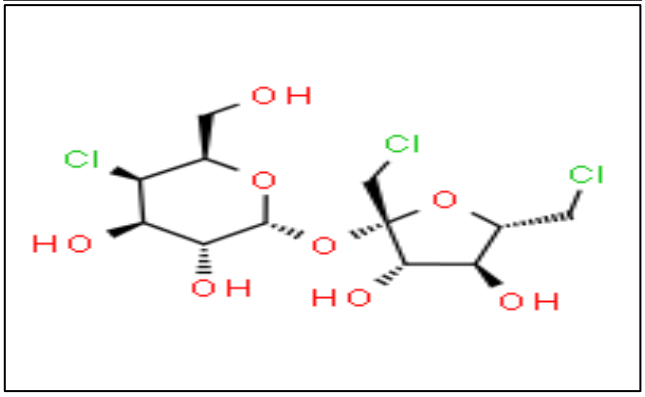
2019 Sampling Report for Emerging Constituents in the Santa Ana Region



Santa Ana Watershed Project Authority

SAWPA

Final Report *April, 2020*

Report for the 2019 Study of
Emerging Constituents in the Santa Ana River Watershed

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Section 1: Executive Summary

"Emerging Constituents" (EC) is a phrase used to describe a large number of pharmaceuticals, personal care products, food additives, pesticides and other common household chemicals for which federal and state authorities have not yet established an official water quality standard. In 2009, water and wastewater agencies in the Santa Ana River region developed a voluntary program to characterize "Emerging Constituents" in samples collected from the Santa Ana River, the Colorado River aqueduct, the State Water Project, and recycled water produced by local wastewater treatment plants.[1] This work was sponsored and coordinated by the Emerging Constituents Program Task Force that is administered through the Santa Ana Watershed Project Authority (SAWPA).[2]

Commencing in June of 2010, samples were collected and analyzed each summer for four consecutive years. Results were summarized in annual reports to the Santa Ana Regional Water Quality Control Board. The purpose of this voluntary study project was to gather data needed to inform development of statewide EC monitoring requirements. The study was terminated in 2014 after the California State Water Resources Control Board ("State Water Board") finalized its EC monitoring requirements for planned recycled water projects.

In October 2018, representatives from the Orange County Water District (OCWD) met with the Santa Ana River Dischargers Association (SARDA) and presented their initial findings regarding the occurrence of per- and polyfluoroalkyl substances (PFAS) in the Santa Ana River Watershed. OCWD and SARDA subsequently agreed that reconvening the Task Force, to update the previous EC studies, would provide useful insights regarding PFAS occurrence in the watershed.

In December of 2018, the State Water Board amended the Recycled Water Policy and revised the related EC monitoring requirements. Two months later, water and wastewater agencies in the Santa Ana region reconvened the Task Force and elected to update their prior work accordingly. In the summer of 2019, 29 new samples were collected and analyzed for various ECs including several PFAS. Summary results are shown in Table 1, below. More detailed data are provided in Table 4, later in this report.

Throughout this report, all EC concentrations are expressed as nanograms-per-liter (ng/L). One ng/L is equivalent to one part-per-trillion. One would have to drink over one million gallons of water containing the highest level of Ibuprofen measured during this study (240 ng/L) in order to ingest the amount normally found in two Advil® tablets. This does not imply that all substances are safe in the parts-per-trillion range. But, it does help readers better understand and interpret such ultra-low concentrations.

[1] The original EC monitoring program was reviewed and endorsed by the Santa Ana Regional Water Quality Control Board in Res. No. R8-2009-0071 (Dec. 10, 2009).

[2] Members of the Task Force are shown on page 19 of this report.

Table 1: Summary of Results for Emerging Constituents Analyzed in 2019 Study

Emerging Constituent	Freq. of Detection	Reported Range *(ng/L)*
Acetaminophen *(e.g. Tylenol®)*	2 of 29 (7%)	ND -35
Sulfamethoxazole (antibiotic)	10 of 29 (34%)	ND - 760
Gemfibrozil (anti-cholesterol)	4 of 29 (14%)	ND -210
Ibuprofen *(e.g. Advil®)*	5 of 29 (17%)	ND - 240
Iohexol (xray contrast agent)	26 of 28 (93%)	ND - 30,000
Naproxen *(e.g. Aleve®)*	4 of 29 (14%)	ND - 52
Sucralose *(e.g. Splenda®)*	29 of 29 (100%)	1,000 - 89,000
1,4 Dioxane	27 of 29 (93%)	ND - 1,300
N-Nitrosodimethylamine (NDMA)	23 of 29 (79%)	ND - 340
N-Nitrosomorpholine (NMOR)	21 of 29 (72%)	ND - 27
Hexafluoropropylene oxide dimer acid (HFPO-DA)	0 of 27 (0%)	ND
N-ethyl Perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0 of 29 (0%)	ND
N-methyl Perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	1 of 29 (3%)	ND - 5.6
Perfluorobutanesulfonic acid (PFBS)	17 of 29 (59%)	ND - 58
Perfluorodecanoic acid (PFDA)	1 of 29 (3%)	ND - 4
Perfluorododecanoic acid (PFDoA)	0 of 29 (0%)	ND
Perfluoroheptanoic acid (PFHpA)	7 of 29 (24%)	ND - 8.1
Perfluorohexanesulfonic acid (PFHxS)	7 of 29 (24%)	ND - 13.7
Perfluorohexanoic acid (PFHxA)	27 of 29 (93%)	ND - 57
Perfluorononanoic acid (PFNA)	1 of 29 (3%)	ND - 4.2
Perfluorooctane sulfonic acid (PFOS)	12 of 29 (41%)	ND - 32
Perfluorooctanoic acid (PFOA)	26 of 29 (90%)	ND - 57
Perfluorotetradecanoic Acid (PFTA)	0 of 29 (0%)	ND
Perfluorotridecanoic acid (PFTrDA)	0 of 29 (0%)	ND
Perfluoroundecanoic acid (PFUnA)	0 of 29 (0%)	ND
11-chloroeicosafluoro-3-oxaundecane-sulfonic acid	0 of 27 (0%)	ND
9-chlorohexadecafluoro-3-oxanone-sulfonic acid	0 of 27 (0%)	ND
4,8-dioxa-3H-perfluorononanoic acid (ADONA)	0 of 27 (0%)	ND

ng/L (nanogram-per-liter) = 1 part per trillion; ND = Not Detected

Section 2: Background & Purpose of Study

Water quality is routinely analyzed at thousands of locations across the country. Samples are collected from precipitation, storm water runoff, freshwater streams, lakes and reservoirs, groundwater wells and tap water to characterize the quality of these various sources. Additional samples from the sewage systems are analyzed to ensure pollution prevention programs and wastewater treatment plants are meeting all federal and state water quality standards.

Improvements in analytical technology have dramatically improved the ability of laboratories to detect chemicals at much lower concentrations.[3] Today, they are able to identify and quantify some compounds in the range of one part-per-trillion (ppt).[4] One part per trillion is equal to just one second in 31,546 years. In water, parts-per-trillion are expressed as nanograms-per-liter (ng/L). One nanogram per liter is equivalent to a single drop of water in twenty Olympic-sized swimming pools.

With the advent of this new technology, trace levels of many different man-made chemicals (including pesticides, pharmaceuticals and personal care products) have been detected in waters across the United States.[5] Collectively, these compounds are referred to as "Emerging Constituents" because we are now becoming aware of their presence.

