## Owens, Cassandra@Waterboards

| | |
|---|---|
| **From:** | Ruth Custance <RCustance@Geosyntec.com> |
| **Sent:** | Monday, October 23, 2017 11:19 AM |
| **To:** | Owens, Cassandra@Waterboards |
| **Cc:** | Costa, Paul J (paul.j.costa@boeing.com); Brandon Steets |
| **Subject:** | Addendum to the SSFL Surface Water HHRA |
| **Attachments:** | SSFL Surface Water HHRA Addendum_10_23_2017 rev.pdf |

Cassandra,

Attached is a revised addendum incorporating the additional analysis.

Please let me know if you have any questions.

Regards,

Ruth


**Ruth Custance, MPH**
**Senior Principal**
-----------------------------------------------------
924 Anacapa Street, Suite 4A
Santa Barbara, CA 93101
Office: 805-897-3800
Direct: 805-979-9139
Cell: 805-570-5854
www.geosyntec.com

Geosyntec consultants

engineers | scientists | innovators

**Attachment B-4**

**Addendum to the Human Health Risk Assessment for Surface Water Outfalls Santa Susana Field Laboratory, Ventura County, CA**

**Evaluation of Potential Contribution of Water Flow from the SSFL to Offsite Downstream Locations**

## Introduction

This addendum to the Human Health Risk Assessment was prepared in response to comments from the Office of Environmental Health Hazard Assessment dated June 28, 2017 regarding providing additional information on potential downstream human exposures to aquatic organisms from surface water exiting the Santa Susana Field Laboratory (SSFL). In particular, this addendum addresses potential exposures to fish and the fish consumption pathway. This addendum was developed with input and in accordance with recommendations from the SSFL Surface Water Expert Panel.

While the fish consumption pathway is considered incomplete in the outfall drainage areas due to the ephemeral nature of the drainages, there could be the potential for fishing and fish consumption at offsite locations farther downstream of SSFL where water is present in sufficient quantity year-round. To evaluate this potential, available information on fishing in the Calleguas Creek and Los Angeles River watersheds was reviewed with focus on locations where fishing is more likely to occur. An analysis was conducted to determine the percent contribution of the water flow from the SSFL to the total amount received at these locations. Because the Calleguas Creek and Los Angeles River watersheds contain numerous sources of chemicals (e.g., from urban and agricultural runoff, wastewater treatment plant effluent, etc.) that cumulatively control water quality along these receiving waters, it is important to understand the relative contribution of SSFL flows compared to all other flows to these downstream locations.

Downstream and north of the SSFL outfalls in Ventura County, receiving waters include Arroyo Simi, which flows into the Arroyo Las Posas, Calleguas Creek and finally to the Pacific Ocean at Mugu Lagoon, collectively referred to as the Calleguas Creek Watershed (Figure 1). The Southern California Coastal Water Research Project (SCCWRP) performed a study of the frequency of fishing and consuming the fish caught in both Los Angeles and Ventura Counties, which included surveys of some of the waterways (SCCWRP, 2005). Data on extent of fishing were collected by censusing anglers at sites within different fishing areas (habitats) for each watershed. The survey focused on coastal terrace streams and creeks, the mouth of rivers and estuaries, urban lakes, mountain reservoirs and streams.

For the SCCWRP study, fishing areas were targeted within the Calleguas Creek Watershed, including the estuary (Mugu Bay), seven costal terrace streams (Lower Reach Calleguas Creek -- Highway 1 to confluence with Conejo Creek, Revolon Slough, Conejo Creek, Upper Reach Calleguas Creek to Conejo Creek confluence, Arroyo Simi, Fox Barranca, and Happy Camp Canyon), and one urban Lake (Rancho Simi Park Lake). A total of 22 site visits were conducted in this watershed, with Mugu Lagoon being visited the most times (8), followed by upper Calleguas Creek (4), Lower Calleguas Creek (3), and Arroyo Simi (3). The majority of fishers observed in the study were fishing at mountain reservoirs and urban lakes with the least likely observed at coastal terrace streams.

Over the survey, seven fishers were observed along coastal terrace streams, specifically along Arroyo Simi, which begins approximately 2.5 miles from the SSFL. In addition, it is known that Rancho Simi Park Lake, a lined urban lake adjacent to the Arroyo Simi farther downstream is stocked with fish[1]. This lake was not selected for survey due to the survey design but fishing occurs at the lake.

Downstream and south of the SSFL in the Los Angeles River Watershed, water flows intermittently through Dayton Canyon and Chatsworth Creek and Bell Canyon and Bell Creek where Bell Creek joins the Arroyo Calabasas and forms the beginning of the upper-most main stem of the Los Angeles River. Downstream of the confluence of Bell Creek and Arroyo Calabasas, the Los Angeles River receives flow from Browns Canyon, Aliso Creek and Caballero Creek, along with flows from numerous storm drain outfalls, where water then flows into the Sepulveda Basin and Sepulveda Dam Recreation Area approximately 10 miles from the SSFL (Figure 2). The lower reach of Bell Creek as well as the Los Angeles River in this area are concrete engineered channels with limited access (vertical or near vertical concrete walls and fencing to prevent access) to the Sepulveda Basin area where the river enters an area that is soft bottomed and not concrete lined. During dry weather, when fishing activity is most likely to occur, water depths in the engineered channels are typically a few inches whereas in the Sepulveda Basin depths can reach several feet. The Sepulveda Basin is a 2,150-acre open space area to collect floodwaters and is kept in a semi-natural state. Contributions to the Sepulveda Basin also include treated wastewater effluent from the Donald C. Tillman Water Reclamation Plant and several tributaries such as Bull and Haskell Creeks.

