Middle Santa Ana River Bacterial Indicator TMDL 2011 Dry Season Report

December 21, 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 2011 dry 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*) are 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 and Quality Assurance Project Plan (QAPP). The TMDL Task Force implemented the monitoring program in July 2007 following RWQCB approval of program documents. The Task Force updated the Monitoring Plan (SAWPA 2011a) and QAPP in 2011 (SAWPA 2011b)[1]. The RWQCB approved the revised documents by letter (July 28, 2011).

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 2011c) provide the monitoring program results for the 2009-2010 and 2010-2011 wet seasons, respectively. This report provides the results from the 2011 dry 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 2010b).

[1] The Middle Santa Ana River Monitoring Plan and Quality Assurance Project Plan are available at www.sawpa.org/roundtable-MSARTF.html under the Monitoring Program tab.

Section 2
Study Area

This section describes the study area and identifies the watershed-wide compliance monitoring locations sampled during the 2011 dry 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.

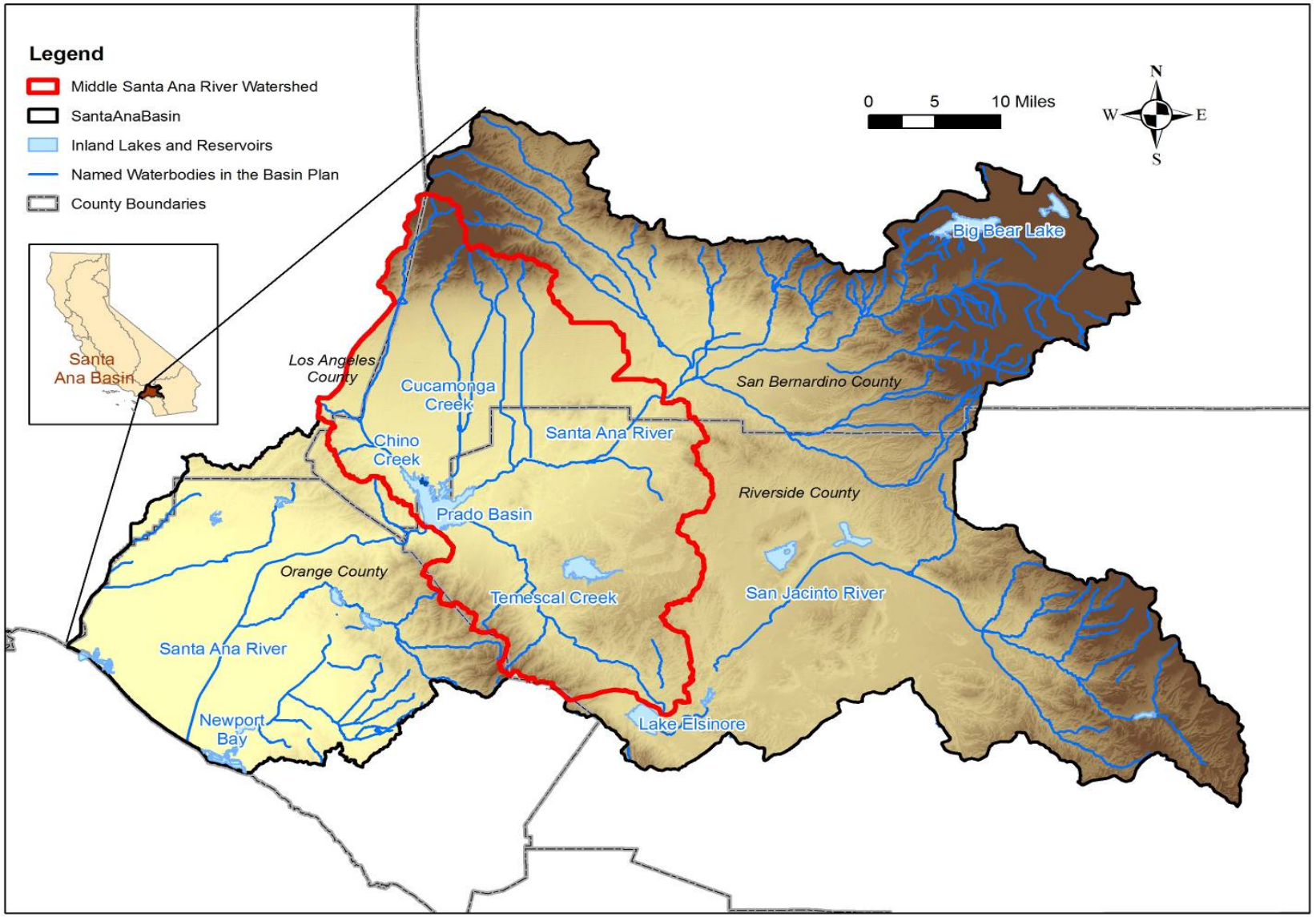


Figure 2-1. Location of the Middle Santa Ana River watershed (red outline) within the Santa Ana River watershed in southern California

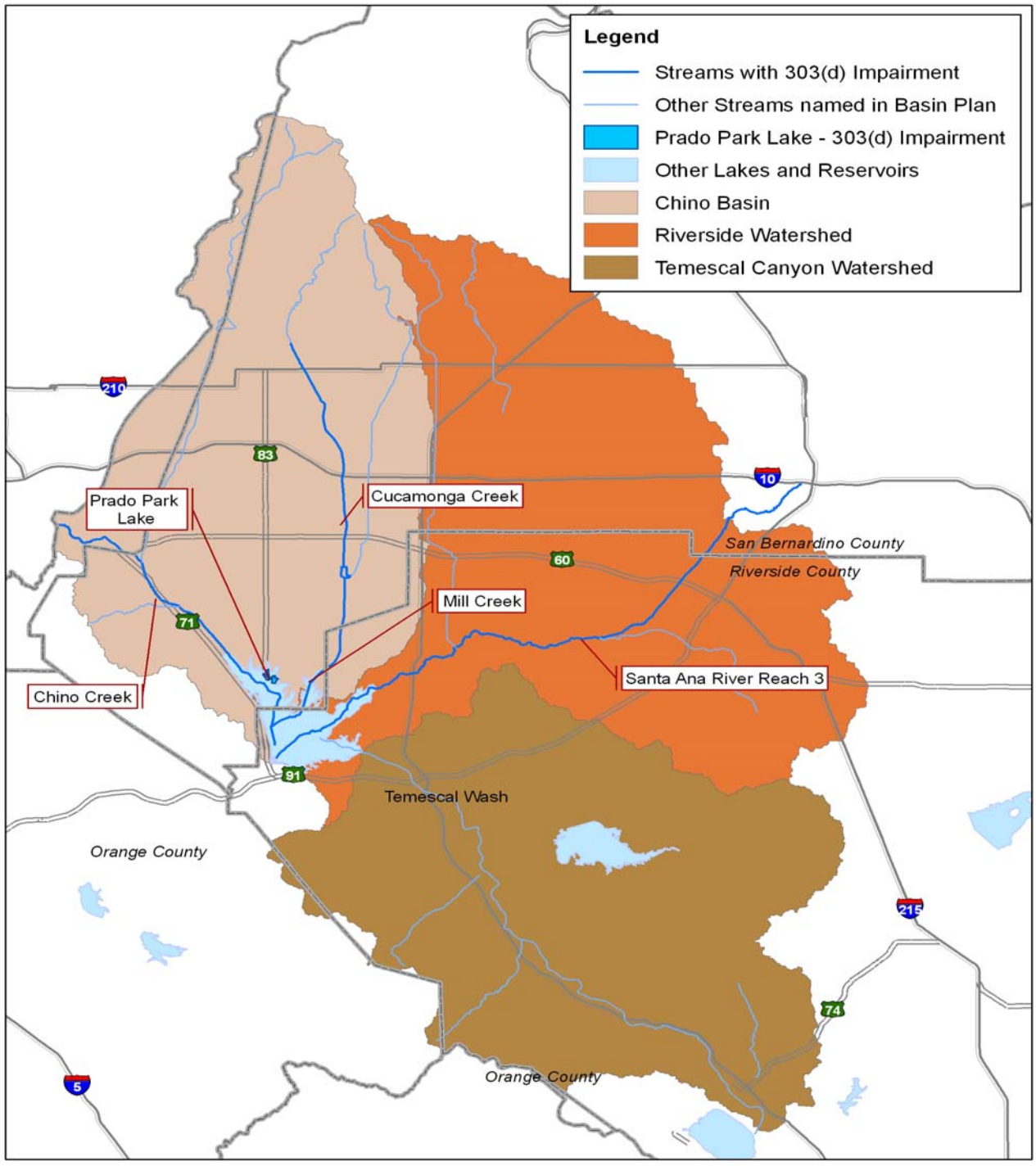


Figure 2-2. Major geographic areas of the Middle Santa Ana River watershed

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 cities of Eastvale and Jurupa Valley, which incorporated October 1, 2010 and July 1, 2011, respectively.

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 Dry 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 (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 mean monthly flow observed in these waterbodies for the April 1 to October 31, 2011 dry season (note: data set includes provisional data). Daily mean values are provided in Appendix A (Tables A-10 through A-12).

Table 2-1. Monthly mean flow summary (cfs) from USGS gauged sites near sample locations

Month	Santa Ana River at MWD Crossing	Chino Creek at Schaefer near Chino	Cucamonga Creek near Mira Loma
April	147.3	1.0	21.4
May	67.6	1.8	17.3
June	68.8	1.7	24.4
July	51.9	79.3	22.5
August	44.5	60.7	25.7
September	46.6	32.7	19.4
October	62.4	9.0	44.3

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 Control 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 (April – June, 2011)[2]. Appendix A (Table A-13) provides the currently available daily rainfall measurements from each gauged location.

[2] SAWPA periodically updates its rainfall and flow data. Data for the time periods not available at the time of report preparation may be obtained by contacting SAWPA or the agencies that actually collect the data: (1) Flow – USGS; (2) Rainfall – Riverside County Flood Control and Water Conservation District.

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
April	0.10	0.14	0.19	0.17
May	0.46	0.30	0.33	0.29
June	NA	NA	NA	0.04

[1] NA indicates June data were not available for this report. Rainfall totals for July, August, September and October were not available for any station.

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 2011c) 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 during the dry season in 2011[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	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.

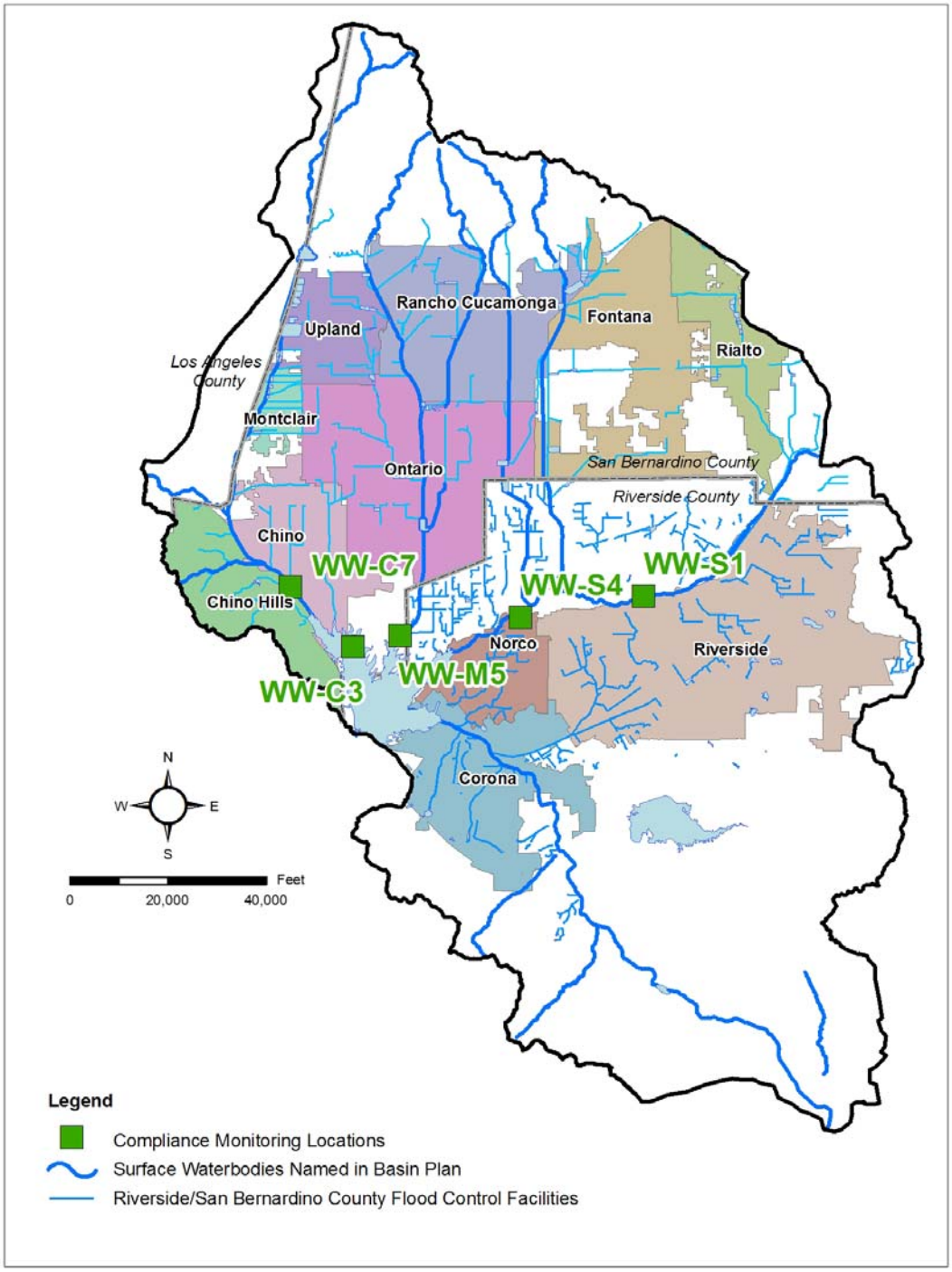


Figure 2-3. Location of watershed-wide compliance monitoring program sample locations in the Middle Santa Ana River watershed

Section 3
Methods

The RWQCB-approved Monitoring Plan and QAPP (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. The 2011 dry season sample dates were planned as follows: Collect weekly samples over a 20 week period from the week of May 16, 2011 to the week of September 26, 2011. Table 3-1 summarizes the results of the 2011 dry season sampling effort. All planned 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 2011 dry season

Sample Month	Planned[1]	Collected	Samples Missed
May	15	15	0
June	20	20	0
July	20	20	0
August	25	25	0
September	20	20	0
Total	**100**	**100**	**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 August five sites were planned for sampling during each of the five sample weeks that occurred in August for a total of 25 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 dry 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 QAPP. 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.

