



Memorandum

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Subject: Source Evaluation - Task 2.4 Dry Weather Bacterial Indicator Mass Balance

The role of discharges from municipal separate storm sewers systems (MS4s) in receiving water bacterial quality was evaluated in the USEP Study in the dry seasons of 2007 and 2008. Generally, this characterization provided monitoring data from most urban drainages upstream of watershed wide TMDL compliance monitoring sites. The Comprehensive Bacteria Reduction Plan (CBRP) synthesized these data to approximate the bacterial indicator source contribution from MS4s for each of the Middle Santa Ana River (MSAR) Bacteria TMDL compliance monitoring sites.

In the dry season of 2011, additional dry season bacterial indicator and flowrate data were collected at key MS4 outfalls that were not monitored as part of the original USEP Study or where additional data was needed to support source characterization. This technical memorandum updates the MSAR bacterial indicator source contribution analysis for average dry season conditions based on the results of 2011 dry season source evaluation monitoring activities. The original data for this analysis are summarized in the CBRP. New data used incorporated into this updated analysis are described in the following technical memoranda:

- Source Evaluation Task 2.1 Box Springs Channel Follow-up Study
- Source Evaluation Task 2.2 Preliminary Characterization of Bacteria Loading in Pomona And Claremont
- Source Evaluation Task 2.3 Survey of Dry Weather Flows from MS4 Outfalls to Major Tributaries.

Data Summary

For each of the 2007-2008 USEP Study sites, data were collected for dry weather flow (DWF) rates and bacterial indicator concentration. In the 2011 dry season, follow up DWF measurements were performed at Anza Drain (US-ANZA), Box Springs Channel (US-BXSP), County Line Channel (US-CLCH), and Sunnyslope Channel (US-SNCH). In addition, DFW

measurements were collected at nine new outfalls from MS4 systems in both San Bernardino and Riverside Counties to receiving waterbodies (Figure 1).

