9.9	10.2	10.0
		07/11/06	4.2	4.8	4.8	5.1
		07/14/06	4.8	5.3	4.8	5.2
		07/18/06	3.4	3.9	3.8	4.3
		08/04/06	3.1	3.2	3.4	3.8
		08/11/06	3.0	3.9	2.6	3.8
TIB	7	05/16/06	7.3	9.7	7.8	13.6
		07/21/06	10.0	12.7	9.5	12.0
		07/24/06	6.8	9.9	7.7	8.8
		07/28/06	5.4	6.5	5.8	6.6
		08/04/06	5.0	6.8	5.0	5.7
		08/11/06	4.8	4.0	4.6	5.1
TIB	8	07/21/06	9.1	11.8	9.2	10.5
		07/24/06	5.8	7.3	5.5	7.0

		07/28/06	5.6	6.7	5.8	7.1
		08/04/06	4.2	7.1	5.2	8.2
		08/11/06	4.8	0.3	4.6	5.0
MAB	9	09/03/06	8.0	11.1	8.1	8.3

- No trend is apparent that rice field drain outlets influence the DOC or TOC concentrations in lateral or peripheral drains.

Table 45. Within-growing season EC, TDS, Turbidity, and TSS from lateral or peripheral drains UPSTREAM and DOWNSTREAM of the outlet.

Grower ID	Field	Date	EC		TDS		Turbidity		TSS	
			µS cm^{-1}		mg L^{-1}		NTU		mg L^{-1}	
			Up	Down	Up	Down	Up	Down	Up	Down
MAT	3	07/21/06	117.5	160.7	58.8	80.1	10.3	23.6	11.4	21.5
		08/14/06	141.8	131.5	71.2	65.2	159	40.6	2287	1250
MEY	5	06/02/06	180.8	188.3	91.2	94.9	12.0	10.2	14.8	13.8
		06/05/06	174.6	170.4	87.6	85.4	56.0	61.1	121	270
		06/09/06		162.7		82.2		45.1		110
		07/18/06	431	178.1	214	88.6	111	26.7	227	113
		07/21/06	358	186	180	93.2	74.6	7.79	36.5	19.9
		07/24/06	226	157.2	113	79.3	46.9	19.2	908	407
		08/04/06	120	109.6	60.2	55.7	22.5	17.7	341	318
		08/11/06	124	108.5	32.1	54.7	18.2	8.22	278	138
		09/03/06	817	166.9	404	84.9	56.1	161	981	4139
MEY	6	06/02/06	172	196.6	86.9	98.3	86.4	24.3	509	32.0
		06/05/06	115	121.1	57.4	60.7	44.8	32.3	115	13.9
		06/09/06	125	121.5	62.7	60.7	21.1	18.2	21.4	20.0
		07/11/06	237	229	118	114	16.2	17.9	29.0	35.3
		07/14/06	257	249	128	124	12.7	12.8	24.5	23.8
		07/18/06	122	121.2	60.6	61.2	9.22	9.42	13.7	15.9
		08/04/06	133	130.8	66.4	65.5	19.9	19.3	320	342
		08/11/06	140	140.7	70.5	70.1	16.3	18.5	283	299
TIB	7	05/16/06	241	256	120	128	56.5	159	75.0	203
		07/21/06	818	760	408	380	40.1	40.6	53.0	54.6
		07/24/06	361	326	183	160	39.6	49.8	462	558
		07/28/06	338	328	165	162	35.6	36.6	438	501
		08/04/06	471	465	235	231	81.9	76.8	1131	995
		08/11/06	473	472	239	238	45.9	43.3	815	653
TIB	8	07/21/06	718	631	359	314	47.2	41.2	78.3	48.2
		07/24/06	502	529	254	265	52.3	45.5	655	617
		07/28/06	403	395	195	195	41.1	57.4	616	788
		08/04/06	605	326	302	163	43.0	1.85	995	1305
		08/11/06	511	560	258	276	48.8	48.8	653	880
MAB	9	09/03/06	732	609	361	316	47.5	18.6	1493	324