Section 4
Sample Results

This section summarizes the results of data analyses applied to the 2011 dry 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 2011c).

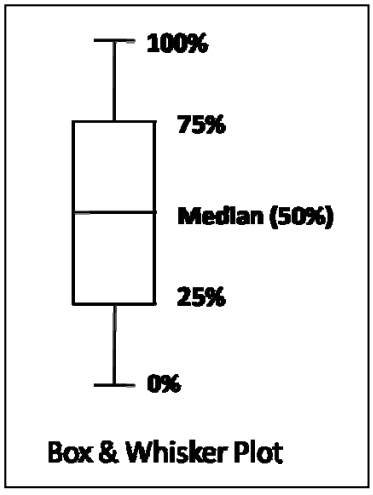
4.1 Water Quality Observations

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 fecal coliform and *E. coli* data collected from all sites over all sample dates during the 2011 dry season. Tables 4-3 and 4-4 summarize the geometric mean, median, and coefficient of variation of the fecal coliform and *E. coli* data, respectively, for all samples collected at each site during the 2011 dry season.

Figure 4-1 summarizes 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). The Mill-Cucamonga Creek and Chino Creek sites had the highest observed median bacterial indicator concentrations (fecal coliform: 580 cfu/100 mL and 260 cfu/100 mL, respectively; *E. coli*: 740 cfu/100 mL and 300 cfu/100 mL, respectively) (see Tables 4-3 and 4-4). The lowest median fecal coliform and *E. coli* concentrations were observed at Prado Park Lake (fecal coliform: 65 cfu/100 mL; *E. coli*: 40 cfu/100 mL). The Santa Ana River sites had similar median concentrations (fecal coliform: 170 - 185 cfu/100 mL; *E. coli*: 130 - 170 cfu/100 mL) (see Figure 4-1; Tables 4-3 and 4-3).



4.3 Bacterial Indicator Compliance Analysis

The compliance analysis compared the bacterial indicator data for existing REC-1 fecal coliform and *E. coli* to the existing 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.

Table 4-1. Summary of water quality monitoring data collected during 2011 dry 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)	Santa Ana River at Pedley (WW-S4)
Fecal coliform (cfu/100 mL)					
N	20	20	20	20	20
Median	65	260	580	170	185
Range	9 – 1,500	140 – 4,800	200 – 5,000	40 – 3,000	40 – 5,000
***E. coli* (cfu/100 mL)**					
N	20	20	20	20	20
Median	40	300	740	170	130
Range	30 – 260	140 – 2,700	240 – 7,800	70 - 620	40 – 1,500
Total Suspended Solids (mg/L)					
N	20	20	20	20	20
Median	12.7	9.9	11.4	16.4	26.8
Range	5.1 – 33.0	1.6 – 32.5	5.8 – 21.0	7.2 – 59.9	13.1 – 157.3
Dissolved Oxygen (mg/L)					
N	20	20	20	20	20
Median	7.4	8.1	9.2	9.2	8.7
Range	3.1 – 9.7	5.9 – 28.6	0.4 – 13.2	5.9 – 13.0	5.4 – 11.3
pH (Standard Units)					
N	20	20	20	20	20
Median	8.7	8.7	8.2	7.6	7.8
Range	7.4 – 9.5	7.7 – 9.7	7.6 – 8.7	6.8 – 7.8	7.2 – 8.1
Turbidity (NTU)					
N	20	20	20	20	20
Median	9.4	3.8	3.8	5.5	5.2
Range	4.3 – 24.8	2.0 – 30.8	2.2 – 7.6	1.8 – 11.4	2.2 – 11.7
Water Temperature (°C)					
N	20	20	20	20	20
Median	24.6	26.5	20.3	19.0	21.0
Range	19.7 – 27.7	18.8 – 29.8	16.5 – 24.9	15.4 – 21.2	16.1 – 24.7
Flow (cfs)					
N	19[1]	19[1]	19[1]	20	19[2]
Median	5.5	43.1	51.7	51.9	117.5
Range	1.4 – 18.5	3.0 – 127.6	11.4 – 585.0	8.4 – 140.5	59.3 – 445.4
Conductivity (µS/cm)					
N	20	20	20	20	20
Median	957	448	647	1007	923
Range	631 – 1,280	283 – 1,070	256 – 760	587 – 1,100	527 – 1,043

[1] – Equipment failure on August 9, 2011 at three sites

[2] – Unusually high value from May 17, 2011 not included; likely field data error

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

Statistic	*E. coli*	Fecal coliform
Sample Size (n)	100	100
Geometric Mean	210	240
10^{th} Percentile	40	50
25^{th} Percentile	80	128
50^{th} Percentile (median)	190	220
75^{th} Percentile	385	443
90^{th} Percentile	1,070	2,010

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

Site	N	Geometric Mean	Median	Coefficient of Variation[1]
Prado Park Lake	20	80	65	0.28
Chino Creek	20	347	260	0.16
Mill-Cucamonga Creek	20	731	580	0.15
SAR @ MWD Crossing	20	184	170	0.21
SAR @ Pedley Ave.	20	213	185	0.24

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

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

Site	N	Geometric Mean	Median	Coefficient of Variation[1]
Prado Park Lake	20	61	40	0.17
Chino Creek	20	337	300	0.14
Mill-Cucamonga Creek	20	852	740	0.14
SAR @ MWD Crossing	20	166	170	0.12
SAR @ Pedley Ave.	20	141	130	0.19

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

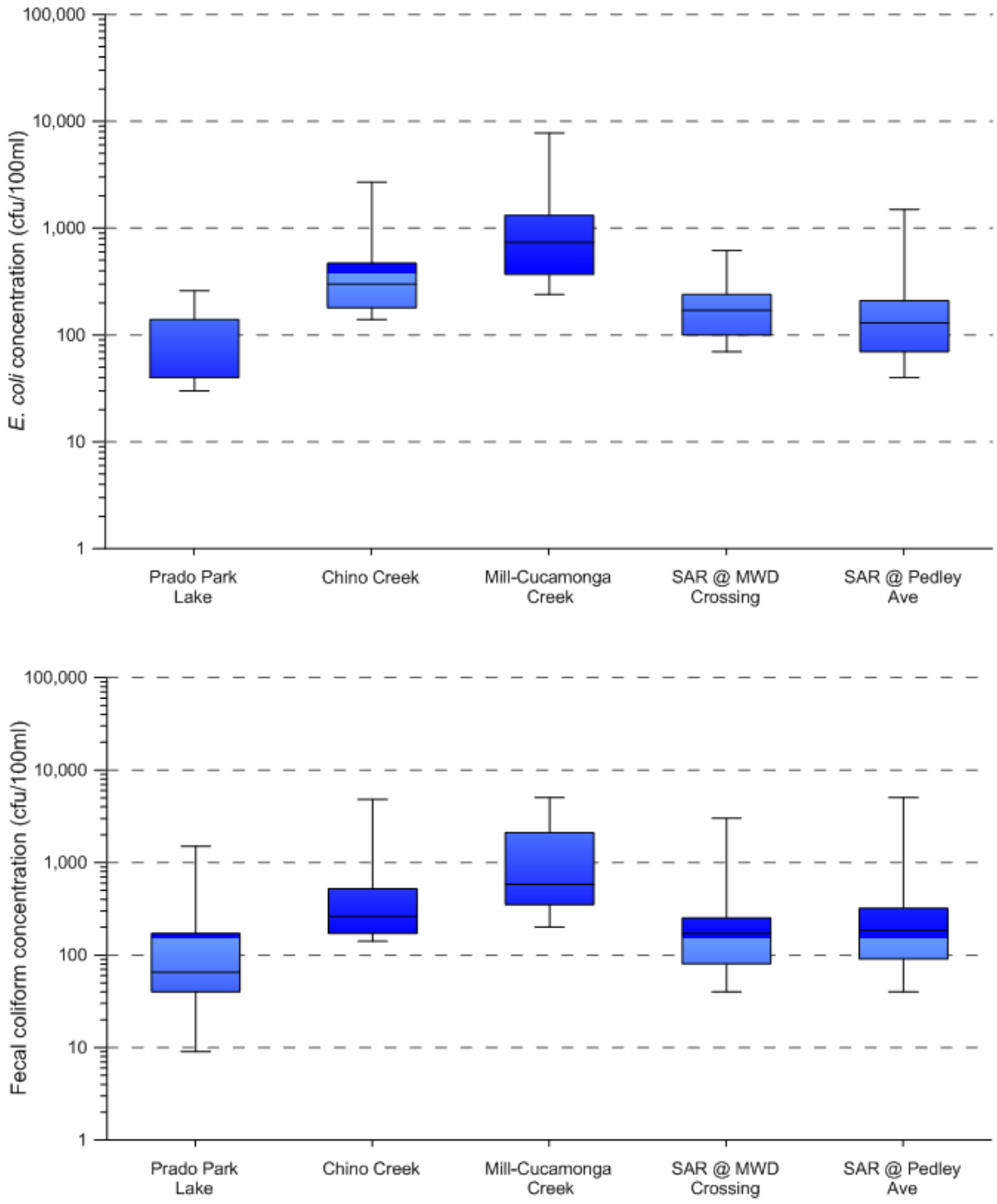


Figure 4-1. Statistical distribution of bacterial indicator data collected during the 2011 dry season illustrated using Box & Whisker box plots. Upper figure: *E. coli*; lower figure: fecal coliform.

The calculated 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.

The fecal coliform single sample exceedance frequency was lowest at the Prado Park Lake (10%) and Santa Ana River sample sites (10 and 20%) (Table 4-5). Higher exceedance frequencies were observed at the Chino Creek and Mill-Cucamonga Creek sites, ranging from 35 to 60%, respectively (Table 4-5).

The fecal coliform geometric mean exceedance frequency was lowest at the Prado Park Lake site (25%) (Table 4-5). The exceedance frequency was higher at the two Santa Ana River sites (44 to 50%). All geometric mean results exceeded the fecal coliform water quality objective at the Chino Creek and Mill-Cucamonga Creek sites (Table 4-5).

No exceedances of the proposed *E. coli* geometric mean water quality objective were observed at the Prado Park Lake site during dry season 2011 (Table 4-6). The exceedance frequency for *E. coli* at the two Santa Ana River sites ranged from 50 to 56%. Similar to the fecal coliform observations, all geometric mean results exceeded the proposed *E. coli* water quality objective at the Chino Creek and Mill-Cucamonga Creek sites (Table 4-6).

Figures 4-2 through 4-6 illustrate the variability in single sample results and rolling geometric mean values for fecal coliform for the period beginning with the 2007 dry season through the end of the 2011 dry season. Figures 4-7 through 4-11 illustrate comparable results for *E. coli* for the same period of record. The extended period of record illustrates how the bacterial indicator concentrations have varied over time.

4.4 Correlation Analysis

Table 4-7 summarizes the results of a correlation analysis between fecal coliform and *E. coli* concentrations. Bacterial indicator results were correlated for all sites. Highly significant correlations were observed at four of five sites.

Table 4-8 summarizes the results of correlation analyses between bacterial indicators and field parameters. Only one significant correlation was observed – correlation between *E. coli* concentrations and conductivity.

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

Table 4-5. Frequency of compliance with single sample and geometric mean water quality objectives for fecal coliform during the 2011 dry season

Site	Single Sample Criterion Exceedance Frequency (%)	Geometric Mean Criterion Exceedance Frequency (%)
Prado Park Lake	10%	25%
Chino Creek	35%	100%
Mill-Cucamonga Creek	60%	100%
SAR @ MWD Crossing	10%	44%
SAR @ Pedley Ave.	20%	50%

Table 4-6. Frequency of compliance with proposed geometric mean water quality objectives for *E. coli* during the 2011 dry season

Site	Geometric Mean Criterion Exceedance Frequency (%)[1]
Prado Park Lake	0%
Chino Creek	100%
Mill-Cucamonga Creek	100%
SAR @ MWD Crossing	56%
SAR @ Pedley Ave.	50%

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

Table 4-7. Correlation of natural log *E. coli* concentrations (cfu/100 mL) and natural log fecal coliform concentrations (cfu/ 100 mL) during the 2011 dry season

Site	Pearson's r coefficient	Degrees of freedom (n - 2)	t-statistic	p-value	Significant?[1]
Prado Park Lake	0.58	18	3.1	< 0.01	Yes+
Chino Creek	0.88	18	7.7	< 0.0001	Yes+
Mill-Cucamonga Creek	0.85	18	6.9	< 0.0001	Yes+
SAR @ MWD Crossing	0.88	18	7.9	< 0.0001	Yes+
SAR @ Pedley Ave.	0.93	18	10.5	< 0.0001	Yes+

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

Table 4-8. Correlation analysis between bacterial indicator concentrations and field parameters during the 2011 dry season

Data Subset/Comparison	Pearson's r coefficient	Degrees of freedom (n - 2)	Student-t statistic	p-value[1]
Fecal Coliform vs.				
Conductivity	- 0.18	98	1.78	0.08
Dissolved Oxygen	0.04	98	0.40	0.69
pH	- 0.07	98	0.65	0.52
Total Suspended Solids	- 0.03	98	0.28	0.78
Temperature	0.02	98	0.17	0.87
Turbidity	0.07	98	0.69	0.49
***E. coli* vs.**				
Conductivity	-0.26	98	2.72	0.01
Dissolved Oxygen	0.06	98	0.57	0.57
pH	0.03	98	0.33	0.74
Total Suspended Solids	-0.07	98	0.73	0.47
Temperature	0.01	98	0.08	0.94
Turbidity	-0.01	98	0.08	0.94