Emerging Constituents is one of several similar phrases used to describe the same phenomena. Synonyms include: chemicals of emerging concern (CEC), micro-constituents, micro-pollutants, trace organics, etc. However, such phrases may mistakenly imply that it is the concern that is "emerging" rather than the technology to detect these compounds in a water sample. Similarly, referring to such compounds as "Emerging Pollutants" or "Emerging Contaminants" may unintentionally and improperly suggest that the levels detected pose a known hazard to people or the environment when the true risk, if any, has not yet been established by federal or state authorities.

In general, water pollutants can be divided into two categories: regulated and unregulated chemicals. Regulated chemicals include those for which formal water quality standards or state notification levels have been established. State and federal authorities often impose restrictions governing the release of such compounds into the environment. These requirements may range from relatively simple monitoring and reporting obligations to strict discharge prohibitions.

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[3] Vanderford, B.J., et al. "Analysis of Endocrine Disruptors and Personal Care Products in Water Using Liquid Chromatography and Tandem Mass Spectrometry." Analytical Chemistry. 2003 (75:6265-6274)

[4] Vanderford, B.J. and Shane Snyder. "Analysis of Pharmaceuticals in Water by Isotope Dilution Liquid Chromatography/Tandem Mass Spectrometry." Environmental Science and Technology. 2006 (p. 7312-7320).

[5] New York City Environmental Protection. 2010 Occurrence of Pharmaceutical and Personal Care Products (PPCPs) in Source Water of the New York City Water Supply. August 19, 2011.

By contrast, most ECs are initially unregulated. However, regulatory requirements can change as new information is developed. To that end, additional data are needed to characterize the presence and persistence of ECs in various water sources. This information, along with epidemiological and toxicological data, is used to set priorities for developing new drinking water standards, new water quality standards, new state Notification and Response Levels, and new monitoring requirements.[6]

Once ECs have been detected, the question naturally arises as to what effect, if any, these compounds may have on humans and the environment.[7] Several different regulatory agencies share responsibility for determining the acceptable concentration of these chemicals. This is a formidable task as there are tens of thousands of chemical compounds in common use.[8] Consequently, state and federal authorities rely on sales/usage information and monitoring data (from studies such as this one) to help determine appropriate research and regulatory priorities.[9]

The California Office of Environmental Health Hazard Assessment (OEHHA) and U.S. EPA have primary legal responsibility for making the necessary risk assessments and recommending appropriate water quality standards for all chemicals including ECs. The State Water Board's Division of Drinking Water (DDW) and Regional Water Quality Control Boards are responsible for implementing these standards in California.

In early 2009, the State Water Board adopted the first Recycled Water Policy (RWP).[10] As part of the RWP, the State Water Board convened a Science Advisory Panel (SAP) to recommend appropriate water quality monitoring strategies for ECs in recycled water. The recommendations were to be based on the best available pharmacological and toxicological information taking into consideration the fate and transport of such chemicals through advanced treatments systems and the natural environment. The SAP published their report in mid-2010.[11]

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[6] Additional information on the regulatory process governing Emerging Constituents is available at U.S. EPA"s official website: http://www.epa.gov/oppt/existingchemicals/

[7] See, for example, "How Safe is Our Water?" Reader's Digest. Aug., 2011; pg. 102.

[8] U.S. Senate Oversight Hearing on EPA's Unregulated Drinking Water Contaminants Program. July 12, 2011. http://epw.senate.gov/public/index.cfm?FuseAction=Hearings.Hearings&Hearing ID=fc5a8756-8021-23ad-454a-b9eeb7bf1c36

[9] U.S. Government Accountability Office. Environmental Health: Action Needed to Sustain Agencies' Collaboration on Pharmaceuticals in Drinking Water. GAO-11-346. August, 2011.

[10] SWRCB. Recycled Water Policy. Resolution No. 2009-0011 (adopted 2/3/09).

[11] Drewes, J.E., P. Anderson, N. Denslow, A. Olivieri, D. Schlenk & S. Snyder. Monitoring Strategies for Chemicals of Emerging Concern (CECs) in Recycled Water. Final Report and Recommendations of a Science Advisory Panel convened by the State Water Resources Control Board. Sacramento, CA. June 25, 2010.

The State Water Board relied on the SAP's recommendations to amend the RWP and establish formal EC monitoring requirements in January of 2013.[12] Five years later, in early 2018, the SAP reconvened and updated their recommendations for EC monitoring.[13] The State Water Board revised the Recycled Water Policy a second time, including the related EC monitoring requirements, later that same year.[14]

In addition, in mid-2014, the California Department of Health (DPH) finalized the EC monitoring requirements for groundwater recharge projects using recycled water.[15] These requirements remain in effect although responsibility for California's Drinking Water Program was transferred from DPH to DDW at the State Water Board in July of 2014.

The purpose of this study is to update the Santa Ana watershed's EC sampling program by evaluating the potential occurrence of several new EC compounds, including PFAS. Another goal is to gather data needed to assess long-term trends for some of the other ECs that had been previously monitored. Copies of all prior reports prepared by the EC Task Force are available for download from SAWPA's website.[16]

Section 3: Study Approach and Methods

The Sampling and Laboratory Analysis Plan (SLAP) previously developed by the Task Force was updated to be consistent with the revised EC monitoring program in the 2018 amendments to the RWP.[17] Thus, water samples were tested for the nine compounds listed in that policy (including PFOA & PFOS) plus three common over-the-counter analgesics that the Task Force had evaluated in prior years.

In addition, all samples were also tested for 16 other PFAS compounds in the same general class of chemicals as PFOA & PFOS. These supplemental analyses were performed in order to provide data that may be useful to state and federal authorities as they begin the process of determining whether or not to establish additional Notification Levels or new water quality standards for a broader range of PFAS.

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[12] State Water Resources Control Board. Attachment A: Requirements for Monitoring Constituents of Emerging Concern for Recycled Water. Jan. 22, 2013 [SWRCB Resolution No. 2013-0003].

[13] Southern California Coastal Water Research Project. Monitoring Strategies for Constituents of Emerging Concern (CECs) in Recycled Water: Recommendations of a Science Advisory Panel. SCCWRP Technical Report #1032; April, 2018.

[14] SWRCB. Amendments to the Policy for Water Quality Control for Recycled Water. Res. No. 2018-0057 (12/11/18).

[15] DPH-14-003E (May 30, 2014) See 22 CCR §60320.201(c)(1) et seq.

[16] SAWPA. 2013 Sampling Report for Emerging Constituents in the Santa Ana Region. April, 2014.

[17] A copy of the revised SLAP is provided in Appendix B to this report. Because this EC study was a voluntary effort, the SLAP was not required to meet the same Quality Assurance Project Plan (QAPP) specifications that apply to state-mandated water quality monitoring programs used to evaluate regulatory compliance.

