Middle Santa Ana River Bacterial Indicator TMDL 2010-2011 Wet Season Report

May 25, 2011

CDM

ON BEHALF OF

Santa Ana Watershed Project Authority

San Bernardino County Stormwater Program

County of Riverside

Cities of Chino Hills, Upland, Montclair, Ontario, Rancho Cucamonga, Rialto, Chino, Fontana, Norco, Corona, Riverside, Pomona, and Claremont

Agricultural Operators

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Section 1
Introduction

Various waterbodies in the Middle Santa Ana River (MSAR) watershed are listed on the state 303(d) list of impaired waters due to high levels of fecal coliform bacterial indicators. The Santa Ana Regional Water Quality Control Board (RWQCB) adopted the MSAR Bacterial Indicator Total Maximum Daily Load (TMDL) in 2005 (RWQCB 2005) to address the fecal coliform bacterial indicator impairments. Following approval by the State Water Resources Control Board, the Environmental Protection Agency (EPA) Region 9 approved the TMDL on May 16, 2007 making the TMDL effective.

The TMDL requires implementation of a watershed-wide compliance monitoring program for bacterial indicators. This program was initiated in July 2007. This report summarizes the findings from water quality monitoring conducted during the 2010-2011 wet season and, where appropriate, compares results to previous sample periods.

1.1 Regulatory Background

Table 3-1 of the Santa Ana Regional Water Quality Control Plan (Basin Plan) designates beneficial uses for surface waters in the Santa Ana River watershed (RWQCB 1995). The beneficial uses applicable to waterbodies in the MSAR watershed include Water Contact Recreation (REC-1), which is defined in the Basin Plan as follows:

> "…waters are used for recreational activities involving body contact with water where ingestion of water is reasonably possible. These uses may include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, whitewater activities, fishing, and use of natural hot springs" (Basin Plan, page 3-2).

The Basin Plan (Chapter 4) specifies fecal coliform as a bacterial indicator for pathogens ("bacterial indicator"). Fecal coliform present at concentrations above certain thresholds are believed to be an indicator of the presence of fecal pollution and harmful pathogens, thus increasing the risk of gastroenteritis in bathers exposed to the elevated levels. The Basin Plan currently specifies the following water quality objectives for fecal coliform:

> ***REC-1*** *- Fecal coliform: log mean less than 200 organisms/100 mL based on five or more samples/30 day period, and not more than 10% of the samples exceed 400 organisms/100 mL for any 30-day period.*

The EPA published new bacterial indicator guidance in 1986 (EPA 1986). This guidance advised that for freshwaters *Escherichia coli* (*E. coli*) is a better bacterial indicator than fecal coliform. Specifically, epidemiological studies found that the positive correlation between *E. coli* concentrations and the frequency of gastroenteritis

was better than the correlation between fecal coliform concentrations and gastroenteritis.

The RWQCB is currently considering replacing the REC-1 bacteria water quality objectives for fecal coliform with *E. coli* objectives. This evaluation is occurring through the work of the Stormwater Quality Standards Task Force (SWQSTF), comprised of representatives from various stakeholder interests, including the Santa Ana Watershed Protection Authority (SAWPA), the counties of Orange, Riverside, and San Bernardino, Orange County Coastkeeper, Inland Empire Waterkeeper, the RWQCB, and EPA Region 9.

In 1994 and 1998, because of exceedances of the fecal coliform objective established to protect the REC-1 use, the RWQCB added the following waterbodies in the MSAR watershed to the state 303(d) list of impaired waters:

- Santa Ana River, Reach 3 – Prado Dam to Mission Boulevard
- Chino Creek, Reach 1 – Santa Ana River confluence to beginning of hard lined channel south of Los Serranos Road
- Chino Creek, Reach 2 – Beginning of hard lined channel south of Los Serranos Road to confluence with San Antonio Creek
- Mill Creek (Prado Area) – Natural stream from Cucamonga Creek Reach 1 to Prado Basin
- Cucamonga Creek, Reach 1 – Confluence with Mill Creek to 23rd Street in City of Upland
- Prado Park Lake

The 2005 RWQCB-adopted TMDL for these waters established compliance targets for both fecal coliform and *E. coli*:

- Fecal coliform: 5-sample/30-day logarithmic mean less than 180 organisms/ 100 mL and not more than 10% of the samples exceed 360 organisms/100 mL for any 30-day period.
- *E. coli*: 5-sample/30-day logarithmic mean less than 113 organisms/100 mL and not more than 10% of the samples exceed 212 organisms/100 mL for any 30-day period.

To focus TMDL implementation efforts, the MSAR Watershed TMDL Task Force ("TMDL Task Force") was established. This Task Force, which meets regularly to coordinate water quality management activities, includes representation by key watershed stakeholders, e.g., urban stormwater dischargers, agricultural operators, and the RWQCB.

1.2 Watershed-Wide Compliance Monitoring

The MSAR Bacterial Indicator TMDL required urban and agricultural dischargers to implement a watershed-wide bacterial indicator monitoring program by November 2007 (RWQCB 2005). The dischargers worked collaboratively through the TMDL Task Force to develop this program and prepared a Monitoring Plan (SAWPA 2008a) and Quality Assurance Project Plan (SAWPA 2008b)[1]. The TMDL Task Force implemented the monitoring program in July 2007 following RWQCB approval of program documents.

SAWPA (2009a) summarizes the findings from the first year of dry and wet season monitoring (2007-2008). SAWPA (2009b, 2009c, and 2009d) summarize the findings from the 2008 dry, 2008-2009 wet and 2009 dry seasons, respectively. SAWPA (2010a) and SAWPA (2010b) provide the monitoring program results for the 2009-2010 wet and 2010 dry seasons, respectively. This report provides the results from the 2010-2011 wet season.

In addition to the regular seasonal reports summarized above, the TMDL requires preparation of Triennial Reports. The purpose of these reports is to assess water quality data collected during the preceding three year period and evaluate progress towards achieving the MSAR TMDL wasteload and load allocations. The TMDL Task Force submitted its first TMDL Triennial Report in 2010 (SAWPA 2010c).

[1] The Middle Santa Ana River Monitoring Plan and Quality Assurance Project Plan are available at http://sawpa.org/roundtable-MSARTF.html

Section 2
Study Area

This section describes the study area and identifies the watershed-wide compliance monitoring locations sampled during the 2010-2011 wet season. SAWPA (2009a) provides a more detailed characterization of the watershed.

2.1 Middle Santa Ana River Watershed

2.1.1 General Description

The Santa Ana River watershed, located in southern California, is approximately 2800 square miles in size. Surface water flows begin in the San Bernardino and San Gabriel Mountains and flow in a generally northeast to southwest direction to the Pacific Ocean. The MSAR watershed is 488 square miles in size and located generally in the north central portion of the Santa Ana River watershed. The watershed includes the southwestern part of San Bernardino County, the northwestern part of Riverside County, and a small portion of Los Angeles County (Figure 2-1).

Lying within an arid region, limited natural perennial surface water is present in the watershed. Flows derived from mountain areas (snowmelt or storm runoff) are mostly captured by dams or percolated in recharge basins. In the transition zone from mountains to lower lying valley areas, the sources of surface water flows vary, e.g., dry weather urban runoff, such as occurs from irrigation, stormwater runoff during rain events, highly treated wastewater effluent, or rising groundwater.

The largest order waterbody in the MSAR watershed is Reach 3 of the Santa Ana River which flows from the La Cadena Drive bridge downstream to the Prado Basin, where Prado Dam controls flows from the middle to the lower part of the Santa Ana River watershed. A number of major tributaries to the MSAR exist, many of which have been modified for flood control purposes.

Three major geographic areas comprise the MSAR watershed (RWQCB 2005) (Figure 2-2):

- *Chino Basin* (San Bernardino County, Los Angeles County, and Riverside Counties) – Surface drainage in this area, which is directed to Chino Creek and Mill-Cucamonga Creek, flows generally southward, from the San Gabriel Mountains toward the Santa Ana River and the Prado Flood Control Basin.

- *Riverside Watershed* (Riverside County) – Surface drainage in this area is generally northwestward or southwestward from the incorporated and unincorporated areas of Riverside County to Reach 3 of the Santa Ana River.

- *Temescal Canyon Watershed* (Riverside County) – Surface drainage in this area is generally northwest to Temescal Creek, which drains to the Prado Flood Control Basin.

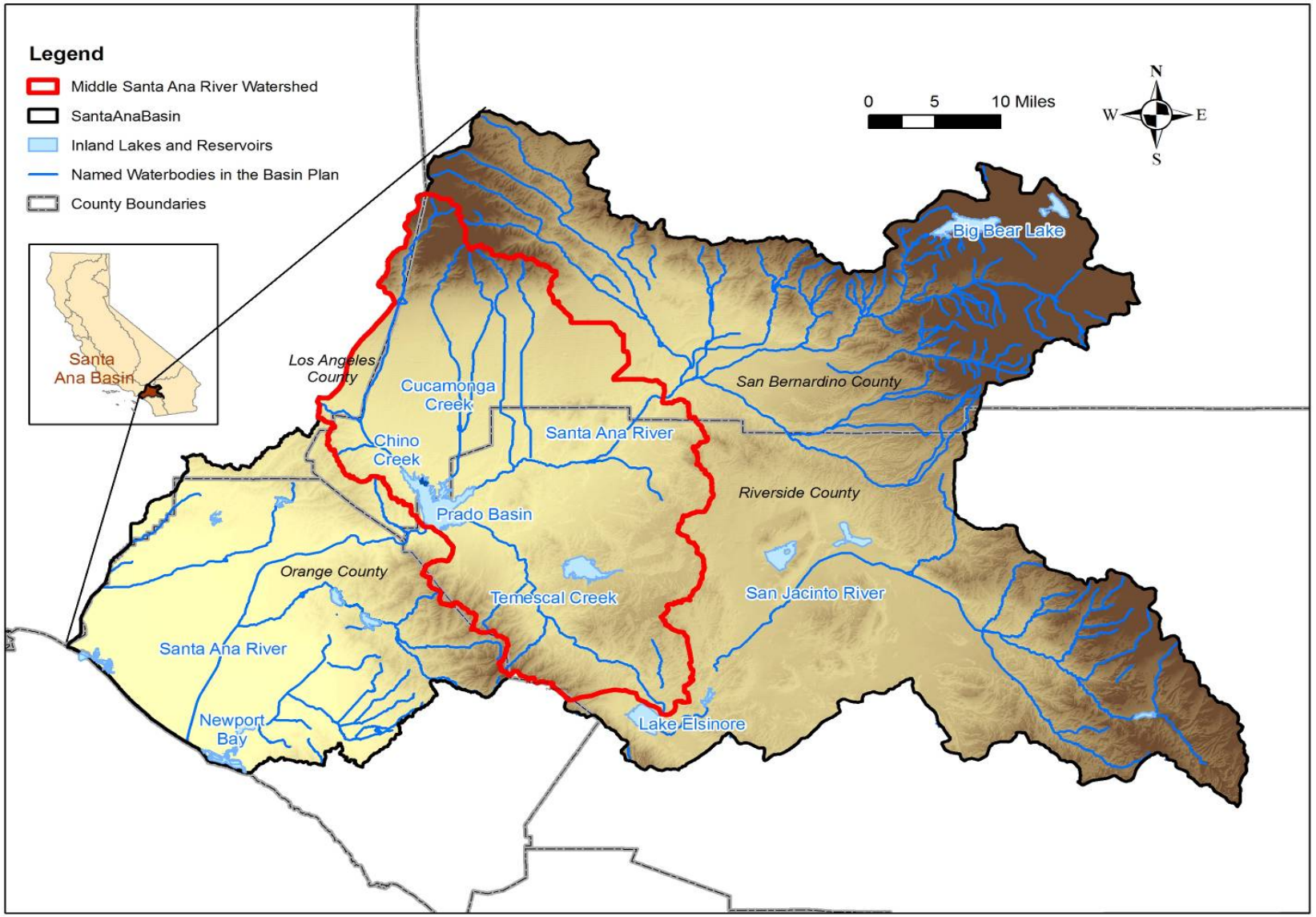


Figure 2-1. Location of the Middle Santa Ana River watershed (red outline) within the Santa Ana River watershed in southern California

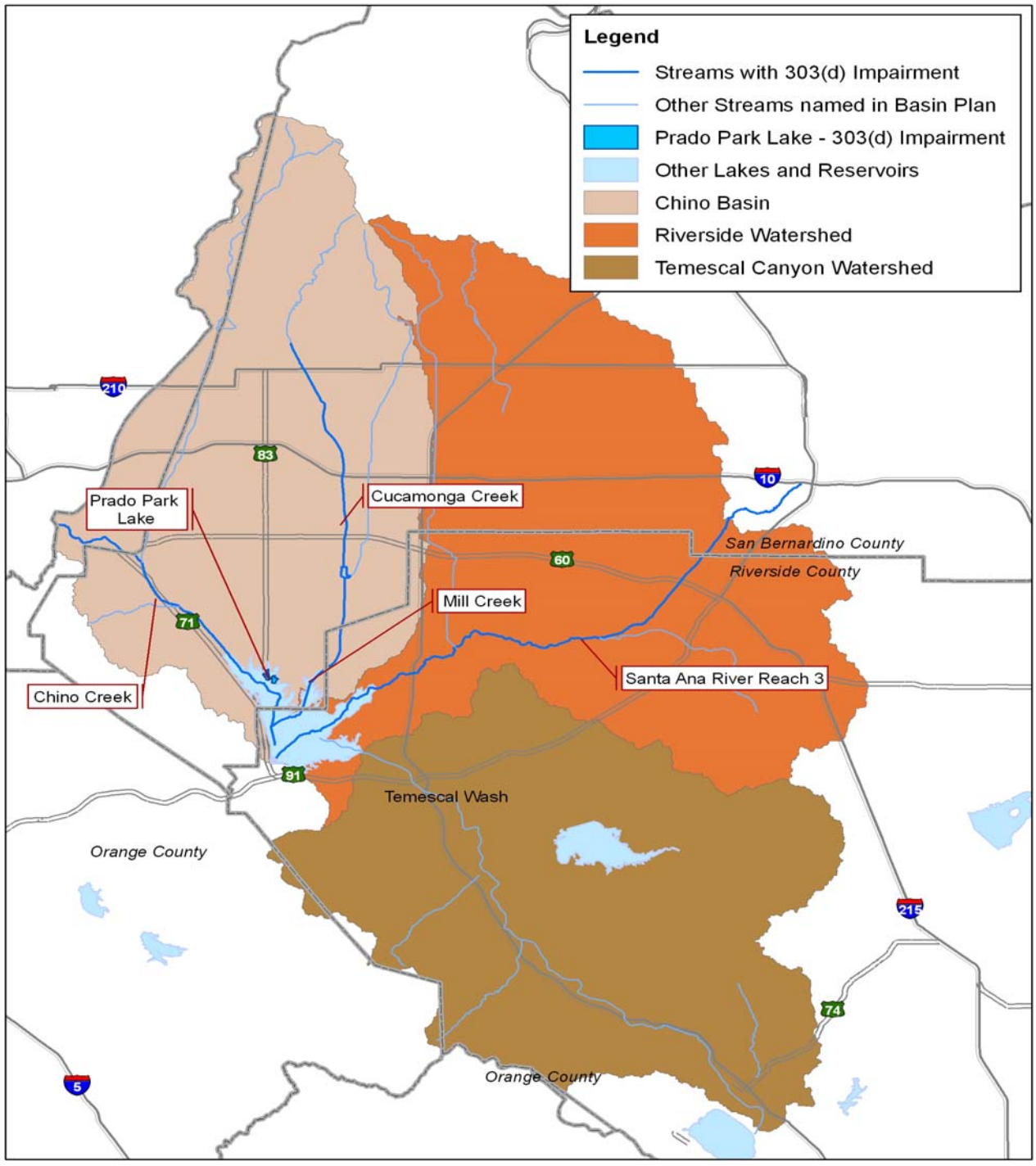


Figure 2-2. Major geographic areas of the Middle Santa Ana River watershed

Based on 2000 census data, the population of the MSAR watershed is approximately 1.4 million people. Much of the lowland areas are highly developed; however, a portion of the watershed remains largely agricultural - the area formerly known as the Chino Dairy Preserve. This area is located in the south central part of the Chino Basin subwatershed. At the time of TMDL development the area contained approximately 300,000 cows (RWQCB 2005). As of January 2009, this number was down to about 138,500 (email communication, Ed Kashak [RWQCB] to Pat Boldt, December 8, 2009). In recent years, the cities of Ontario, Chino, and Chino Hills annexed the San Bernardino County portions of this area (RWQCB 2005). The remaining portion of the former preserve, which is in Riverside County, consists primarily of the City of Eastvale (which incorporated in 2010) and City of Jurupa Valley (which recently voted to incorporate and become a city July 1, 2011).

2.1.2 Physical Description

The following sections summarize the regional hydrology, annual precipitation and temperature, and sources of information for previously reported bacterial indicator concentrations in the study area.

2.1.2.1 Regional Hydrology

The Santa Ana River watershed experiences a Mediterranean type climate with hot, dry summers, and cooler, wetter winters. Average annual precipitation varies and ranges from 12 inches per year in the lower watershed along the Pacific coast to 18 inches per year in the inland valleys. In the mountains of the northern and eastern parts of the watershed annual precipitation may reach 40 inches per year. Most precipitation falls between November and March and may include variable amounts of snow in the higher mountains (SAWPA 2005).

On average, instream flows are typically low; however, periods of significant precipitation or localized intense rain events can result in rapid increases in surface flows by one to two orders of magnitude. Following such an event, streams tend to return to baseflow conditions quickly (SAWPA 2005, 2009a). Instream flows in the watershed are influenced by the following:

- Dams capture wet weather flows in some subwatersheds resulting in attenuated flows in downstream waters. For example, the Chino Creek subwatershed receives releases from San Antonio Dam via its San Antonio Channel tributary.

- The effort to recharge groundwater by facilitating infiltration of surface water runoff reduces runoff in receiving waters by diversion and spreading of runoff in basins with high infiltration capacity.

- The importation of water to the watershed increases surface flows in certain areas, e.g., importation of water to Chino Creek.

- A number of publicly owned treatment works discharge highly treated effluent to MSAR waterbodies, e.g., a significant portion of the flow along segments of Reach

3 of the Santa Ana River is comprised mostly of treated effluent. Treated effluent is also discharged to Cucamonga Creek and Chino Creek.

2.1.2.2 Wet Season Flow

The United States Geological Survey (USGS) gathers flow data from the following locations nearby watershed-wide compliance sites:

- Santa Ana River at MWD Crossing in Riverside County (USGS Station No.: 11066460)
- Chino Creek at Schaefer Avenue near Chino (USGS Station No.: 11073360)
- Cucamonga Creek near Mira Loma (USGS Station No.: 11073495)

Table 2-1 summarizes the available[2] mean monthly flow observed in these waterbodies for the 2010-2011 wet season (Note: Data set includes provisional data). Available daily mean values are provided in Appendix A (Table A-10).

Table 2-1. Monthly mean flow summary (cfs) from USGS gauged sites near sample locations (M = Missing)[1]

Month	Santa Ana River at MWD Crossing (Riverside County)	Chino Creek at Schaefer near Chino	Cucamonga Creek near Mira Loma
November	84.7	6.8	41.4
December	1,675.4[2]	95.8	325.6
January	M	M	M
February	M	M	M
March	M	M	M

[1] Data unavailable from the USGS as of April 29, 2011
[2] Data missing for December 23-31, 2011

2.1.2.3 Rainfall

Table 2-2 provides the locations of key rainfall gauges in the MSAR watershed (data provided by Riverside County Flood and Water Conservation District). Table 2-3 summarizes the mean monthly rainfall data from each location for the period of record available for this report (November, 2010 – January, 2011). Appendix A (Table A-11) provides the daily rainfall measurements from each gauged location.

[2] Currently, USGS data is only available through December 31, 2010. Final report will include data through March 31, 2011 only if it becomes available by the due date for this report (May 31, 2011).

Table 2-2. Location of key rainfall gauges in Middle Santa Ana River Watershed

Station No.	Station Name	Latitude	Longitude
178	Riverside North	34.00277778	117.37777778
179	Riverside South	33.95111111	117.38750000
35	Corona	33.84500000	117.57444444
131	Norco	33.92147222	117.57244444

Table 2-3. Monthly rainfall totals (inches) at key rainfall gauges[1]

Month	Riverside North	Riverside South	Corona	Norco
November	0.92	0.77	1.19	0.5
December	9.97	8.89	13.87	9.13
January	0.5	0.43	0.7	0.45

[1] Rainfall totals for February and March 2011 were not available at the time this report was prepared.

