FINAL REPORT

Upper Santa Ana River Watershed Water Quality Assessment Project

for

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A. Executive Summary

Areas of the Santa Ana River have been impaired by large concentrations of pathogen indicators such as *E.coli* bacteria. More specifically, Reach 4 of the Santa Ana River was placed on the 303(d) list of the Clean Water Act for consistently exceeding the pathogen indicator objectives from unknown sources. It has been hypothesized that the local tributaries to Reach 4 have been partially responsible for the problem. The purpose of this project is to provide the Regional Water Quality Control Board with water quality data from key tributaries so that informed judgment can be made whether to continually monitor one or more of these tributaries and/or to evaluate if one or more of the creeks are contributing to the impairment of the Santa Ana River. The project's goal is to show a data set that represents typical water quality characteristics of each stream during cool and warm seasons.

As requested by the Regional Board the scope of work was as follows: acquire GPS information about each site prior to work, implement a Project Assessment and Evaluation Plan, employ a Monitoring Plan, adhere to a Quality Assurance Project Plan, comply with the California Environmental Quality Act, and obtain all appropriate permits and approval for entry into reach locations and flood control channels. The bacteria data is also expected to be compatible for inclusion in the Surface Water Ambient Monitoring Program (SWAMP) database. The activities of the Project included: weekly water monitoring of the designated tributaries (San Timoteo, Warm Creek and City Creek), GPS tracking and coding of sampling locations, analysis of bacteriological samples, monthly collection of non-bacteriological samples for third party laboratory analysis (E.S. Babcock and Sons Environmental Laboratories), and observing local riparian fauna and wildlife. Performed alongside these activities was also a short period of testing for optic brighteners with a fluorimeter, characteristic of septic leeched water.

Results suggest that San Timoteo Creek is a year-round contributor of *E.coli* indicator bacteria, and the Warm Creek 2 and Warm Creek 4 sites are warm season contributors. Each sample site of the nine that had flow has at least two constituents that exceeded the water quality objectives listed in the QAPP, enough times to warrant possible 303(d) listing. All sites except those on City Creek showed either year-round or seasonal physical changes in color, odor and clarity.

Insert figure of all sample sites

B. Methodology

In order to measure accurately and precisely, while keeping continuity, specific techniques described in the Quality Assurance Project Plan were employed at each site. To measure flow rate, a velocity-area method was used whereby the sampler measures depths across the width of the stream and then measures the velocity by recording the time it took wooden bobbers to travel twenty feet downstream. Measuring other water quality characteristics required calibrated instrumentation such as: pH meter, dissolved oxygen meter, electrical conductivity meter, and digital thermometer. We took triplicate readings with each meter at three equidistant locations across the width of the stream and then averaged for the results included herein. If the flow was so shallow that readings had to be read from a sterile bag or cup, only one reading was used. Each instrument was calibrated (with exception of the thermometer) at the beginning of every work day to ensure accuracy and precision (see QA/QC report). Water samples taken for third-party analysis were collected with sterile transfer devices. Refer to the Project Performance and Lessons Learned sections, and the Quality Assurance/Quality Control Report (under separate cover) for more detailed information and observations about the techniques used for the Project.

The following is a list of assumptions made for the project: If the result was greater than the objective, then it was considered an exceedance. If the sample site had no flow (i.e., "dry"), then the site visit was not considered a sample, and not included in the analysis. Geomeans of less than 5 samples/30 days were not considered in the analysis but they are shown in the data tables in Appendix A and the data graphs in Appenix B. Duplicates are not included in the results tables because their purpose was for QA/QC only and they are discussed in the QA/QC report. When a creek was braided, we measured the flow rate of each braid and summed them for the total flow rate. Total coliform is a somewhat ambiguous number especially for inland surface waters so we performed no analysis and have included no discussion about the total coliform results. They are shown simply as future reference if needed. As discussed in the QAPP, no sampling occurred when rain was eminent, ongoing or within 24 hours of a rain event.

Results based on geomeans of 4 data points are shown in the tables in *italics* and **bold**. Likewise, viable results that are greater than the objectives stated in Table 3 of the QAPP are shown in red. Blank spaces in the tables indicate no results collected or the analysis failed.

C. Project Summary by Sample Site

Below is a site-by-site description and results discussion from the entire 14-month project. We have defined the cool season from November 1 through March 31, and the warm season from April 1 through October 31.

Table 1: Sampling locations, IDs and descriptions.

Site Name	Site ID	Thomas Guide Page, Grid	GPS Coordinates	Town	Identifier
San Timoteo Creek 1	ST 1	RivC p. 690, J-4	33°58.037 N, 116°58.432 W	Cherry Valley	Noble Creek/ Little San Gorgonio Creek confluence
San Timoteo Creek 2	ST 2	RivC p. 688, E-1	33°59.754 N, 117°09.567 W	Redlands	Redlands Blvd./San Timoteo Canyon Rd./Live Oak Cyn Rd.
San Timoteo Creek 3	ST 3	SBD p. 647, J-4	34°01.976 N, 117°12.491 W	Redlands	San Timoteo Canyon Rd./ Fern St.
San Timoteo Creek 4	ST 4	SBD p. 606, J-6	34°03.987 N, 117°16.702 W	San Bernardino	Waterman/Hospitality
City Creek 1	CC 1	SBD p. 578, A-1	34°10.088 N, 117°10.884 W	Above Highland	Hwy 330 white flag / access "road" and boulders
City Creek 2	CC 2	SBD p. 578, A-5	34°07.027 N, 117°11.582 W	Highland	Baseline Ave. and Boulder St.
Warm Creek 1	WC 1	SBD p. 547, A-6	34°09.895 N, 117°16.038 W	Arrowhead Springs	Waterman basin/Twin Creek basin/40th Street
Warm Creek 2	WC 2	SBD p. 577, B-6	34°07.076 N, 117°15.648 W	Highland	Tippecanoe/Waterman/Upper Warm Creek & Del Rosa Channel
Warm Creek 3	WC 3	SBD p. 577, A-3	34°08.1811 N, 117°16.1078 W	San Bernardino	Shack on east side of Twin Creek, just north of Highland
Warm Creek 4	WC 4	SBD p. 606, F-6	34°04.084 N, 117°18.449 W	San Bernardino	Fairway Dr. /Mt. Vernon Rd.

A total of six tables have been prepared for each site; the first being a summary and included in the text, the second through sixth being data tables included in Appendix A. Likewise, five graphs have been prepared for each site illustrating the data results and included in Appendix B. One rainfall gauge was found near each creek; the daily precipitation for each during the project is included in Appendix C. Appendix D contains representative photos from each site throughout the project duration, and Appendix E contains the quality assurance/quality control report.

As mentioned in the executive summary, we used a fluorimeter to test for optic brighteners that can indicate a source of septic tank leech water. Equipment, training and materials were provided by Erick Burres of the State Clean Water Team. Samples were run from each site for the month of December 2009; however no optic brighteners were detected.

Fluorimeter Results

Date	Sites	Result
12/12/08	ST2, ST3, ST4	All negative
12/19/08	WC1, WC2, WC3, WC4	All negative
12/20/09	ST2, ST3, ST4	All negative
12/21/09	CC1, CC2	All negative
1/2/09	ST2	Negative

INSERT ST FIGURE

(1) San Timoteo Creek 1
Cherry Valley, below confluence of Little San Gorgonio and Noble Creeks

This sample site would receive drainage from the mountain headwaters and represent the “natural” condition; however we observed no runoff. It is presumed to flow during storms; however the QAPP limited us from sampling during rain events.