Table 2: Emerging Constituents Analyzed in 2019

Compound	Category
N-Nitrosodimethylamine (NDMA)*	Disinfection By-Product
Gemfibrozil	Prescription Pharmaceutical
Sucralose *(e.g. Splenda®)*	Artificial Sweetener
1,4 Dioxane*	Industrial Chemical
N-Nitrosomorpholine (NMOR)*	Industrial Chemical & Disinfection By-Product
Iohexol	Xray Contrast Agent
Sulfamethoxazole	Prescription Antibiotic
Acetaminophen *(e.g. Tylenol®)*	Over-the-Counter Analgesic
Ibuprofen *(e.g. Advil®)*	Over-the-Counter Analgesic
Naproxen *(e.g. Aleve®)*	Over-the-Counter Analgesic
Perfluorooctanesulfonic acid (PFOS)*	Consumer/Industrial Chemical
Perfluorooctanoic acid (PFOA)*	Consumer/Industrial Chemical
Hexafluoropropylene oxide dimer acid (*"GenX"* or HFPO-DA)	Consumer/Industrial Chemical
N-ethyl Perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	Consumer/Industrial Chemical
N-methyl Perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	Consumer/Industrial Chemical
Perfluorobutanesulfonic acid (PFBS)	Consumer/Industrial Chemical
Perfluorodecanoic acid (PFDA)	Consumer/Industrial Chemical
Perfluorododecanoic acid (PFDoA)	Consumer/Industrial Chemical
Perfluoroheptanoic acid (PFHpA)	Consumer/Industrial Chemical
Perfluorohexanesulfonic acid (PFHxS)	Consumer/Industrial Chemical
Perfluorohexanoic acid (PFHxA)	Consumer/Industrial Chemical
Perfluorononanoic acid (PFNA)	Consumer/Industrial Chemical
Perfluorotetradecanoic Acid (PFTA)	Consumer/Industrial Chemical
Perfluorotridecanoic acid (PFTrDA)	Consumer/Industrial Chemical
Perfluoroundecanoic acid (PFUnA)	Consumer/Industrial Chemical
11-chloroeicosafluoro-3-oxaundecane-sulfonic acid	Consumer/Industrial Chemical
9-chlorohexadecafluoro-3-oxanone-sulfonic acid	Consumer/Industrial Chemical
4,8-dioxa-3H-perfluorononanoic acid (ADONA)	Consumer/Industrial Chemical

** denotes compounds with established state drinking water Notification and Response Levels or Monitoring Threshold Levels (MTLs) specified in 2018 RWP.*

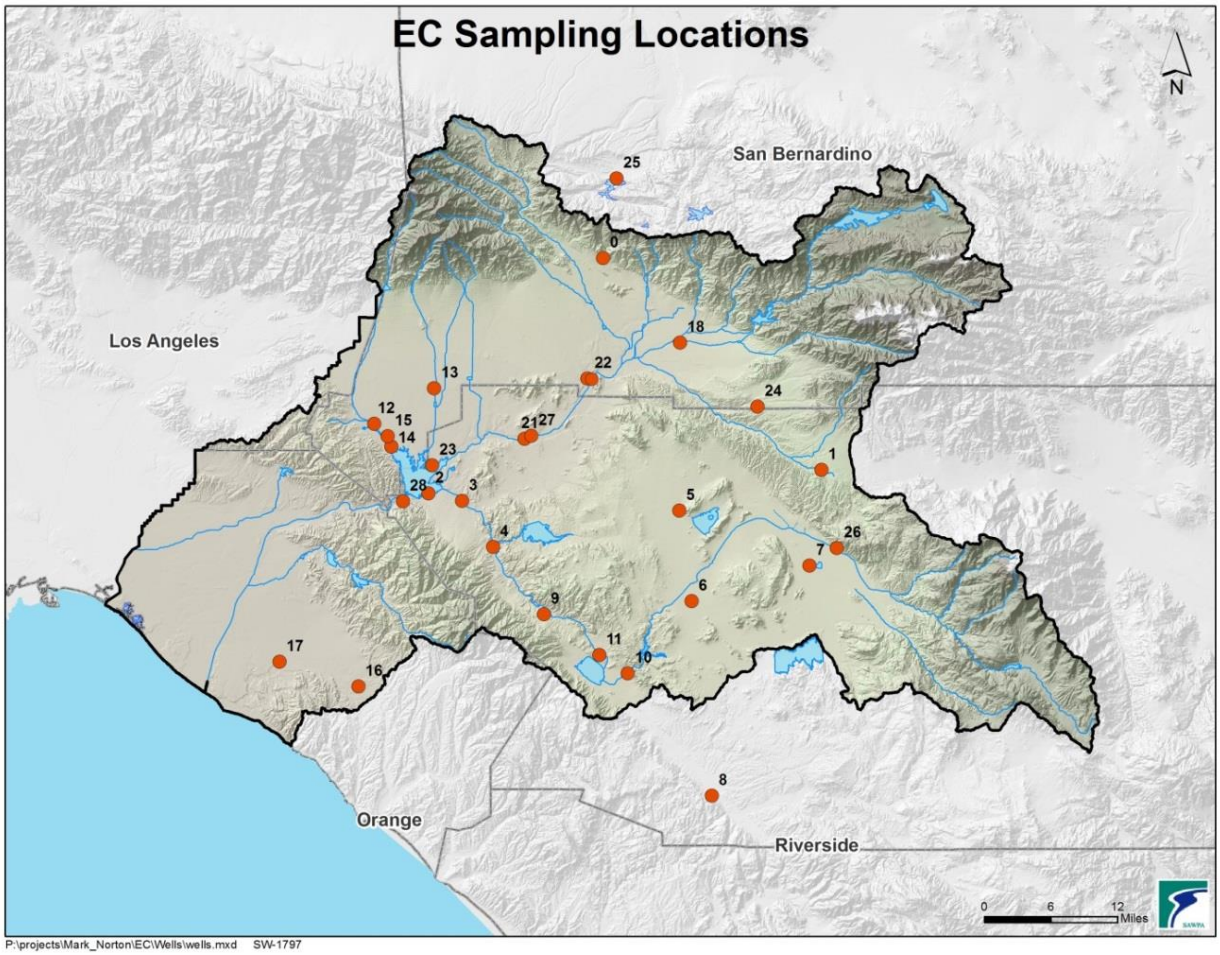
Samples were collected from 29 different locations throughout the region, including 25 wastewater treatment plant effluents, two imported water facilities and two sites along the Santa Ana River (see Table 3 and Figure 1).

Table 3: Sampling Locations for the 2019 EC Study

#	SAMPLING SITE	SAMPLE TYPE
1	City of Beaumont WWTP No. 1	POTW Effluent
2	City of Corona WRF 1B	POTW Effluent
3	City of Corona WRF 2	POTW Effluent
4	City of Corona WRF 3	POTW Effluent
5	EMWD MV-RWRF	POTW Effluent
6	EMWD PV-RWRF	POTW Effluent
7	EMWD SJV-RWRF	POTW Effluent
8	EMWD TV-RWRF (Units 1 & 2) + (Unit 3)*	POTW Effluent
9	EVMWD Horse Thief Canyon WRP	POTW Effluent
10	EVMWD Railroad Canyon WRP	POTW Effluent
11	EVMWD Regional WRP	POTW Effluent
12	IEUA CCWRF	POTW Effluent
13	IEUA RP1-02	POTW Effluent
14	IEUA RP1-1B	POTW Effluent
15	IEUA RP5	POTW Effluent
16	IRWD Los Alisos Plant	POTW Effluent
17	IRWD Michelson Plant	POTW Effluent
18	City of Redlands (Secondary Effluent)	POTW Effluent
19	City of Redlands (Tertiary Effluent)	POTW Effluent
20	City of Rialto WWTP	POTW Effluent
21	City of Riverside RWQCP	POTW Effluent
22	Cities of San Bernardino & Colton (RIX)	POTW Effluent
23	WRCWRA River Rd. Plant (WMWD)	POTW Effluent
24	Yucaipa Valley Water District WRF	POTW Effluent
25	State Project Water at Silverwood Lake	Imported Surface Water
26	Colorado River at San Jacinto West Portal	Imported Surface Water
27	Santa Ana River near MWD crossing	Local Surface Water
28	Santa Ana River below Prado Dam	Local Surface Water

**Two different samples were collected to characterize EMWD TV's final effluents; as a result, a total of 29 separate samples were analyzed during the 2019 EC study.*

Figure 1: Sampling Locations for ECs in the Santa Ana River Watershed (2019)



All of the samples were evaluated with the best analytical technology commercially available. These techniques are often capable of detecting select ECs in de-ionized laboratory water at concentrations in the low part-per-trillion range. For most of the ECs in this study, the mandatory reporting levels were set equal to those specified by the Recycled Water Policy. The mandatory reporting level was specified as 4 ng/L for PFAS analyzed in this study.[18]

Some of the tests conducted during this study relied on analytical methods EPA has published for drinking water; however, EPA has not yet promulgated standard methods for analysis of ECs in wastewater or surface water samples.[19] Data generated from the un-promulgated methods employed during this study have not been certified for purposes related to implementing the Clean Water Act. This includes, but is not limited to: 303(d) listing decisions, antidegradation analyses, or translating narrative criteria into numeric effluent limits, etc.