[1] - Significance determined by a p-value < 0.05

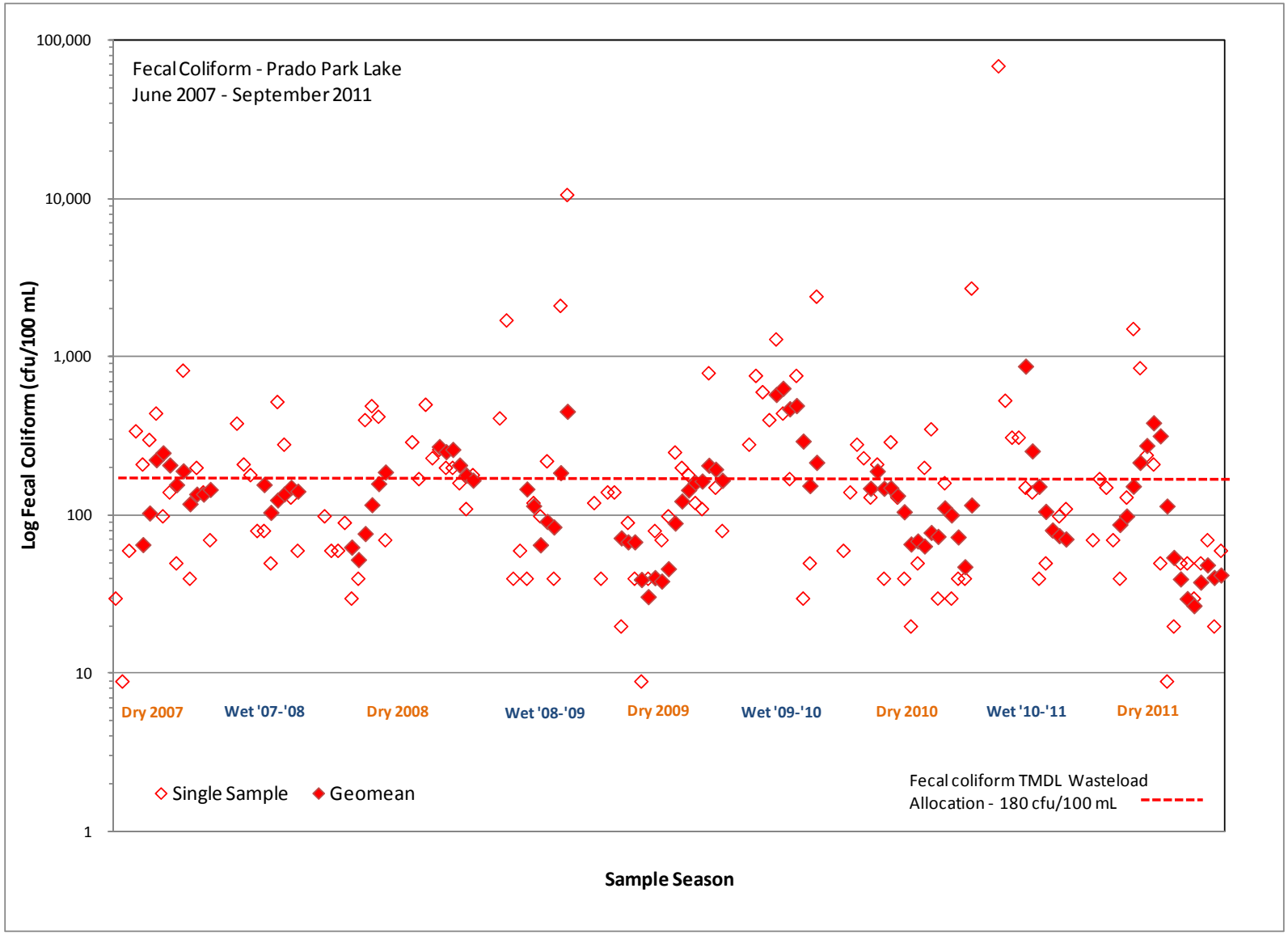


Figure 4-2. Time series plot of fecal coliform single sample results and geometric means for samples collected from Prado Park Lake from July 2007 through September 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates the geometric mean water quality objective).

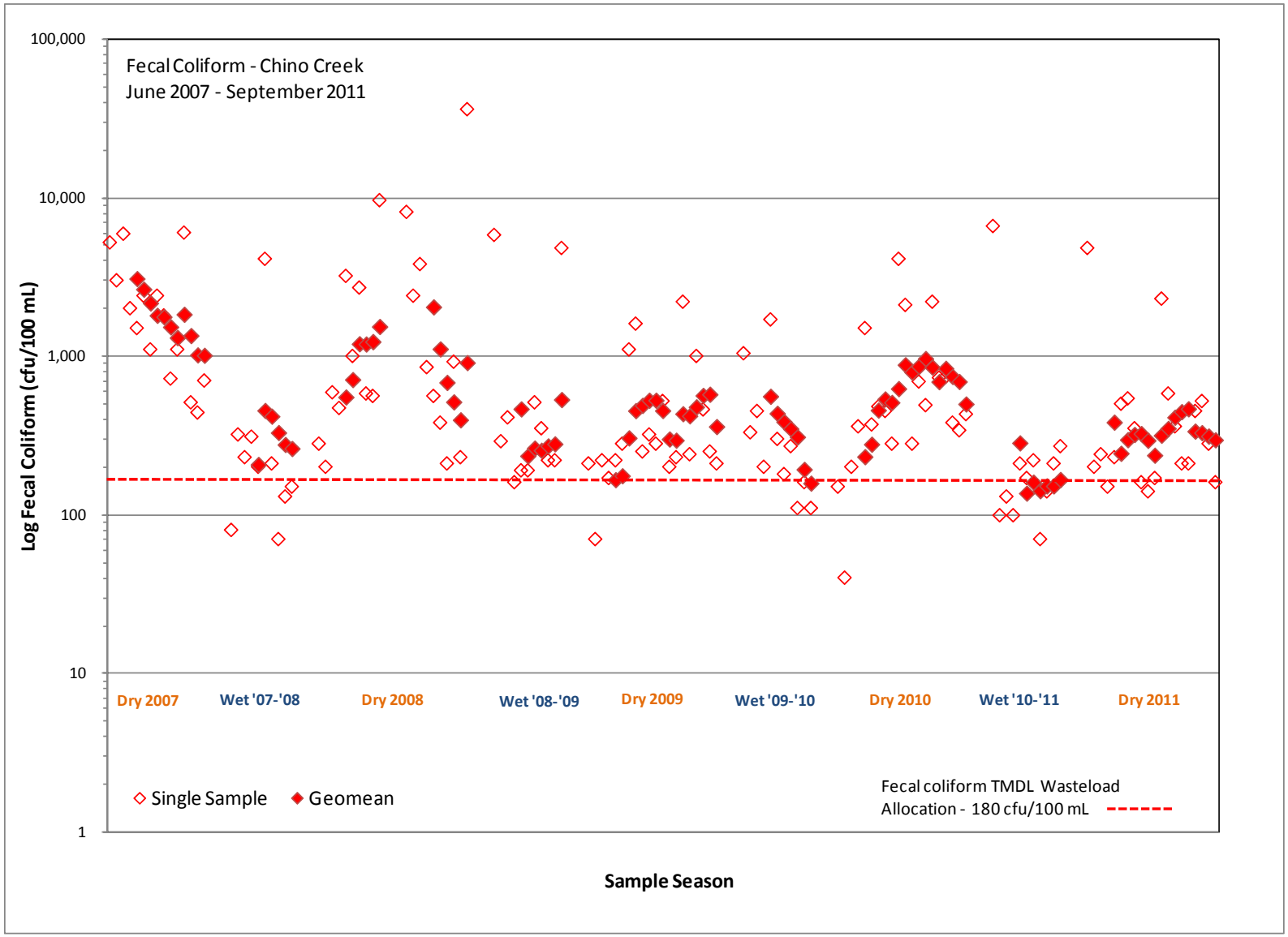


Figure 4-3. Time series plot of fecal coliform single sample results and geometric means for samples collected from Chino Creek from July 2007 through September 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates the geometric mean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

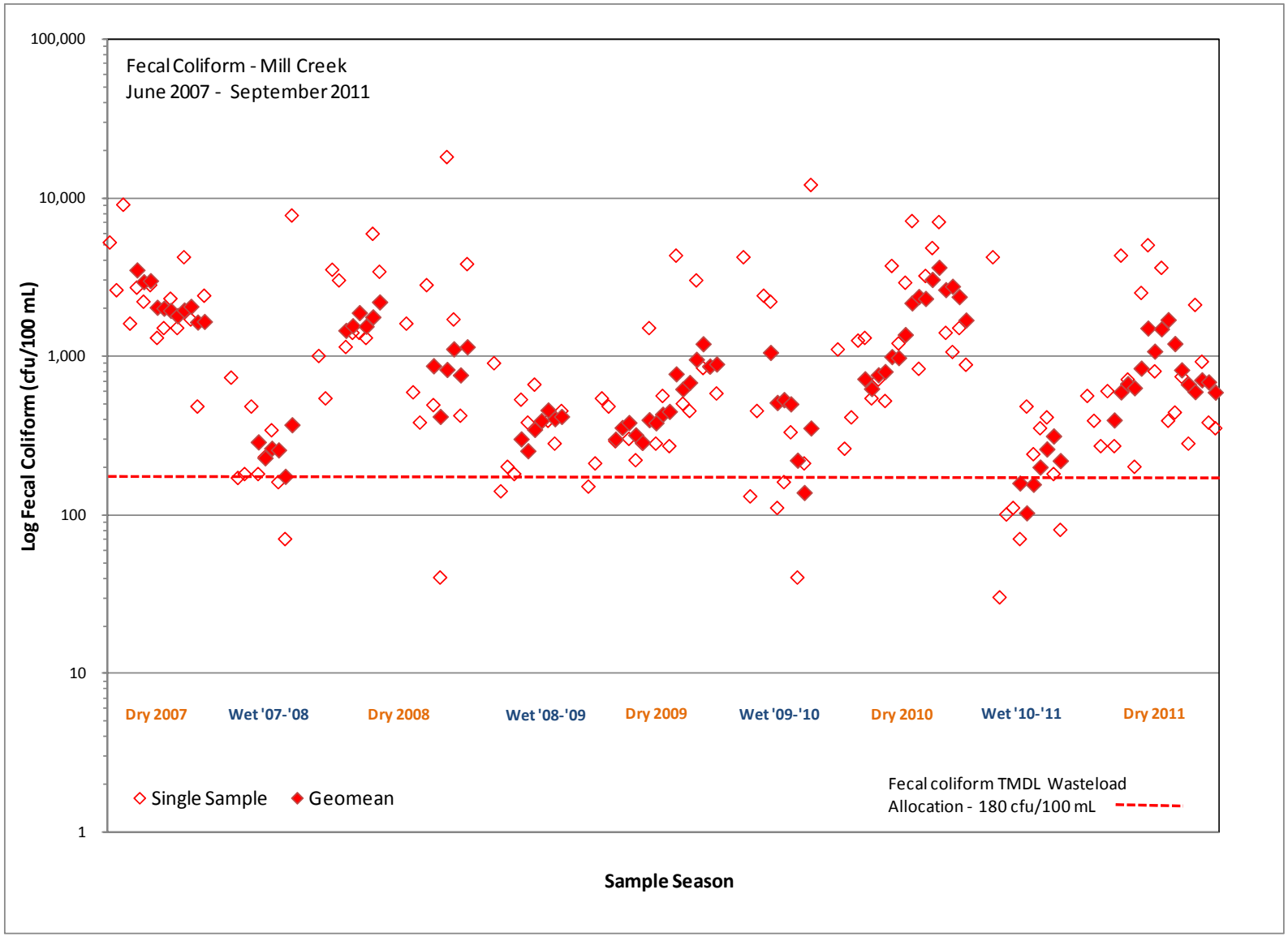


Figure 4-4. Time series plot of fecal coliform single sample results and geometric means for samples collected from Mill-Cucamonga Creek from July 2007 through September 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates the geometric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