Rice Experiment Station

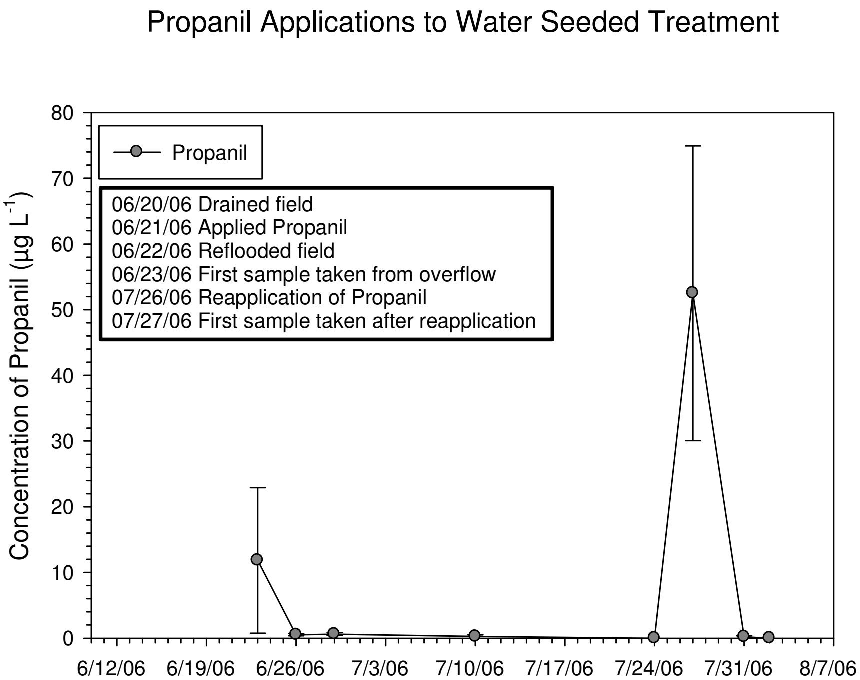

Figure 10. UC Monitoring – Propanil Applications to Water Seeded Treatment

- The second application of propanil was applied to plots when water was in maintenance flow. Error bars are standard error.

Propanil Applications to Drill Seeded Treatment

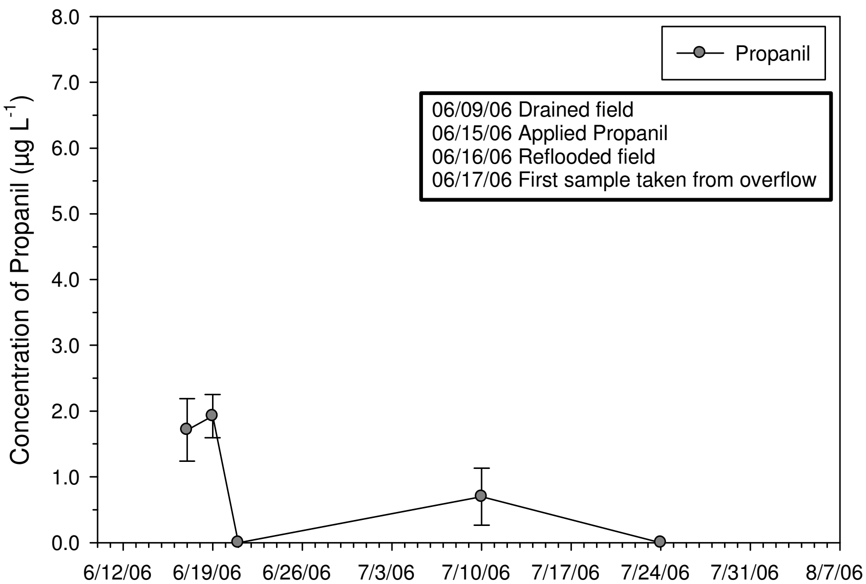

Figure 11. UC Monitoring – Propanil Applications to Drill Seeded Treatment

- The non-zero concentration at 7/10/06 may have been caused by drift from application on adjacent field