(2) San Timoteo Creek 2
San Timoteo Canyon, upstream of Live Oak Canyon Road, downstream of Redlands Blvd.

This sample site represents Reach 3 of San Timoteo Creek. It receives runoff from agricultural and ranching land uses, open space, and suburban residential (under construction). Flow runs year-round at this site, and we are unsure as to its primary source. Possible upstream contributors include the Beaumont wastewater treatment plant, each of the creek’s adjacent developments, the Casco Lakes and the East Valley Golf Course. The site has consisted of a wide, flat sandy riverbed with vegetation lining the banks. Animals onsite consisted of free range cows and a coyote spotted on one occasion. Birds ranged from the common sparrow and killdeer to red tailed hawks and turkey vultures. A sewage odor was present during most sampling events, both in the water and sediment as were numerous piles of old and fresh cow feces. The path of the stream was uninhibited and unobstructed as was access to the creek bank.

After the first flood events in 2008, the vegetation closest to the stream bank was washed away and the stream began to change paths. Between winter 2008 and spring 2009, the stream became deeper and thinner exposing cobbles within the riverbed. The vegetation along the creek grew rapidly and began to obstruct the view of the stream from the bank of the riverbed. The most rapid growth occurred in late June and July of 2009. In late August of 2009 the stream's path was entirely obstructed by vegetation along its edge with 5-6’ tall bushes and shrubs. Even with early fall 2009 flooding events the vegetation stayed in place and created reinforced banks along the stream's path, which created a deeper channel and exposed larger cobbles. Even with large fluctuations in stream flow rate the clarity was uninhibited and would usually consist of large suspended solids, not claylike solids as seen in December 2008.

In both the cool and warm seasons, we observed average conductivity readings that always exceeded the Basin Plan objective. On the other hand, average pH and dissolved oxygen results were always within the acceptable ranges of 6.5 to 8.5 and greater than 5.0 mg/L, respectively.

We visited the site 43 times during the warm season (see Table 2-A below). The temperature objective to stay below 32.2°C was exceeded three times, and the proposed single sample *E.coli* objective of 235 mpn/100 mL was exceeded 27 times out of 41 samples (63%). A total of 22 geomeans were calculated from five *E. coli* samples taken in 30 days; 19 of which exceeded the proposed objective of 126 mpn/100 mL (86%). For illustrative purposes, including the ten additional geomeans calculated from four *E. coli* samples taken in 30 days (all of which exceed the proposed objective) gives 92% exceedance rate (see Table 2-B for data).

Staff visited the site 17 times during the cool season. Unlike the warm season, the average water temperatures stayed below the objective. Of the 17 *E.coli* single sample results, a total of four exceed the proposed objective of 235 mpn/100 mL (37%). Seven geomeans were calculated from five samples collected in 30 days; none of which exceed the proposed objective. Compared to the warm season results, this is a significant reduction. For illustrative purposes, five geomeans based on four samples in 30 days were also calculated and only two were higher than the proposed objective, which gives a 17% exceedance rate (see Table 2-C for data).

Table 2-A: Results Summary Table for San Timoteo Creek 2 Site

	Flow Rate (cfs)	Air Temp (°C)	Water Temp (°C)	pH	DO (mg/L)	EC (uS/cm)	*E. coli* single (mpn)	Total coliform (mpn)	*E.coli* geomean (mpn)[a]
Warm Season									
N	43	41	43	43	42	43	41	41	22
Average	8.5	30.1	25.7	8.3	8.1	816	726.3	38445.8	422.2
Median	8.1	31.9	26.3	8.3	8.1	810	344.8	30760.0	237.1
# exceed	-	-	3	0	0	43	27	-	19
% exceed	-	-	7%	0%	0%	100%	63%	-	86%
Cool Season									
N	17	17	17	17	16	17	17	17	7
Average	14.6	20.8	17	8.3	9	832.4	220.3	17661.9	59.7
Median	14.1	22	17.4	8.3	8.9	831	64.5	14136	61.4
# exceed	-	-	0	0	0	17	4	-	0
% exceed	-	-	0%	0%	0%	100%	24%	-	0%

[a] Results shown in summary table reflect only the usable data, i.e., the 5 sample geomeans. Any bacteria results that were > or < a value are not included in the summary table.

Observations of water clarity, sediment/water color and odor were recorded for each site and shown in Table 2-D for the warm season, and Table 2-E for the cool season. At the ST 2 site, water color was yellow or brown from the end of October through mid-June. A noticeable odor ranging from sewage-like to unidentifiable was noted for nearly the entire project. The water clarity was semi-clear or turbid during the wettest months of the year.

Additional samples were collected once a month for nine months to send to a local contract laboratory (E.S. Babcock & Sons) to analyze cations, anions, conductance, TDS, COD, nutrients, metals/metalloids, PCBs and organochlorine pesticides. Objectives were exceeded at the ST 2 site in every month for sodium, chloride, specific conductance, and TDS (see Table 2-F for data).

(3) San Timoteo Creek 3
San Timoteo Canyon, immediately upstream of San Timoteo Canyon Road bridge

The ST 3 site represents Reach 2 of San Timoteo Creek and is located immediately upstream of where San Timoteo Canyon Road crosses over the creek. It is also within a habitat restoration project by San Bernardino County and the Army Corps of Engineers. Therefore it receives inputs from more urban influences, agriculture, earth work and road traffic. This site is unique compared to the other sites in this project because it is has artificial damming. Banks at the site are concrete rip-rap. Above the sample location, banks are primarily compacted dirt with concrete reinforced bases.

It was apparent from the start of the project that ST 3 has very fertile sediment; however, the fauna is temporary as the ongoing habitat project clear cuts vegetation on a regular basis to alleviate damming and overgrowth. It should also be noted that the physical characteristics of the stream channel were not as consistent as others. Since the creek is divided into detention basins both upstream and downstream from the sampling location, flow rate is dependent upon upstream basin conditions (i.e. percentage of culvert(s) unobstructed).

The habitat was consistently occupied by different birds and small animals. Birds ranged from crows and killdeer to red-tailed hawk and turkey vultures. Small birds nested among shrubs and cattails within the basin during the spring months. During the late winter months and early spring, a large population of swallows built nests underneath the bridge. The presence of raccoon and ground squirrel was obvious from tracks and scat.

From July 08 to November 08, flow at the site was quite marginalized and at the lowest limits of measurement. Upstream basins retained water from the start of the project until they were cleaned or a runoff event occurred. Construction crews from the County of San Bernardino were primarily responsible for cleaning and dredging the basins. The cleaning crews were on site after most rainfall events and during the spring months. The crews removed all vegetation and large amounts of silt and clay deposits from each basin. Sprinkler systems were installed during September 2008 that watered the basins quite frequently (apparent from damp soil conditions not near rainfall events). The vegetation grew very rapidly from the watering and is shown in the following pictures.

After rainfall events, the culverts that drained each basin became clogged with debris and created ponds. The ponds quickly filled with sediment as well, which contributed to 1-2 feet thick mud in places and deeper still in others. In late January it was possible to make measurements below the bridge and culvert since some clear cutting and dredging was done to alleviate blockage at the end of the culvert. Here the soil and fauna conditions were the same as above the bridge.

In the late spring and throughout the summer the culvert was kept clear of large debris and the stream channel maintained uniformity compared to previous months. The vegetation grew very rapidly during these months as the water supply was fairly consistent and no clear cutting was done.

Not until Fall 09 did clear cutting and dredging occur at the sampling location (upstream of bridge). At this point the stream channel was somewhat uniform from the top to bottom of the basin as well as fast moving compared to other periods during sampling.