A few studies have been conducted in the Los Angeles River to evaluate the recreational use of the engineered tributaries within the watershed and to survey fish and fishers (RWQCB, 2013, LA River Expedition, 2008 and FOLAR, 2016). In 2008, a group surveyed the Los Angeles River to determine if it was possible to kayak along its length. As a part of the survey observations indicated that no recreational activity was occurring in the lower reaches of Bell Creek and the upper reaches of the Los Angeles River due to prohibited access and limited opportunities for adjacent recreational use. In addition, there is very little flow in this section of the river except for immediately following storm events. However, at the Sepulveda Basin and Sepulveda Dam Area where fishing was observed (Los Angeles River Expedition as cited in RWQCB, 2010) water flow and depth increases and there is tree cover and a soft bottom providing a habitat for fish. The Friends of the LA River (FOLAR) have been conducting studies at popular fishing locations along the Los Angeles River including the Glendale Narrows, Long Beach and the Sepulveda Basin. The Sepulveda Basin Fish Study was started in November 2015 and study results are expected in

[1] https://www.dfg.ca.gov/m/fishplantings/Details?county=Ventura&water=Rancho%20Simi%20Park%20Lake

2018. Fish have been collected as a part of the study with the majority being small (less than 1 inch) (FOLAR, 2016).

Based on the information summarized above, two locations were selected to evaluate the percent contribution of SSFL surface water flow to the overall water flow. For SSFL's northern drainages, the Arroyo Simi at the confluence with Meier Canyon was selected as the nearest location where fishing may occur. For SSFL's southern drainages, the Sepulveda Basin is the nearest location that has fishable water and was therefore selected at the most likely location where fishing could occur.

**Water Flow Evaluation**

An analysis was performed to determine the percent contribution of flow from the SSFL NPDES outfalls to the total flow at the analysis locations along the Arroyo Simi and Los Angeles River identified above ("analysis locations"). The first is located on Arroyo Simi at the confluence with Meier Canyon, in the Calleguas Creek watershed. The second location is on the Los Angeles River at the beginning of the Sepulveda basin (at Louise Avenue), in the Los Angeles River watershed. These analysis locations receive flow from SSFL outfalls as described below:

- Arroyo Simi
    - Outfalls 003 through 007 and 010 – stormwater runoff draining to these outfalls is typically pumped to Silvernale Pond and then discharged through Outfall 002, as noted below. However, if these storage and pumping systems reach capacity, then overflows are discharged through each outfall to drainages that flow to Arroyo Simi.
    - Outfall 009 – includes the entire Outfall 009 watershed, with the exception of runoff from the Helipad area, which is pumped to Silvernale Pond and therefore included in Outfall 002 discharge volumes, as noted below. Overflows from the Helipad continue down toward Outfall 009.
- Los Angeles River
    - Outfall 001 – also includes flow from Outfall 011[2], which includes stormwater from the Perimeter Pond upstream.
    - Outfall 002 – also includes flow from Outfall 018[3], which includes stormwater pumped to Silvernale Pond from Outfalls 003 through 007 and 010 and the Helipad, up to the systems' storage and pumping capacity.
    - Outfall 019 – this outfall represents the proposed location for discharge from the Groundwater Extraction Treatment System (GETS), for which the analysis was performed both including and not including a constant average flowrate of 60 gallons per minute (gpm).
    - Outfall 008

The drainage areas to each SSFL outfall are shown in Table 1.

[2] Outfall 015 also discharges to Outfall 011, but was discontinued.
[3] Outfall 017 also discharges to Outfall 018, but was discontinued.

**Table 1. SSFL Outfall Drainage Areas**

| SSFL Outfall | Drainage Area (acre) |
|---|---|
| 001 | 306 |
| 002 | 360 |
| 003 | 11 |
| 004 | 5.9 |
| 005 | 0.0016 |
| 006 | 12 |
| 007 | 3.0 |
| 008 | 62 |
| 009 | 530 |
| 010 | 5.1 |
| 011 | 297 |
| 018 | 540 |

### Analysis

To perform this analysis, the total flow at the selected analysis locations was first estimated. For consistency with the HHRA, the total annual flow during the average hydrologic water year (WY) 2009/10 was determined. The drainage areas to each analysis location were first delineated, then spatial data were compiled in order to determine representative runoff coefficients (or percent of rainfall that is converted to runoff) within the drainage areas. Spatial data describing the soils within the area[4], specifically the hydrologic soil groups, in addition to the imperviousness based on the 2011 National Land Cover Database (NLCD), were used to determine runoff coefficients, as shown in the following equation (Ventura Countywide Stormwater Quality Management Program, 2011):

$$C = 0.95 \times IMP + C_p \times (1 - IMP) \qquad \textbf{(1)}$$

Where,
C = runoff coefficient
IMP = impervious fraction
$C_p$ = pervious runoff coefficient, determined based on soil type (see Table 2)

[4] Soils data for Ventura County was provided by the Ventura County Watershed Protection District and soils data for Los Angeles County was downloaded from a National Resources Conservation Service (NRCS) SSURGO database.

**Table 2. Pervious Runoff Coefficients (Ventura Countywide Stormwater Quality Management Program, 2011)**

| Hydrologic Soil Group[5] | $C_p$ |
|---|---|
| D | 0.15 |
| C | 0.10 |
| B | 0.05 |
| A | 0 |

A volumetric runoff coefficient method was then used, with the total annual rainfall of 19.48 inches in 2009/10 and the drainage area sizes previously delineated, to calculate the average annual runoff volume to each analysis location, as shown in the equation below:

$$Q = \sum_x \frac{P}{12} \times R_v \times A_x \qquad \textbf{(2)}$$

Where:
Q = runoff volume (ac-ft)
P = rainfall depth (in)
$R_v$ = runoff coefficient
$A_x$ = drainage area (ac)
x = each unique imperviousness and soil type combination

Finally, these estimated runoff volumes were calibrated to measured streamflow data (with baseflow removed[6]) from the United States Geological Survey (USGS) Los Angeles River Sepulveda Dam (# 11092450) station. The annual runoff volumes to this station were estimated using the methodology described above for each WY from 2002/03 through 2016/17[7], and a runoff volume adjustment factor was determine based on a comparison of observed and predicted runoff volumes for all WYs examined. This adjustment factor value was found to be 0.92, and the same value was applied to predicted runoff volumes for the Arroyo Simi drainage area, which did not have a nearby streamflow gauge available to allow a separate calibration.

