Chollas Creek Total Maximum Daily Load
Compliance Monitoring
Investigation Order No. R9-2004-0277

2008–2009 Water Quality Monitoring

Final Report

Prepared for:
San Diego Regional Water Quality Control Board

Prepared by:
City of San Diego
City of La Mesa
City of Lemon Grove
County of San Diego
San Diego Unified Port District
United States Navy
Caltrans

January 5, 2010

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Prepared for:

City of San Diego

Prepared by:

Weston Solutions, Inc.
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Carlsbad, California 92010

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LIST OF ACRONYMS

BMP	best management practice
COC	chain of custody
CCC	criteria continuous concentration
CMC	criteria maximum concentration
CTR	California Toxics Rule
DWM	dry weather monitoring
ICID	illicit connection and illegal discharge
IPM	integrated pest management
NPDES	National Pollutant Discharge Elimination System
PSA	Public Service Announcement
REC-1	contact water recreation (beneficial use)
REC-2	non-contact water recreation (beneficial use)
SOP	standard operating procedure
TIE	toxicity identification evaluation
TKN	total kjeldahl nitrogen
TMDL	total maximum daily load
TSS	total suspended solids
UCCE	University of California Cooperative Extension
WARM	warm freshwater habitat (beneficial use)
WQO	water quality objective
WILD	wildlife habitat (beneficial use)

EXECUTIVE SUMMARY

This report summarizes the activities conducted by the seven Chollas Creek Dischargers in compliance with San Diego Regional Water Quality Control Board (Regional Board) Order No. R9-2004-0277 and the *Total Maximum Daily Loads (TMDLs) for Dissolved Copper, Lead and Zinc in Chollas Creek, Tributary to San Diego Bay* during the 2008–2009 Monitoring Season. The following activities were conducted:

- Public outreach and education.
- Water quality monitoring, including wet weather monitoring for Diazinon, total and dissolved copper, lead, and zinc, hardness, and toxicity to *Ceriodaphnia dubia* at SD8(1) in the north fork of Chollas Creek and at DPR2 in the south fork of Chollas Creek.
- Water quality monitoring at SD8(1) and DPR2 for additional analytes not required under Order No. R9-2004-0277 (e.g., indicator bacteria, synthetic pyrethroids, and toxicity to *Hyalella azteca*)

<u>Summary of Wet Weather Monitoring</u>

Storm water monitoring samples were collected at the two mass loading stations, SD8(1) and DPR2, in the Chollas Creek Watershed during three separate storm water events (October 4, 2008, November 4, 2008, and February 5, 2009). During the 2008–2009 Monitoring Season four analytes named in Order No. R9-2004-0277 exceeded water quality objectives (WQOs): dissolved copper, dissolved lead, dissolved zinc and toxicity to *C. dubia.* The dissolved copper acute criteria WQO (criteria maximum concentration, or CMC) was exceeded three times at SD8(1) and twice at DPR2. The dissolved copper chronic criteria WQO (criteria continuous concentration, or CCC) was exceeded at both sites for all three storm events. There were two CCC exceedances for dissolved lead at SD8(1). The CMC and CCC for dissolved zinc was exceeded at at SD8(1) for all three storm events. There were no exceedances of dissolved lead or dissolved zinc (CMC or CCC) at DPR2. One instance of toxicity to *C. dubia* was observed at SD8(1). There were no exceedances for Diazinon during the 2008–2009 Monitoring Season.

Additional analytes with wet weather WQO exceedances included total suspended solids (TSS), Malathion (both sites, second storm only), oil and grease (first and third storm at SD8(1)), and fecal coliform. TSS concentrations were above the 100 mg/L WQO for all three storm events monitored at SD8(1). Fecal coliform concentrations were highest during the second storm event and WQO exceedances were noted at both sites for all three storm events. In general, synthetic pyrethroids were detected at greater concentrations in the north fork (SD8(1)) than in the south fork (DPR2). Bifenthrin concentrations were above the published LC_{50}s for *H. azteca* at both sites during all three storms. Permethrin exceeded the benchmark during all three storms at SD8(1) only. Toxicity to *H. azteca* was observed at SD8(1) for all three storm events and for the first two storm events at DPR2.

In Chollas Creek, synthetic pyrethroid (Bifenthrin and Permethrin) concentrations and toxicity to *H. azteca* are trending upwards while Diazinon concentrations are decreasing. Mann-Kendall trend analysis performed on the long-term data collected from SD8(1) indicated significantly increasing trends for copper and zinc (total and dissolved phases). At DPR2, TSS concentrations have significantly decreased over the last five years of monitoring.

Conclusions

Dissolved copper and dissolved zinc concentrations at SD8(1) and DPR2 exceeded the concentration-based waste load allocations of the Chollas Creek Dissolved Metals Total Maximum Daily Load. Dissolved lead concentrations exceeded the waste load allocations for the long-term chronic condition at SD8(1) for the first two storm events, but was in compliance for the short-term acute condition. Chronic reproductive toxicity to *C. dubia* was observed at SD8(1) during the third storm event. In general, metals concentrations were similar, with the highest concentration occurring during the October 2008 first flush event.

Steps Forward

The Chollas Creek TMDL Implementation Plan (Implementation Plan) (WESTON, 2009a) was specifically prepared in response to Resolution No. R9-2007-0043 in which the Regional Board incorporated the TMDLs for dissolved copper, lead, and zinc into the Basin Plan. The Implementation Plan uses an iterative and adaptive management strategy for identifying, planning, implementing, and assessing best management practices (BMPs) for the Chollas Creek Watershed over the 20-year compliance schedule. The Implementation Plan was submitted to the Regional Board on October 21, 2009. The seven named TMDL Dischargers, which include the five Chollas Creek Watershed Municipal Copermittees, the US Navy, and Caltrans, will use the Implementation Plan as a framework for the next steps forward, including compliance monitoring and participating in four voluntary special studies during the 2009–2010 Monitoring Season.

1.0 INTRODUCTION

The San Diego Regional Water Quality Control Board (Regional Board) Order No. R9-2004-0277 defines the monitoring and reporting requirements for Diazinon and metals (copper, lead, and zinc) in the Chollas Creek Watershed. Order No. R9-2004-0277 was issued to assess water quality for metal Total Maximum Daily Loads (TMDLs). The purpose of this report is to present the activities conducted as part of the annual monitoring and reporting requirements.[1] Studies conducted in the Chollas Creek Watershed during the 2008–2009 Monitoring Season include the following:

- Public outreach and education.
- Water quality monitoring in accordance with the requirements of Order No. R9-2004-0277. This includes wet weather monitoring for Diazinon, total and dissolved metals (copper, lead, and zinc), hardness, and toxicity to *Ceriodaphnia dubia* at SD8(1) in the north fork of Chollas Creek and at DPR2 in the south fork of Chollas Creek.
- Water quality monitoring at SD8(1) and DPR2 for additional analytes not required under Order No. R9-2004-0277 (e.g., indicator bacteria, synthetic pyrethroids, toxicity to *Hyalella azteca*, nutrients, etc.)

The Chollas Creek Watershed encompasses 18,249 acres consisting predominately of urbanized land located within San Diego County. The Chollas Creek Watershed is located southeast of downtown San Diego, in the San Diego Mesa Hydrologic Area, and within the larger Pueblo San Diego Hydrologic Unit. Though much of the creek has been channelized (a mix of highly developed earthen channels and concrete channels), there have been efforts to restore natural flow in the watershed. The creek is somewhat ephemeral in nature, flowing primarily during the wet season.

Chollas Creek consists of two main tributaries, the north fork and the south fork. The drainage area to the northern fork of the watershed (8,794 acres) is larger than that to the southern fork (7,575 acres). The headwaters of the north fork originate approximately 1.5 miles west of the jurisdictional boundary of the City of La Mesa. From this point, the north fork flows in a southwesterly direction for approximately 3 miles before it is joined by several smaller tributaries which feed into the main stem of the creek. The creek then flows in a southerly direction for approximately 1.5 miles before discharging into San Diego Bay. The south fork of Chollas Creek flows in a west, southwesterly direction from its headwaters in the City of Lemon Grove and is the product of two smaller creek branches. The north fork and south fork merge approximately 0.8 miles east of the creek's mouth, near the upper extent of the tidal influence from San Diego Bay. An aerial representation of the Chollas Creek Watershed is shown on Figure 1-1.

The Chollas Creek Watershed is highly urbanized. Land use in the Chollas Creek Watershed is predominantly residential (48%), roads (22%) and freeways and highways (5%), as shown on

[1] Progress reports for the watershed activities listed in the Chollas Creek Dissolved Metals TMDL Implementation Plan are provided as appendices to Discharger's annual storm water reports, including the San Diego Bay WURMP Annual Report and the Caltrans Stormwater Management Program Annual Report.

Figure 1-2. The remaining watershed land uses consist of commercial and industrial facilities and landfills (7%), open space (7%), schools (3.5%), cemeteries (1.5%), and other miscellaneous land uses.

The California Department of Transportation (Caltrans) is responsible for the California State Highway System, which possesses its own Municipal Separate Storm Sewer System (MS4) Permit (Order No. 99-06-DWQ) (Regional Board, 2005). The United States Navy is responsible for NAVFAC Southwest and possesses its own National Pollutant Discharge Elimination System (NPDES) Permit (Order No. R9-2002-0169). Portions of the cities of San Diego, Lemon Grove, and La Mesa are also located within the watershed. The Unified Port of San Diego, the United States Navy, and the County of San Diego each hold jurisdiction over approximately 1% of the Chollas Creek Watershed. A small portion of the watershed consists of tidelands immediately adjacent to San Diego Bay. Some of this tideland area is under the jurisdiction of the Port, and the remainder falls under the jurisdiction of the Navy.