[18] The MRL for PFAS in this study is slightly more sensitive than required by the RWP, 2018.

[19] Standard methods for analyzing wastewater and surface waters must be promulgated by EPA in accordance with 40 CFR Part 136 and 40 CFR Part 141. However, where EPA or the SWRCB have deemed certain un-promulgated methods as acceptable for ECs, these published methods were used in this 2019 study.

In past years (2010-13), the EC studies included concurrent analysis of identical split samples spiked with known concentrations of target analytes. This was done because, at that time, the analytical technology was relatively new and split samples increased confidence in the data. Since then, the labs have gained considerable experience with these methods and there is less need to include additional check samples beyond those that the labs already use as part of their internal QA/QC protocols.

In addition, the PFAS methods require that a field reagent blank be evaluated concurrently with each sample collected.[20] This effectively doubles the analytical costs. Consequently, in the 2019 EC study, the external QA/QC program focused exclusively on the new PFAS analytes. Results of the field blank samples are presented in Table 5 (see pages 14-15). Orange County Water District (OCWD) also submitted identical PFAS-spiked check samples to three labs and had the SAR stream sample collected below Prado Dam analyzed by the same three labs.[21]

The 2019 sampling program was performed in accordance with the study plan approved by the Task Force and the resultant QA/QC was judged acceptable. OCWD's low-level spike data indicates that the analytical error band for PFOA and PFOS concentrations measured near the state's revised Notification Levels (i.e., 5-7 ng/L) was only about plus or minus 1.5 ng/L (see Table 7 in Appendix A). In addition, results for the identical split samples showed very good agreement between the three independent labs. The relative coefficient-of-variation (CV) was just 4.3% for PFOA and 7.4% for PFOS (see Table 9 in Appendix A). This compares favorably with interlaboratory CV values typically observed for other chemicals commonly monitored in wastewater.

Tables 4 and 5 include numerous footnotes referencing the "data qualifiers" reported by the laboratories. These exceptions illustrate the difficulties encountered when attempting to identify and quantify organic chemicals at such extremely low concentrations. It is particularly noteworthy that, on rare occasion, trace amounts of PFAS were "detected" in some of the field blank samples (cells highlighted by yellow in Table 5). Anomalous results like these could be caused by sample contamination, analytical interference, sample mislabeling or laboratory error. There is no way to know for certain based on the information available. Therefore, great care must be exercised when interpreting such results.

Results for the 29 samples analyzed as part of the 2019 EC Study are presented in Section 4.

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[20] A "field blank" is a comprised of pure de-ionized water and preservative (if required by the method) prepared and sealed, in advance, by the laboratory. The laboratory ships the sealed field blank bottle to clients along with other bottles that will be used to collect effluent or stream samples. Sampling teams are instructed to open the sealed field blank bottle, transfer all contents to another empty bottle (without preservative) previously sealed by the lab, and reseal the second bottle. This transfer is done at the same time, in the same location, by the same persons, using the same procedures that are used to collect the effluent or stream sample. Field blanks are used to evaluate the potential for contamination throughout the entire sample handling process. Ideally, there should be no detectable pollutants when field blanks are analyzed by the lab.

[21] Results from OCWD's supplemental QA/QC samples are provided in Tables 7, 8, & 9 (see Appendix A).

Section 4: Results

Table 4a: Results of 2019 EC Sampling Study *(part 1 of 3)*

Sampling Location	Acetaminophen	Sulfamethoxazole	Gemfibrozil	Ibuprofen	Iohexol	Naproxen	Sucralose	1,4- Dioxane	NDMA	NMOR
Units	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Beaumont No. 1	<10.0	410	140	39	330	82	39000	750	5.3	<2.0
Corona-1B	<50.0 D1	<10.0	<10.0	94	10000	<10.0	57000	850	36	10
Corona-2	<50.0 D1	<10.0	<10.0	120	1500	<10.0	48000	870	260	7.4
Corona-3	<50.0 D1	<10.0	<10.0	<100 D1	360	<10.0	75000	800	12	6
EMWD MV	<50.0	<10.0 R7	<10.0	<10.0	13000	<10.0	51000	970	9.7	11
EMWD PV	<50.0	<10.0 R7	<10.0	<10.0	920	<10.0	55000	800	8	5
EMWD SJV	<50.0	<10.0 R7	<10.0	<10.0	1500	<10.0	47000	970	5.4	3
EMWD TV (#1 & #2)	<50.0 BA,LK	<10.0	<10.0	<10.0	3100	<10.0	57000	730	8	4.3
EMWD-TV (#3)	<50.0 BA,LK	<10.0	<10.0	<10.0	5100	<10.0	54000	780	6.1	8.2
EVMWD Horsethief	<10.0	<10.0	<10.0	<10.0	4500	<10.0	89000	630	7.3	2.4
EVMWD RR Canyon	<10.0	760	200	240	10000	52	85000	730	74 S7	3.3 S7
EVMWD Regional	<10.0	150	<10.0	<10.0	68	<10.0	75000	860	<2.0	<2.0
IEUA CCWRF	<10.0	<10.0	<10.0	<10.0	9200	<10.0	60000	810	7.6	23
IEUA RP1-02	<10.0	<10.0	<10.0	<10.0	30000	<10.0	78000	810	9.3	16
IEUA RP1-1B	<10.0	<10.0	<10.0	<10.0	28000	<10.0	68000	760	10	16
IEUA RP5	<10.0	<10.0 R7	<10.0	<10.0	1200 R7	<10.0	62000	750	9.7	8.2
IRWD Los Alisos	<50.0	440	210	210	10000	45	81000	600	340	10
IRWD Michelson	<50.0	<10.0	<10.0	<10.0	6900	<10.0	49000	840	8.4	15
Redlands-Tertiary	<10.0	<10.0	<10.0	<10.0 M1	2400	<10.0	50000	730	7.7	20
Redlands-Secondary	<10.0	740	<10.0	<10.0	1700	<10.0	72000	770	5.9	18
Rialto	15	<10.0	<10.0	<10.0	4500	<10.0	74000	1100	6.9	10
Riverside	<10.0	<10.0	<10.0	<10.0	14000	<10.0	66000	1300	9.3	27
RIX	<10.0	390 M2	<10.0	<10.0	<50.0	<10.0	53000 M1	730	<2.1	<2.1
WRCWRA	35	<10.0	<10.0	<10.0	3900	<10.0	62000	1100	7.9	18
YVWD	<10.0	410	23	<10.0 M1	320	17	51000 M2	440	47	<2.0
SPW-Silverwood	<10.0	10.0	<10.0	<10.0	NR	<10.0	1000	<500.0	<2.0	<2.0
Colo. Riv. Aqueduct	<10.0	<10.0	<10.0	<10.0	<50.0	<10.0	1000	<500.0	<2.0	<2.0
SAR @ MWD Xing	<10.0	122	<10.0	<10.0	338	<10.0	26300	849	<2.0	<2.0
SAR @ Prado Dam	<10.0	36.4	<10.0	<10.0	2020	<10.0	43400	917	<2.0	<2.0