Similar findings between cool and warm season samples suggest that average conductivity readings, and *E.coli* concentrations almost always exceed objectives. Unlike the ST2 site, the results from ST3 are very similar between the cool and warm seasons. Also, the *E.coli* concentrations are on average an order of magnitude higher here than at ST2 suggesting a source of additional bacteria and/or some sort of internal mechanism causing the increase (see Table 3-A below).

We visited the ST3 site 43 times during the warm season, in which the objective for temperature was exceeded three times (two of the same instances as ST 2). The pH objective was exceeded twice and the average dissolved oxygen concentrations always met the objective. On the other hand, average conductivity always exceeded the objective, and similarly the single sample *E.coli* measurements exceeded the proposed objective all but twice. We were able to calculate 16 geomeans of *E.coli* with five samples taken in 30 days, of which all exceeded the proposed objective. Six additional geomeans could be calculated with only 4 samples in 30 days and they too exceeded the objective (see Table 3-B for data).

We visited the ST 3 site 17 times in the cool season and observed very similar results to the warm season; juxtaposed with the ST 2 site, where we saw large increases in compliance rates between the warm and cool seasons. Temperature, pH and dissolved oxygen always met the objectives. Again, average conductivity always exceeded the objective, and single samples of *E.coli* were over the limit except for five times (69% noncompliance rate). We were able to calculate six *E.coli* geomeans of 5 samples taken in 30 days. All of them exceed the proposed objective of 126 mpn/100 mL. Likewise, the four additional geomeans of 4 samples in 30 days also always exceeded the objective (see Table 3-C for data).

Table 3-A: Results Summary Table for San Timoteo Creek 3 Site

	Flow Rate (cfs)	Air Temp (°C)	Water Temp (°C)	pH	DO (mg/L)	EC (uS/cm)	*E. coli* single (mpn)	Total coliform (mpn)	*E.coli* geomean (mpn)[a]
Warm Season									
N	42	43	38	38	37	38	36	29	16
Average	2.3	30.2	24.6	8.4	7.7	1005.7	2113.3	86713.9	1177.8
Median	1.3	32	24.9	8.4	7.7	975.7	1119.9	48840	1217.7
# exceed	-	-	3	2	0	38	34	-	16
% exceed	-	-	8%	5%	0%	100%	92%	-	100%
Cool Season									
N	13	15	16	16	15	16	16	14	6
Average	7.7	21.4	15.9	8.4	9.5	923.8	5211.7	33702.5	702.7
Median	5.9	21.1	16.5	8.4	9.4	939.7	339.1	24196	524.7
# exceed	-	-	0	0	0	16	11	-	6
% exceed	-	-	0%	0%	0%	100%	69%	-	100%

[a] Results shown in summary table reflect only the usable data, i.e., the 5 sample geomeans. Any bacteria results that were > or < a value are not included in the summary table.

Physical observations of color, clarity and odor of both the water and sediment at ST 3 suggest that the most improvement occurs in late spring/early summer. During the winter, water color was consistently brown, water clarity was consistently turbid and water odor was consistently unidentifiable with periodic sewage-like smells. The creek sediment was also malodorous during this time. During the warm season the color, clarity and odor worsened during May, June and somewhat in October (see Table 3-D for warm season and Table 3-E for cool season).

Additional samples were collected once a month for nine months to send to a local contract laboratory (E.S. Babcock & Sons) to analyze cations, anions, conductance, TDS, COD, nutrients, metals/metalloids, PCBs and organochlorine pesticides. Samples from the ST 3 site exceeded objectives for total hardness, sodium, chloride, specific conductance, and TDS in every month. This is the same as ST 2 except for the addition of total hardness. At least half of samples for sulfate, chemical oxygen demand, ammonia-nitrogen, and lead also exceeded their respective water quality objectives (see Table 3-F for data).

(4) San Timoteo Creek 4
Concrete box channel between Hospitality and Waterman Avenues in San Bernardino

The ST 4 site represents Reach 1A and 1B of the creek immediately upstream of its confluence with the Santa Ana River. It receives flows from mostly urban sources, and some agriculture and open space influences. This section of the creek is a large concrete box channel where we would expect the most pollution. The vegetation at the site consisted of sparse weeds and small amounts of grasses growing out of cracks in the concrete. Sediment was present during most site visits and consisted of very fine silt and clay, which had been pushed out to the side and settled on the very edge of the stream flow. The stream bed was concrete with a thin film of algae across it. This algae was present most sampling events. ST 4 was a haven for pigeons, crows, ravens, sparrows, swallows, and one pair of mallard ducks. The swallows were present late winter 09 to early summer 09. During the project the channel was cleared of debris and sediment on more than one occasion.

During both the cool and warm seasons the average pH was always higher than the objective, which is significantly different than the previous ST 2 and ST 3 sites. It ranges from an average low of 8.6 to an average high of 10.8. This suggests an input of something that reduces the hydrogen ions in solution between ST 3 and ST 4. On the other hand, average conductivity is consistent with measurements at ST 2 and ST 3 and continues to exceed the objective at ST 4. Single sample *E.coli* concentrations show noncompliance rates of 46% in the warm season and 75% in the cool season. This suggests little reduction in *E.coli* bacteria concentrations between ST 3 and ST 4 in the cool season but a little more in the warm season. Roughly two-thirds of the *E.coli* geomeans during the warm season exceed the objective compared to all of the *E.coli* geomeans during the cool season that are in noncompliance (see Table 4-A below).

Focusing just on the warm season at ST4, we see the highest number of water temperature exceedances of all the San Timoteo sites (11 of 43) and the highest average dissolved oxygen concentrations thus far (maximum 14.3). There is likely a relation between the algae and high daytime dissolved oxygen concentrations (we were not able to sample at night to measure a diurnal change). The single sample *E.coli* results fluctuate greatly compared to previous sites, ranging from less than 1.0 mpn to greater than 2419.6 mpn. We were able to calculate 23 five sample/30 day geomeans, of which 15 exceed the objective (65%). Likewise, seven of the ten additional 4 sample/30 day geomeans are in noncompliance of the proposed objective (see Table 4-B for data).

The cool season at ST 4 produced even higher average dissolved oxygen concentrations, up to 17.2 mg/L. Of the 16 single samples of *E.coli,* 12 samples or 75% exceed the proposed objective. All of the 5 sample/30 day *E.coli* geomeans exceed the proposed objective. As do the additional four geomeans calculated from 4 samples/30 days (see Table 4-C for data).

Table 4-A: Results Summary Table for San Timoteo Creek 4 Site

	Flow Rate (cfs)	Air Temp (°C)	Water Temp (°C)	pH	DO (mg/L)	EC (uS/cm)	*E. coli* single (mpn)	Total coliform (mpn)	*E.coli* geomean (mpn)[a]
Warm Season									
N	43	41	43	43	41	43	41	36	23
Average	2.7	32.1	29	10.1	11.1	695.9	604.9	20747.8	310.3
Median	2.2	34.2	30.5	10.2	10.5	701.0	489.2	14264.0	178.8
# exceed	-	-	11	43	0	42	25	-	15
% exceed	-	-	26%	100%	0%	98%	61%	-	65%
Cool Season									
N	16	15	16	16	15	16	16	13	7
Average	9.2	22.2	17.6	9.3	12.9	874.9	2115.4	32425.9	459.1
Median	9.3	24.2	17.5	9.2	12.7	832.7	504.3	26130.0	446.0
# exceed	-	-	0	16	0	16	12	-	7
% exceed	-	-	0%	100%	0%	100%	75%	-	100%

[a] Results shown in summary table reflect only the usable data, i.e., the 5 sample geomeans. Any bacteria results that were > or < a value are not included in the summary table.

