Middle Santa Ana River Bacterial TMDL 2013 Dry Season Tier 2 Source Assessment Final Report

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CDM Smith

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, Eastvale, Jurupa Valley, Pomona, and Claremont

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Acronyms

BASMP	bacteria source management plan
BRSC	Boys Republic South Channel
CCCH	Carbon Canyon Creek Channel
CBRP	Comprehensive Bacteria Reduction Plan
CYP	Cypress Channel
District	Riverside County Flood Control & Water Conservation District
DWF	Dry Weather Flow
EVLD	Eastvale Line D
EVLE	Eastvale Line E
IRWD	Irvine Ranch Water District
mL	milliliter
MP	Monitoring Plan
MPN	most probable number
MS4	Municipal Separate Storm Sewer System
MSAR	Middle Santa Ana River
MWDOC	Metropolitan Water District of Orange County
OCWD	Orange County Water District
RWQCB	Riverside Water Quality Control Board
SBCFCD	San Bernardino County Flood District
TMDL	Total Maximum Daily Load
TSS	total suspend solids
USEP	Urban Source Evaluation Program
WRCAC	Western Riverside County Agricultural Coalition

Section 1
Introduction

The Santa Ana Regional Water Quality Control Board (Regional Board) adopted Resolution No. R8 2005-0001, amending the Basin Plan to incorporate Bacterial Indicator TMDLs for the Reach 3 of the Santa Ana River, Reaches 1 and 2 of Chino Creek, Mill-Cucamonga Creek, and Prado Park Lake (Regional Board, 2005[1]). The Total Maximum Daily Loads (TMDLs) adopted by the Regional Board were subsequently approved by the State Board on May 15, 2006, by the California Office of Administrative Law on September 1, 2006, and by EPA Region 9 on May 16, 2007. The EPA approval date became the TMDL effective date.

The most recent Municipal Separate Storm Sewer System (MS4) permit updates for Riverside, San Bernardino, and Los Angeles Counties within the Santa Ana River watershed required the development of Comprehensive Bacteria Reduction Plans (CBRP) by responsible parties within each County. The CBRP is a long term plan designed to achieve compliance with dry weather condition (April 1 – October 31) wasteload allocations for bacterial indicators established by the Middle Santa Ana River (MSAR) Bacterial Indicator TMDL ("MSAR Bacteria TMDL").

1.1 Comprehensive Bacteria Reduction Plan

The CBRP is designed to provide a comprehensive plan for attaining MSAR Bacterial Indicator TMDL WLAs applicable to urban runoff by integrating existing control programs and efforts with new permit mandates and other additional activities necessary to address controllable urban sources of bacterial indicators. Riverside and San Bernardino Counties submitted final CBRPs to the Regional Board in June 2011. The Regional Board approved both CBRPs on February 10, 2012 (Riverside County: Order No. R8-2012-0015; San Bernardino County: Order No. R8-2012-0016). CBRPs for the Cities of Pomona and Claremont in Los Angeles County were submitted to the Regional Board in January 2014. The Regional Board approved both CBRPs on March 14, 2014 (City of Claremont: Order No. R8-2014-0030; City of Pomona: Order No. R8 2014 0031). Each of these CBRPs contains the same basic elements with regard to source evaluation activities.

CBRP implementation includes inspection activities to (a) identify controllable MS4 Dry Weather Flow (DWF) sources and their contribution to elevated bacterial indicator concentrations; (b) prioritize controllable DWF sources for follow-up mitigation activity; and (c) identify alternatives to mitigate prioritized controllable urban sources. This effort was initiated in 2012, and will continue over an extended period so that MS4 outfalls to reach 3 of the Santa Ana River can be properly prioritized, investigated and evaluated for mitigation.

[1] http://www.swrcb.ca.gov/rwqcb8/water_issues/programs/tmdl/msar_tmdl.shtml

To date, two years of dry season bacteria source evaluation from MS4 systems in the MSAR watershed have been completed. Data from the first year, 2012, was analyzed and reported in Section 3 of the MSAR Bacteria TMDL Implementation Report (CDM Smith, 2013[2]). In 2012, source evaluations involved monitoring at all major MS4 outfalls to receiving waterbodies, referred to as Tier 1 sites. In total, 34 Tier 1 sites were monitored covering multiple jurisdictions (Figure 1-1). Some of the Tier 1 monitoring sites were also sampled in 2007-2008 as part of implementation of the Urban Source Evaluation Program (USEP)[3].

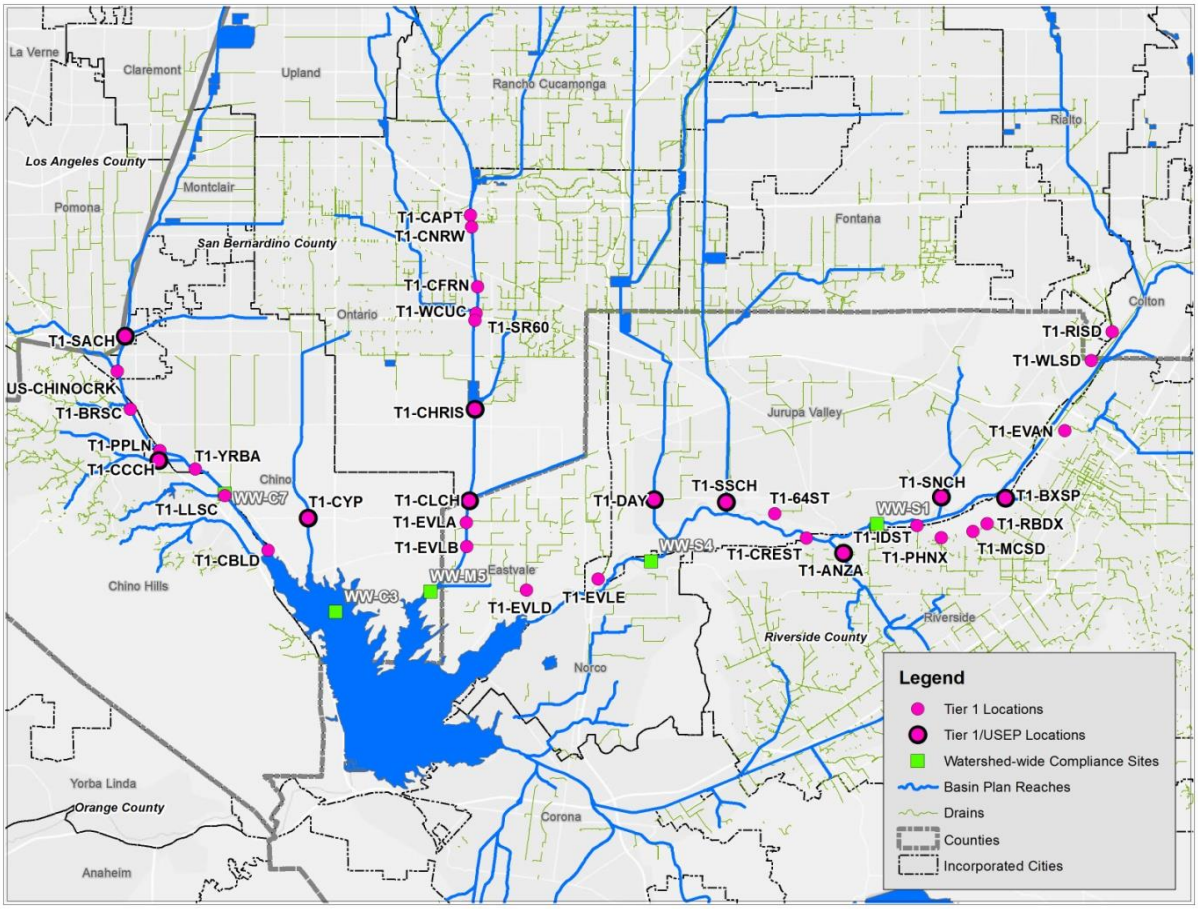

Figure 1-1
CBRP Tier 1 source evaluation monitoring sites

Tier 1 source evaluation activities were designed to gather sufficient DWF and bacterial indicator data to provide the basis for prioritizing MS4 drainage areas within the MSAR watershed for subsequent source assessments and, where necessary, development of alternatives to mitigate controllable urban sources of bacterial indicators.

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[2] http://www.sawpa.org/collaboration/projects/tmdl-taskforce/

[3] The MSAR Bacterial Indicator TMDL required permitted MS4 discharges to develop the USEP within six months after TMDL adoption or by November 30, 2007. Per Section 4.1 of the TMDL, the purpose of the USEP was to identify specific activities, operations, and processes in urban areas that contribute bacterial indicators to MSAR waterbodies. The Regional Board approved the USEP developed by the MS4 permittees April 18, 2008 (RWQCB Resolution R8-2008-0044). The inspection activities identified in the CBRP (adopted February 15, 2012) replaced the requirements of this 2008-adopted USEP.

On February 11, 2013 MS4 Permittees within the MSAR watershed (Permittees) submitted a CBRP Tier 1 Source Evaluation Report to the Regional Board. The report contained the results of analysis of the monitoring data collected for 10 consecutive weeks in the 2012 dry season at Tier 1 outfalls to the TMDL waterbodies; Chino Creek, Mill-Cucamonga Creek, and the Santa Ana River. The report contained a prioritization of MS4 drainage areas upstream of Tier 1 outfalls (Figure 1-2).

The drainage areas to each of the prioritized Tier 1 sites are spread across multiple cities in each of Riverside, San Bernardino, and Los Angeles Counties and range in size from 334 acres to 7,313, acres (Table 1-1). Table 1-1 also shows the frequency of human *Bacteroides* detections from the 2012 dry season.

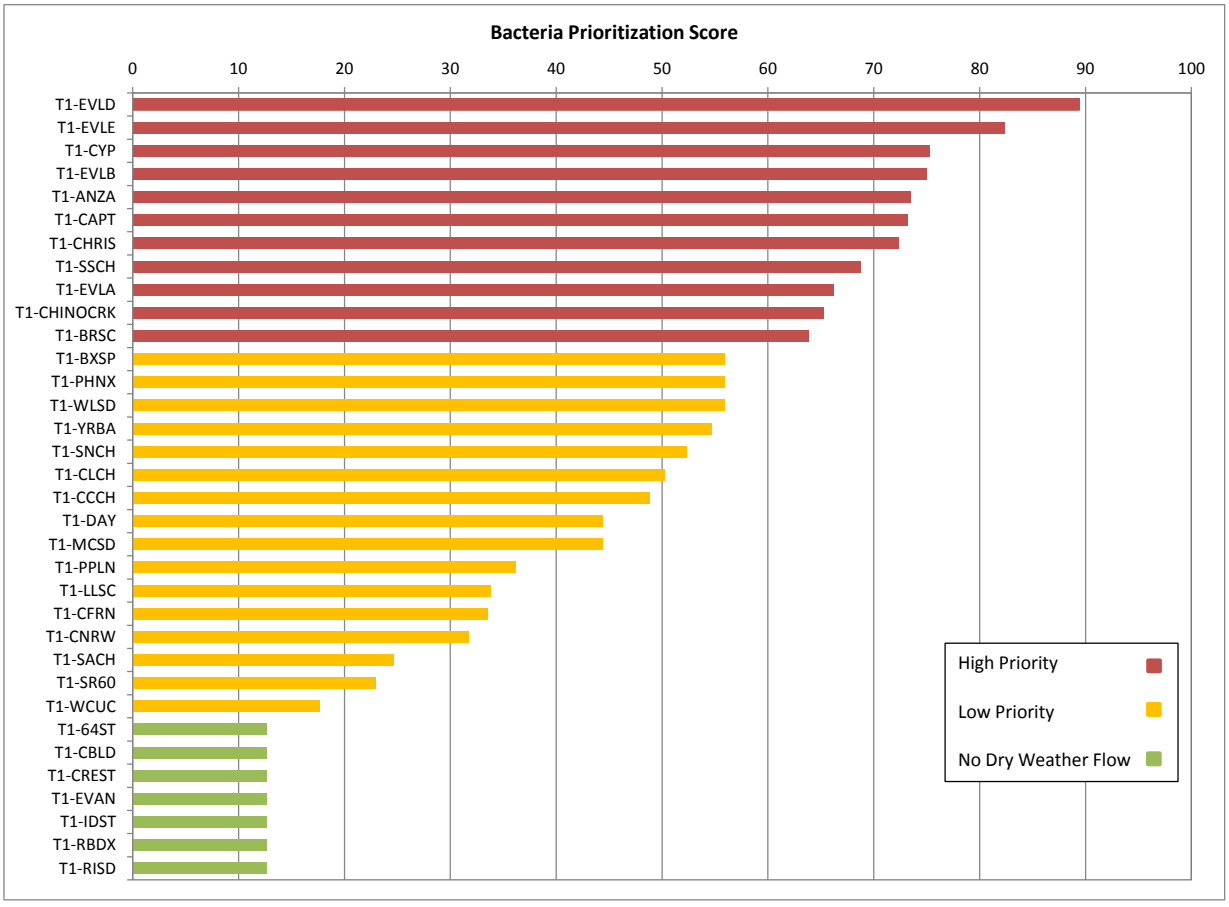

Figure 1-2
Bacteria Prioritization Score used to Prioritize Tier 1 sites for Tier 2 Source Evaluation

Table 1-1 Prioritized Tier 1 Drainage Areas for Tier 2 Source Evaluation Activities

Site ID	Jurisdictions	Drainage Acres	Human Presence	MS4 Drainage Features
T1-EVLD	Eastvale	852	30%	Storm drains
T1-EVLE	Eastvale	798	100%	Storm drains
T1-CYP	Chino, Ontario	4,952	20%	Open channel with storm drain outfalls
T1-EVLB	Eastvale	334	80%	Storm drains
T1-ANZA	Riverside	7,313	20%	Open channel with storm drain outfalls
T1-CAPT	Ontario	1,050	40%	Storm drains
T1-CHRIS	Ontario	5,774	30%	Open channel with storm drain outfalls, culverts
T1-SSCH	Jurupa Valley, Fontana	3,337	40%	Open channel with storm drain outfalls
T1-EVLA	Eastvale	498	10%	Storm drains
CHINOCRK	Pomona, Claremont	6,032	30%	Storm drains
T1-PHNX	Riverside	503	10%	Storm drains
T1-CCCH	Chino Hills	3,934	0%	Open channel with storm drain outfalls
T1-BRSCH	Chino Hills	1,160	10%	Open channel with storm drain outfalls

1.2 Tier 2 Source Evaluation Objectives

Tier 2 source evaluations were conducted within the drainage areas of high priority Tier 1 sites (see Figure 1-2). Tier 2 source evaluations focused on the stormwater networks of individual MS4 Permittees, each with unique drainage areas, DWF sources, and management challenges. Despite these differences, there were several objectives common to all MS4 Permittees, including:

- Identification of specific sources of human fecal bacteria within MS4 drainage areas that could be eliminated. In 2012, there were several Tier 1 sites with persistent detection of human *Bacteroides*. Rigorous field surveillance upstream of these sites was conducted by all Permittees and several potential sources of human bacteria were identified and mitigated.
- Segregation of smaller subareas; neighborhoods, street blocks, or in one case, individual properties, where DWF rates and bacteria is a greater concern.
- Development of supplemental source evaluation activities to reduce or eliminate controllable sources of bacteria within the MS4s.
- Characterization of urban dry weather hydrology to facilitate understanding of the potential to implement DWF controls at the subwatershed scale.

Section 2

Source Evaluation Methods in 2013 Dry Season

2.1 Monitoring Summary

2.1.1 Monitoring Locations

Tier 2 source evaluation activities took place in the drainage areas upstream of prioritized Tier1 sites (Figure 2-1). Dry weather flow samples were taken from a variety of outlets, including channels, manholes, storm drains, and culverts, within the drainage areas (Table 2-2). In total, 114 sites were monitored covering 7 cities in 3 counties. Some of the Tier 2 monitoring sites were also previously designated as Tier 1 monitoring sites; this allowed an evaluation of changes in DWF and bacterial indicators over time.

Prior to conducting Tier 2 source evaluation monitoring in 2013, MS4 Permittee staff visited the proposed sites to confirm the locations and assess the feasibility for collecting samples. In some cases, site locations were adjusted based on field reconnaissance.