Code	Laboratory Qualifier
BA	Target analyte detected in method blank at or above the laboratory minimum reporting limits (MRL), but analyte not present in the sample.
D1	Sample required dilution due to matrix.
LK	The associated blank spike recovery was above method acceptance limits. This target analyte was not detected in the sample.
M1	Matrix spike recovery was high; the associated blank spike recovery was acceptable.
M2	Matrix spike recovery was low; the associated blank spike recovery was acceptable.
R7	LFB/LFBD RPD exceeded the laboratory acceptance limit. Recovery met acceptance criteria.
S7	Surrogate recovery was below laboratory and method acceptance limits. Unable to confirm matrix effect.

Table 4b: Results of 2019 EC Sampling Study *(part 2 of 3)*

Sampling Location	Hexafluoropropylene oxide dimer acid (HFPO-DA)	N-ethyl Perfluorooctane sulfonamidoacetic acid (N-EtFOSAA)	N-methyl Perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	Perfluorobutane sulfonic acid (PFBS)	Perfluorodecanoic acid (PFDA)	Perfluorododecanoic acid (PFDoA)	Perfluoroheptanoic acid (PFHpA)	Perfluorohexane sulfonic acid (PFHxS)	Perfluorohexanoic acid (PFHxA)
Units	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Beaumont No. 1	<5.0	<4.0	<4.0	15	<4.0	<4.0	<4.0	<4.0	39
Corona-1B	<5.0	<4.0	<4.0	9.2	<4.0	<4.0	5.2	<4.0	44
Corona-2	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	20
Corona-3	<5.0[S4]	<4.0[S4]	<4.0[S4]	13[S4]	<4.0[S4]	<4.0[S4]	8.1[S4]	<4.0[S4]	57[S4]
EMWD MV	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	38
EMWD PV	<5.0	<4.0	<4.0	8.2	<4.0	<4.0	<4.0	<4.0	31
EMWD SJV	<5.0	<4.0[SA]	<4.0	8	<4.0	<4.0	<4.0	<4.0	22[SA]
EMWD TV (#1 & #2)	<5.0	<4.0	<4.0	14	<4.0	<4.0	5.3	6.8	34
EMWD-TV (#3)	<5.0	<4.0	<4.0	24	<4.0	<4.0	<4.0	<4.0	42
EVMWD Horsethief	<5.0[S7]	<4.0	<4.0	58	<4.0	<4.0	<4.0	<4.0	25
EVMWD RR Canyon	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	7.8	7.8	30
EVMWD Regional	<5.0	<4.0	<4.0	27	<4.0	<4.0	<4.0	4.9	23
IEUA CCWRF	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	22
IEUA RP1-02	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	27
IEUA RP1-1B	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	27
IEUA RP5	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	33
IRWD Los Alisos	<5.0	<4.0	5.6	<4.0	4	<4.0	<4.0	<4.0	22
IRWD Michelson	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	34
Redlands-Tertiary	<4.0	<4.0[J]	<4.0[J]	5.4	<4.0[J]	<4.0	<4.0[J]	<4.0[J]	15
Redlands-Secondary	<4.0	<4.0	<4.0	4	<4.0[J]	<4.0	<4.0[J]	<4.0[J]	15
Rialto	<4.0	<4.0	<4.0	6.2	<4.0	<4.0	<4.0	<4.0	19
Riverside	<4.0	<4.0	<4.0[J]	6.1	<4.0[J]	<4.0	<4.0	4.2	24
RIX	<5.0	<4.0	<4.0	11[M2]	<4.0	<4.0	8	9.1	40[M3]
WRCWRA	<4.0	<4.0	<4.0	6.9	<4.0[J]	<4.0	<4.0	<4.0	20
YVWD	<5.0	<4.0	<4.0	<4.0[MC]	<4.0	<4.0	<4.0[MC]	<4.0	9.7
SPW-Silverwood	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Colo. Riv. Aqueduct	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
SAR @ MWD Xing	NA	<4.0	<4.0	11.8	<4.0	<4.0	6.5	13.7	27.7
SAR @ Prado Dam	NA	<4.0	<4.0	12.5	<4.0	<4.0	5.2	9.5	29.7

Code	Laboratory Qualifier
J	Estimated value; above the MDL but below the RDL; equivalent to "Detected but not quantified (DNQ)"
M2	Matrix spike recovery was low; the associated blank spike recovery was acceptable.
M3	The spike recovery value is unusable because analyte concentration in sample is disproportionate to spike level. The associated blank spike recovery was acceptable.
MC	Matrix spike recovery was high; associated blank spike recovery was acceptable. MS/MSD RPD met acceptance criteria.
NA	Not Analyzed
R7	LFB/LFBD RPD exceeded the laboratory acceptance limit. Recovery met acceptance criteria.
SA	Surrogate recovery was above laboratory and method acceptance limits. Re-extraction and or re-analysis confirm high recovery caused by matrix effect.
S4	Surrogate recovery was above laboratory and method acceptance limits. No target analytes were detected in the sample.
S7	Surrogate recovery was below laboratory and method acceptance limits. Unable to confirm matrix effect.

Table 4c: Results of 2019 EC Sampling Study *(part 3 of 3)*

Sampling Location	Perfluorononanoic acid (PFNA)	Perfluorooctane sulfonic acid (PFOS)	Perfluorooctanoic acid (PFOA)	Perfluorotetradecanoic Acid (PFTA)	Perfluorotridecanoic acid (PFTrDA)	Perfluoroundecanoic acid (PFUnA)	11-chloroeicosafluoro-3-oxaundecane-sulfonic acid	9-chlorohexadecafluoro-3-oxanone-sulfonic acid	4,8-dioxa-3H-perfluorononanoic acid (ADONA)
Units	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Beaumont No. 1	<4.0	<4.0	23	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Corona-1B	<4.0	6.2	16	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Corona-2	<4.0	<4.0	11	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Corona-3	<4.0[SP]	4[SP]	57[SP]	<4.0[SP]	<4.0[SP]	<4.0[SP]	<4.0[SP]	<4.0[SP]	<4.0[SP]
EMWD MV	<4.0	<4.0	10	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
EMWD PV	<4.0	<4.0	12	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
EMWD SJV	<4.0	<4.0	6.4	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
EMWD TV (#1 & #2)	<4.0	7.4	18	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
EMWD-TV (#3)	<4.0	<4.0	17	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
EVMWD Horsethief	<4.0	5.5	30	<4.0	<4.0	<4.0	<4.0[L5]	<4.0	<4.0[LK]
EVMWD RR Cyn.	<4.0	7.8	34	<4.0	<4.0	<4.0	<4.0[L5]	<4.0	<4.0[LK]
EVMWD Regional	<4.0	<4.0	19	<4.0	<4.0	<4.0	<4.0[L5]	<4.0	<4.0[LK]
IEUA CCWRF	<4.0	<4.0	8	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
IEUA RP1-02	<4.0	5.6	7.5	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
IEUA RP1-1B	<4.0	<4.0	6.2	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
IEUA RP5	<4.0	<4.0	16	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
IRWD Los Alisos	<4.0	4.6	14	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
IRWD Michelson	<4.0	<4.0	15	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Redlands-Tertiary	<4.0[J]	<4.0	8.8	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Redlands-Secondary	<4.0[J]	<4.0	11	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Rialto	<4.0	<4.0	5.9	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Riverside	<4.0[J]	5.4	13	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
SB & Colton: RIX	4.2	32[M3]	8.6[M3]	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
WMWD-WRCWRA	<4.0[J]	9.8	12	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
YVWD	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0[L5]	<4.0	<4.0[LK,MC]
SPW-Silverwood	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Colo. Riv. Aqueduct	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
SAR @ MWD Xing	<4.0	26.6	10.1	<4.0	<4.0	<4.0	NA	NA	NA
SAR @ Prado Dam	<4.0	17.9	18.5	<4.0	<4.0	<4.0	NA	NA	NA