2.1.2.4 Water Quality

Bacterial indicator water quality data have been collected for many years in the MSAR watershed. SAWPA (2009a) references and summarizes the findings from MSAR watershed studies conducted prior to 2007. SAWPA (2009a, 2009b, 2009c, 2009d, 2010a, 2010b, and 2010c) report and evaluate bacterial indicator data collected since 2007.

2.2 Watershed-Wide Compliance Monitoring Sites

The TMDL Task Force established the watershed-wide compliance monitoring sites in the MSAR watershed. Table 2-4 and Figure 2-3 identify the location of each site sampled in 2010[3]. Attachment A of the Monitoring Plan (see footnote 1) provides additional information about each sample location.

Table 2-4. Watershed-wide compliance monitoring program sample locations

Waterbody	Sample Location	Site Code
Prado Lake	Prado Lake Outlet	WW-C3
Chino Creek	Central Avenue	WW-C7
Mill-Cucamonga Creek	Chino-Corona Road	WW-M5
Santa Ana River	MWD Crossing (Riverside County)	WW-S1
Santa Ana River	Pedley Avenue	WW-S4

[3] Prior to the 2009 dry season, Icehouse Canyon was included as watershed-wide compliance monitoring site. However, with RWQCB approval the Task Force removed this site from the sampling program prior to the start of the 2009 dry season monitoring program.

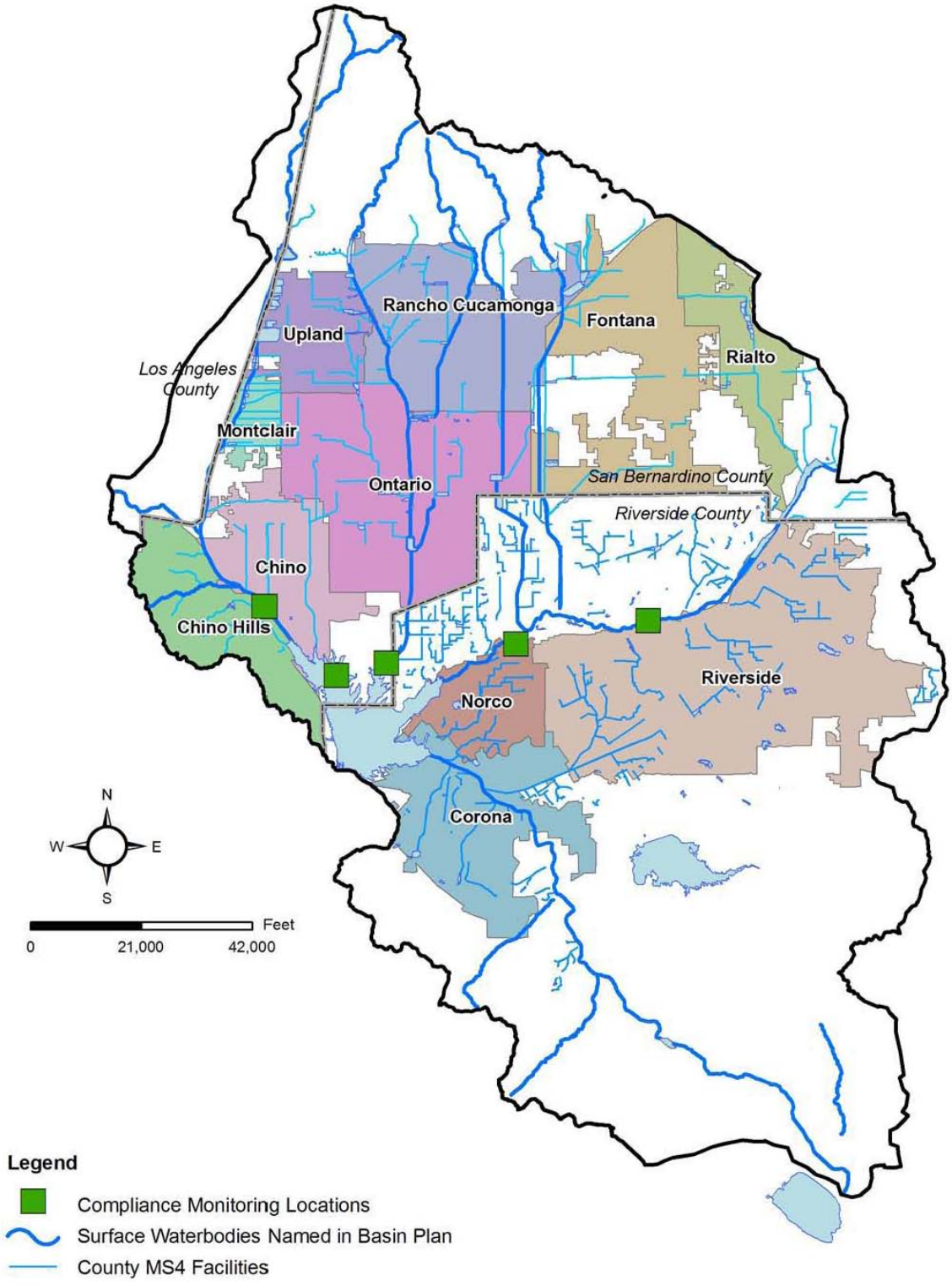


Figure 2-3. Location of watershed-wide compliance monitoring program sample locations in the Middle Santa Ana River watershed

Section 3
Methods

The RWQCB-approved Monitoring Plan and Quality Assurance Project Plan (see footnote 1) provide detailed information regarding the collection and analysis of field data and water quality samples. The following sections provide a summary of these methods.

3.1 Water Quality Measurements

At each sample site water quality measurements include the collection of field parameter data and water samples for laboratory analysis:

- *Field Measurements*: Flow, temperature, conductivity, pH, dissolved oxygen, and turbidity.

- *Laboratory Analysis*: Fecal coliform, *E. coli*, and total suspended solids (TSS).

3.2 Sample Frequency

The Monitoring Plan established sample collection dates for each year of the monitoring program. During 2010-2011, the wet season sample dates were planned as follows: Collect weekly samples over an 11 week period from the week of December 20, 2010 to the week of February 28, 2011.

In addition to regular weekly collections, the Monitoring Plan requires the collection of samples during one storm event as follows: (1) collect samples on the day of the storm event; (2) collect additional samples 48, 72 and 96 hours after the onset if the storm event. This past wet season a storm event was sampled beginning November 20, 2011. Additional samples were collected 48, 72 and 96 hours after the storm event on November 22, 23 and 24, respectively.

Table 3-1 summarizes the results of the 2010-2011 sampling effort. All planned bacterial water quality samples were successfully collected.

3.3 Data Collection

San Bernardino County Flood Control District staff collected the field measurements and water quality samples (actual names of sample collectors may be obtained from the District or field forms). CDM coordinated the activities of the sample team and the submittal of samples to the laboratory for analysis.

Table 3-1. Summary of water sample collection activity during 2010-2011 wet season

Sample Month	Planned[1]	Collected	Samples Missed
December	10	10	0
January	20	20	0
February	20	20	0
March	5	5	0
Total	**55**	**55**	**0**

[1] – Number of planned samples depends on the number of sample weeks per month times the number of sites planned for sampling. For example, in January five sites were planned for sampling during each of the four sample weeks that occurred in January for a total of 20 samples.

3.4 Sample Handling

Sample collection and laboratory delivery followed approved chain of custody procedures, holding time requirements, and required storage procedures for each water quality analysis. The Orange County Health Care Agency Water Quality Laboratory conducted all analyses for fecal coliform, *E. coli,* and TSS. Appendix B includes a brief summary of QA/QC activities conducted during the wet season.

3.5 Data Handling

CDM and SAWPA maintain a file of all laboratory and field data records (e.g., data sheets, chain of custody forms) as required by the Quality Assurance Project Plan. CDM entered all field measurements and laboratory analysis results into a project database that is compatible with guidelines and formats established by the California Surface Water Ambient Monitoring Program. CDM periodically submits to SAWPA updates of this for incorporation into the Santa Ana Watershed Data Management System (SAWDMS), which SAWPA manages. Prior to a data submittal to SAWPA, CDM completes a QA/QC review of the data.

3.6 Data Analysis

Data analysis relied primarily on the use of descriptive and correlation statistics. For any statistical analyses, the bacterial indicator data were assumed to be log-normally distributed as was observed in previous studies (SAWPA 2009a). Accordingly, prior to conducting statistical analyses, the bacterial indicator data were log transformed.

The 2010-2011 wet season sampling program only targeted one storm event for sampling. However, during regular weekly sampling activities, samples could still have been collected at times when a sample location was influenced by wet weather conditions. Given the potential for wet weather conditions to be present at different times, the following data sources/criteria were evaluated to provide a basis for classifying a sample as having been collected during wet or dry weather conditions:

- Rainfall recorded at a nearby meteorological station;

- Daily flow record from several U.S. Geological Survey (USGS) or San Bernardino County Flood Control District operated flow gauges in the watershed (as available); and

- Comparison of the flow measurement taken at the time of sample collection to the typical site baseflow observed during the sample period.

Table 3-2 summarizes the sample results classified as being influenced by a wet weather flow condition. All remaining samples were classified as dry weather; however, the available flow data suggested that baseflow was generally elevated during the late December through February sample period.

Table 3-2. Summary of samples classified as wet weather samples during 2010-2011 wet season

Site	Sample Date	Preceding 3-Day Rainfall (inches)	Measured Flow (cfs)	Approximate Baseflow (cfs)
Prado Park Lake Outflow	11/24/10	0.09	5.1	4
	12/21/10	6.39	n/a[1]	4
Chino Creek at Central Ave	11/20/10	0.00	158.4	30
	11/24/10	0.09	32.11	30
	12/21/10	6.39	n/a[1]	30
Mill-Cucamonga Creek at Chino Corona Rd	11/20/10	0.76	841	40
	12/21/10	5.54	n/a[1]	40
Santa Ana River at MWD Crossing (Riverside County)	11/22/10	0.69	40	100
	11/24/10	0.10	144	100
	12/21/10	4.37	n/a[1]	100
	2/22/11	0.54	224	100
Santa Ana River at Pedley Ave	11/20/10	0.04	343	200
	11/22/10	0.69	302	200
	11/24/10	0.10	305	200
	12/21/10	4.37	n/a[1]	200
	2/22/11	0.54	170	200

[1] – Unsafe flow conditions prevented flow measurement

Section 4
Sample Results

This section summarizes the results of data analyses applied to the 2010-2011 wet season dataset. Where appropriate to provide context, data results are compared to water quality results previously reported (e.g., SAWPA 2009a, 2009b, 2009c, 2009d, 2010a and 2010b).

4.1 Water Quality Observations

Table 4-1 provides the median value and range of observations for each sampled water quality constituent. Appendix A (Tables A-1 through A-9) summarizes the water quality data results observed at each site throughout the sample period covered by this report. No data outliers were identified in the data set.

4.2 Characterization of Bacterial Indicators

Table 4-2 summarizes the distribution of the fecal coliform and *E. coli* data collected from all sites over all sample dates during the 2010-2011 wet season.

Table 4-3 summarizes the geometric mean, median, and coefficient of variation of the fecal coliform data for all samples collected regardless of whether the sample was classified as being a wet or dry weather sample (See Section 3.6 for classification of samples as wet weather samples). Table 4-4 provides the fecal coliform results for the samples collected only during dry weather conditions.

Table 4-5 summarizes the geometric mean, median, and coefficient of variation of the *E. coli* data for all samples collected regardless of whether the sample was classified as being a wet or dry weather sample. Table 4-6 provides the *E. coli* results for the samples collected only during dry weather conditions.

For the most part, the 2010-2011 wet season fecal coliform and *E. coli* geometric mean and median concentrations (regardless of wet or dry weather conditions) at the Chino Creek and Mill-Cucamonga Creek sites were lower than previous wet seasons (Tables 4-3 through 4-6). In contrast, the geometric mean and median concentrations observed at the Santa Ana River sites were higher. Observations at the Prado Park Lake site were generally similar to what has been previously observed at that site during the wet season (Tables 4-3 through 4-6).

Table 4-1. Summary of water quality monitoring data collected during 2010 - 2011 wet season (where sample results were less than or greater than a particular data value, the data value was used to calculate the median).

Constituent	Prado Park Lake Outflow (WW-C3)	Chino Creek at Central Ave (WW-C7)	Mill-Cucamonga Creek (WW-M5)	Santa Ana River at MWD Crossing (WW-S1) (Riverside County)	Santa Ana River at Pedley (WW-S4)
Fecal coliform (cfu/100 mL)					
N	15	15	15	15	15
Median	140	210	340	170	270
Range	40 – 68,000	70 – 9,400	30 – 7,400	9 – 5,100	110 – 11,200
***E. coli* (cfu/100 mL)**					
N	15	15	15	15	15
Median	170	220	250	240	310
Range	70 – 71,000	99 – 8,800	40 – 5,300	30 – 1,550	130 – 5,600
Total Suspended Solids (mg/L)					
N	15	15	15	15	14[1]
Median	20.5	2.8	5.5	122.0	103.9
Range	7.3 – 45.5	1.6 – 139.6	2.7 – 144.0	7.0 – 7,590.0	19.8 – 2,312.0
Dissolved Oxygen (mg/L)					
N	14[1]	15	15	15	15
Median	6.2	8.5	9.3	9.0	8.9
Range	2.0 – 10.0	5.9 – 10.5	7.0 – 15.3	6.1 – 10.7	6.3 – 10.3
pH (Standard Units)					
N	15	15	15	15	15
Median	7.6	8.0	8.1	7.2	7.3
Range	6.5 – 8.3	7.1 – 8.7	6.4 – 8.6	6.1 – 7.8	6.1 – 7.9
Turbidity (NTU)					
N	15	15	15	12[1]	13[1]
Median	17.7	3.4	3.6 – 159.0	53.4	35.0
Range	7.6 – 61.2	2.1 – 333.7	2.1 – 24.2	3.2 – 467.0	17.3 – 355.0
Water Temperature (°C)					
N	15	15	15	15	15
Median	14.4	19.3	15.6	12.2	12.5
Range	11.4 – 16.9	12.7 – 22.6	12.2 – 18.3	8.7 – 18.5	10.3 – 16.4
Flow (cfs)					
N	12[1]	14[1]	14[1]	11[1]	11[1]
Median	4.3	30.8	101.9	153.8	246.7
Range	1.2 – 8.3	14.6 – 158.4	11.2 – 64.9	40.0 – 224.5	135.1 – 343.0
Conductivity (µS/cm)					
N	15	15	15	15	15
Median	948.3	736.0	556.7	669.0	662.3
Range	246.0 – 1,383.0	85.0 – 914.7	74.0 – 640.7	136.0 – 1,016.7	169.0 – 1020.0

[1] – Data missing for one or more of fifteen sample events because of unsafe conditions, excess turbidity (caused by Seven Oaks Dam release) or equipment/laboratory problems.

Table 4-2. Statistical distribution of bacterial indicator data (cfu/100 mL) during the 2010-2011 wet season

Statistic	2010 – 2011 Wet Season	
	E. coli	**Fecal coliform**
Sample Size (n)	75	75
Geometric Mean	322	297
10^{th} Percentile	103	70
25^{th} Percentile	150	125
50^{th} Percentile (median)	240	210
75^{th} Percentile	475	465
90^{th} Percentile	2120	4200

Table 4-3. Summary of fecal coliform concentrations (cfu/100 mL) and data variability by sample location during the 2010-2011 wet season

Site	2010 - 2011				Range of Wet Season Observations (2007 -2011)		
	N	Geometric Mean	Median	Coefficient of Variation[1]	Geometric Mean	Median	Coefficient of Variation[1]
Prado Park Lake	15	215	140	0.33	144 - 230	144 – 280	0.14 – 0.28
Chino Creek	15	298	210	0.26	365 - 776	230 – 320	0.22 – 0.26
Mill-Cucamonga Creek	15	329	340	0.26	431 – 635	215 – 450	0.18 – 0.30
SAR @ MWD Crossing (Riverside County)	15	214	170	0.27	176 – 196	135 – 160	0.30 – 0.36
SAR @ Pedley Ave.	15	514	270	0.24	219 - 363	125 - 210	0.24 – 0.34

[1] - Coefficient of variation was calculated using natural log-transformed data

Table 4-4. Summary of dry weather fecal coliform concentrations (cfu/100 mL) and data variability by sample location during the 2010-2011 wet season

Site	2010 - 2011				Range of Wet Season Observations (2007 -2011)		
	N	Geometric Mean	Median	Coefficient of Variation[1]	Geometric Mean	Median	Coefficient of Variation
Prado Park Lake	13	142	140	0.17	113 – 184	80 – 280	0.15 – 0.29
Chino Creek	12	155	155	0.08	283 – 388	255 – 285	0.18 – 0.22
Mill-Cucamonga Creek	13	214	240	0.20	297 – 430	297 – 430	0.11 – 0.33
SAR @ MWD Crossing (Riverside County)	11	143	150	0.26	58 – 118	60 – 120	0.11 – 0.24
SAR @ Pedley Ave.	10	232	215	0.07	87 - 193	85 - 205	0.15 – 0.24

[1] - Coefficient of variation was calculated using natural log-transformed data

Table 4-5. Summary of *E. coli* concentrations (cfu/100 mL) and data variability by sample location during the 2010-2011 wet season

Site	2010 - 2011				Range of Wet Season Observations (2007 -2011)		
	N	Geometric Mean	Median	Coefficient of Variation[1]	Geometric Mean	Median	Coefficient of Variation[1]
Prado Park Lake	15	276	170	0.30	138 - 235	120 - 275	0.11 - 0.27
Chino Creek	15	300	220	0.23	311 - 806	225 - 450	0.22 – 0.27
Mill-Cucamonga Creek	15	339	250	0.23	323 - 718	200 - 820	0.15 – 0.28
SAR @ MWD Crossing (Riverside County)	15	254	240	0.17	148 - 189	100 - 140	0.23 – 0.36
SAR @ Pedley Ave.	15	489	310	0.20	214 - 276	125 - 190	0.28 – 0.34

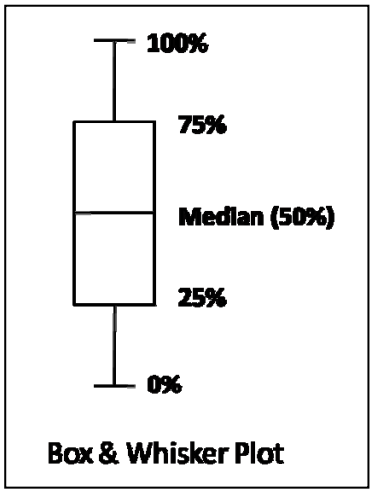
[1] - Coefficient of variation was calculated using natural log-transformed data

Table 4-6. Summary of dry weather *E. coli* concentrations (cfu/100 mL) and data variability by sample location during the 2010-2011 wet season

Site	2010 - 2011				Range of Wet Season Observations (2007 -2011)		
	N	Geometric Mean	Median	Coefficient of Variation[1]	Geometric Mean	Median	Coefficient of Variation[1]
Prado Park Lake	13	188	170	0.14	137 – 221	115 - 250	0.12 – 0.26
Chino Creek	12	184	190	0.09	251 - 386	220 -399	0.13 – 0.27
Mill-Cucamonga Creek	13	226	250	0.16	226 - 474	175 - 580	0.08 – 0.30
SAR @ MWD Crossing (Riverside County)	11	199	190	0.17	48 - 126	50 - 135	0.18 – 0.36
SAR @ Pedley Ave.	10	268	225	0.11	83 - 143	80 - 135	0.11 – 0.34

[1] - Coefficient of variation was calculated using natural log-transformed data

Figures 4-1 and 4-2 summarize fecal coliform and *E. coli* concentrations, respectively, for each sample site using Box and Whisker box plots (see text box for explanation of the box plots). Box and Whisker box plots are shown for (1) all samples collected during the 2010-2011 wet season, and (2) samples collected only during dry weather conditions. For the latter presentation, wet weather sample results are shown individually (yellow circles) to illustrate the often substantial difference in bacterial indicator concentrations observed in samples collected under wet weather conditions.



For samples collected under both wet and dry weather conditions, the lowest observed median bacterial indicator concentrations occurred at the Prado Park Lake site (fecal coliform: 140 cfu/100 mL; *E. coli*: 170 cfu/100 mL) (see Figure 4-1 and 4-2 [upper]; Tables 4-3 and 4-5). In contrast, the highest observed median fecal coliform concentrations occurred at the Mill-Cucamonga Creek site (340 cfu/100 mL); the highest *E. coli* median concentrations occurred at the Santa Ana River at Pedley site (310 cfu/100 mL) (see Figures 4-1 and 4-2 [upper]; Tables 4-3 and 4-5).