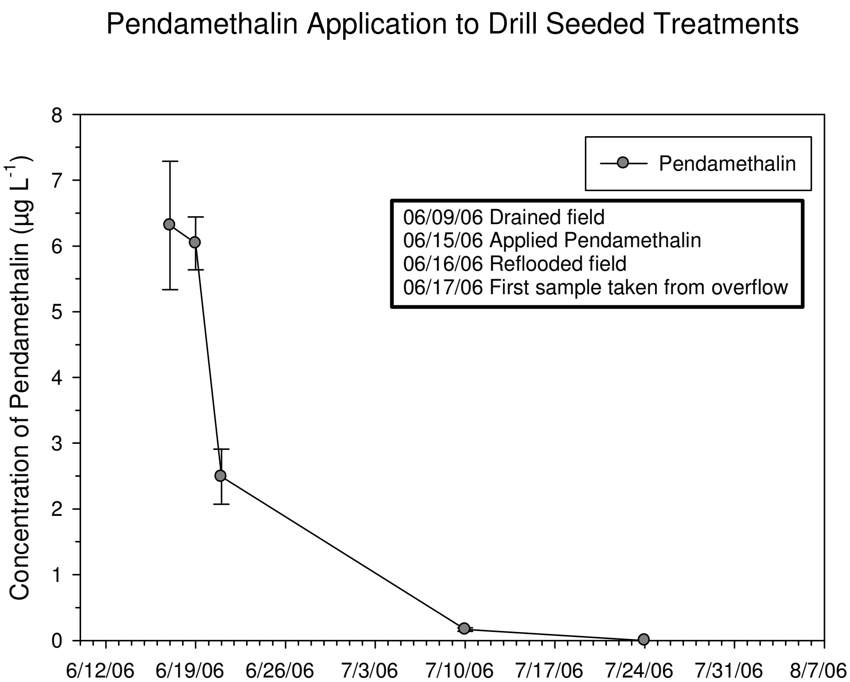

Figure 12. Pendamethalin Application to Drill Seeded Treatments

- Cyhalofop-butyl was not detected in any water collected from Drill Seeded treatments

5.7 Evaluation of Historic Dissolved Oxygen, pH, and Temperature Data

Historic field data are available for the historic rice monitoring stations BS1, CBD1, CBD5, and SS1 (which has now been replaced by SSB in order to provide safe access for field technicians). The following summarizes the results of this statistical analysis.

pH

- 97.5% (627 samples of 643) of the 1995-2005 pH data were in compliance with the pH water quality objective (WQO). The few exceedances that did occur were for pH too low (pH<6.5, 13 samples) as opposed to too high (pH>8.5, 3 samples).
- Most of the exceedances occurred in two years: 1995 (8 exceedances) and 2005 (5 exceedances).
- There was no apparent effect of month on the exceedances or pH generally.
- Most of the exceedances occurred at 2 sites: BS1 (6 exceedances) and Sacramento River 1 (SR1) (8 exceedances). SR1 is a site historically monitored under the RPP and is a river site. In spite of this, there were only small differences in pH generally between different sites.
- The relatively high number of exceedances in 2005 is troubling because there is evidence that median annual pH has been slowly decreasing at SR1 and BS1 for the

last five years, and decreasing for several years at CBD5. There is no obvious explanation for these decreases.

D.O.