[5] Hydrologic soil group A is defined by a high saturated hydraulic conductivity (i.e., high infiltration potential) and therefore has low runoff potential. Alternatively, hydrologic soil group D is defined by a low saturated hydraulic conductivity and therefore has a high runoff potential.

[6] Baseflow removal was performed on the measured streamflow data to extract the flow contribution from discharges such as the treated effluent from the Tillman Water Reclamation Plant, which enters the Sepulveda Basin below the analysis location but above the streamflow gauge at the dam.

[7] These WYs were used based on the availability of recent streamflow data.

**Results**

The drainage area to each analysis location, in addition to the total contributing drainage area from the SSFL and the percent contributing drainage area from the SSFL, are shown in Table 3.

**Table 3. Drainage Area Contributions from SSFL**

| **Location** | **Drainage Area (sq. mi.)** | **Contributing Drainage Area from SSFL** (assuming pumping to Silvernale Pond is occurring) (sq. mi.) | **Contributing Drainage Area from SSFL** (assuming pumping/storage to Silvernale Pond has reached capacity) (sq. mi.) | **% of the Total Drainage Area Contributed by SSFL** (assuming pumping to Silvernale Pond is occurring) | **% of the Total Drainage Area Contributed by SSFL** (assuming pumping/storage to Silvernale Pond has reached capacity) |
|---|---|---|---|---|---|
| Arroyo Simi (Meier Canyon confluence) | 32 | 0.83 | 0.89 | 2.6% | 2.8% |
| LA River (Sepulveda Basin at Louise Ave) | 118 | 2.5 | 2.4 | 2.1% | 2.1% |

Once calibrated total annual runoff volumes to the analysis locations were determined, the contribution from SSFL outfalls was determined by summing daily flows measured from each outfall during the 2009/10 WY (with the exception of Outfall 019, which assumed an average GETS discharge flowrate). The total flow measured from each outfall was then compared to the calibrated total estimated runoff volumes at each downstream analysis location. These results are shown in Table 4 and Figures 1 and 2. With respect to the year to year variability of these estimates, SSFL's percent flow contribution is not expected to increase much in a wet year, when SSFL and the rest of the watersheds are flowing heavily. At these times, percent flow contribution would essentially max out at the percent area contribution (i.e., 2-3%). However, in a dry year, given SSFL's low imperviousness relative to the urban areas, SSFL's percent flow contributions could drop to near zero. For example, this effectively occurred during recent drought years when SSFL's outfalls experienced very low discharge volumes and days with flow (many outfalls were without any discharge).

**Table 4. Flow Contributions from SSFL**

| Location | Predicted Annual Runoff Volume (adjusted) (ac-ft) | Contribution from SSFL excluding OF 019 (ac-ft) | Contribution from SSFL including OF 019 (ac ft) | Percent Contribution from SSFL excluding OF 019 | Percent Contribution from SSFL including OF 019 |
|---|---|---|---|---|---|
| Arroyo Simi (Meier Canyon confluence) | 6,300 | 91 | 91 (unaffected) | 1% | N/A |
| LA River (Sepulveda Basin at Louise Ave) | 37,000 | 150 | 250 | 0.4% | 0.7% |

Flow contributions ranged from 0.7% to 1% depending on the drainage area. To evaluate further, the percent contribution values were used to scale the outfall-specific exposure point concentrations (EPCs) that were used for the HHRA analysis to calculate theoretical contribution concentrations from the SSFL at the downstream locations where fishing may occur. The contribution concentration estimates are theoretical in nature because they only represent what may be coming for the SSFL and not actual concentrations measured downstream which would include flows and constituent concentrations commingled from all other sources within the drainage areas to these creek/river evaluation locations (e.g., from urban and agricultural runoff, wastewater treatment plant effluent, etc.). The theoretical contribution concentrations were then compared to California Toxics Rule (CTR) human health water quality criteria values for consumption of organisms, which account for bioaccumulation and addresses the fish consumption pathway.

To calculate theoretical contribution concentrations at the downstream locations, EPCs for constituents with CTR criteria from the outfalls were identified from the HHRA. For the Arroyo Simi evaluation, the EPCs from Outfall 009 were used. For the Los Angeles River evaluation, the EPCs from Outfalls 001, 002, 008, and 019 were selected. Outfalls 011 and 018 are upstream of Outfalls 001 and 002, respectively, and therefore are represented by flows and concentrations from Outfalls 001 and 002[8].

For the Los Angeles River evaluation, a volume-weighted concentration was then calculated to provide an estimate of each constituent concentration that could be present in water flowing from the Site downstream to the Los Angeles River. To calculate the volume-weighted concentration the EPC from Outfalls 001, 002, 008 and 019 were adjusted by the proportion of the total discharge volume (measured during the 2009/10 water year) from each outfall in Table 5 below. When constituents were not detected at an outfall, one-half the maximum detection limit was used to represent the constituent concentration.

[8] Due to SSFL stormwater capture/storage and pumping practices, these Outfall 001, 002, 011, and 018 discharge samples (which are used to establish the EPCs used in the HHRA and in this Addendum analysis) also include stormwater from Outfalls 003 through 007 and 010, as well as runoff from the helipad in the Outfall 009 watershed.

**Table 5. Discharge Volume Contributions from SSFL's Southern Outfalls**

| Outfall | Volume (gallons) in 2009/10 WY | Percent Contribution |
|---|---|---|
| 001 | 7,414,530 | 9.2% |
| 002 | 39,222,060 | 49% |
| 008 | 2,116,495 | 2.6% |
| 019 | 31,536,000 | 39% |
| ***Total*** | ***80,289,085*** | ***100%*** |

Table 6 summarizes the EPCs for the outfalls that flow towards the Los Angeles River. These concentrations were then volume-averaged for each constituent using the percent contributions from Table 5. Table 8 summarizes the resulting single volume-averaged EPCs to represent the blended SSFL discharge to the Los Angeles River.