Physical observations of water color and water odor are ubiquitous during the cool and warm seasons. Color varies from yellow, green, and brown, while the odor varies from nitrates to sewage or hydrogen sulfide. Clarity improves during the warm season but clearly worsens as expected, during the cool season. These findings are consistent with the previous sample sites (see Table 4-D for warm season and Table 4-E for cool season).

Additional samples were collected once a month for nine months to send to a local contract laboratory (E.S. Babcock & Sons) to analyze cations, anions, conductance, TDS, COD, nutrients, metals/metalloids, PCBs and organochlorine pesticides. Samples from the ST 4 site exceeded objectives for sodium, chloride, specific conductance, and TDS in every month. This is the same as ST 2 and nearly the same as ST 3. At least half of samples for total hardness and chemical oxygen demand also exceeded their respective water quality objectives (see Table 4-F for data).

INSERT CC FIGURE

(4) City Creek 1
San Bernardino Mountains, East of Highway 330 at 34°10.088N, 117°10.884W

The CC 1 site represents the "natural" mountain headwaters of City Creek, which flow year-round and should be of relatively high quality. We also noted that this site could contain endangered mountain yellow-legged frogs and thus received guidance from the Forest Service for ensuring we did not carry harmful bacteria into, or out of the site. Certainly one of the most beautiful canyons in this study, City Creek is difficult to access and would be dangerous in a wildfire or flash flood situation because of the steep and narrow canyon walls. The trail to the site is a path constructed for repairs and maintenance of the retaining wall for Highway 330. The stream bed contained large gravel and water smoothed boulders.

Local fauna did not change as dramatically as other sites. In fact, the vegetation growth was very limited even during the spring of '09. The fauna consisted mostly of low lying shrubs, grasses, and vines. During warm weather, algae blooms occurred within eddies along the banks. We observed mosquito and water bug larvae as well as, tadpoles and water spiders. Evidence of larger animals (i.e. garter snake, raccoon, coyote, and ground squirrel) was found on site in the form of prints and scat. Birds ranged from the common crow and blackbird to red tailed hawk, blue jays and a Northern cardinal. Approximately 50 feet upstream from the sampling location is a man-made pool that existed from the inception of the project to about late spring '09. After rainfall and snow melt events it acted more like a weir than a dam.

During the cool and warm seasons we observed consistent and stable results (note the closeness of the average and median values) with relatively few objectives exceeded (see Table 5-A below). In the warm season, the stable pH readings averaged higher than the objective five times, and the conductivity exceeded the limit five times. None of the *E.coli* single samples, geomeans, or total coliform results are higher than the proposed limits. We even saw three instances of *E.coli* concentrations less than 1.0 mpn (see Table 5-B for data).

The results from the cool season were very similar, with two average pH results higher than 8.5, and two average conductivity readings higher than the objective. Single sample readings of *E.coli* never got close to exceeding the threshold, and included results less than 1.0 mpn four times. Average single sample *E.coli* concentrations in the warm season are nearly 4 times greater than concentrations in the cool season. We were able to calculate three geomeans from five samples/30 days, and three geomeans from four samples/30 days. None of the geomeans during the cool season exceeded the proposed *E.coli* objective (see Table 5-C for data).

Table 5-A: Results Summary Table for City Creek 1 Site

	Flow Rate (cfs)	Air Temp (°C)	Water Temp (°C)	pH	DO (mg/L)	EC (uS/cm)	*E. coli* (mpn)	Total coliform (mpn)	*E.coli* geomean (mpn)[a]
					Warm Season				
N	42	42	42	42	40	42	39	33	22
Average	4.5	25.2	19.0	8.4	8.9	289.3	12.3	1764.2	10.2
Median	3.6	25.9	18.8	8.4	8.8	289.7	6.3	1413.6	12.0
# exceed	-	-	0	5	0	8	0	-	0
% exceed	-	-	0%	12%	0%	19%	0%	-	0%
					Cool Season				
N	15	15	15	15	15	15	11	15	3
Average	16.2	16.9	9.8	8.4	10.7	264.8	2.9	1238.0	3.3
Median	10.5	16.1	10.0	8.4	10.7	275.3	3.1	1046.2	2.5
# exceed	-	-	0	2	0	2	0	-	0
% exceed	-	-	0%	13%	0%	13%	0%	-	0%

[a] Results shown in summary table reflect only the usable data, i.e., the 5 sample geomeans. Any bacteria results that were > or < a value are not included in the summary table.

The creek did not exhibit changes in color, clarity or odor during this project (see Table 5-D for warm season and Table 5-E for cool season data).

Additional samples were collected once a month for nine months to send to a local contract laboratory (E.S. Babcock & Sons) to analyze cations, anions, conductance, TDS, COD, nutrients, metals/metalloids, PCBs and organochlorine pesticides. Results produced scattered exceedances of hardness, chloride, conductance, and copper. The parameter that exceeded limits most often was COD; six of nine measurements were higher than the objective, but the remaining three measurements were ND or non-detect (see Table 5-F for data).

On October 15, 2009, the lab reported hits of 4,4-DDE and 4,4-DDT that were significantly over the limits specified in the California Toxics Rule. 4,4-DDE is an organochlorine chemical largely banned in the U.S. that bioaccumulates and is linked to cancer and reproductive harm. DDE is also a breakdown product of DDT. Waterkeeper did not follow up with the lab to re-check the results in case of lab contamination.

(5) City Creek 2
At Boulder Street Bridge in the City of Highland

This sample location represents the change in mountain headwaters after flowing through an urban city. The channel contains boulders and cobbles, and often the path of the water would split and braid within the channel from week to week. We often observed people in the channel usually just "hanging out" and not recreating in the water. This area of the creek is scenic and retains natural qualities that would make for a nice trail or pocket park.

During the month of February 2009, the creek split into two separate paths upstream from the sampling location. The total flow rate was calculated as the sum of each; however water quality data was gathered from the larger of the two braids. Throughout the project objects such as logs, planks, and sheet metal were laid across the stream path like small bridges.

Animal life was fairly abundant for a site in very near proximity to busy streets and local businesses. Birds ranged from the common crow and raven to pigeons, killdeer, sparrows, thrushes and blackbirds. In mid-summer a kingfisher was spotted at the site but other animals include feral cats, coyotes, and ground squirrel. Insect life was very abundant throughout the year. During the warmer months, water bugs, flies, mosquitoes and dragonflies were prevalent.

The local fauna was primarily centralized to the edges of the stream path. There were low lying shrubs and taller grasses that only grew to a height of approximately one and half feet. During the winter of 2009 the low lying shrubs grew very rapidly because of the increase in flow. The shrubs grew into the water of the stream and at points covered over half of the stream path acting as dampeners to the velocity of the stream. In May 2009 the shrubs and new willows grew to over three feet in height and some over five feet in diameter. By June 2009 the low lying shrubs started to die off, but all other fauna stayed.

At some sampling events the usual sampling location was dry. During one of these site visits, we explored upstream to the Baseline Road bridge and found water to sample. This occurred on September 22, 2009 and the site is within 200 meters of our primary sampling location. According to the Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List, samples that are collected within 200 meters of each other are considered samples from the same location (page 23).

We observed some similarities in the samples taken during the cool and warm seasons. First, they reveal very similar rates of noncompliance for average conductivity and pH. Second, we observe year-round water temperatures that stay within the limits. Third, the percent of *E.coli* results higher than the single sample objective drop from 16% in the warm season to zero in the cool season (see Table 6-A below).