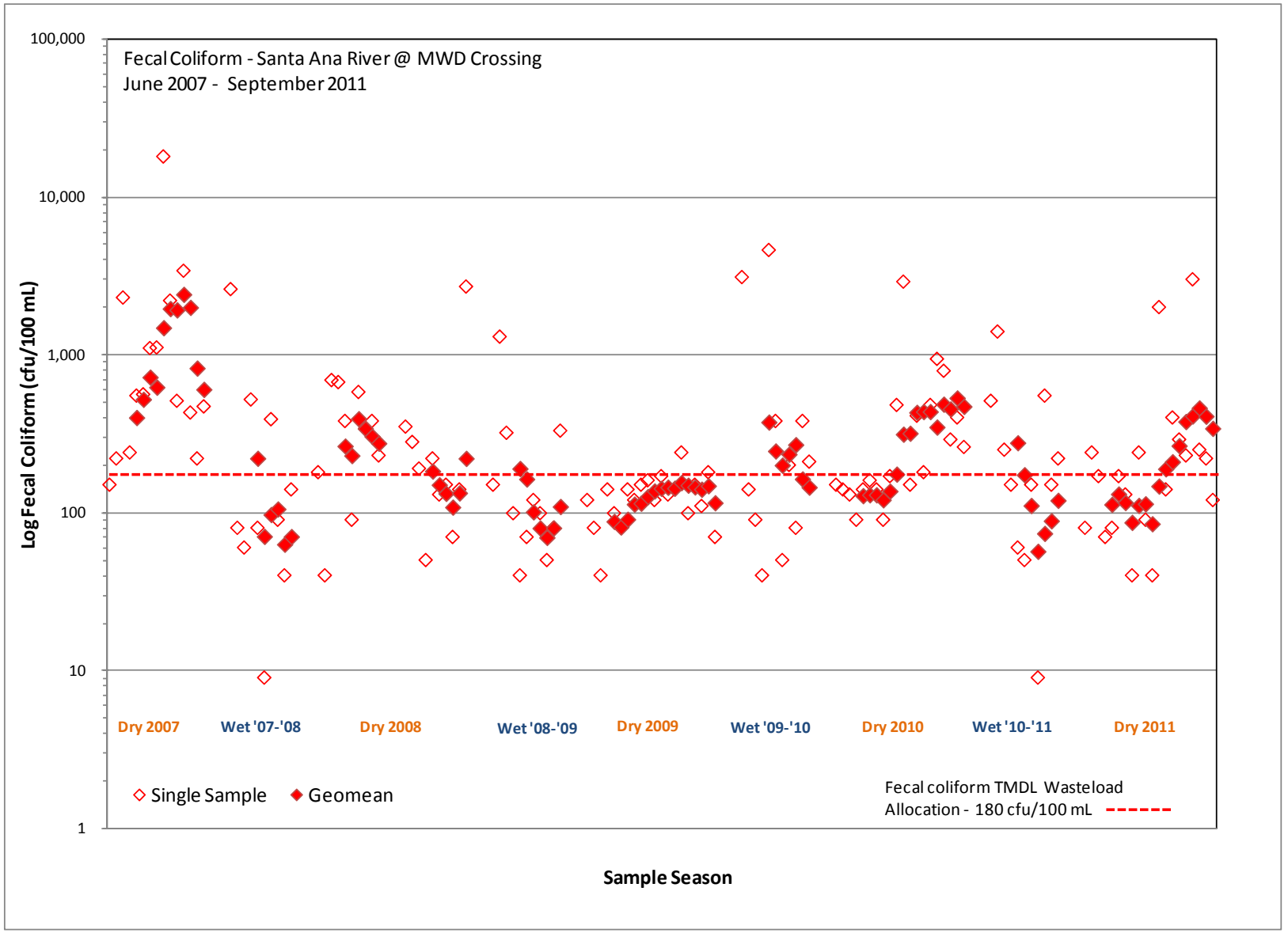


Figure 4-5. Time series plot of fecal coliform single sample results and geometric means for samples collected from Santa Ana River at MWD Crossing from July 2007 through September 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates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

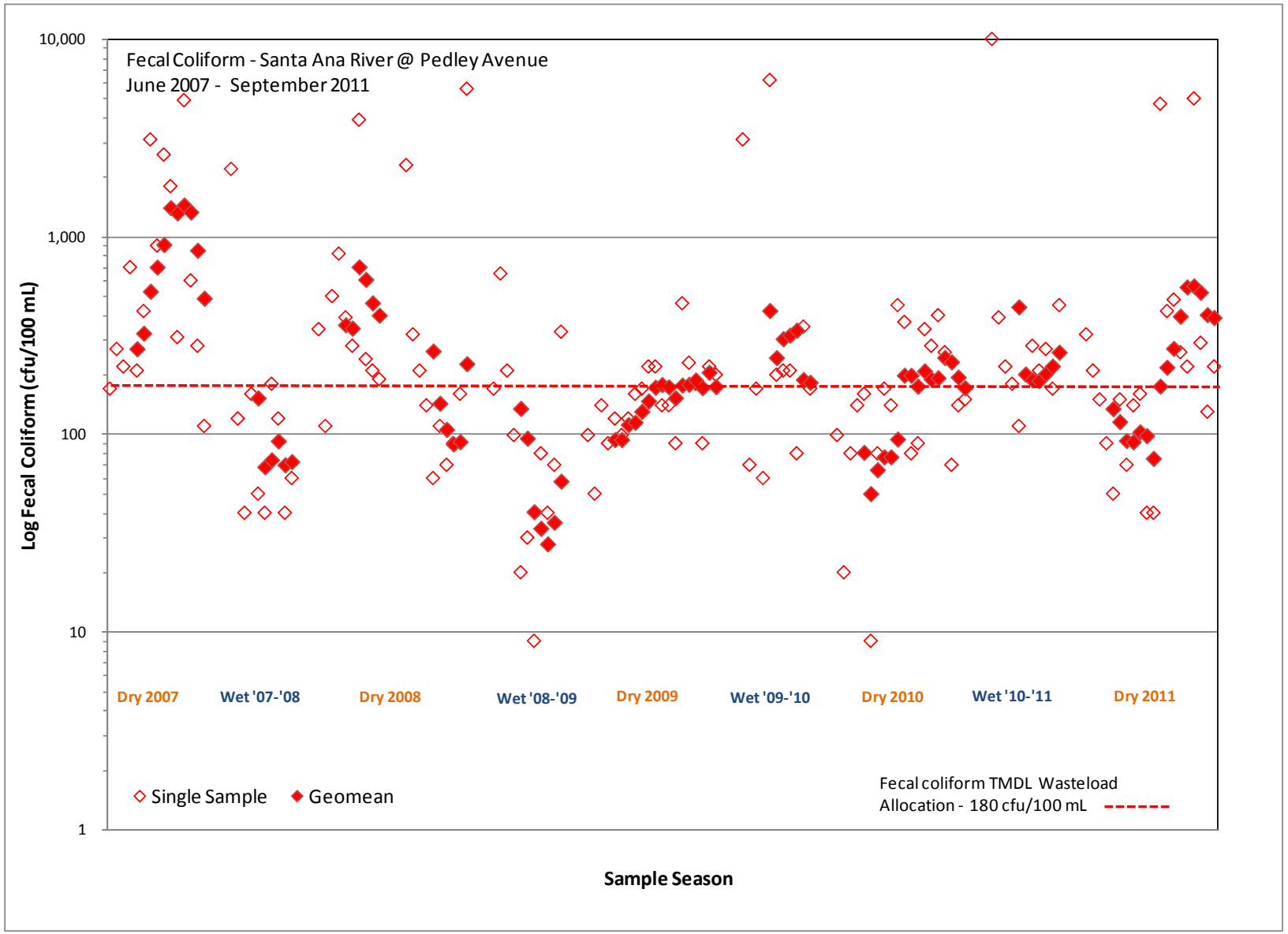


Figure 4-6. Time series plot of fecal coliform single sample results and geometric means for samples collected from Santa Ana River at Pedley Avenue from July 2007 through September 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates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

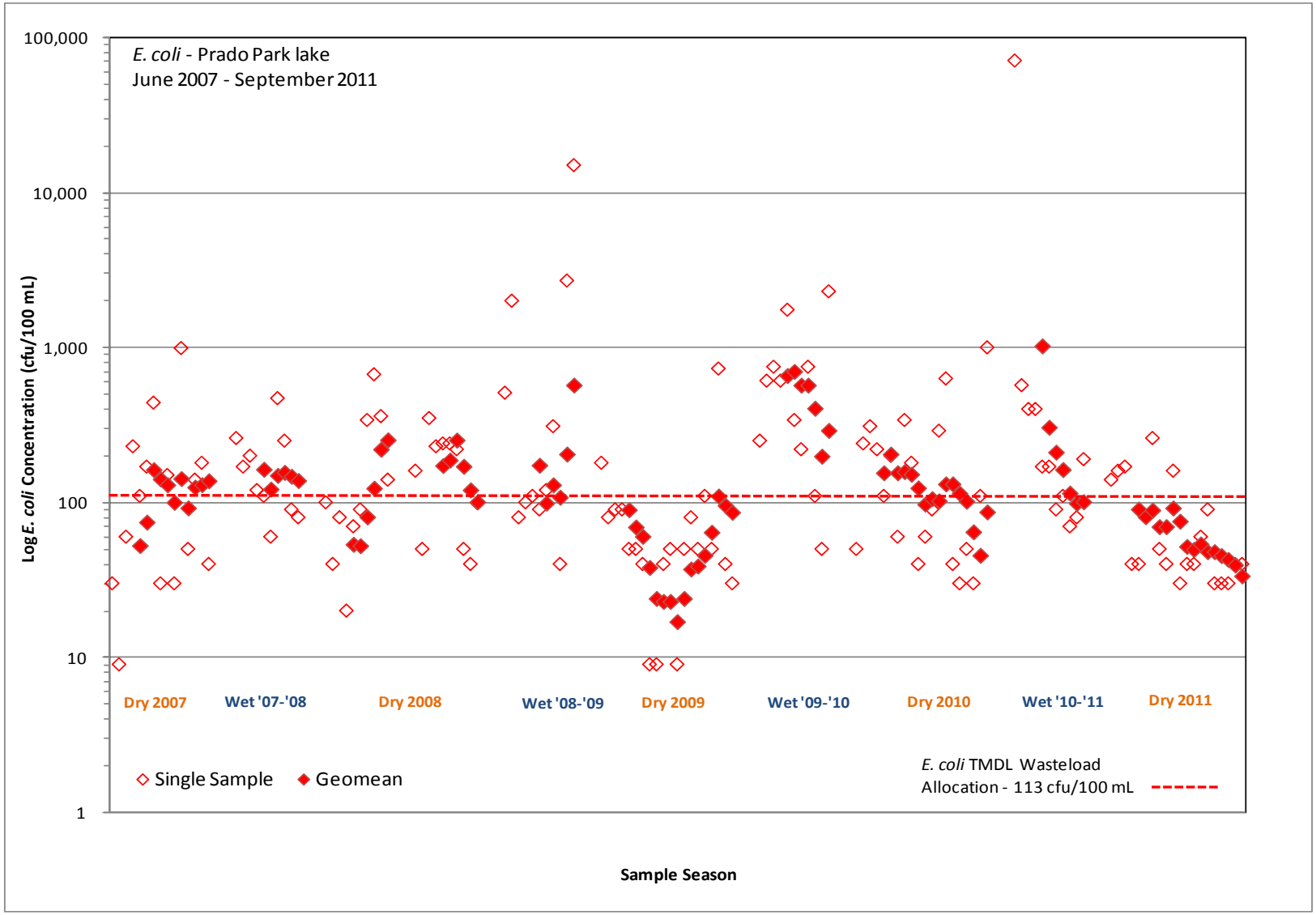


Figure 4-7. Time series plot of *E. coli* single sample results and geometric means for samples collected from Prado Park Lake from July 2007 through September 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates proposed geometric mean water quality objective).

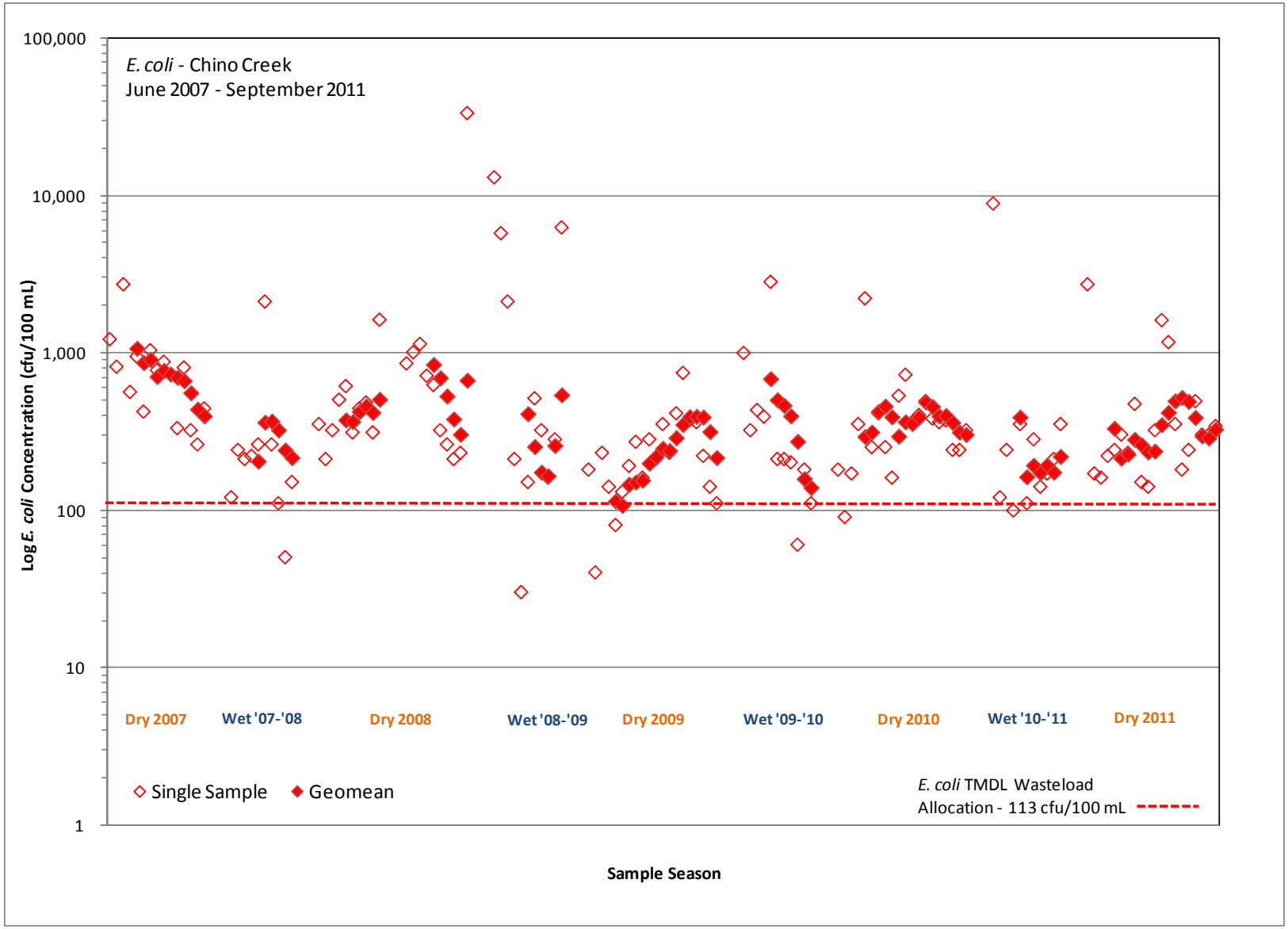


Figure 4-8. Time series plot of *E. coli* single sample results and geometric means for samples collected from Chino Creek from July 2007 through September 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates proposed geometric mean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