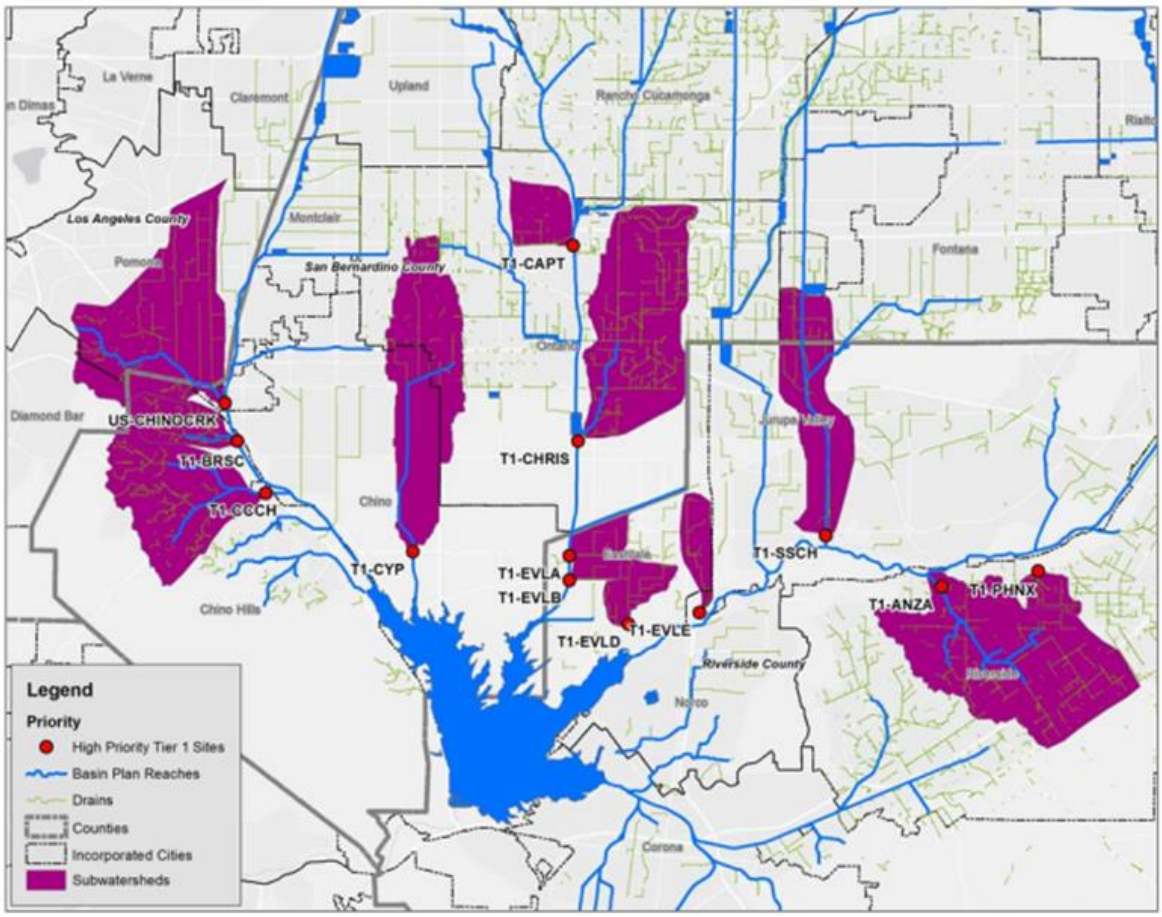

Figure 2-1
Map of Prioritized Tier 1 MS4 Drainage Areas

2.1.2 Data Collection

MS4 Permittee staff collected field measurements and water quality samples from Tier 2 sites during the 2013 dry season, approximately from May through October, in accordance with the QAPP[4]. Table 2-1 provides a summary of the number of samples collected by each jurisdiction in the 2011, 2012, and 2013 dry seasons. Generally, there were fewer Tier 1 sites when compared to Tier 2, however, during the Tier 1 effort samples collected weekly for ten consecutive weeks. In 2013, Tier 2 samples were taken from more sites; however, samples were taken less frequently, so that the total number of samples collected was not substantially different between the two efforts., Each Permittee developed a distinct approach to source evaluation in the 2013 dry season that best fit their needs. The Monitoring Plan[4] (MP) was designed be used like a toolbox from which permittees could customize their monitoring program to fill their needs., The monitoring plan enabled Permittees to implement an iterative program where they could adjust sites and sample analytes weekly, based on DWF observations and as bacterial indicator data was obtained.

Table 2-1 Tier 1 and Tier 2 Sampling Information

MSAR Bacteria TMDL Monitoring Type and Jurisdiction	Period of Record	Number of Sites	Number of Samples in Dry Season
Tier 1 Source Evaluation			
Riverside	May 2012 – July 2012	10	44
Jurupa valley	May 2012 – July 2012	3	18
Eastvale	May 2012 – July 2012	4	39
Ontario	May 2012 – July 2012	7	39
Chino	May 2012 – July 2012	4	31
Chino Hills	May 2012 – July 2012	4	25
Pomona	April 2011 – July 2011	1	10
Tier 2 Source Evaluation			
Riverside	Sept 2013 – Oct 2013	10	33
Jurupa Valley	Sept 2013 – Oct 2013	6	15
Eastvale	Sept 2013	14	42
Ontario	July 2013 – Nov 2013	32	60
Fontana	Aug 2013 – Oct 2013	4	36
Chino	Aug 2013 – Sept 2013	20	67
Chino Hills	Aug 2013 – Sept 2013	25	41
Pomona	Aug 2013 – Oct 2013	7	54

In-stream sampling consisted of grab samples collected approximately mid-stream and at the water surface where the stream appeared to be completely mixed and free from debris and algae. This condition was often difficult to achieve when sampling very low depth waters from MS4 facilities. Each Permittee developed a method to collect clean samples, ranging from the use of

[4] http://www.sawpa.org/collaboration/projects/tmdl-taskforce/

various scoop devices with sterile water sampling bags to having confined space certified staff climb down manholes to collect samples.

Water samples were collected first before conducting any field measurements, including flow, to ensure measurements were representative of water chemistry and quality from time of collection. Site water quality measurements included the collection of field parameter data (where feasible) and water samples for laboratory analysis. Water samples were collected from the upstream side, preserved, stored, and transported as specified by protocol and chain of custody requirements.

Where field measurements were feasible, they included flow, temperature, conductivity, pH, dissolved oxygen, and turbidity. These constituents were measured on site at the time of sampling using YSI or equivalent multi-parameter meters. Additionally, some Permittees chose to field measure ammonia, potassium chlorine, copper, and surfactant/detergent using Hach Company test strips or equivalent.

Water samples were collected for submittal to Orange County Public Health Laboratory for *E. coli* analysis. A subset of water samples was also analyzed by Orange County Water District (OCWD) for the presence/absence of the human *Bacteroides* marker. The Cities of Chino Hills, Chino, and Fontana also sent samples to Source Molecular in Florida for assessment of fecal sources.

Additional information regarding sample collection methods and requirements is available in the MP and the QAPP.

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Section3
Summary of Results

3.1 Common Characteristics

Several findings were common for all of the drainage areas where Tier 2 source evaluations were conducted in the 2013 dry season, as described below. These findings are considered representative of urban subwatersheds in southern California. A finding common to all drainage areas evaluated was that irrigation excess runoff is the predominant source of DWF.

3.1.1 Exceedance of TMDL WLA

Analysis of average *E. coli* concentrations of all Tier 2 samples collected in each MS4 drainage area to prioritized Tier 1 sites showed bacteria levels exceeding WLA (Figures 3-1, 3-2). Some drainage areas had much greater average *E. coli* concentrations than others, such as shown for Tier 2 samples upstream of the T1-CAPT site. This information can be useful for Permittees when deciding where to allocate resources for locating controllable sources of bacterial indicators.

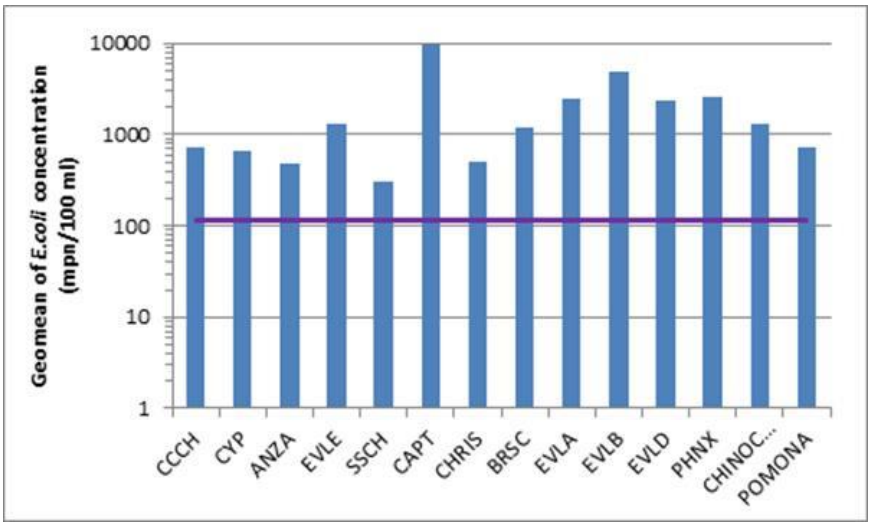

Figure 3-1
***E. coli* Concentration in Tier 2 Source Evaluation Monitoring Sites**

3.1.2 Bacteria Growth/Decay in MS4 Systems

One very important finding for stormwater program managers was the change in bacterial indicator concentrations from the upstream Tier 2 sites to the associated downstream Tier 1 site. A significant reduction of bacterial indicator concentrations was observed in subwatersheds where there is a segment of open channel prior to reaching the downstream Tier 1 site. Figure 3-2 illustrates this water quality improvement with the red diamonds showing the *E. coli* concentration at the Tier 1 site and the box/whisker characterizing the range of *E. coli* concentrations for upstream Tier 2 sites. The box and whisker plots on the left side of the chart are for subwatersheds with an open channel segment. The reduction of *E. coli* was observed in Carbon Canyon Creek Channel (CCCH), Cypress Channel (CYP), Anza Drain, and Eastvale Line E (EVLE) subwatersheds. This information can be useful

for Stormwater program managers, as it can present options for potential future BMP deployments where results from focused source evaluations do not locate a controllable source of impairment.

Conversely, for MS4s that are entirely underground (on right side of the chart in Figure 3-2), the Tier 1 site concentration generally falls within the range of upstream Tier 2 concentrations. In some subwatersheds, a higher concentration at the Tier 1 site relative to the range of upstream Tier 2 concentrations may point to an additional source of bacteria from within the MS4 facilities, such as wildlife, transient camps, or re-growth in biofilms where dark, warm, and damp conditions may create a habitat for bacteria. This could be the case in the MS4 networks upstream of the Boys Republic South Channel (BRSC), Lower Deer Creek (CHRIS), Eastvale Line D (EVLD), and Pomona Storm Drain Tier 1 sites.

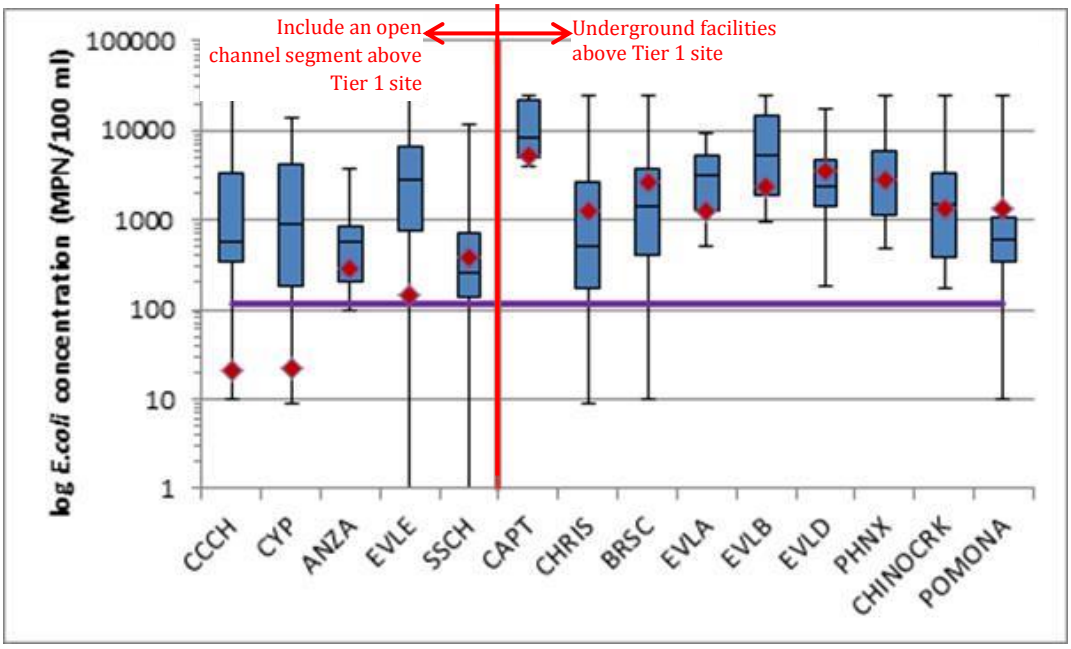

Figure 3-2
Box-Whisker Plot of *E. coli* Concentrations at Tier 2 Source Evaluation Monitoring Sites that Drain to a Downstream Tier 1 Site (Red Diamond Shows *E. coli* Concentration at Downstream Tier 1 Site)

3.1.3 Property Specific Influences

Bacterial indicator concentrations from the Tier 2 source evaluation sites were extremely variable with samples ranging from non-detect to greater than 24,000 MPN/100 mL *E. coli*. This finding was true, even when evaluating weekly samples collected from the same site and at similar times of day. One hypothesis that may explain this extreme variability in results is the differences among individual properties in the quantity and quality of irrigation excess runoff. Unlike rainfall driven runoff, where rain is spread across the entire watershed, the primary source of DWF in an urban catchment at any given point in time is outdoor water use by a subset of properties.

Numerous factors impact which property(ies) would be creating offsite runoff at the time a downstream sample is collected, including irrigation schedules, irrigation system efficiency, and timing of other outdoor water uses, which are a function of the day to day routine of each resident at

each property. Data from the Residential Runoff Reduction (R3) Study by Irvine Ranch Water District (IRWD) and Metropolitan Water District of Orange County (MWDOC) shows that DWF from residential neighborhoods occurs at varying times of day, based on varying irrigation schedules of upstream properties (A & N Technical Services, 2006[5]).

The presence of DWF over extended period of time means that not all properties create irrigation excess runoff at the exact same time. Accordingly, a sample taken at any given time downstream of a residential neighborhood is likely only representative of the properties that were actively generating offsite runoff prior to the sample collection. Figure 3-3 shows an example of a field visit in the City of Chino, where DWF inputs to the MS4 is clearly generated from just one of three potential street gutters. In fact, it is likely that only a few properties caused the DWF shown in the photograph.

In routine site visits at a given street inlet, properties generating downstream DWF will likely be different, and the spatial variability of property specific bacteria water quality then translates into the extreme fluctuation in results between site visits. In other words, samples from the same site may be representative of completely different contributing subareas. The randomness in the timing of peak *E. coli* concentrations was particularly evident in data collected from City of Pomona Tier 2 monitoring sites, as described in Section 3.3.8 below.

Figure 3-3
Frequency of Detection of Human *Bacteroides* in Tier 2 Source Evaluation Monitoring Sites (photo taken by Ruben Valdez)

[5] A & N Technical Services, 2006. Commercial ET-Based Irrigation Controller Water Savings Study, prepared for Irvine Ranch Water District and US Bureau of Reclamation.

3.1.4 Reduction in Human Detections

The human *Bacteroides* marker was evaluated in a subset of Tier 2 DWF samples. Only one Tier 2 site had more than one detection of human *Bacteroides*; T2-GARY in the City of Pomona. Other sites had one-detection, including the Peyton drain in the BRSC subwatershed, the Tier 1 site EVLB and Tier 2 sites within the drainage areas to Eastvale Lines D and E. Results from analysis for human *Bacteroides* was not completed until the end of the 2013 dry season. The data regarding these instances was used to design focused source assessments to take place in 2014 dry season. Overall, the frequency of *Bacteroides* presence has decreased from the initial USEP studies conducted in 2007-2008 and the Tier 1 source evaluation. This line of evidence suggests that mitigation activities conducted in 2013-14 have been successful at eliminating controllable sources of Bacterial Indicators in some subareas (Figure 3-4).