- In contrast to pH, D.O. variances from COLD water quality objectives (i.e. D.O.<7 mg/L) occurred frequently (45%, 283 of 642 total samples).
- Exceedances were common in all years, but especially frequent in 1995, 2000, 2003 and 2005. There was no trend in D.O. concentrations over years.
- Although there were significant differences in exceedance frequencies between sites, all sites except SR1 had substantial exceedances in every year (>10 %).
- Sites BS1, CBD1 and SS1 had > 67% exceedances across all years; SR1 and CBD5 exceedance percentages over all years were 21 and 33%, respectively.
- D.O. concentrations were much lower in during the months of June and July in virtually all years.
- D.O. showed a strong inverse correlation with temperature. Higher temperatures were probably a key driving force for low D.O. in June and July.
- Figure 13 shows the relationship between waterbody temperature and oxygen solubility. It is noted that within the range of waterbody temperatures observed in the field that the saturated D.O. levels can be as low as 7.8 mg/L, which is approaching the COLD WQO of 7 mg/L.

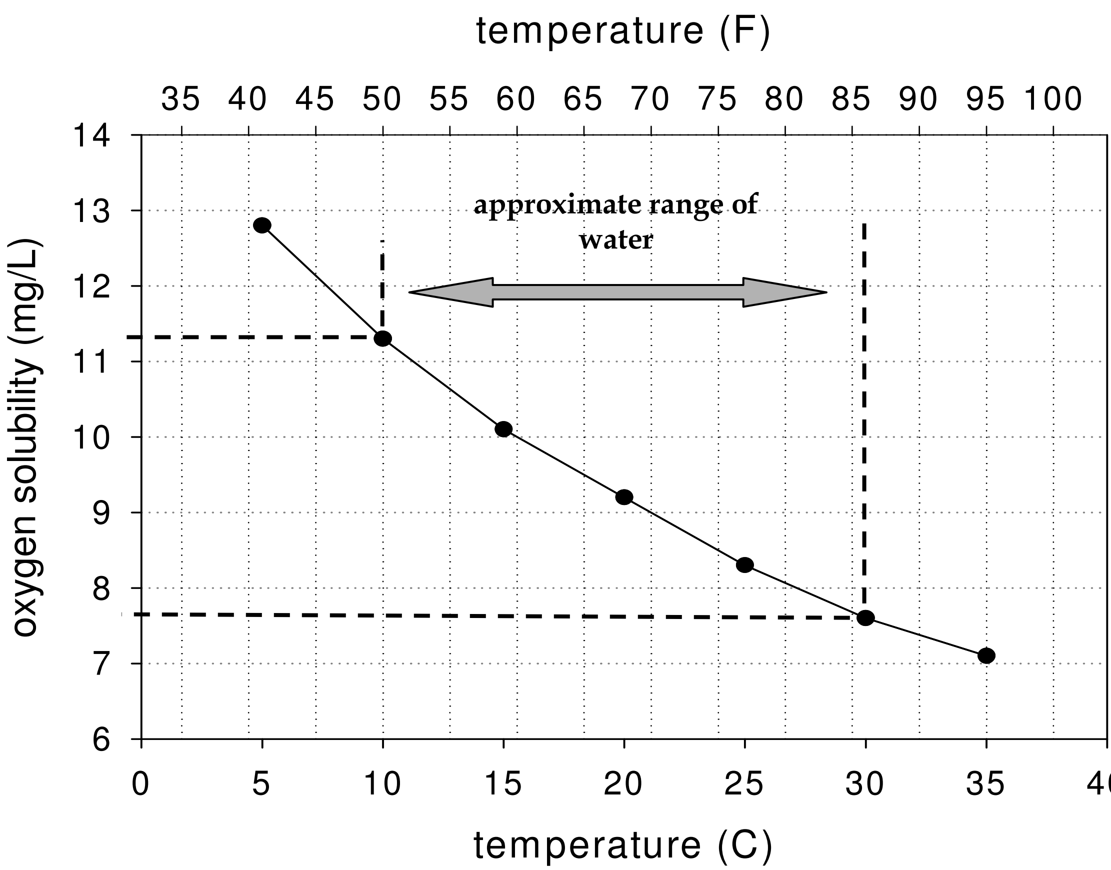

Figure 13. Oxygen solubility as a function of temperature.