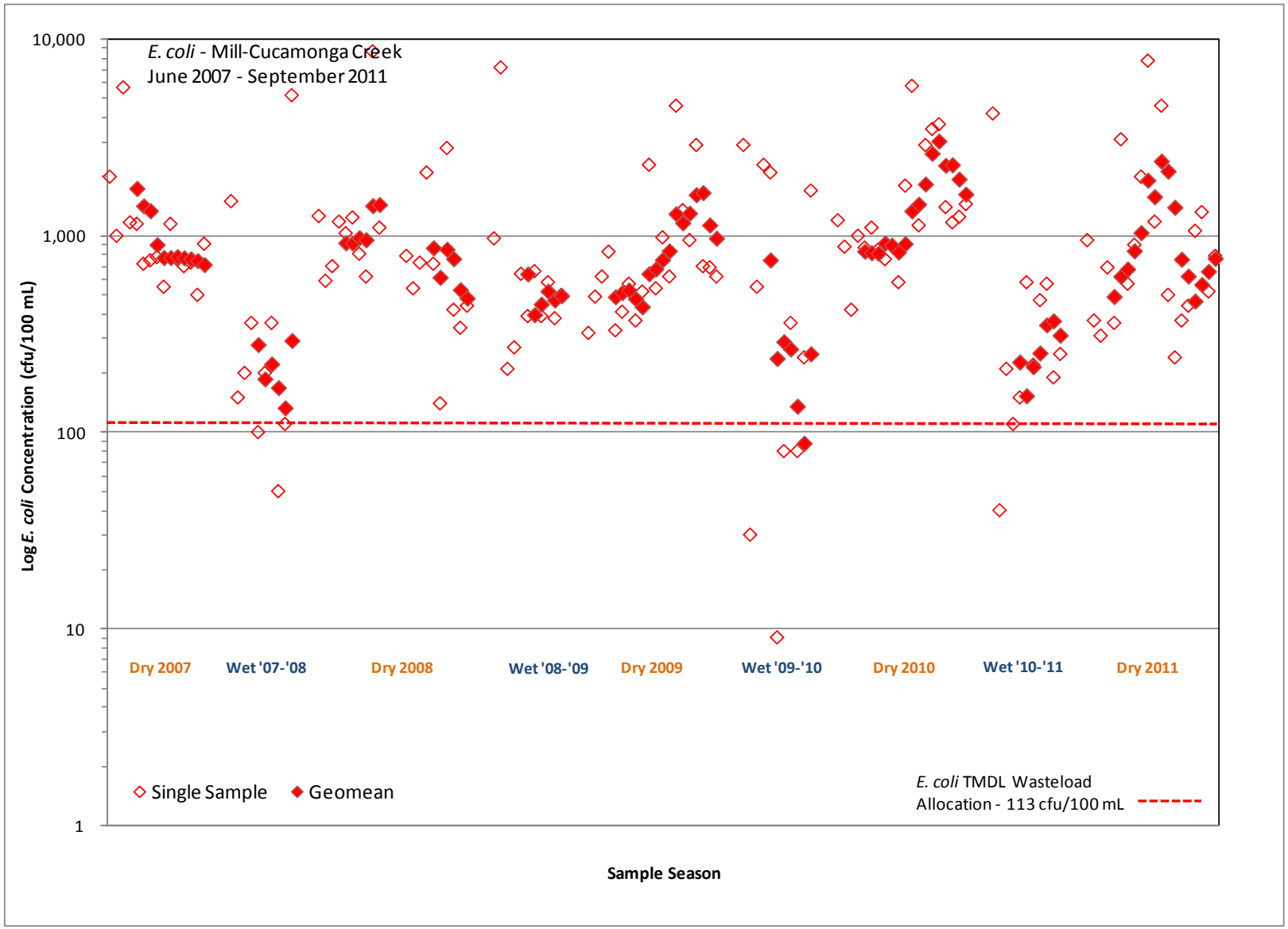


Figure 4-9. Time series plot of *E. coli* single sample results and geometric means for samples collected from Mill-Cucamonga Creek from July 2007 through September 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates proposed geometric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

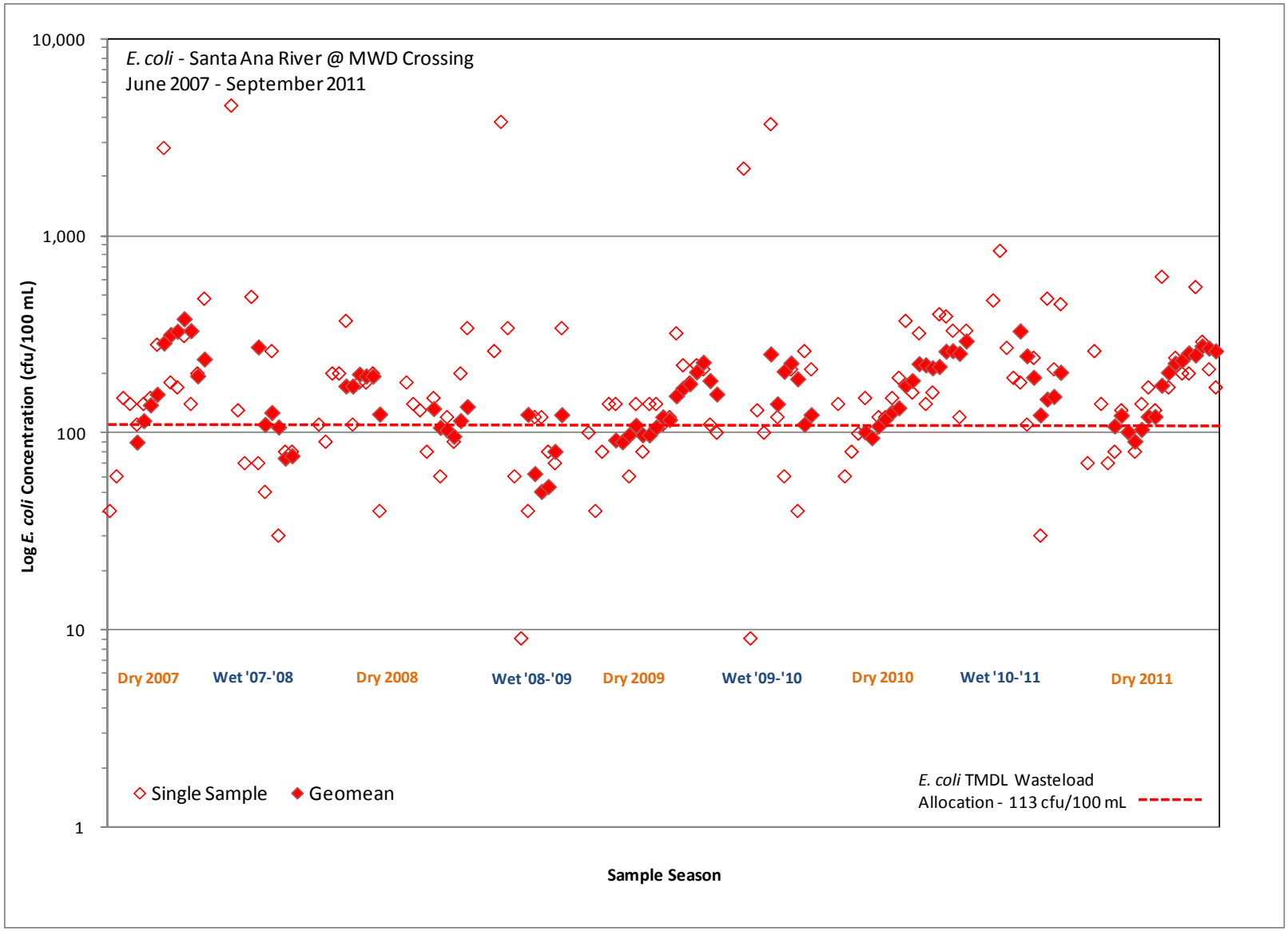


Figure 4-10. Time series plot of *E. coli* single sample results and geometric means for samples collected from Santa Ana River at MWD Crossing from July 2007 through September 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates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

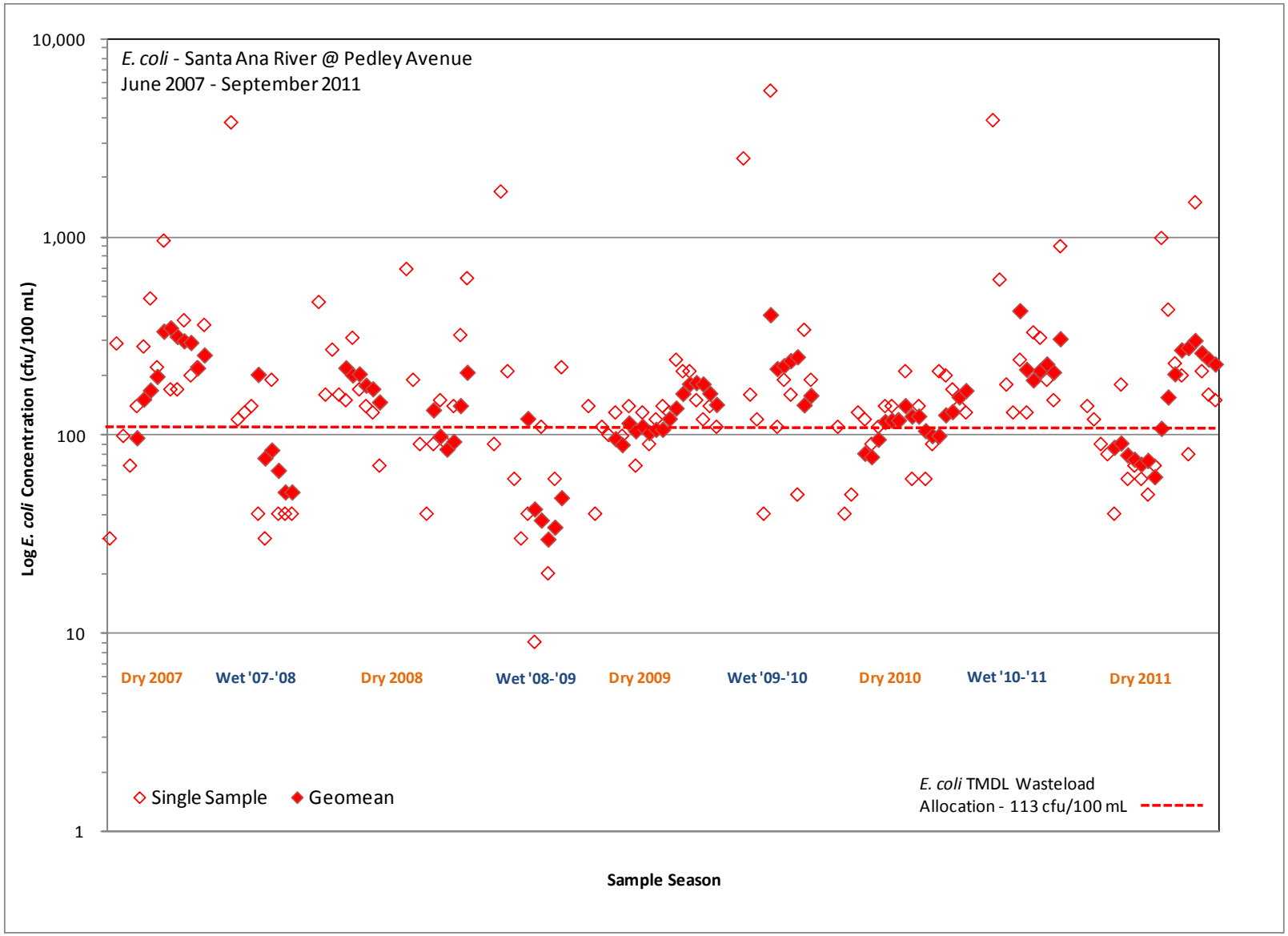


Figure 4-11. Time series plot of *E. coli* single sample results and geometric means for samples collected from Santa Ana River at Pedley Avenue from July 2007 through September 2011. A geometric mean was calculated only if five samples were collected during the previous five weeks (red line indicates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

Section 5
References

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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 2011 dry season sampling period. Tables A-10 through A-12 summarize the daily mean flow measured at USGS gauges in the MSAR watershed. Table A-13 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 2011 dry season (geometric mean 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)		SAR @ Pedley Avenue (WW-S4)	
	Result	Geomean	Result	Geomean	Result	Geomean	Result	Geomean	Result	Geomean
5/17/2011	70		4,800		> 560		80		320	
5/24/2011	170		200		390		240		210	
5/31/2011	150		240		270		170		150	
6/7/2011	70		150		600		70		90	
6/14/2011	40	87	230	380	270	394	80	113	50	135
6/21/2011	130	99	> 500	242	4,300	593	170	131	150	116
6/28/2011	> 1,500	152	> 540	295	> 710	669	130	116	70	93
7/5/2011	850	215	> 350	318	> 200	630	40	87	140	92
7/12/2011	240	276	160	322	2,500	838	240	111	160	103
7/19/2011	> 210	384	140	292	5,000	1,502	90	114	40	99
7/28/2011	50	317	170	235	> 800	1,073	40	85	40	76
8/2/2011	9	114	2,300	314	> 3,600	1,484	2,000	147	4,700	176
8/9/2011	20	54	> 580	348	> 390	1,696	> 140	189	> 420	219
8/16/2011	50	39	360	409	440	1,198	400	209	480	273
8/23/2011	50	30	210	443	740	818	290	265	260	397
8/30/2011	30	27	210	463	280	663	230	376	220	558
9/6/2011	50	38	> 450	334	2,100	595	3,000	407	5,000	565
9/13/2011	70	48	> 520	327	> 920	707	250	457	290	525
9/20/2011	20	40	280	311	380	686	220	406	130	404
9/27/2011	60	42	> 160	294	> 350	591	120	340	220	391