Code	Laboratory Qualifier
J	Estimated value; above the MDL but below the RDL; equivalent to "Detected but not quantified (DNQ)"
LK	The associated blank spike recovery was above method acceptance limits. This target analyte was not detected in the sample.
L5	The associated blank spike recovery was above laboratory/method acceptance limits. This analyte was not detected in the sample.
MC	Matrix spike recovery was high; the associated blank spike recovery was acceptable. MS/MSD RPD met acceptance criteria.
M3	The spike recovery value is unusable because analyte concentration in sample is disproportionate to spike level. The associated blank spike recovery was acceptable.
NA	Not Analyzed
SP	S10-Surrogate recovery was above laboratory and method acceptance limits.

Section 5: QA/QC

Table 5a: Field Blanks for PFAS *(part 1 of 2)*

Sampling Location	Hexafluoropropylene oxide dimer acid (HFPO-DA)	N-ethyl Perfluorooctane sulfonamidoacetic acid (N-EtFOSAA)	N-methyl Perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	Perfluorobutane sulfonic acid (PFBS)	Perfluorodecanoic acid (PFDA)	Perfluorododecanoic acid (PFDoA)	Perfluoroheptanoic acid (PFHpA)	Perfluorohexane sulfonic acid (PFHxS)	Perfluorohexanoic acid (PFHxA)
Units	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Beaumont No. 1	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Corona-1B	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Corona-2	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Corona-3	<5.0 S4	<4.0 S4	<4.0 S4	<4.0 S4	<4.0 S4	<4.0 S4	<4.0 S4	<4.0 S4	<4.0 S4
EMWD MV	<5.0	<4.0	<4.0	<4.0	<4.0 S4	<4.0	<4.0	<4.0	<4.0
EMWD PV	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
EMWD SJV	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
EMWD TV (#1 & #2)	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
EMWD TV (#3)	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
EVMWD Horsethief	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
EVMWD RR Canyon	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
EVMWD Regional	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
IEUA CCWRF	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	25*
IEUA RP1-02	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
IEUA RP1-1B	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
IEUA RP5	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	34*
IRWD Los Alisos	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
IRWD Michelson	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Redlands-Tertiary	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Redlands-Secondary	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Rialto	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Riverside	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
RIX	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
WRCWRA	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
YVWD	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
SPW-Silverwood	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Colo. Riv. Aqueduct	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
SAR @ MWD Xing	NA	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
SAR @ Prado Dam	NA	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0

Code	Laboratory Qualifier
S4	Surrogate recovery was above laboratory and method acceptance limits. No target analytes were detected in the sample.
*	Field blank results for some were nearly identical to PFAS concentrations reported for effluent samples collected concurrently (see Table 4b & 4c). It is possible that Field Duplicates were collected instead of Field Blanks.

Table 5b: Field Blanks for PFAS *(part 2 of 2)*

Sampling Location	Perfluorononanoic acid (PFNA)	Perfluorooctane sulfonic acid (PFOS)	Perfluorooctanoic acid (PFOA)	Perfluorotetradecanoic Acid (PFTA)	Perfluorotridecanoic acid (PFTrDA)	Perfluoroundecanoic acid (PFUnA)	11-chloroeicosafluoro-3-oxaundecane-sulfonic acid	9-chlorohexadecafluoro-3-oxanone-sulfonic acid	4,8-dioxa-3H-perfluorononanoic acid (ADONA)
Units	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Beaumont No. 1	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Corona-1B	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Corona-2	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Corona-3	<4.0 S4	<4.0 S4	<4.0 S4	<4.0 S4	<4.0 S4	<4.0 S4	<4.0 SC	<4.0 S4	<4.0 S4
EMWD MV	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
EMWD PV	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
EMWD SJV	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
EMWD TV (#1 & #2)	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
EMWD TV (#3)	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
EVMWD Horsethief	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0 L5	<4.0	<4.0 LK
EVMWD RR Cyn.	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0 L5	<4.0	<4.0 LK
EVMWD Regional	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0 L5	<4.0	<4.0 LK
IEUA CCWRF	<4.0	<4.0	9.1*	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
IEUA RP1-02	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
IEUA RP1-1B	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
IEUA RP5	<4.0	<4.0	16*	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
IRWD Los Alisos	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
IRWD Michelson	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Redlands-Tertiary	<4.0	<4.0	<4.0 PblkJ, J	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Redlands-Secondary	<4.0	<4.0	<4.0 PblkJ, J	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Rialto	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Riverside	<4.0	<4.0	<4.0 J	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0 J
SB & Colton: RIX	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
WMWD-WRCWRA	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
YVWD	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0 L5	<4.0	<4.0 LK
SPW-Silverwood	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Colo. Riv. Aqueduct	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
SAR @ MWD Xing	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	NA	NA	NA
SAR @ Prado Dam	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	NA	NA	NA

Code	Laboratory Qualifier
J	Estimated value; above the MDL but below the RDL; equivalent to "Detected but not quantified (DNQ)"
LK	The associated blank spike recovery was above method acceptance limits. This target analyte was not detected in the sample.
L5	The associated blank spike recovery was above laboratory/method acceptance limits. This analyte was not detected in the sample.
NA	No Sample Available.
PblkJ	The analyte was detected in the Method Blank at a concentration between the MDL and the MRL.
S4	Surrogate recovery was above laboratory and method acceptance limits. No target analytes were detected in the sample.
*	Field blank results for some were nearly identical to PFAS concentrations reported for effluent samples collected concurrently (see Table 4b & 4c). It is possible that Field Duplicates were collected instead of Field Blanks.

Section 6: Discussion

The EPA has not yet published recommended water quality criteria for any of the emerging constituents evaluated as part of the 2019 EC Study.[22] Nor has the State Water Board or the Santa Ana Regional Water Quality Control Board established water quality objectives for any of these compounds, including PFAS.

EPA has published Drinking Water Lifetime Health Advisories for some ECs.[23] California's Office of Environmental Health Hazard Assessment (OEHHA) has also published Public Health Goals for some of these chemicals. In addition, the State Water Board has established Notification and Response Levels for a few of the ECs evaluated during this study.[24] These various threshold values are summarized in Table 6.