The warm season results show nearly uniform pH readings above the upper limit (86%). Likewise, conductivity exceeds the objective in every sample except for the months of May and June. A total of 42 *E.coli* single samples were collected during this season and only six are higher than the proposed single sample objective. From those, we calculated 19 geomeans (five samples/30 days) and only one in August 2009 exceeds the proposed geomean objective. Several geomeans made of only 4 samples in 30 days in July and August 2009 also exceed the objective, which would suggest that concentrations increase as summer progresses; however, the previous year shows geomeans of less than 40 mpn. Therefore a new source of *E.coli* may have appeared between the summers of 2008 and 2009 (see Table 6-B for data).

The cool season results also show a majority of average pH and conductivity readings within compliance. None of the thirteen single sample *E.coli* results were above the proposed single sample water quality objective. Likewise, none of the three *E.coli* geomeans approached the proposed objective (see Table 6-C for data).

Table 6-A: Results Summary Table for City Creek 2 Site

	Flow Rate (cfs)	Air Temp (°C)	Water Temp (°C)	pH	DO (mg/L)	EC (uS/cm)	*E. coli* (mpn)	Total coliform (mpn)	*E.coli* geomean (mpn)[a]
Warm Season									
N	41	42	37	37	35	37	42	14	19
Average	3.2	30.2	24.1	8.9	9.5	379.9	152.9	25379.4	70.8
Median	2.6	31.2	24.5	8.9	9.7	408.7	38.8	12997.0	35.9
# exceed	-	-	0	32	0	28	6	-	1
% exceed	-	-	0%	86%	0%	76%	16%	-	5%
Cool Season									
N	15	14	15	15	14	15	13	14	3
Average	12.2	22.1	14.1	8.7	10.9	326.6	32.2	3996.4	24.7
Median	9.9	20.8	14.3	8.7	10.8	307.0	7.3	2202.9	19.5
# exceed	-	-	0	9	0	7	0	-	0
% exceed	-	-	0%	60%	0%	47%	0%	-	0%

[a] Results shown in summary table reflect only the usable data, i.e., the 5 sample geomeans. Any bacteria results that were > or < a value are not included in the summary table.

Field observations of water color, clarity and odor suggest a distinct change in August 2009 and a petroleum-like odor in October 2009. Otherwise, the water appears clear with no turbidity or odor (see Table 6-D for warm season and Table 6-E for cool season data).

Additional samples were collected once a month for nine months to send to a local contract laboratory (E.S. Babcock & Sons) to analyze cations, anions, conductance, TDS, COD, nutrients, metals/metalloids, PCBs and organochlorine pesticides. Chloride and COD were most often exceeding the objectives (5 out of 8, and 6 out of 8, respectively). Scattered exceedances were recorded for total hardness, sodium, sulfate, conductance, and TDS (see Table 6-F for data).

INSERT WC FIGURE

(5) Warm Creek 1
At Twin Creek Basin and 40th Street in San Bernardino

The WC 1 sample site is located approximately 60 feet below East 40th Street within the Twin Creek Flood Control Basin. The bottom is natural with boulders, cobbles and coarse sand. During the course of the project the stream path was dredged and clear cut of all vegetation by the San Bernardino County Flood Control District sometime between November 1st and December 5th, 2008.

Sometime during September 2009, the stream became dry and did not flow for the remainder of the project. One hypothesis is that the stream path was diverted upstream by the MWD pipeline project. Animal life at the site was fairly scarce but common to just crows and killdeer. Two coyotes were spotted during a sampling event drinking and resting downstream of the sampling site. Another time a solitary coyote was seen meandering through the channel and chasing crows. Before the stream path was dredged a small school of minnow occupied the sampling location. After the dredging these minnows were not seen again. Insects ranged from flies and mosquitoes to dragonflies and water beetles. The area is frequented by pedestrian walkers and runners.

The vegetation at the site varied quite significantly before and after the dredging. Before the dredging, fauna was quite lush and reached overhead. We observed tall grasses, sunflowers, small trees, and willows. The fauna was green until the month of September 2008 when it drastically turned brown. After the stream had been dredged the vegetation consisted of low lying weeds and grasses. In spring 2009 there was a presence of wild flowers.

During the warmer months and after dredging, we observed algae and a thick, fibrous plant that covered the stream banks and bottom. The algae and plants created an odor similar to hydrogen sulfide and dampened the velocity of the stream. The algae and plants only lasted for two months or so and died off dramatically. These blooms were not seen again for the remainder of the project.

Waterkeeper visited the site 42 times during the warm season. The average water temperature exceeded its limit once and dissolved oxygen concentrations never dropped below the objective. On just three occasions did single samples of *E.coli* contain more than 235 mpn/100 mL. Average conductivity readings however, exceeded the objective during every site visit. Out of 24 *E.coli* five sample geomeans/30 days, we found only one to exceed 126 mpn/100 mL (see Table 7-A below, and Table 7-B for data).

Waterkeeper visited the site 16 times during the cool season and found the site completely dry in November of 2009. The average water temperature never exceeded the objective, and the dissolved oxygen concentrations never dropped below their limit. On the other hand, pH was greater than the objective four times, and conductivity was nearly 100% out of compliance. None of the 11 single sample *E.coli* results were greater than 235 mpn, and the singular *E.coli* geomean did not exceed the objective. Three geomeans were calculated from 4 samples/30 days and they too, did not exceed (see Table 7-C for data).

Table 7-A: Results Summary Table for Warm Creek 1 Site

	Flow Rate (cfs)	Air Temp (°C)	Water Temp (°C)	pH	DO (mg/L)	EC (uS/cm)	*E. coli* (mpn)	Total coliform (mpn)	*E.coli* geomean (mpn)[a]
Warm Season									
N	42	42	35	35	33	35	35	23	24
Average	1.7	28.9	24.4	8.6	8.2	1068.2	96.7	24904.5	57.5
Median	0.4	29.7	24.1	8.5	8.3	1121.3	41.0	15531.0	58.6
# exceed	-	-	1	17	0	35	3	-	1
% exceed	-	-	3%	49%	0%	100%	9%	-	4%
Cool Season									
N	16	16	12	12	12	12	11	11	1
Average	4.3	20.6	15.9	8.5	9.8	721.0	20.9	5564.6	11.76
Median	3.8	22.2	15.6	8.4	9.8	721.8	19.9	3076.0	11.76
# exceed	-	-	0	4	0	11	0	-	0
% exceed	-	-	0%	33%	0%	92%	0%	-	0%

[a] Results shown in summary table reflect only the usable data, i.e., the 5 sample geomeans. Any bacteria results that were > or < a value are not included in the summary table.

Field observations suggest that the water here is mostly clear, colorless and odorless. Once in September 2008 and again in September 2009 do we see a change (see Table 7-D for warm season and Table 7-E for cool season data).

Additional samples were collected once a month for nine months to send to a local contract laboratory (E.S. Babcock & Sons) to analyze cations, anions, conductance, TDS, COD, nutrients, metals/metalloids, PCBs and organochlorine pesticides. We found the following constituents to be higher than their respective limits in all of the seven samples taken: sodium, chloride, sulfate, conductance, and TDS. One sample of COD exceeded (see Table 7-F for data).

(6) Warm Creek 2
Below confluence of Del Rosa Channel and Upper Warm Creek at Tippecanoe Avenue Bridge in San Bernardino

The Warm Creek 2 (WC 2) site is within a concrete box flood control channel and accessed using a ladder. Fauna did not exist at the site except in the form of weeds growing in crevices within the concrete. The sampling location was either downstream of Tippecanoe Street Bridge or underneath depending upon where the most water was present. Flow at the site was always a standing water condition and analyses were therefore conducted out of sterile cup or WhirlPak® bag. The primary source of water at the site came from an inlet that drained the street gutters above and apartment complex adjacent to channel.