Under dry weather conditions in the wet season, the lowest median concentrations were observed for *E. coli* at the Prado Park Lake site (170 cfu/100 mL). For fecal coliform, the Santa Ana River @ MWD Crossing and Prado Park Lake sites had the lowest observed median concentrations (150 cfu/100 mL and 140 cfu/100 mL, respectively). Highest concentrations were observed at Mill-Cucamonga Creek with median fecal coliform and *E. coli* concentrations of 340 and 250 cfu/100 mL, respectively (see Figures 4-1 and 4-2 [lower]; Tables 4-4 and 4-6).

Figures 4-1 and 4-2 (lower) illustrate the differences in bacterial indicator concentrations observed during wet versus dry weather conditions. With few exceptions, the bacterial indicator concentrations observed during wet weather (yellow circles) were well above the median values observed during dry weather conditions.

4.3 Bacterial Indicator Compliance Analysis

The compliance analysis compared the bacterial indicator data for fecal coliform and *E. coli* to the existing REC-1 fecal coliform geometric mean and single sample objectives and the proposed REC-1 geometric *E. coli* objectives under development by the SWQSTF. Geometric means were calculated only when at least five sample results were available from the previous five week period. Geometric mean calculations included all data regardless of whether the sample was collected under dry or wet weather conditions.

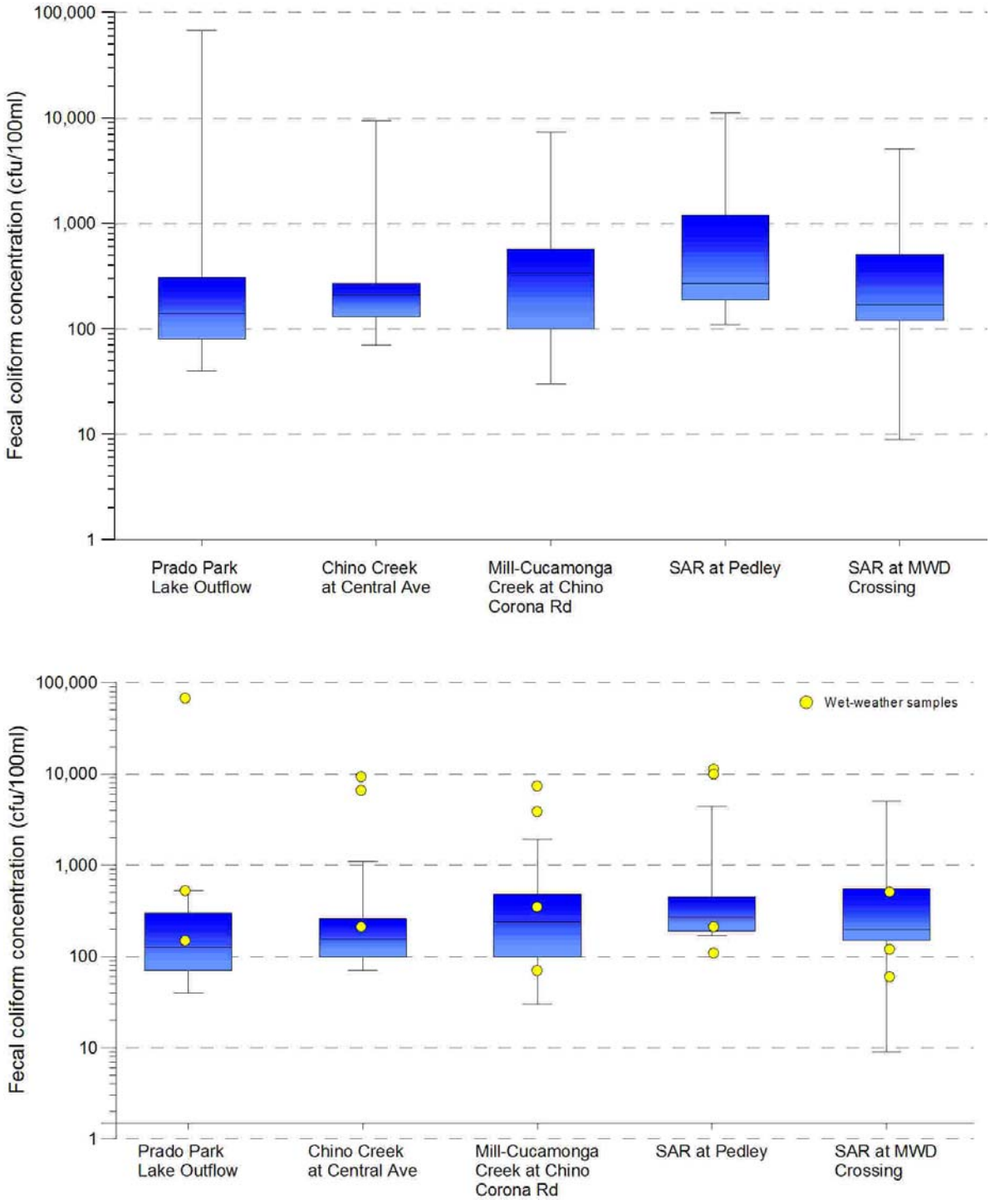


Figure 4-1. Statistical distribution of fecal coliform data collected during the 2010-2011 wet season illustrated using Box & Whisker box plots. *Upper Figure*: All samples collected under wet and dry conditions. *Lower Figure*: Box & Whisker box plot is for samples collected only under dry weather conditions; for comparative purposes, the sample results classified as wet weather are shown as yellow circles.

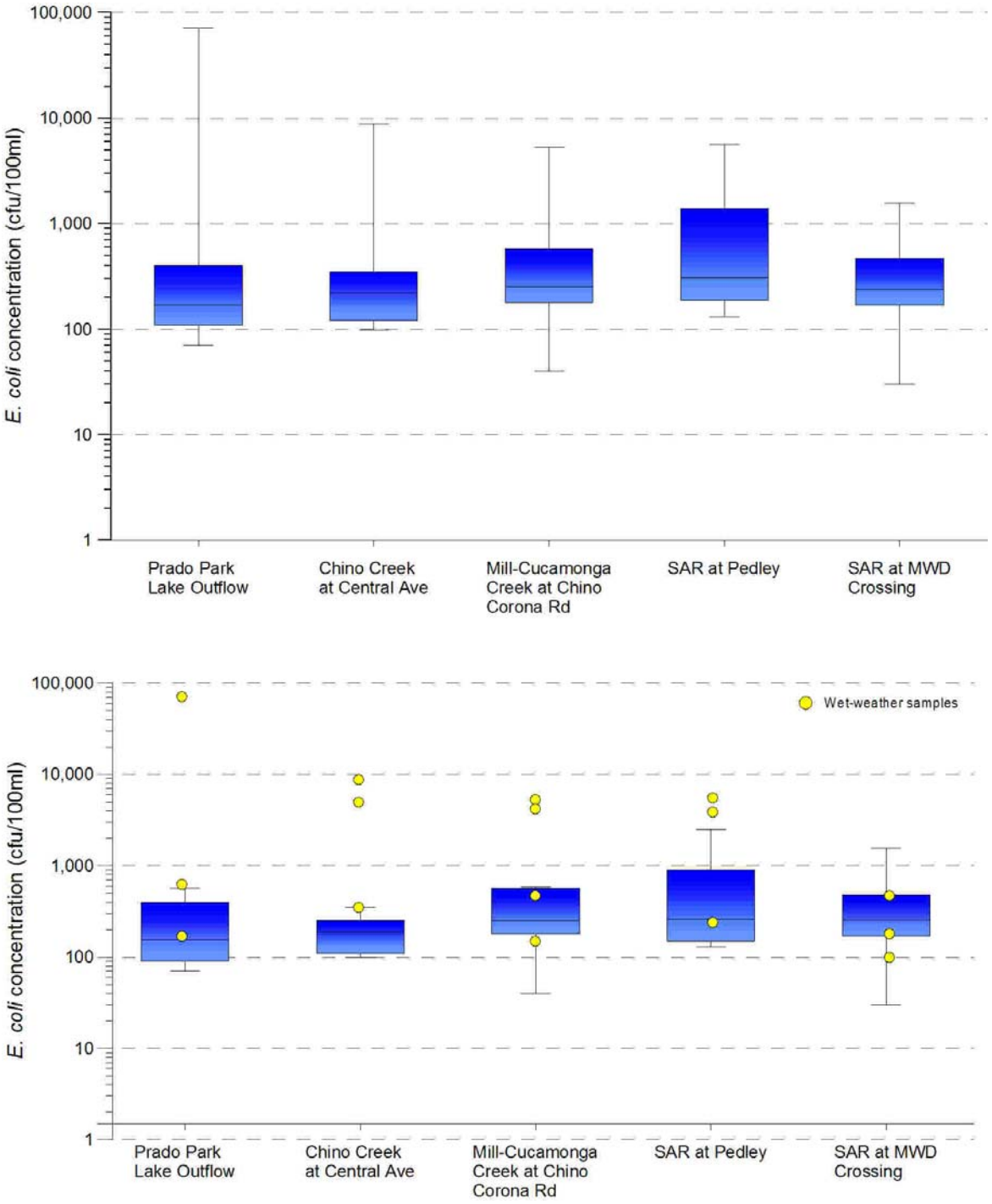


Figure 4-2. Statistical distribution of *E. coli* data collected during the 2010-2011 wet season illustrated using Box & Whisker box plots. *Upper Figure*: All samples collected under wet and dry conditions. *Lower Figure*: Box & Whisker box plot is for samples collected only under dry weather conditions; for comparative purposes, the sample results classified as wet weather are shown as yellow circles.

The geometric means were compared to the following fecal coliform Basin Plan objective and proposed *E. coli* objective[4]:

- Fecal coliform: log mean less than 200 organisms/100 mL based on five or more samples/30 day period
- *E. coli*: log mean less than 126 organisms/100 mL based on five or more samples/30 day period

The single sample exceedance frequency analysis was completed by calculating the frequency that all fecal coliform sample results exceeded the fecal coliform single sample objective of 400 cfu/100 mL.

During dry weather, no exceedances of the fecal coliform single sample objective occurred at the Chino Creek site. Exceedances at the other sites ranged from 10% at the Santa Ana River at Pedley site to 31% at the Mill-Cucamonga Creek site (Table 4-7). During wet weather, exceedances of the single sample objectives were common at all sites (Table 4-7). The lowest observed exceedance frequency occurred at the Prado Park Lake site (50%). The exceedance frequency was 75% at both Santa Ana River sites and 100% at the Mill-Cucamonga and Chino Creek sites (Table 4-7).

The fecal coliform geometric mean exceedance frequency ranged from 45 - 64% at four of the five sites with the lowest exceedance frequency observed at the Chino Creek and Santa Ana River at MWD Crossing sites (Table 4-7). The highest geometric mean exceedance occurred at the Santa Ana River at Pedley site (82%) (Table 4-7).

The *E. coli* geometric mean exceedance frequency ranged from 73 – 100% at the five sample sites. The highest exceedance frequency (100%) was observed at two sites: Chino Creek and Santa Ana River at Pedley Avenue (Table 4-8).

Figures 4-3 through 4-7 illustrate the single sample and rolling geometric mean values for fecal coliform since the 2007 dry season. Figures 4-8 through 4-12 illustrate the results for *E. coli*. Providing the extended period of record illustrates how the 2010-2011 wet season results compare to previous seasons.

4.4 Correlation Analysis

Table 4-9 summarizes the results of a correlation analysis between fecal coliform and *E. coli* concentrations. A significant correlation was observed at all watershed-wide compliance sites, with the best correlation (r= 0.98) at Prado Park Lake. Observations of significant correlations between bacterial indicators are consistent with previous findings at these sample locations (e.g., see SAWPA 2009a).

[4] See www.sawpa.org/roundtable-SWQTF_IV.html for additional information

Table 4-7. Frequency of compliance with existing fecal coliform water quality objectives during the 2010-2011 wet season

Site	Single Sample Criterion Exceedance Frequency (%)		Geometric Mean Criterion Exceedance Frequency (%)
	Dry Conditions	Wet Conditions	
Prado Park Lake	15%	50%	55%
Chino Creek	0%	100%	45%
Mill-Cucamonga Creek	31%	100%	64%
Santa Ana River @ MWD Crossing (Riverside County)	18%	75%	45%
Santa Ana River @ Pedley Ave.	10%	75%	82%

Table 4-8. Frequency of compliance with proposed geometric mean water quality objectives for *E. coli* during the 2010-2011 wet season

Site	Geometric Mean Criterion Exceedance Frequency (%)
Prado Park Lake	73%
Chino Creek	100%
Mill-Cucamonga Creek	91%
Santa Ana River @ MWD Crossing (Riverside County)	91%
Santa Ana River @ Pedley Ave.	100%

* - Evaluation of compliance based on proposed geometric mean water quality objectives (See www.sawpa.org/roundtable-SWQTF_IV.html).

Table 4-9. Correlation of natural log *E. coli* concentrations (cfu/100 mL) and natural log fecal coliform concentrations (cfu/ 100 mL) during the 2010-2011 wet season

Site	Pearson's r coefficient	Degrees of freedom (n - 2)	t-statistic	p-value	Significant?[1]
Prado Park Lake	0.98	13	20.1	< 0.001	Yes +
Chino Creek	0.92	13	8.5	< 0.001	Yes +
Mill-Cucamonga Creek	0.92	13	8.2	< 0.001	Yes +
SAR @ MWD Crossing (Riverside County)	0.96	13	12.9	< 0.001	Yes +
SAR @ Pedley Ave.	0.95	13	11.1	< 0.001	Yes +

[1] – Significance determined by p value < 0.05; (-) = negative correlation; (+) = positive correlation

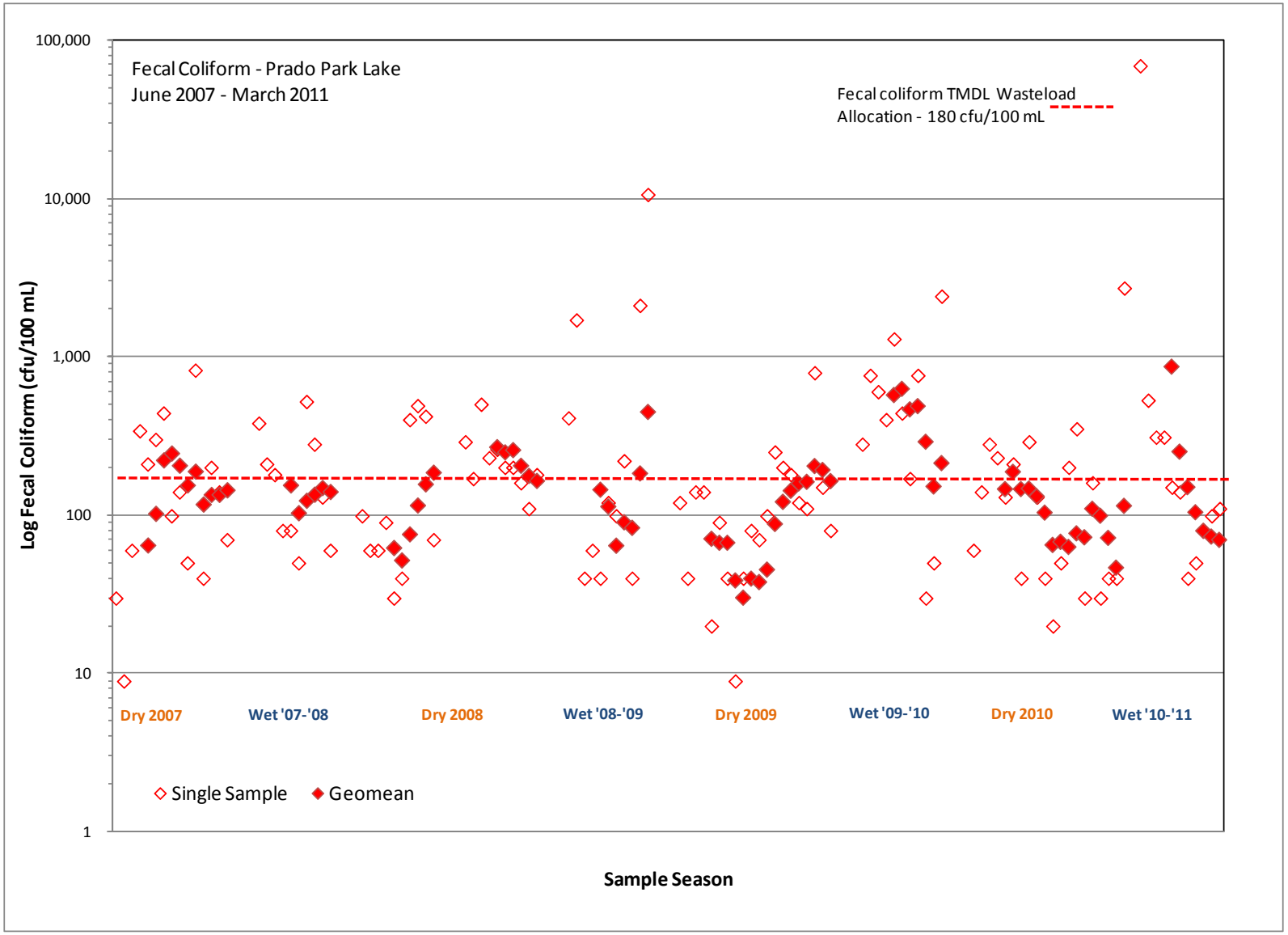


Figure 4-3. Time series plot of fecal coliform single sample results and geometric means for samples collected from Prado Park Lake from July 2007 through March 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates the geometric mean water quality objective).

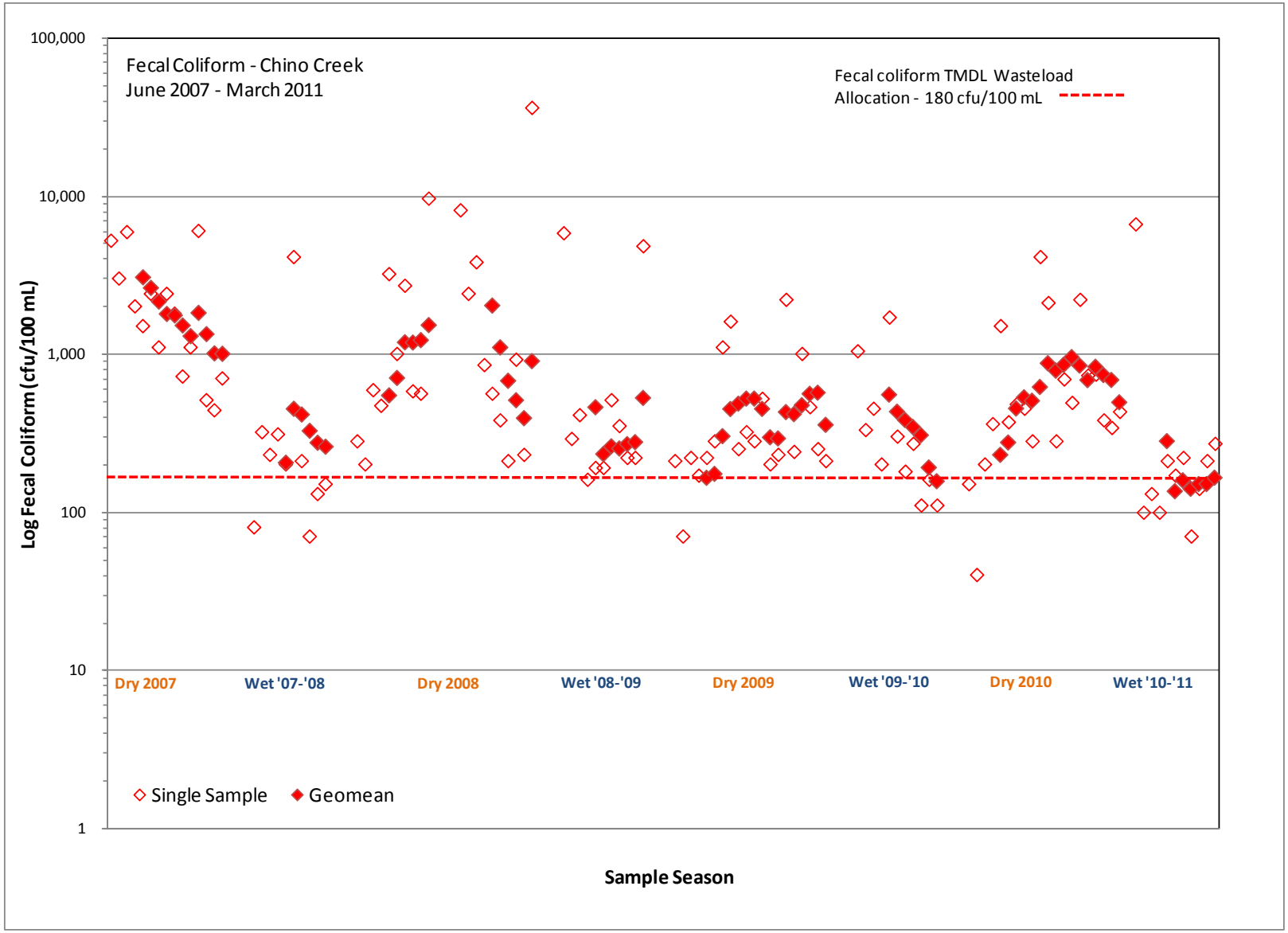


Figure 4-4. Time series plot of fecal coliform single sample results and geometric means for samples collected from Chino Creek from July 2007 through March 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates the geometric mean water quality objective).