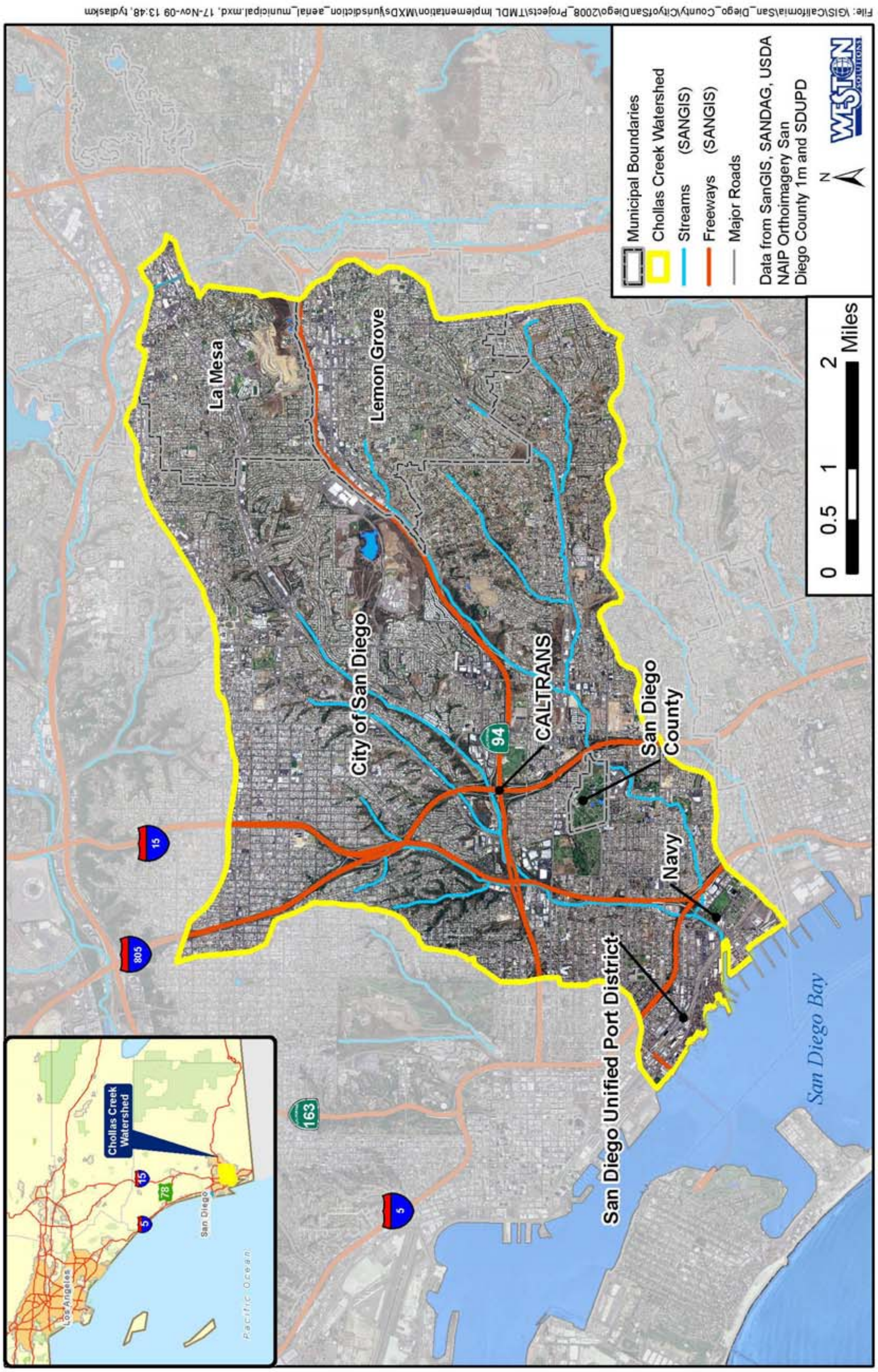


Figure 1-1. Aerial View of the Chollas Creek Watershed

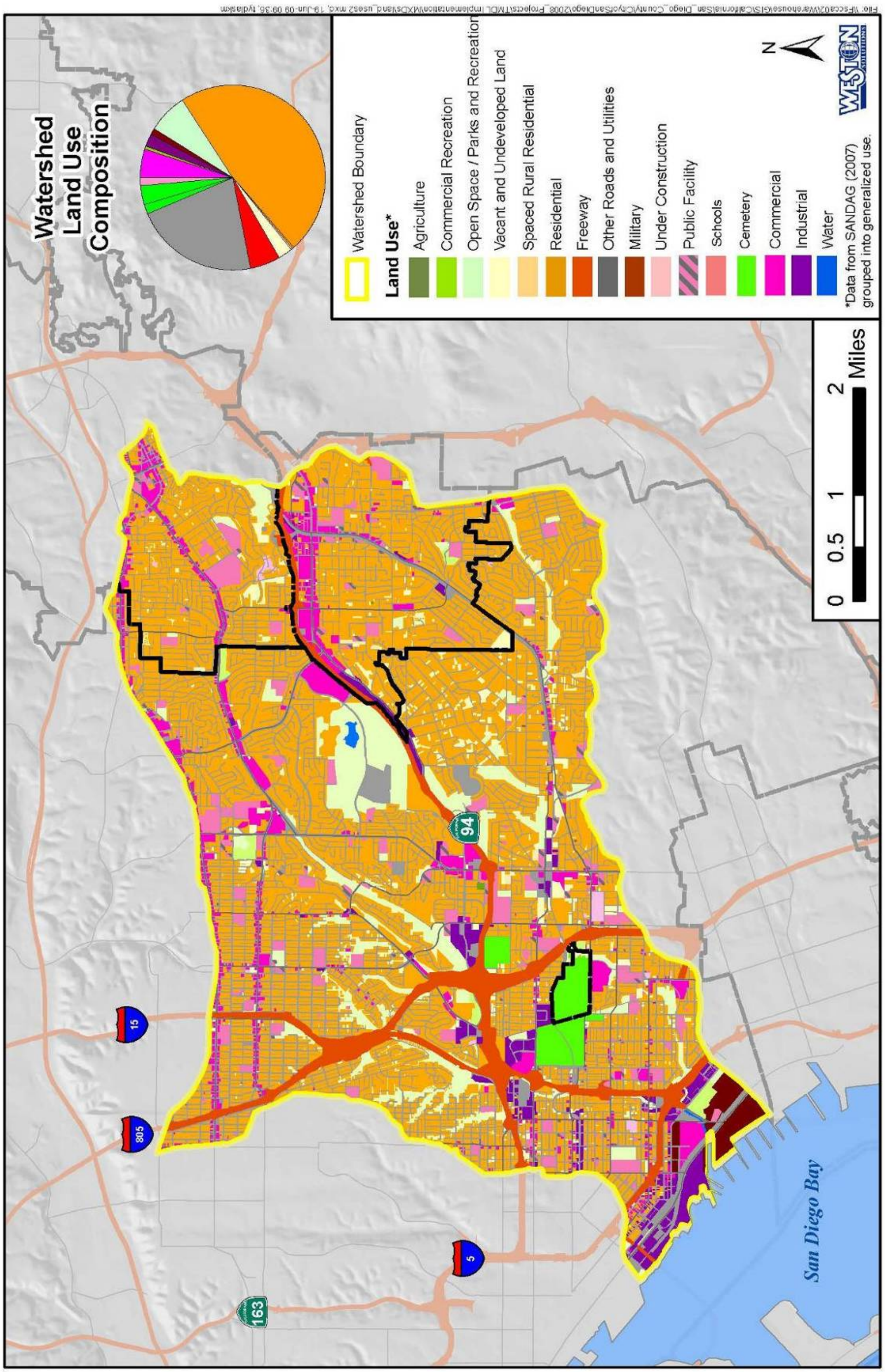


Figure 1-2. Land Uses within the Chollas Creek Watershed

1.1 State Water Resources Control Board Section 303(d) Listings and Total Maximum Daily Load Overview

The Water Quality Control Plan for the San Diego Region (Basin Plan) lists the inland surface water beneficial uses of Chollas Creek as non-contact water recreation (REC-2), warm freshwater habitat (WARM), and wildlife habitat (WILD). The Chollas Creek Watershed also has the potential to support a contact water recreation (REC-1) beneficial use. The 2006 Clean Water Act (CWA) State Water Resources Control (State Board) Board Section 303(d) List identifies dissolved copper, dissolved lead, dissolved zinc, and indicator bacteria as pollutants which impair Chollas Creek. Diazinon appeared on the State Board Section 303(d) list in 1999, but was removed in 2006 after the Diazinon TMDL was developed. Table 1-1 summarizes the State Board Section 303(d) listings and beneficial uses for Chollas Creek above the tidal prism (corresponding to the two branches of the creek).

Table 1-1. Beneficial Uses and State Water Resources Control Board Section 303(d) Listings in the Chollas Creek Watershed

<table>
<tr><th>Beneficial Uses
(Chollas Creek Watershed, tributary to San Diego Bay)</th><th>Chollas Creek
(3.5 miles)</th><th>Creek State Board Section 303(d) Pollutant</th><th>San Diego Bay</th><th>San Diego Bay State Board Section 303(d) Stressor</th></tr>
<tr><td>Contact water recreation (REC-1)</td><td>o</td><td rowspan="13">Dissolved copper[1]
Dissolved lead[1]
Dissolved zinc[1]
Indicator bacteria
Diazinon[2]</td><td>•</td><td rowspan="13">Sediment toxicity
Benthic community effects</td></tr>
<tr><td>Non-contact water recreation (REC-2)</td><td>•</td><td>•</td></tr>
<tr><td>Warm freshwater habitat (WARM)</td><td>•</td><td>–</td></tr>
<tr><td>Wildlife habitat (WILD)</td><td>•</td><td>•</td></tr>
<tr><td>Rare, threatened, or endangered species</td><td>–</td><td>•</td></tr>
<tr><td>Marine habitat</td><td>–</td><td>•</td></tr>
<tr><td>Migration of aquatic organisms</td><td>–</td><td>•</td></tr>
<tr><td>Preservation of biological habitats of special significance</td><td>–</td><td>•</td></tr>
<tr><td>Estuarine habitat</td><td>–</td><td>•</td></tr>
<tr><td>Shellfish harvesting</td><td>–</td><td>•</td></tr>
<tr><td>Industrial service supply</td><td>–</td><td>•</td></tr>
<tr><td>Commercial and sport fishing</td><td>–</td><td>•</td></tr>
<tr><td>Navigation</td><td>–</td><td>•</td></tr>
</table>

• Existing beneficial use o Potential beneficial use – Not applicable

1. These pollutants are on the 2006 State Board Section 303(d) list of Water Quality Limited Segments for the San Diego Bay. In 1996, Chollas Creek was also listed for cadmium, but this pollutant was delisted in 2006.
2. Diazinon was added to the State Board Section 303(d) list in 1996. The Diazinon TMDL was developed in 2002 to address the contribution of this organophosphate pesticide to storm water toxicity.

Federal law requires the Regional Board to develop TMDLs for waters on the State Board Section 303(d) list. The purpose of a TMDL is to attain applicable water quality objectives and to restore the beneficial uses of impaired waters. The pesticide Diazinon historically exceeded water quality standards in most of San Diego County's watersheds, including Chollas Creek. In 2002, the Regional Board adopted the *Chollas Creek TMDL for Diazinon* (Diazinon TMDL) (Resolution No. R9-2002-0123). Diazinon was also phased out of manufacturing and no longer available for retail sale as of December 2004. Water quality results to date indicate the TMDL and ban have been effective. Diazinon concentrations are trending downward and are no longer frequently detected.

Metals have frequently exceeded the California Toxics Rule (CTR) criteria. The Regional Board issued Order No. R9-2004-0277 to provide additional metals data for the Chollas Creek Watershed. The *TMDL for Dissolved Copper, Lead and Zinc in Chollas Creek, Tributary to San Diego Bay* (Chollas Creek Dissolved Metals TMDL) was adopted by the Regional Board in 2007 (Resolution No. R9-2007-0043) and was approved by the Office of Administrative Law on October 22, 2008.

1.2 Dissolved Metals Total Maximum Daily Load Implementation Plan and Annual Report

The Chollas Creek Dissolved Metals TMDL Implementation Plan (Implementation Plan) (WESTON, 2009a) was specifically prepared in response to Resolution No. R9-2007-0043 in which the Regional Board incorporated the TMDLs for dissolved copper, lead, and zinc into the Basin Plan. The Implementation Plan represents the Discharger's (Table 1-2) strategy for conducting watershed activities within Chollas Creek Watershed to meet TMDL WLA targets. The Implementation Plan uses an iterative, adaptive management strategy for identifying, planning, implementing, and assessing BMPs over the 20-year compliance schedule. The Implementation Plan (available on the City of San Diego's Think Blue website) was submitted to the Regional Board on October 21, 2009.

Table 1-2. Dischargers Named in the Chollas Creek Dissolved Metals Total Maximum Daily Load

TMDL	San Diego Region Municipal Storm Water Copermittees	Dischargers
Chollas Creek Dissolved Metals TMDL	City of San Diego City of La Mesa City of Lemon Grove County of San Diego Unified Port District of San Diego	Caltrans City of San Diego City of La Mesa City of Lemon Grove County of San Diego Unified Port District of San Diego United States Navy

1.3 Legal Authority

As indicated in Table 1-2, five of the seven Dischargers are also San Diego Region Municipal Storm Water Copermittees. Order No. R9-2004-0277 (item 2-a) requires reports of information on how Copermittees implemented their legal authority to remedy the condition of pollution. Copermittees accomplish this primarily through the current Dry Weather Monitoring (DWM) Program and facility inspections conducted under NPDES Order No. R9-2007-0001 (Regional Board, 2007a). DWM is conducted throughout Chollas Creek to identify and eliminate illicit connections and illegal discharges (ICIDs). As part of the DWM Program, Diazinon and metals are monitored, and any illicit discharge of Diazinon or metals is eliminated through this program by the issuing of violations and/or citations. Each Copermittee/Discharger in the Chollas Creek Watershed has ordinances in place to enforce the illegal and unauthorized discharge of waste into their storm drain systems. For more information on enforcement mechanisms, please refer to the Copermittees'/Dischargers' individual Jurisdiction Urban Runoff Management Plans (JURMPs).

2.0 EDUCATION AND OUTREACH PROGRAMS

2.1 Diazinon Toxicity Control Plan

Order No. R9-2004-0277 (item 2-c) requires reports of information on the implementation and efficacy of a Diazinon Toxicity Control Plan. Per Investigation Order No. R9-2004-0277, the pesticide component of the education program can serve as the Diazinon Toxicity Control Plan required by the TMDL.

2.2 Diazinon Public Outreach/Education Program

Order No. R9-2004-0277 (item 2-c) requires reports of information on the implementation and efficacy of a Diazinon Public Outreach/Education Program.

The outreach program was implemented as a joint effort by the Chollas Creek Watershed Copermittees. It was previously funded by a State Board Proposition 13 Grant and used a network of staff from the County of San Diego, the University of California Cooperative Extension (UCCE), and the City of San Diego to publicize less harmful ways to kill pests. All of the Copermittees were project partners, and the Outreach Workgroup served as the Technical Advisory Committee to the program's goals and objectives.

The City of San Diego participated in 11 events during 2008–2009 and distributed Integrated Pest Management (IPM) cards (Appendix A) to educate Chollas Creek Watershed residents and other members of the public in San Diego County regarding the use of IPM solutions to reduce pesticide concentrations found in San Diego County waterways. IPM uses environmentally sound ways to keep pests under control without harming people, pets, or the environment. These materials were designed to encourage positive behavior changes and attitudes of San Diego residents when dealing with pesticides in their homes and gardens.

Events in which Copermittees have participated during Fiscal Year (FY) 2008–2009 are detailed in Table 2-1.

Table 2-1. Community Events (Fiscal Year 2008–2009)

Date	Copermittee	Event Type	Event Title	Audience	Estimated Audience No.	Site Name/Location	Materials Distributed
08/31/08	City of San Diego	Education/outreach	Chihuahua National Race	Pet owners	40,000	Petco Park, San Diego	Think Blue Tips Brochure, 3Cs Card, Laminated Tip Card, IPM Pest Tip Cards, Best Management Practice Giveaways
09/02/08–09/27/08	City of San Diego	Education/outreach	San Diego Film Festival	General public / Business owners	18,000	Gaslamp Quarter, San Diego	Think Blue Tips Brochure, Laminated Tip Cards, IPM Pest Tip Cards, Best Management Practice Giveaways
12/29/08–01/03/09	City of San Diego	Education/outreach	San Diego Auto Show	Auto enthusiasts – male skewed	100,000	San Diego Convention Center	Laminated Tip Cards, IPM Pest Tip Cards, Best Management Practices Giveaways
02/28/09	City of San Diego	Community festival	Heritage Day Festival and Parade	General public	10,000	Market Creek Plaza	Think Blue Tips Brochure, Laminated Tip Cards, IPM Pest Tip Cards, 3Cs Card, Car Washing Fact Sheet, Best Management Practices Giveaways
03/18/09	City of San Diego	Public awareness/ Education	Cesar Chavez Day	General public	1,000	Cesar Chavez Elementary School	Think Blue Tips Brochure, Laminated Tip Cards, 3Cs Card, IPM Pest Tip Card, Car Washing Fact Sheet, Kids Worksheet, Best Management Practices Giveaways
03/20/09	City of San Diego	Public awareness/ Education	Cesar Chavez Day	General public	5,000	Logan Avenue	Think Blue Tips Brochure, Laminated Tip Cards, 3Cs Card, IPM Pest Tip Card, Car Washing Fact Sheet, Best Management Practices Giveaways
04/06/09	City of San Diego	Children's science fair	Science Festival	School-aged children	100,000	Balboa Park	Think Blue Tips Brochure, Laminated Tip Cards, IPM Pest Tip Card, Kids Worksheets, Best Management Practices Giveaways
04/04/09	City of San Diego	Public awareness	Chollas Creek Walk the Watershed	General public	100	Chollas Creek Watershed	Think Blue Tips Brochure, Laminated Tip Cards, 3Cs Card, IPM Pest Tip Cards, Best Management Practices Giveaways
04/19/09	City of San Diego	Environmental fair	Earth Fair 2009	General public	80,000	Balboa Park	Think Blue Tips Brochure, Laminated Tip Cards, 3Cs Card, IPM Pest Tip Cards, Best Management Practices Giveaways
04/23/09	City of San Diego	Tree planting event	Arbor Day 2009	General public	250	Balboa Park	Think Blue Tips Brochure, Laminated Tip Cards, 3Cs Card, IPM Pest Tip Cards, Best Management Practices Giveaways
04/25/09	City of San Diego	Public awareness/ Clean up	Creek to Bay Clean Up	General public	4,090	Chollas Creek	Think Blue Tips Brochure, Laminated Tip Cards, 3Cs Card, IPM Pest Tip Cards, Best Management Practices Giveaways

2.3 Public Outreach Plan

This report includes a description of outreach and education strategies for the Chollas Creek Watershed component of the IPM program led by the City of San Diego Storm Water Pollution Prevention Program.

2.3.1 Project Outreach and Education Strategy

Strategic Objectives

Based on the research and general principles of behavioral change through public outreach programs, the outreach and education strategy sought to continue to meet the following objectives:

- Raise awareness among target audiences of the benefits of using IPM practices.
- Provide tools and information that make it easy for target audiences to use IPM.
- Identify third-party spokespeople in the community to help spread information regarding IPM and reinforce IPM use.

Audiences

Priority audiences for the project's outreach and education strategy included the following members of the Chollas Creek Watershed:

- Residents who use pesticides.
- Community organizations that influence local residents, including ecumenical groups, ethnic organizations, and neighborhood groups.
- Property managers.

Since partnerships with retail outlets and gardeners are being handled by the County of San Diego, these audiences are not included in the strategy. However, the broad-based regional outreach by the County of San Diego and UCCE should continue to provide valuable messages to San Diego County residents.

Messages

The following messages were stressed in outreach efforts:

- Chollas Creek is polluted from overuse of pesticides.
- Safe alternatives to pesticides are better for your family and the environment, today and for future generations.
- Using natural methods is easy and inexpensive.

Tools and Tactics

The City of San Diego continued to use the following tools and tactics to achieve the strategic objectives.

Informational Materials

Reproduced educational and informational materials specific to Chollas Creek Watershed outreach were used, based upon the UCCE statewide IPM model. The pest tip cards were the primary outreach materials. Residents found the cards and the information they provided useful. The City of San Diego received numerous requests to provide additional cards to community groups who, in turn, facilitated distribution to residents. The City of San Diego will incorporate IPM messaging where appropriate as part of its planned outreach for the pending metals TMDL as well as a pilot study to reduce trash in the Chollas Creek area.