In regards to the *E. coli* bacteria concentrations, this site was the worst. The concentrations were magnitudes different than that of upstream and downstream sample sites. The source of the high concentrations could be partially attributed to the bird population underneath the bridge. Furthermore, vagrants were often within the channel, but the site was cleaned of debris by county flood control personnel periodically throughout the course of the project.

We visited the site 42 times during the warm season but could not gain access on two occasions when our lock on the access gate had been removed. Notably, the sample was always taken from standing water; perhaps it flowed in the early morning or nighttime. All field parameters exceeded water quality objectives in both seasons (see Table 8-B for data). During the cool season, we visited the site 16 times (but locked out once). We were unable to get a geomean of 5 samples in 30 days during the cool season; however the seven geomeans from 4 samples/30 days were some of the highest concentrations of the whole project (see Table 8-C for data). This suggests there may be a direct source of *E.coli* bacteria and further investigation should be pursued (see Table 8-A below).

Table 8-A: Results Summary Table for Warm Creek 2 Site

	Flow Rate (cfs)	Air Temp (°C)	Water Temp (°C)	pH	DO (mg/L)	EC (uS/cm)	*E. coli* (mpn)	Total coliform (mpn)	*E.coli* geomean (mpn)[a]
Warm Season									
N	40	35	32	32	26	31	29	12	10
Average	0	28.7	25.0	8.8	6.7	1594.4	8666.2	55217.0	3243.9
Median	0	29.1	23.9	8.5	6.2	1245.0	2489.0	32986.5	3191.9
# exceed	-	-	6	15	10	31	22	-	10
% exceed	-	-	19%	47%	38%	100%	76%	-	100%
Cool Season									
N	15	14	14	14	13	14	14	9	0
Average	0	20.9	18.2	8.7	7.7	990.3	3421.1	45728.0	-
Median	0	21.6	16.9	8.5	8.0	753.5	1251.5	8664.0	-
# exceed	-	-	2	7	2	13	10	-	-
% exceed	-	-	14%	50%	15%	93%	71%	-	-

[a] Results shown in summary table reflect only the usable data, i.e., the 5 sample geomeans. Any bacteria results that were > or < a value are not included in the summary table.

Field observations on the physical nature of the water suggest it is often malodorous, with a distinctive color and turbidity in both the cool and warm seasons (see Table 8-D for warm season and Table 8-E for cool season data).

Additional samples were collected once a month for nine months to send to a local contract laboratory (E.S. Babcock & Sons) to analyze cations, anions, conductance, TDS, COD, nutrients, metals/metalloids, PCBs and organochlorine pesticides. We found the following to be higher than their respective limits in seven of the eight samples taken: total hardness, sodium, chloride, sulfate, conductance, TDS and lead. COD and ammonia-nitrogen exceeded in 6 and 5 samples, respectively (see Table 8-F for data).

On October 16, 2009, the lab reported a hit of 4,4-DDE that was significantly over the limit specified in the California Toxics Rule. 4,4-DDE is an organochlorine chemical largely banned in the U.S. that bioaccumulates and is linked to cancer and reproductive harm. DDE is also a breakdown product of DDT. Waterkeeper did not follow up with the lab to re-check the results in case of lab contamination. Remember that the day before at sample site CC1 we also had a hit of DDE and DDT.

(6) Warm Creek 3
Below Twin Creek Flood Control Basin and above Highland Avenue Bridge in San Bernardino

The Warm Creek 3 (WC 3, actually Twin Creek) site is a large concrete box channel with access from a gated ladder next to a flood event flow rate recorder. The site is mostly dry and consistently used for trash dumping from adjacent apartments and homes. Stream flow was unpredictable as flood control basins emptied into the channel upstream as well as local street runoff. The amount of water varied from stagnant to two to three inches of water across the span of the channel. Fauna at the site was exclusive to small clumps of grasses growing out of cracks in the concrete floor and algae. At times when the stream flow may have covered the entire channel bottom the algae grew to almost a half an inch thick. The algae also emitted an odor, somewhat like hydrogen sulfide when air temperatures were hot. Animal life was scarce with only a few small birds, blackbirds and sparrows mostly, and there was the occasional hawk, raven and crow.

We visited the WC-3 site 42 times during the warm season, but only were able to collect samples on 19 visits. Of those we found results of temperature, pH, conductivity and single sample *E.coli* exceeding water quality objectives. Based on the timing of the sampling and available flow from which to sample, we were not able to calculate more than one 5 sample/30 day geomean of *E.coli*. Single samples of *E.coli* ranged from less than 1.0 mpn to 9804 mpn (see Table 9-A below, and Table 9-B for data).

During the cool season, we visited the site 16 times but were only able to collect samples on half of the visits. The results for pH and conductivity exceeded limits. The single sample *E.coli* results show a spike on 1/16/2009 but otherwise results are within limit. No 5 sample/30 day geomeans could be calculated from the cool season single samples (see Table 9-C for data).

Table 9-A: Results Summary Table for Warm Creek 3 Site

	Flow Rate (cfs)	Air Temp (°C)	Water Temp (°C)	pH	DO (mg/L)	EC (uS/cm)	*E. coli* (mpn)	Total coliform (mpn)	*E.coli* geomean (mpn)[a]
Warm Season									
N	41	41	19	19	12	19	15	9	1
Average	0.26	28.7	28.5	9.9	8.7	577.1	1642.3	109667.5	67.71
Median	0	29.7	30.0	10.1	8.6	577.0	249.5	111990.0	67.71
# exceed	-	-	5	18	0	15	8	-	0
% exceed	-	-	26%	95%	0%	79%	53%	-	0%
Cool Season									
N	15	15	8	8	8	8	8	5	0
Average	1.4	20.5	14.2	8.7	9.2	676.2	3067.2	8960.6	-
Median	0	22.5	13.4	8.6	9.0	594.0	39.3	7270.0	-
# exceed	-	-	0	4	0	7	1	-	-
% exceed	-	-	0%	50%	0%	88%	13%	-	-

[a] Results shown in summary table reflect only the usable data, i.e., the 5 sample geomeans. Any bacteria results that were > or < a value are not included in the summary table.

Field observations on the physical nature of the water suggest it is often malodorous, with a distinctive color and turbidity in both the cool and warm seasons. No clear pattern emerges (see Table 9-D for warm season and Table 9-E for cool season data).

Additional samples were collected once a month for nine months to send to a local contract laboratory (E.S. Babcock & Sons) to analyze cations, anions, conductance, TDS, COD, nutrients, metals/metalloids, PCBs and organochlorine pesticides. No samples could be collected in five of the nine months due to lack of flow; therefore only 4 sets of samples were analyzed. The following constituents had at least one result that exceeds objectives: hardness (3), TDS (3), chloride (2), conductivity (2), COD (2), ammonia-nitrogen (2), sodium (1), sulfate (1), total organic nitrogen (1), and lead (1). The sample size is so limited for this location that we cannot determine whether one of these constituents should be listed per the 303(d) list (see Table 9-F).