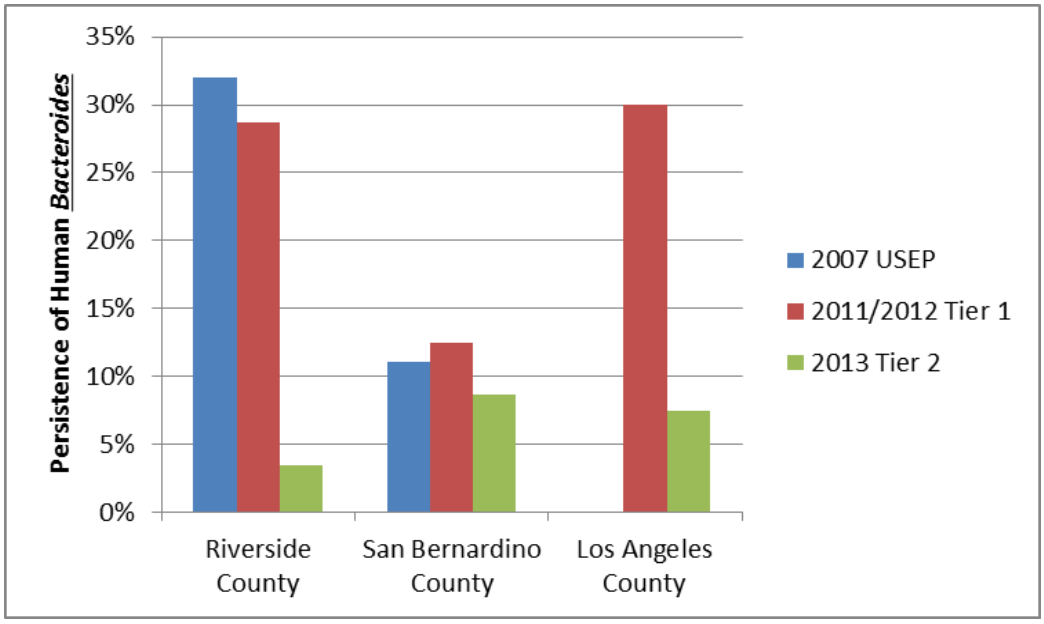

Figure 3-4
Change in Persistence of Human *Bacteroides* by County from 2007 to 2013 (Note that there are no data for Lo Angeles County In 2007; not an absence of *Bacteroides*)

3.2 MS4 Permittee Specific Analysis

The following sections briefly summarize MSAR Permittee-specific findings that were not necessarily common to the overall watershed. For each Permittee, sample sites are shown on a map overlying the MS4 network, field observations of DWF are described, monitoring results are summarized for *E. coli* and *Bacteroides*, and key findings are discussed.

3.2.1 Eastvale

All four Tier 1 MS4 drainage areas in the City of Eastvale were prioritized for Tier 2 source assessment based on the results of the 2012 Tier 1 source evaluation. The 2013 Tier 2 source evaluation sampling in the City of Eastvale was conducted over four events; on September 3rd, 19th, 23rd, and 30th. Prior to the sample collection events, a desktop survey was conducted to map out the layout of the MS4 system. The MS4 system layout was used to determine possible sampling locations within the

drainage areas which would yield information to help the Permittees locate any potential controllable sources of Bacterial Indicators. Once sample locations were selected based on the desktop survey, field surveys were conducted to verify the accessibility of proposed sampling locations and to determine how far up the MS4 system dry weather flows occurred. This helped to eliminate some areas from further assessment. The criteria used to exclude areas for further assessment was that if the manhole downstream of a drainage area was observed to be dry after two visits, it was assumed to not require additional follow up. Furthermore, these field surveys helped to identify some potential sources of bacterial indicators. For example at the upper end of the Eastvale Line E drainage area there is an area where day laborers congregated near a Home Depot located at the corner of Hamner Avenue and Limonite Avenue in the City of Eastvale. This area drew attention because just upstream of this particular location there is a drop inlet which connects to Eastvale Line E. The drop inlet was constructed so that it was located approximately 3 feet below the surrounding surface. It was speculated that due to the lack of lavatory facilities nearby, this below grade drop inlet could potentially be used as a makeshift restroom facility. During Tier 1 source assessments, Eastvale Line E was a facility where the *Bacteroides* showed a human signal in every one of the ten samples analyzed. With this information, the City of Eastvale code enforcement efforts were directed at this area to enforce anti-loitering statues.

Sample sites included collection of bacterial water quality samples at the downstream Tier 1 sites as was conducted in the 2012 monitoring program; two within the Mill-Cucamonga Creek watershed (EVLA and EVLB) and two in the Santa Ana River watershed (EVLD and EVLE). Upstream of these Tier 1 sites, the City of Eastvale also collected DWF samples for bacterial water quality analysis at 10 Tier 2 sites, as shown in Figure 3-5 below. Tier 2 site names included reference to the downstream Tier 1 site (ex. Site T2-EVLB34 is within the T1-EVLB subwatershed), with two to three Tier 2 sites located within each of the Tier 1 subwatersheds. Samples were collected from entirely underground collection systems, except for the T1-EVLE site which is collected from within an open concrete lined channel.

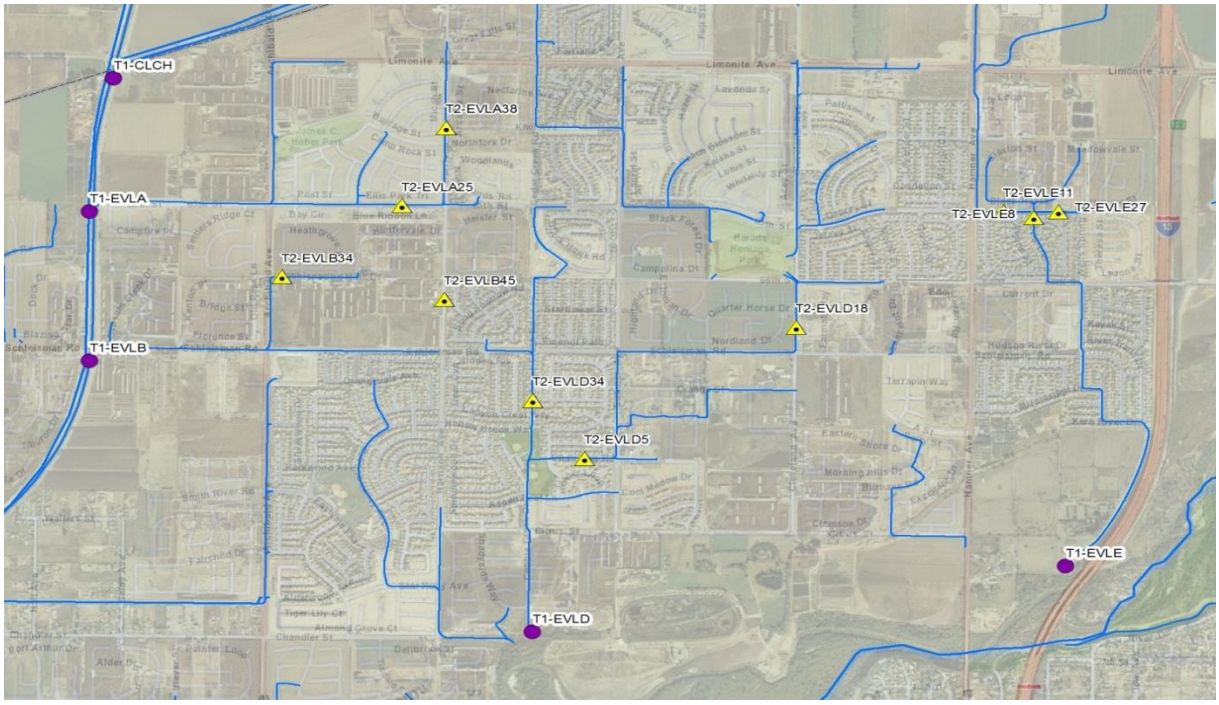

Figure 3-5
Map of Bacteria Source Evaluation Monitoring Sites in the City of Eastvale

Individual sample results for *E. coli* concentration are reported in Table 3-1 Three detections were found of the 35 samples analyzed for human *Bacteroides*, as noted in Table 3-1. The geometric mean of each site is shown in Figure 3-6, with the Tier 1 sites shown in green on the left side of the chart and the Tier 2 sites shown in blue on the right side of the chart.

Table 3-1 Grab Sample Results for City of Eastvale Tier 2 Source Evaluation in the 2013 Dry Season

Site	*E. coli* Concentration (MPN/100mL)			
	9/3/13	9/19/13	9/23/13	9/30/13
T1-EVLA	520	722	4,352	1,450
T2-EVLA25	CNS	CNS	7,701	9,208
T2-EVLA38	CNS	CNS	2,014	4,352
T1-EVLB	1,376 *	2,142	12,033	960
T2-EVLB34	CNS	24,196	2,098	8,664
T2-EVLB45	CNS	CNS	24,196	CNS
T1-EVLD	10,462	4,611	2,359	1,439
T2-EVLD18	2,187	4,106	CNS	CNS
T2-EVLD34	17,329 *	1,553	CNS	181
T2-EVLD5	4,884	2,909	959	650
T1-EVLE	6,488	754	84	1
T2-EVLE11	CNS	4,106	2,755	7,270
T2-EVLE27	CNS	4,884	650	CNS
T2-EVLE8	24,196 *	9,804	880	1,153

* Indicates samples that had a positive detection of human *Bacteroides*

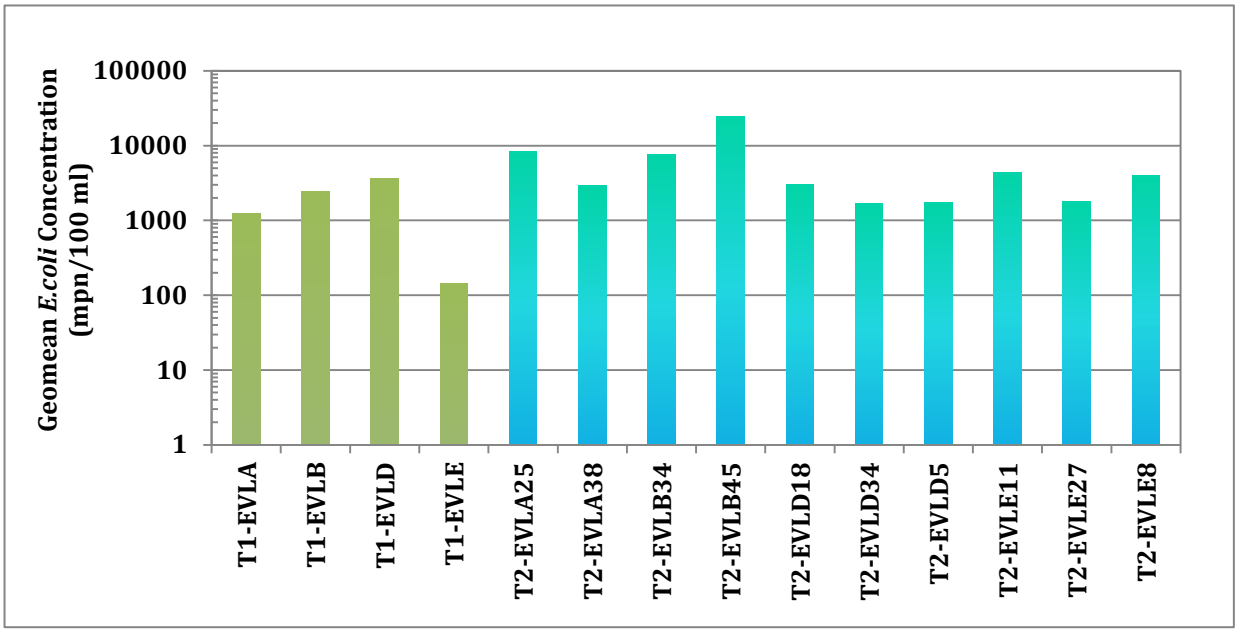

Figure 3-6
Geomean of *E. coli* Concentrations in City of Eastvale's Tier 2 Source Evaluations

Key findings from the City of Eastvale's Tier 2 bacteria source evaluation in the 2013 dry season are discussed below:

- The most significant observation from the Tier 2 source evaluation in the City of Eastvale was the detection of human *Bacteroides* at three Tier 2 sites on September 3, 2013, each in a different MS4 drainage area (Eastvale Lines B, D, and E). None of the other 41 samples analyzed for *Bacteroides* in the City of Eastvale in 2013 had a human *Bacteroides* detection. This is a sharp

decline from samples collected during the 2012 dry season, Tier 1 source assessments were positive detections were found in 10, 30, 80, and 100 percent of samples from site T1-EVLA, EVLD, EVLB, and EVLE, respectively. The detections that did occur were all along or just downstream of Schleismann Avenue (which transects the entire City), and all occurred on September 3, which was the Tuesday after Labor Day weekend. Thus, it is possible these detections are related, despite being in separate drainages, but no potential source has been identified. These results were not available prior to the conclusion of the 2013 dry season, therefore additional source assessments will take place in the 2014 dry season to locate and eliminate these potential controllable sources. Moreover, if the potential sources cannot be located, the Permittees are currently evaluating potential BMPs such as proprietary fiber rolls infused with a bacteria reducing agent and/or diversions to infiltration galleries.

- For T1-EVLE, samples taken during the same day at the downstream Tier 1 location had bacterial concentrations that were on average, three times lower than from the underground MS4 network. This finding suggests that bacteria decay from exposure to ultraviolet light in the daylighted open channel segment of Eastvale Line E, may play a significant role in bacteria concentrations. This revelation can potentially be used in the future as a possible solution to eliminate controllable sources of bacterial Indicators.

3.2.2 Riverside

Two MS4 drainage areas in the City of Riverside were prioritized based on the results of the 2012 Tier 1 source evaluation; Anza and Phoenix Drains. The 2013 Tier 2 source evaluation in the City of Riverside was conducted over four events; on September 5th, 10th, 24th, and October 1st. Prior to the sample collection events, a desktop survey was conducted to map out the layout of the MS4 system. The MS4 system layout was used to determine possible sampling locations within the drainage areas which would yield information to help the Permittees locate any potential controllable sources of Bacterial Indicators. Once sample locations were selected based on the desktop survey, field surveys were conducted to verify the accessibility of proposed sampling locations and to determine how far up the MS4 system dry weather flows occurred. This helped to eliminate some areas from further assessment. The criteria used to exclude areas for further assessment was that if the manhole downstream of a drainage area was observed to be dry after two visits, it was assumed to not require additional follow up.

Sample sites included collection of bacterial water quality samples at the same Tier 1 sites as was conducted in the 2012 monitoring program, T1-ANZA and T1-PHNX, both of which discharge DWF to the MSAR. Upstream of these Tier 1 sites, the City of Riverside also collected DWF samples for bacterial water quality analysis at 8 Tier 2 sites, as shown in Figure 3-7 below. Tier 2 site names included reference to the downstream Tier 1 site (ex. Site T2-ANZA 10 is within the T1-ANZA subwatershed). Six and two Tier 2 sites are located within the MS4 drainage areas to the T1-ANZA and T1-PHNX subwatersheds, respectively. Samples sites included a mix of underground collection systems (manholes) and open concrete lined channels.