Media

For the Hispanic community in the Chollas Creek Watershed, a special effort was made to get information to Spanish radio and television media, including:

- KLNV (106.5 FM).
- KLQV (102.9 FM).
- XEWT-TV (Hispanic).

Public Service Announcement Development

The City of San Diego placed advertising on local television and radio outlets. The City of San Diego designed the ad, "Ants in Your Plants" (funded by the San Diego Regional Storm Water Copermittees) and features IPM tips and suggestions the public should implement to control ants. The “Ants in Your Plants” PSA was placed on the television and radio stations:

Television Stations

- KFMB.
- KGTV.
- KNSD.
- KSWB.
- KUSI.
- XEWT-TV (Hispanic).

Radio Stations

- KIFM (Jazz 98.1).
- KLNV.
- KLQV.
- KMYI (Star 94.1).
- KPRI.
- KSON.
- KYXY.

Outdoor Media

Table 2-2 details the City of San Diego’s radio and television media buy for FY 2009. The highlighted column represents the number of PSAs that aired and were related to IPM.

Table 2-2. Think Blue Fiscal Year 2008 Media Buy Year End Summary

Television Stations	IPM PSA	Radio Stations	IPM PSA
KFMB	85	KIFM (Jazz 98.1)	202
KGTV	19	KLNV	18
KNSD	68	KLQV	61
KSWB	53	KMYI (Star 94.1)	149
KUSI	42	KPRI	39
XEWT-TV (Hispanic)	123	KSON	143
-	-	KYXY	65
TOTAL	**390**	**TOTAL**	**677**

Think Blue Website

The City of San Diego posted IPM outreach materials developed for the project on the Think Blue web site on an ongoing basis to provide City of San Diego residents easy access to these materials. Web materials included a fact sheet on how to hire a pest control service and electronic versions of all of the tip cards. In FY 2009, the IPM pest card information page received 1,090 visits.

3.0 COMPLIANCE MONITORING

Order No. R9-2004-0277 requires water quality monitoring at SD8(1) and DPR2. Compliance with the Chollas Creek Dissolved Metals TMDL and the Diazinon TMDL is determined by water quality at these two locations.

3.1 Monitoring Location Drainage Areas

The Chollas Creek Watershed is divided into two drainage areas separated by the northern and southern forks of Chollas Creek. SD8(1) is the mass loading station located at the base of the north fork and drains a total of approximately 8,794 acres. DPR2 is the mass loading station located at the base of the south fork of Chollas Creek and drains approximately 7,575 acres. The drainage areas captured from each site are presented in Table 3-1 and on Figure 3-1.

Table 3-1. Drainage Area Estimates

Portion of Chollas Creek	Monitoring Locations	Drainage Area (acres)	Percentage of Watershed
North fork	SD8(1)	8,794	48%
South fork	DPR2	7,575	42%

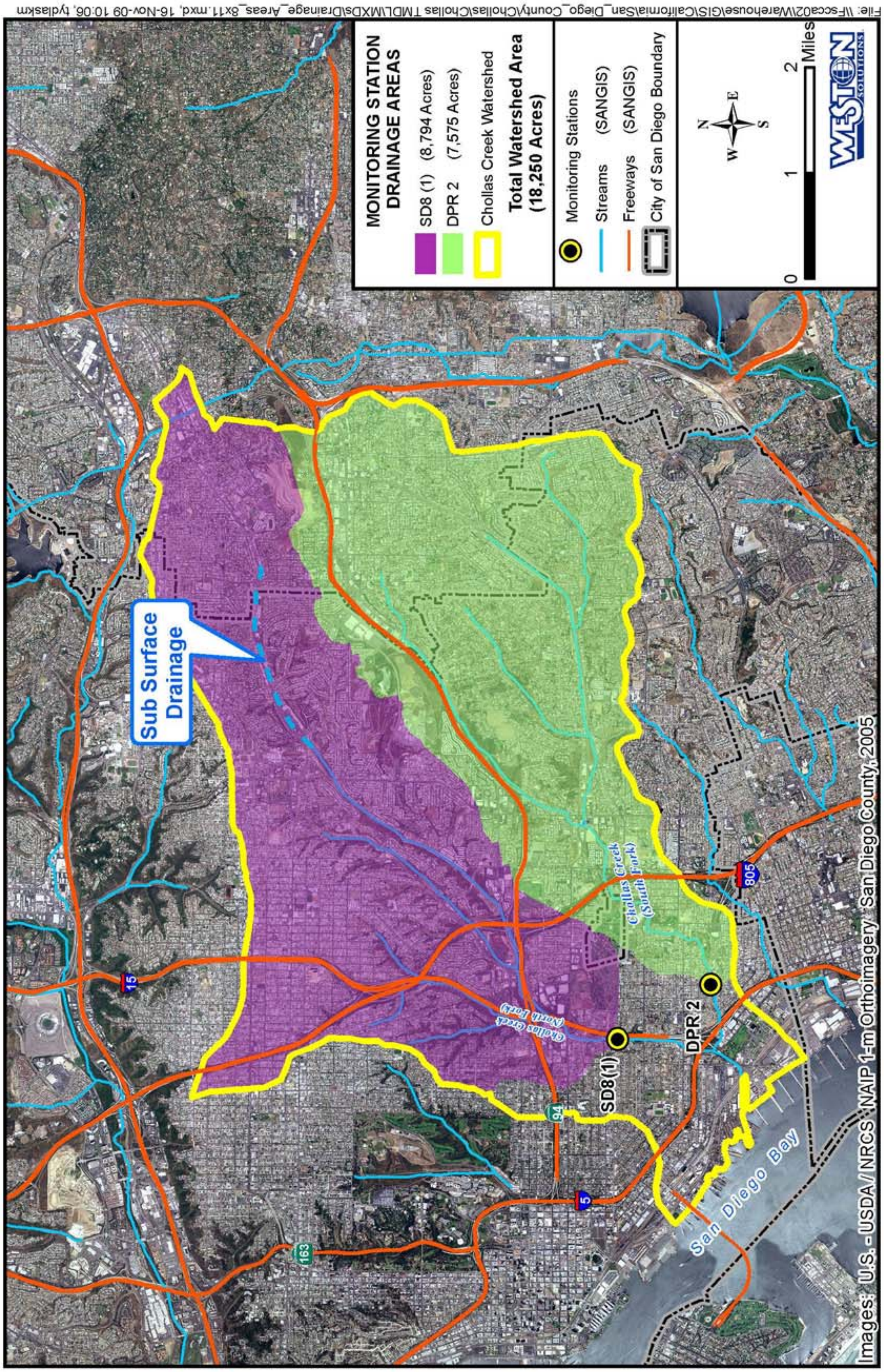


Figure 3-1. Chollas Creek Mass Loading Stations, SD8(1) and DPR2

3.2 Sampling and Analytical Methods

3.2.1 Sampling Methods and Storm Water Quality Monitoring

Storm water runoff was collected using flow-weighted composite techniques over the duration of each storm event. Sample collection was targeted for termination when the storm flow returned to within approximately 10% of the base flow condition, indicating the end of the precipitation event and the cessation of storm water flow. However, the variable nature of storm water monitoring may have resulted in slight protocol deviations where noted.

Automated flow and sampling equipment were installed at each site to collect flow-weighted composite samples during storm events. American Sigma flowmeters with pressure transducers or bubblers were used to measure velocity and stage height. The flow sensors were installed on the channel bottom in the center of the channel. In the event that a flow sensor was rendered inoperable, meter tapes were used to measure stage height and slope of the main channel to determine velocity of the flow. Instream equipment damage during storm events is common at SD8(1) due to high velocity debris. Of particular concern during the 2008–2009 Monitoring Season was the accumulation of approximately 1-ft thick of sediment at SD8(1) where the sampler intake and pressure transducer were located in the channel bottom.

Using the data collected by the flowmeters, sample intervals were set to collect approximately 40 L of water throughout the storm event. The sample intake point was located adjacent to the flowmeter, on the channel bottom in the center of the channel. American Sigma automated samplers were used to collect 1-L sample grabs at a flow dependent rate. The 1-L grab samples were composited into 20-L borosilicate glass sample bottles.

The automated sampler collects grab samples via a peristaltic pumping mechanism. Water samples are pumped through a Teflon intake device and Teflon tubing into a 20-L borosilicate glass sample bottle. Bottles were kept on ice during the storm event. Field crews maintained and replaced the sampling bottles as they filled to capacity. Multiple bottles are composited at Weston Solutions, Inc.'s (WESTON's®) facility and subsampled for delivery to the laboratory for chemistry and bioassay toxicity analyses.

A field data log was completed at each site (Appendix B). The field data log includes empirical observations of the site and water quality characteristics. Observations include parameters such as meteorological conditions at time of sampling and odor, color, and general turbidity of the runoff. Changes in the condition of vegetation as well as any observed erosion along the channel's side slopes were also noted on field data logs.

3.2.1.1 Compliance Monitoring

Flow-weighted composite samples were collected and analyzed for the constituents listed on Table 3-2, in accordance with Order No. R9-2004-0277. Bioassay water samples were collected for use in acute and chronic toxicity tests using *C. dubia*. Grab samples were collected for the field parameters, pH, temperature, and conductivity, which are not conducive to automated composite sampling. Grab samples were collected from the horizontal and vertical center of the channel, where possible.

Table 3-2. Water Quality Analytical Parameters for Field Parameters and Analytes Required Under Order No. R9-2004-0277

Analytical Parameter	Analytical Method	Sample Volume	Container Type	Preservation (chemical/temperature /light-protected)	Maximum Holding Time: Preparation/ Analysis
pH	N/A	N/A	Analyzed in field	N/A	N/A
Temperature	N/A	N/A	Analyzed in field	N/A	N/A
Conductivity	N/A	N/A	Analyzed in field	N/A	N/A
Total hardness	SM 2340-B	100 mL	Plastic	HNO_3	Six months
Total/dissolved copper	USEPA 200.8	1 L	Plastic	Store cool at <4ºC *	Six months
Total/dissolved lead	USEPA 200.8	1 L	Plastic	Store cool at <4ºC *	Six months
Total/dissolved zinc	USEPA 200.8	1 L	Plastic	Store cool at <4ºC *	Six months
Acute toxicity *C. dubia*	USEPA 821-R-02-012	10 L	10 L glass	Store cool at <6ºC	36 hours
Chronic toxicity *C. dubia*	USEPA 821-R-02-013	20 L	20 L glass	Store cool at <6ºC	36 hours
Diazinon (Organophosphorus pesticide)	USEPA 625	2 L	Amber glass	Store cool at <4ºC	Extraction – seven days; Analysis – 40 days

N/A = not applicable
* Dissolved metals are filtered with a 0.45 µm filter.

3.2.1.2 Additional Analytes

The flow-weighted composite samples were also analyzed for the additional analytes listed in Table 3-3. Synthetic pyrethroids and bioassay testing of *H. azteca* were added to the suite of tests being performed in this study as a response to shifts in pesticide use and shifts in toxicity results observed during regional monitoring conducted at SD8(1). Nutrients were included in this study for historical continuity, based on past monitoring and reporting requirements of the Chollas Creek Quality Protection and Habitat Enhancement Grant No. 04-015-559-0.

Grab samples were collected for indicator bacteria (Table 3-3). The holding time for indicator bacteria makes them not conducive to automated composite sampling. Grab samples were collected from the horizontal and vertical center of the channel, where possible.

Table 3-3. Water Quality Analytical Parameters for Additional Analytes

Analytical Parameter	Analytical Method	Sample Volume	Container Type	Preservation (chemical/temperature/ light-protected)	Maximum Holding Time: Preparation/ Analysis
Total Coliforms	SM 9221 B, E	100 mL	Plastic	Store cool at <4ºC	Six hours
Fecal Coliforms	SM 9221 B, E	100 mL	Plastic	Store cool at <4ºC	Six hours
Enterococci	SM 9320	100 mL	Plastic	Store cool at <4ºC	Six hours
Total Suspended Solids	SM 2540D	1 L	Plastic	Store Cool at <4ºC	Seven days
Nitrate	SM 4500-NO3	100 mL	Plastic or glass	Store Cool at <4ºC	48 hours
Nitrite	SM 4500-NO2	100 mL	Plastic or glass	Store Cool at <4ºC	48 hours
Total Kjeldahl Nitrogen	USEPA 351.3	500 mL	Amber glass	Acidify to pH<2 with H2S04	28 days
Ammonia (N)	SM 4500-NH3	250 mL	Plastic or glass	Acidify to pH<2 with H2S04	28 days

Table 3-3. Water Quality Analytical Parameters for Additional Analytes

Analytical Parameter	Analytical Method	Sample Volume	Container Type	Preservation (chemical/temperature/ light-protected)	Maximum Holding Time: Preparation/ Analysis
Total Organic Carbon	USEPA 415.1	250 mL	Clear glass	Acidify to pH<2 with H2S04	28 days
Organophosphorus pesticides	USEPA 625	2 L	Amber glass	Store Cool at <4ºC	Extraction – seven days; Analysis – 40 days
Synthetic pyrethroids	USEPA 625-NCI	2 L	Amber glass	Store Cool at <4ºC	Extraction – seven days; Analysis – 40 days
Acute toxicity *H. azteca*	USEPA 821-R-02-012	10 L	10 L glass	Store Cool at <6ºC	36 hours

3.2.2 Quality Assurance / Quality Control Procedures

Field measurements for pH, conductivity, and temperature were made using an Oakton CON10 pH/temperature/conductivity meter according to the manufacturer specifications. Calibration of the instrument was conducted prior to each sampling event.

Quality assurance and quality control for sampling processes included proper collection of the samples to minimize the possibility of contamination. All samples were collected in clean, contaminant-free sample bottles. Field staff wore powder-free nitrile gloves during sample collection. Sampling personnel were trained according to the field sampling standard operating procedures (SOPs). Additionally, the field staff was made aware of the significance of the project’s detection limits and the requirement to avoid contamination of samples at all times.

3.2.3 Chain-of-Custody Procedures

Chain-of-custody (COC) procedures were used for all samples throughout the collection, transport, and analytical process. Samples were considered to be in custody if they were in the custodian’s possession or view, retained in a secured place (under lock) with restricted access, or placed in a container and secured with an official seal such that the sample could not be reached without breaking the seal. The principal documents used to identify samples and to document possession were COC records, field logbooks, and field tracking forms.

The COC procedures were initiated during sample collection. A COC record was provided with each sample or group of samples. Each person who had custody of the samples signed the form and ensured the samples were not left unattended unless properly secured. Documentation of sample handling and custody included the following:

- Sample identifier.
- Sample collection date and time.
- Any special notations on sample characteristics or analyses.
- Initials of the person collecting the sample.
- Date the sample was sent to the analytical laboratory.
- Shipping company and waybill information.

Completed COC forms were placed in a plastic envelope and kept inside the container with the samples. Once delivered to the analytical laboratory, the COC form was signed by the person receiving the samples. The condition of the samples (i.e., confirming all samples were accounted for and properly labeled, the temperature of the samples, and the integrity of the sample jars) was noted and recorded by the receiver. COC records were included in the final reports prepared by the analytical laboratories and are considered an integral part of the report.