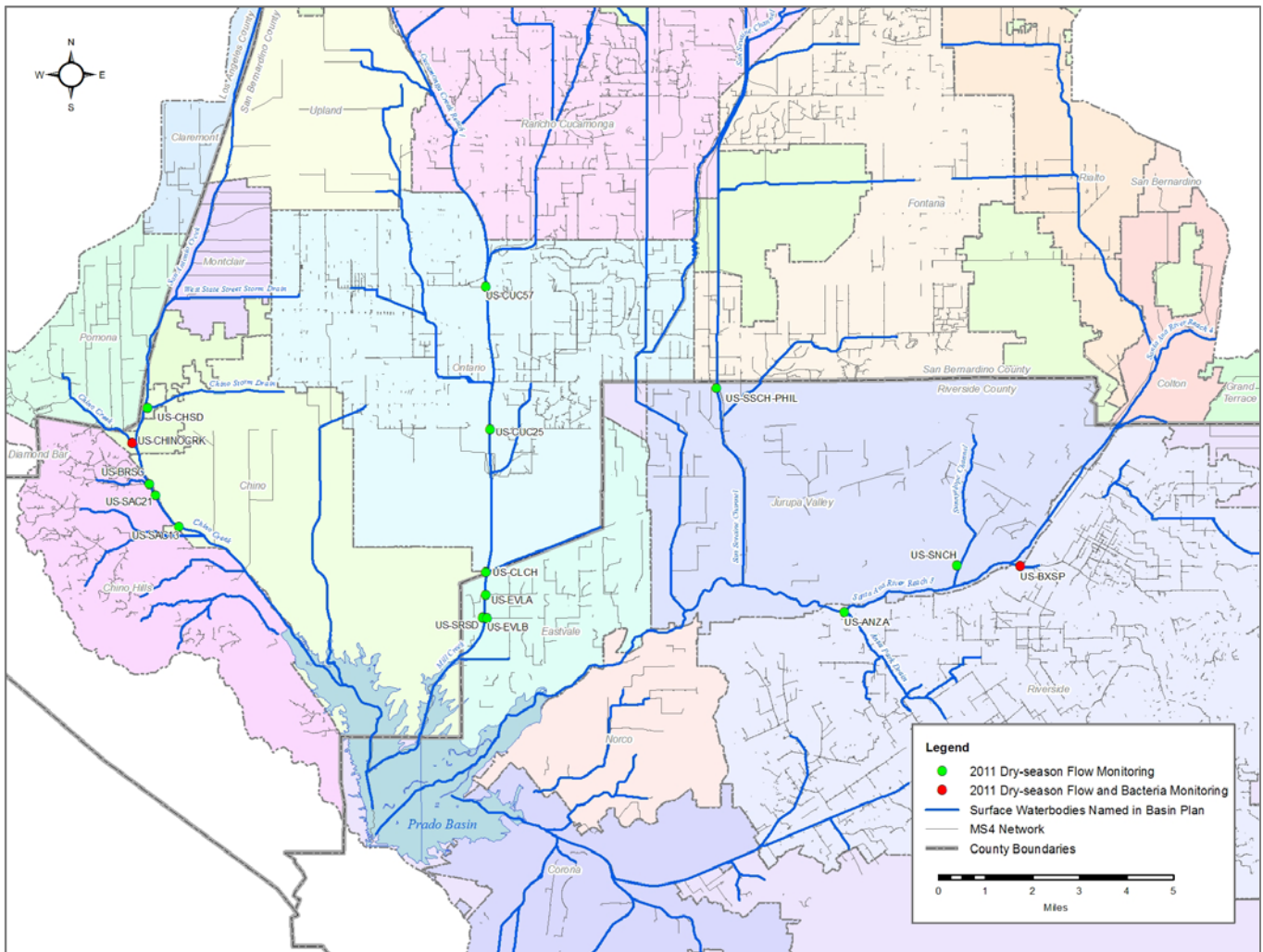


Figure 1. 2011 Dry Season DWF and Bacterial Water Quality Monitoring Sites

While DWF measurements were recorded weekly for 10 weeks in the 2011 dry season, bacterial indicator samples were only collected at two sites; Box Spring Channel (US-BXSP) and Chino Creek above San Antonio Creek (CHINOCRK). To allow for estimation of bacterial indicator loads to receiving waterbodies, the median *E. coli* concentration from all source evaluation monitoring samples in the MSAR watershed from the 2007 and 2011 dry seasons (560 cfu/100 mL) was assumed for MS4 systems discharges without any data.

Source Contribution Analysis

Relative source contribution analyses were prepared for each of the watershed-wide compliance locations. This analysis provided a comparison of monitored inputs of DWF (Q_{inflow}) and

bacterial indicator concentrations (C_{inflow}) from MS4 facilities and POTWs with downstream flow (Q_{comp}) and bacterial indicator concentrations (C_{comp}), as follows:

$$FIB_{comp} = Q_{comp} * C_{comp} = \left[\sum_i^J Q_{inflow} * C_{inflow} \right] + e$$

This type of analysis characterizes the relative role of different flow sources in the watershed on downstream bacterial indicator concentrations. An important outcome of this analysis is the identification of the level of bacterial indicators (e) at the compliance locations that cannot be explained by known DWF sources within the watershed (referred to as “unaccounted-for sources”). The presence of an unbalanced set of inputs and outputs in relation to downstream bacterial indicator levels is not surprising, given the potential for increases in bacteria indicator levels from illegal and illicit discharges, direct input from wildlife, air deposition, transient encampments, environmental growth, or resuspension, or decreases in bacterial indicator levels due to environmental decay or settling.

Source Contribution Results

Table 1 provides the average DWF (column 2) and bacteria concentrations (column 3) used to estimate *E. coli* loads (column 4) from MS4 drainages and total loads at downstream compliance monitoring sites. The difference between loads from urban source evaluation sites and watershed wide TMDL compliance sites approximates the contribution of MS4s discharges to receiving water impairments relative to other unaccounted-for sources of bacterial indicators. This table is equivalent to Table 3-2 in the CBRP. Highlighted cells indicate data that were updated based on source evaluation activities completed during the 2011 dry season.

The relative source contribution analysis shows high amounts of unaccounted-for bacterial indicators at all four compliance points during DWF in the dry season (Figure 2). The following sections discuss the findings of the this analysis and remaining data gaps specific to each watershed-wide compliance monitoring location.