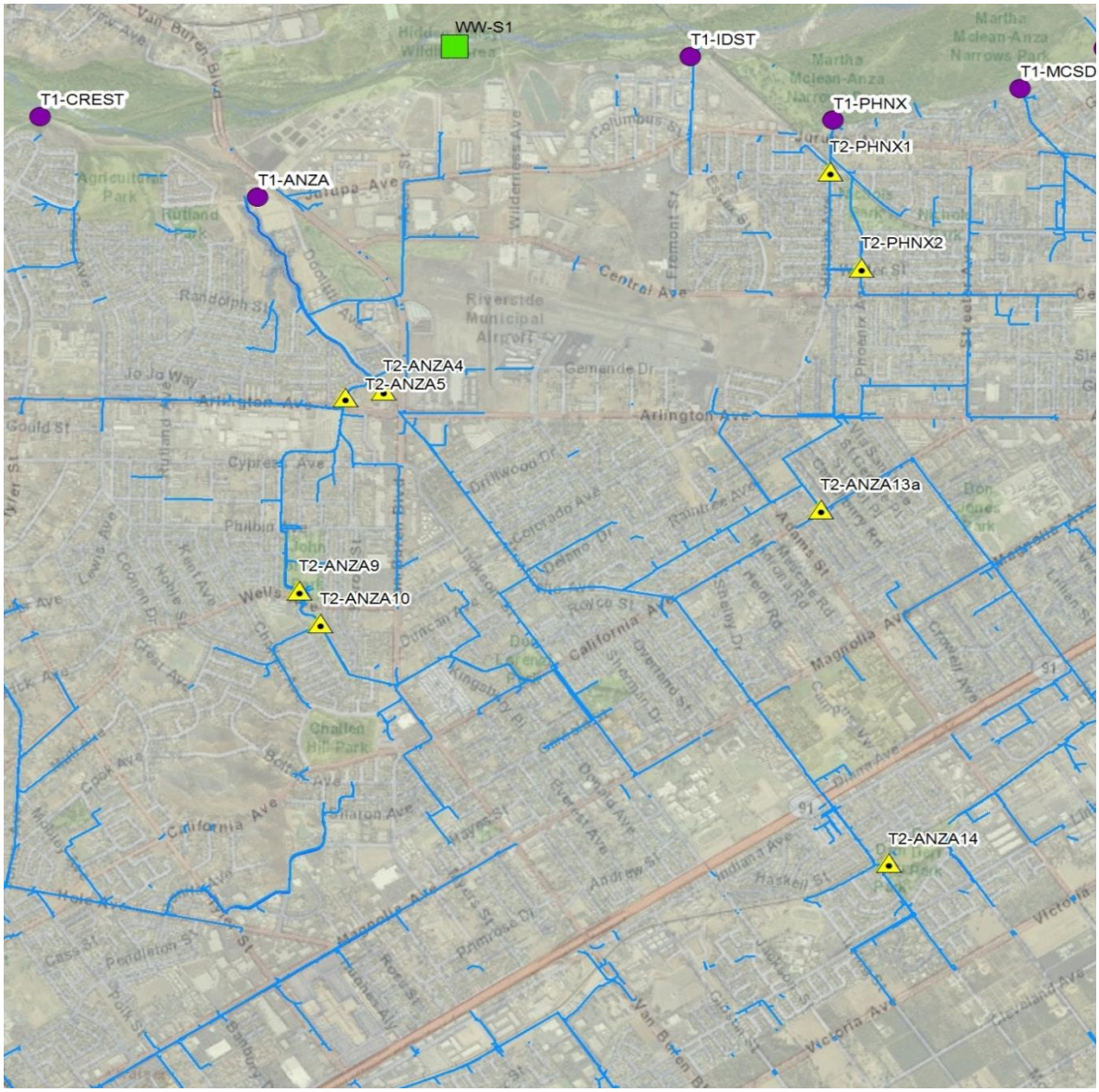

Figure 3-7
Map of Bacteria Source Evaluation Monitoring Sites in the City of Riverside

During the source assessment efforts in the drainage area to Anza channel, an area of interest as a source of dry weather flow was the Arlington Greenbelt Area which is situated upstream of the MS4 network from portions of the City of Riverside. This agricultural region is comprised primarily of citrus groves. Roughly half of the citrus groves employ furrow irrigation methods, which involve completely filling of furrows between rows of citrus trees with water. In order to ensure that downstream end of the furrows are completely filled, there is an unavoidable volume of excess irrigation water that becomes DWF. Irrigation excess is then discharged to street gutters or roadside ditches (Figures 3-7 and 3-8). About half of the Arlington Greenbelt Area is within the Anza Drain subwatershed to the MSAR. Specifically, DWF from this portion of the Arlington Greenbelt Area is all routed to Don Derr Park or the Jefferson Street storm drain, both of which outfall to Monroe Channel. The City of Riverside collected bacterial indicator samples at Don Derr Park at site

T2-ANZA 14 and Jefferson Street storm drain at T2-ANZA13a (Figure 3-7). Field observations noted a relatively high rate of DWF at these sites despite their position on the MS4 network. Don Derr Park is a dual use basin. during storm events it used as a flood control basin to capture large volumes of storm water and then slowly release storm water, during periods of dry weather the basin bottom is used as a sports field. The City of Riverside, working together with the Riverside County Flood Control & Water Conservation District (District), has begun preliminary designs to infiltrate the dry weather flows from the upstream citrus groves as they enter the park. The remaining portion of the Arlington Greenbelt Area drains westward to Arlington Channel and ultimately Temescal Wash (not currently on 303(d) list of impaired waters for bacterial indicators).

Figure 3-8
Photo of DWF from use of Furrow Irrigation in the City of Riverside Arlington Greenbelt Area

Individual sample results for *E. coli* concentration are reported in Table 3-2 There were no detections (n=32) of human *Bacteroides*. The geometric mean of each site is shown in Figure 3-9, with the Tier 1 sites shown in green on the left side of the chart and the Tier 2 sites shown in blue on the right side of the chart.

Table 3-2 Grab Sample Results for City of Riverside Tier 2 Source Evaluation in the 2013 Dry Season

Site	*E. coli* Concentration (MPN/100mL)			
	9/5/13	9/10/13	9/24/14	10/1/13
T1-ANZA	185	175	313	605
T2-ANZA4	288	602	3,654	1,336
T2-ANZA5	697	414	591	530
T2-ANZA9	1,354	670	907	213
T2-ANZA13a	121	97	135	
T2-ANZA14	860	399	1,354	98
T1-PHNX	5,794	3,873	1,106	2,755
T2-PHNX1	1,576	480		24,196
T2-PHNX2	7,270	480		

* No positive detection of human *Bacteroides* were found in Riverside's MS4

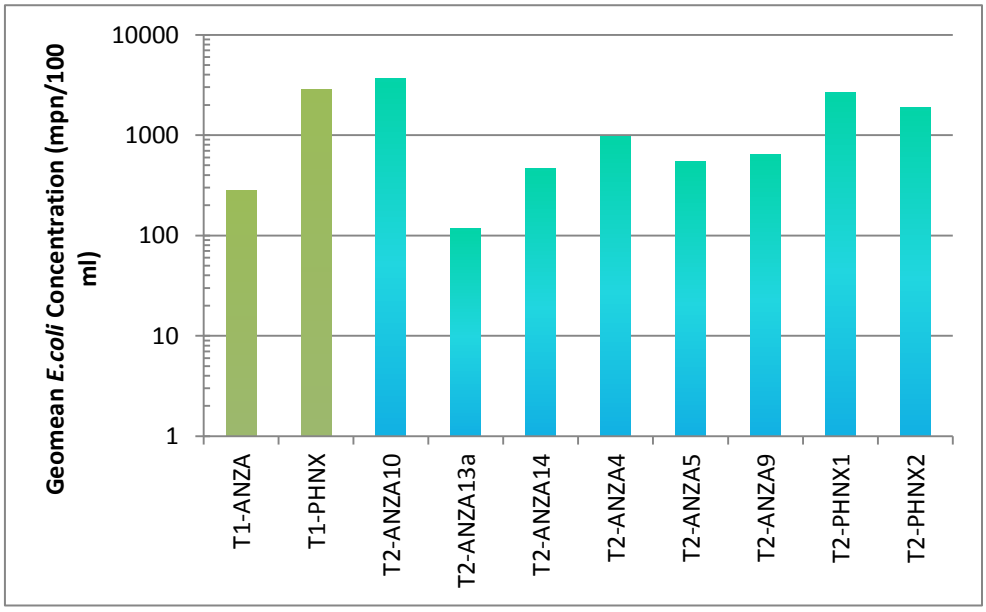

Figure 3-9
Geomean of *E. coli* Concentrations in Riverside's Tier 2 Source Evaluation

Key findings from the City of Riverside's Tier 2 bacteria source evaluation in the 2013 dry season are discussed below:

- Each Tier 2 site had at least one sample with concentrations greater than 7,000 mpn/100ml; however, results were generally higher in the Phoenix Storm Drain subwatershed area than in the Anza Channel sub watershed. The amount of DWF observed at the outfall of Phoenix Storm Drain is small. As a result, In the 2014 dry season the City of Riverside and the District will work together to perform further source assessments to find and eliminate any potential controllable sources of Bacterial Indicators. Moreover, due to the small amount of flow present

during dry weather the feasibility of a potential project to divert dry weather flows to the sanitary sewer is being evaluated.

- The Anza Drain subwatershed is one of the largest MS4s where source evaluation was performed in the 2013 dry season. This drainage area has two distinct subareas; upstream of the Tier 2 sites T2-ANZA4 (Monroe Channel) and T2-ANZA5 (Anza Drain past John Bryant Park). *E. coli* concentrations at T2-ANZA5 were fairly consistent, with a relatively narrow range of approximately 400-700 mpn/100ml. Conversely, *E. coli* in the Monroe Channel tributary was highly variable, ranging from approximately 300-3,700 mpn/100ml. Bacterial quality at the downstream Tier 1 site (T1-ANZA) was mostly influenced by changes in *E. coli* and flow in the Monroe Channel subarea. This finding makes sense since there are high volumes of DWF discharged into this portion of Riverside's MS4 from a combination of urban DWF, rising groundwater, and irrigation excess runoff from citrus groves in the Arlington Greenbelt Area. During the fourth and final sampling event on October 1, 2013, there was no DWF present at T2-ANZA13a. During this event, concentrations of *E. coli* at the Tier 1 site downstream doubled from approximately 300 mpn/100ml to 600 mpn/100ml, which could be caused by removing the dilution achieved during the first three events (*E. coli* concentration at T2 ANZA13a ranged from 97-135 mpn/100ml in first three events). As mentioned earlier at the other major drainage area to Monroe Channel (Monroe Basin/Don Derr park), preliminary design is underway to retrofit the basin to infiltrate dry weather flows.

3.2.3 Jurupa Valley

The entire San Sevaine subwatershed was prioritized based on the results of the 2012 Tier 1 source evaluation. This subwatershed includes jurisdictional areas in both the Cities of Jurupa Valley and Fontana. This section presents the findings from Tier 2 source evaluation conducted in the 2013 dry season by the City of Jurupa Valley and the District Staff (see Section 3.2.7 for the City of Fontana data summary and analysis). The 2013 Tier 2 source evaluation in the City of Jurupa Valley was conducted over four events; on September 5th, 10th, 24th, and October 1st. Preliminary work in the office and in the field was done to choose sample locations which would provide information to aid in locating and eliminating controllable sources of Bacterial Indicators (see description of desktop and field surveys in sections on Eastvale and Jurupa Valley above).

Sample sites included collection of bacterial water quality samples at the same Tier 1 site as was conducted in the 2012 monitoring program, T1-SSCH. Upstream of the Tier 1 site, the City of Jurupa Valley also collected DWF samples for bacterial water quality analysis at six Tier 2 sites, as shown in Figure 3-10 below. Tier 2 site names included reference to the downstream Tier 1 site (ex. Site T2-SSCH12 is within the T1-SSCH subwatershed). Samples sites included a mix of outfalls from underground collection systems (T2-SSCH10 and T2-SSCH12) and from within the open concrete lined segment of San Sevaine Channel at points upstream from the Tier 1 site (T2 SSCH1, T2-SSCH8a, T2-SSCH11). Tier 2 sites within the City of Fontana (T2-SSM-C, T2-SSM A, T2-PHSS, and T2-PHMB) are also shown in Figure 3-E and discussed in Section 3.2.7.

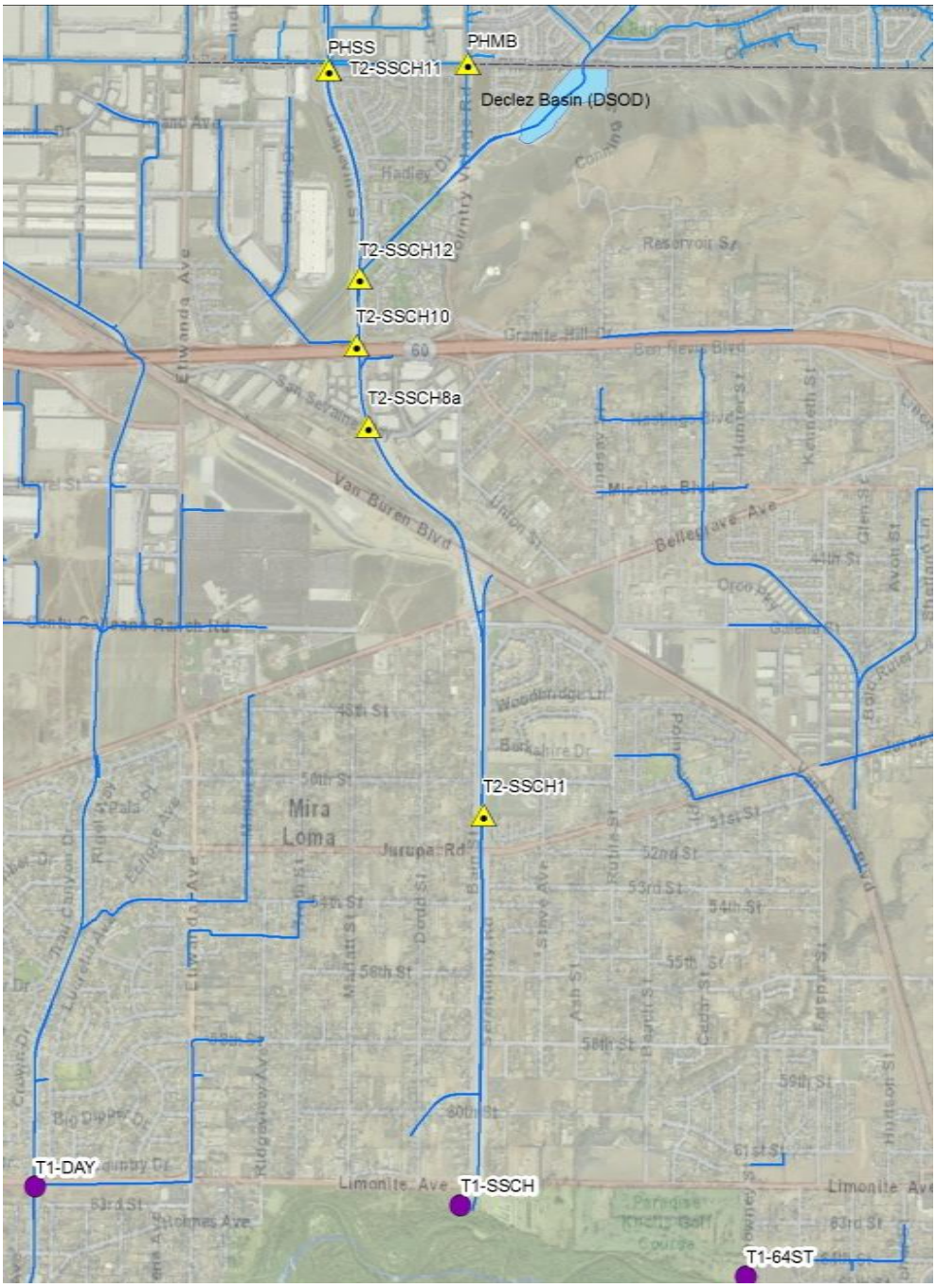

Figure 3-10
Map of Bacteria Source Evaluation Monitoring Sites in the City of Jurupa

Most of the DWF from the San Sevaine Channel subwatershed is captured and recharged in the Jurupa or Declez Basins in the southern part of the City of Fontana. The Jurupa Basin captures DWF from the upper mainstem of San Sevaine Channel, and Declez Basin captures DWF from Declez Channel. Declez Channel continues for one mile downstream of Declez Basin through the City of Jurupa Valley before the confluence with San Sevaine Channel. San Sevaine Channel then routes DWF in a large trapezoidal concrete lined channel for over three miles to the MSAR.