As temperature increases, oxygen solubility decreases and approaches the WQO objective of 7 mg/L D.O. This means that biological activity [e.g from microorganisms breaking down detritus, other organic matter) can easily consume enough oxygen to depress D.O. below the WQO, particularly under warmer conditions. Oxygen solubilities on graph are approximate because additional factors influence oxygen solubility such as salinity and humidity. However, estimates should be accurate to within ~ 0.1 - 0.2 mg/L for rice-growing conditions.

6. Summary

6.1 Assessment of the 2006 CWFR Program

This year, 2006, represents the second full year of the CWFR program. During 2006, the CRC invested significant effort and budget to comply with the requirements and intent of the CWFR and its associated MRP. Through this investment, the CRC has been focused on developing the capacity of its technical consultant resources, as well as providing timely reporting to the CVRWQCB when water quality concerns are identified.

The following summarizes the key successes and challenges faced during 2006 program implementation and

Metals

The following summarizes the results of the metals analysis:

- **Arsenic:** One sample, the 14 ug/L concentration measured at LCC, exceeded the drinking water primary MCL of 10 ug/L. No other samples exceed the drinking water MCL. It is noted that pesticides containing arsenic are no longer registered for use, and further, such chemicals have never historically been applied to rice.
- **Boron:** There is no aquatic ecosystem boron limit specified within the CVRWQCB's Water Quality Goals report. The maximum detected concentration of boron was 0.32 ug/L. L.
- **Cadmium:** All samples were non-detect for cadmium.
- **Copper:** Copper water quality results were compared to the hardness-adjusted aquatic ecosystem 1-hour maximum criterion. Compared to this threshold, one sample, taken in March at LCC, exceeded copper criterion. The measured hardness for the sample was 72 mg/L as CaCO3, which resulted in a CTR hardness-adjusted criterion of 10.3. The copper concentration of the sample was 12 ug/L, or 1.7 ug/L greater than the criterion. For the March sample event, stormwater runoff dominated the flows at LCC.
- **Lead:** All sample results for lead were non-detect.
- **Nickel:** Nickel water quality results were compared to the hardness-adjusted aquatic ecosystem 1-hour maximum criterion. All samples were significantly below the hardness-adjusted one-hour maximum criteria.
- **Selenium:** All sample results for selenium were non-detect.
- **Zinc:** All sample were non-detect.

Specified Pesticides

Two pesticides were monitored during Year 2 (2006). These include carfentrazone-ethyl (Shark) and bispyribac-sodium (Regiment). Results for the entire year were non-detect.

Aquatic Toxicity Testing

In accordance with the MRP, acute and chronic toxicity tests were performed on three test species. Tests are performed on samples collected at each station and are performed concurrent with tests on control samples. The three test species are:

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

Where toxicity tests resulted in significant effects and fell below specified triggers, re-sampling and/or Toxicity Identification Evaluations (TIEs) were performed. Re-sampling is performed to monitor the persistence of toxicity, while TIEs are performed in attempt to identify the specific toxicant(s) contributing to toxicity.

Fathead Minnow

- There was no statistically significant observed toxicity to minnows for any of the samples collected during 2006.
- The tests performed on the June samples had a laboratory control failure. Based on the failure of the lab control, the CRC performed re-sampling, the results of which showed no statistically significant toxicity to minnows.

C. daphnia

- There was no statistically significant observed toxicity to C. *daphnia* for the samples collected March through September.
- There was statistically significant toxicity to *C. daphnia* observed in the BS1 sample collected in October, with a survival of 15% as compared to the control. However, due to miscommunication between within the CRC/consultant team, no re-sampling was performed, and no formal TIEs were conducted. This error in communication is being addressed to prevent the failure of the consultant to perform follow-up monitoring and appropriate communication with the CRC and the CVRWQCB.