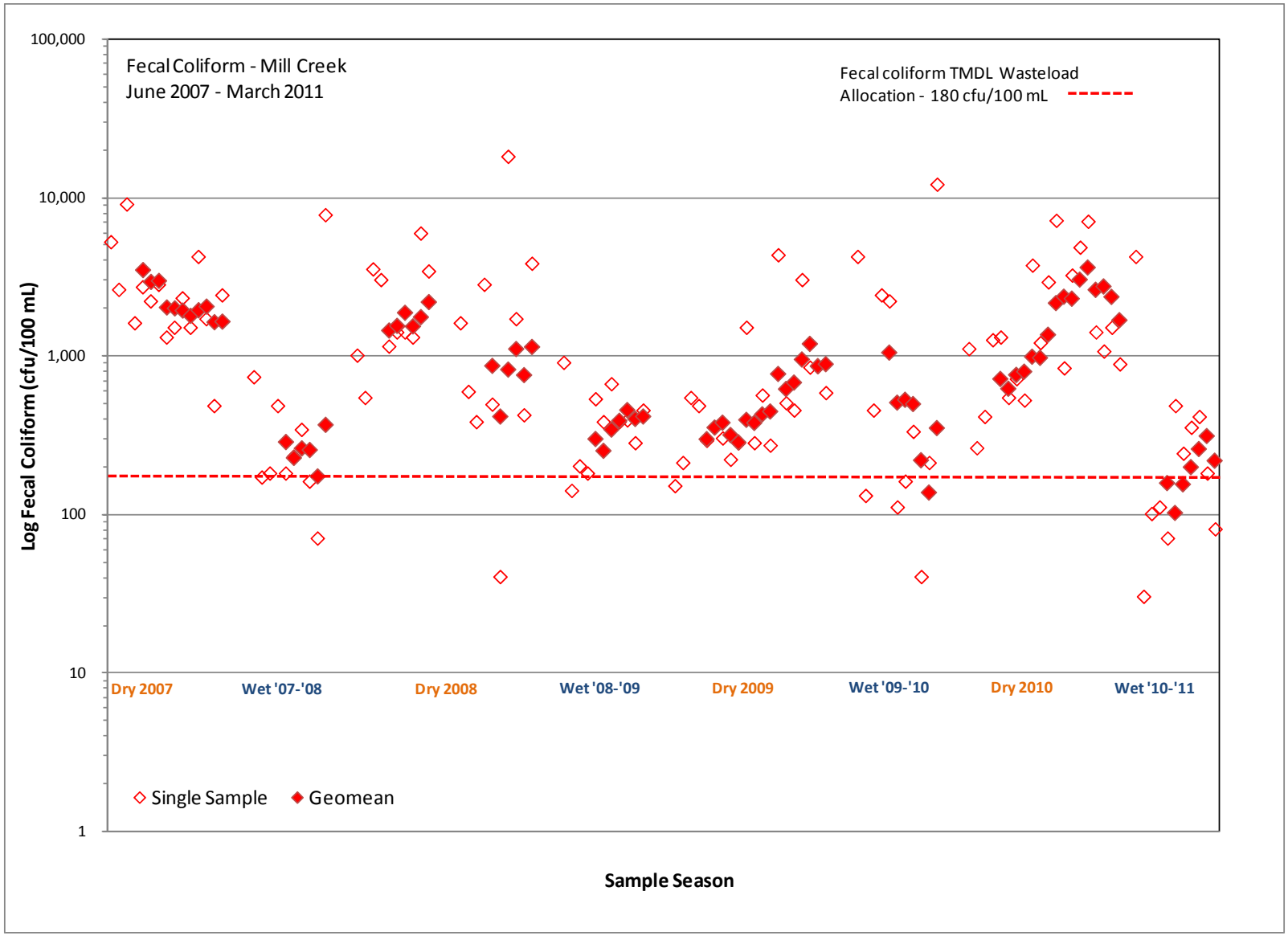


Figure 4-5. Time series plot of fecal coliform single sample results and geometric means for samples collected from Mill-Cucamonga Creek from July 2007 through March 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates the geometric mean water quality objective).

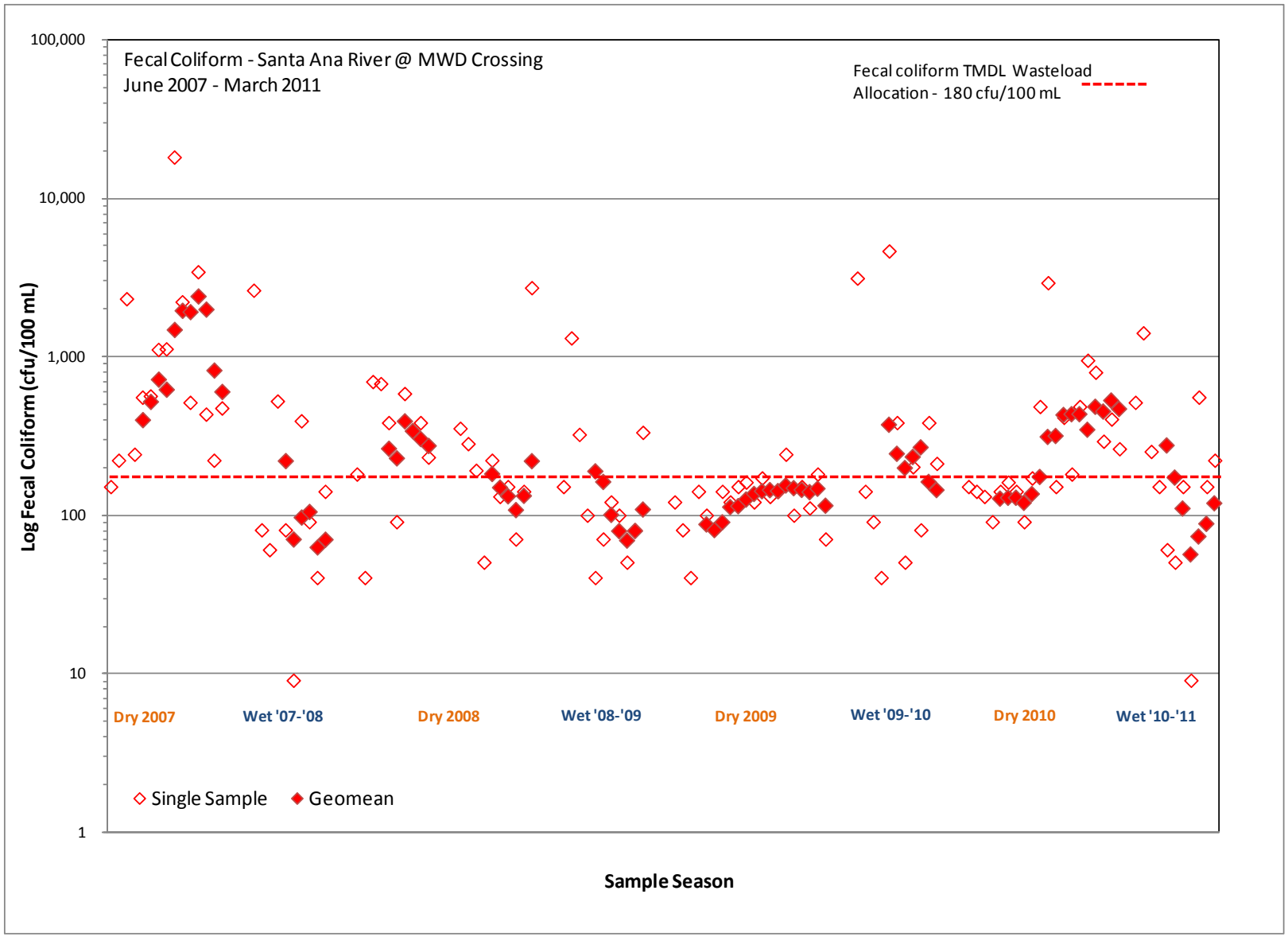


Figure 4-6. Time series plot of fecal coliform single sample results and geometric means for samples collected from Santa Ana River at MWD Crossing (Riverside County) from July 2007 through March 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates the geometric mean water quality objective).

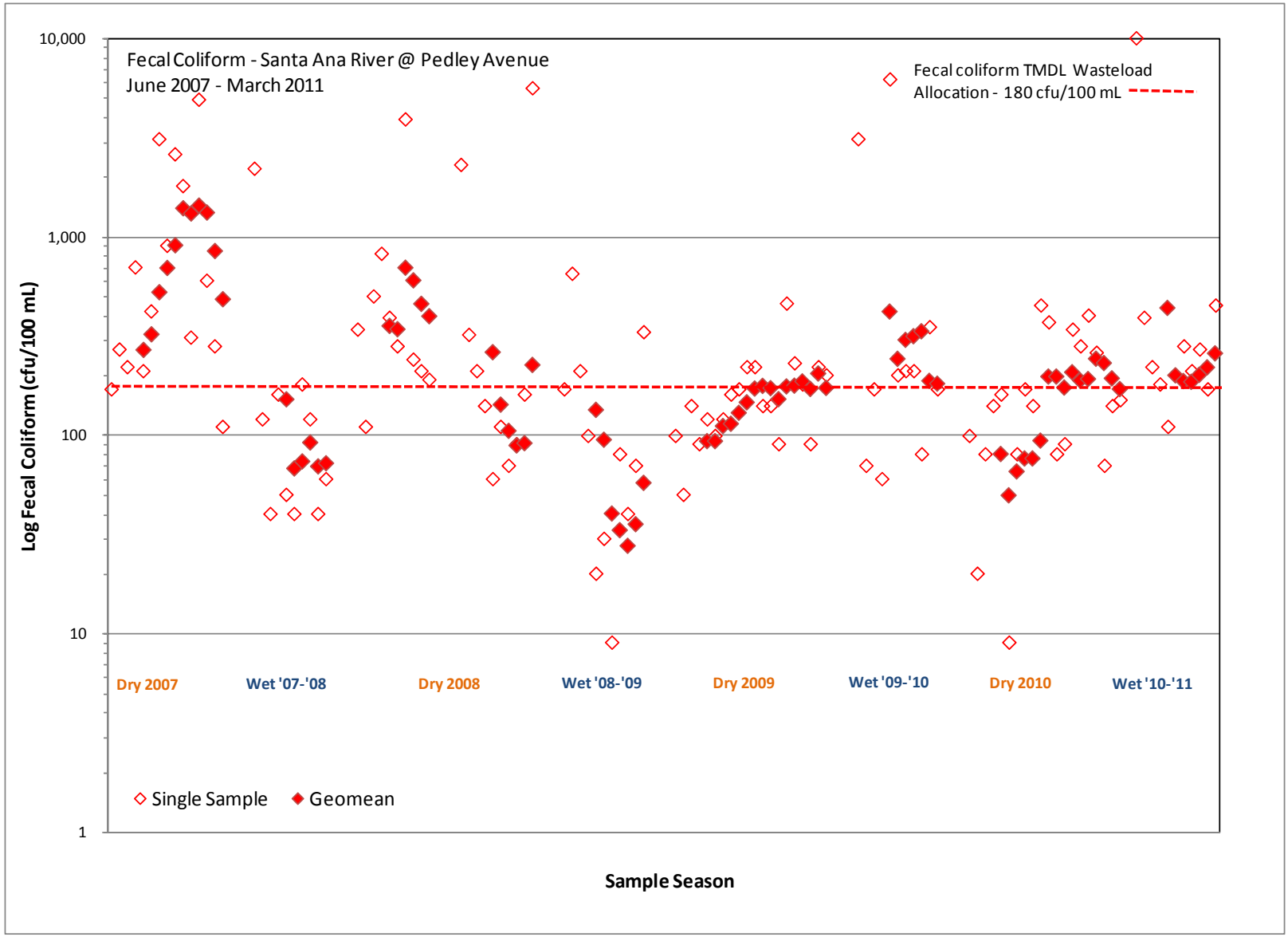


Figure 4-7. Time series plot of fecal coliform single sample results and geometric means for samples collected from Santa Ana River at Pedley Avenue from July 2007 through March 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates the geometric mean water quality objective).

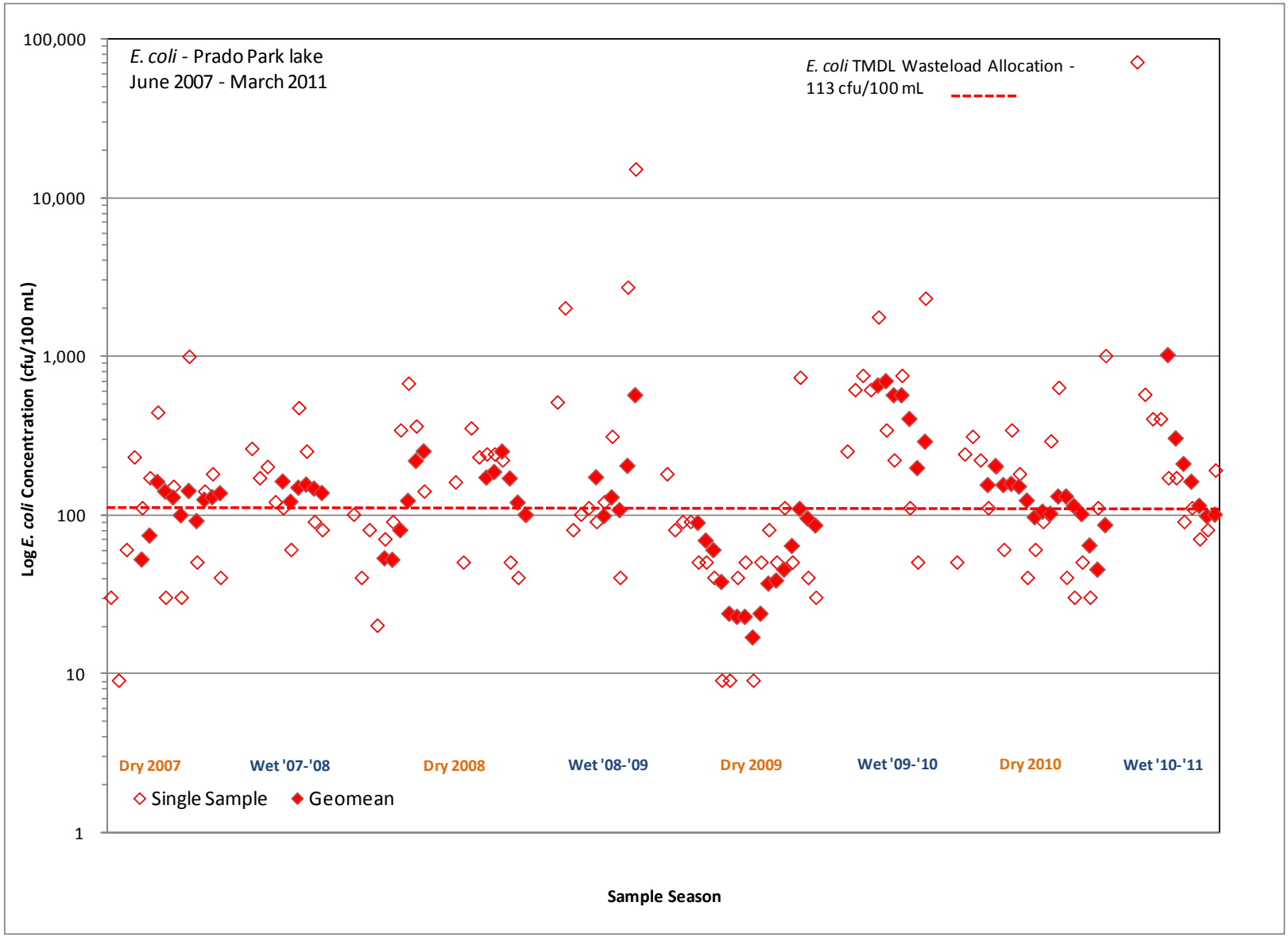


Figure 4-8. Time series plot of *E. coli* single sample results and geometric means for samples collected from Prado Park Lake from July 2007 through March 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates proposed geometric mean water quality objective).

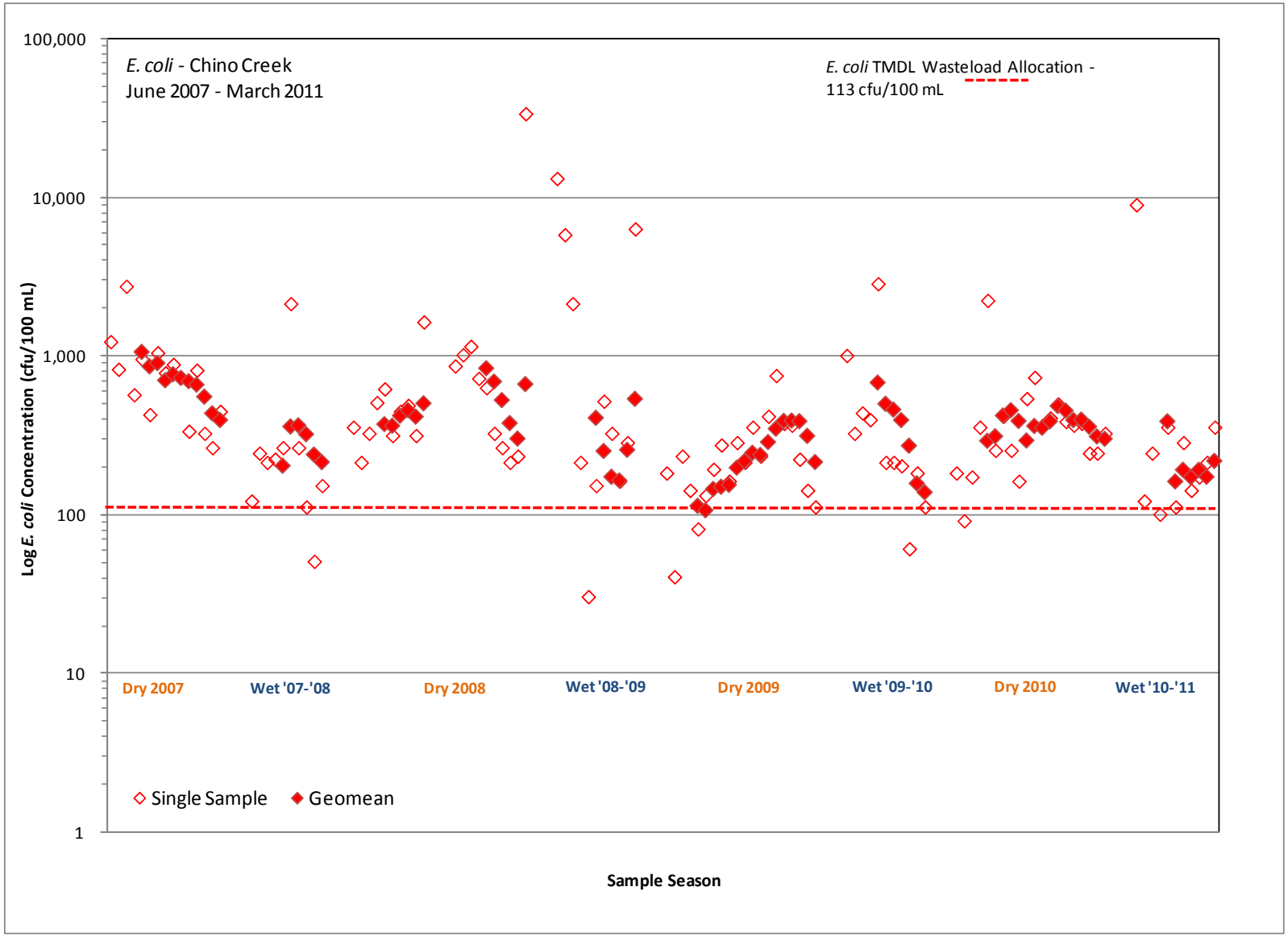


Figure 4-9. Time series plot of *E. coli* single sample results and geometric means for samples collected from Chino Creek from July 2007 through March 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates proposed geometric mean water quality objective).