Individual sample results for *E. coli* concentration are reported in Table 3-3. There were no detections (n=14) of human *Bacteroides*. The geometric mean of each site is shown in Figure 3-11, with the Tier 1 site shown in green on the left side of the chart and the Tier 2 sites shown in blue on the right side of the chart.

Table 3-3 Grab Sample Results for City of Jurupa Valley Tier 2 Source Evaluation in the 2013 Dry Season

Site	*E. coli* Concentration (MPN/100mL)			
	9/5/13	9/10/13	9/24/14	10/1/13
T1-SSCH	1,515	84	384	437
T2-SSCH1	CNS	CNS	CNS	134
T2-SSCH8a	1	256	CNS	CNS
T2-SSCH10	CNS	CNS	CNS	CNS
T2-SSCH11	181	110	538	169
T2-SSCH12	3,441	10,462	2,510	1,723

* No positive detection of human *Bacteroides* were found in Jurupa Valley's MS4

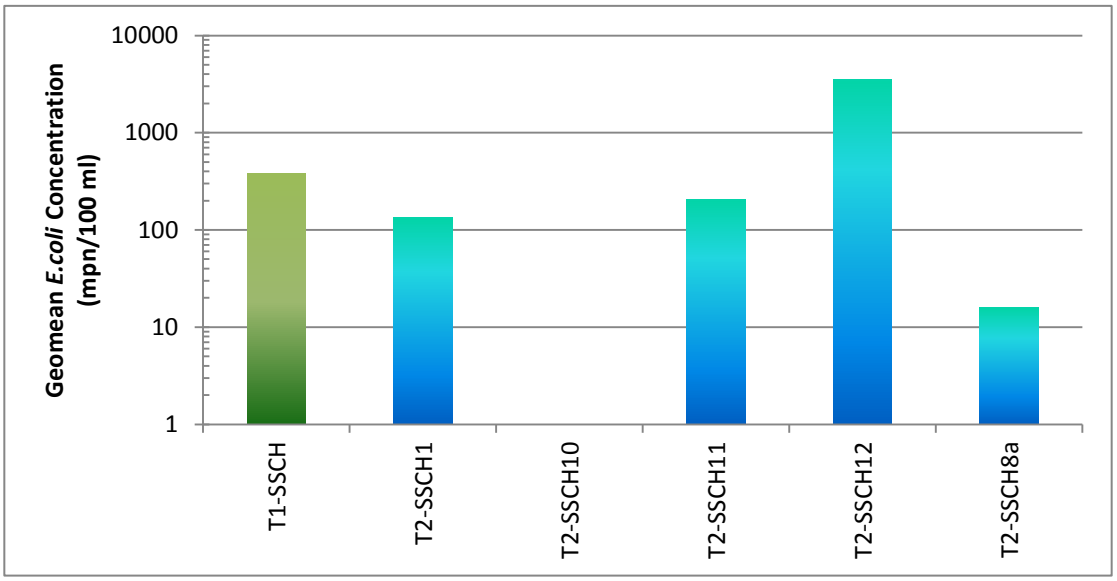

Figure 3-11
Geomean of *E. coli* Concentrations in Jurupa Valley's Tier 2 Source Evaluation

Key findings from the City of Jurupa Valley's Tier 2 bacteria source evaluation in the 2013 dry season are discussed below:

- Both Fontana (T2-PHSS) and Jurupa Valley (T2-SSCH11) collected samples in San Sevaine Channel at the county boundary. Taken together the geomean of *E. coli* in San Sevaine Channel leaving San Bernardino County and entering Riverside County was 133 mpn/100ml, which is relatively close to the WLA.
- DWF at the Declez Channel outfall to San Sevaine Channel (T2-SSCH12) had consistently high bacteria concentrations over the four monitoring events, which suggests there may be a

persistent source in the subarea to this site. The drainage area within the City of Jurupa Valley to Declez Channel (site T2-SSCH12), downstream of the Declez Basin, is relatively small and is made up of 3 residential neighborhoods. The City of Jurupa Valley in partnership with the District is developing a plan to conduct supplemental Tier 2 source evaluation in this area during the 2014 dry season. Moreover the City of Jurupa Valley and the District are evaluating the possibility of repurposing an abandoned basin downstream of this area for the purposes of infiltrating dry weather flows.

3.2.4 Chino Hills

Two subwatersheds, Boys Republic South Channel (BRSC) and Carbon Canyon Creek Channel (CCCH), within the City of Chino Hills were identified as high priority for bacterial water quality and therefore the City conducted Tier 2 source evaluations in these drainage areas in the 2013 dry season. The 2013 Tier 2 source evaluation in the City of Chino Hills was conducted in ten weeks over a period of roughly three months beginning on August 2, 2013, and extending through
October 25, 2013. Sample sites included collection of bacterial water quality samples at the same Tier 1 sites as was conducted in the 2012 monitoring program, T1-BRSC and T1-CCCH. Upstream of the Tier 1 site, the City of Chino Hills also collected DWF samples for bacterial water quality analysis at 14 Tier 2 sites in the BRSC subwatershed and nine Tier 2 sites in the CCCH subwatershed, as shown in Figure 3-12 below. Tier 2 site names are generally arranged alphabetically in order of downstream to upstream. (Sites T2-CH-B through T2-CH-M in the BRSC subwatershed; T2-CH-O through T2-CH-T in the CCCH subwatershed). Subscripts and superscripts to sites were employed to represent samples of DWF from different connections at the same manhole junction.

Most of the MS4 in the City of Chino Hills is underground, except for the downstream segment of CCCH. Both the CCCH and BRSC have open space areas upstream of the MS4 that are drained by natural channels. Additionally, both drainages receive some inputs from natural groundwater springs.

Individual sample results for *E. coli* concentration are reported in Table 3-4. The geometric mean of each site is shown in Figure 3-13, with the Tier 1 site shown in green on the left side of the chart and the Tier 2 sites shown in blue on the right side of the chart. Chino Hills also sent samples to OCWD (n=7) and Source Molecular Inc. (n=8) for molecular source tracking analysis. The samples sent for microbial source tracking represented distinct events, and did not allow for laboratory comparison. One of eight samples analyzed by Source Molecular detected human sourced fecal bacteria at the downstream end of the Peyton box culvert above the confluence with the Grand Avenue culvert on October 25, 2013. In addition, dogs were found to be persistent, detected in 7 of 8 samples analyzed by Source Molecular for dog markers. No human *Bacteroides* was detected in the samples analyzed by OCWD.

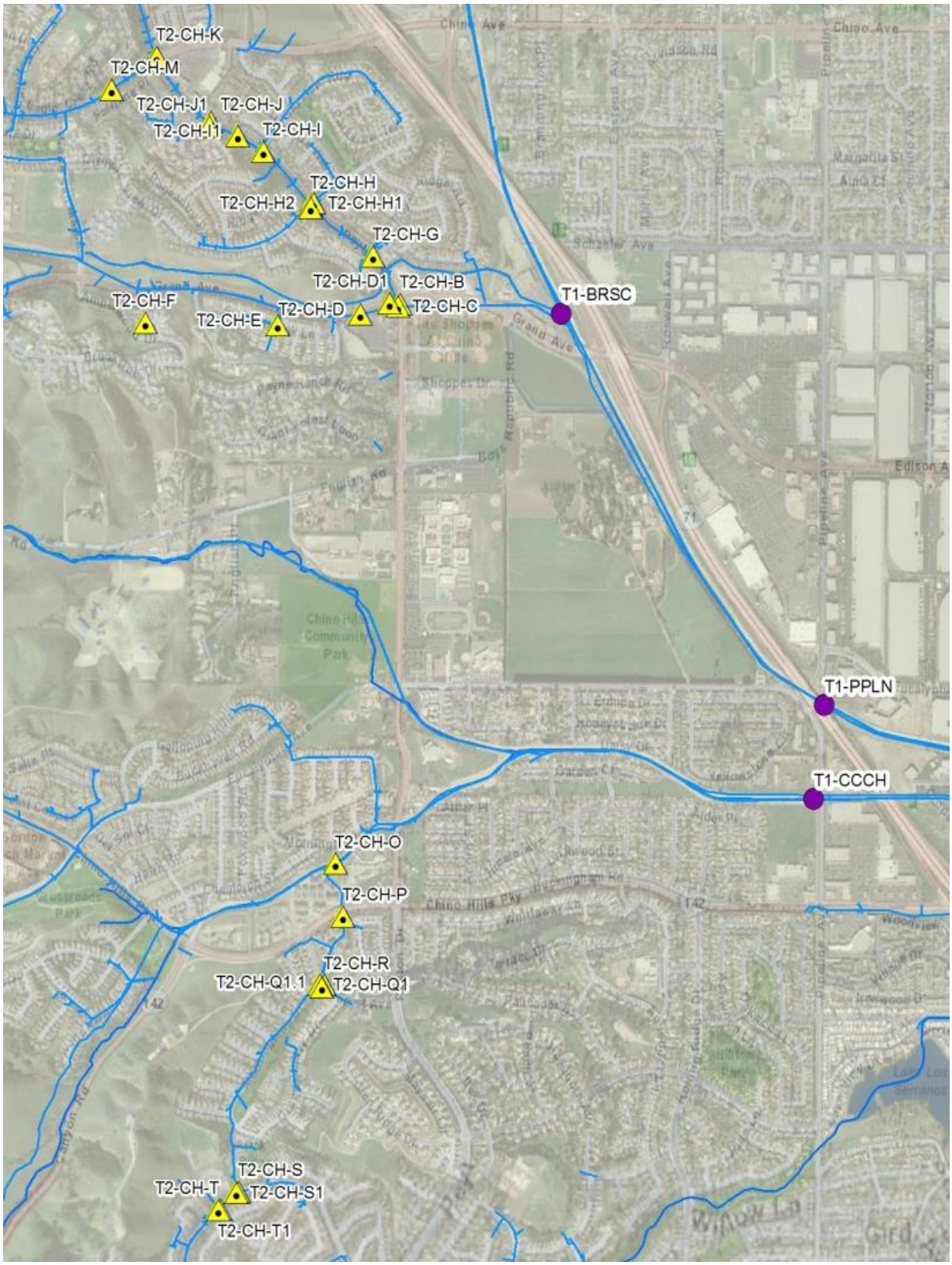

Figure 3-12
Map of Bacteria Source Evaluation Monitoring Sites in the City of Chino Hills

Table 3-4 Grab Sample Results for City of Chino Hills Tier 2 Source Evaluation in the 2013 Dry Season

Site	*E. coli* Concentration (MPN/100mL)						*Bacteroides* detections	
	8/1/13	8/8/13	8/15/13	8/22/13	9/5/13	9/26/13	10/4/13	10/25/13
T1-BRSC				1,600	5,200 [1]	2,400	Dog	
T2-CH-B	1,100	20,000	24,000					Human, Dog
T2-CH-C	270	450	6,100				Dog	Dog
T2-CH-D								
T2-CH-D1	460							
T2-CH-E				3,900				
T2-CH-F				2,300				
T2-CH-G				2,050				
T2-CH-H			7,500	300				
T2-CH-H1	160		1,200					
T2-CH-I				1,000				
T2-CH-I1			230					
T2-CH-J		10						
T2-CH-J1		380						
T2-CH-M			3,400					
T1-CCCH				10	10 [1]	86		Dog
T2-CH-O				3,100			Dog	Dog
T2-CH-P			8,200					
T2-CH-Q	500	320	16,000	1,500		2,600		
T2-CH-Q1	3,400							
T2-CH-Q1.1						41		
T2-CH-R		560	590	9,200				
T2-CH-S	500							
T2-CH-S1	24,000							

1) Ammonia detected in sample from T1-BRSC at 0.12 mg/L and at T1-CCCH at 0.86. All other samples were non-detect for ammonia

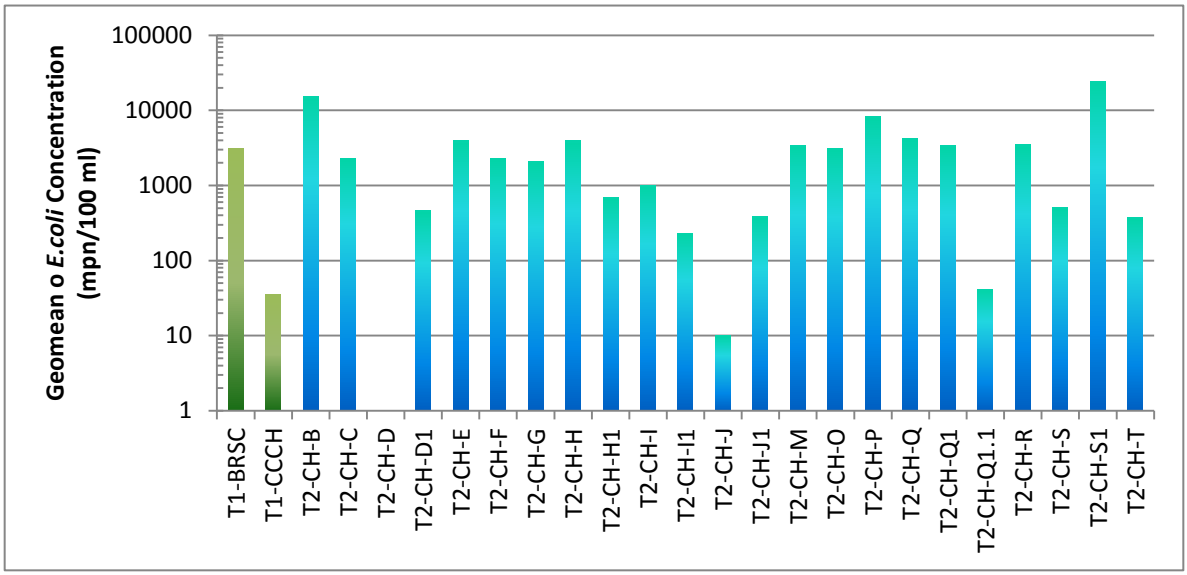

Figure 3-13
Geomean of *E. coli* Concentrations in Chino Hills

Key findings from the City of Chino Hills Tier 2 bacteria source evaluation in the 2013 dry season are discussed below:

- Review of the bacterial indicator results did not suggest the presence of any single subareas that would be a greater concern to downstream bacterial 6water quality. Instead, Chino Hills identified a subwatershed-wide condition of high bacteria levels that vary significantly from week to week, which led to the interpretation discussed previously regarding property level influences in bacterial water quality of DWF in MS4s (see Section 3.1.3).
- In the Carbon Canyon Creek Channel subwatershed, samples were collected from multiple Tier 2 sites in the underground portion of the Chino Hills MS4 upstream of the open channel segment. Data was also collected at the downstream Tier 1 site. These samples corroborated data interpretations from previous years, which suggested that natural decay, treatment, and/or channel bottom recharge processes in this roughly one mile stretch of open channel provide significant bacteria removal. One unique feature of this channel is the presence of rock check dams that impound flow in shallow pools (Figure 3-14).

Figure 3-14
Photo of Unlined Segment of Carbon Canyon Creek Channel

3.2.5 Chino

The City of Chino conducted a rigorous source investigation in the Cypress Creek subwatershed in the 2013 dry season based on findings of elevated *E. coli* concentrations and multiple detections of human *Bacteroides* at the Tier 1 site in 2012. Sample sites included collection of bacterial water quality samples at the same Tier 1 site (T1-CYP) as was conducted in the 2012 monitoring program. Upstream of the Tier 1 site, the City of Chino collected samples from stations within the MS4 network, moving sites weekly to progressively track potential sources from the outfalls to laterals to street gutters and ultimately to individual property scale (Figure 3-14). Samples collected from street gutters are shown as orange triangles in Figure 3-15. Figure 3-16 shows how the types of facilities sampled changed weekly over ten consecutive weeks of the 2013 dry season.