For TCDD-TEQ, EPCs were calculated for this evaluation using Toxicity Equivalency Factors (TEFs) and Biological Equivalency Factors (BEFs). BEFs account for the different biological uptake from the water column of the various dioxin congeners into aquatic organisms. The United States Environmental Protection Agency (USEPA) and California EPA Regional Water Quality Control Boards have incorporated the use of BEFs for dioxin-TEQ when comparing to human health water quality criteria for consumption of organisms. USEPA has stated, "TEFs and BEFs shall be used when calculating a 2,3,7,8-TCDD toxicity equivalence concentration when implementing both human health noncancer and cancer criteria." [40 CFR, Part 132, Appendix F]. TCDD-TEQ EPC concentrations were calculated using the methodology from the HHRA using the 2005 TEFs and including "j"-estimated or DNQ (detected not quantified) congener concentrations and BEFs. Table A-1 in Attachment A presents the TCDD-TEQ EPC estimates using TEFs and BEFs for all the Outfalls.

Concentrations from the Site were then adjusted by the drainage contributions presented in Table 4 to calculate theoretical contribution concentrations that may be present at the downstream locations where fishing may occur (Tables 7 and 8).

All theoretical contribution concentration estimates for the Arroyo Simi and Los Angeles River were below their applicable CTR criteria values (Table 7 and 8). These theoretical concentration estimates comparison is considered conservative given the conservative nature of the CTR criteria derivation (assuming frequent fish consumption) as opposed to potential exposure from outfall discharges which would occur for only a few weeks each year, primarily during the winter months. Furthermore, bioaccumulation based human health criteria are based on equilibrium assumptions, where water and tissue are exposed over long, continuous durations, which is vastly different from and more conservative than the episodic and shorter duration occurrence of stormflows from SSFL to the downstream fishable reaches. Therefore, equilibrium bioaccumulation is never expected to be achieved within fish-stormwater exposure timeframes.

## Conclusions

Based on the review of available information on fishing in the Calleguas Creek and Los Angeles River watersheds, two locations were selected for evaluation where fishing may occur. For SSFL's northern drainages, the Arroyo Simi at the confluence with Meier Canyon approximately 2.5 miles from the SSFL was selected as the nearest location where fishing may occur. For SSFL's southern drainages, the Sepulveda Basin approximately 10 miles from the SSFL was selected as the nearest location where fishing may occur. As shown in Table 4, estimated flow contributions from SSFL at these downstream analysis locations are *de minimis*, with ≥ 99% of these wet weather flows being from stormwater runoff from other urban and undeveloped areas. Theoretical contribution concentrations based on the outfall EPCs and flow contributions were below the CTR criteria for human consumption of aquatic organisms. Based on the evaluation, the contribution of water flow from the SSFL to water quality at these locations is considered insignificant and would not adversely impact potential fishing activities.

## References

Victor J. Bierman, Jr et al. 2008. Bay Area Clean Water Agencies' Draft Dioxin Issue Paper: Expert Panel Response and Recommendations. April 2008.

Friends of the Los Angeles River (FOLAR), 2016. State of the River 3 - Long Beach Fish Study. June 2016.

Los Angeles Regional Water Quality Control Board (LARWQCB). 2013. Recreational Use Reassessment (RECUR) of the Engineered Channels of the Los Angeles River Watershed. Draft December 2013.

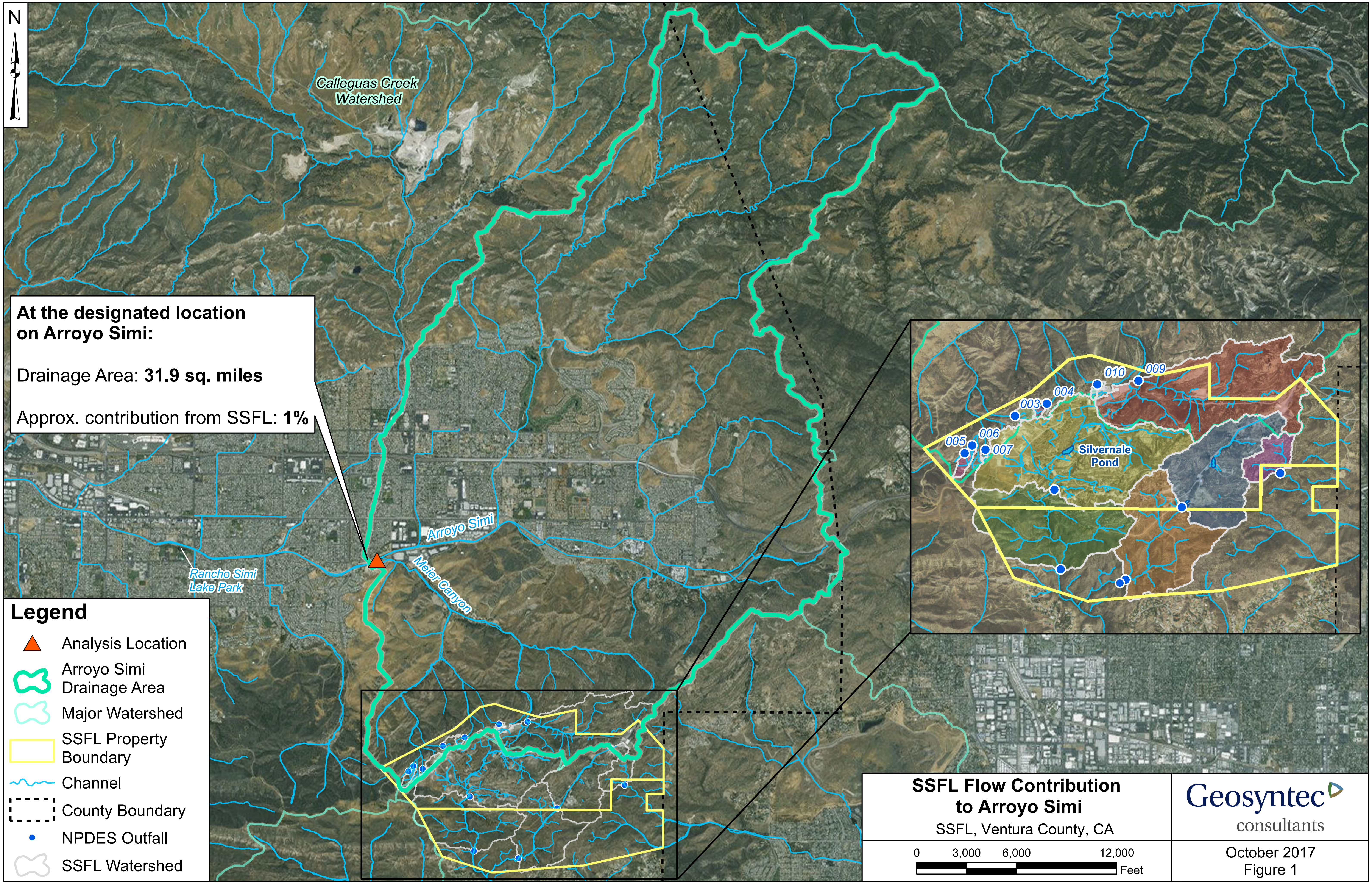
Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at https://websoilsurvey.nrcs.usda.gov/. Accessed September 2017.