3.2.4 Trend Assessment Methodology

Using the long-term data sets for SD8(1) and DPR2, a non-parametric trend analysis was conducted using the Mann-Kendall trend test to evaluate the presence or absence of significant trends using available monitoring data. This trend test is often employed for analysis of environmental time series data. The test does not assume any single distribution for the data being tested, which is an advantage when analyzing environmental data. The test does not incorporate magnitude, but instead calculates the number of positive and negative differences between samples. The number of positive and negative differences is summed to calculate the S-statistic, which is compared to a table value to determine significance. Sen’s slope estimator (Sen, 1968) was used to estimate the magnitude of change over time when a significant trend was observed. Sen's slope estimator is a non-parametric method that is insensitive to outliers and can be used to infer the magnitude of a trend in the data.

The two long-term data sets contain constituent measurements with levels below the detection limit of the analytical method (non-detect results). Large numbers of values below the detection limit may create statistical problems for trend analyses. The Sen slope estimator begins to exhibit noticeable bias when the number of non-detects exceed 15%. At non-detect levels of 15% or less, both the Mann-Kendall test results and the Sen slope estimator were found to be reliable.

4.0 MONITORING RESULTS

Monitoring results were assessed in relation to Regional Board Order No. R9-2004-0277. This assessment involved chemical, bacterial, and toxicological test results from three wet weather sampling events at SD8(1) and DPR2. Rainfall and flow data from the 2008–2009 Monitoring Season are provided in Appendix C. The laboratory chemistry and toxicity results are provided in Appendix D.

Sample results were compared to the water quality objectives (WQOs) shown in Table 4-1. Water chemistry results were compared to criteria from the following references to determine the magnitude of any impacts from storm water runoff to Chollas Creek:

- Water Quality Control Plan (Regional Board, 1994) for San Diego County.
- Title 40 of the Code of Federal Regulations (Part 131; Water Quality Standards) (USEPA, 2000a).
- The NPDES Storm Water Multi-Sector General Permit (USEPA, 2000b).
- Water quality criteria for Chlorpyrifos and Malathion (CDFG, 2000).
- Resolution No. R9-2002-0123, Chollas Creek Total Maximum Daily Loads for Diazinon (Regional Board, 2002).
- Resolution No. R9-2007-0043, Total Maximum Daily Loads for Dissolved Copper, Lead, and Zinc in Chollas Creek, Tributary to San Diego Bay Chollas Creek Watershed (Regional Board, 2007b).

Table 4-1.Wet Weather Water Quality Objective Criteria for All Analyzed Constituents

Constituent List	Water Quality Objective Criteria	Criteria Source
pH	6.5–9.0	Basin Plan (Regional Board, 1994)
Conductivity	–	–
Temperature	–	–
Total Coliforms	–	–
Fecal Coliforms	4,000 (REC-2)	Basin Plan (Regional Board, 1994)
Total Organic Carbon	50 mg/L	Multi-Sector General Permit (USEPA, 2000b)
Total Suspended Solids	100 mg/L	Multi-Sector General Permit (USEPA, 2000b), NSQD
Total/dissolved copper	(a)	Resolution No. R9-2007-0043
Total/dissolved lead	(a)	Resolution No. R9-2007-0043
Total/dissolved zinc	(a)	Resolution No. R9-2007-0043
Hardness	–	
Diazinon	72 ng/L (acute exposure); 45 ng/L (chronic exposure)	Resolution No. R9-2002-0123(b)
Chlorpyrifos	20 ng/L	CDFG (2000)
Malathion	430 ng/L (acute); 100 ng/L (chronic)	CDFG (2000)
Ammonia (N)	(c)	USEPA water quality criteria

Table 4-1.Wet Weather Water Quality Objective Criteria for All Analyzed Constituents

Constituent List	Water Quality Objective Criteria	Criteria Source
Nitrate	1 mg/L	Basin Plan (Regional Board, 1994)
Nitrite	1 mg/L	Basin Plan (Regional Board, 1994)
Total Kjeldahl Nitrogen	–	–
Bifenthrin	9.3 ng/L	Anderson et al. in press (wet weather), (d)
Cyfluthrin	344 ng/L	Wheelock et al., 2004 (wet weather), (d)
Cypermethrin	683 ng/L	Wheelock et al., 2004 (wet weather), (d)
Esfenvalerate	250 ng/L	Wheelock et al., 2004 (wet weather), (d)
L-Cyhalothrin	200 ng/L	Wheelock et al., 2004 (wet weather), (d)
Permethrin	21 ng/L	Anderson et al., in press (wet weather), (d)
Acute toxicity *C. dubia*	100 no-observed-effect concentration (NOEC) (%)	Regional Board Order No. R9-2007-0001
Acute toxicity *H. azteca*	100 NOEC (%)	Regional Board Order No. R9-2007-0001
Chronic toxicity *C. dubia*	100 NOEC (%)	Regional Board Order No. R9-2007-0001

(a) WQO for dissolved metal fractions are based on total hardness (as $CaCO_3$) and are calculated as described by Title 40 of the Code of Federal Regulations (Part 131) (USEPA, 2000). Samples collected for the 2008–2009 Monitoring Season are compared to the acute (CMC) and chronic (CCC) condition, multiplied by 0.90 (margin of safety).
(b) For the Diazinon TMDL (Resolution No. R9-2002-0123), the waste load allocation is set at 72 ng/L for acute exposures and 45 ng/L for chronic exposures. The 45 ng/L chronic exposure is applied to samples collected using a flow-weighted composite method.
(c) WQO is based on CMC (salmonids absent) using pH described in the USEPA, 1999 Update of Ambient Water Quality Criteria for Ammonia, USEPA-822-R-99-014, December 1999.
(d) The LC50 values for synthetic pyrethroids were used as the WQO for the purposes of this report.

In years past, this report only compared results for dissolved metals to the acute (CMC) criteria which were calculated in accordance with Title 40 of the Code of Federal Regulations (Part 131) (USEPA, 2000). The historical WQOs for copper, lead, and zinc were set to the CMC criteria because storm events typically only represent conditions in the short term.

During the 2008–2009 Monitoring Season, the Chollas Creek Dissolved Metals TMDL was formally adopted. To provide a comparison with future TMDL compliance analyses, this report used the TMDL waste load allocations for the 2008–2009 metals monitoring results. The TMDL waste load allocations for dissolved copper, lead, and zinc are defined by both the CMC and the chronic criteria (CCC) of the CTR, multiplied by a 10% margin of safety. The waste load allocations were only applied to results from the 2008–2009 Monitoring Season.

4.1 2008–2009 Rainfall and Flow Data

Order R9-2004-0277 requires monitoring at SD8(1) and DPR2 for the first and second rainfall events of the storm season after October 1 and the first rainfall event after February 1. Estimation of a representative storm event in San Diego County was based on an evaluation of the long-term data records from the National Weather Service rain gauge located at Lindbergh Field. A typical storm event at Lindbergh Field yields 0.19–0.57 inch of rain and lasts six to 12 hours. Since the depth and duration of a typical storm event varies depending on the monitoring station's location within San Diego County, storm events that were preceded by at least 72 hours of dry weather and were forecast to be greater than 0.10 inch were considered viable events for monitoring.

Three storm events (October 4, 2008, November 4, 2008, and February 5, 2009) were monitored over the course of the 2008–2009 Monitoring Season. Annual rainfall totals and event-specific rainfall for the 2008–2009 Monitoring Season at SD8(1) and DPR2 are shown on Table 4-2. The watershed received approximately 12.00 inches of rain based on the rain gauge at DPR2. The rain gauge at SD8(1) clogged partially in January and February 2009. A comparison of rainfall patterns between SD8(1) and DPR2 indicate that a portion of the total annual rainfall data for SD8(1) were not recorded.

The average daily rainfall for the Chollas Creek Watershed is shown on Figure 4-1. Monitored storm events are signified by raindrops on Figure 4-1. The total rainfall measured at San Diego's Lindbergh Field from October 1, 2008 to April 30, 2009, was 9.08 inches.

Table 4-2. Rainfall Totals for SD8(1) and DPR2 in the Chollas Creek Watershed

Storm Event Date	SD8(1) (inch)	DPR2 (inch)
10/04/2008–10/05/2008	0.29	0.38
11/04/2008	0.26	0.33
02/05/09–02/06/2009	0.20	0.19
2008–2009 Monitoring Season Total Rainfall	*****	**12.00**

* The rain gauge was inoperable during January and February 2009.

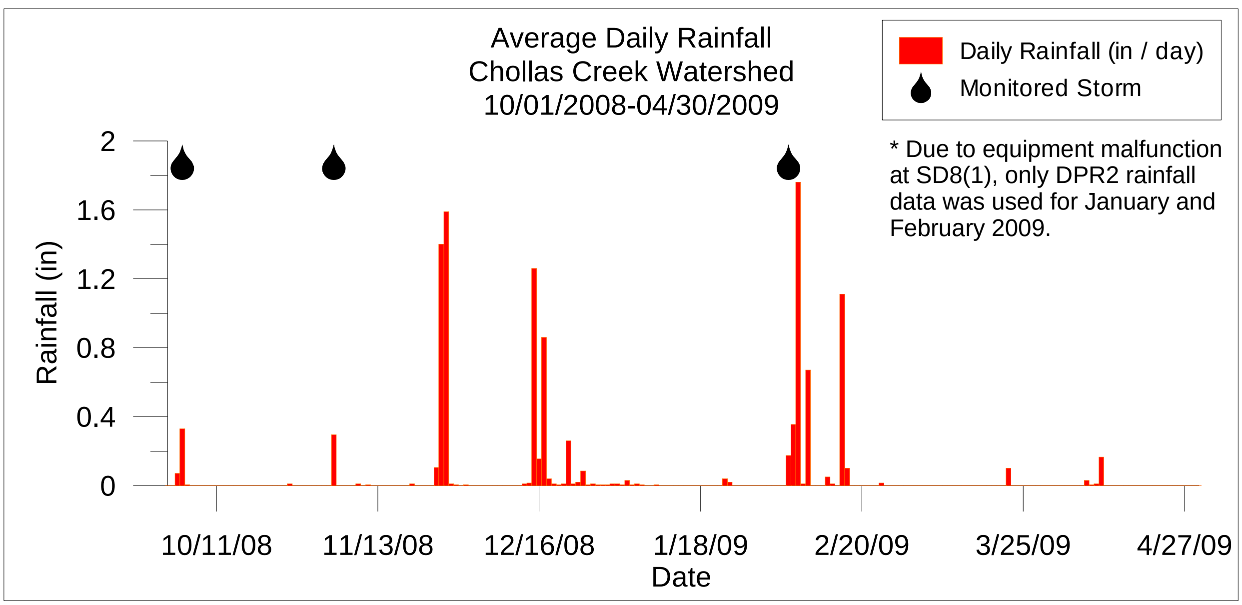


Figure 4-1. 2008–2009 Average Daily Rainfall Totals for the Chollas Creek Watershed

Hydrographs depicting flow rates, rainfall, and sample times for the three storm events monitored at SD8(1) and DPR2 during the 2008–2009 Monitoring Season are presented on Figure 4-2 and Figure 4-3, respectively. Annual hydrographs and season flow data for the sites are presented in Appendix C. Rainfall during the 2008–2009 Monitoring Season occurred primarily in the lower watershed. Monitoring programs in the City of La Mesa were not implemented due to insufficient rainfall in the upper watershed.

The flow sensors installed at SD8(1) and DPR2 at the beginning of the 2008–2009 Monitoring Season measured date, time, and level. The flow rates were calculated based on the channel dimensions and slope.

Over the course of the 2008–2009 Monitoring Season, cobble and sand deposition occurred at SD8(1). After November 2009, levels and flows at this site were artificially elevated due to ponding upstream of the deposition area. The flow calculations were adjusted to account for the additional cobble.

On Saturday, October 4, 2008, a storm system affected the Chollas Creek Watershed with rainfall of 0.29 inches at SD8(1) and 0.38 inches at DPR2. Based on conditions observed at SD8(1), sampling at DPR2 was discontinued at 02:41, after three storm peaks had passed. After sampling was terminated, a large storm cell resulted in additional flow that was not monitored. However, the sample duration was estimated to be representative of first flush conditions compared to historical flows. The additional flow may be observed by comparing in the annual hydrographs for 2008–2009 (Appendix C).

On Tuesday, November 4, 2008, 0.26 inches and 0.33 inches of rain fell at SD8(1) and DPR2, respectively. Runoff at SD8(1) was characterized by two peak runoff periods. At DPR2, only one large, sustained peak was observed.

The first storm which affected the Chollas Creek Watershed after February 1 was on Thursday, February 5, 2009, where 0.20 inches and 0.19 inches of rain fell at SD8(1) and DPR2, respectively. As shown on the hydrograph (Figure 4-2), all 0.20 inches of rainfall at SD8(1) were recorded at 20:40 which likely was the result of rain gauge clearing due to being clogged with debris. The Manning's roughness coefficient and subsequent flow measurements for the February 2009 storm event were adjusted to account for the cobble which accumulated at this site during the monitoring season.