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Table 1. Source Contribution Analysis for *E. coli* in Dry Season for Each Watershed Wide Bacterial Indicator TMDL Compliance Site in the MSAR Watershed

Site	Hydrologically Connected MS4 Acres	Dry Weather Runoff (cfs)	Dry Weather Geometric Mean of <i>E. coli</i> (cfu/100ml)	Dry Weather <i>E. coli</i> (cfu/day)
Santa Ana River at MWD Crossing (WW-S1)	6,297	73.2	149	265
POTW Influent	n/a	68.7	2	4
USEP SNCH	2,104	2.0	183	9
USEP BXSP	4,193	1.8	1,549	69
MS4 Runoff		4.5		78
Unaccounted-for Sources				183
Santa Ana River at Pedley Ave (WW-S4)	17,921	55.5	149	202
POTW Influent	n/a	49.4	2	3
USEP ANZA	6,335	3.3	492	38
USEP DAY	2,759	0.5	577	7
USEP SSCH	2,489	1.3	320	10
Other MS4 Areas ¹	6,338	1.0	560 ²	13
MS4 Runoff		6.1		69
Unaccounted-for Sources				131
Chino Creek at Central Ave (WW-C7)	17,678	19.0	394	183
POTW Influent	n/a	8.8	2	0.5
USEP CCCH	1,766	6.5	61	10
USEP SACH	5,031	0.7	412	7
CHINOCRK	4,357	1.7	499	21
BRSC	707	0.4	560 ²	5
SAC13	1,080	0.02	560 ²	0
SAC 21	266	0.1	560 ²	2
Other MS4 Areas ¹	4,472	0.7	560 ²	9
MS4 Runoff		10.2		54
Unaccounted-for Sources				128
Mill Creek at Chino Corona Rd (WW-M5)	5,510	30.9	877	663
POTW Influent	n/a	27.1	2	1
USEP CHRIS	3,091	0.8	868	17
USEP CLCH	373	0.1	1,194	2
USEP CUC	602	2.8	139	9
CUC57	760	0.02	560 ²	0
CUC25	38	0.01	560 ²	0
EVLA	184	0.1	560 ²	1
EVLB	45	0.004	560 ²	0
SRSD	417	0.1	560 ²	1
MS4 Runoff		3.8		30
Unaccounted-for Sources				632

1) Other MS4 areas include all MS4 outfalls to receiving waterbodies where DWF measurements have not been recorded. For these areas, the source contribution analysis assumed a DWF generation rate of 100 gallons per day per acre of urbanized land use. DWF and bacterial indicator concentrations for these areas will be evaluated through CBRP source evaluation activities prior to 2015 and IDDE programs.