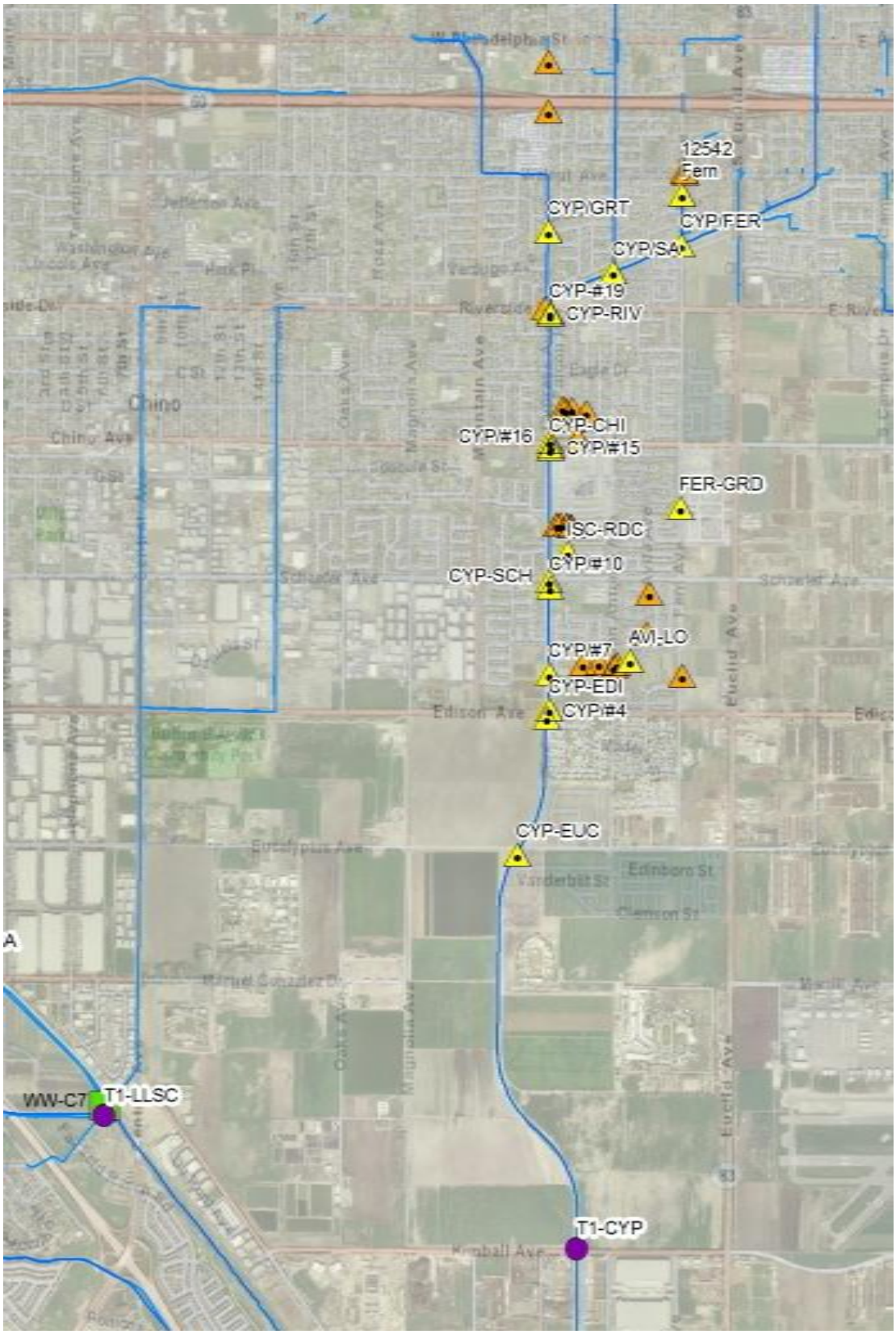

Figure 3-15
Map of Bacteria Source Evaluation Monitoring Sites in the City of Chino

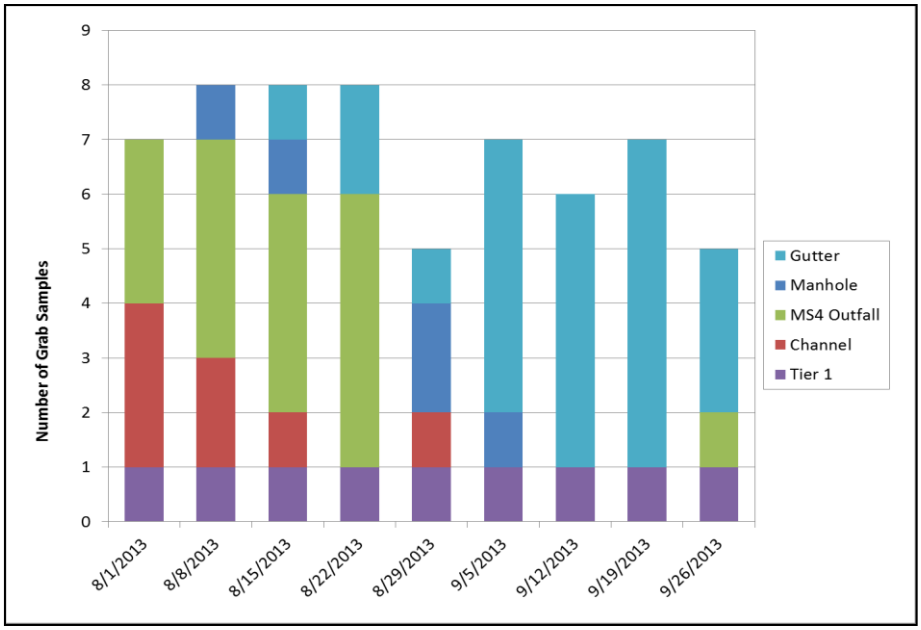

Figure 3-16
Weekly Distribution of Sampled Facility Types in the 2013 Dry Season

Individual sample results for *E. coli* concentration are reported in Table 3-5. The geometric mean of each site is shown in Figure 3-17, with the Tier 1 site shown in green on the left side of the chart and the Tier 2 sites shown in blue on the right side of the chart. Chino also sent three samples from street gutters (on Lunt Court, Potomac Drive, and Edam Street) collected on October 9, 2013 to Source Molecular Inc. for molecular source tracking analysis. There was no detection of human *Bacteroides* and one of the three samples was detected for the dog marker (Potomac Drive).

Key findings from the City of Chino Tier 2 bacteria source evaluation in the 2013 dry season are discussed below:

- *E. coli* concentration at the downstream Tier 1 site met WQOs for all 10 weeks of the monitoring program in 2013, which is different from the significant exceedances observed in the 2012 dry season. Similarly, no human *Bacteroides* was detected in 2013, which is a significant water quality improvement from the 2012 dry season when 3 of 10 samples had a human *Bacteroides* detection. The improvement of bacterial water quality in Cypress Channel may be the result of stormwater program implementation and IC/ID activities. Another potential explanation of the bacterial water quality improvements is in-stream processes. As DWF passed through the open channel segment of Cypress Channel, between Eucalyptus Avenue and Kimball Avenue. Samples from Tier 2 sites, all upstream of Eucalyptus Avenue, had a geometric mean of 1500 mpn/100mL over the course of the dry season versus 18 mpn/100mL at downstream Tier 1 site. Natural decay by ultraviolet light exposure or channel bottom recharge in the unlined segment extending for ½ mile upstream from the Tier 1 site, may be the primary mechanisms providing for significant bacteria reductions. This same channel segment may not have provided the same removal effectiveness in 2012 because of maintenance activities that had removed most vegetation from Cypress Channel prior to the 2012 dry season. The channel bottom was completely re-vegetated prior to the 2013 dry season.

Table 3-5 Grab Sample Results for City of Chino Tier 2 Source Evaluation in the 2013 Dry Season

Site	*E. coli* Concentration (MPN/100mL)									
	8/1/13	8/8/13	8/15/13	8/22/13	8/29/13	9/5/13	9/12/13	9/19/13	9/26/13	10/3/13
T1-CYP	41	52	10	10	10	10	10	52	20	63
T2-AVI-LO						620				
T2-CHI	7,700									24,000
T2-CYP10			6,100	2,100						
T2-CYP15		4,100		4,400					11,000	
T2-CYP16			680							
T2-CYP19	600	880	220	20						990
T2-CYP4			2,100	3,900						
T2-CYP7				2,400						
T2-EDI	2,400									5,200
T2-EUC										6,500
T2-GIRD					1,200					
T2-ISC					5,800					
T2-RIV	2,600	203	270		1,200					150
T2-SA	620	390								
T2-SCH										6,100
T2-FERN	7,300	2,500								
T2-GRT		10								
T2-CURB Sites										
13223 ROBIN							4,900			
6513-LU									730	
6525-LU								24,000		
6531-PO									24,000	
6545-Poto										
6549-LU							24,000	24,000		
6609-PINON									540	
CHI-ROS		8,700		8,700				20,000		
Cyp-N60	120		120							
CYP-S60						350				
FER-CP						550				
FERN-CRK								230		
FER-WAL							1,300			
MAN/AVL					270					
NW-CYP/RIV		3,300		3,300						
OL-PI								4,100		
PA-AV							480			
RDC-L.E.						360				
RDC-L.W.						4,600				
RO-PO								24,000		
ROS-ORG						170				
SA-ED										
SA-ED.NE							2,800			
13223 ROBIN							4,900			
6513-LU									730	
6525-LU								24,000		
6531-PO									24,000	
6545-Poto										
6549-LU							24,000	24,000		

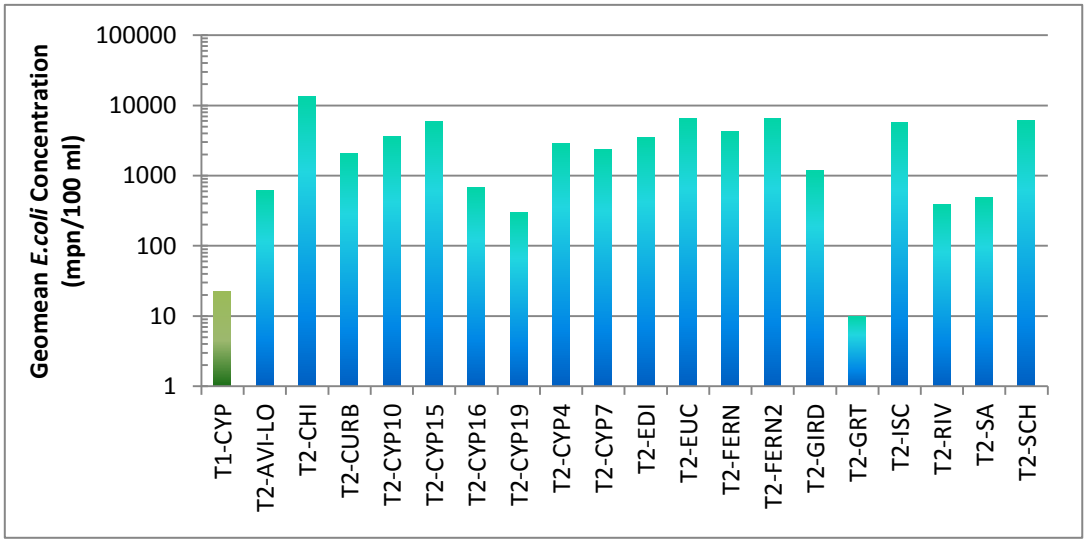

Figure 3-17
Geomean of *E. coli* Concentrations in Chino

- The approach taken by the City of Chino in the 2013 dry season, involving tracking bacteria from downstream to upstream by changing sites each week, effectively identified a specific property of concern on Lunt Court, where bacteria levels in street gutter samples showed a marked increase relative to samples from upstream. The effort expended to identify this property on Lunt Court would be difficult to implement for a larger watershed, especially if such properties are abundant. Instead, this finding has led the City of Chino, in conjunction with the City of Chino Hills, to embark upon a randomized bacterial water quality monitoring study of residential property scale irrigation excess DWFs. The objectives of the study are to determine the proportion of properties which generate high bacterial indicator concentrations, and to assess the unique features of such properties to guide watershed management approaches.
- During the 2013 dry season source evaluation in the Cypress Creek MS4 drainage area, the City also performed reconnaissance surveys of open channels within several neighborhoods, and identified multiple instances of illegal dumping that may have caused or contributed to high bacterial indicator concentrations in the MS4. The City performed outreach for each property where illegal dumping was identified and follow up surveillance has confirmed that the problems have been resolved

3.2.6 Ontario

The City of Ontario performed Tier 2 source evaluations in drainage areas upstream of three prioritized Tier 1 subwatersheds; T1-CAPT, T1-CYP, and T1-CHRIS. The City of Ontario collected 62 *E. coli* samples during the 2013 dry season from these drainage areas with 3, 6, and 30 sites within each subwatershed, in the order listed above (Figure 3-18). Sampling was also conducted at the same Tier 1 sites as was conducted in the 2012 monitoring program. Samples sites included a mix of underground collection systems (manholes) and open concrete lined channels. The 2013 Tier 2 source evaluation in the City of Ontario was conducted in 11 events over a 14 week period from July 30, 2013 to November 6, 2013.

The T1-CAPT subwatershed is a small MS4 system (less than 1,000 acre drainage area) west of Cucamonga Creek and just north of Ontario Airport. The MS4 is entirely underground in this area of the City of Ontario. The outfall to Cucamonga Creek is equipped with a large flap gate that is open enough to allow for a trickle of DWF to be discharged, but also creates a condition of trash accumulation within the pipe prior to the outfall. Tier 2 sites in the City of Ontario within the Cypress Creek subwatershed are from entirely underground MS4 systems that are conveyed into the City of Chino MS4. The Lower Deer Creek subwatershed (toT1-CHRIS) has the largest drainage area of all the prioritized Tier 1 sites in the MSAR watershed. The MS4 network in predominantly underground, except for the downstream segment of Lower Deer Creek from Hwy 60 to Chris Basin.

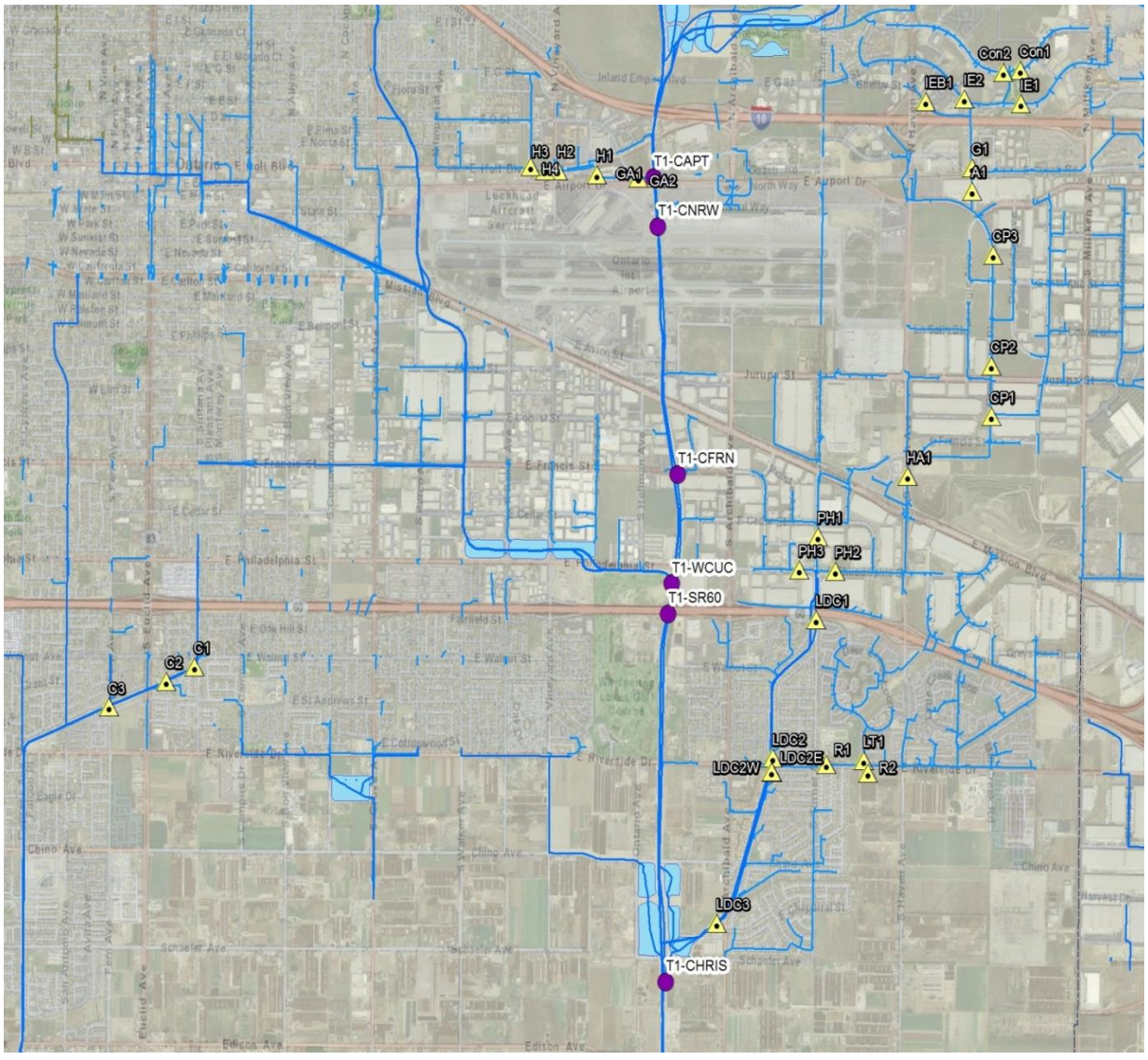

Figure 3-18
Map of Bacteria Source Evaluation Monitoring Sites in the City of Ontario

Individual sample results for *E. coli* concentration are reported in Table 3-6. The geometric mean of each site is shown in Figure 3-19, with the Tier 1 site shown in green on the left side of the chart and the Tier 2 sites shown in blue on the right side of the chart. Ontario did not collect samples for molecular source tracking analysis in the 2013 dry season.