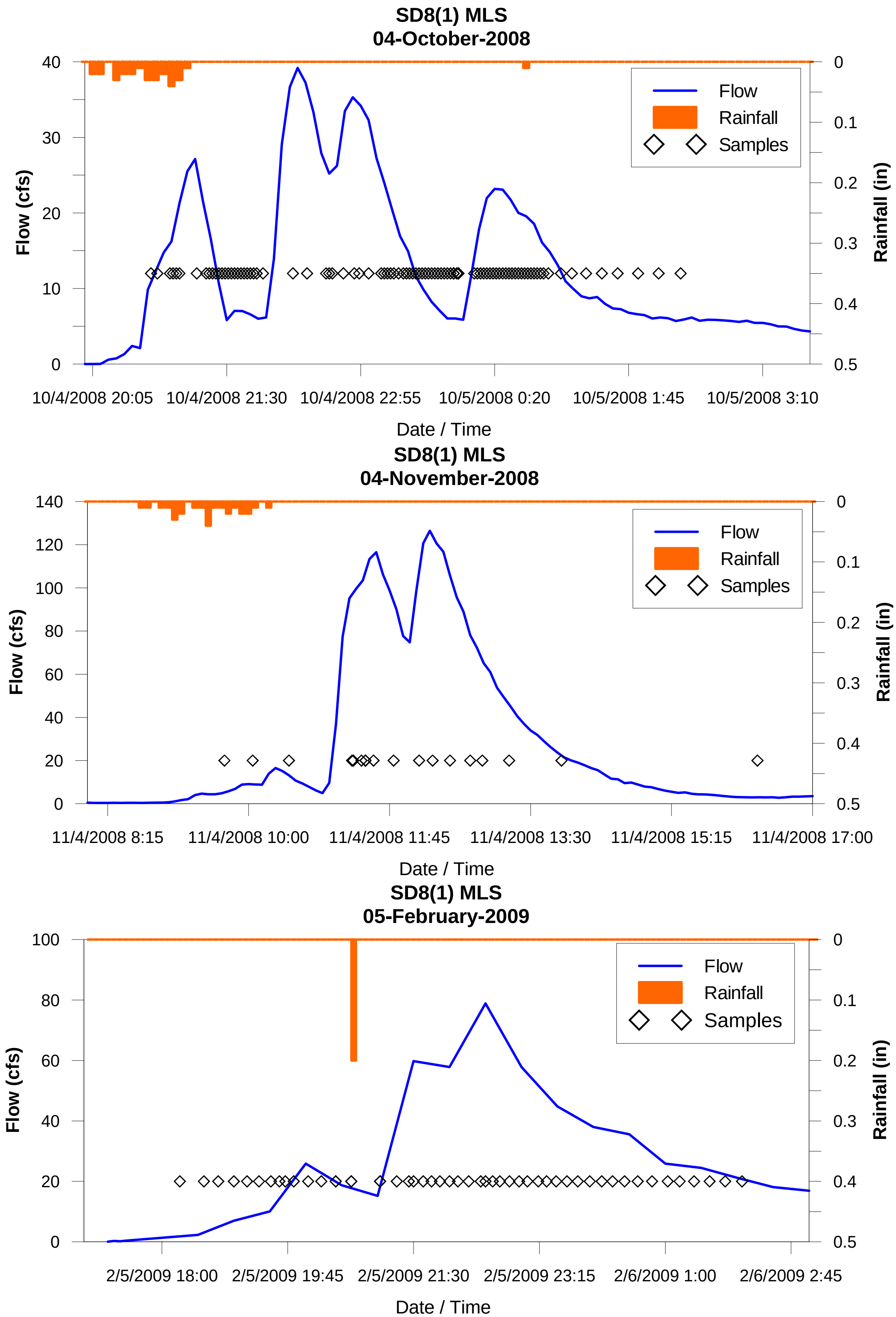


Figure 4-2. 2008–2009 Storm Hydrographs for SD8(1)

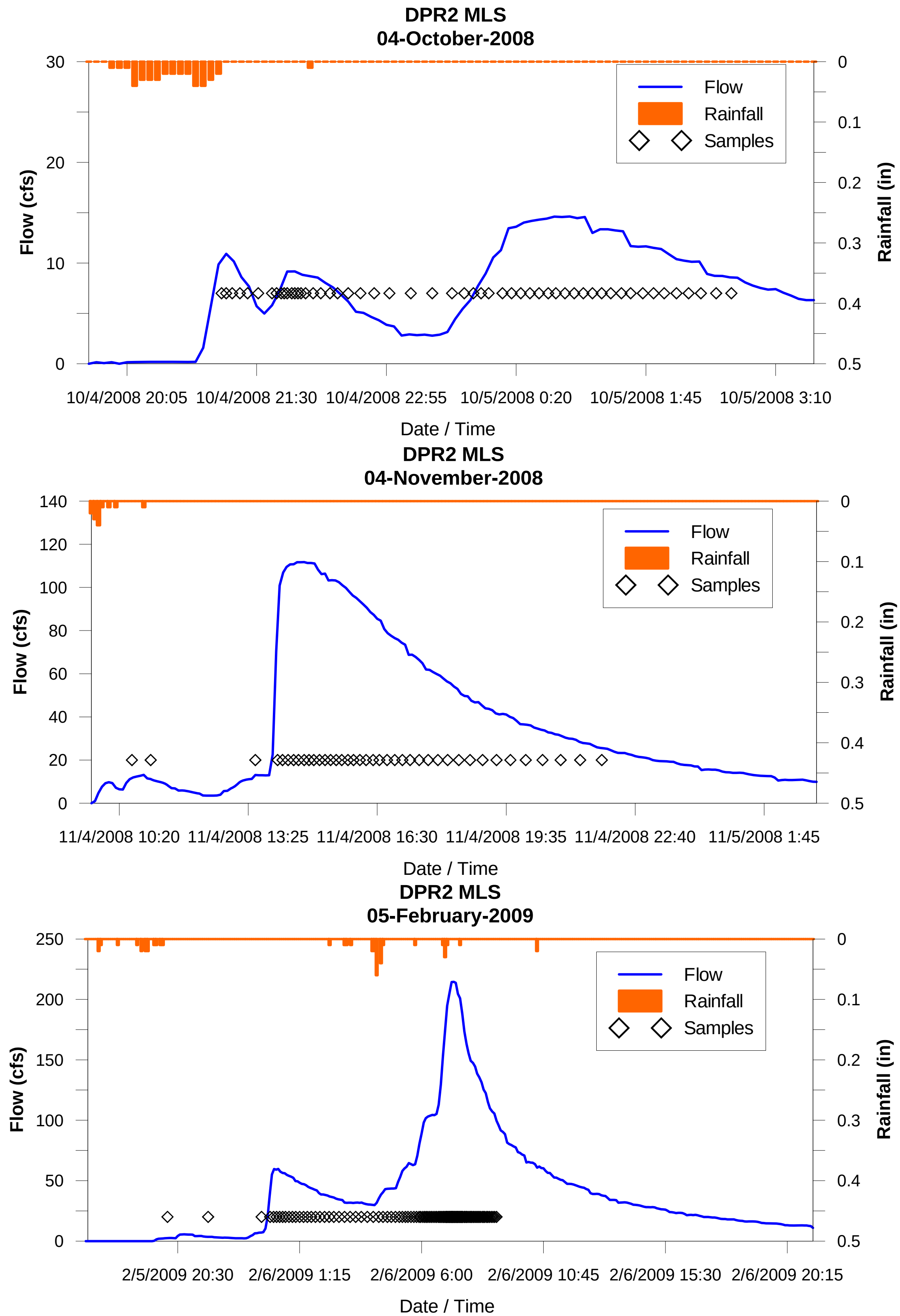


Figure 4-3. 2008–2009 Storm Hydrographs for DPR2

4.2 Compliance Monitoring Results

This section presents the water quality monitoring results for SD8(1) and DPR2 to satisfy the requirements of Order No. R9-2004-0277. Samples were analyzed for conventional field parameters, total and dissolved copper, lead, and zinc, Diazinon, and toxicity to *C. dubia*. Wet weather chemistry results for SD8(1) and DPR2 are presented in Table 4-3. Results for toxicity to *C. dubia* are presented in Table 4-4. Results which were above the WQO were bolded and shaded.

Metals
Dissolved copper and dissolved zinc concentrations were greater than the CMC at SD8(1) for all three storm events. Only dissolved copper was greater than the CMC during the first two storm events monitored at DPR2. Dissolved lead concentrations at SD8(1) and DPR2 were below the CMC for all three storms.

Dissolved copper concentrations were greater than the CCC at SD8(1) and DPR2 for all three storm events. Dissolved lead concentrations were greater than the CCC for the first two storm events at SD8(1) and dissolved zinc concentrations were greater than the CC for all three storms. Dissolved lead and zinc concentrations at DPR2 remained below the CCC during all three monitored storms.

Exceedance ratios at SD8(1) were generally less than three and less than two at DPR2. The largest ratio of 3.27 (CCC for dissolved copper) was observed during the October 2008 first flush storm event at SD8(1).

Diazinon and Toxicity
Diazinon was not detected at either SD8(1) or DPR2 during three monitored storm events. Toxicity was not observed for acute or chronic survival tests. Seven-day chronic reproductive toxicity was observed to *C. dubia* for the February 5, 2008 storm event for water collected from SD8(1). It should be noted that this sample also had the highest concentration of Permethrin (a synthetic pyrethroid) of all the monitored storm events at SD8(1).

Table 4-3. 2008–2009 Chollas Creek Wet Weather Compliance Monitoring Chemistry Results

Parameter	Units	WQO	Source	SD8(1) 10/4/2008-10/5/2008	DPR2 10/4/2008-10/5/2008	SD8(1) 11/4/2008	DPR2 11/4/2008	SD8(1) 2/5/2009-2/6/2009	DPR2 2/5/2009-2/6/2009
Physical Chemistry									
Conductivity	uS/cm	-	-	248	718	184.33	526.67	179.77	473
Temperature	Celsius	-	-	22.97	22.4	19.57	19.7	16.1	14.9
pH	pH Units	6.5-9.0	Basin Plan	7.04	6.92	7.34	7.13	7.54	7.17
General Chemistry									
Total Hardness as $CaCO_3$	mg/L	-	-	143.8	202.7	112.1	122.1	110.7	148.6
CTR Metals									
Total Copper (Cu)	µg/L	-	-	79.9	56.4	50.4	27.4	51	21.4
Total Lead (Pb)	µg/L	-	-	23.67	4.88	24.33	9.21	20.21	4.9
Total Zinc (Zn)	µg/L	-	-	496.5	193.5	299.8	125.2	287	80.3
Dissolved Copper (Cu)	µg/L	(a)	40 CFR 131.38	**40**	**42.5**	**27.6**	**20.3**	**25.1**	**14.9**
Dissolved Lead (Pb)	µg/L	(a)	40 CFR 131.38	**5.15**	1.82	**3.39**	2.11	0.72	0.21
Dissolved Zinc (Zn)	µg/L	(a)	40 CFR 131.38	**358.6**	163.7	**166**	99	**171.4**	53.4
Organophosphorus Pesticides									
Diazinon	ng/L	72/45	Chollas Creek TMDL for Diazinon (acute/chronic)	<4	<4	<4	<4	<4	<4

< = result less than the method detection limit

(a) WQO for dissolved metal fractions are based on Total Hardness (as $CaCO_3$) and are calculated as described by Title 40 of the Code of Federal Regulations (Part 131) (USEPA, 2000). Samples collected for the 2008-2009 Monitoring Season are compared to the CMC and CCC, multiplied by 0.90. This multiplier lowers the CTR value in accordance with the 10% margin of safety which has been incorporated into the concentration-based waste load allocations for the Chollas Creek Metals TMDL.

Shaded and bold=results above the water quality benchmark and the CMC water quality benchmark for metals.

Bold only=results above the CCC water quality benchmark for metals.

Table 4-4. 2008–2009 Chollas Creek Wet Weather Biological Toxicity Results for *Ceriodaphnia dubia*

Test	Reporting Value	Unit	SD8(1)			DPR2		
			10/5/2008	11/4/2008	2/5/2009	10/5/2008	11/4/2008	2/5/2006
96-hour acute toxicity (*C. dubia*)	Mean % survival for control	%	80	100	100	100	100	100
	% survival in 100% concentration	%	100	90	100	100	100	100
	LC_{50}	%	>100	>100	>100	>100	>100	>100
	LOEC	%	>100	>100	>100	>100	>100	>100
	Tu_a		0	0.59	0	0	0	0
	LT_{50}	Hours	>96	>96	>96	>96	>96	>96
Toxicity Observed			No	No	No	No	No	No
7-day chronic toxicity (*C. dubia*)	Mean % survival for control	%	80	100	100	100	100	90
	% survival in 100% concentration	%	100	90	100	100	100	100
	LC_{50} (survival)	%	>100	>100	>100	>100	>100	>100
	NOEC (survival)	%	100	100	100	100	100	100
	LOEC (survival)	%	>100	>100	>100	>100	>100	>100
	Tu_a (survival)		1	1	1	1	1	1
	LT_{50}	Hours	>168	>192	>144	>144	>168	>192
	NOEC (reproduction)	%	100*	100	**50**	100*	100	100
	LOEC (reporduction)	%	>100*	>100	100	>100*	>100	>100
	Tu_c (reproduction)	%	1*	1	2	1*	1	1
Toxicity Observed			No	No	Yes	No	No	No

* Original test did not meet test acceptability criteria for reproduction. This test was re-started as a screen on 10/10/08 (5 days past the 36-hour holding time).

4.3 Additional Analyte Results

Water quality samples were also collected to provide additional relevant information. These samples were analyzed for indicator bacteria, oil and grease, nutrients, organophosphorus pesticides, synthetic pyrethroids, and toxicity to *H. azteca*. Wet weather chemistry results for the additional analytes from SD8(1) and DPR2 are presented in Table 4-5. Results for toxicity to *H. azteca* are presented in Table 4-6. Results which were above the WQO were bolded and shaded.

Wet weather chemistry sample results for SD8(1) were above the WQO for total suspended solids (TSS) during all three of the monitored storm events. TSS concentrations in the north fork were 4.2 to 6.0 times larger than at DPR2. The TSS concentrations at DPR2 did not exceed the WQO for the three monitored storm events for the 2008–2009 Monitoring Season.

Oil and grease results were above the WQO at SD8(1) during the first and third storm events. Generally results were approximately three times greater in the north fork than in the south fork. At DPR2, oil and grease results were below the WQO.

Concentrations of the organophosphorus pesticide Malathion exceeded the WQO during the November 4, 2008 storm event at both sites. Malathion was detected in measurable quantities at DPR2 for the other two monitored storm events. Malathion was also detected at SD8(1) during the February 5, 2009 storm event. In contrast, the other 24 monitored organophosphorus pesticides, including Diazinon and Chlorpyrifos, were not detected.

Fecal coliform bacteria concentrations were higher than the Basin Plan's REC-2 WQO of 4,000 MPN/100 mL for all events sampled at both SD8(1) and DPR2. Concentrations were highest during the second storm event.

In recent years, there has been an observed shift in pesticide use from banned Diazinon products to synthetic pyrethroids. During the 2008–2009 Monitoring Season, Bifenthrin was above the published literature LC_{50} value for *H. azteca* at both sites during all three storm events but was only detected at low concentrations at DPR2 during the first monitored storm. Permethrin was detected at concentrations above the LC_{50} value at SD8(1) during all three storms. As indicated by previously conducted toxicity identification evaluation (TIE) studies, synthetic pyrethroids have been identified as the likely causative agent of toxicity to *H. azteca* in Chollas Creek storm water. Toxicity to *H. azteca* was observed during the three storm events monitored at SD8(1) and during the first two storms monitored at DPR2.