2) Median of all 2007 and 2011 dry season *E. coli* samples from MS4 systems

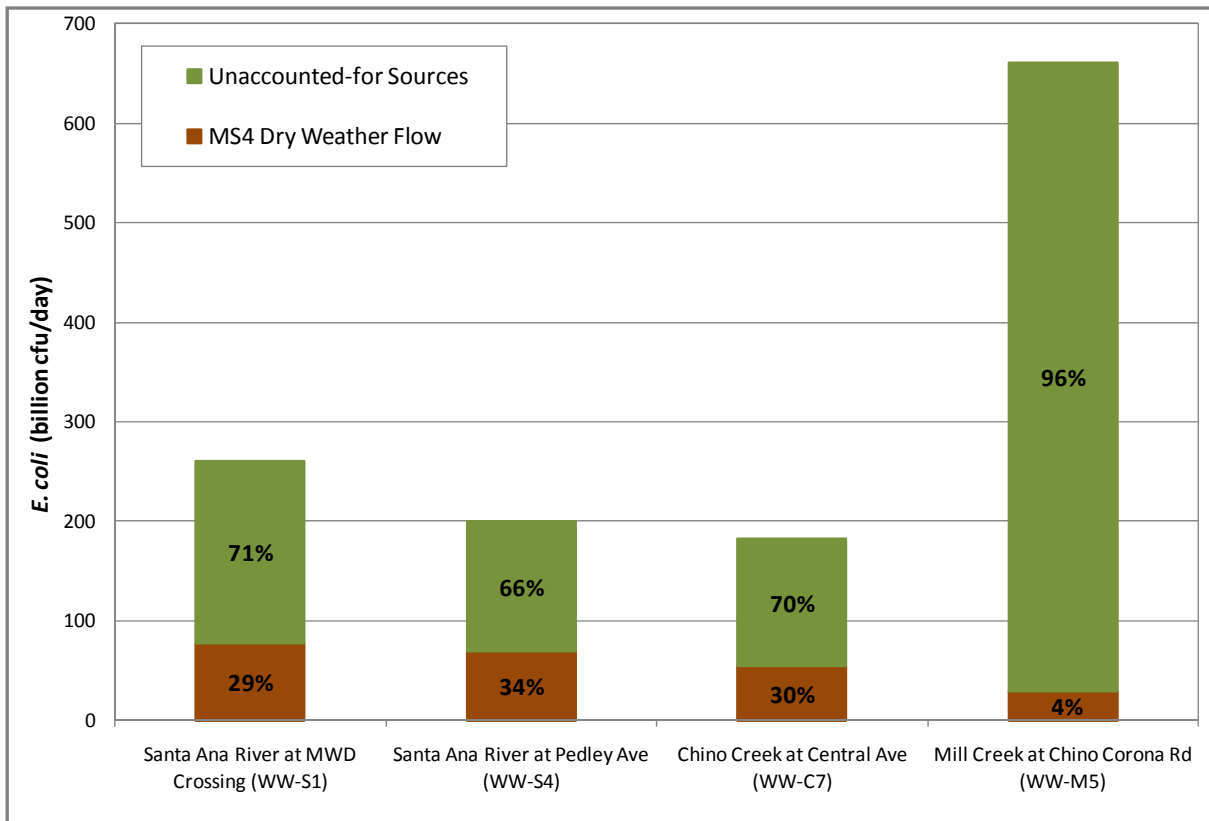


Figure 2. Relative Contribution of Bacterial Indicators from MS4 Discharges to Total Downstream Loading

Santa Ana River at MWD Crossing

Sources of urban runoff to the Santa Ana River at MWD Crossing during the dry season are limited to two key tributaries; Sunnyslope Channel and Box Springs Channel. Sunnyslope Channel DWF includes mostly rising groundwater and therefore has significantly lower *E. coli* concentrations than other USEP sites. Conversely, Box Springs Channel was the single highest priority site based on ranking from the 2007 USEP Study. One of the reasons for this was the presence of human source bacteria in the majority of samples collected in 2007. In 2008, Riverside County Flood Control and Water Conservation District (RCFC&WCD) and the City of Riverside discovered that a single restroom toilet located in the Sam Evans Sports Complex on the Riverside Community College (RCC) Campus was inadvertently connected to a storm drain pipe rather than a sewer line. Data collected after the elimination of this source of bacteria in Box Springs Channel indicated the elimination of human polymerase chain reaction (PCR) markers in runoff from Box Springs Channel. Despite this correction, follow up monitoring of bacterial indicators at Box Springs Channel in the 2011 dry season showed that this MS4 drainage area remains to be a high priority for non-human bacterial indicators.

Field observations of other potential MS4 discharges to the Santa Ana River upstream of the MWD Crossing site were conducted on March 17, 2011 by CDM and RCFC&WCD. With one

exception, these observations found no measurable DWF was observed to connect to the Santa Ana River from other MS₄ drainages in this watershed including High Grove Channel, Agua Mansa Storm Drain, Phoenix Storm Drain, and a few other minor outfalls along the north side of the river. For Magnolia Storm Drain, significant DWF was observed at the outfall; however the distance from the MS₄ outfall to the mainstem of the SAR is approximately one-half mile, over which recharge into the river bottom sediment may occur. Observations at Magnolia Storm Drain and other MS₄ outfalls should continue to assess DWF connectivity or confirm that the lack of DWF is consistent.

Santa Ana River at Pedley Avenue

In the 2011 dry season, DWF measurements were recorded for the Anza Drain tributary to the Santa Ana River. The cross section used to collect the flow measurement allowed for a more accurate reading than was obtained in 2007 during the original USEP Study. Reduced estimates of DWF from Anza Drain (from 6.3 cfs in 2007 to 3.2 cfs in 2011) resulted in a reduction in the urban MS₄ source contribution to *E. coli* loads in the Santa Ana River.

Other sources of urban DWF from MS₄s in this watershed include San Sevaine Channel and Day Creek. San Bernardino County Flood Control District (SBCFCD) field observations for the 2011 dry season included 10 visits to San Sevaine Channel at the county line. Most of San Sevaine Channel within San Bernardino County is upstream of the Jurupa Basin, where urban DWF is spread for groundwater recharge. The field observations confirm that DWF is effectively captured in Jurupa Basin and that MS₄ outfalls between the Jurupa Basin and county line generate minimal DWF during typical operating conditions (<0.05 cfs).

Field observations of other potential MS₄ discharges to the Santa Ana River upstream of the Pedley Avenue site were conducted on March 17, 2011 by CDM and RCFC&WCD. During these field observations, no measurable DWF was observed from any other MS₄ outfalls in this watershed. Observations at these MS₄ outfalls should continue to confirm that the lack of DWF is consistent.