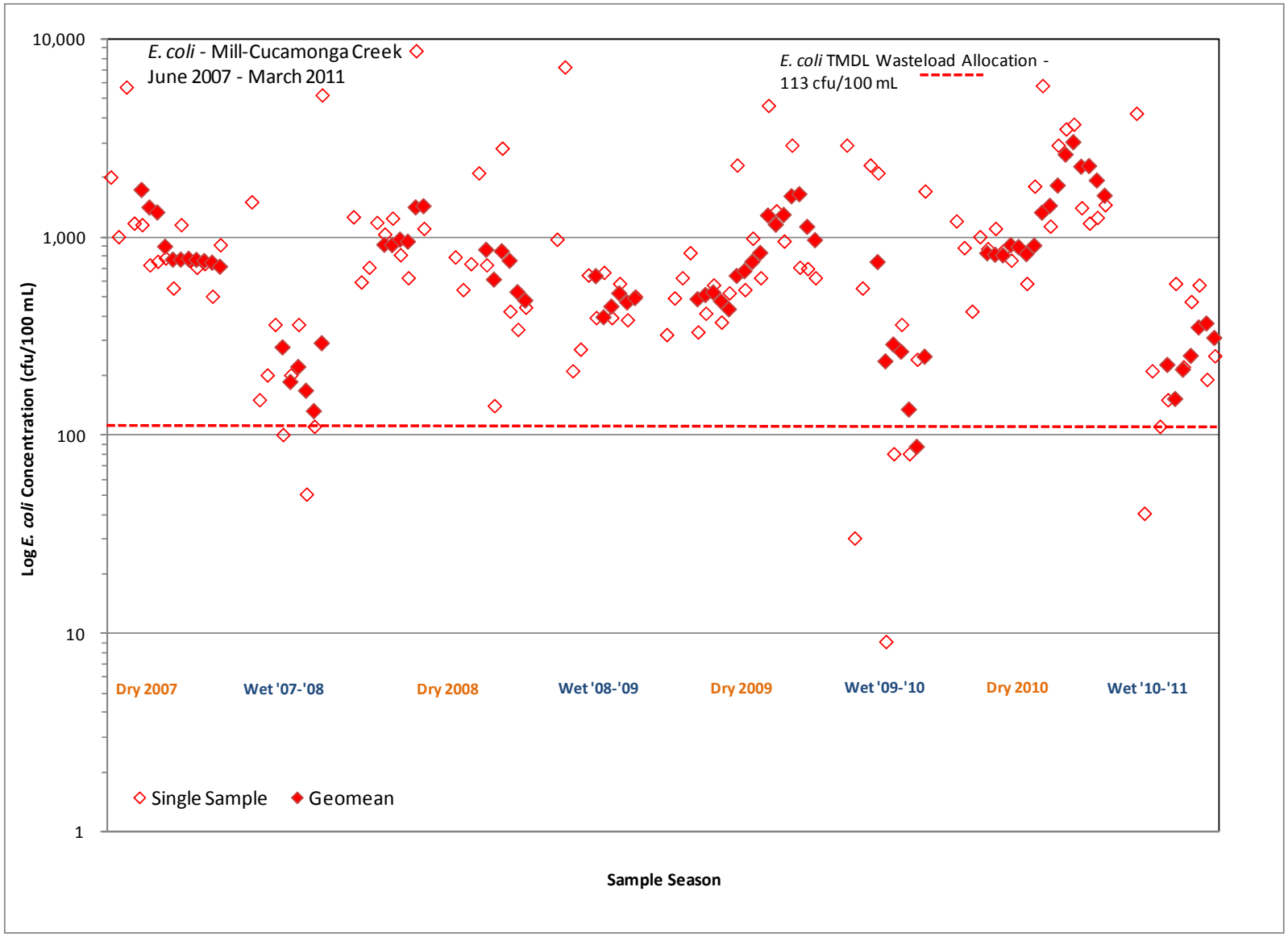


Figure 4-10. Time series plot of *E. coli* single sample results and geometric means for samples collected from Mill-Cucamonga Creek from July 2007 through March 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates proposed geometric mean water quality objective).

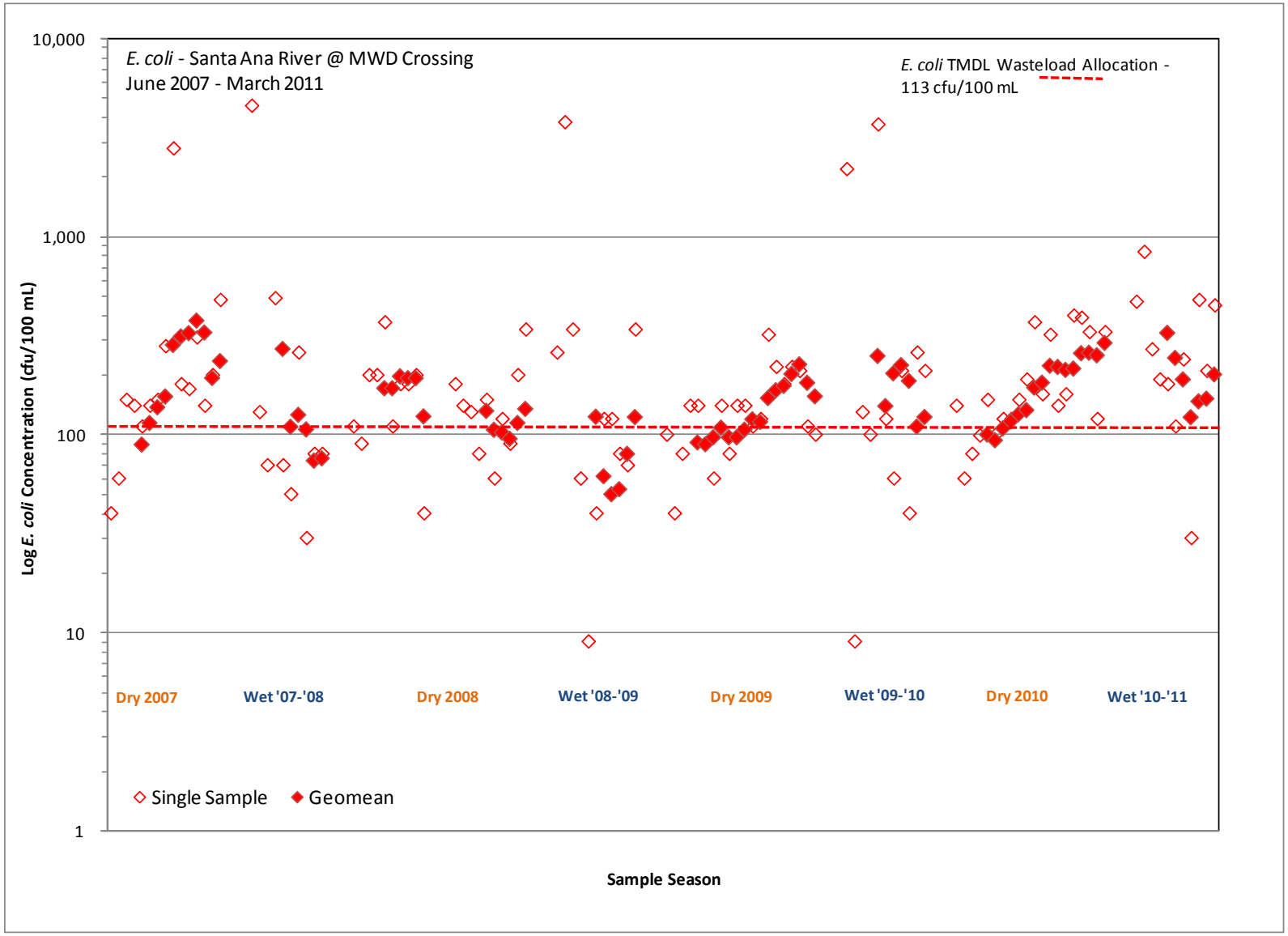


Figure 4-11. Time series plot of *E. coli* single sample results and geometric means for samples collected from Santa Ana River at MWD Crossing (Riverside County) from July 2007 through March 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates proposed geometric mean water quality objective).

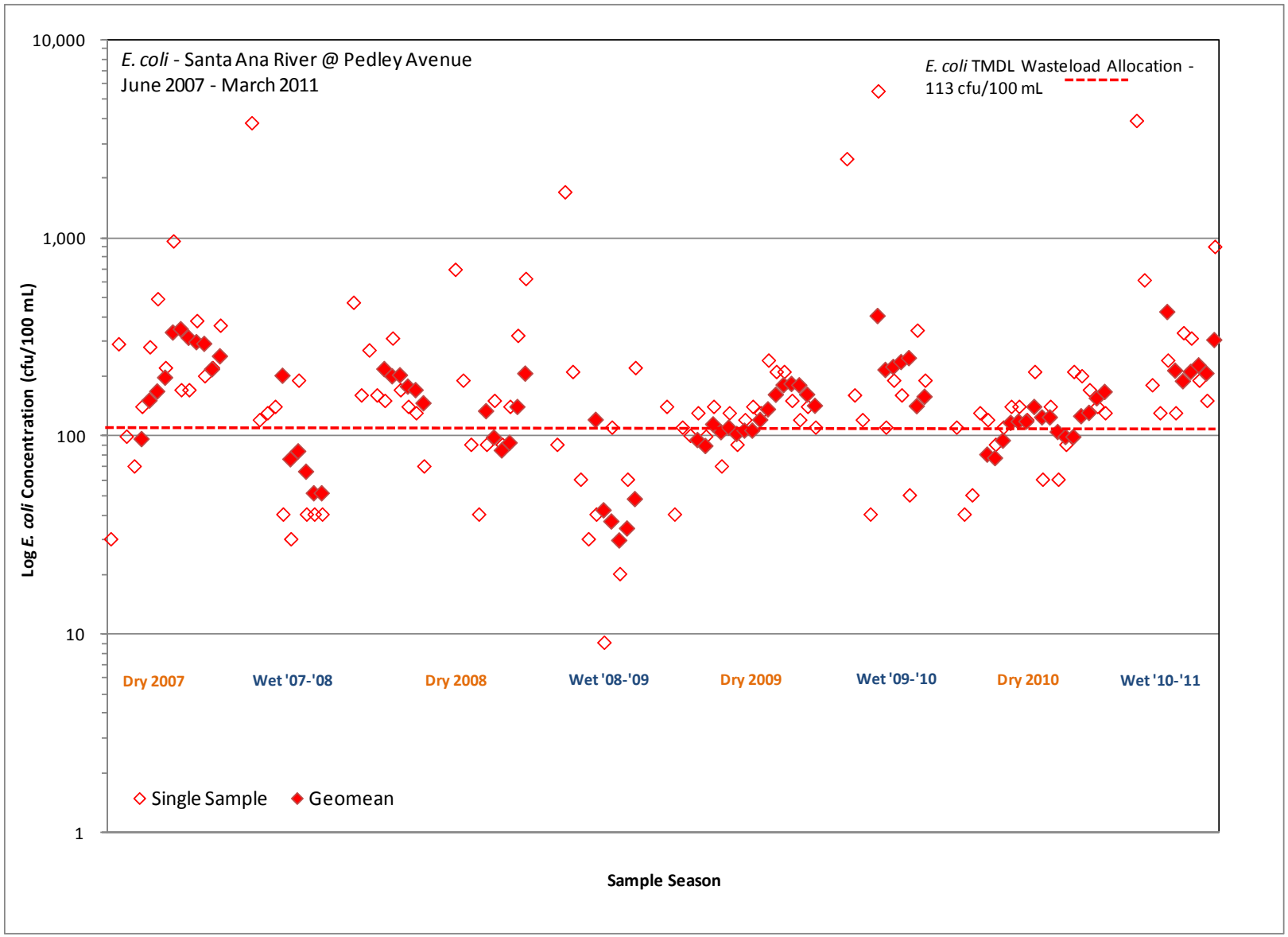


Figure 4-12. Time series plot of *E. coli* single sample results and geometric means for samples collected from Santa Ana River at Pedley Avenue from July 2007 through March 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates proposed geometric mean water quality objective).

Table 4-10 summarizes the results of correlation analyses between bacterial indicators and field parameters measured during each sample event using all sample data regardless of whether the sample was collected during dry or wet conditions. Only one significant correlation was observed with this data set: fecal coliform concentrations vs. pH.

Table 4-11 provides correlation results between bacterial indicators and field parameters, but only for samples collected under dry weather conditions. For fecal coliform correlations were observed with water conductivity and turbidity. Strong correlations were observed between *E. coli* concentrations and conductivity, total suspended solids and turbidity.

4.5 Storm Event Data

Figure 4-13 illustrates changes in bacterial indicator concentrations that were observed at all sites over the four-day sample event that occurred around a storm that took place on November 20, 2010. With the exception of the Santa Ana River at Pedley Avenue site, there is a clear increase in bacterial indicator concentrations during the storm with a steady reduction in concentrations at 48 and 72 hours after the event. Concentrations appear to rise again at 96 hours after the storm event.

Figures 4-14 and 4-15 illustrate bacterial indicator concentrations in Chino Creek in relation to the hydrograph during wet weather events in November and December 2010. During the December event, which lasted a number of days, it is clear that Chino Creek flows were already elevated prior to the day of sampling (December 21).

Figures 4-16 through 4-18 illustrate bacterial indicator concentrations observed around three storm events that affected flows in the Santa Ana River. During the December event, bacterial indicators were sampled during the time when the river was near its peak flow. As would be expected, bacterial indicator concentrations were elevated during this high flow. In February, a sample event occurred soon after a peak flow event. During this event, bacterial indicator concentrations were relatively low after flow had returned to near normal.

Table 4-10. Correlation analysis between bacterial indicator concentrations and field parameters during the 2010-2011 wet season

Data Subset/Comparison	Pearson's r coefficient	Degrees of freedom (n - 2)	Student-t statistic	p-value[1]
Fecal Coliform vs.				
Conductivity	-0.19	73	1.6	0.1139
Dissolved Oxygen	-0.15	73	1.3	0.1977
pH	-0.28	73	2.4	0.0189*
Total Suspended Solids	-0.04	73	0.3	0.7650
Temperature	-0.04	73	0.3	0.7650
Turbidity	0.03	68	0.3	0.7651
***E. coli* vs.**				
Conductivity	-0.14	73	1.2	0.2340
Dissolved Oxygen	-0.14	73	1.2	0.2340
pH	-0.26	73	2.3	0.2430
Total Suspended Solids	-0.03	73	0.2	0.8420
Temperature	-0.05	73	0.4	0.6903
Turbidity	0.03	68	0.3	0.7651

[1] - * indicates correlation significant; significance determined by a p-value < 0.05

Table 4-11. Correlation analysis between bacterial indicator concentrations and field parameters during dry weather conditions for the 2010-2011 wet season

Data Subset/Comparison	Pearson's r coefficient	Degrees of freedom (n - 2)	Student-t statistic	p-value[1]
Fecal Coliform vs.				
Conductivity	-0.28	57	2.2	0.0319*
Dissolved Oxygen	-0.01	57	0.1	0.9207
pH	-0.04	57	0.3	0.7653
Total Suspended Solids	0.16	57	1.2	0.2351
Temperature	-0.01	57	0.1	0.9207
Turbidity	0.33	54	2.6	0.0120
***E. coli* vs.**				
Conductivity	-0.41	57	3.4	0.0012*
Dissolved Oxygen	-0.12	57	0.9	0.3719
pH	-0.17	57	1.3	0.1988
Total Suspended Solids	0.45	57	3.8	0.0004*
Temperature	-0.20	57	1.5	0.1391
Turbidity	0.45	54	3.7	0.0005*

[1] - * indicates correlation significant; significance determined by a p-value < 0.05

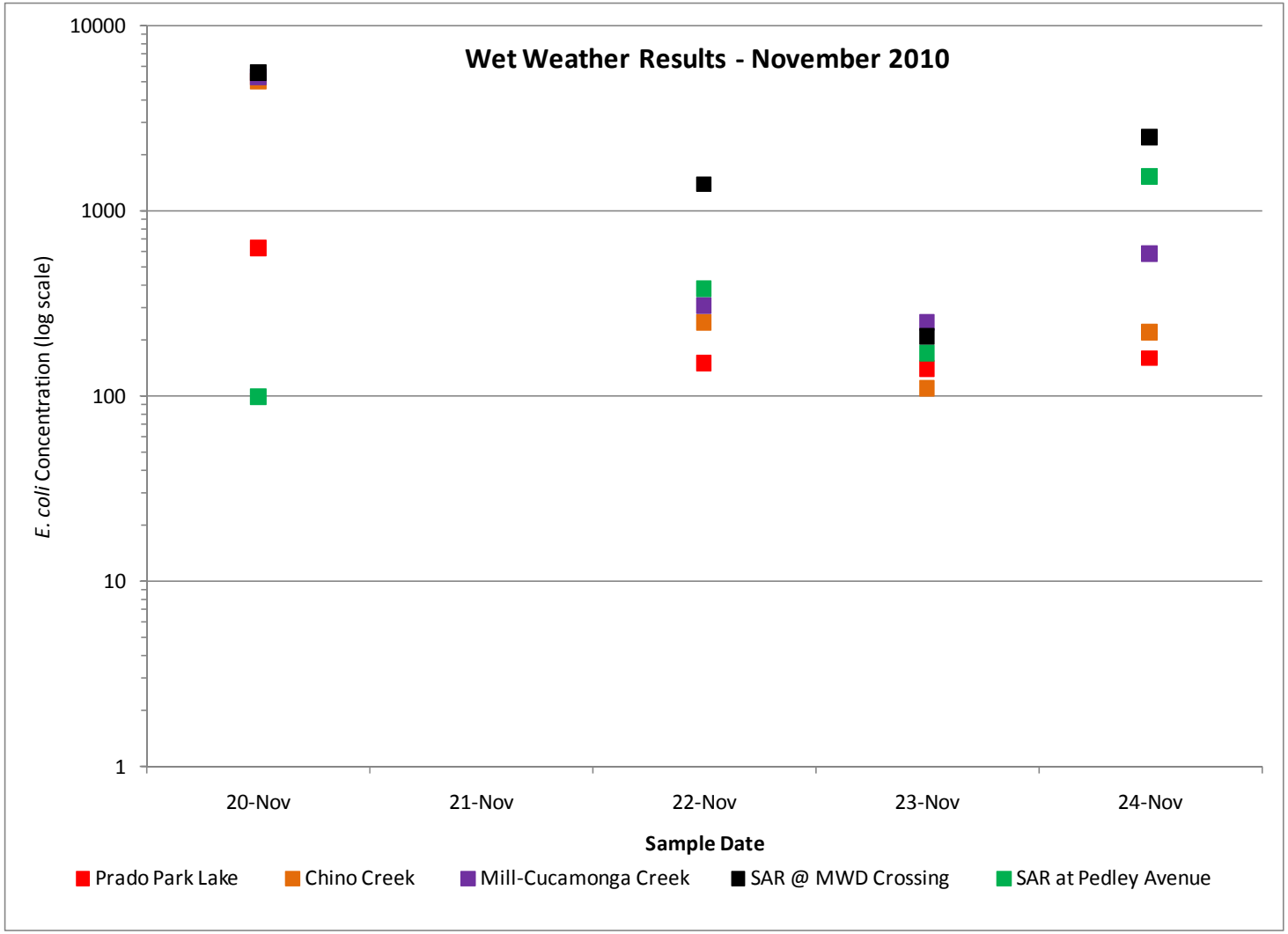


Figure 4-13. *E. coli* concentrations (cfu/100 mL) observed at the five watershed-wide compliance sites during and after the November 20, 2010 storm event.