(6) Warm Creek 4
Below confluence of Lytle Cajon Channel and East Branch of Lytle Creek Above Fairway Drive Bridge in Colton

The Warm Creek 4 (WC 4) site is a wide concrete trapezoidal flood control channel with widths up to approximately 400 feet. Just downstream, it drains into the Santa Ana River. The stream flow was directed down a predetermined path that lay about one foot below the rest of the channel floor and was about fifteen feet in width. On occasion there would be a second stream that would flow approximately 80 feet parallel to the primary stream. This second stream's flow rate was marginal compared to the primary stream's flow rate and was not included in the flow rate, nor tested for quality. The source water for this section of Warm Creek was probably all outfall discharge from a treatment plant located upstream. During a few sampling events the flow rate noticeably gained volume and the quality of the water became inundated with suspended solids and an odor similar to that of cured manure.

Local fauna ranged from weeds and grasses to small vegetative strips along the stream edges. Animals in the area ranged from common crows, ground squirrels, and ravens to swallows nesting underneath the nearby bridge. There were a few sampling events where small krill-like larva were seen swimming along the edge or being swept downstream. The numbers were tremendous compared to other water insects seen at other sites. This larva had a milky white outer shell and a small fanned tail, like that of a lobster. They were seen in and out of the water along the stream's edge and some buried themselves within the fine sediment and organic material that had accumulated along the water's edge.

We visited the WC-4 site 42 times during the warm season and 16 times during the cool season. This site showed consistently high pH levels during the entire project. Average water temperatures exceeded limits for 50% of the warm season, and conductivity was nearly always higher than the objective. Single sample and geomean *E.coli* results also showed significant rates of non-compliance (see Table 10-A below and Table 10-B for data).

During the cool season, only two single sample and three geomean *E.coli* results were beyond the proposed objectives. Only five 5 sample/30 day geomeans could be calculated. Scattered exceedances of water temperature and conductivity were also noted (see Table 10-C for data).

Table 10-A: Results Summary Table for Warm Creek 4 Site

	Flow Rate (cfs)	Air Temp (°C)	Water Temp (°C)	pH	DO (mg/L)	EC (uS/cm)	*E. coli* (mpn)	Total coliform (mpn)	*E.coli* geomean (mpn)[a]
Warm Season									
N	42	41	42	42	40	42	41	18	27
Average	4.3	31.6	30.2	9.3	9.1	532.4	511.5	42240.3	207.4
Median	2.7	32.1	31.2	9.4	9.2	518.7	133.3	24543.0	67.1
# exceed	-	-	19	42	0	36	15	-	10
% exceed	-	-	45%	100%	0%	86%	37%	-	37%
Cool Season									
N	15	15	15	15	15	15	15	13	5
Average	5.0	22.1	20.9	9.5	11.7	468.2	154.9	16738.5	149.9
Median	2.6	24.4	21.1	9.5	11.6	449.3	76.3	19863.0	126.3
# exceed	-	-	2	15	0	6	2	-	3
% exceed	-	-	13%	100%	0%	40%	13%	-	60%

[a] Results shown in summary table reflect only the usable data, i.e., the 5 sample geomeans. Any bacteria results that were > or < a value are not included in the summary table.

Field observations on the physical nature of the water suggest it can be malodorous, with a distinctive color and turbidity in both the cool and warm seasons. Odors range from sewage and petroleum to hydrogen sulfide. Water colors vary from yellow, brown and green (see Table 10-D for warm season and Table 10-E for cool season data).

Additional samples were collected once a month for nine months to send to a local contract laboratory (E.S. Babcock & Sons) to analyze cations, anions, conductance, TDS, COD, nutrients, metals/metalloids, PCBs and organochlorine pesticides. Thankfully this site flows year-round and all nine samples could be collected. Although no constituent exceeded limits in every sample, sodium and chloride exceeded limits 8 times each. Other constituents with at least half of samples exceeding include: conductivity, TDS, and COD. The three exceedances of lead are significant because it meets the criteria for listing of toxic pollutants (see Table 10-F for data).

D. Impaired Waterway Data Summarized

A significant part of this project was to analyze the results in light of the State's listing criteria for impaired waterbodies. Based solely on the results contained herein, below is a list by sample site of the pollutants that exceeded their respective objectives enough times to warrant listing. Each contains a short reasoning and whether it applies to one season or another.

Table 11: Pollutants by site exceeding objectives often enough to warrant 303(d) listing.

Site	Pollutant	Season[1]	Reason
San Timoteo 2	Sodium	-	9 of 9 Babcock samples greater than 30 mg/L
	Chloride	-	9 of 9 Babcock samples greater than 20 mg/L
	Conductivity	Warm and cool	9 of 9 Babcock samples, 43 of 43 Waterkeeper samples in warm season, and 17 of 17 Waterkeeper samples in cool season greater than 462 µS/cm.
	Total dissolved solids	-	9 of 9 Babcock samples greater than 300 mg/L
	Ammonia-nitrogen	-	5 of 9 Babcock samples greater than 0.098 mg/L
	E.coli bacteria	Warm	19 of 22 Waterkeeper warm season geomeans greater than 126 mpn/100 mL
San Timoteo 3	Hardness	-	9 of 9 Babcock samples greater than 190 mg/L
	Sodium	-	9 of 9 Babcock samples greater than 30 mg/L
	Chloride	-	9 of 9 Babcock samples greater than 20 mg/L
	Sulfate	-	5 of 9 Babcock samples greater than 60 mg/L
	Conductivity	-	9 of 9 Babcock samples, 38 of 38 Waterkeeper warm season and 16 of 16 cool season samples greater than 462 uS/cm
	TDS	-	9 of 9 Babcock samples greater than 300 mg/L
	Chemical oxygen demand (COD)	-	6 of 9 Babcock samples greater than 25 mg/L
	Ammonia-nitrogen	-	5 of 9 Babcock samples greater than 0.098 mg/L
	Lead[2]	-	7 of 9 Babcock samples greater than calculated limit
	E.coli bacteria	Warm and Cool	16 of 16 Waterkeeper warm season geomeans and 6 of 6 Waterkeeper cool season geomeans greater than 126 mpn/100 mL
San Timoteo 4	Hardness	-	6 of 9 Babcock samples greater than 190 mg/L
	Sodium	-	9 of 9 Babcock samples greater than 30 mg/L
	Chloride	-	9 of 9 Babcock samples greater than 20 mg/L
	Conductivity	-	9 of 9 Babcock samples,
	TDS	-	9 of 9 Babcock samples greater than 300 mg/L
	COD	-	8 of 9 Babcock samples greater than 25 mg/L
	Lead[2]	-	4 of 9 Babcock samples greater than calculated limit
	Temperature	Warm	11 of 43 Waterkeeper samples greater than 32.2
	pH	Warm and cool	43 of 43 Waterkeeper warm samples and 16 of 16 cool season samples greater than 8.5
	E.coli bacteria	Warm and cool	15 of 23 warm season and 7 of 7 cool season samples greater than 126 mpn/100 mL

[1] Season designations (warm/cool) could not be assigned to Babcock samples because the sample size was too small.
[2] Lead is considered a toxicant and should be listed if the number of exceedances is equal to or greater than 2 when the sample size is between 2 and 24.