Mill-Cucamonga Creek at Chino Corona Road

Mill-Cucamonga Creek has the largest fraction of unaccounted for bacteria of the impaired waterbodies in the MSAR watershed. Additional DWF measurements of outfalls to Cucamonga Creek were conducted in the 2011 dry season to characterize outfalls that were not assessed in the 2007 dry season USEP Study. Weekly DWF measurements at five key MS₄ outfalls (EVLA, EVLB, SRSD, CUC 25, and CUC57) downstream of the Turner Basins were recorded for 10 consecutive weeks. The results showed that these outfalls contribute less than expected volumes of DWF to Cucamonga Creek, thus the unaccounted-for source of bacterial indicators in this watershed may not be attributable to previously unmonitored MS₄ discharges.

The 2007 dry season DWF measurements at US-CUC (Cucamonga Creek above RP₁) are high relative to expected DWF generation rates, if all MS₄ drainage areas upstream of the Turner Basins are hydrologically disconnected. Thus, it was important to assess MS₄ sources to

Cucamonga Creek downstream of the Turner Basins, largely between Highway 10 and Highway 60 in the City of Ontario. In 2011, DWF measurements were taken at a MS4 outfall, which discharge to this segment of Cucamonga Creek (CUC57). DWF measurements at this outfall showed very low DWF (average of 0.02 cfs). In addition, SBCFCD windshield surveys evaluated all 36" diameter and larger outfalls in this segment of Cucamonga Creek. These surveys identified only minimal additional DWF, which could not explain the DWF in Cucamonga Creek above RP1. Therefore, DWF in Cucamonga Creek above RP1 is most likely from MS4 discharges that bypass or flow through the Turner Basins. Inland Empire Utilities Agency is currently developing a project to improve operations at the Turner Basins, which will improve the capacity to capture urban DWF from Upper Deer and Cucamonga Creeks. It is important to note that reducing DWF in Cucamonga Creek above RP1 will only address the portion of downstream bacteria loads that could be attributed to MS4 discharges (~5 percent). Source evaluation activities included in the CBRP will attempt to characterize the unaccounted-for fraction of bacterial indicators, which are the predominant cause for non-compliance.

Chino Creek at Central Avenue

In the Chino Creek watershed, there were several key tributaries that were not monitored during the 2007 dry season USEP Study. New data obtained in the dry season of 2011 improved the characterization of urban DWF and bacterial indicators in this watershed. DWF measurements and bacterial indicator samples were collected from Chino Creek upstream of the San Antonio Creek confluence (CHINOCRK). This tributary captures DWF from most of the City of Pomona's MS4 drainage area within the MSAR watershed. The data indicate an average *E. coli* concentration of 500 cfu/100, which is comparable to the assumed concentration used in previous source contribution analyses. DWF measurements were also taken in a major MS4 outfall to San Antonio Creek, which also includes drainage from the City of Pomona. With an assumed *E. coli* concentration for this MS4 discharge of 500 cfu/100mL (median of all 2007 and 2011 dry season samples from MS4 systems), the combined loading from City of Pomona accounts for approximately 40 percent of all *E. coli* loads attributed to urban DWF sources in the Chino Creek watershed.

Other DWF measurements during the 2011 dry season increased source contribution analysis input data for MS4 discharge to Chino Creek. Accordingly, the relative role of MS4 sources to bacterial indicator loads in Chino Creek at Central is greater than approximated in the CBRP, increasing the estimated contribution of *E. coli* loads from MS4s to 30 percent.

Summary of Findings

DWF measurements and windshield surveys, and bacterial water quality samples collected in the 2011 dry season provided some key information necessary to understand the sources of bacterial indicators in the MSAR watershed. Each of the following findings characterizes specific MS4 drainage areas and will be used to guide future source evaluation activities to be completed as part of CBRP implementation:

- Non-human sources of bacterial indicators at Box Springs Channel are a high priority in the Santa Ana River at MWD Crossing watershed.
- DWF from the Anza Drain MS4 drainage area is 50 percent less than measured in the 2007 dry season. Flow measurements taken in the 2011 dry season involved an improved approach, using a better cross section and more readings in developing a cross-sectional velocity profile to compute flowrate. Consequently, MS4s have reduced relative source contribution to total bacterial loads in the Santa Ana River at Pedley Avenue watershed.
- DWF measurements and windshield surveys suggest that unaccounted-for bacterial indicator loads may be predominantly from non-urban sources in the Mill-Cucamonga Creek at Chino Corona Rd watershed.
- The Turner Basins do not typically capture 100 percent of DWF from the Upper Deer and Cucamonga Creek watersheds.
- Approximately 40 percent of the bacterial load in the Chino Creek watershed could be attributed to MS4 discharges from the City of Pomona.