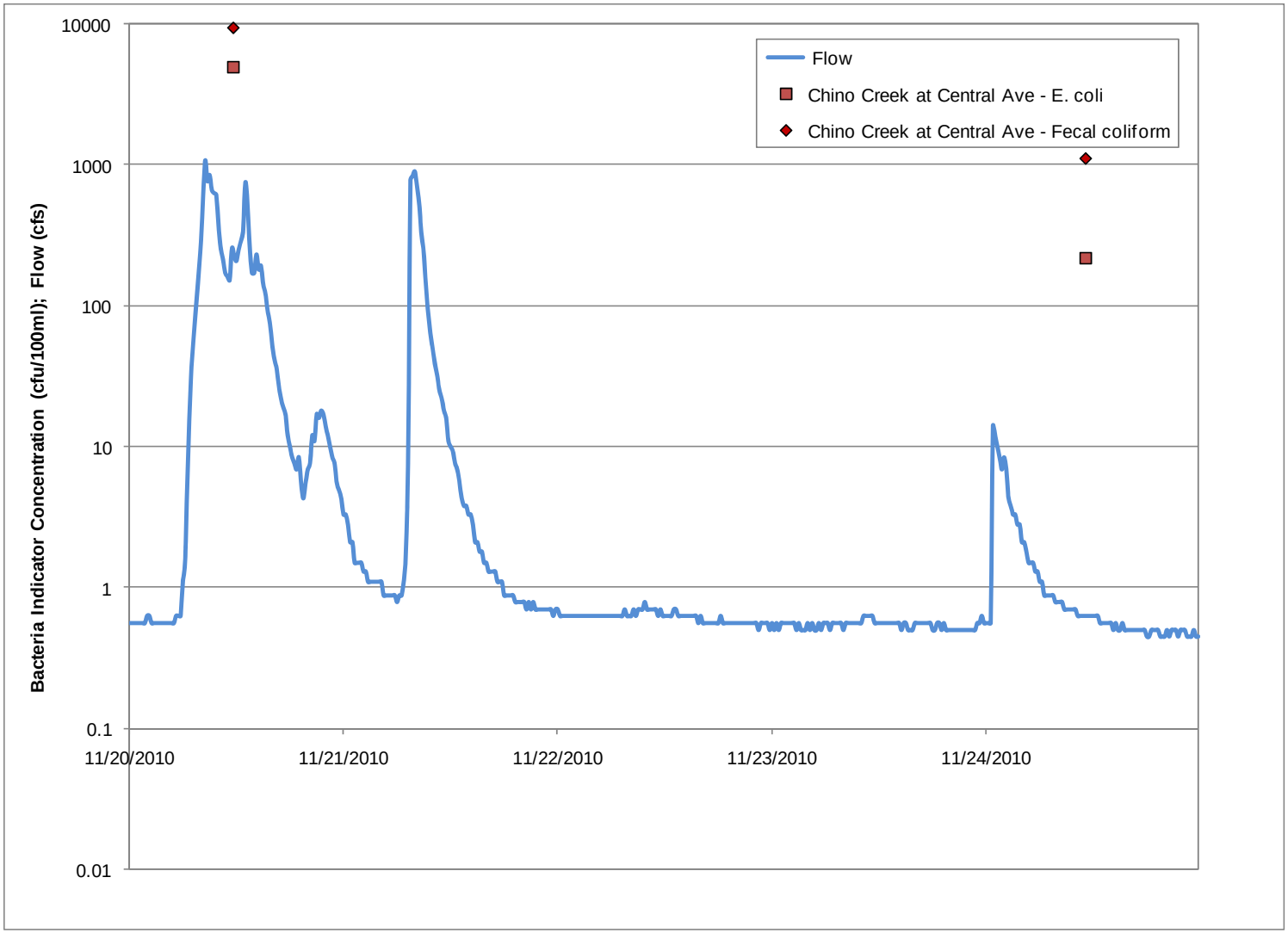


Figure 4-14. Bacterial indicator concentrations (cfu/100 mL) observed at the Chino Creek site during and after the November 20, 2010 storm event (hydrograph from USGS gauge 11073360, Chino Creek at Schaefer Avenue).

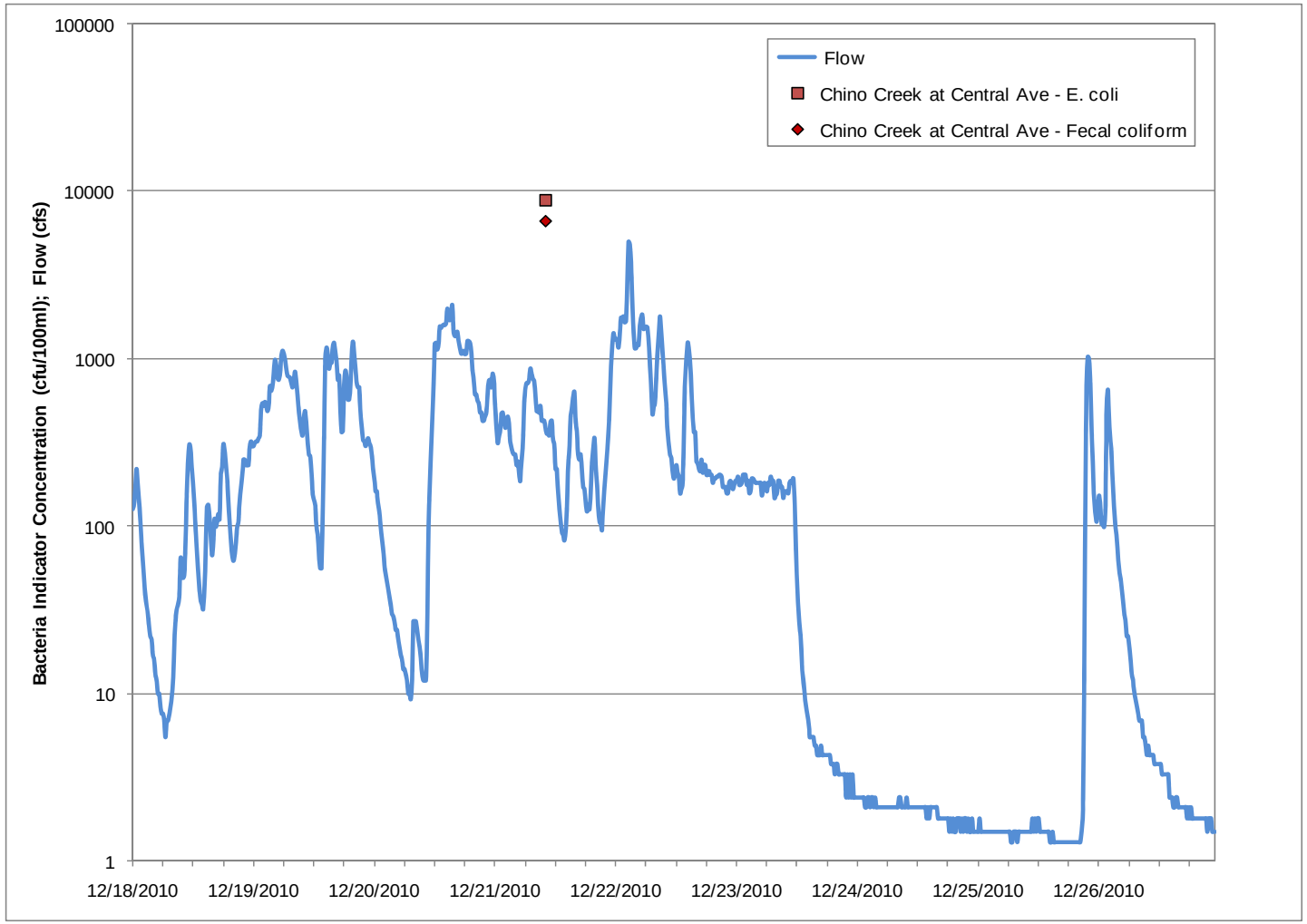


Figure 4-15. Bacterial indicator concentrations (cfu/100 mL) and flow (cfs) observed at Chino Creek during a December 2010 storm event (hydrograph from USGS gauge 11073360, Chino Creek at Schaefer Avenue).

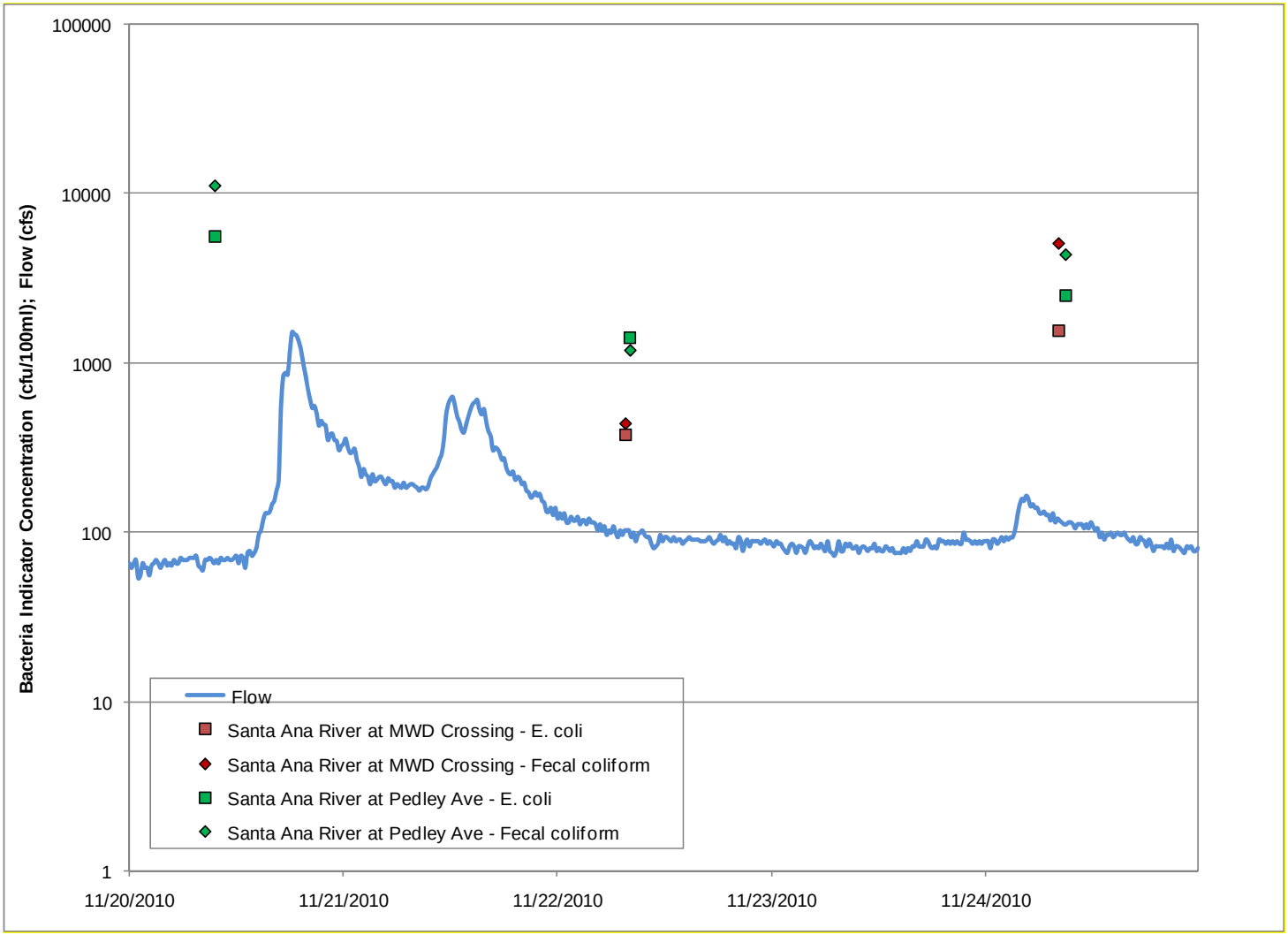


Figure 4-16. Bacterial indicator concentrations (cfu/100 mL) and flow observed in the Santa Ana River during and after the November 20,' 2010 storm event (hydrograph from USGS Gauge 11066460 at Santa Ana River at MWD Crossing).

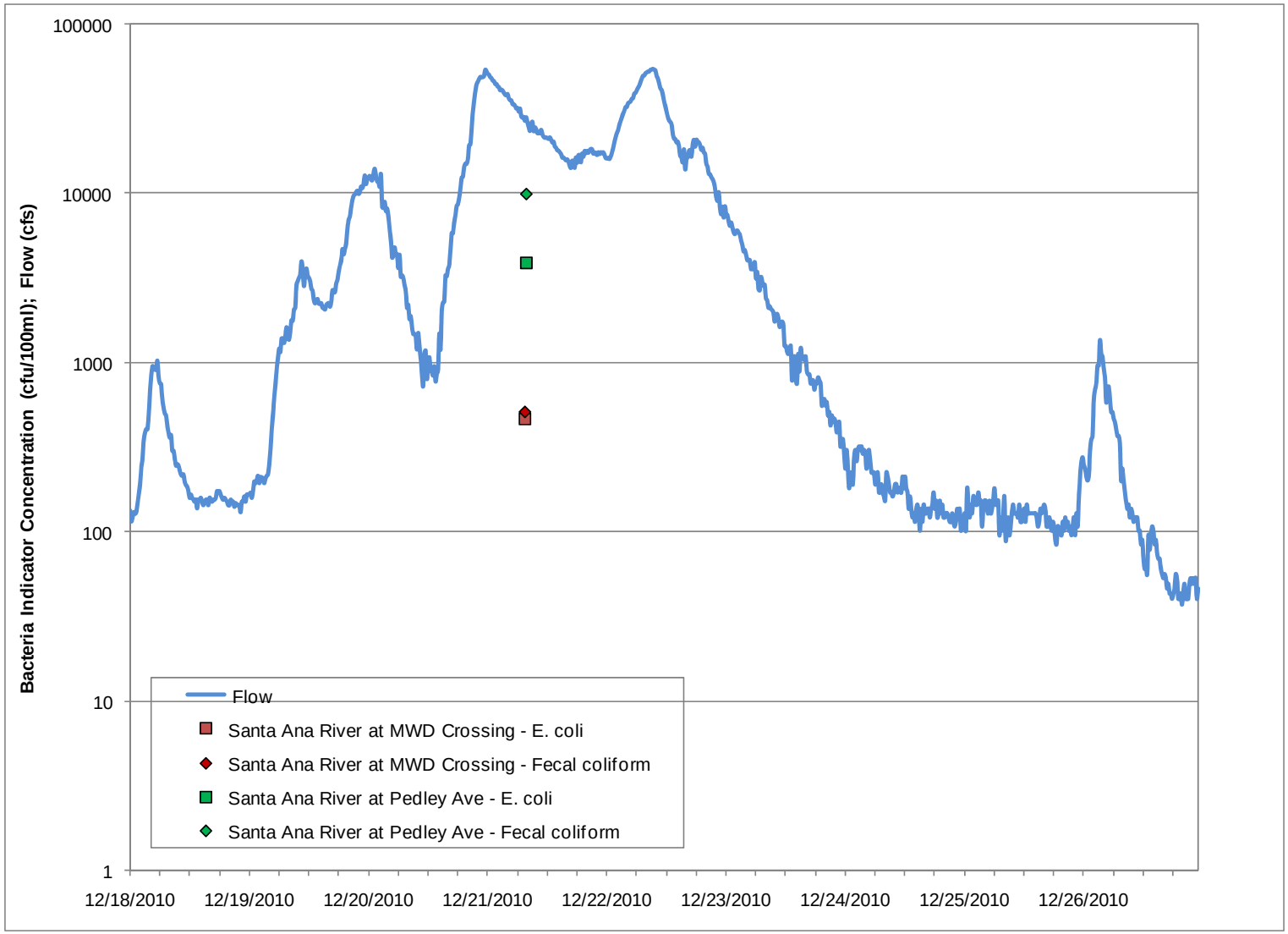


Figure 4-17. Bacterial indicator concentrations (cfu/100 mL) and flow observed in the Santa Ana River during an extended storm event in December 2010 (hydrograph from USGS Gauge 11066460 at Santa Ana River at MWD Crossing in Riverside County).

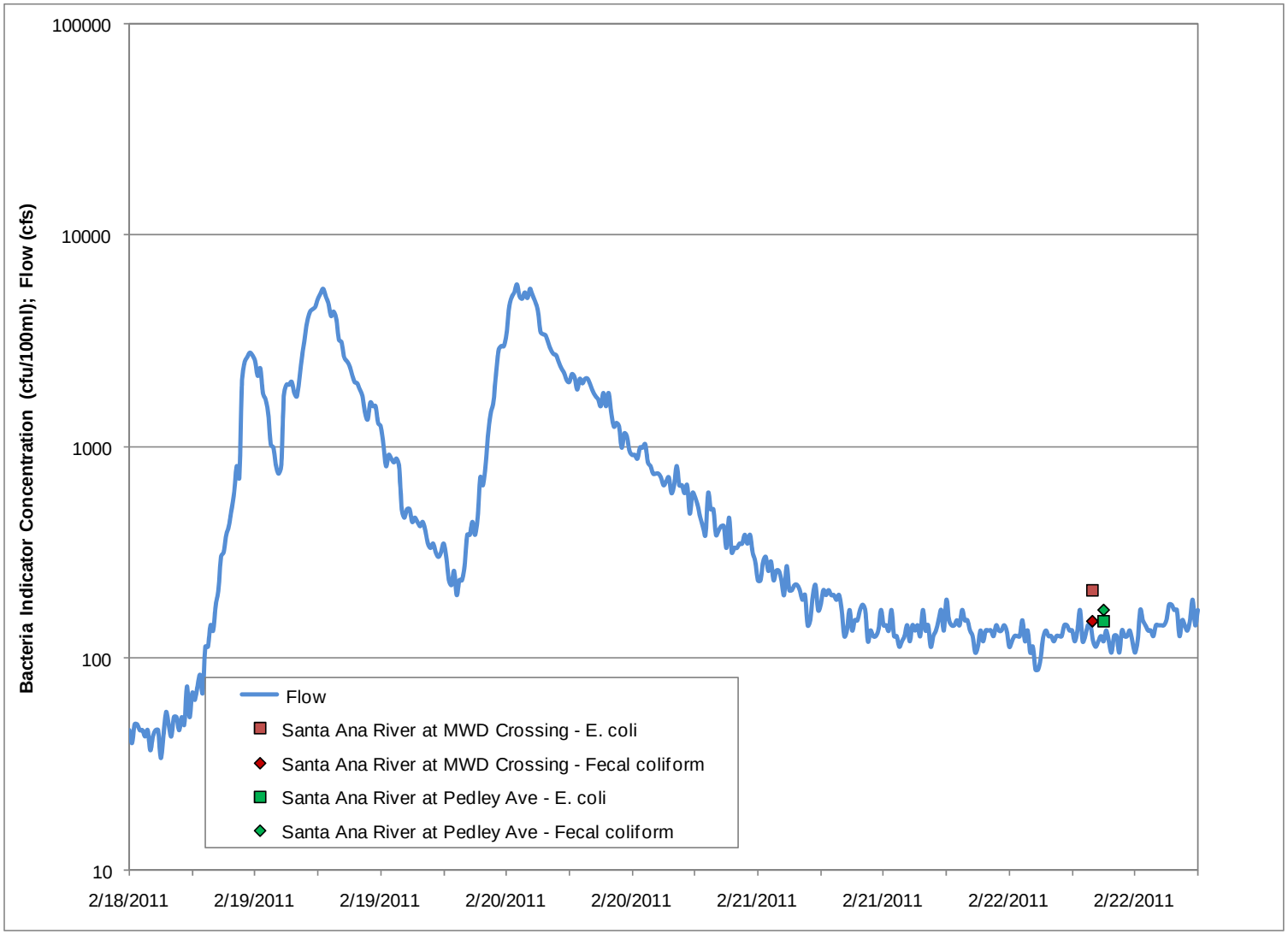


Figure 4-18. Bacterial indicator concentrations (cfu/100 mL) and flow observed in the Santa Ana River during a storm event in February 2011 (hydrograph from USGS Gauge 11066460 at Santa Ana River at MWD Crossing in Riverside County).

Section 5
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Appendix A
Data Summary

Tables A-1 through A-9 summarize the water quality results obtained for bacterial indicators, TSS and field measurements during the 2010-11 wet season sampling period. Table A-10 summarizes the daily mean flow measured at USGS gauges in the MSAR watershed (as available April 29, 2011). Table A-11 summarizes the available daily rainfall recorded at key gauges in the MSAR watershed.