Table 4-5. 2008–2009 Chollas Creek Wet Weather Results for Additional Analytes

Parameter	Units	WQO	Source	SD8(1) 10/4/2008-10/5/2008	DPR2 10/4/2008-10/5/2008	SD8(1) 11/4/2008	DPR2 11/4/2008	SD8(1) 2/5/2008-2/6/2009	DPR2 2/5/2008-2/6/2009
Bacteria									
Enterococci	MPN/100 mL	-	-	130,000	110,000	80,000	50,000	50,000	280,000
Fecal Coliforms	MPN/100 mL	4000	Basin Plan REC-2	**80,000**	**13,000**	**110,000**	**130,000**	**30,000**	**30,000**
Total Coliforms	MPN/100 mL	-	-	170,000	23,000	500,000	800,000	500,000	240,000
General Chemistry									
Ammonia-N	mg/L	(a)	U.S. EPA Water Quality Criteria (Freshwater)	1.37	1.36	1.41	0.81	1.42	0.79
Dissolved Organic Carbon	mg/L	-	-	96.5	69.2	53.7	41.3	25.1	17.1
Nitrate-N by IC	mg/L	10	Basin Plan	3.55	1.98	2.6	2.32	1.48	1.33
Nitrite-N by IC	mg/L	1	Basin Plan	0.17	0.35	0.12	0.2	0.15	0.14
Oil & Grease	mg/L	10	MSGP 2000	**13.5**	4.1	9.2	1.6	**17.2**	6.1
Total Kjeldahl Nitrogen	mg/L	-	-	11	10	5.5	4.1	4.9	2.8
Total Nitrogen	mg/L	1	Basin Plan	**14.72**	**12.33**	**8.22**	**6.62**	**6.53**	**4.27**
Total Organic Carbon	mg/L	-	-	107.4	73.6	64	39.9	35.1	26.1
Total Suspended Solids	mg/L	100	MSGP 2000	**117.6**	27.6	**142.7**	23.8	**161**	29
Organophosphorus Pesticides									
Azinphos Methyl	ng/L	-	-	NA	NA	NA	NA	<100	<100
Bolstar (Sulprofos)	ng/L	-	-	<4	<4	<4	<4	<4	<4
Chlorpyrifos	ng/L	20 / 14	CA Dept. of Fish & Game, 2000 (acute/chronic)	<2	<2	<2	<2	<2	<2
Demeton	ng/L	-	-	<2	<2	<2	<2	<2	<2
Dichlorvos	ng/L	-	-	<6	<6	<6	<6	<6	<6
Dimethoate	ng/L	-	-	<6	<6	<6	<6	<6	<6
Disulfoton	ng/L	-	-	<2	<2	<2	<2	<2	<2
Ethoprop (Ethoprofos)	ng/L	-	-	<2	<2	<2	<2	<2	<2
Ethyl Parathion	ng/L	-	-	NA	NA	NA	NA	<10	<10
Fenchlorphos (Ronnel)	ng/L	-	-	<4	<4	<4	<4	<4	<4
Fenitrothion	ng/L	-	-	NA	NA	NA	NA	<100	<100
Fensulfothion	ng/L	-	-	<2	<2	<2	<2	<2	<2
Fenthion	ng/L	-	-	<4	<4	<4	<4	<4	<4
Malathion	ng/L	430 / 100	CA Dept. of Fish & Game, 1998 (acute/chronic)	<6	42.5	**232.6**	**154.1**	98.5	97.5
Merphos	ng/L	-	-	<2	<2	<2	<2	<2	<2
Methamidophos (Monitor)	ng/L	-	-	NA	NA	NA	NA	<50	<50
Methidathion	ng/L	-	-	NA	NA	NA	NA	<10	<10
Methyl Parathion	ng/L	-	-	<1	<1	<1	<1	<1	<1
Mevinphos (Phosdrin)	ng/L	-	-	<16	<16	<16	<16	<16	<16
Phorate	ng/L	-	-	<12	<12	<12	<12	<12	<12
Phosmet	ng/L	-	-	NA	NA	NA	NA	<50	<50
Tetrachlorvinphos (Stirofos)	ng/L	-	-	<4	<4	<4	<4	<4	<4
Tokuthion	ng/L	-	-	<6	<6	<6	<6	<6	<6
Trichloronate	ng/L	-	-	<2	<2	<2	<2	<2	<2
Pyrethroids									
Allethrin	ng/L	-	-	<2	<2	<2	<2	<2	<2
Bifenthrin	ng/L	9.3	Anderson et al. 2006	**88.7**	**15.1**	**276.1**	**31.1**	**112.3**	**13.1**
Cyfluthrin	ng/L	344	Wheelock et al. 2004	35.3	6.1	70.6	<0.5	61.6	9.4
Cypermethrin	ng/L	683	Wheelock et al. 2004	51	5.9	75.8	<0.5	74.6	10.8
Danitol	ng/L	-	-	<2	<2	<2	<2	<2	<2
Deltamethrin	ng/L	-	-	<2	<2	<2	<2	<2	<2
Esfenvalerate	ng/L	250	Wheelock et al. 2004	<2	<2	<2	<2	<2	<2
Fenvalerate	ng/L	-	-	1.3	<2	<2	<2	<2	<2
Fluvalinate	ng/L	-	-	<2	<2	<2	<2	<2	<2
L-Cyhalothrin	ng/L	200	Wheelock et al. 2004	5	<2	<2	<2	5.4	<2
Permethrin	ng/L	21	Anderson et al. 2006	**295.3**	9.4	**394.6**	<5	**445.7**	<5
Prallethrin	ng/L	-	-	<2	<2	<2	<2	<2	<2
Resmethrin	ng/L	-	-	<25	<25	<25	<25	<25	<25

NA = Not analyzed
< = result less than the method detection limit
(a) Water Quality Benchmark is based on CMC (salmonids absent) using pH described in the U.S. EPA, 1999 Update of Ambient Water Quality Criteria for Ammonia, EPA-822-R-99-014, December 1999.
Shaded and bold=results above the water quality benchmark.

Table 4-6. 2008–2009 Chollas Creek Wet Weather Biological Toxicity Results for *Hyalella azteca*

Test	Reporting Value	Unit	SD8(1)			DPR2		
			10/5/2008	11/4/2008	2/5/2009	10/5/2008	11/4/2008	2/5/2006
96-hour acute toxicity (*H. azteca*)	Mean % survival for control	%	100	100	100	100	100	95
	NOEC	%	**25**	**12.5**	**12.5**	**50**	**50**	100
	LC_{50}	%	61.4	46.4	42.8	90.7	>100	>100
	LOEC	%	50	25	25	100	100	>100
	Tu_a		1.63	2.15	2.34	1.10	0.93	0.92
Toxicity Observed			Yes	Yes	Yes	Yes	Yes	No

5.0 DATA ANALYSIS AND INTERPRETATION

Historical wet weather data have been collected at SD8(1) since 1994 and at DPR2 since 2004. The following sections provide analysis and interpretation of the compliance monitoring and additional analytical results from SD8(1) and DPR2 during the 2008–2009 Monitoring Season as compared to historical data.

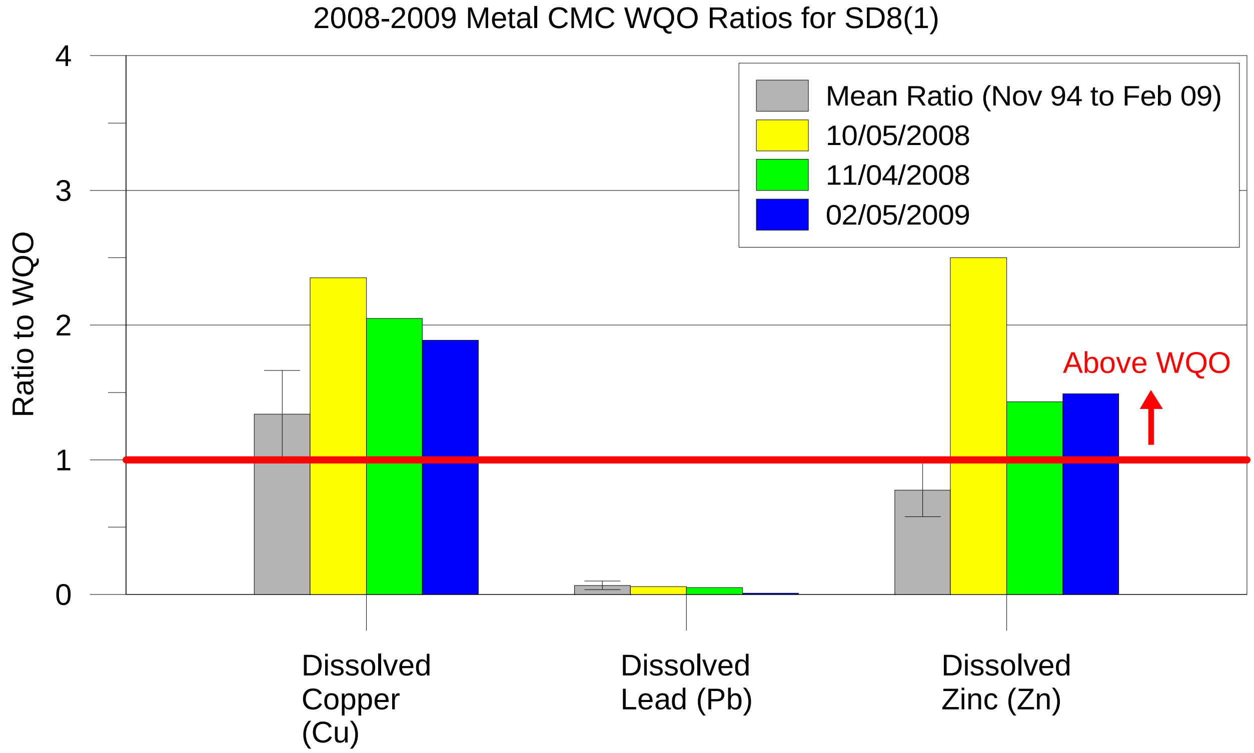
Only those constituents with significant trends are shown. All scatterplots from SD8(1) and DPR2 can be found in Appendix E. A table of trend results for each site, including P-values, is also included in Appendix E.

5.1 Compliance Monitoring Analysis

Exceedance Ratios for Metals

The acute CMC condition ratios for 2008–2009 monitoring and mean historical conditions are shown on Figure 5-1; the chronic CCC condition ratios are shown on Figure 5-2. These ratio plots reflect generally understood patterns for the Chollas Creek Watershed, including the following:

- Exceedance ratios in the north fork (SD8(1)) are generally greater than in the south fork (DPR2).
- Metals concentrations have higher rates of exceedance during the first flush storm event of the season. In both the north and the south forks, the acute and chronic ratios for the October 2008 first flush storm event are greater than the mean historical ratio for dissolved copper and zinc.
- Copper has a higher detection rate and exceedance rate (compared to the CMC and CCC criteria) than other metals. The mean historical ratios (acute and chronic) are greater than or equal to one for dissolved copper, but less than one for dissolved zinc.
- The CCC mean ratio for dissolved lead indicates a historical water quality problem at SD8(1) in the north fork of Chollas Creek, but this result is not reflected in the short-term acute condition ratio plot or the 2008–2009 wet weather monitoring results.
- The mean exceedance ratios are less than two for the acute condition at SD8(1) and DPR2. The mean chronic exceedance ratios are less than three for SD8(1) and less than two for DPR2.



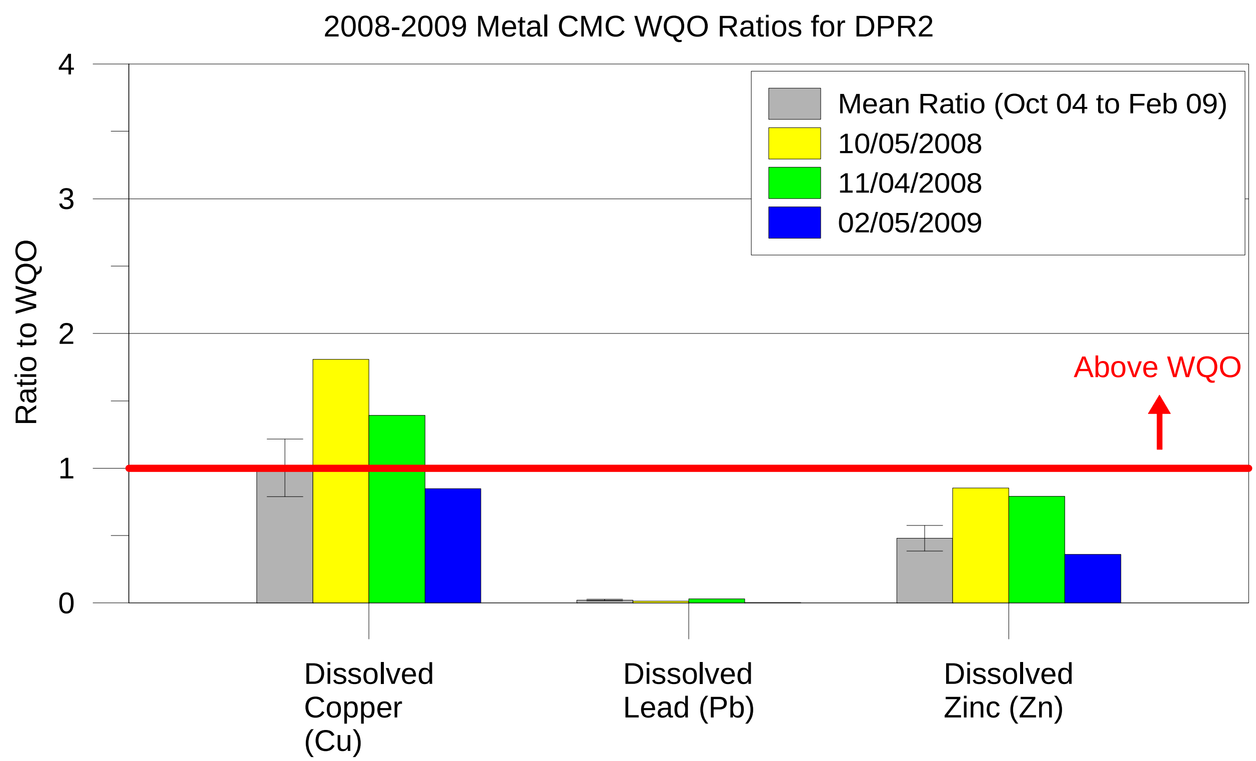
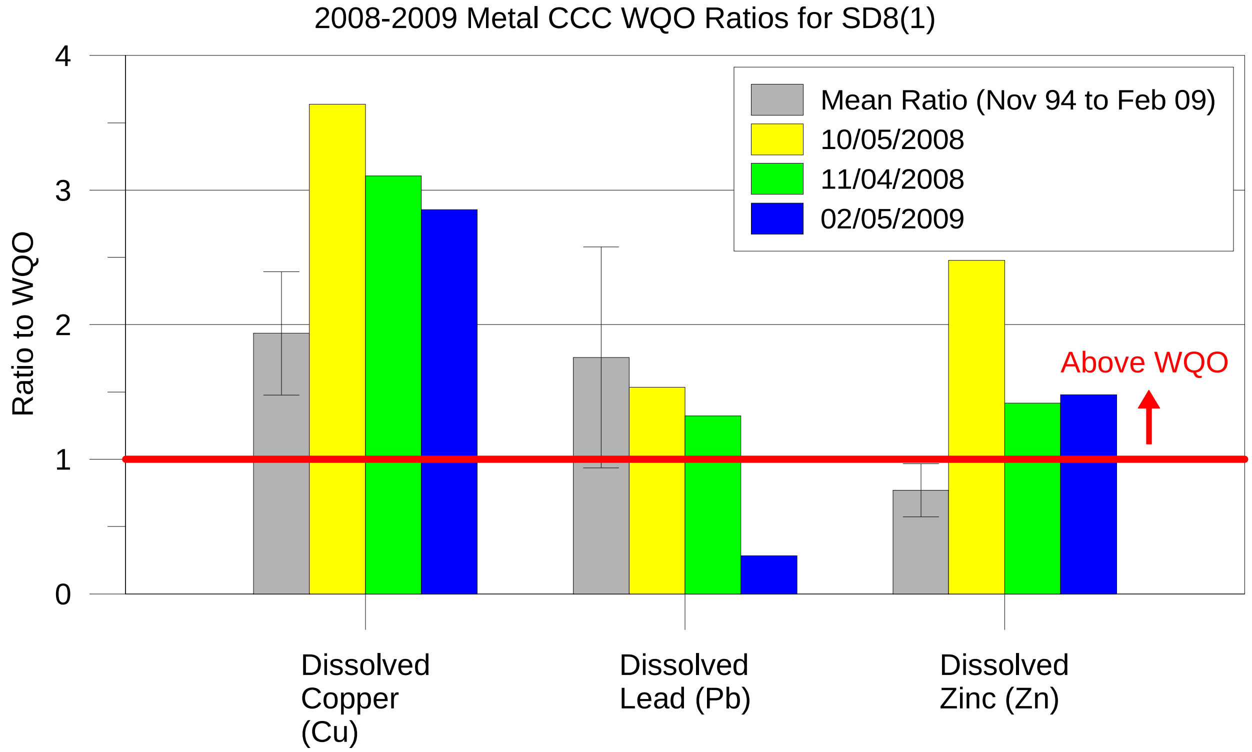