Table 12 (Continued)

Site	Pollutant	Season[1]	Reason
City Creek 1	Chemical oxygen demand (COD)	-	6 of 9 Babcock samples greater than 5 mg/L
	Conductivity	Warm	8 of 42 Waterkeeper warm season samples greater than 308 uS/cm
City Creek 2	Chloride	-	5 of 8 Babcock samples greater than 10 mg/L
	COD	-	6 of 8 Babcock samples greater than 5 mg/L
	pH	Warm and cool	32 of 37 Waterkeeper warm samples and 9 of 15 cool samples greater than 8.5.
	Conductivity	Warm and cool	28 of 37 Waterkeeper warm and 7 of 15 cool season samples greater than 308 uS/cm.
Warm Creek 1	Sodium	-	7 of 7 Babcock samples greater than 30 mg/L
	Chloride	-	7 of 7 Babcock samples greater than 20 mg/L
	Sulfate	-	7 of 7 Babcock samples greater than 60 mg/L
	Conductivity	Warm and cool	7 of 7 Babcock samples, 35 of 35 warm season and 11 of 12 cool season samples greater than 462 uS/cm
	Total dissolved solids	-	7 of 7 Babcock samples greater than 300 mg/L
	pH	Warm	17 of 35 Waterkeeper warm season samples greater than 8.5
Warm Creek 2	Hardness	-	7 of 8 Babcock samples greater than 190 mg/L
	Sodium	-	7 of 8 Babcock samples greater than 30 mg/L
	Chloride	-	7 of 8 Babcock samples greater than 20 mg/L
	Sulfate	-	7 of 8 Babcock samples greater than 60 mg/L
	Conductivity	Warm and cool	7 of 8 Babcock samples, 31 of 31 Waterkeeper warm season, 13 of 14 Waterkeeper cool season samples greater than 462 uS/cm
	TDS	-	7 of 8 Babcock samples greater than 300 mg/L
	Chemical Oxygen Demand (COD)	-	6 of 8 Babcock samples greater than 25 mg/L
	Ammonia-nitrogen	-	5 of 8 Babcock samples greater than 0.098 mg/L
	Lead[2]	-	7 of 8 Babcock samples greater than calculated limit.
	Temperature	Warm	6 of 32 Waterkeeper warm season samples greater than 32.2 or 25.6
	pH	Warm and cool	15 of 32 warm season and 7 of 14 cool season samples greater than 8.5
	E. coli bacteria	Warm	10 of 10 warm season geomeans (5 samples/30 days) greater than 126 mpn/100 mL
Warm Creek 3	Temperature	Warm	5 of 19 Waterkeeper samples greater than 32.2 or 25.6
	pH	Warm	18 of 19 warm season samples greater than 8.5
	Conductivity	Warm and cool	15 of 19 warm season, and 7 of 8 cool season samples greater than 462 uS/cm
Warm Creek 4	Sodium	-	8 of 9 Babcock samples greater than 30 mg/L
	Chloride	-	8 of 9 Babcock samples greater than 20 mg/L
	Conductivity	Warm and cool	6 of 9 Babcock samples, 36 of 42 Waterkeeper warm season, and 6 of 15 cool season greater than 462 uS/cm
	TDS	-	7 of 9 Babcock samples greater than 300 mg/L
	COD	-	5 of 9 Babcock samples greater than 25 mg/L
	Lead [2]	-	3 of 9 Babcock samples greater than calculated limit
	Temperature	Warm	19 of 42 Waterkeeper warm season greater than 32.2 or 25.6
	pH	Warm and cool	42 of 42 warm season and 15 of 15 cool season greater than 8.5
	E. coli bacteria	Warm	10 of 27 warm season geomeans greater than 126 mpn/100 mL

[1] Season designations (warm/cool) could not be assigned to Babcock samples because the sample size was too small.
[2] Lead is considered a toxicant and should be listed if the number of exceedances is equal to or greater than 2, when the sample size is between 2 and 24.

E. Lessons Learned

During the process of analyzing the contract lab data, we found that it would have been more robust if just one more “cool season” data point was collected. In this project we have five warm season and four cool season results; but the minimum for listing is five. Another lesson we learned is to keep the order of sample sites the same week after week. In the first half of the project we alternated the order of site visits each week that resulted mostly in being unable to calculate a true five sample geomean.

F. Evaluation of Project Assessment and Evaluation Plan (PAEP)

The tasks of the project were as follows:

Task 1 – *IEWK will prepare and submit for approval a Monitoring Plan with Quality Assurance Project Plan detailing the project. IEWK will also obtain access permits and keys from San Bernardino County and Riverside County Flood Control Districts. IEWK will assist Regional Board staff in submitting proper CEQA documentation once the Regional Board members have officially approved the project.*

Monitoring plan, QAPP were submitted and approved. Access was granted to the channels, free of charge thanks to the San Bernardino County Flood Control District. A CEQA Notice of Exemption was filed for the project.

Task 2 – *IEWK staff will begin the weekly and monthly sampling and monitoring regimes as described in the Monitoring Plan. Bacteria testing will be performed in-house while other tests will be sent to E.S. Babcock & Sons Laboratory in Riverside. Probes for field measurements will be calibrated by IEWK staff.*

Sampling began and ended on time with the expected number of site visits completed. The required number of tests were sent to Babcock Labs. Field meters were calibrated by IEWK staff following standard operating procedures.

Task 3 – *IEWK will prepare 3 quarterly progress reports containing the data of the previous months. Each will contain a description of work completed, a description of any activities or results of special note, as well as tables summarizing the data generated.*

Three quarterly reports were submitted on time and complete.

Task 4 – *IEWK will prepare a final report containing a project QC report and results analysis. IEWK will also prepare a SWAMP-comparable database of results.*

This document constitutes the final report and the QA/QC report is contained under separate cover. IEWK has prepared the SWAMP database and will submit after June 1, 2010 when the “regional data center” at the Southern California Coastal Water Research Project (SCCWRP) is established for SWAMP data.

Project Goals - *Develop representative data on typical water quality and flow rates from 10 locations on Warm Creek, City Creek and San Timoteo Creek*

The goal was mostly achieved but not completely because San Timoteo Creek 1 in Cherry Valley never had flow from which to measure, albeit this is still useful information. For the other sites we have developed a source of typical and representative water quality data.

Desired Outcomes - *1. Understand weekly, monthly and seasonal fluctuations in E.coli concentrations, dissolved oxygen, pH, conductivity, temperature and flow rates. 2. Understand seasonal changes in other constituents (minerals, metals, nutrients, COD, pesticides, PCBs).*

The data generated from this project could provide insight with further analysis into monthly and seasonal fluctuations; however we focused on warm weather and cool weather seasonal changes only because of its importance with listing criteria. Other constituents were measured and seasonal changes observed as well.

Output Indicators - *1. Project approvals, document approvals, access approvals. 2. Water monitoring program implemented and data gathered according to plan.*

Project, document and access approvals were all obtained. The monitoring program was implemented and data gathered according to the schedule.

Outcome Indicators - *1. Regulators provided database with usable, robust data. 2. Improved water quality in creek reaches where pollutants were found.*

The state will be provided usable and robust data from this extensive, long-term project. It is our hope that they in turn use the data to improve water quality conditions over time where exceedances occurred.

Methods of Measurement - *1. SWAMP-comparable database of results using SWAMP QA/QC guidelines*

A database of all the bacteria results will be uploaded to the “regional data center” at SCCWRP sometime after June 1, 2010.

Targets - *1. 90% completion of site and parameter monitoring. 2. 100% increase in the understanding of the water quality in these creeks. 3. 100% completion of quarterly reports and final report. 4. 0 accidents or injuries.*

Each site was monitored no less than 55 times, or 92% of target. The total number of field tests fluctuates around 80-90% per site due to lack of flow or equipment failure. The total number of bacteria results also fluctuates due to lack of adequate flow, and because those with a “>” symbol in the result are not included herein. We think regulators will have a significant increase in the understanding of these creeks. All quarterly reports and the final report were completed on schedule. Unfortunately, one injury was recorded during monitoring that resulted in a day of findings lost for the WC sites.

APPENDIX A

APPENDIX B

APPENDIX C

APPENDIX D

APPENDIX E