Table A-2. *E. coli* (cfu/100 mL) concentrations observed at watershed-wide compliance sites during the 2011 dry season (geometric mean 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)		SAR @ Pedley Avenue (WW-S4)	
	Result	Geomean	Result	Geomean	Result	Geomean	Result	Geomean	Result	Geomean
5/17/2011	140		2,700		> 950		70		140	
5/24/2011	160		170		370		260		120	
5/31/2011	170		160		310		140		90	
6/7/2011	40		220		690		70		80	
6/14/2011	40	91	240	329	360	486	80	107	40	86
6/21/2011	80	81	300	212	> 3,100	615	130	122	180	91
6/28/2011	> 260	89	> 230	225	570	671	100	100	60	79
7/5/2011	50	70	470	280	900	830	80	90	70	75
7/12/2011	40	70	150	259	2,000	1,027	140	103	60	71
7/19/2011	> 160	92	> 140	233	7,800	1,901	170	120	50	74
7/28/2011	30	76	320	236	> 1,180	1,567	130	120	70	62
8/2/2011	40	52	1,600	347	> 4,600	2,379	> 620	173	> 990	108
8/9/2011	> 40	50	> 1,160	416	> 500	2,115	> 170	201	> 430	155
8/16/2011	60	54	350	493	240	1,384	240	224	230	203
8/23/2011	90	48	180	518	370	752	200	231	200	268
8/30/2011	30	48	240	489	440	618	200	252	80	275
9/6/2011	30	45	490	386	> 1,060	460	> 550	246	1,500	299
9/13/2011	30	43	300	295	1,320	559	290	274	210	259
9/20/2011	40	40	300	286	520	653	210	266	160	241
9/27/2011	40	34	340	325	790	760	170	258	150	227

Table A-3. Total suspended solids (mg/L) concentrations observed at watershed-wide compliance sites during the 2011 dry 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)	SAR @ Pedley Avenue (WW-S4)
5/17/2011	11.50	32.50	8.60	21.10	157.30
5/24/2011	5.10	1.60	9.60	59.90	61.20
5/31/2011	16.50	4.10	5.94	48.60	88.98
6/7/2011	6.40	16.25	6.60	27.10	40.68
6/14/2011	9.30	5.54	20.00	37.72	69.89
6/21/2011	15.50	6.81	11.85	25.38	53.30
6/28/2011	11.65	4.10	17.80	26.20	59.10
7/5/2011	13.70	17.10	13.20	18.40	26.50
7/12/2011	11.46	16.60	13.40	24.20	25.56
7/19/2011	11.30	9.95	21.00	11.16	33.77
7/28/2011	18.18	6.90	5.80	10.61	27.13
8/2/2011	13.55	20.90	11.80	24.20	27.60
8/9/2011	21.63	4.20	8.53	7.20	15.80
8/16/2011	13.00	16.20	19.00	13.40	20.60
8/23/2011	11.60	9.75	18.25	12.20	21.90
8/30/2011	15.10	7.95	10.90	14.40	26.10
9/6/2011	18.10	16.20	16.60	9.40	22.00
9/13/2011	33.00	9.70	10.20	12.65	16.80
9/20/2011	12.40	12.80	7.80	7.45	13.25
9/27/2011	8.00	13.42	6.80	7.80	13.10

Table A-4. Dissolved oxygen (mg/L) concentrations observed at watershed-wide compliance sites during the 2011 dry 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)	SAR @ Pedley Avenue (WW-S4)
5/17/2011	9.09	9.72	13.17	13.04	10.01
5/24/2011	6.95	7.03	6.49	9.00	8.55
5/31/2011	9.66	9.61	9.85	10.42	10.35
6/7/2011	7.00	10.66	9.50	8.58	10.37
6/14/2011	4.37	5.94	8.21	5.87	6.27
6/21/2011	5.02	10.16	11.73	11.11	11.27
6/28/2011	7.30	6.88	0.99	8.99	7.98
7/5/2011	9.68	14.45	10.51	9.75	8.99
7/12/2011	8.87	10.28	10.35	10.45	9.66
7/19/2011	5.64	28.60	11.66	9.47	8.75
7/28/2011	3.06	9.32	8.79	10.03	8.76
8/2/2011	4.12	7.85	4.14	8.97	8.29
8/9/2011	8.98	7.23	12.72	10.06	9.73
8/16/2011	9.09	9.07	12.10	10.12	9.22
8/23/2011	6.06	7.61	8.81	8.69	6.28
8/30/2011	6.42	7.60	0.40	8.77	5.43
9/6/2011	9.34	8.27	8.00	9.10	8.24
9/13/2011	8.60	7.88	9.51	9.24	8.32
9/20/2011	8.32	6.18	8.11	8.73	8.44
9/27/2011	7.52	6.34	7.28	8.61	7.88

Table A-5. pH (standard units) observed at watershed-wide compliance sites during the 2011 dry 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)	SAR @ Pedley Avenue (WW-S4)
5/17/2011	8.07	7.70	8.10	7.43	7.60
5/24/2011	8.00	8.70	8.00	7.67	7.97
5/31/2011	8.30	8.63	8.50	7.70	8.00
6/7/2011	7.70	8.45	8.17	7.67	7.82
6/14/2011	7.40	8.10	8.23	7.43	7.67
6/21/2011	7.83	8,53	8.60	7.67	7.97
6/28/2011	8.73	8.30	8.10	7.50	7.70
7/5/2011	9.37	9.70	8.67	7.53	8.03
7/12/2011	9.27	9.70	8.33	7.77	8.10
7/19/2011	8.67	9.37	8.60	7.77	8.00
7/28/2011	8.40	9.10	8.20	7.47	7.90
8/2/2011	8.30	9.10	7.93	7.67	7.67
8/9/2011	9.43	9.10	8.70	7.70	7.83
8/16/2011	9.50	9.30	8.73	7.63	7.77
8/23/2011	9.20	8.71	8.10	7.50	7.57
8/30/2011	9.30	9.20	7.80	7.77	7.73
9/6/2011	9.27	9.33	8.27	7.23	7.70
9/13/2011	8.53	8.73	7.63	6.77	7.20
9/20/2011	9.20	8.53	8.17	7.53	7.87
9/27/2011	8.93	8.60	7.77	7.30	7.47

Table A-6. Turbidity (NTU) observed at watershed-wide compliance sites during the 2011 dry 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)	SAR @ Pedley Avenue (WW-S4)
5/17/2011	12.07	30.83	4.40	11.00	11.67
5/24/2011	5.77	2.91	4.08	11.37	11.10
5/31/2011	4.29	2.72	3.15	10.26	10.73
6/7/2011	4.69	1.99	2.35	7.50	8.72
6/14/2011	7.77	2.57	2.24	7.05	8.20
6/21/2011	11.00	2.29	4.28	6.85	7.26
6/28/2011	7.85	2.52	4.45	6.59	7.04
7/5/2011	9.29	5.75	2.80	6.05	4.93
7/12/2011	8.75	5.95	7.61	7.78	4.54
7/19/2011	12.57	5.08	6.73	5.50	4.78
7/28/2011	16.60	8.34	3.73	4.60	5.42
8/2/2011	18.30	3.21	3.53	3.67	8.79
8/9/2011	24.80	3.81	4.34	5.44	6.09
8/16/2011	9.47	3.75	4.92	1.82	3.58
8/23/2011	9.12	4.25	3.28	4.40	4.35
8/30/2011	11.73	4.84	3.77	3.96	4.27
9/6/2011	13.80	4.44	2.95	1.80	3.60
9/13/2011	14.60	4.36	4.39	3.24	2.98
9/20/2011	8.03	3.58	2.96	3.33	2.21
9/27/2011	9.13	3.82	2.75	2.56	2.73

Table A-7. Water temperature (°C) observed at watershed-wide compliance sites during the 2011 dry 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)	SAR @ Pedley Avenue (WW-S4)
5/17/2011	19.67	18.83	17.83	15.43	16.10
5/24/2011	21.47	21.63	16.53	16.40	18.90
5/31/2011	21.20	23.73	18.60	17.70	19.00
6/7/2011	20.91	23.92	17.73	16.90	18.56
6/14/2011	21.00	25.13	20.20	18.63	20.17
6/21/2011	21.58	25.50	21.52	19.91	21.31
6/28/2011	26.50	27.37	21.10	19.90	21.70
7/5/2011	27.73	29.82	24.88	21.22	24.71
7/12/2011	27.37	26.63	22.97	20.00	21.67
7/19/2011	24.51	27.26	23.42	21.12	22.50
7/28/2011	24.37	26.50	20.37	20.07	21.83
8/2/2011	24.50	29.43	21.02	20.57	23.66
8/9/2011	26.37	26.07	20.13	18.90	20.23
8/16/2011	26.89	27.08	21.83	19.72	21.45
8/23/2011	26.33	26.87	18.50	18.70	20.97
8/30/2011	27.37	27.73	20.03	19.00	21.07
9/6/2011	26.66	28.27	22.64	20.15	22.31
9/13/2011	25.43	26.53	20.10	19.00	20.63
9/20/2011	24.60	26.37	19.40	17.90	19.37
9/27/2011	24.27	25.80	20.40	17.33	18.33

Table A-8. Flow (cubic feet/second) observed at watershed-wide compliance sites during the 2011 dry season (as measured by field staff)

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)	SAR @ Pedley Avenue (WW-S4)
5/17/2011	4.86	16.28	136.34	140.50	N/A[1]
5/24/2011	8.52	28.11	31.70	121.62	151.56
5/31/2011	3.72	69.20	56.80	134.85	109.85
6/7/2011	1.68	3.03	35.56	8.41	63.29
6/14/2011	1.72	58.68	51.14	64.00	184.59
6/21/2011	1.68	12.90	55.62	124.34	445.52
6/28/2011	6.78	5.86	11.35	23.77	118.25
7/5/2011	11.48	41.76	74.22	40.81	60.89
7/12/2011	5.56	68.94	72.51	30.16	95.67
7/19/2011	1.81	127.55	484.01	60.06	73.55
7/28/2011	1.41	104.00	32.61	48.00	110.85
8/2/2011	16.28	39.37	33.75	99.41	140.63
8/9/2011	NA[2]	NA[2]	NA[2]	31.99	121.68
8/16/2011	6.59	43.12	169.37	119.78	68.80
8/23/2011	3.07	78.96	51.69	77.93	186.65
8/30/2011	6.99	58.46	20.97	47.14	98.04
9/6/2011	9.04	44.98	57.08	47.40	117.48
9/13/2011	5.47	44.26	65.76	55.75	122.07
9/20/2011	8.83	5.66	47.26	36.08	59.32
9/27/2011	18.47	4.94	27.72	28.07	193.66

[1] – Unusually high value recorded on data sheets; data being checked

[2] – Equipment failure occurred at these sites on 8/9/11

Table A-9. Conductivity (µS/cm) observed at watershed-wide compliance sites during the 2011 dry 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)	SAR @ Pedley Avenue (WW-S4)
5/17/2011	631	359	367	587	527
5/24/2011	984	1,020	546	908	857
5/31/2011	1,110	941	556	976	910
6/7/2011	1,213	964	516	590	887
6/14/2011	1,280	1,007	666	1,003	964
6/21/2011	1,193	999	637	943	928
6/28/2011	955	1,070	760	1,030	942
7/5/2011	920	422	672	1,100	1,043
7/12/2011	931	308	718	1,043	999
7/19/2011	1,140	287	698	1,001	958
7/28/2011	1,237	283	657	1,077	978
8/2/2011	1,043	435	581	904	872
8/9/2011	900	491	256	1,017	886
8/16/2011	893	338	264	1,013	918
8/23/2011	954	407	452	1,010	711
8/30/2011	958	369	757	1,010	975
9/6/2011	952	462	682	1,030	1,013
9/13/2011	986	360	689	1,060	933
9/20/2011	929	950	525	819	886
9/27/2011	907	946	661	986	905

Table A-10. Daily mean flow (cfs), Chino Creek at Schaeffer Avenue, as measured by the USGS from April 1 to October 31, 2011 (Data are provisional)

Date	April	May	June	July	August	September	October
1	1.2	0.91	1.1	32	9.1	56	0.76
2	1.1	1.0	1.0	43	67	66	0.66
3	0.98	1.00	1.1	38	126	66	0.75
4	1.0	1.0	0.99	31	110	61	0.72
5	1.0	1.0	0.99	40	83	50	260
6	0.92	1.1	1.2	45	66	50	1.0
7	1.2	0.93	0.82	42	61	65	0.64
8	0.85	0.93	0.76	66	44	60	0.58
9	0.94	1.0	0.79	68	44	62	0.58
10	1.3	1.1	0.78	57	43	62	0.63
11	0.89	0.99	0.82	59	41	64	0.65
12	0.92	1.1	0.84	71	54	65	0.65
13	0.88	1.1	0.86	87	54	56	0.66
14	0.95	0.95	0.84	85	55	52	0.65
15	1.00	4.2	0.78	74	46	30	0.64
16	1.1	1.0	0.78	104	57	39	0.63
17	1.1	1.5	0.75	105	59	30	0.62
18	0.94	21	0.78	98	57	25	0.83
19	1.0	1.1	0.76	99	56	13	0.64
20	0.96	1.1	0.89	101	57	0.84	0.68
21	0.99	1.1	0.67	97	62	1.9	0.61
22	1.0	1.1	0.70	97	64	0.80	0.63
23	1.0	1.1	0.69	87	64	0.82	0.63
24	0.96	1.0	0.77	97	66	0.71	0.61
25	1.0	0.93	0.71	103	65	0.72	0.67
26	1.1	0.98	0.72	102	65	0.71	0.64
27	1.0	0.98	0.72	108	66	0.72	0.62
28	1.2	0.96	0.74	108	66	0.72	0.58
29	0.98	1.2	0.72	108	66	0.69	0.58
30	0.96	1.00	26	102	52	0.70	0.59
31	--	1.0	--	103	48	--	0.63
COUNT	**30**	**31**	**30**	**31**	**31**	**30**	**31**
MAX	**1.3**	**21**	**26**	**108**	**126**	**66**	**260**
MIN	**0.85**	**0.91**	**0.67**	**31**	**9.1**	**0.69**	**0.58**

Table A-11. Daily mean flow (cfs), Cucamonga Creek near Mira Loma, as measured by the USGS from April 1 to October 31, 2011 (Data are provisional)