Figure 5-1. 2008–2009 Ratio Plots for Metals Concentrations Compared to the Acute Condition Water Quality Criteria at SD8(1) and DPR2



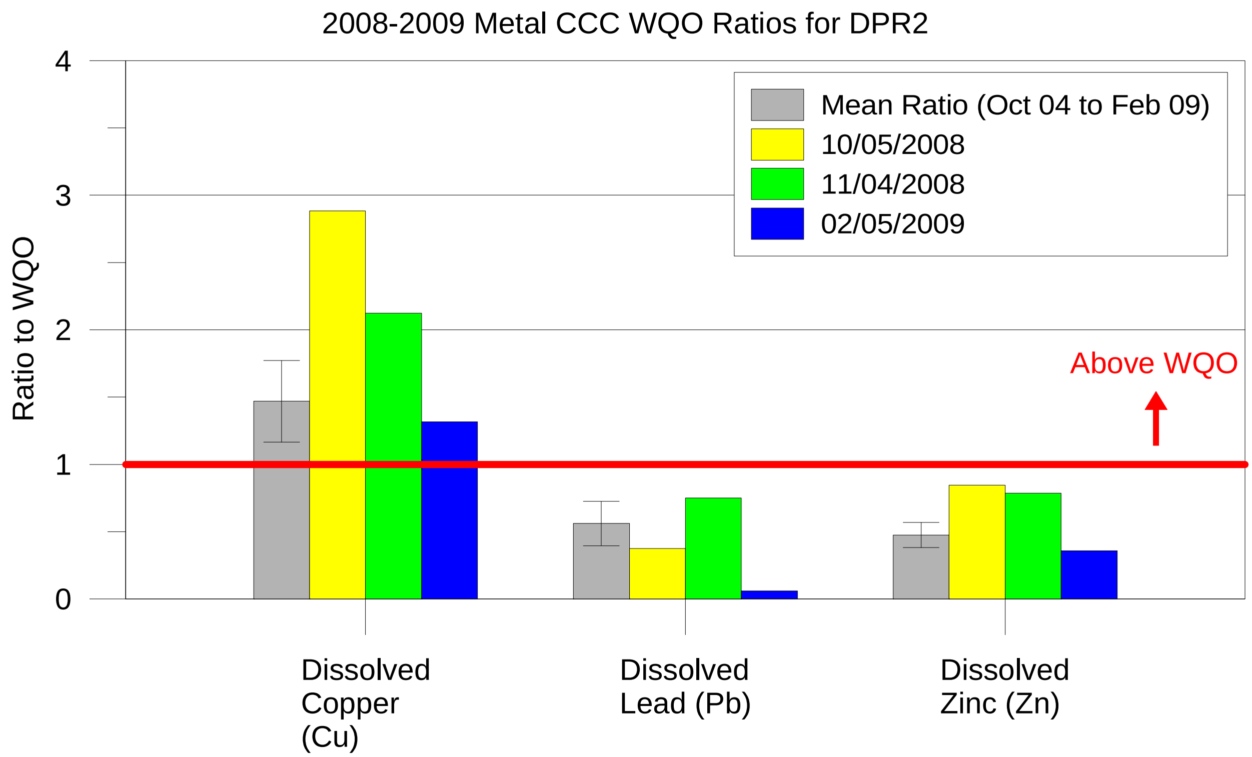


Figure 5-2. 2008–2009 Ratio Plots for Metals Concentrations Compared to the Chronic Condition Water Quality Criteria at SD8(1) and DPR2

Trends for Metals

As shown in Subsection 4.2, the north and south forks of Chollas Creek have WQO exceedances for primarily dissolved copper and dissolved zinc. The Mann-Kendall analysis did not indicate significant water quality trends for metals at DPR2. Similar to 2007–2008 results, trend analyses for the north fork indicate significantly increasing trends for total copper (p=0.006) and total zinc (p=0.002). Unlike previous years, the 1994–2009 analysis also indicates significant increasing trends for dissolved copper and dissolved zinc (p=0.036 for copper and p=0.019 for zinc) at SD8(1). Trend plots for copper and zinc at SD8(1) are shown on Figure 5-3. However, the magnitudes of the trends are relatively low.

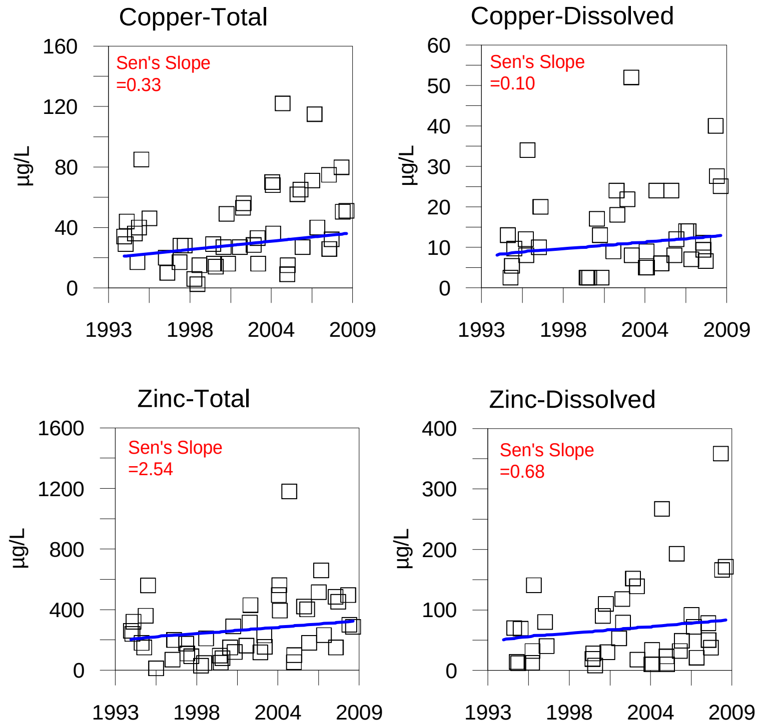


Figure 5-3. SD8(1) Trend Plots for Total and Dissolved Copper and Zinc

The Chollas Creek Dissolved Metals TMDL sets the numeric targets equal to the CTR criteria. The CTR is the most current, conservative WQO for dissolved copper, lead, and zinc in freshwater. The CTR WQOs for dissolved copper, lead, and zinc are comprised of hardness-based equations that vary with sample hardness concentrations, as shown on Figure 5-4. The Chollas Creek Watershed is unique in that it has significantly lower hardness concentrations, and therefore lower dissolved metals WQOs, than other watersheds in San Diego County. The historical mean wet weather hardness concentration at the SD8(1) is 90 mg $CaCO_3$/L compared to other watersheds where the mean wet weather hardness concentrations are approximately 120 mg $CaCO_3$/L. As a result of the low hardness values, it is more likely that slightly elevated wet weather monitoring results for dissolved metals will exceed the CTR WQO. The typically lower hardness results in the north fork (SD8(1)) may also contribute to the greater number of exceedances in comparison to the south fork.

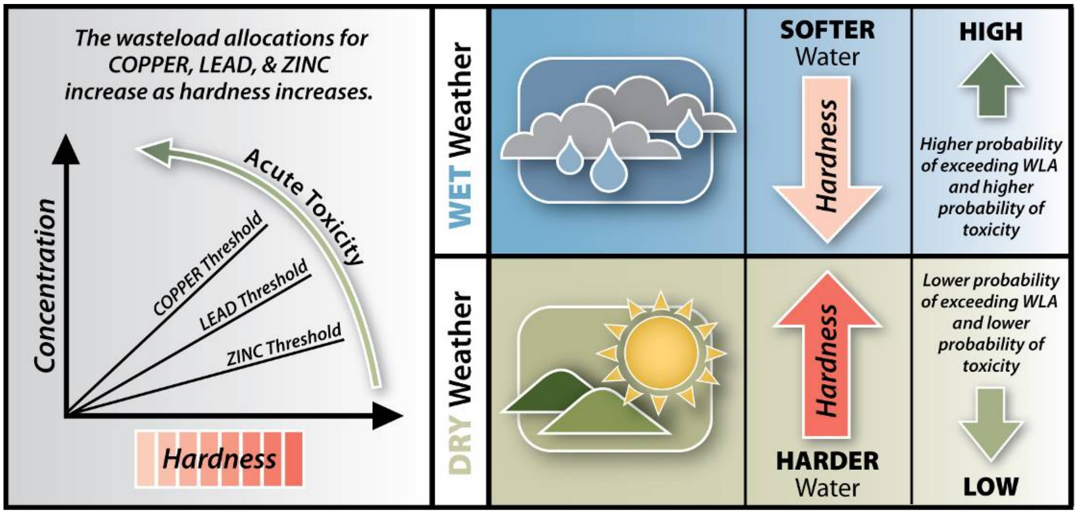


Figure 5-4. Impact of Hardness as a Dominant Variable in the California Toxics Rule Criteria

Trends for Diazinon and Toxicity

The United States Environmental Protection Agency (USEPA) implemented a nationwide ban on the retail sale of pesticides containing Diazinon on January 1, 2005. Trend analysis indicates a significant decreasing trend for SD8(1) ($p < 0.001$) and Diazinon at DPR2 ($p < 0.001$). As shown on Figure 5-5, the magnitude of this trend at DPR2 is relatively small and equal to -0.28 ng/L per year. The magnitude of decrease could not be quantified for SD(1) due to the number of non-detects in the historical data set (48%). The historical Diazinon concentrations and long-term decreasing trends for SD8(1) and DPR2 are shown on Figure 5-6 and Figure 5-7. As the residual supply of Diazinon becomes exhausted, Diazinon concentrations and the frequency of detection should continue to decrease.

No significant trends for toxicity to *C. dubia* were observed for either site. A review of historical data indicates that both sites have high rates of non-toxic results (64–78% at SD8(1) and 81–94% at DPR2).

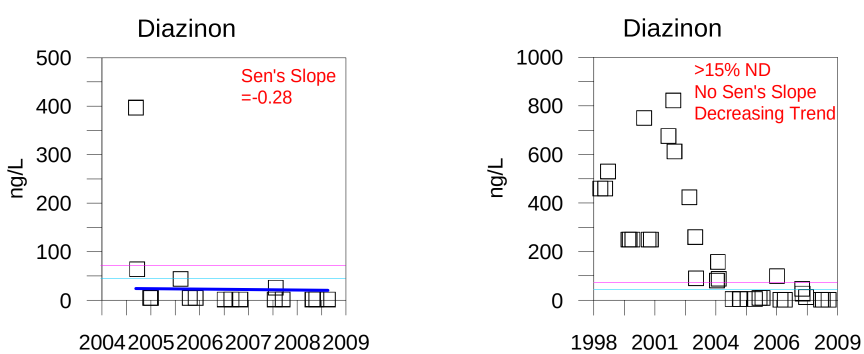


Figure 5-5. Trend Plots for Diazinon (DPR2 on left, SD8(1) on right)