Table 3-6 Grab Sample Results for City of Ontario Tier 2 Source Evaluation in the 2013 Dry Season

Site	*E. coli* Concentration (MPN/100mL)										
	7/30/2013	8/8/2013	8/15/2013	8/30/2013	9/12/2013	9/19/2013	9/24/2013	9/25/2013	10/9/2013	10/17/2013	11/6/2013
T1-CAPT	24,001										
T1-CHRIS		410		4,100							
T2-A1							510			24,001	
T2-C1	640		690	430	1,100						
T2-C2	160	360									
T2-C3			2,700	560	9						
T2-CP1						990		220			
T2-CP2								210			
T2-CP3								270	10,000		
T2-G1									16,000		41
T2-GA2		24,001	3,900								
T2-H1		4,400	4,100	9,200	6,500						
T2-H2					7,700						
T2-H3						17,000					
T2-H4						24,001					
T2-HA1						2,500					
T2-IE1									670		
T2-IEB1										24,001	9
T2-LDC1	340		240	1,300	580						
T2-LDC2	9	9	9	330							
T2-LDC2E					2,600			1,300	2,600		
T2-LDC2W					9			130			
T2-LDC3	31	130	9	24,001							
T2-LT1										24,001	
T2-PH1				370							
T2-PH2		170		920		2,600					
T2-PH3		8,700		220							
T2-R1									3,100		
T2-R2										680	

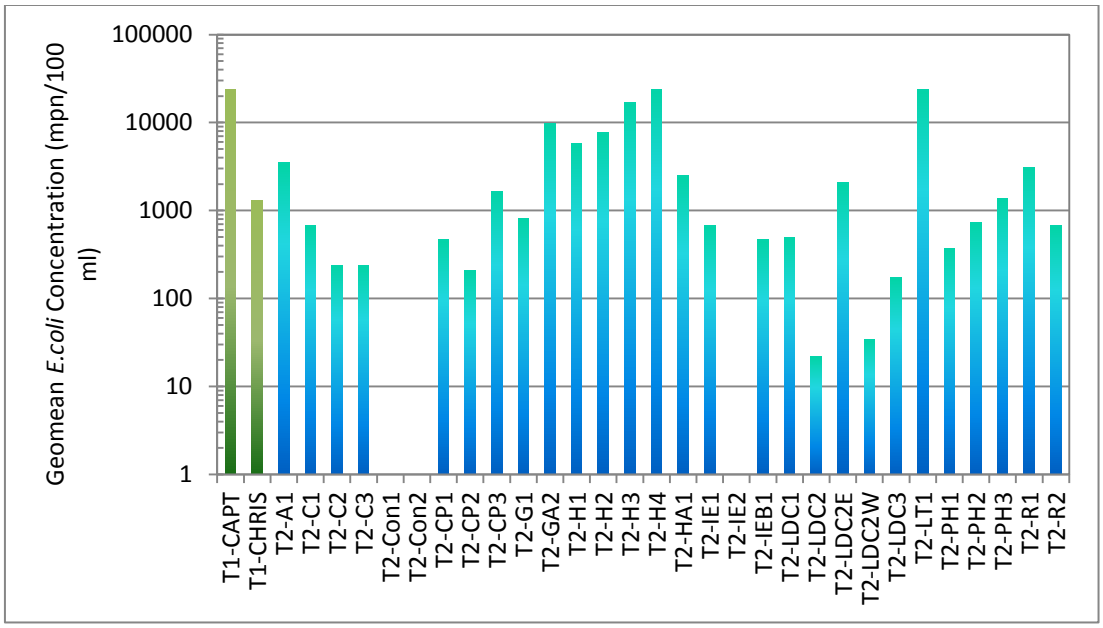

Figure 3-19
Geomean of *E. coli* Concentrations in Ontario

Key findings from the City of Ontario Tier 2 bacteria source evaluation in the 2013 dry season are discussed below:

- The Lower Deer Creek subwatershed (to T1-CHRIS) has the largest drainage area of all the prioritized Tier 1 sites. Samples collected from this subwatershed were extremely variable. City staff observed very high DWF rates at T2-IEB1 that goes through the parking lot of the Ontario Airport Hotel. *E. coli* samples collected at this site as well as in other downstream Tier 2 sites exceeded 10,000 mpn/100ml in samples collected on October 9 and 17 of 2013; however, concentrations were less than 50 on this same portion of the MS4 on November 6, 2013. Human *Bacteroides* was not detected in three samples analyzed by OCWD from the Lower Deer Creek subwatershed on October 9, 2013.
- Another area of concern in the Lower Deer Creek subwatershed was just downstream of the Creekside neighborhood, where *E. coli* concentrations were consistently over 1,000 mpn/100ml. The City identified a MS4 facility in this area that has not been cleaned in many years and has accumulated a substantial amount of debris. The City is currently developing a plan to clean this potential source of bacteria from its MS4.
- The T1-CAPT MS4 drainage area in particular had the highest geomean of *E. coli* concentration of all drainage areas monitored in the 2013 dry season. All 10 samples from this drainage area, collected from six different sites over six weeks, exceeded 3900 mpn/100ml

3.2.7 Fontana

The City of Fontana performed Tier 2 source evaluations in a small portion of the southwest corner of its MS4 network that is not captured and recharged in either the Jurupa or Declez basins (approximate drainage area of 1,500 acres). This drainage area is entirely within the San Sevaine Channel subwatershed (Figure 3-20). Samples were collected at the Tier 1 sites by the City of Jurupa Valley (see Section 3.2.3). The 2013 Tier 2 source evaluation in the City of Fontana was conducted at four

sites over nine weeks. Two of the sites were taken from outfalls on the west and east side of San Sevaine Channel from laterals on Marlay Avenue; T2-SSM-A and T2-SSM-C, respectively, one was taken from a manhole along Philadelphia Avenue on the east side of San Sevaine Channel; T2-PHMB, and one was taken from within San Sevaine Channel at the county boundary (T2-PHSS).

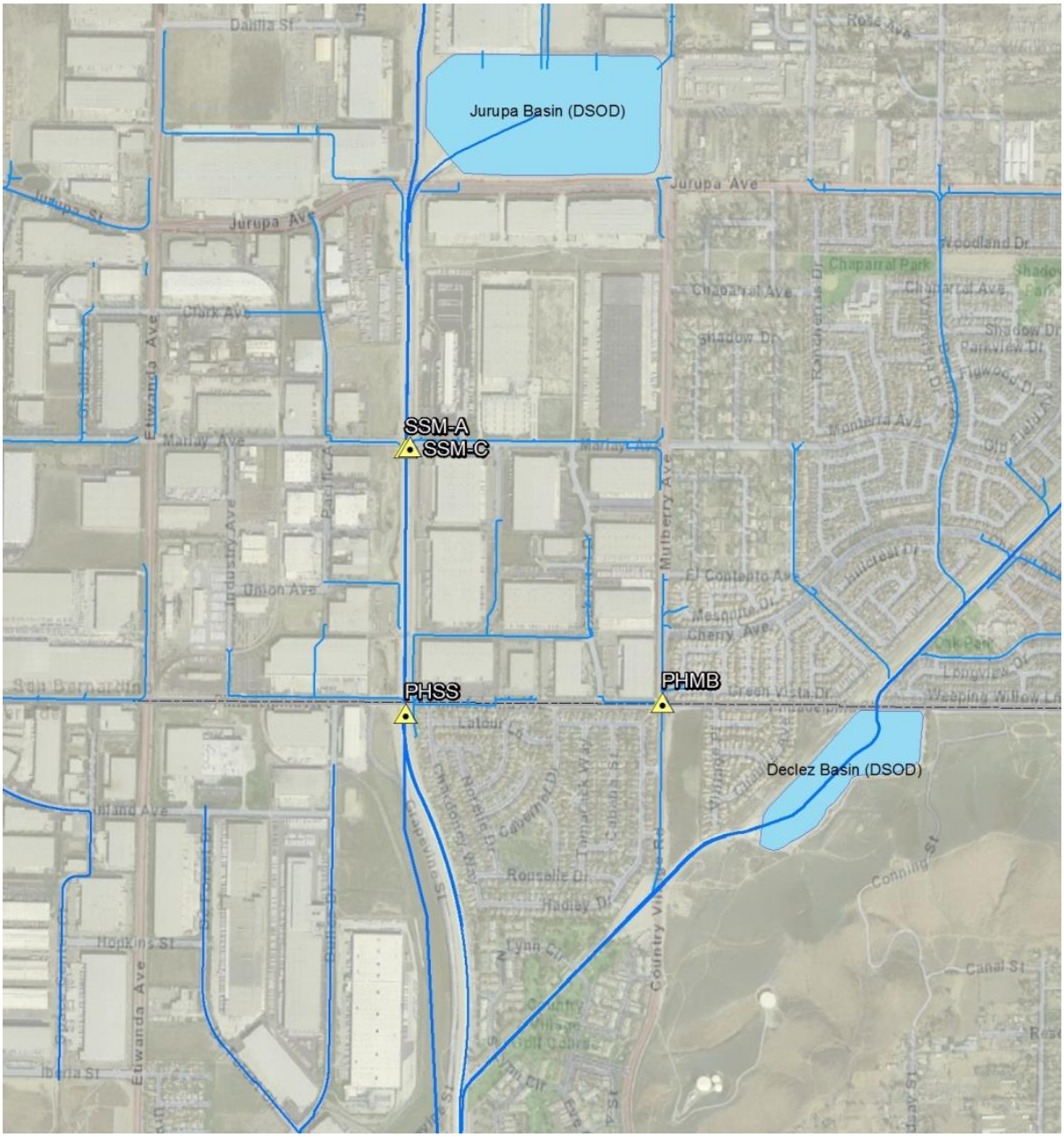

Figure 3-20
Map of Bacteria Source Evaluation Monitoring Sites in the City of Fontana

Individual sample results for *E. coli* concentration are reported in Table 3-7. The geometric mean of each site is shown in Figure 3-21, with the Tier 1 site shown in green on the left side of the chart (computed from data collected by the City of Jurupa Valley) and the Tier 2 sites shown in blue on the right side of the chart. Samples from the final sampling event on October 2, 2013 were sent to Source

Molecular for source tracking. No evidence of any cows, birds, dogs, horses, chickens, or other ruminant animals was found in the samples.

Table 3-7 Grab Sample Results for City of Fontana Tier 2 Source Evaluation in the 2013 Dry Season

Site	*E. coli* Concentration (MPN/100mL)								
	8/1/13	8/8/13	8/15/13	8/22/13	8/29/13	9/5/13	9/12/13	9/19/13	10/2/13
T2-PHMB	590	190	690	960	84	240	170	230	4,600
T2-PHSS	230	170	570	300	41	10	41	150	12,000
T2-SSM-A	CNS	CNS	CNS	3,300	720	63	110	120	CNS
T2-SSM-C	CNS	CNS	2,000	170	580	1,100	380	10	450

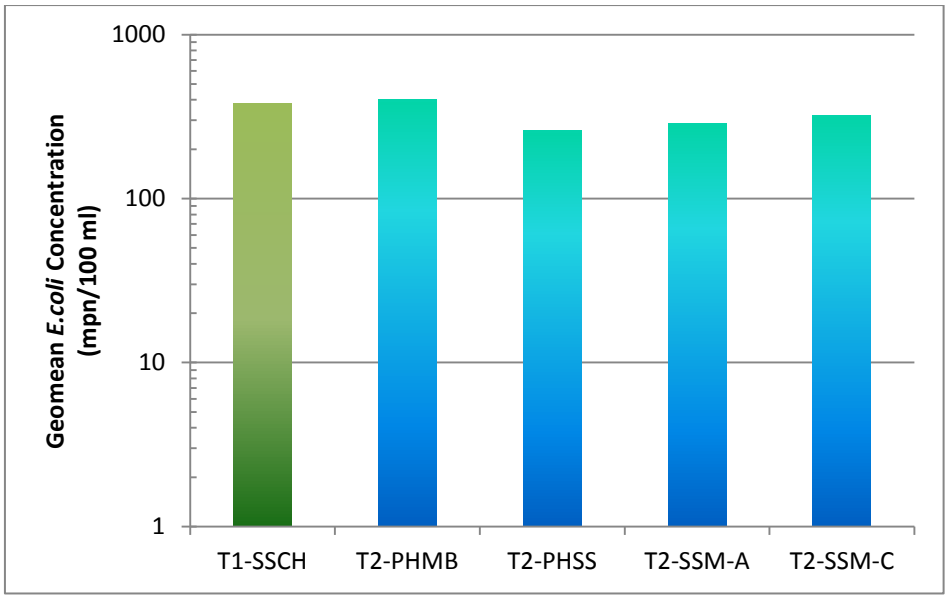

Figure 3-21
Geomean of *E. coli* Concentrations in Fontana

Key findings from the City of Fontana Tier 2 bacteria source evaluation in the 2013 dry season are discussed below:

- Both Fontana (T2-PHSS) and Jurupa Valley (T2-SSCH11) collected samples in San Sevaine Channel at the county boundary. Taken together the geomean of *E. coli* in San Sevaine Channel leaving San Bernardino County and entering Riverside County was 133 mpn/100ml, which is very close to the WLA. Additionally, longitudinal sampling along San Sevaine Channel within Riverside County suggests the presence of another source of bacteria between Jurupa Valley's most downstream MS4 outfall at Bellegrave Ave and the Tier 1 site at the Santa Ana River (see Section 3.2.2 above).

3.3.8 Pomona & Claremont

The Cities of Pomona and Claremont represent the Los Angeles County jurisdictional areas within the MSAR watershed. Monitoring by these cities in 2011-2013 was conducted prior to the adoption of

their respective CBRPs. The Cities implemented monitoring within Chino Creek just upstream of San Antonio Chanel (T1-CHINOCRK) in the 2011 dry season, which was categorized as a Tier 1 site in the CBRP implementation report (CDM Smith, 2013). This data was the basis for being included in the subset of prioritized MS4 drainage areas for Tier 2 source evaluation. During the 2012 dry season, Pomona continued to collect samples, but within San Antonio Channel downstream of Brooks Basin. In 2013, these cities joined forces with the rest of the Task Force to participate in a rigorous Tier 2 source evaluation.