Southern California Coastal Research Project (SCCRP), 2005. Extent of Fishing and Fish Consumption by Fishers in Ventura and Los Angeles County Watersheds in 2005. Technical Report 574 – September 2008.

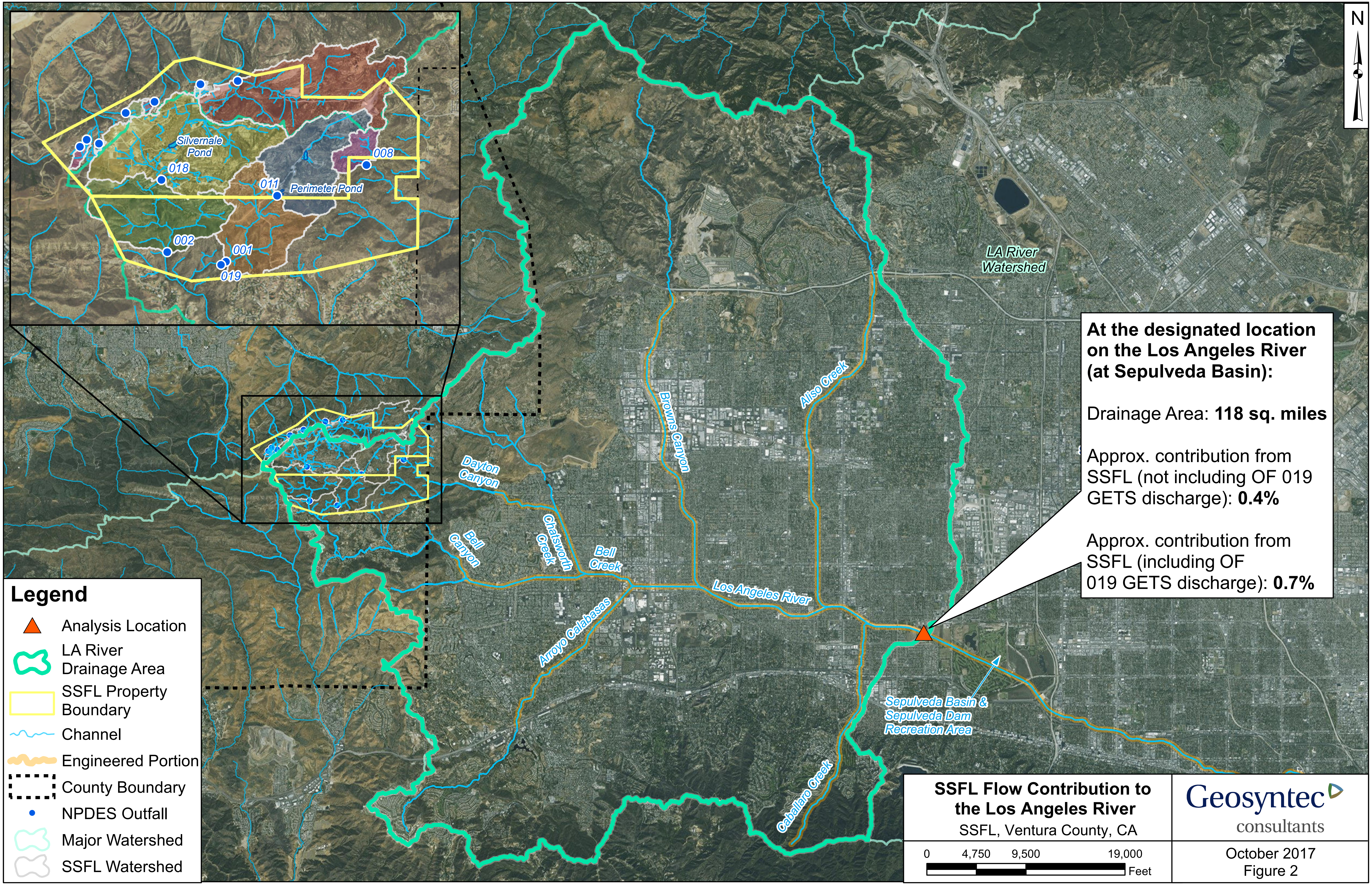
Ventura Countywide Stormwater Quality Management Program, 2011. *Ventura County Technical Guidance Manual for Stormwater Quality Control Measures.* Prepared by Geosyntec Consultants and Larry Walker Associates. July 2011.

George Wolfe, 2008. Los Angeles River Expedition – A Watershed Moment. September 2008 (as cited in LARWQCB, 2013).