Date	April	May	June	July	August	September	October
1	38	21	12	25	20	8.4	40
2	34	9.6	18	37	8.1	8.5	29
3	38	7.8	18	27	13	11	28
4	37	15	23	31	18	13	43
5	33	8.1	25	36	29	16	460
6	31	6.2	27	15	45	14	61
7	26	9.4	20	14	45	9.3	46
8	24	16	18	21	45	6.2	45
9	26	12	19	31	45	7.6	40
10	25	13	32	31	42	15	35
11	23	12	24	38	43	22	25
12	16	11	30	32	45	21	39
13	17	8.6	25	19	46	12	21
14	16	12	20	13	45	17	15
15	9.2	29	19	15	45	15	20
16	9.7	16	17	15	44	15	40
17	14	35	28	29	43	16	32
18	10	55	38	18	31	26	35
19	14	27	40	8.1	15	23	36
20	14	19	30	10	18	21	31
21	18	18	28	9.1	18	24	24
22	18	20	35	11	14	18	26
23	21	16	24	16	8.3	25	29
24	32	11	28	14	7.0	29	24
25	21	16	26	21	10	40	26
26	22	19	28	11	8.0	35	25
27	14	22	18	11	7.2	28	17
28	13	19	26	14	9.1	22	16
29	12	18	16	12	8.6	26	15
30	15	18	21	20	8.0	29	29
31		18		69	13		21
COUNT	30	31	30	31	31	30	31
MAX	38	55	40	69	46	40	460
MIN	9.2	6.2	12	8.1	7	6.2	15

Table A-12. Daily mean flow (cfs), Santa Ana River at MWD Crossing, as measured by the USGS from April 1 to October 31, 2011 (Data are provisional)

Date	April	May	June	July	August	September	October
1	546	70	67	56	59	40	52
2	547	67	65	54	56	42	51
3	474	64	75	53	51	42	52
4	389	67	73	52	50	43	57
5	247	65	69	49	52	44	240
6	142	62	70	50	50	46	107
7	78	56	71	50	49	42	61
8	89	57	73	51	49	41	55
9	91	54	68	51	48	43	55
10	96	59	73	50	51	44	54
11	88	66	75	54	58	43	50
12	88	68	77	53	46	44	50
13	82	67	74	55	44	43	51
14	90	67	75	56	46	43	51
15	90	60	68	55	43	46	51
16	88	59	71	52	44	46	51
17	86	68	74	52	39	48	49
18	80	103	69	51	41	47	52
19	80	74	71	50	40	46	53
20	83	73	76	51	39	51	54
21	87	71	78	51	37	49	52
22	94	71	66	51	36	49	55
23	96	72	65	49	37	49	55
24	99	71	64	52	39	50	54
25	96	70	61	51	39	54	64
26	92	67	62	52	39	52	61
27	86	68	58	51	38	52	60
28	77	71	60	52	37	53	59
29	71	71	57	53	39	54	55
30	66	70	58	51	39	53	60
31	--	68	--	86	40	--	58
COUNT	30	31	30	31	31	30	31
MAX	547	103	78	86	59	54	240
MIN	66	54	57	49	36	40	49

Table A-13. Daily rainfall data (inches) from key rainfall gauges in MSAR watershed during dry season 2011 (during preparation of this report, data were not available at three sites for month of June and all sites for July through October)

Date	Rainfall Gauge			
	Riverside North	Riverside South	Corona	Norco
1-Apr	0	0	0	0
2-Apr	0	0	0	0
3-Apr	0	0	0	0
4-Apr	0	0	0	0
5-Apr	0	0	0	0
6-Apr	0	0	0	0
7-Apr	0	0	0	0
8-Apr	0	0	0.01	0
9-Apr	0.09	0.13	0.16	0.15
10-Apr	0.01	0.01	0.01	0.01
11-Apr	0	0	0	0
12-Apr	0	0	0	0
13-Apr	0	0	0	0
14-Apr	0	0	0	0
15-Apr	0	0	0	0
16-Apr	0	0	0	0
17-Apr	0	0	0	0
18-Apr	0	0	0	0
19-Apr	0	0	0	0
20-Apr	0	0	0	0
21-Apr	0	0	0	0
22-Apr	0	0	0	0
23-Apr	0	0	0	0
24-Apr	0	0	0.01	0
25-Apr	0	0	0	0.01
26-Apr	0	0	0	0
27-Apr	0	0	0	0
28-Apr	0	0	0	0
29-Apr	0	0	0	0
30-Apr	0	0	0	0
1-May	0	0	0	0
2-May	0	0	0	0
3-May	0	0	0	0
4-May	0	0	0	0
5-May	0	0	0	0
6-May	0	0	0	0
7-May	0.01	0	0	0
8-May	0	0	0	0
9-May	0.02	0	0	0
10-May	0	0	0	0
11-May	0	0	0	0

Table A-13. Daily rainfall data (inches) from key rainfall gauges in MSAR watershed during dry season 2011 (during preparation of this report, data were not available at three sites for month of June and all sites for July through October)

Date	Rainfall Gauge			
	Riverside North	Riverside South	Corona	Norco
12-May	0	0	0	0
13-May	0	0	0	0
14-May	0	0	0	0
15-May	0	0	0	0
16-May	0.07	0.02	0.01	0.07
17-May	0.02	0	0.02	0
18-May	0.27	0.26	0.28	0.21
19-May	0.07	0.02	0.01	0.01
20-May	0	0	0	0
21-May	0	0	0	0
22-May	0	0	0	0
23-May	0	0	0	0
24-May	0	0	0	0
25-May	0	0	0	0
26-May	0	0	0	0
27-May	0	0	0	0
28-May	0	0	0	0
29-May	0	0	0.01	0
30-May	0	0	0	0
31-May	0	0	0	0
1-Jun	--	--	--	0
2-Jun	--	--	--	0
3-Jun	--	--	--	0
4-Jun	--	--	--	0
5-Jun	--	--	--	0
6-Jun	--	--	--	0.03
7-Jun	--	--	--	0.01
8-Jun	--	--	--	0
9-Jun	--	--	--	0
10-Jun	--	--	--	0
11-Jun	--	--	--	0
12-Jun	--	--	--	0
13-Jun	--	--	--	0
14-Jun	--	--	--	0
15-Jun	--	--	--	0
16-Jun	--	--	--	0
17-Jun	--	--	--	0
18-Jun	--	--	--	0
19-Jun	--	--	--	0
20-Jun	--	--	--	0
21-Jun	--	--	--	0
22-Jun	--	--	--	0

Table A-13. Daily rainfall data (inches) from key rainfall gauges in MSAR watershed during dry season 2011 (during preparation of this report, data were not available at three sites for month of June and all sites for July through October)

Date	Rainfall Gauge			
	Riverside North	Riverside South	Corona	Norco
23-Jun	--	--	--	0
24-Jun	--	--	--	0
25-Jun	--	--	--	0
26-Jun	--	--	--	0
27-Jun	--	--	--	0
28-Jun	--	--	--	0
29-Jun	--	--	--	0
30-Jun	--	--	--	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 2011 dry season. The basis for this evaluation is the approved QAPP.

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 2011 dry season data.

Field Measured Parameters

Completeness

Table B-1 shows the field measurements collected versus planned for the dry weather season. For the 20 dry season sample events, with the exception of three flow measurement all field measurements were collected at each watershed-wide compliance site. The missing flow data resulted from (1) equipment failure at three sites on one sample date (August 9, 2011); and (2) a suspect value on May 17, 2011 at the Santa Ana River at Pedley Avenue site.

Table B-1. Field parameter completeness summary

Parameter	Collected	Planned	% Complete
Conductivity	100	100	100
Dissolved Oxygen	100	100	100
Flow	96	100	96
pH	100	100	100
Temperature	100	100	100
Turbidity	100	100	100

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 2011 dry weather season, 20 weeks of sampling at five compliance sites was planned to begin the week of May 16, 2011 and end the week of September 26, 2011. A total of 100 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)	20	20	0
Chino Creek at Central Ave (WW-C7)	20	20	0
Mill-Cucamonga Creek at Chino Corona Road (WW-M5)	20	20	0
SAR at MWD Crossing (WW-S1)	20	20	0
SAR at Pedley Ave (WW-S4)	20	20	0
Total	100	100	0

Field/Equipment Blanks

The QAPP calls for a field/equipment blank to be collected during each sample event. Accordingly, a total of 20 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%, except for one duplicate pair collected on June 14, 2011, which had an RPD of 26%.

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

Sample Date	Sample Location	Duplicate Result (mg/L)	Sample Result (mg/L)	RPD(%)
5/17/2011	SAR at Pedley Ave (WW-S4)	202	157.3	24.9
5/24/2011	SAR at MWD Crossing (WW-S1)	69.6	59.9	15.0
5/31/2011	Prado Park Lake Outlet (WW-C3)	15.3	16.5	7.9
6/7/2011	Chino Creek at Central (WW-C7)	14.0	16.3	14.9
6/14/2011	Mill-Cucamonga Creek (WW-M5)	15.4	20	**26.0**
6/21/2011	SAR at Pedley Ave (WW-S4)	68.0	53.5	23.9
6/28/2011	SAR at MWD Crossing (WW-S1)	28.7	26.2	9.0
7/5/2011	Prado Park Lake Outlet (WW-C3)	14.0	13.7	2.2
7/12/2011	Chino Creek at Central (WW-C7)	14.6	16.6	12.8
7/19/2011	Mill-Cucamonga Creek (WW-M5)	17.0	21	21.1
7/28/2011	SAR at Pedley Ave (WW-S4)	34.3	27.1	23.3
8/2/2011	SAR at MWD Crossing (WW-S1)	29.5	24.2	19.7
8/9/2011	Prado Park Lake Outlet (WW-C3)	22.8	21.6	5.4
8/16/2011	Chino Creek at Central (WW-C7)	14.3	16.2	12.5
8/23/2011	Mill-Cucamonga Creek (WW-M5)	21.5	18.3	16.4
8/30/2011	SAR at Pedley Ave (WW-S4)	29.4	26.1	11.9
9/6/2011	SAR at MWD Crossing (WW-S1)	11.7	9.4	21.8
9/13/2011	Prado Park Lake Outlet (WW-C3)	27.8	33	17.3
9/20/2011	Chino Creek at Central (WW-C7)	11.3	12.8	12.4
9/27/2011	Mill-Cucamonga Creek (WW-M5)	8.4	6.8	21.1

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 August 9, 2011, at Prado Park Lake (WW-C3) exceeded the calculated precision criterion. For *E. coli*, two duplicate pairs, collected on July 5 and September 13, 2011, at Prado Park Lake (WW-C3) 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/100 mL)	Sample Result (cfu/100 mL)	Log of Duplicate Result (L_1)	Log of Sample Result (L_2)	Range of Logs (L_1 - L_2) or (R_{log})
5/17/2011	SAR at Pedley Ave (WW-S4)	150	320	2.1761	2.5051	0.3291
5/24/2011	SAR at MWD Crossing (WW-S1)	200	240	2.3010	2.3802	0.0792
5/31/2011	Prado Park Lake Outlet (WW-C3)	140	150	2.1461	2.1761	0.0300
6/7/2011	Chino Creek at Central (WW-C7)	130	150	2.1139	2.1761	0.0621
6/14/2011	Mill-Cucamonga Creek (WW-M5)	250	270	2.3979	2.4314	0.0334
6/21/2011	SAR at Pedley Ave (WW-S4)	200	150	2.3010	2.1761	0.1249
6/28/2011	SAR at MWD Crossing (WW-S1)	70	130	1.8451	2.1139	0.2688
7/5/2011	Prado Park Lake Outlet (WW-C3)	760	850	2.8808	2.9294	0.0486
7/12/2011	Chino Creek at Central (WW-C7)	200	160	2.3010	2.2041	0.0969
7/19/2011	Mill-Cucamonga Creek (WW-M5)	3,900	5,000	3.5911	3.6990	0.1079
7/28/2011	SAR at Pedley Ave (WW-S4)	50	40	1.6990	1.6021	0.0969
8/2/2011	SAR at MWD Crossing (WW-S1)	2,000	2,000	3.3010	3.3010	0.0000
8/9/2011	Prado Park Lake Outlet (WW-C3)	60	20	1.7782	1.3010	**0.4771**
8/16/2011	Chino Creek at Central (WW-C7)	320	360	2.5051	2.5563	0.0512
8/23/2011	Mill-Cucamonga Creek (WW-M5)	810	740	2.9085	2.8692	0.0393
8/30/2011	SAR at Pedley Ave (WW-S4)	190	220	2.2788	2.3424	0.0637
9/6/2011	SAR at MWD Crossing (WW-S1)	4,400	3,000	3.6435	3.4771	0.1663
9/13/2011	Prado Park Lake Outlet (WW-C3)	60	70	1.7782	1.8451	0.0669
9/20/2011	Chino Creek at Central (WW-C7)	340	280	2.5315	2.4472	0.0843
9/27/2011	Mill-Cucamonga Creek (WW-M5)	410	350	2.6128	2.5441	0.0687
					Sum of R_{log}	2.2954
					Mean R_{log}	0.1148
					Precision Criterion (3.27*Mean R_{log})	0.3753

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

Date	Compliance Site	Duplicate Result (cfu/100 mL)	Sample Result (cfu/100 mL)	Log of Duplicate Result (L_1)	Log of Sample Result (L_2)	Range of Logs (L_1 - L_2) or (R_{log})
5/17/2011	SAR at Pedley Ave (WW-S4)	180	140	2.2553	2.1461	0.1091
5/24/2011	SAR at MWD Crossing (WW-S1)	250	260	2.3979	2.4150	0.0170
5/31/2011	Prado Park Lake Outlet (WW-C3)	210	170	2.3222	2.2304	0.0918
6/7/2011	Chino Creek at Central (WW-C7)	190	220	2.2788	2.3424	0.0637
6/14/2011	Mill-Cucamonga Creek (WW-M5)	300	360	2.4771	2.5563	0.0792
6/21/2011	SAR at Pedley Ave (WW-S4)	200	180	2.3010	2.2553	0.0458
6/28/2011	SAR at MWD Crossing (WW-S1)	110	100	2.0414	2.0000	0.0414
7/5/2011	Prado Park Lake Outlet (WW-C3)	9	50	0.9542	1.6990	**0.7447**
7/12/2011	Chino Creek at Central (WW-C7)	140	150	2.1461	2.1761	0.0300
7/19/2011	Mill-Cucamonga Creek (WW-M5)	8,200	7,800	3.9138	3.8921	0.0217
7/28/2011	SAR at Pedley Ave (WW-S4)	70	70	1.8451	1.8451	0.0000
8/2/2011	SAR at MWD Crossing (WW-S1)	700	620	2.8451	2.7924	0.0527
8/9/2011	Prado Park Lake Outlet (WW-C3)	40	40	1.6021	1.6021	0.0000
8/16/2011	Chino Creek at Central (WW-C7)	240	350	2.3802	2.5441	0.1639
8/23/2011	Mill-Cucamonga Creek (WW-M5)	340	370	2.5315	2.5682	0.0367
8/30/2011	SAR at Pedley Ave (WW-S4)	110	80	2.0414	1.9031	0.1383
9/6/2011	SAR at MWD Crossing (WW-S1)	550	550	2.7404	2.7404	0.0000
9/13/2011	Prado Park Lake Outlet (WW-C3)	70	30	1.8451	1.4771	**0.3680**
9/20/2011	Chino Creek at Central (WW-C7)	310	300	2.4914	2.4771	0.0142
9/27/2011	Mill-Cucamonga Creek (WW-M5)	820	790	2.9138	2.8976	0.0162
					Sum of R_{log}	2.0344
					Mean R_{log}	0.1017
					Precision Criterion (3.27*Mean R_{log})	0.3326

Appendix C
Orange County Public Health Laboratory QA/QC Report

Appendix C
Orange County Public Health Laboratory QA/QC Reports

Appendix C includes additional QA/QC evaluations (e.g., laboratory method blanks, laboratory duplicates, and laboratory control samples) conducted by the Orange County Public Health Laboratory (OCPHL).