Table A-1. Fecal coliform (cfu/100 mL) concentrations observed at watershed-wide compliance sites during the 2010-2011 wet season (geomean based on previous five weekly samples; if reported value has a < or > qualifier, the actual value was used)

Sample Week	Prado Park Lake Outlet (WW-C3)		Chino Creek @ Central Avenue (WW-C7)		Mill-Cucamonga Creek @ Chino-Corona Rd (WW-M5)		SAR @ MWD Crossing (WW-S1) (Riverside County)		SAR @ Pedley Avenue (WW-S4)	
	Result	**Geomean**	**Result**	**Geomean**	**Result**	**Geomean**	**Result**	**Geomean**	**Result**	**Geomean**
Regular Sampling Events										
12/21/10	68,000	-	6,600	-	3,900	-	510	-	10,000	-
12/28/10	530	-	99	-	30	-	1,400	-	> 390	-
1/4/11	310	-	130	-	100	-	250	-	220	-
1/11/11	300	-	99	-	110	-	150	-	180	-
1/18/11	150	877	310	281	70	158	60	276	110	443
1/25/11	140	255	170	135	480	102	50	174	200	202
2/1/11	40	152	220	159	240	155	150	111	280	189
2/8/11	50	105	70	140	350	199	9	57	210	188
2/15/11	80	80	140	150	410	259	550	74	270	204
2/22/11	99	74	210	150	180	312	150	89	170	222
3/1/11	110	71	270	165	80	218	220	120-	450	261
Storm Event										
11/20/10	530	--	9,400	--	7,400	--	120	--	11,200	--
11/22/10	140	--	260	--	340	--	440	--	1,200	--
11/23/10	70	--	130	--	570	--	170	--	190	--
11/24/10	> 150	--	1,100	--	1,900	--	5,100	--	4,400	--

Table A-2. *E. coli* (cfu/100 mL) concentrations observed at watershed-wide compliance sites during the 2010-2011 wet season (geomean based on previous five weekly samples; if reported value has a < or > qualifier, the actual value was used)

Sample Week	Prado Park Lake Outlet (WW-C3)		Chino Creek @ Central Avenue (WW-C7)		Mill-Cucamonga Creek @ Chino-Corona Rd (WW-M5)		SAR @ MWD Crossing (WW-S1) (Riverside County)		SAR @ Pedley Avenue (WW-S4)	
	Result	Geomean	Result	Geomean	Result	Geomean	Result	Geomean	Result	Geomean
Regular Sampling Event										
12/21/10	71,000	-	8,800	-	4,200	-	470	-	3,900	-
12/28/10	570	-	120	-	40	-	840	-	610	-
1/4/11	400	-	240	-	180	-	270	-	210	-
1/11/11	400	-	99	-	50	-	190	-	130	-
1/18/11	170	1,019	350	388	150	225	180	325	240	422
1/25/11	170	305	110	161	580	152	110	243	130	214
2/1/11	90	211	280	191	220	213	240	189	330	189
2/8/11	110	163	140	172	470	251	30	122	310	211
2/15/11	70	115	170	191	570	348	480	147	190	227
2/22/11	80	99	210	173	190	365	210	152	150	207
3/1/11	190	101	350	218	250	309	400	201	900	305
Storm Event										
11/20/10	630	--	5,000	--	5,300	--	99	--	5,600	--
11/22/10	150	--	250	--	310	--	380	--	1,400	--
11/23/10	140	--	110	--	250	--	170	--	210	--
11/24/10	160	--	220	--	590	--	1,550	--	2,500	--

Table A-3. Total suspended solids (mg/L) concentrations observed at watershed-wide compliance sites during the 2010-2011 wet season

Sample Week	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek @ Chino-Corona Rd (WW-M5)	SAR @ MWD Crossing (WW-S1) (Riverside County	SAR @ Pedley Avenue (WW-S4)
Regular Sampling Events					
12/21/10	45.50	20.10	144.00	7,590.00	0.00
12/28/10	18.75	1.61	3.83	389.00	408.00
1/4/11	22.60	139.50	13.50	183.00	268.00
1/11/11	17.30	2.70	2.70	122.00	113.50
1/18/11	20.50	3.60	6.20	35.00	58.30
1/25/11	14.60	3.60	8.00	41.00	95.00
2/1/11	12.20	2.80	3.80	140.00	353.00
2/8/11	19.30	3.00	6.90	43.50	66.10
2/15/11	27.50	2.50	9.80	2,282.00	93.30
2/22/11	14.00	2.67	3.10	291.50	322.00
3/1/11	7.30	3.94	2.80	2,357.00	2,312.00
Storm Event					
11/20/10	35.50	42.60	73.60	8.83	112.83
11/22/10	39.30	2.20	5.50	35.80	48.60
11/23/10	33.50	2.30	4.00	7.00	19.80
11/24/10	33.00	2.30	3.20	68.00	60.60

Table A-4. Dissolved oxygen (mg/L) concentrations observed at watershed-wide compliance sites during the 2010-2011 wet season

Sample Week	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek @ Chino-Corona Rd (WW-M5)	SAR @ MWD Crossing (WW-S1) (Riverside County	SAR @ Pedley Avenue (WW-S4)
Regular Sampling Events					
12/21/10	5.82	8.54	8.79	9.85	9.00
12/28/10	2.00	7.23	7.21	7.40	7.21
1/4/11	0.00	7.03	9.29	7.21	7.18
1/11/11	5.72	5.94	10.34	7.69	7.77
1/18/11	6.16	7.39	9.41	7.28	7.01
1/25/11	5.49	9.40	8.34	9.60	9.55
2/1/11	5.92	9.43	7.75	9.79	10.18
2/8/11	9.0	7.86	7.04	9.57	9.35
2/15/11	10.01	10.51	10.43	9.42	10.29
2/22/11	8.84	9.50	15.25	9.71	10.22
3/1/11	6.68	9.33	13.62	10.69	9.94
Storm Event					
11/20/10	5.45	7.15	7.54	6.39	6.81
11/22/10	6.19	6.71	7.35	6.13	6.27
11/23/10	9.49	9.29	10.39	8.98	8.91
11/24/10	8.72	9.54	10.43	7.56	8.22

Table A-5. pH (standard units) observed at watershed-wide compliance sites during the 2010-2011 wet season

Sample Week	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek @ Chino-Corona Rd (WW-M5)	SAR @ MWD Crossing (WW-S1) (Riverside County	SAR @ Pedley Avenue (WW-S4)
Regular Sampling Events					
12/21/10	6.50	7.10	6.40	6.10	6.40
12/28/10	7.63	8.03	7.20	6.93	7.20
1/4/11	7.40	7.83	8.10	7.73	7.27
1/11/11	7.00	8.03	8.27	6.23	7.30
1/18/11	8.00	8.70	8.10	7.13	7.00
1/25/11	6.47	7.73	7.13	7.73	7.33
2/1/11	7.37	8.33	8.17	7.70	7.87
2/8/11	7.30	8.20	7.57	7.40	7.67
2/15/11	7.80	8.47	8.07	7.17	7.87
2/22/11	7.93	8.23	8.20	7.10	7.30
3/1/11	7.53	8.27	8.63	7.20	7.33
Storm Event					
11/20/10	7.60	7.10	7.40	7.40	7.30
11/22/10	7.70	8.00	7.10	6.80	6.10
11/23/10	8.30	7.90	8.23	7.40	7.73
11/24/10	8.10	7.90	8.27	7.83	7.80

Table A-6. Turbidity (NTU) observed at watershed-wide compliance sites during the 2010-2011 wet season

Sample Week	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek @ Chino-Corona Rd (WW-M5)	SAR @ MWD Crossing (WW-S1) (Riverside County	SAR @ Pedley Avenue (WW-S4)
Regular Sampling Events					
12/21/10	61.20	22.20	159.00	n/a	n/a
12/28/10	28.50	3.71	5.68	467.00	355.00
1/4/11	17.73	333.67	4.25	78.47	98.83
1/11/11	11.87	7.64	3.57	94.00	62.00
1/18/11	11.67	2.56	3.57	28.10	30.43
1/25/11	15.33	3.40	9,34	28.37	27.63
2/1/11	11.50	2.06	5.85	129.00	224.00
2/8/11	14.03	2.17	5.05	19.67	27.63
2/15/11	19.27	3.29	4.99	n/a	25.40
2/22/11	10.90	3.52	3.87	79.80	113.67
3/1/11	7.59	2.63	4.04	n/a	n/a
Storm Event					
11/20/10	25.60	32.80	36.00	3.19	34.90
11/22/10	37.80	2.63	4.06	24.90	35.00
11/23/10	31.27	2.89	4.02	14.73	17.27
11/24/10	33.67	4.67	8.79	79.23	45.60

Table A-7. Water temperature (°C) observed at watershed-wide compliance sites during the 2010-2011 wet season

Sample Week	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek @ Chino-Corona Rd (WW-M5)	SAR @ MWD Crossing (WW-S1) (Riverside County	SAR @ Pedley Avenue (WW-S4)
Regular Sampling Events					
12/21/10	14.23	12.72	12.20	11.50	12.40
12/28/10	13.67	18.80	12.40	12.13	12.40
1/4/11	11.41	16.92	15.61	10.70	10.33
1/11/11	12.90	16.93	15.27	11.08	10.80
1/18/11	14.38	21.65	18.30	14.62	15.64
1/25/11	13.67	19.83	14.43	12.17	12.50
2/1/11	13.98	19.26	14.42	11.71	12.43
2/8/11	14.77	19.83	12.47	12.33	13.23
2/15/11	14.61	19.09	16.53	14.03	14.82
2/22/11	14.72	19.43	16.38	11.20	12.20
3/1/11	12.55	17.63	17.00	8.68	11.14
Storm Event					
11/20/10	16.90	16.60	15.00	18.50	16.40
11/22/10	16.40	22.10	15.90	13.90	14.20
11/23/10	16.77	22.60	17.83	14.50	14.80
11/24/10	16.03	21.50	18.23	14.80	15.70

Table A-8. Flow (cubic feet/second) observed at watershed-wide compliance sites during the 2010-2011 wet season (as measured by field staff; n/a indicates no measure taken because of unsafe conditions)

Sample Week	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek @ Chino-Corona Rd (WW-M5)	SAR @ MWD Crossing (WW-S1) (Riverside County	SAR @ Pedley Avenue (WW-S4)
Regular Sampling Events					
12/21/10	n/a	n/a	n/a	n/a	n/a
12/28/10	n/a	35.27	90.02	n/a	n/a
1/4/11	n/a	21.29	134.66	185.39	254.75
1/11/11	3.29	25.07	116.85	n/a	n/a
1/18/11	3.81	27.62	82.63	79.18	246.71
1/25/11	3.44	30.24	44.19	168.38	135.05
2/1/11	3.29	20.07	115.21	153.84	198.78
2/8/11	7.83	26.89	42.00	106.74	259.32
2/15/11	7.21	14.61	113.67	221.28	220.17
2/22/11	4.52	31.42	188.35	224.45	170.17
3/1/11	8.26	37.78	294.46	n/a	n/a
Storm Event					
11/20/10	1.21	158.40	840.53	184.39	343.01
11/22/10	3.99	41.86	62.20	40.00	302.28
11/23/10	5.23	48.73	63.01	97.47	171.30
11/24/10	5.08	32.11	79.81	144.44	305.14

Table A-9. Conductivity (µS/cm) observed at watershed-wide compliance sites during the 2010-2011 wet season

Sample Week	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek @ Chino-Corona Rd (WW-M5)	SAR @ MWD Crossing (WW-S1) (Riverside County	SAR @ Pedley Avenue (WW-S4)
Regular Sampling Events					
12/21/10	568	85	74	136	169
12/28/10	246	915	634	603	634
1/4/11	266	780	557	676	634
1/11/11	1,290	667	585	669	651
1/18/11	1,383	868	641	816	832
1/25/11	1,300	801	572	751	731
2/1/11	1,290	782	554	687	721
2/8/11	915	813	528	781	766
2/15/11	948	776	571	613	813
2/22/11	1,180	736	522	596	663
3/1/11	709	724	540	236	357
Storm Event					
11/20/10	826	110	83	755	507
11/22/10	697	655	435	545	499
11/23/10	1,077	691	586	1,017	1,020
11/24/10	1,143	649	584	597	662

Table A-10. Daily mean flow (cfs) as measured by the USGS from November 1, 2010 to March 31, 2011 (M = missing value; data from January 1 – March 31 were not available during preparation of this report; in addition the available USGS data are currently provisional)

Date	USGS Gauge		
	Santa Ana River at MWD Crossing (Riverside County)	Chino Creek at Schaefer near Chino	Cucamonga Creek near Mira Loma
1-Nov	61	0.63	26
2-Nov	58	0.6	19
3-Nov	66	0.57	9.6
4-Nov	62	0.61	12
5-Nov	62	0.59	12
6-Nov	60	0.56	21
7-Nov	65	0.54	17
8-Nov	83	9.1	28
9-Nov	75	0.57	14
10-Nov	78	0.54	14
11-Nov	68	0.5	16
12-Nov	67	0.54	17
13-Nov	67	0.54	22
14-Nov	66	0.52	22
15-Nov	65	0.54	18
16-Nov	68	0.55	23
17-Nov	67	0.57	21
18-Nov	68	0.56	20
19-Nov	68	0.56	42
20-Nov	267	126	337
21-Nov	278	51	161
22-Nov	97	0.62	42
23-Nov	83	0.55	44
24-Nov	102	1.5	43
25-Nov	75	0.47	44
26-Nov	70	0.46	44
27-Nov	72	0.67	42
28-Nov	78	1.6	47
29-Nov	74	0.46	35
30-Nov	72	0.45	30
1-Dec	75	0.46	30
2-Dec	78	0.52	31
3-Dec	83	0.49	37
4-Dec	90	0.48	38
5-Dec	84	25	87
6-Dec	310	51	173
7-Dec	100	0.69	35
8-Dec	89	0.55	37
9-Dec	82	0.53	38
10-Dec	79	0.52	40
11-Dec	77	0.56	39

Table A-10. Daily mean flow (cfs) as measured by the USGS from November 1, 2010 to March 31, 2011 (M = missing value; data from January 1 – March 31 were not available during preparation of this report; in addition the available USGS data are currently provisional)

Date	USGS Gauge		
	Santa Ana River at MWD Crossing (Riverside County)	Chino Creek at Schaefer near Chino	Cucamonga Creek near Mira Loma
12-Dec	75	0.52	43
13-Dec	77	0.51	37
14-Dec	82	0.53	26
15-Dec	78	0.52	32
16-Dec	111	14	64
17-Dec	93	34	117
18-Dec	276	106	246
19-Dec	3080	599	1930
20-Dec	9890	573	2040
21-Dec	9950	361	1500
22-Dec	12000	863	2500
23-Dec	M	95	285
24-Dec	M	2	98
25-Dec	M	47	89
26-Dec	M	45	116
27-Dec	M	1.5	48
28-Dec	M	2	46
29-Dec	M	141	189
30-Dec	M	1.8	52
31-Dec	M	1.4	50
1-Jan	M	M	M
2-Jan	M	M	M
3-Jan	M	M	M
4-Jan	M	M	M
5-Jan	M	M	M
6-Jan	M	M	M
7-Jan	M	M	M
8-Jan	M	M	M
9-Jan	M	M	M
10-Jan	M	M	M
11-Jan	M	M	M
12-Jan	M	M	M
13-Jan	M	M	M
14-Jan	M	M	M
15-Jan	M	M	M
16-Jan	M	M	M
17-Jan	M	M	M
18-Jan	M	M	M
19-Jan	M	M	M
20-Jan	M	M	M
21-Jan	M	M	M

Table A-10. Daily mean flow (cfs) as measured by the USGS from November 1, 2010 to March 31, 2011 (M = missing value; data from January 1 – March 31 were not available during preparation of this report; in addition the available USGS data are currently provisional)

Date	USGS Gauge		
	Santa Ana River at MWD Crossing (Riverside County)	Chino Creek at Schaefer near Chino	Cucamonga Creek near Mira Loma
22-Jan	M	M	M
23-Jan	M	M	M
24-Jan	M	M	M
25-Jan	M	M	M
26-Jan	M	M	M
27-Jan	M	M	M
28-Jan	M	M	M
29-Jan	M	M	M
30-Jan	M	M	M
31-Jan	M	M	M
1-Feb	M	M	M
2-Feb	M	M	M
3-Feb	M	M	M
4-Feb	M	M	M
5-Feb	M	M	M
6-Feb	M	M	M
7-Feb	M	M	M
8-Feb	M	M	M
9-Feb	M	M	M
10-Feb	M	M	M
11-Feb	M	M	M
12-Feb	M	M	M
13-Feb	M	M	M
14-Feb	M	M	M
15-Feb	M	M	M
16-Feb	M	M	M
17-Feb	M	M	M
18-Feb	M	M	M
19-Feb	M	M	M
20-Feb	M	M	M
21-Feb	M	M	M
22-Feb	M	M	M
23-Feb	M	M	M
24-Feb	M	M	M
25-Feb	M	M	M
26-Feb	M	M	M
27-Feb	M	M	M
28-Feb	M	M	M
29-Feb	M	M	M
1-Mar	M	M	M
2-Mar	M	M	M

Table A-10. Daily mean flow (cfs) as measured by the USGS from November 1, 2010 to March 31, 2011 (M = missing value; data from January 1 – March 31 were not available during preparation of this report; in addition the available USGS data are currently provisional)

Date	USGS Gauge		
	Santa Ana River at MWD Crossing (Riverside County)	Chino Creek at Schaefer near Chino	Cucamonga Creek near Mira Loma
3-Mar	M	M	M
4-Mar	M	M	M
5-Mar	M	M	M
6-Mar	M	M	M
7-Mar	M	M	M
8-Mar	M	M	M
9-Mar	M	M	M
10-Mar	M	M	M
11-Mar	M	M	M
12-Mar	M	M	M
13-Mar	M	M	M
14-Mar	M	M	M
15-Mar	M	M	M
16-Mar	M	M	M
17-Mar	M	M	M
18-Mar	M	M	M
19-Mar	M	M	M
20-Mar	M	M	M
21-Mar	M	M	M
22-Mar	M	M	M
23-Mar	M	M	M
24-Mar	M	M	M
25-Mar	M	M	M
26-Mar	M	M	M
27-Mar	M	M	M
28-Mar	M	M	M
29-Mar	M	M	M
30-Mar	M	M	M
31-Mar	M	M	M

Table A-11. Daily rainfall data (inches) from key rainfall gauges in MSAR watershed (Data for the months of February and March 2011 were not available for the preparation of this report)

Date	Rainfall Gauge			
	Riverside North	Riverside South	Corona	Norco
1-Nov	0	0	0	0
2-Nov	0	0	0	0
3-Nov	0	0	0	0
4-Nov	0	0	0	0
5-Nov	0	0	0	0
6-Nov	0	0	0	0
7-Nov	0	0	0	0
8-Nov	0.13	0.08	0.06	0.02
9-Nov	0	0	0.01	0.01
10-Nov	0	0	0	0
11-Nov	0	0	0	0
12-Nov	0	0	0	0
13-Nov	0	0	0	0
14-Nov	0	0	0	0
15-Nov	0	0.01	0	0
16-Nov	0	0	0	0
17-Nov	0	0	0	0
18-Nov	0	0	0	0
19-Nov	0	0	0	0
20-Nov	0.03	0.02	0.15	0.06
21-Nov	0.59	0.27	0.74	0.28
22-Nov	0.08	0.1	0.13	0.02
23-Nov	0	0.01	0.01	0
24-Nov	0.02	0.24	0.07	0.09
25-Nov	0.01	0	0	0
26-Nov	0	0	0	0
27-Nov	0	0	0	0
28-Nov	0.06	0.03	0.01	0.02
29-Nov	0	0.01	0.01	0
30-Nov	0	0	0	0
1-Dec	0	0	0	0
2-Dec	0	0	0	0
3-Dec	0	0	0	0
4-Dec	0	0	0	0
5-Dec	0	0	0	0
6-Dec	0.55	0.59	0.57	0.39
7-Dec	0	0.01	0	0
8-Dec	0	0	0	0.01
9-Dec	0	0	0	0
10-Dec	0	0	0	0
11-Dec	0	0	0	0

Table A-11. Daily rainfall data (inches) from key rainfall gauges in MSAR watershed (Data for the months of February and March 2011 were not available for the preparation of this report)

Date	Rainfall Gauge			
	Riverside North	Riverside South	Corona	Norco
12-Dec	0	0	0	0
13-Dec	0	0	0	0
14-Dec	0	0	0	0
15-Dec	0	0	0	0
16-Dec	0.2	0.18	0.19	0.12
17-Dec	0	0.01	0	0
18-Dec	0.24	0.15	0.6	0.29
19-Dec	0.47	0.28	0.98	1.12
20-Dec	1.16	1.09	1.12	0.72
21-Dec	2.89	2.53	4.05	2.01
22-Dec	2.83	2.8	3.98	2.81
23-Dec	0.87	0.45	0.89	0.61
24-Dec	0	0	0	0
25-Dec	0.01	0	0	0.01
26-Dec	0.22	0.2	0.47	0.37
27-Dec	0.01	0	0	0.01
28-Dec	0	0	0	0.01
29-Dec	0.16	0.16	0.2	0.15
30-Dec	0.36	0.43	0.81	0.49
31-Dec	0	0.01	0.01	0.01
1-Jan	0	0	0	0
2-Jan	0	0	0	0
3-Jan	0.3	0.17	0.65	0.39
4-Jan	0.03	0.02	0.04	0.06
5-Jan	0	0	0.01	0
6-Jan	0	0	0	0
7-Jan	0	0	0	0
8-Jan	0	0	0	0
9-Jan	0	0	0	0
10-Jan	0	0	0	0
11-Jan	0	0	0	0
12-Jan	0	0	0	0
13-Jan	0	0	0	0
14-Jan	0	0	0	0
15-Jan	0	0	0	0
16-Jan	0	0	0	0
17-Jan	0	0	0	0
18-Jan	0	0	0	0
19-Jan	0	0	0	0
20-Jan	0	0	0	0
21-Jan	0	0	0	0
22-Jan	0	0	0	0

Table A-11. Daily rainfall data (inches) from key rainfall gauges in MSAR watershed (Data for the months of February and March 2011 were not available for the preparation of this report)

Date	Rainfall Gauge			
	Riverside North	Riverside South	Corona	Norco
23-Jan	0	0	0	0
24-Jan	0	0	0	0
25-Jan	0	0	0	0
26-Jan	0	0	0	0
27-Jan	0	0	0	0
28-Jan	0	0	0	0
29-Jan	0	0	0	0
30-Jan	0	0	0	0
31-Jan	0.17	0.15	0	0

Appendix B
QA/QC Summary

Introduction

This section provides the Quality Assurance/Quality Control (QA/QC) evaluation for samples and data collected during the 2010-11 wet season. The basis for this evaluation is the approved QAPP.