Selanastrum

- Statistically significant selanastrum toxicity was observed in samples collected in June, July, September and October.
- Re-sampling was triggered in June and July. Re-sampling was triggered at four of the five sites in June. The CRC elected to perform re-sampling for all sites in June. Based on the results of re-sampling, TIEs were triggered at BS1, CBD1, CBD5, and SSB.
- The results of the June TIEs implicated non-polar organic pesticides, but follow-up chemistry did not confirm a specific causative toxicant.

- Re-sampling was triggered for all sites in July and TIEs were initiated for all sites. Again, non-polar organic pesticides were implicated in the toxicity, but follow-up chemistry did not identify the causative agent.
- TIEs were performed on original sample for the September event because sufficient sample volume existed to perform the tests on the original sample. Again, non-polar organic pesticides were implicated in the toxicity, but follow-up chemistry did not identify the causative agent.
- Statistically significant toxicity was observed on samples collected in October. However, due to miscommunication within the CRC/consultant team no re-sampling was performed, and no formal TIEs were conducted. This error in communication is being addressed to prevent the failure of the consultant to perform follow-up monitoring and appropriate communication with the CRC and CVRWQCB.
- Algae toxicity was the focus of a significant amount of effort during the 2006 CWFR program. Throughout the course of the year, approaches were developed in attempt determine the causative toxicant to this test organism. The CRC submitted samples for additional chemistry analysis to determine if the algae toxicity was caused by rice pesticides, and, further, included analysis to screen for herbicides used by other agricultural commodities, counties and water districts for roadside and aquatic weed control (simazine, glyphosate and diuron) purposes. The results of the additional chemistry were non-detect for all herbicides analyzed. This is likely attributed to the apparent short-lived nature of the causative toxicant and the timing of the chemistry with respect to sample collection.
- Revisions to the procedure have been proposed for 2007, which will include chemistry analysis for pesticides at the initiation of toxicity tests, rather than at the conclusion. This revision is hoped to result in an improved ability to identify the algae toxicant.

Sediment Toxicity Testing

Sediment toxicity tests, using the test species *Hyalella azteca,* were performed on samples collected in July and September.

- *Hyalella* toxicity tests performed on samples collected in July showed no statistically significant effects (94% to 97% survival).
- Some samples, collected on 9/19/2006, were broken during shipment to the sediment toxicity testing lab. One of the jars from BS1 and both of the jars from CBD1 broke. There was adequate sediment remaining the intact BS1 jar to conduct the sediment toxicity test. The CRC initiated replacement sampling the day after it was notified of the broken sample jar, and re-sampling was CBD1 on 9/27/2006. The replacement was submitted the to the lab and arrived to the lab intact. All other sample jars arrived at the lab intact. The replacement sampling occurred within the same month as the originally schedule sample event.
- *Hyalella* toxicity tests performed on samples collected in September showed no statistically significant effects (92% to 99% survival).

Assessment of the 2006 CWFR Program

This year, 2006, represents the second full year of the CWFR program. During 2006, the CRC invested significant staff and financial resources to comply with the requirements and intent of the CWFR and its associated MRP. Through this investment, the CRC has been focused on continuing to educate its members about water quality protection, as well as developing the capacity of its technical consultant resources, and providing timely reporting to the CVRWQCB when water quality concerns are identified. The CRC communicated with CVRWQCB on a frequent basis to confirm and clarify the understanding of program requirements.

The following summarizes the key successes and challenges faced during 2006 program implementation:

- Management practices continued to be implemented, including water-holds, education and outreach (newsletters and grower meetings), 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.

- No new management practices were triggered as a result of the 2006 water quality monitoring results.

- Regularly scheduled sampling was conducted as required under the MRP. This sampling included analysis for field parameters (temperature, D.O., pH, electrical conductivity/total dissolved solids, flow), metals (arsenic, boron, cadmium, copper, lead, nickel, selenium and zinc), specified pesticides (carfentrazone-ethyl and bispyribac-sodium), toxicity (fathead minnow, water flea, and green algae).