For the City of Pomona, most of its MS4 network within the MSAR watershed fell into a high priority drainage area, which led to the strategic selection of Tier 2 sites at manholes where generally north-south stormdrains discharge into the underground box culvert segment of Chino Creek, which runs west to east and daylights just before reaching the Tier 1 site (Figure 3-22). Instead of increasing the number of sites to reduce upstream drainage areas for source evaluation, the cities opted to increase the frequency of monitoring, and collected weekly samples for eight consecutive weeks, to then prioritize subwatersheds for supplemental source evaluation. The City of Claremont is mostly tributary to San Antonio Channel upstream of diversions that capture 100 percent of DWF for groundwater recharge in the Montclair Basins or in Brooks Basin. A small portion of the City of Claremont flows into the City of Pomona's MS4 at Mountain Ave (T2-CLARM) and is then discharged to San Antonio Channel downstream of any DWF diversions at the T2-SIGNA, which was sampled in the Tier 2 source evaluation. The remaining five sites where Tier 2 samples were collected are all tributaries to T1-CHINOCRK.

Individual sample results for *E. coli* concentration are reported in Table 3-8. Figure 3-23 shows the eight week geometric mean from the seven Tier 2 sites sampled during the 2013 dry season. Samples were not collected from T1-CHINOCRK in the 2013 dry season to compare with the Tier 2 sample results. Two detections were found of the 21 samples analyzed for human *Bacteroides*, both from the T2-GARY site, as noted in Table 3-8.

Table 3-8 Grab Sample Results for City of Pomona and Claremont Tier 2 Source Evaluation in the 2013 Dry Season

Site	*E. coli* Concentration (MPN/100mL)							
	8/14/13	8/21/13	8/28/13	9/4/13	9/11/13	9/18/13	9/25/13	10/2/13
T2-CLARM		373	379	2,064	404	209	4,611	5,794
T2-SIGNA	1,333	1,989	405	7,270	24,196	1,723	1,467	175
T2-FICUS	327	529	382	857	573	609	4,352	780
T2-TOWN	146	10	52	605	842	216	41	52
T2-GARY	717 *	295	313	908	663	717		14,136 *
T2-RIOR	243	9,208	420	565	1,017	1,076	345	830
T2-OLDP	8,164	480	2,382	408	7,701	24,196	4,352	9,208

* Indicates samples that had a positive detection of human *Bacteroides*

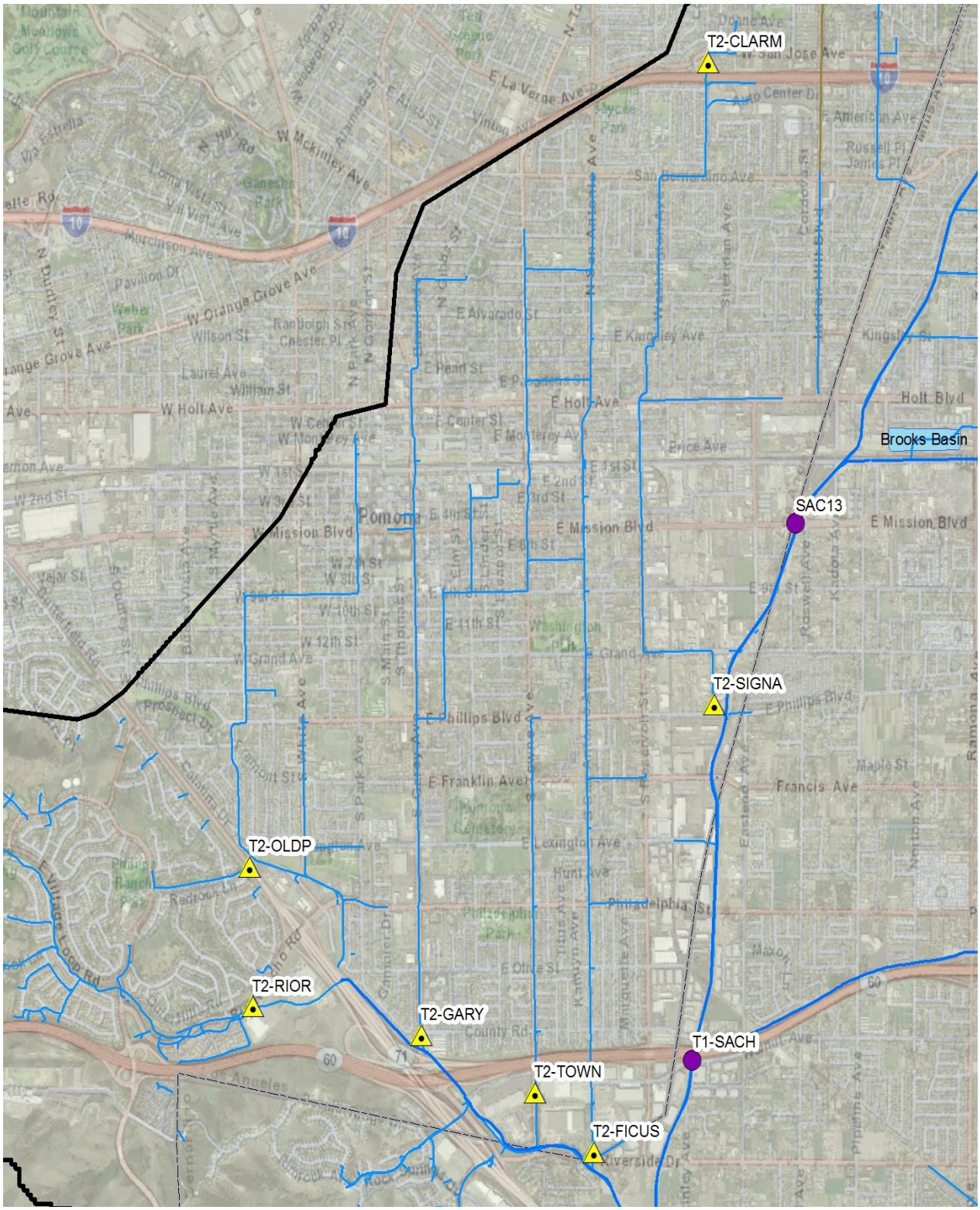

Figure 3-22

Map of Bacteria Source Evaluation Monitoring Sites in the Cities of Pomona and Claremont

Key findings from the City of Fontana Tier 2 bacteria source evaluation in the 2013 dry season are discussed below:

- The most significant finding for the City of Pomona was the detection of human *Bacteroides* in two of three samples analyzed from the T2-GARY site. The drainage area to this site is ~1,500 acres and includes the commercial center as well as City Hall. The City is in the process of developing an approach to track the specific source of human fecal bacteria in supplemental source evaluation activities.

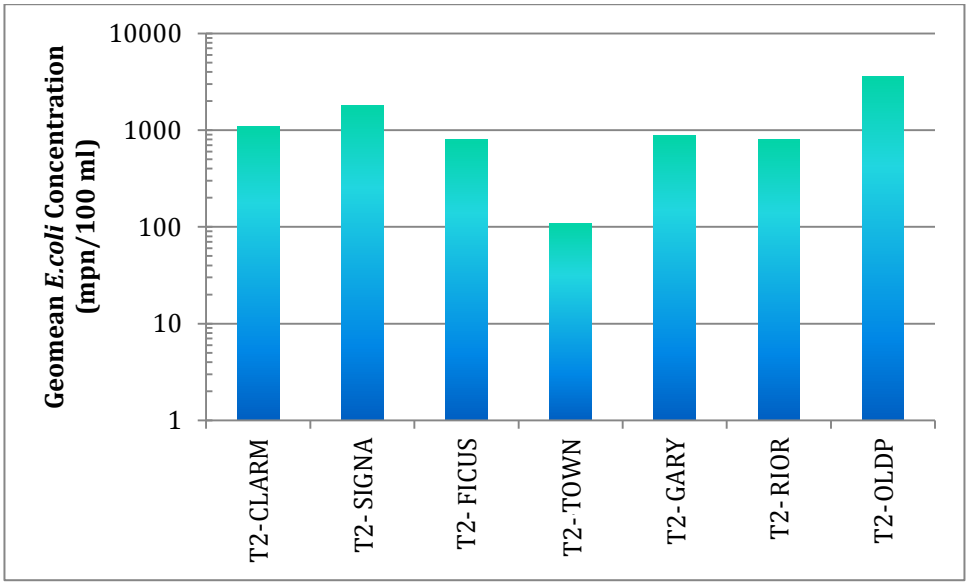

Figure 3-23
Geomean of *E. coli* Concentrations in Pomona and Claremont

- The highest DWF rates of all sites were consistently observed at the T2-RIOR site, which drains most of the Phillips Ranch development. The geometric mean of *E. coli* samples from this site was 800 mpn/100ml. The relatively higher volume of DWF and associated bacterial water quality carries a large weight in downstream *E. coli* concentrations which makes it a priority to reduce.

- While sometimes high in bacterial indicator concentration, the DWF from the City of Claremont is minimal and does not influence downstream concentrations. This observations is most apparent in asynchronous peaks of *E. coli* concentrations on September 11 (T2-SIGNA was over 24,000 mpn/100ml; T2-CLARM was 404 mpn/100ml), and conversely on December 11 (T2-CLARM was 5,794 mpn/100ml; T2-SIGNA was 175 mpn/100ml).

- The geometric mean of *E. coli* samples at the T2-TOWN site was below the wasteload allocation, therefore this drainage area is not a priority for supplemental source evaluation

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Section 4
Management Actions

Concurrent with the Tier 1 and 2 source evaluations, the MSAR Permittees have also evaluated and in some cases implemented strategic bacteria source management options targeting DWF from the prioritized subwatersheds. Actions range from enforcement of City ordinances to construction of new structural BMPs. The following sections describe management actions taken within several of the high priority MS4 drainages by individual Permittees or multi-agency groups that may directly or indirectly improve bacterial water quality for the receiving waterbodies.

4.1 Eastvale Line E

The City of Eastvale Line E was prioritized for source evaluation as a result of high *E. coli* and human *Bacteroides* during Tier 1 source assessments. To locate the potential source the City of Eastvale worked with the District to undertake a rigorous field reconnaissance and drainage area monitoring program. These investigations identified a potential source of human fecal bacteria in the MS4 system. The evidence available suggested that migrant day laborers were congregating near a drop inlet tributary to the Eastvale line E. This drop inlet was located below grade and provided a semi private area which could have potentially been used as a makeshift restroom facility. Eastvale Code Enforcement focused their efforts in this area to eliminate this potential source of human fecal bacteria. Water quality has since improved, as evidenced by a substantial reduction in the frequency of human *Bacteroides* detection between the 2012 and 2013 dry seasons. The City is also planning to conduct additional source evaluation monitoring in the 2014 dry season at Tier 2 sites to track and take action to eliminate any remaining sources of human fecal bacteria. As mentioned earlier the District is working with the city to evaluate potential BMPs to deploy at this outfall if additional reduction is necessary. So far Fiber rolls infused with bacteria reducing agents have been deployed in the form of check dams. Monitoring upstream and downstream of these installations will be conducted to evaluate their effectiveness.

4.2 Anza Storm Drain

RCFC&WCD and WMWD are working collaboratively to facilitate the construction of three stormwater recharge facilities in the Arlington area and expansion of the Arlington Desalter Project. Two of the stormwater recharge facilities will be integrated into Southwest Riverside MDP Line G. The third facility will be adjacent to Arlington Channel near Van Buren and Indiana Avenue. The project is estimated to develop 1,848 acre-feet per year of new water supply. A portion of the DWF at the Anza Drain outfall to the MSAR is from groundwater. This project is expected to shift the slope of the groundwater table away from the river and reduce DWF rates and associated bacterial indicator loads.

Another key source of DWF in the Anza Drain watershed in irrigation runoff from the use of furrow irrigation in the citrus groves on the south side of the City of Riverside referred to as the Arlington Greenbelt Area. Western Riverside County Agricultural Coalition (WRCAC) is developing an agricultural bacteria source management plan (BASMP), which will address these flows. The MSAR MS4 Permittees will work with WRCAC to support projects that ultimately reduce the volume of DWF entering MS4 drains.

As mentioned earlier, the City of Riverside and the District are working together to evaluate preliminary designs to infiltrate the dry weather flows from the upstream citrus groves as they enter the Monroe basin (Don Derr park).

4.3 Phoenix Storm Drain

Bacterial indicator concentrations in the Phoenix Storm Drain area are persistently high, but the rate of DWF is low (<0.1 cfs on average). The District is working with the City of Riverside to evaluate the feasibility of diverting this small volume of urban DWF from the MS4 to its own Riverside Water Quality Control Plant located about one-half mile to the west of the outfall. This would effectively eliminate all DWFs from this outfall and increase the volume of disinfected effluent in the river.

4.4 San Sevaine Channel

San Sevaine Channel spans over 20 miles the mountains to the outfall to the SAR. During dry weather, most urban runoff is captured and retained upstream of Jurupa and Declez Basins. Tier 2 source evaluation monitoring by the City of Jurupa Valley and the District shows a very high concentration of bacterial indicators from the section of Declez Channel downstream of Declez basin. Urban DWF from this site is largely generated by three small Neighborhoods. The City of Jurupa Valley is working with the District to conduct detailed source assessments in this sub drainage area during the 2014 dry season. Moreover, the District and the City of Jurupa valley are evaluating the opportunity of repurposing an abandoned basin downstream of these neighborhoods to infiltrate these DWF and thus eliminate the potential to contribute controllable sources of Bacterial Indicators. .

4.5 Boys Republic South Channel

The City of Chino Hills has conducted rigorous sampling and field reconnaissance throughout the Boys Republic South Channel (BRSC) subwatershed since 2012. In the 2013 dry season, the City identified several specific sources of fecal bacteria were identified and mitigation actions were taken. One involved the use of the BRSC culvert as a nesting site for cliff swallows. Netting was installed to inhibit these birds from nesting within this MS4 facility in upcoming years. The second involved a mobile fish market business that was washing off its equipment into the MS4. The source was located by popping a series of manholes to track the source of DWF within the MS4 to its source.

In 2013, the City continued to find high concentrations of bacterial indicators, and identified a condition of extreme variability, with weekly samples ranging from non-detect to greater than 24,000 mpn/100ml. One hypothesis that may explain this extreme variability in results is that the variability is associated with differences among individual properties in the quantity and quality of irrigation excess runoff (see Section 3.1 for discussion on this concept). This hypothesis led the Cities of Chino and Chino Hills to identify two key scientific questions, which if better understood after investigation, could influence regional bacteria source management approaches, as follows:

- What is the proportion of problematic properties with elevated DWF and/or fecal bacteria concentrations that is likely contributing to downstream impairments?
- Are there any unique characteristics of problematic properties (focus group), including but not limited to the specific sources of fecal bacteria and reasons for excess water waste?

4.6 Cypress Channel

As discussed in earlier sections there was a substantial improvement to bacterial indicator water quality in Cypress Channel in the 2013 dry season, which was a result of in-stream processes in the open channel segment between Eucalyptus and Kimball Avenues. High levels in the upper part of the watershed led the City of Chino to partner with the City of Chino Hills in the development of the residential property scale bacteria water quality study.

4.7 Lower Deer Creek

The Lower Deer Creek subwatershed is one of the largest of the prioritized drainage areas in the MSAR. Results from the Tier 2 source evaluation as well as field observations indicated that a potentially significant issue is debris accumulation within MS4 facilities. The City of Ontario plans to conduct focused drain cleaning to remove accumulated debris in the 2014 dry season.

Chris Basin receives runoff from Lower Deer Creek prior to the outfall to Cucamonga Creek and could be modified to provide water quality treatment as well as flood protection. Soils in Chris Basin are not conducive to infiltration BMPs; therefore other types of treatment would be needed to reduce bacteria in outflow to Cucamonga Creek. The MSAR TMDL Task Force evaluated one alternative to retrofit the basin bottom to serve as a subsurface flow wetland. The City of Ontario and SBCFCD are collaborating on a revised basin bottom that would facilitate longer residence time in the basin and more contact with soils, which have been shown to promote bacteria reduction (Kadlec and Wallace, 2009[6]).

4.8 Cucamonga Creek

The Mill Creek wetland BMP was recently constructed at the downstream end of Cucamonga Creek. A portion of DWF is diverted from Cucamonga Creek to the wetland for treatment and is then discharged back to Mill-Cucamonga Creek at Chino Corona Road. The effectiveness of this BMP has not yet been evaluated.

[6] Kadlec, Robert H. and Scott Wallace. *Treatment Wetlands; 2nd Edition*, CRC Press, 2009.

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