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To: CDM

From: Manisha Sulakhe,
Orange County Public Health Laboratory

Date: 10/12/11

Subject: MSAR Watershed-wide QA/QC for TSS
Wet Season -05/17/2011-09/27/2011

I. Method Blank

A. Field/Equipment Blank: One single field blank per batch of 7 samples collected each week were analyzed.

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, except for sample date 6/14/2011, were within the relative percent difference (RPD) which meets the acceptance criteria of ±25%.

Precision-Results of TSS Field Duplicate Pairs 5/17/11 to 9/27/11

Date	Compliance Site	Site Id.	Dup. Result mg/l	Sample Result mg/l	%RPD
5/17/2011	SAR at Pedley	WW S4	157.30	202.00	24.88
5/24/2011	SAR at MWD Crossing	WW S1	59.88	69.60	15.02
5/31/2011	Prado Park Lake Outlet	WW C3	16.50	15.25	7.87
6/7/2011	Chino Creek at Central	WW C7	16.25	14.00	14.88
6/14/2011	Mill-Cucamonga Creek	WW M5	20.00	15.40	25.99
6/21/2011	SAR at Pedley	WW S4	53.50	68.00	23.87
6/28/2011	SAR at MWD Crossing	WW S1	26.20	28.66	8.97
7/5/2011	Prado Park Lake Outlet	WW C3	13.70	14.00	2.17
7/12/2011	Chino Creek at Central	WW C7	16.60	14.60	12.82
7/19/2011	Mill-Cucamonga Creek	WW M5	21.00	17.00	21.05
7/28/2011	SAR at Pedley	WW S4	27.13	34.28	23.29
8/2/2011	SAR at MWD Crossing	WW S1	24.20	29.50	19.74
8/9/2011	Prado Park Lake Outlet	WW C3	21.63	22.83	5.40
8/16/2011	Chino Creek at Central	WW C7	16.20	14.30	12.46
8/23/2011	Mill-Cucamonga Creek	WW M5	18.25	21.50	16.35
8/30/2011	SAR at Pedley	WW S4	26.10	29.42	11.96
9/6/2011	SAR at MWD Crossing	WW S1	9.40	11.70	21.80
9/13/2011	Prado Park Lake Outlet	WW C3	33.00	27.75	17.28
9/20/2011	Chino Creek at Central	WW C7	12.80	11.30	12.45
9/27/2011	Mill-Cucamonga Creek	WW M5	6.80	8.40	21.05
				Mean	15.96
				sd	7.25
				WL	18.20
				CL	23.71

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. Duplicate pairs were within the relative percent difference (RPD) which meets the acceptance criteria of ±25% for this study.

Precision-Results of TSS Laboratory Duplicate Pairs 5/17/11 to 9/27/11

Date	Compliance Site	Site Id.	Dup. Result mg/l	Sample Result mg/l	%RPD
5/17/2011	Chino Creek at Central	WW C7	32.33	32.67	1.03
5/24/2011	Mill-Cucamonga Creek	WW M5	9.70	9.50	2.08
5/31/2011	SAR at Pedley	WW S4	90.20	87.75	2.75
6/7/2011	SAR at Pedley	WW S4	43.10	38.25	11.92
6/14/2011	Prado Park Lake Outlet	WW C3	9.20	9.38	1.88
6/21/2011	SAR at MWD Crossing	WW S1	24.40	26.38	7.78
6/28/2011	Prado Park Lake Outlet	WW C3	11.20	12.10	7.73
7/5/2011	Chino Creek at Central	WW C7	16.20	18.00	10.53
7/12/2011	Prado Park Lake Outlet	WW C3	11.70	11.22	4.19
7/19/2011	Chino Creek at Central	WW C7	9.80	10.10	3.02
7/28/2011	Chino Creek at Central	WW C7	6.90	7.00	1.44
8/2/2011	SAR at MWD Crossing	WW S1	24.10	24.30	0.83
8/9/2011	Chino Creek at Central	WW C7	4.50	3.90	14.29
8/16/2011	Prado Park Lake Outlet	WW C3	13.30	12.70	4.62
8/23/2011	Chino Creek at Central	WW C7	9.90	9.60	3.08
8/30/2011	Chino Creek at Central	WW C7	8.30	7.60	8.81
9/6/2011	Mill-Cucamonga Creek	WW M5	17.00	16.20	4.82
9/13/2011	SAR at MWD Crossing	WW S1	12.20	13.10	7.11
9/20/2011	SAR at Pedley	WW S4	12.90	13.60	5.28
9/27/2011	Chino Creek at Central	WW C7	13.50	13.30	1.49
				Mean	5.08
				sd	4.09
				WL	10.28
				CL	13.39

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.

Date	QC Standard Used	True Value	LCS Result	% Recovery
5/17/2011	Std. Set# 3160, Id# 17101	65.6	70.7	107.7743902
5/24/2011	Std. Set 3160, Id# 17098	57	59.1	103.6842105
5/31/2011	Std. Set 3160, Id# 17102	69.2	71.90	103.9017341
6/7/2011	Std. Set 4410 , Id# 18059	250.5	247.35	98.74251497
6/14/2011	Std. Set 3120, Id# 17059	57.5	57.32	99.68695652
6/21/2011	Std. Set 3120, Id# 17060	66.5	66.75	100.3759398
6/28/2011	Std. Set 3120, Id# 17058	64.5	58.5	90.69767442
7/5/2011	Std. Set 3120, Id# 17061	56.7	53.65	94.62081129
7/12/2011	Std. Set 3120, Id# 17062	56.7	52	91.71075838
7/19/2011 & 7/28/11	Std. Set 3120, Id# 17064	68.2	68.6	100.5865103
8/2/2011	Std. Set 3160, Id# 17103	63.4	67.2	105.9936909
8/9/2011	Std. Set 4410, Id# 18063	257.6	271.3	105.318323
8/16/2011	Std. Set 3160, Id# 17104 l	57.6	55.9	97.04861111
8/23/2011	Std. Set 3160, Id# 17105	70.1	70.1	100
8/30/2011	Std. Set 3160, Id# 17106	54.1	58	107.2088725
9/6/2011	Std. Set 3160, Id# 17107	61	64.55	105.8196721
9/13/2011	Std. Set 3120, Id# 17065	62.3	60.7	97.4317817
9/20/2011	Std. Set 3120, Id# 17063	58.8	60.7	103.2312925
9/27/2011	Std. Set 3120, Id# 17066	58.8	62.8	106.8027211
			Mean	101.0861298

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To: **CDM**

From: **Joseph A. Guzman,**
Orange County Public Health Laboratory

Date: **11/02/11**

Subject: **MSAR Watershed-wide Monitoring**
QA/QC for Fecal coliform, *E. coli*
Dry Season: 05/17/2011 – 09/27/2011

I. Cooler Temperature during sample transport

Acceptable transport temperature for this monitoring program was set at 4°C for each sampling event. (Standard Methods states: <10°C is acceptable for sample transport conditions).

Thermometers placed in coolers that samples were transported in all gave acceptable readings below 4°C when samples were received in the laboratory.

II. Method Blank

A. **Field/Equipment Blank**: 20 field blanks were tested over the 20-week sampling effort, 1 single field blank per batch of 6 samples collected each week was analyzed.

B. **Laboratory Blank**: 182 sterile phosphate buffered saline blanks were processed alongside 1116 water samples submitted to the OCPHL on the days that MSAR samples were tested.

For Fecal coliform and *E. coli*, all field blank results were reported below the reporting limit of <9 CFU/100ml. Results for all laboratory blanks showed no growth or <1 CFU/100ml which met the established acceptance criteria.

III. Duplicates:

A. Field Duplicates

Field duplicates were collected at a frequency of 20% of total samples collected. The duplicate samples were analyzed for the same parameters as its paired field sample. Results of the field duplicate analyses can be used to assess field adherence to sample collection protocols. Also, laboratory precision can be assessed by examining the results from the field sample and its duplicate pair. Precision of duplicate analysis was determined using Standard Methods, 20th Ed. 9020 B section 8.

1. For the field duplicate samples submitted for fecal coliform testing, a precision criteria of 0.3753 (3.27 x 0.1148) was established. Of the 20 duplicates samples submitted, one sample had a range between the grab and duplicate sample above the precision criteria. See Table 1.

Table 1.

Date Collect	Time Collect	Site	Accession	Parameter	Type	Result
8/9/11	10:33	WW-C3	WL-11-05959	Fecal coli	Grab	20 CFU/100ml
8/9/11	10:36	WW-C3	WL-11-05960	Fecal coli	Duplicate	60 CFU/100ml

2. For the field duplicate samples submitted for *E. coli* testing, a precision criteria of 0.3326 (3.27 x 0.1017) was established. Of the 20 duplicate samples submitted, two samples had a range between the grab and duplicate sample above the precision criteria. See Table 2.

Table 2.

Date Collect	Time Collect	Site	Accession	Parameter	Type	Result
7/5/11	10:18	WW-C3	WL-11-04909	E. coli	Grab	9 CFU/100ml
7/5/11	10:21	WW-C3	WL-11-04910	E. coli	Duplicate	50 CFU/100ml
9/13/11	10:33	WW-C3	WL-11-07244	E. coli	Grab	30 CFU/100ml
9/13/11	10:36	WW-C3	WL-11-07245	E. coli	Duplicate	70 CFU/100ml

B. Laboratory Duplicates

Laboratory duplicates were analyzed on 10% (120/1116) of total samples received on the days MSAR samples were tested. The results of duplicate analyses are used to assess laboratory precision during analysis. Precision of duplicate analysis was determined using Standard Methods, 20th Ed. 9020 B section 8.

1. For the 120 laboratory duplicates tested, a precision criteria of 0.3480 (3.27 x 0.1064) was established. Only one sample had a difference in results greater than the precision criteria. See Table 3.

Table 3.

Date Collect	Time Collect	Site	Accession	Parameter	Type	Result
8/30/11	8:34	ELMORO	WL-11-06738	Total coli	Grab	≥4000 CFU/100ml
8/30/11	8:34	ELMORO	WL-11-06738	Total coli	Duplicate	≥10000 CFU/100ml

Although there were some field and laboratory duplicates above the respective precision criteria value, the increased imprecision is determined to be acceptable.

For the field duplicates that were above the precision criteria value, regardless of parameter tested, all samples had relatively low colony counts for the sample volumes tested (1-7 colonies). In all cases the difference between the grab and duplicate was 4 colonies.

For the single laboratory duplicate that was above the precision criteria value, again the difference in colony count between the grab and duplicate was 4 colonies versus 10 colonies. The other factor with this sample was a lot of background growth so the plates counted had over 200 colonies of all colony types.

There is one procedural difference between the field and laboratory duplicates that should be noted. There is a difference in collection time between the grab and duplicate sample for the field duplicates. Although the samples are collected at the same site, because there is a 3 minute difference in the time collected, these would be considered separate samples and not “true” duplicates. For the laboratory duplicates repeat testing for each sample was performed by doing the

test twice from the same sample bottle. Another way to get a “true” duplicate sample would be to collect one bulk sample and then split the sample into two separate bottles. Studies have been done where samples collected minutes apart can have very different results.

IV. Laboratory Control Samples:

A. Fecal coliform on m-FC media

27 lots of mFC media were used during the MSAR dry season monitoring. There are 4 parameters tested for with each new lot:

1 - *E. coli* culture used as a positive control with growth and typical blue colonies.

2 - *E. aerogenes* culture used as a negative control with growth on the media, but no blue colonies.

3 - *E. faecalis* culture used as a negative control, with growth inhibited by the media.

4 – 1% of media is set aside and incubated un-inoculated as sterility check.

B. *E. coli* on Modified m-TEC media

6 lots of m-TEC media were used during the MSAR dry season monitoring. There are 4 parameters tested for with each new lot:

1 - *E. coli* culture used as a positive control with growth and typical magenta colonies

2 - *E. aerogenes* culture used as a negative control with growth on the media, but no magenta colonies.

3 - *E. faecalis* culture used a negative control, with growth inhibited by the media.

4 – 1% of media is set aside and incubated un-inoculated as sterility check.

All lots of media had appropriate responses for the parameters tested.