Appendix C includes additional QA/QC evaluations (e.g., laboratory method blanks, laboratory duplicates, laboratory matrix spikes/matrix spike duplicates, and laboratory control samples) conducted by the Orange county Public Health Laboratory (OCPHL). This information will be appended when received from OCPHL.

Field measurements were made for the following constituents: conductivity, dissolved oxygen, pH, turbidity, water temperature, and flow. Field data were checked to ensure that all required data were gathered and recorded. This check included a data review to ensure correct units of measurements were reported and that reported values were within expected ranges.

Laboratory analyses were conducted for three constituents: fecal coliform, *E. coli*, and TSS. Data validation included a check to ensure that samples were delivered to laboratories within required holding times and that all sample handling and custody protocols were followed. Field/equipment blank and duplicate results were evaluated against various reporting requirements and data were checked to ensure correct units of measurement were reported.

The following sections summarize the results of the QA/QC evaluation for the 2010-11 wet season data. Data collected during this season have been submitted to SAWPA for inclusion in the SAWPA database.

Field Measured Parameters

Completeness

Table B-1shows the field measurements collected versus planned for the wet weather season.

Table B-1. Summary of field parameter collection activity

Parameter	Collected	Planned	% Complete
Conductivity	75	75	100
Dissolved Oxygen	75	75	100
Flow	62	75	83
pH	75	75	100
Temperature	75	75	100
Turbidity	72	75	96

- Flow - Thirteen (13) flow measurements were not collected due to unsafe conditions due to high flows.

- Turbidity – Five (5) turbidity measurements were not collected due to overly turbid conditions associated with Army Corps of Engineers release of water at Seven Oaks Dam for testing dam gates and structural integrity.

Accuracy and Precision

Field staff used a Horiba multi-parameter probe to collect *in situ* field measurements for conductivity, dissolved oxygen, pH, and water temperature at all sample locations during each sample event. Turbidity and flow were measured with a Hach Turbidity meter and Marsh-McBirney Flo-Mate meter with top-setting rod, respectively. Field staff calibrated each of the water quality meters prior to each sample event to ensure accuracy and precision of the measurements. Table B-2 summarizes the accuracy and repeatability associated with the use of each meter.

Table B-2. Summary of accuracy and repeatability expectations for field measurement meters

Water Quality Constituent	Accuracy	Repeatability
Dissolved Oxygen	± 0.2 mg/L	± 0.1 mg/L
pH	± 0.1 units	± 0.05 units
Conductivity	± 1%	± 0.05%
Water Temperature	± 0.3 °C	±0.1 °C
Turbidity	± 2%	± 1%
Flow	± 2%	N/A

Laboratory Constituents

Table B-3 describes the number of grab samples planned versus actual samples collected. During the 2010-11 wet weather season, 11 weeks of sampling at five compliance sites was planned to begin the week of December 20, 2010 and end the week of February 28, 2011. In addition, wet weather event sampling was conducted on four separate events on November 20, 22, 23, and 24. A total of 75 samples were planned for collection.

No samples were missed. In addition, holding time requirements for bacterial indicators (6 hours) and TSS (7 days) analyses were met for all samples.

Table B-3. Summary of grab sample collection activity

Sample Location	Planned	Collected	Missed
Prado Park Lake (WW-C3)	15	15	0
Chino Creek at Central Ave (WW-C7)	15	15	0
Mill-Cucamonga Creek at Chino Corona Road (WW-M5)	15	15	0
SAR at MWD Crossing (WW-S1)	15	15	0
SAR at Pedley Ave (WW-S4)	15	15	0
Total	75	75	0

Field Blanks

The QAPP calls for a field/equipment blank to be collected during each sample event. Accordingly, a total of 15 field/equipment blanks were collected (frequency of 20%), well above the typically required frequency.

Per the QAPP, the reporting target limits for TSS and bacterial indicators were 1.0 mg/L and 10 cfu/100 mL, respectively. These method sensitivity guidelines were met. Field/equipment blank results were all below detectable counts (< 9 cfu/100 mL) for *E. coli* and fecal coliform. For TSS, all field/equipment blank results were reported below the target reporting limit.

Field Duplicates

The QAPP requires the collection of a field duplicate at a minimum frequency of at least 5% of the total samples collected. Field staff collected a field duplicate during each sample event. As a result, the frequency of field duplicate collection was 20%, well above the required frequency.

Each duplicate sample was analyzed for the same parameters as its paired field sample. Results of the field duplicate analyses can be used to assess adherence to field sampling collection protocols and laboratory precision.

Table B-4 summarizes the field duplicate analysis results for TSS. All duplicate pairs were within the QAPP's relative percent difference (RPD) goal of ± 25%.

Table B-4. Results of field duplicate analysis for TSS

Sample Date	Sample Location	Duplicate Result (mg/L)	Sample Result (mg/L)	RPD (%)
11/20/2010	SAR at Pedley Ave (WW-S4)	107.5	112.83	4.7
11/22/2010	SAR at MWD Crossing (WW-S1)	34.3	35.8	4.2
11/23/2010	Prado Park Lake Outlet (WW-C3)	36.5	33.5	-9.0
11/24/2010	Chino Creek at Central (WW-C7)	2.5	2.3	-8.7
12/21/2010	Mill-Cucamonga Creek (WW-M5)	146	144	-1.4
12/28/2010	SAR at Pedley Ave (WW-S4)	412	408	-1.0
1/4/2011	SAR at MWD Crossing (WW-S1)	193.5	183	-5.7
1/11/2011	Prado Park Lake Outlet (WW-C3)	17.8	17.3	-2.9
1/18/2011	Chino Creek at Central (WW-C7)	3.8	3.6	-5.6
1/25/2011	Mill-Cucamonga Creek (WW-M5)	8.3	8	-3.8
2/1/2011	SAR at Pedley Ave (WW-S4)	310	353	12.2
2/8/2011	SAR at MWD Crossing (WW-S1)	51.2	43.5	-17.7
2/15/2011	Prado Park Lake Outlet (WW-C3)	26.2	27.5	4.7
2/22/2011	Chino Creek at Central (WW-C7)	2.56	2.67	4.1
3/1/2011	Mill-Cucamonga Creek (WW-M5)	2.9	2.8	-3.6

To determine the precision of the duplicate analysis for each bacterial indicator the following method was used[5]:

- Calculate the logarithm of each sample and associated duplicate ("laboratory pair")
- Determine the range for each laboratory pair (R_{log})
- Calculate the mean of the ranges (Mean R_{log})
- Calculate the precision criterion, where the precision criteria = 3.27 * Mean R_{log}
- Compare R_{log} for each duplicate pair with the calculated precision criterion for the data set to determine if R_{log} is less than the precision criterion.

Tables B-5 and B-6 summarize the field duplicate analysis results for fecal coliform and *E. coli*, respectively.

For fecal coliform, only one duplicate pair, collected on February 8, 2011, at SAR at MWD Crossing (WW-S1) exceeded the calculated precision criterion.

For *E. coli*, only one duplicate pair, collected on February 8, 2011, at SAR at MWD Crossing (WW-S1) exceeded the calculated precision criterion.

[5] Standard Methods, Section 9020B, 18th, 19th, or 20th Editions

Table B-5. Results of field duplicate analysis for fecal coliform

Date	Compliance Site	Duplicate Result (cfu/100mL)	Sample Result (cfu/100mL)	Log of Duplicate Result (L_1)	Log of Sample Result (L_2)	Range of Logs (L_1 - L_2) or (R_{log})
11/20/2010	SAR at Pedley Ave (WW-S4)	7,500	11,200	3.8751	4.0492	0.1742
11/22/2010	SAR at MWD Crossing (WW-S1)	370	440	2.5682	2.6435	0.0753
11/23/2010	Prado Park Lake Outlet (WW-C3)	90	70	1.9542	1.8451	0.1091
11/24/2010	Chino Creek at Central (WW-C7)	570	1,100	2.7559	3.0414	0.2855
12/21/2010	Mill-Cucamonga Creek (WW-M5)	4,400	3,900	3.6435	3.5911	0.0524
12/28/2010	SAR at Pedley Ave (WW-S4)	460	390	2.6628	2.5911	0.0717
1/4/2011	SAR at MWD Crossing (WW-S1)	210	250	2.3222	2.3979	0.0757
1/11/2011	Prado Park Lake Outlet (WW-C3)	310	300	2.4914	2.4771	0.0142
1/18/2011	Chino Creek at Central (WW-C7)	80	210	1.9031	2.3222	0.4191
1/25/2011	Mill-Cucamonga Creek (WW-M5)	410	480	2.6128	2.6812	0.0685
2/1/2011	SAR at Pedley Ave (WW-S4)	250	280	2.3979	2.4472	0.0492
2/8/2011	SAR at MWD Crossing (WW-S1)	60	9	1.7782	0.9542	**0.8239**
2/15/2011	Prado Park Lake Outlet (WW-C3)	40	80	1.6021	1.9031	0.3010
2/22/2011	Chino Creek at Central (WW-C7)	140	210	2.1461	2.3222	0.1761
3/1/2011	Mill-Cucamonga Creek (WW-M5)	30	80	1.4771	1.9031	0.4260
					Sum of R_{log}	**3.1219**
					Mean R_{log}	**0.2081**
					Precision Criterion (3.27*Mean R_{log})	**0.6806**

Table B-6. Results of field duplicate analysis for *E. coli*

Date	Compliance Site	Duplicate Result (cfu/100mL)	Sample Result (cfu/100mL)	Log of Duplicate Result (L_1)	Log of Sample Result (L_2)	Range of Logs (L_1 - L_2) or (R_{log})
11/20/2010	SAR at Pedley Ave (WW-S4)	6,000	5,600	3.7782	3.7482	0.0300
11/22/2010	SAR at MWD Crossing (WW-S1)	410	380	2.6128	2.5798	0.0330
11/23/2010	Prado Park Lake Outlet (WW-C3)	130	140	2.1139	2.1461	0.0322
11/24/2010	Chino Creek at Central (WW-C7)	270	220	2.4314	2.3424	0.0889
12/21/2010	Mill-Cucamonga Creek (WW-M5)	3,700	4,200	3.5682	3.6232	0.0550
12/28/2010	SAR at Pedley Ave (WW-S4)	450	610	2.6532	2.7853	0.1321
1/4/2011	SAR at MWD Crossing (WW-S1)	320	270	2.5051	2.4314	0.0738
1/11/2011	Prado Park Lake Outlet (WW-C3)	360	400	2.5563	2.6021	0.0458
1/18/2011	Chino Creek at Central (WW-C7)	350	350	2.5441	2.5441	0.0000
1/25/2011	Mill-Cucamonga Creek (WW-M5)	560	580	2.7482	2.7634	0.0152
2/1/2011	SAR at Pedley Ave (WW-S4)	310	330	2.4914	2.5185	0.0272
2/8/2011	SAR at MWD Crossing (WW-S1)	50	30	1.6990	1.4771	**0.2218**
2/15/2011	Prado Park Lake Outlet (WW-C3)	70	70	1.8451	1.8451	0.0000
2/22/2011	Chino Creek at Central (WW-C7)	220	210	2.3424	2.3222	0.0202
3/1/2011	Mill-Cucamonga Creek (WW-M5)	340	250	2.5315	2.3979	0.1335
					Sum of R_{log}	**0.9088**
					Mean R_{log}	**0.0606**
					Precision Criterion (3.27*Mean R_{log})	**0.1981**

Appendix C
Laboratory QA/QC Data

This section provides QA/QC data for the 2010-2011 wet season provided by OCPHL, including laboratory method blanks, laboratory duplicates, laboratory matrix spikes/matrix spike duplicates, and laboratory control samples.

The attached information summarizes the OCPHL QA/QC data resulting from the analysis of the TSS samples. Additional laboratory information for the bacteria analyses will be appended when received from OCPHL (information first requested in March 2011).

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Excellence
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To: CDM

From: Manisha Sulakhe,
Orange County Public Health Laboratory

Date: 04/29/2011

Subject: MSAR Watershed-wide QA/QC for TSS
Wet Season -11/20/2010-3/2011

I. Method Blank

A. **Field/Equipment Blank**: One single field blank per batch of 7 to 20 samples collected in the field and analyzed in the laboratory along with all samples.

B. **Laboratory Blank**: One Type 1 water sample is analyzed per batch of samples analyzed.

For TSS, all field blanks results were reported below the target reporting limit of <1 mg/L. Laboratory accomplished MDL is at 1.0mg/l and all results below the value will be reported at <1.0mg/l which meets the acceptance criteria of Target Reporting Limit.

II. Duplicates:

A. Field Duplicates

Field duplicates were collected for at least 5% of total samples. Field duplicates were collected well above this required frequency at 20% of total samples collected. The duplicate samples were analyzed for the same parameters as its paired field sample. The results of the field duplicate analyses can be used to assess field adherence to field sampling collection protocols. Also, laboratory precision can be assessed by examining the results from the field sample and its duplicate pair.

Table1 shows the results for the sample and field duplicate pairs for TSS. All duplicate pairs were within the relative percent difference (RPD) which meets the acceptance criteria of ±25%.

Table 1. Precision-Results of TSS Field Duplicate Pairs

Date	Compliance Site	Site Id.	Sample Result mg/l	Duplicate Result 2 mg/l	%RPD
11/20/2010	SAR at Pedley Ave	WW S4	112.83	107.5	4.84
11/22/2010	SAR at MWD Crossing	WW S1	35.8	34.33	4.19
11/23/2010	Prado Park Lake Outlet	WW C3	36.5	33.5	8.57
11/24/2010	Chino Creek at Central	WW C7	2.45	2.3	6.32
12/21/2010	Milli-Cucamonga Creek	WW M5	146.25	144	1.55
12/28/2010	SAR at Pedley Ave	WW S4	420	412	1.92
1/4/2011	SAR at MWD Crossing	WW S!	193.5	183	5.58
1/13/2011	Prado Park Lake Outlet	WW C3	17.8	17.33	2.68
11/18/2011	Chino Creek at Central	WW C7	3.75	3.6	4.08
1/25/2011	Milli-Cucamonga Creek	WW M5	8.3333333	8	4.08
2/1/2011	SAR at Pedley Ave	WW S4	352	308.25	13.25
2/8/2011	SAR at MWD Crossing	WW S1	51.166667	43.5	16.20
2/16/2011	Prado Park Lake Outlet	WW C3	27.5	26.25	4.65
2/22/2011	Chino Creek at Central	WW C7	2.6666667	2.56	4.08
3/1/2011	Milli-Cucamonga Creek	WW M5	2.9	2.8125	3.06
				Mean	5.67

B. Laboratory Duplicates

Laboratory duplicates were analyzed for at least 5% of total samples received per batch. The laboratory duplicate samples were analyzed with the same parameters like all samples analyzed in the laboratory but with varying volumes. The results of the duplicate analyses are used to assess laboratory practices and precision during analysis.

Table 2 shows the results for the sample and laboratory duplicates pairs for TSS. All duplicate pairs, except for one duplicate pair (sampled on 2/8/2011 at WW-S1) were within the relative percent difference (RPD) which meets the acceptance criteria of ±25%.

Table 2. Precision-Results of TSS Laboratory Duplicate Pairs

Date	Compliance Site	Site Id.	Sample Result mg/l	Duplicate Result 2 mg/l	%RPD
11/20/2010	Prado Park Lake Outlet	WW C3	36	35	2.817
11/22/2010	Milli-Cucamonga Creek	WW M5	5.6	5.375	4.100
11/23/2010	Chino Creek at Central	WW C7	2.3	2.2	4.444
11/24/2010	SAR at Pdeley	WW S4	60.75	60.5	0.412
12/21/2010	SAR at Pdeley	WW S4	9350	9280	0.751
12/28/2010	Prado Park Lake Outlet	WW C3	19	18	5.405
1/4/2011	Prado Park Lake Outlet	WW C3	22.67	22.5	0.753
1/13/2011	Chino Creek at Central	WW C7	2.75	2.625	4.651
11/18/2011	SAR at MWD Crossing	WW S1	33.875	33.8	0.222
1/25/2011	SAR at Pdeley	WW S4	95	94.857	0.151
2/1/2011	Prado Park Lake Outlet	WW C3	12.33	12	2.713
2/8/2011	SAR at MWD Crossing	WW S1	3	2.125	34.146
2/16/2011	SAR at MWD Crossing	WW S1	2282	2190.5	4.092
2/22/2011	SAR at Pdeley	WW S4	333	310	7.154
3/1/2011	Prado Park Lake Outlet	WW C3	7.33	7.2	1.789
				Mean	4.907

III. Laboratory Control Samples:

Laboratory uses certified quality control sample and spikes it in the laboratory blank. Percent Recovery is meet with the acceptance criteria of 80-120%

Table 3 shows the results for the laboratory control samples percent recovery results meet with 80-120% of the certified values for TSS.

Table 3: Accuracy-Results of TSS for Laboratory Control Samples

Date	QC Standard Used	True Value	LCS Result	% Recovery
11/20/2010	EE QC Id#1115-USS3 Nominal TSS=111.3mg,Range=38.5	111.3	117.1	105.21
11/22/2010	EE QC Id#663-USS3 Nominal TSS=26.2mg,Range=9.1	26.2	29.95	114.31
11/23/2010	EE QC Id#1659-USS3 Nominal TSS=27.6mg,Range=9.6	27.6	23.6	85.51
11/24/2010	EE QC Id#658-USS3 Nominal TSS=27.1mg,Range=9.4	27.1	30.55	112.73
12/21/2010	EE QC Id#11114-USS3 Nominal TSS=112.1mg,Range=38.8	112.1	117.2	104.60
12/28/2010	EE QC Id#11113-USS3 Nominal TSS=112.5mg,Range=39.0	112.5	126.85	112.76
1/4/2011	EE QC Id# 660-USS3 Nominal TSS=26.8 mg,Range=9.3	26.8	32.2	120.15
1/13/2011	EE QC Id# 661-USS3 Nominal TSS=27.7 mg,Range=9.6	27.7	28.55	103.07
11/18/2011	EE QC Id# 662-USS3 Nominal TSS=28 mg,Range=9.7	28	31.1	111.07
1/25/2011	EE QC Id# 1111-USS3 Nominal TSS=104.3mg,Range=36.1	104.3	120.3	115.34
2/1/2011	EE QC Id# 1112-USS3 Nominal TSS=91.6 mg,Range=31.7	91.6	103.2	112.66
2/8/2011	EE QC Id# 1110-USS3 Nominal TSS=105.0 mg,Range=36.4	105	116.85	111.30
2/16/2011	EE QC ID# 18061 Nominal TSS = 237.0 Range = 25.6	237	245.5	103.59
2/22/2011	EE QC Id# 4410-USS3 Nominal TSS=243.3 mg,Range=26.3	243.3	250.6	103.00
3/1/2011	EE QC Id# 18062 Nominal TSS=263.4 mg,Range=28.5	263.4	263.1	99.89
			Mean	107.67
			sd	8.39
			%RSD	7.79