Table 6: Summary of State and Federal Health Advisories for ECs Monitored in 2019

Agency	Threshold Name	NDMA *(ng/L)*	NMOR *(ng/L)*	1,4-Dioxane *(ng/L)*	PFOA *(ng/L)*	PFOS *(ng/L)*
EPA	Drinking Water Health Advisory	0.7	---	350	70 combined	
OEHHA[25]	Public Health Goals (PHG)	3	---	TBD	TBD	TBD
SWRCB	Drinking Water Notification Level	10	---	1,000	5.1	6.5
SWRCB	Drinking Water Response Level	300	---	35,000	10	40
SWRCB	Monitoring Trigger Level for Recycled Water Projects	10	12	1,000	14*	13*

** The MTLs for PFOA & PFOS in the RWP were based on the interim Notification Levels that were initially established in June of 2018, not the revised Notification levels that the State Board subsequently published in August of 2019.*

[22] EPA develops and recommends water quality criteria, for specific pollutants, pursuant to §304(a) of the Clean Water Act. States commonly rely on these recommended criteria to establish water quality standards (also called "water quality objectives" in California) to protect designated beneficial uses in lakes and streams.

[23] For example, in November of 2016, EPA published a Drinking Water Health Advisory recommending that the combined concentration of 70 ng/L would provide a "margin of protection for all Americans throughout their life from the adverse health effects resulting from exposure to PFOA and PFOS in drinking water." (EPA-800-F-16-003).

[24] For example, in February of 2020, the State Water Board lowered the Response Level for PFOA to 10 ng/L and the Response Level for PFOS to 40 ng/L. Previously, the Response Level was 70 ng/L for the combined total concentration of PFOA and PFOS.

[25] OEHHA is in the process of developing PHG's and/or MCLs for 1,4-Dioxane and several PFAS.

EPA's Health Advisories, OEHHA's Public Health Goals, and the State Water Board's Notification/Response Levels for PFAS presently apply only to drinking water and not to treated municipal wastewater. However, the Notification Levels and the RWP's Monitoring Trigger Levels for 1,4-Dioxane, NDMA, NMOR, PFOA and PFOS do apply where recycled water is intentionally used to augment groundwater or surface water supplies.[26]

PFAS concentrations for the municipal effluents and Santa Ana River samples, evaluated as part of the 2019 EC study, were generally in the same range as Orange County Water District had previously observed.[27] None of the samples evaluated during the 2019 study exceeded EPA's Lifetime Health Advisory Level (70 ng/L) for the combined concentration of PFOA & PFOS.

PFOS was detected in 10 of the 25 effluent samples tested; however, only 4 of those 10 samples was above the state Notification Level (6.5 ng/L) for drinking water, which is more stringent than EPA's Lifetime Health Advisory Level. PFOA was detected, at concentrations higher than the state Notification Level for drinking water, in 24 of the 25 effluent samples and in both Santa Ana River samples tested. PFOA was not detected in samples collected from the State Water Project aqueduct or the Colorado River aqueduct.

Because the Santa Ana River and its major tributaries are comprised primarily of treated municipal wastewater and stormwater runoff from urban areas, the Regional Board removed the domestic water supply (MUN) designation from these waterbodies in 1989.[28] However, groundwater recharge (GWR) remains a designated beneficial use for these streams and the underlying aquifers are routinely used for domestic water supply. EC concentrations are evaluated in surface waters recharging to groundwater provide an early indication of potential future problems.

In the months following the Task Force's decision to conduct an EC study in 2019, the State Water Board began issuing a series of mandatory Monitoring Orders requiring well owners, landfill operators and chrome plating facilities to analyze samples for PFAS. The State Water Board is expected to issue orders requiring similar PFAS testing for treated wastewater in 2020.

In addition, the State Water Board's Division of Drinking Water has formally requested that OEHHA provide recommendations regarding appropriate drinking water Notification Levels for PFHxS, PFBS, PFHxA, PFHpA, PFNA, PFDA, and ADONA. This request also asked OEHHA to include consideration of whether some PFAS should be grouped together and evaluated cumulatively and collectively for regulatory purposes.[29]

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[26] SWRCB. Amendments to the Policy for Water Quality Control for Recycled Water. Res. No. 2018-0057 (12/11/18).

[27] Orange County Water District. "PFAS, PFOA and PFOS in Orange County." Powerpoint presentation to the SAWPA Commission on July 2, 2019 (see slides #19, #20 & #21).

[28] Santa Ana Regional Water Quality Control Board Res. No. R8-1989-0042 was enacted in accordance with the State Water Board's Sources of Drinking Water Policy (Res. No. 88-63).

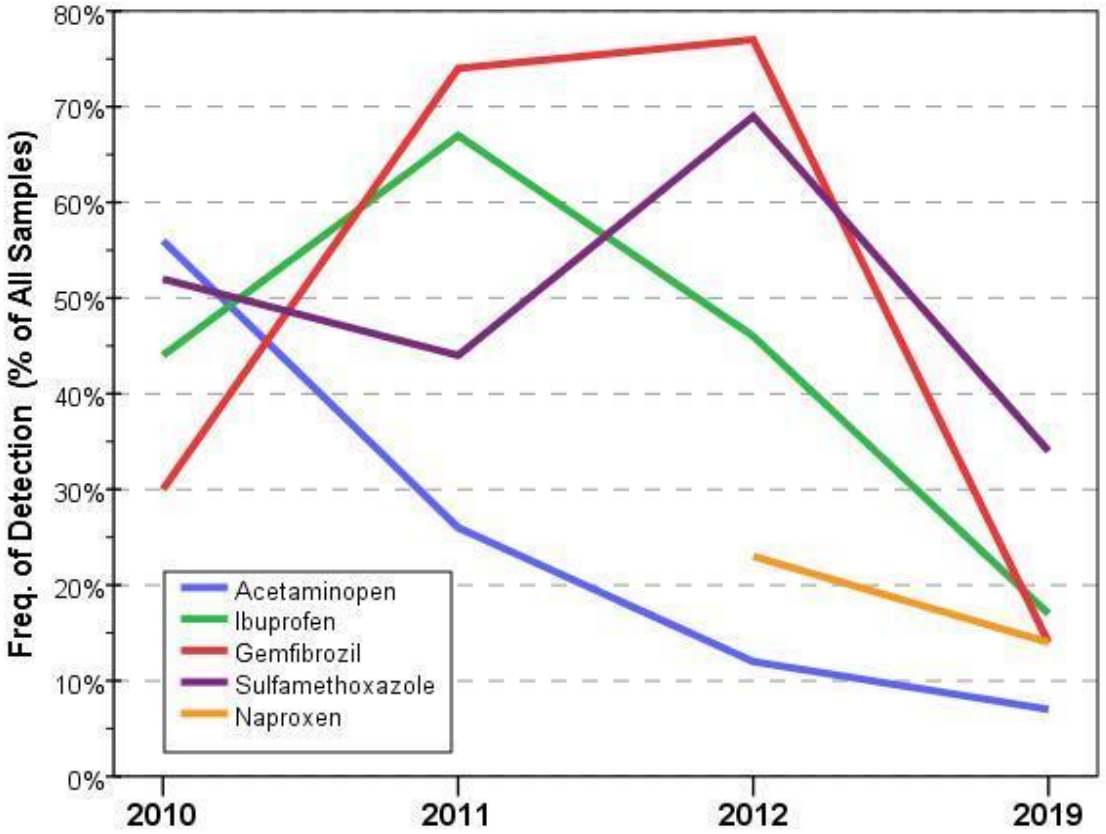
[29] Letter from Darrin Polhemus, Deputy Director for the Division of Drinking Water to Lauren Zeise, Director of OEHHA, dated Feb. 6, 2020.