- Low dissolved oxygen, particularly at BS1 and LCC sites, was consistently measured. Low D.O. was prevalent during the hot summer months. The CRC is implementing D.O. 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 D.O.

- Based on the results of *selanastrum* toxicity tests, re-sampling was triggered in June, July, September and October. Re-sampling was conducted in June, July and September. Re-sampling was not conducted in October, as noted below.

- No fathead minnow toxicity was observed.

- *C. daphnia* toxicity was observed in October (a month in which rice growers do not use pesticides). *C. daphnia* toxicity was not detected in any other month.

- *Selanastrum* toxicity was observed in several months. The CRC implemented re-sampling and TIEs, as required by the MRP; however, this technical process did not result in a definitive determination of the causative agent. Through the TIEs, the laboratories were able to determine that toxicity is caused by a "non-polar organic herbicide with a short half life", though follow-up chemistry analysis for rice herbicides and other suspect herbicides did not provide information to aid in the definitive identification of the toxicant (all results were non-detect). By the end of the season, it was determined that the technical design of the program was such that the ability of the approach to identify a short-lived herbicide could be improved with the additional of herbicide analysis at the initiation of the toxicity tests. Though this will be more costly, the CRC is hopeful that this technical modification of the program will provide an opportunity to identify the specific toxicant. The additional herbicide analysis will include rice herbicides, as well as suspect herbicides that are utilized within the sampling period.

- The identification s*elanastrum* toxicity and of a "non-polar organic herbicide with a short half life" as the causative toxicant is an advance in the scientific understanding of drain water quality.

- Communications reports were submitted on all results.

- The application of the tributary rule to drain sites may not be appropriate, though it is recognize the protection of existing beneficial uses is an important part of water quality protection.

- Early season confusion over the interpretation of the re-sampling triggers and the requirements to perform TIEs resulted in significant consultation with CVRWQCB staff. As a result of consultation, the CRC/consultant team developed improved communication processes to rapidly identify re-sample and/or TIE requirements. The CRC conducted re-sampling and TIEs, as required for all months, except for the month of October, when a communication lapse resulted in a failure to perform a TIE and re-sample.

- Communication lapses within the CRC/consultant team posed some challenges in program implementation. Specifically, communication regarding toxicity results and failed laboratory control during the first half of the season resulted in a decision to change aquatic toxicity laboratories to address concerns over failed laboratory controls. Additionally, in October, a communication lapse resulted in a failure to perform a TIE and resample. Though rice growers do not use pesticides in October, the MRP nonetheless calls for re-sampling based on defined triggers. The CRC is working with its consultant team to develop improved procedures and tools to prevent this type of lapse in the future.

- As part of its TIE efforts, the CRC performed analysis for pesticides that were used on rice as well as other potential toxicants used within the watershed. This exceeds the requirements of the MRP.

- 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.

6.2 Recommendations for 2007

The following recommendations are recommendation for the 2007 CWFR program:

- Chemistry analysis for rice herbicides and other herbicides used within the watershed should be initiated at the initiation of the toxicity tests. This may result in an ability to identify the toxicant contributing to *selanastrum* toxicity. Coordination with the CACs to identify products used during specific months should continue, in order to understand other (non-rice) products that may be contributing.
- At the conclusion of 2007 monitoring, the CWFR program will have three full years of D.O. data. A trend analysis of these data may prove useful in understanding the D.O. conditions within the drains. Additional data analysis of historic data may also help to inform the understanding of D.O.
- The LCC site should be reevaluated for its inclusion in the program. This site showed very low flow conditions throughout the year and may not be an appropriate reference site to characterize rice drainage. Alternative sites should be evaluated.
- Improved coordination within the CRC/consultant team should rely on standard tools that were developed throughout the course of 2006. These tools include tracking matrices and flow charts that will improve the responsiveness of the team to the program requirements. A chartering meeting should be conducted prior to the initiation of the first sampling event to identify lines of communication and program requirements.

7. References

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