# FIGURES




Date: 9/22/2017, Path: Z:\GIS\Projects\Boeing\SSFL\2017 LA0406\HHRA_Flow_Analysis\HHRA_Flow_ArroyoSimi_20170922(2).mxd, User: SIsaac




Date: 9/22/2017, Path: Z:\GIS\Projects\Boeing\SSFL\2017 LA0406\HHRA_Flow_Analysis\HHRA_Flow_LARiver_20170922.mxd, User: SIsaac

# TABLES

**Table 6**
**Concentrations from Outfalls 001, 002, 008 and 019 used in Flow-Volume Weighted Concentration**

| Analyte | Outfall | Outfall Concentration |
|---|---|---|
| 2,3,7,8-TCDD TEQ (1) | 001 | 9.3E-07 |
| 2,3,7,8-TCDD TEQ (1) | 002 | 7.7E-08 |
| 2,3,7,8-TCDD TEQ (1) | 008 | 2.6E-06 |
| 2,3,7,8-TCDD TEQ (1) | 019 | 2.9E-06 |
| Antimony | 001 | 0.45 |
| Antimony | 002 | 0.3 |
| Antimony | 008 | 0.442 |
| Antimony | 019 | 0.15 |
| Bis(2-ethylhexyl) phthalate | 001 | 0.805 |
| Bis(2-ethylhexyl) phthalate | 002 | 1.005 |
| Bis(2-ethylhexyl) phthalate | 008 | 1.87 |
| Bis(2-ethylhexyl) phthalate | 019 | 3.29 |
| Cyanide Anion | 001 | 1.5 |
| Cyanide Anion | 002 | 1.5 |
| Cyanide Anion | 008 | 8.7 |
| Cyanide Anion | 019 | 1.5 |
| Diethyl phthalate | 001 | 0.226 |
| Diethyl phthalate | 002 | 0.245 |
| Diethyl phthalate | 008 | 0.166 |
| Diethyl phthalate | 019 | 0.226 |
| Mercury | 001 | 0.05 |
| Mercury | 002 | 0.032 |
| Mercury | 008 | 0.029 |
| Mercury | 019 | 0.05 |
| Mercury (dissolved) | 001 | 0.05 |
| Mercury (dissolved) | 002 | 0.03 |
| Mercury (dissolved) | 008 | 0.16 |
| Mercury (dissolved) | 019 | 0.23 |
| Nickel | 001 | 12 |
| Nickel | 002 | 8.3 |
| Nickel | 008 | 20 |
| Nickel | 019 | 2.9 |
| Pentachlorophenol | 001 | 1.5 |
| Pentachlorophenol | 002 | 0.505 |
| Pentachlorophenol | 008 | 1.685 |
| Pentachlorophenol | 019 | 8.3 |

**Table 6**
**Concentrations from Outfalls 001, 002, 008 and 019 used in Flow-Volume Weighted Concentration**

| Analyte | Outfall | Outfall Concentration |
|---|---|---|
| Thallium (dissolved) | 001 | 0.5 |
| Thallium (dissolved) | 002 | 0.25 |
| Thallium (dissolved) | 008 | 1.2 |
| Thallium (dissolved) | 019 | 0.1 |
| Trichloroethene (TCE) | 001 | 0.13 |
| Trichloroethene (TCE) | 002 | 0.733 |
| Trichloroethene (TCE) | 008 | 0.13 |
| Trichloroethene (TCE) | 019 | 0.13 |

(1) TCDD-TEQ values calculated using:
a. Detected Not Quantified (DNQ) estimated concentrations below the reported limit
b. 2005 Toxicity Equivalency Factors (ETFs)
c. Bioequivalency Factors (BEFs)
TEQ - Toxicity Equivalents

**Table 7**

**Theoretical Contribution Concentrations for Arroyo Simi Compared to California Toxics Rule Criteria**

| CAS Number | Analyte | Outfall EPC | Theoretical Contribution Concentation | CTR [(1)] | Above CTR? |
|---|---|---|---|---|---|
| 1746-01-6 | 2,3,7,8-TCDD TEQ with DNQ | 6.8E-07 | 6.8E-09 | 1.4E-08 | No |
| 7440-36-0 | Antimony | 0.813 | 0.00813 | 4300 | No |
| 7440-36-0 | Antimony (dissolved) | 0.795 | 0.00795 | 4300 | No |
| 117-81-7 | Bis(2-ethylhexyl) phthalate | 10.6 | 0.106 | 5.9 | No |
| 84-66-2 | Diethyl phthalate | 0.257 | 0.00257 | 120000 | No |
| 7439-97-6 | Mercury | 0.11 | 0.0011 | 0.051 | No |
| 7440-02-0 | Nickel | 6.17 | 0.0617 | 4600 | No |
| 7440-02-0 | Nickel (dissolved) | 2 | 0.02 | 4600 | No |
| 87-86-5 | Pentachlorophenol | 1.46 | 0.0146 | 8.2 | No |
| 7440-28-0 | Thallium | 0.43 | 0.0043 | 6.3 | No |
| 7440-28-0 | Thallium (dissolved) | 0.29 | 0.0029 | 6.3 | No |

Notes:
CTR - California Toxics Rule
TEQ - dioxin-toxicity equivalencies EPC - Exposure Point Concentration DNQ - Detected Not Quantified
(1) Criteria for Human Consumption of Aquatic Organisms
All Concentrations in micrograms per liter (µg/L)

**Table 8**

**Theoretical Contribution Concentrations for Los Angeles River Compared to California Toxics Rule Criteria**

| CAS Number | Analyte | Outfall EPC (volume-weighted) | Theoretical Contribution Concentation | CTR [(1)] | Above CTR? |
|---|---|---|---|---|---|
| 1746-01-6 | 2,3,7,8-TCDD TEQ with DNQ | 1.3E-06 | 9.3E-09 | 1.4E-08 | No |
| 7440-36-0 | Antimony | 0.33 | 0.0023 | 4300 | No |
| 117-81-7 | Bis(2-ethylhexyl) phthalate | 2.3 | 0.016 | 5.9 | No |
| 57-12-5 | Cyanide Anion | 8.7 | 0.061 | 220000 | No |
| 84-66-2 | Diethyl phthalate | 0.23 | 0.0016 | 120000 | No |
| 7439-97-6 | Mercury | 0.045 | 0.00032 | 0.051 | No |
| 7439-97-6 | Mercury (dissolved) | 0.12 | 0.00084 | 0.051 | No |
| 7440-02-0 | Nickel | 6.8 | 0.048 | 4600 | No |
| 87-86-5 | Pentachlorophenol | 1.5 | 0.011 | 8.2 | No |
| 7440-28-0 | Thallium (dissolved) | 0.29 | 0.0020 | 6.3 | No |
| 79-01-6 | Trichloroethene (TCE) | 0.73 | 0.0051 | 81 | No |