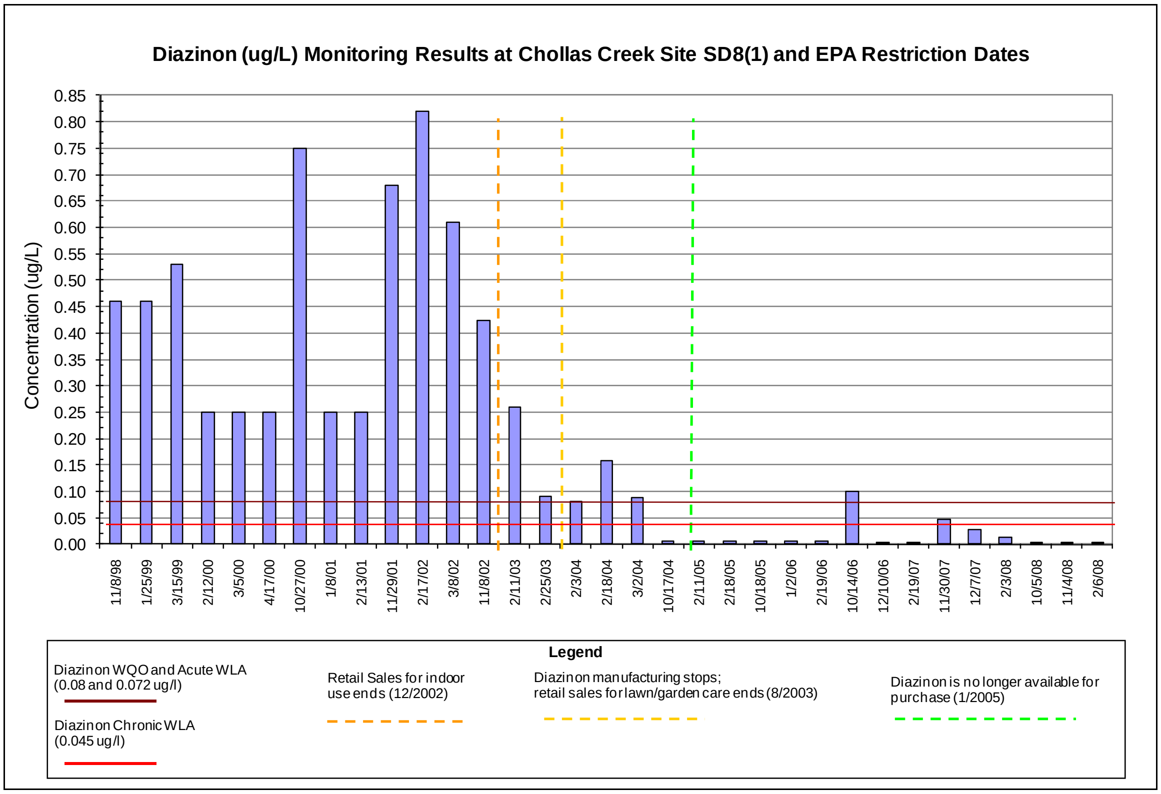


Figure 5-6. Historical Diazinon Concentrations at SD8(1) with Restriction Dates

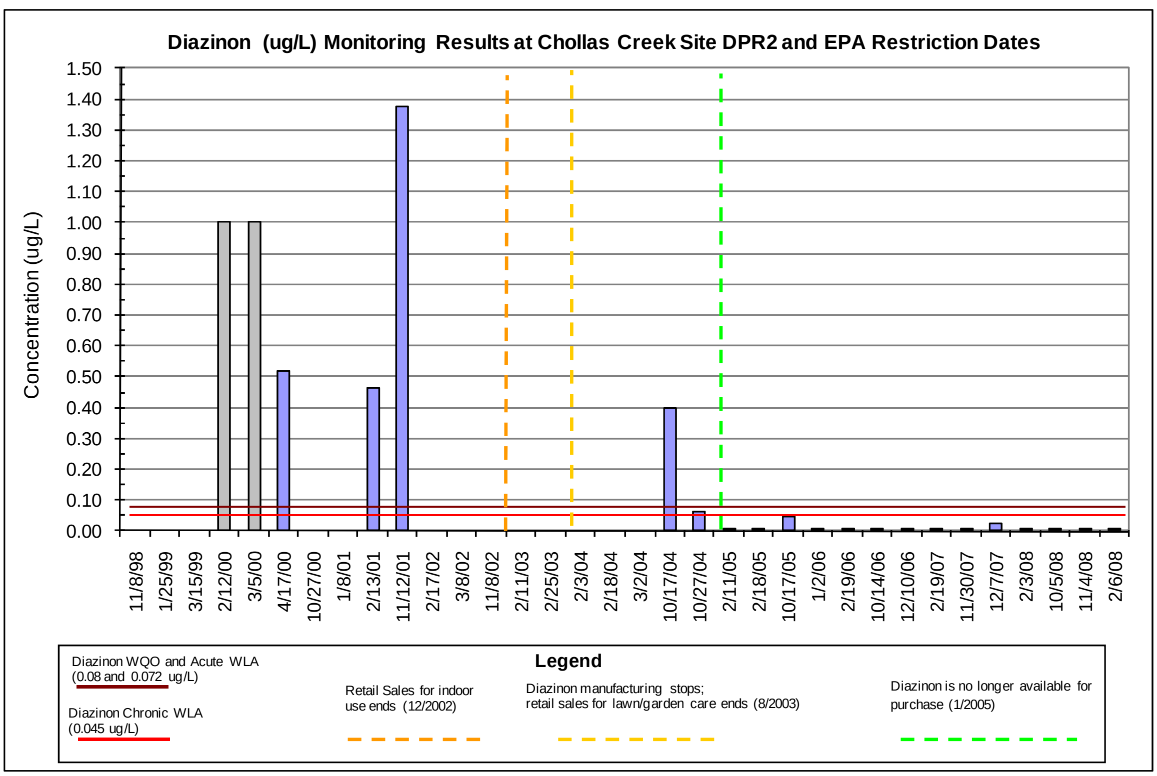


Figure 5-7. Historical Diazinon Concentrations at DPR2 with Restriction Dates

5.2 Additional Analyte Analysis

Exceedance Ratios

The 2008–2009 WQO ratio plots for fecal coliform bacteria for SD8(1) and DPR2 are shown on Figure 5-8. At SD8(1), the largest exceedance ratio of 27.5 corresponds to the largest flow event on November 4, 2008. At DPR2, the largest fecal coliform WQO ratio of 32.5 also occurred on November 4, 2008. However, larger flows were observed at DPR2 during the third storm event. The bacteria grab sample was taken at 23:35 on February 5, 2009 at DPR2, during the trailing portion of the first peak of the hydrograph. The timing of the grab sample may have impacted the concentration. On the other hand, the Design Storm study indicates that bacteria concentrations are relatively unaffected by fluctuations in a storm hydrograph (WESTON, 2009b).

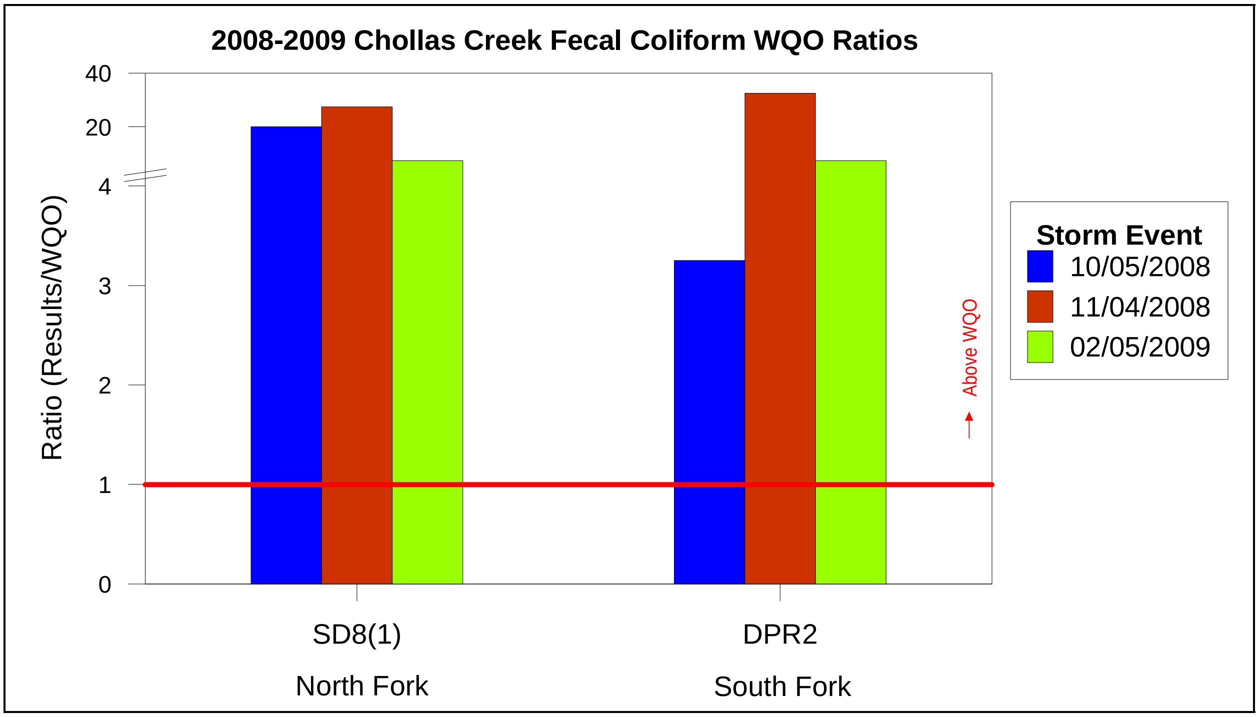


Figure 5-8. 2008–2009 Ratio Plots for Fecal Coliform Bacteria

Trends

During the 2008–2009 Monitoring Season there were no exceedances of the 100 mg/L WQO for TSS at DPR2. Trend analysis indicates a significant decreasing trend for TSS concentrations (p=0.012) at this site. This new decreasing trend may be due to implementation and the successful establishment of channel restoration projects throughout the south fork of Chollas Creek. Construction of the *Chollas Creek Water Quality Protection and Habitat Enhancement* project at the Youth Park site was completed in December 2007. The wide spread TSS results for the 2007–2008 Monitoring Season may be explained by soil disturbance associated with construction and a lack of adult vegetation in the creek. During the 2008–2009 Monitoring Season, vegetation has become established (Figure 5-10).

No other significant trends were observed for additional general chemistry analytes monitored in the 2008–2009.

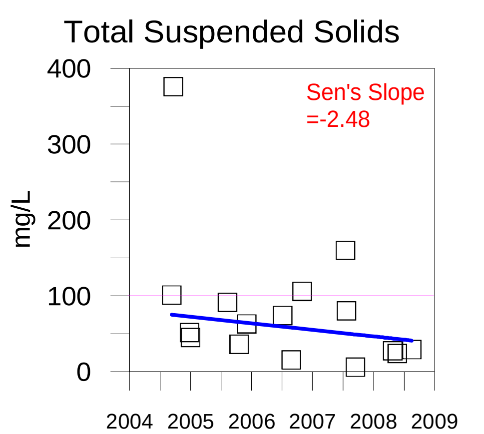


Figure 5-9. DPR2 Trend Plot for Total Suspended Solids

Figure 5-10. Completed Restoration Project at Youth Park Site (June 2008)

As shown in Subsection 4.3, the Chollas Creek Watershed had results above the published literature LC_{50} values for Bifenthrin and Permethrin during all three storm events. Toxicity to *H. azteca* was observed at SD8(1) during all three storm events and at DPR2 during the storms in October and November. Significant increasing trends for concentrations of Bifenthrin and Permethrin and toxicity to *H. azteca* were determined for SD8(1), as shown on Figure 5-11. The magnitude of these increasing trends could not be quantified through a Sen slope analysis due to the high percentage of non-detects in the historical long-term data set (Bifenthrin=33%, Permethrin=44%, toxicity to *H. azteca*=22%). There are no significant trends for synthetic pyrethroids or *H. azteca* for DPR2.

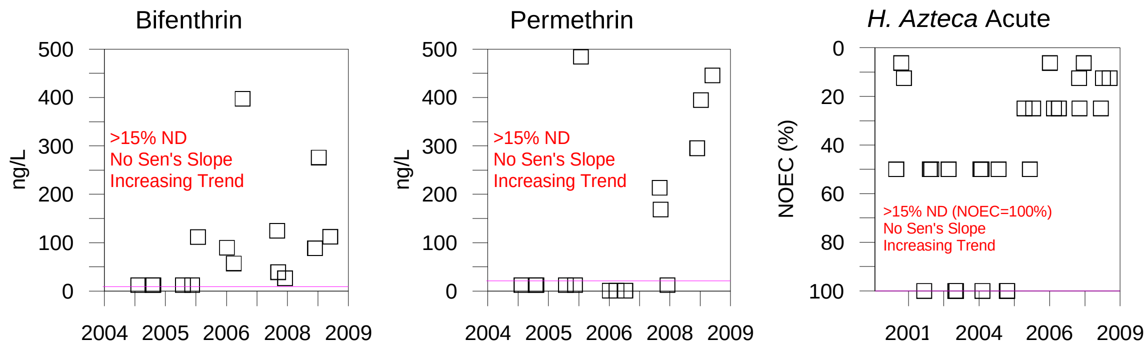


Figure 5-11. SD8(1) Trend Plots for Synthetic Pyrethroids and Toxicity to *Hyalella azteca*

6.0 SUMMARY AND CONCLUSIONS

The Dischargers have complied with Order No. R9-2004-0277 during the 2008–2009 Monitoring Season by conducting the following activities:

- Jurisdictions have exercised their legal authority to regulate pesticide discharges through industrial inspections and dry weather ICID investigations.
- Jurisdictions have performed education and outreach to area residents.
- Jurisdictions have conducted water quality monitoring during three storm events (October 4, 2008, November 4, 2008, and February 5, 2009) at SD8(1) and DPR2.

SD8(1) was located at the base of the north fork of Chollas Creek, and DPR2 was located at the base of the south fork of Chollas Creek. Water quality monitoring was completed for a limited set of analytes which were specifically named in Order No. R9-2004-0277. A suite of additional analytes were assessed to provide the Dischargers supplemental information regarding conditions in the watershed.

Compliance Monitoring

Metals concentrations at SD8(1) and DPR2 during the 2008–2009 Monitoring Season exceeded the concentration-based waste load allocations of the Chollas Creek Dissolved Metals TMDL. The CMC for dissolved copper was exceeded three times at SD8(1) and twice at DPR2. The CCC for dissolved copper was exceeded at both SD8(1) and DPR2 for all three storm events. There were two CCC exceedances for dissolved lead at SD8(1). The CMC for dissolved zinc was exceeded at both sites for all three storm event and the CCC was exceeded at SD8(1) for all three storm events.

Mann-Kendall trend analysis performed on the long-term data set at SD8(1) indicates significantly increasing trends for total and dissolved copper and zinc. The magnitude of the zinc trend is greater than for copper, but both trends are relatively shallow. Significant trends for metals were not observed at DPR2.

The organophosphorus pesticide Diazinon was not detected at either SD8(1) and DPR2. There are significant, observably decreasing trends for Diazinon in both the north fork and south fork. The magnitude of the decreasing trend at DPR2 was quantified to -0.28 ng/L per year. The trend for SD8(1) could not be quantified due to the high number of non-detects. As the residual supply of Diazinon becomes exhausted due to the USEPA ban on Diazinon, concentrations and the frequency of detection in Chollas Creek should continue to decrease.

Acute and chronic survival toxicity to *C. dubia* was not observed at SD8(1) or DPR2. Chronic survival toxicity to *C. dubia* was observed once at SD8(1), during the February 5, 2008 storm event. A review of historical data indicates that both sites have high rates of non-toxic results (64–78% at SD8(1) and 81–94% at DPR2).

Additional Monitoring

WQO exceedances at SD8(1) and DPR2 were observed for the additional analytes Malathion, Bifenthrin, Permethrin, and fecal coliform bacteria. There were no significant trends for water quality conditions in the south fork for these additional analytes. Due to the high percentage of non-detect values the magnitude of the increasing trends for synthetic pyrethroids (Bifenthrin and Permethrin) could not be quantified at SD8(1). Overall, synthetic pyrethroid usage within the watershed also warrants attention. TIE studies have indicated a link between toxicity to *H. azteca* and detections of synthetic pyrethroids. Toxicity to *H. azteca* was observed in both the north and south forks of Chollas Creek during the 2008–2009 Monitoring Season and this toxicity has persisted even as *C. dubia* toxicity has decreased.

WQO exceedances at SD8(1) were also observed for TSS and oil and grease. No significant trends were observed at SD8(1) for these analytes. The TSS concentrations at DPR2 were below the WQO during the 2008–2009 Monitoring Season. Mann-Kendall trend analysis indicated a significant decreasing trend for TSS for the south fork, which may be the result of stream restoration projects that have been completed in the south fork of Chollas Creek (e.g., *Chollas Creek Water Quality Protection and Habitat Enhancement* project at the Youth Park site).

Recommendations

USEPA has provided guidance concerning a procedure that may be used to derive regional aquatic-life criterion, such as the CTR allows for site-specific criterion to be developed for metals. The indicator species procedure is based on the assumption that characteristics of site specific water may influence the bioavailability and toxicity of a pollutant. As part of the procedure, acute toxicity in site water and laboratory water is determined in concurrent toxicity tests. The water effects ratio (WER) (site water to laboratory water toxicity values) would subject the current TMDL waste load allocations to a criteria adjustment factor that accounts for the effect of site-specific water characteristics on pollutant bioavailability and toxicity to aquatic life. In Chollas Creek, a WER would likely raise the WQO above the concentrations typically observed for dissolved metals in storm water. This statement is based on the fact that higher dissolved organic carbon in Chollas Creek waters would result in higher complexation of metals. Additionally, since toxicity is rarely observed to *C. dubia*, the application of a WER would be beneficial. This procedure has been used in the Calleguas Creek Watershed resulting in a WER ranging from 1.51 during dry weather to 3.69 during wet weather conditions (LWA, 2006). Based on the magnitude of exceedances for dissolved copper and dissolved zinc, the Chollas Creek Watershed would benefit from the development of a WER. The City of San Diego will be conducting a WER special study during the 2009–2010 Monitoring Season.

Education and outreach programs and events for area residents and businesses should continue to reduce pesticide usage within the Chollas Creek Watershed.

Synthetic pyrethroids are currently undergoing pesticide re-registration review by the California Department of Pesticide Regulation at this time. Therefore, gaining a deeper understanding of synthetic pyrethroid usage in the watershed (through special studies) also warrants attention.

As Dischargers begin implementing management programs in accordance with the Implementation Plan, additional water quality monitoring should be implemented to identify the sources of metals, evaluate effectiveness, and monitor trends in water quality.

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