Notes:
CTR - California Toxics Rule
TEQ - dioxin-toxicity equivalencies
EPC - Exposure Point Concentration
DNQ - Detected Not Quantified
(1) Criteria for Human Consumption of Aquatic Organisms
All Concentrations in micrograms per liter (µg/L)

# ATTACHMENT A-1

# Table A-1
## TCDD-TEQ Exposure Point Concentrations

| Outfall | Dioxin TEQ with 2005 TEF and BEF, DNQ Included | |
|---|---|---|
| | EPC Value (µg/L) | EPC Type |
| 001 | 9.3E-07 | Maximum Detected Value |
| 002 | 7.7E-08 | 95% Student's-t UCL (1) |
| 008 | 2.6E-06 | Maximum Detected Value |
| 009 | 6.8E-07 | 95% Adjusted Gamma UCL (1) |
| 019 | 2.9E-06 | Maximum Detected Value |

Notes:

(1) Data sufficient for 95 percent Upper Confidence Limit (UCL) calculation

CTR - California Toxics Rule (criteria for human consumption of aquatic organisms)

TEQ - dioxin-toxicity equivalencies

TEF - toxicity equivalency factor

BEF - bioaccumulation equivalency factor

EPC - Exposure Point Concentration

DNQ - Detected Not Quantified

µg/L - microgram per liter

## UCL Statistics for Uncensored Full Data Sets

| | |
|---|---|
| User Selected Options | |
| Date/Time of Computation | ProUCL 5.110/5/2017 3:19:48 PM |
| From File | qryHLE_UCL_Calc_Input_030_ProUCL_Ready_Take2.xls |
| Full Precision | OFF |
| Confidence Coefficient | 95% |
| Number of Bootstrap Operations | 2000 |

**Result (water, storm;outfall 002;dioxin teq with bef, human/mammal (epa, nds excluded))**

### General Statistics

| | | | |
|---|---|---|---|
| Total Number of Observations | 11 | Number of Distinct Observations | 11 |
| | | Number of Missing Observations | 0 |
| Minimum | 5.280E-11 | Mean | 4.6563E-8 |
| Maximum | 1.8190E-7 | Median | 3.0660E-8 |
| SD | 5.4928E-8 | Std. Error of Mean | 1.6561E-8 |
| Coefficient of Variation | N/A | Skewness | 1.69 |

### Normal GOF Test

| | | |
|---|---|---|
| Shapiro Wilk Test Statistic | 0.817 | **Shapiro Wilk GOF Test** |
| 5% Shapiro Wilk Critical Value | 0.85 | Data Not Normal at 5% Significance Level |
| Lilliefors Test Statistic | 0.219 | **Lilliefors GOF Test** |
| 5% Lilliefors Critical Value | 0.251 | Data appear Normal at 5% Significance Level |

**Data appear Approximate Normal at 5% Significance Level**

### Assuming Normal Distribution

| | | | |
|---|---|---|---|
| **95% Normal UCL** | | **95% UCLs (Adjusted for Skewness)** | |
| 95% Student's-t UCL | 7.6580E-8 | 95% Adjusted-CLT UCL (Chen-1995) | 8.2819E-8 |
| | | 95% Modified-t UCL (Johnson-1978) | 7.7986E-8 |

### Gamma GOF Test

| | | |
|---|---|---|
| A-D Test Statistic | 0.275 | **Anderson-Darling Gamma GOF Test** |
| 5% A-D Critical Value | 0.785 | Detected data appear Gamma Distributed at 5% Significance Level |
| K-S Test Statistic | 0.156 | **Kolmogorov-Smirnov Gamma GOF Test** |
| 5% K-S Critical Value | 0.27 | Detected data appear Gamma Distributed at 5% Significance Level |

**Detected data appear Gamma Distributed at 5% Significance Level**

### Gamma Statistics

| | | | |
|---|---|---|---|
| k hat (MLE) | 0.481 | k star (bias corrected MLE) | 0.41 |
| Theta hat (MLE) | 9.6839E-8 | Theta star (bias corrected MLE) | 1.1349E-7 |
| nu hat (MLE) | 10.58 | nu star (bias corrected) | 9.027 |
| MLE Mean (bias corrected) | 4.6563E-8 | MLE Sd (bias corrected) | 7.2693E-8 |
| | | Approximate Chi Square Value (0.05) | 3.343 |
| Adjusted Level of Significance | 0.0278 | Adjusted Chi Square Value | 2.804 |

### Assuming Gamma Distribution

| | | | |
|---|---|---|---|
| 95% Approximate Gamma UCL (use when n>=50)) | 1.2573E-7 | 95% Adjusted Gamma UCL (use when n<50) | 1.4991E-7 |

### Lognormal GOF Test

| | | |
|---|---|---|
| Shapiro Wilk Test Statistic | 0.858 | **Shapiro Wilk Lognormal GOF Test** |
| 5% Shapiro Wilk Critical Value | 0.85 | Data appear Lognormal at 5% Significance Level |
| Lilliefors Test Statistic | 0.24 | **Lilliefors Lognormal GOF Test** |
| 5% Lilliefors Critical Value | 0.251 | Data appear Lognormal at 5% Significance Level |

**Data appear Lognormal at 5% Significance Level**

**Lognormal Statistics**

| | | | |
|---|---|---|---|
| Minimum of Logged Data | -23.66 | Mean of logged Data | -18.21 |
| Maximum of Logged Data | -15.52 | SD of logged Data | 2.54 |

**Assuming Lognormal Distribution**

| | | | |
|---|---|---|---|
| 95% H-UCL | 5.3279E-5 | 90% Chebyshev (MVUE) UCL | 4.7360E-7 |
| 95% Chebyshev (MVUE) UCL | 6.2307E-7 | 97.5% Chebyshev (MVUE) UCL | 8.3053E-7 |
| 99% Chebyshev (MVUE) UCL | 1.2380E-6 | | |

**Nonparametric Distribution Free UCL Statistics**

**Data appear to follow a Discernible Distribution at 5% Significance Level**

**Nonparametric Distribution Free UCLs**

| | | | |
|---|---|---|---|
| 95% CLT UCL | 7.3804E-8 | 95% Jackknife UCL | 7.6580E-8 |
| 95% Standard Bootstrap UCL | 7.2840E-8 | 95% Bootstrap-t UCL | 9.7377E-8 |
| 95% Hall's Bootstrap UCL | 1.2176E-7 | 95% Percentile Bootstrap UCL | 7.4408E-8 |
| 95% BCA Bootstrap UCL | 8.2728E-8 | | |
| 90% Chebyshev(Mean, Sd) UCL | 9.6247E-8 | 95% Chebyshev(Mean, Sd) UCL | 1.1875E-7 |
| 97.5% Chebyshev(Mean, Sd) UCL | 1.4999E-7 | 99% Chebyshev(Mean, Sd) UCL | 2.1135E-7 |

**Suggested UCL to Use**

95% Student's-t UCL 7.6580E-8

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

**Result (water, storm;outfall 009;dioxin teq with bef, human/mammal (epa, nds excluded))**

**General Statistics**

| | | | |
|---|---|---|---|
| Total Number of Observations | 38 | Number of Distinct Observations | 37 |
| | | Number of Missing Observations | 0 |
| Minimum | 3.360E-11 | Mean | 3.6975E-7 |
| Maximum | 2.3600E-6 | Median | 5.1980E-8 |
| SD | 6.8200E-7 | Std. Error of Mean | 1.1063E-7 |
| Coefficient of Variation | N/A | Skewness | 2.175 |

**Normal GOF Test**

| | | |
|---|---|---|
| Shapiro Wilk Test Statistic | 0.586 | **Shapiro Wilk GOF Test** |
| 5% Shapiro Wilk Critical Value | 0.938 | Data Not Normal at 5% Significance Level |
| Lilliefors Test Statistic | 0.296 | **Lilliefors GOF Test** |
| 5% Lilliefors Critical Value | 0.142 | Data Not Normal at 5% Significance Level |

**Data Not Normal at 5% Significance Level**

**Assuming Normal Distribution**

| **95% Normal UCL** | | **95% UCLs (Adjusted for Skewness)** | |
|---|---|---|---|
| 95% Student's-t UCL | 5.5640E-7 | 95% Adjusted-CLT UCL (Chen-1995) | 5.9345E-7 |
| | | 95% Modified-t UCL (Johnson-1978) | 5.6291E-7 |

**Gamma GOF Test**

| | | |
|---|---|---|
| A-D Test Statistic | 0.649 | **Anderson-Darling Gamma GOF Test** |
| 5% A-D Critical Value | 0.86 | Detected data appear Gamma Distributed at 5% Significance Level |
| K-S Test Statistic | 0.118 | **Kolmogorov-Smirnov Gamma GOF Test** |
| 5% K-S Critical Value | 0.156 | Detected data appear Gamma Distributed at 5% Significance Level |

**Detected data appear Gamma Distributed at 5% Significance Level**

**Gamma Statistics**

| | | | |
|---|---|---|---|
| k hat (MLE) | 0.295 | k star (bias corrected MLE) | 0.289 |
| Theta hat (MLE) | 1.2549E-6 | Theta star (bias corrected MLE) | 1.2798E-6 |
| nu hat (MLE) | 22.39 | nu star (bias corrected) | 21.96 |
| MLE Mean (bias corrected) | 3.6975E-7 | MLE Sd (bias corrected) | 6.8789E-7 |
| | | Approximate Chi Square Value (0.05) | 12.31 |
| Adjusted Level of Significance | 0.0434 | Adjusted Chi Square Value | 12.01 |

**Assuming Gamma Distribution**

| | | | |
|---|---|---|---|
| 95% Approximate Gamma UCL (use when n>=50) | 6.5972E-7 | 95% Adjusted Gamma UCL (use when n<50) | 6.7620E-7 |

**Lognormal GOF Test**

| | | |
|---|---|---|
| Shapiro Wilk Test Statistic | 0.951 | **Shapiro Wilk Lognormal GOF Test** |
| 5% Shapiro Wilk Critical Value | 0.938 | Data appear Lognormal at 5% Significance Level |
| Lilliefors Test Statistic | 0.102 | **Lilliefors Lognormal GOF Test** |
| 5% Lilliefors Critical Value | 0.142 | Data appear Lognormal at 5% Significance Level |

**Data appear Lognormal at 5% Significance Level**

**Lognormal Statistics**

| | | | |
|---|---|---|---|
| Minimum of Logged Data | -24.12 | Mean of logged Data | -17.16 |
| Maximum of Logged Data | -12.96 | SD of logged Data | 2.881 |

**Assuming Lognormal Distribution**

| | | | |
|---|---|---|---|
| 95% H-UCL | 2.5058E-5 | 90% Chebyshev (MVUE) UCL | 4.3973E-6 |
| 95% Chebyshev (MVUE) UCL | 5.7381E-6 | 97.5% Chebyshev (MVUE) UCL | 7.5992E-6 |
| 99% Chebyshev (MVUE) UCL | 1.1255E-5 | | |

**Nonparametric Distribution Free UCL Statistics**

**Data appear to follow a Discernible Distribution at 5% Significance Level**

**Nonparametric Distribution Free UCLs**

| | | | |
|---|---|---|---|
| 95% CLT UCL | 5.5173E-7 | 95% Jackknife UCL | 5.5640E-7 |
| 95% Standard Bootstrap UCL | 5.4702E-7 | 95% Bootstrap-t UCL | 6.4402E-7 |
| 95% Hall's Bootstrap UCL | 5.5565E-7 | 95% Percentile Bootstrap UCL | 5.5853E-7 |
| 95% BCA Bootstrap UCL | 5.9807E-7 | | |
| 90% Chebyshev(Mean, Sd) UCL | 7.0166E-7 | 95% Chebyshev(Mean, Sd) UCL | 8.5200E-7 |
| 97.5% Chebyshev(Mean, Sd) UCL | 1.0607E-6 | 99% Chebyshev(Mean, Sd) UCL | 1.4706E-6 |

**Suggested UCL to Use**

| | |
|---|---|
| 95% Adjusted Gamma UCL | 6.7620E-7 |

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.