The State Water Board maintains an on-line database summarizing the relevant regulatory thresholds and other state and federal recommendations regarding the "safe" concentration of various ECs. To access this database, and obtain more detailed information on a wide range of specific chemical compounds, readers may click on the following link:

SWRCB Water Quality Goal Search App.

Comparing results from the 2019 EC study to the Task Force's prior investigations there appears to be a strong downward trend in the detection of common pain medications similar to Tylenol, Advil and Aleve (see Fig. 2). In addition, these compounds are no longer being detected in the Santa Ana River samples. Nor were they detect in either of the imported water samples tested in 2019.

Fig. 2: Long-term Trends for Detecting Common Pharmaceuticals



Two prescription pharmaceuticals (Gemfibrozil and Sulfamethoxazole) were also detected less frequently in 2019 compared to previous years, but this may be due to patients changing medications (see Fig. 2). Low levels of Sulfamethoxazole are still present in the Santa Ana River, but Gemfibrozil is no longer detected at either river site. Neither of these compounds was detected in samples collected from the State Water Project or the Colorado River Aqueduct.

NDMA and NMOR, both by-products of wastewater disinfection, were frequently detected in municipal effluent samples. However, neither compound was detected in samples collected from the Santa Ana River, the State Water Project aqueduct or the Colorado River aqueduct. In addition, NDMA concentrations were below the existing state Notification Levels for drinking water in all but two of the effluent samples.[30] The State Water Board has not yet established a Notification or Response Level for NMOR.

The solvent/stabilizer 1,4-Dioxane was detected in all wastewater effluents and Santa Ana River samples, but not at the imported surface water sites. All of the reported detections were above EPA's Health Advisory Level for drinking water (350 ng/L) but only three were above the state Notification Level (1,000 ng/L).[31]

The artificial sweetener Sucralose was detected in 100% of the samples analyzed in both 2013 and 2019.[32] Sucralose is often used as a surrogate indictor to identify wells that may be under the influence of wastewater, but does not pose any known health hazard to humans at the low concentrations observed in this study.

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Members of SAWPA's Emerging Constituents Program Task Force (2019)

Eastern Municipal Water District	City of Beaumont
Inland Empire Utilities Agency	City of Redlands
Orange County Water District	City of Corona
San Bernardino Valley Mun. Water District	City of Rialto
Western Municipal Water District	City of Riverside
San Gorgonio Pass Water Agency	City of Colton
Elsinore Valley Municipal Water Dist.	City of San Bernardino
Jurupa Community Services District	Yucaipa Valley Water District
Irvine Ranch Water District	Temescal Valley Water District
Metropolitan Water District of So. Calif.	

[30] OEHHA initiated its process to update the existing Public Health Goal for NDMA in March of 2020.
[31] OEHHA initiated its process to develop a Public Health Goal for 1,4-Dioxane in March of 2020.
[32] Based on the SAP recommendations, the Task Force began testing samples for Sucralose in 2013.

Appendix A:

Supplemental QA/QC Data for PFAS

Evaluated in the 2019 Emerging Constituents Study

Table 7: Interlaboratory Quality Control Check for Low Concentrations of PFAS

PFAS Analyte	% RSD	Spiked Value	Mean % Recovery	Median % Recovery	OCWD Result (ng/L)	EUROFINS Result (ng/L)	Babcock Result (ng/L)	OCWD % Recovery	EUROFINS % Recovery	Babcock % Recovery
NEtFOSAA	16.3	6.25	123	125	7.8	6.3	8.8	125	101	141
NMeFOSAA	15.1	7.63	96.0	88.1	6.7	6.7	8.6	87.3	88.1	113
PFBS	8.5	9.04	107.1	105.1	10.6	9.0	9.5	117	99.1	105
PFDA	13.1	7.75	96.8	96.3	6.5	7.5	8.5	84.4	96.3	110
PFDoA	9.3	7.73	76.0	72.7	5.6	5.5	6.5	72.7	71.2	84
PFHpA	11.8	6.14	92.3	93.5	5.0	5.7	6.3	80.9	93.5	103
PFHxS	10.5	5.46	106.2	109.9	6.3	5.1	6.0	115	93.6	110
PFHxA	10.8	6.20	95.2	92.7	5.4	5.8	6.6	86.3	92.7	106
PFNA	15.7	7.50	93.2	98.7	5.7	7.8	7.4	76.5	104	98.7
PFOS	9.0	7.19	104.7	104.9	7.5	6.9	8.2	105	95.3	114
PFOA	8.9	6.20	104.1	101.3	6.0	6.3	7.1	96.6	101	115
PFTA	10.6	9.00	90.4	92.2	7.2	8.3	8.9	80.0	92.2	98.9
PFTrDA	10.1	5.63	93.9	88.8	5.0	5.0	5.9	88.1	88.8	105
PFuNA	11.6	9.45	90.5	85.1	7.9	8.0	9.7	83.8	85.1	103
GenX	7.3	7.75	99.4	99.4	NA	7.3	8.1	NA	94.3	105
11CLPF	6.1	5.42	90.2	90.2	NA	4.7	5.1	NA	86.3	94.1
9CLPF3	10.6	8.53	99.2	99.2	NA	7.8	9.1	NA	91.8	107
ADONA	7.9	9.48	109.9	109.9	NA	9.8	11	NA	104	116

RSD = Relative Standard Deviation (aka Coefficient of Variation); NA = Not Analyzed

Table 8: Interlaboratory Quality Control Check for Mid-Level Concentrations of PFAS

PFAS Analyte	% RSD	Spiked Value	Mean % Recovery	Median % Recovery	OCWD Result (ng/L)	EUROFINS Result (ng/L)	Babcock Result (ng/L)	OCWD % Recovery	EUROFINS % Recovery	Babcock % Recovery
NEtFOSAA	8.0	50.0	112.5	116.0	59.6	51.1	58	119	102	116
NMeFOSAA	11.7	42.7	93.6	89.0	36.6	45.3	38	85.7	106	89.0
PFBS	7.5	110	105.5	101.8	126	112	110	115	102	100
PFDA	8.45	93.0	97.3	92.7	86.2	99.3	86	92.7	107	92.5
PFDoA	12.1	32.8	84.6	85.2	27.9	24.3	31	85.2	74.1	94.5
PFHpA	13.0	63.7	105.4	100.7	64.2	60.3	77	101	94.6	121
PFHxS	14.4	68.3	108.4	109.8	84.2	62.9	75	123	92.1	110
PFHxA	9.8	54.6	103.8	99.9	54.5	52.6	63	99.9	96.3	115
PFNA	4.4	30.0	104.5	106.7	29.8	32.3	32	99.2	108	107
PFOS	13.0	71.9	101.3	98.7	83.0	64.4	71	115	89.6	98.7
PFOA	7.8	155	105.8	107.6	175	167	150	113	108	96.8
PFTA	37.6	150	102.6	88.2	132	219	110	88.2	146	73.3
PFTrDA	7.7	26.3	103.1	102.7	29.3	25.1	27	111	95.4	103
PFuNA	17.1	110	97.9	96.8	106	127	90	96.8	115	81.8
GenX	12.4	49.6	105.7	105.7	NA	47.8	57	NA	96.4	115
11CLPF	5.7	78.0	81.4	81.4	NA	60.9	66	NA	78.1	84.6
9CLPF3	5.9	85.3	99.1	99.1	NA	88.1	81	NA	103	95.0
ADONA	9.9	40.2	111.6	111.6	NA	41.7	48	NA	104	119

RSD = Relative Standard Deviation (aka Coefficient of Variation); NA = Not Analyzed

Table 9: Interlaboratory Quality Control Check for PFAS in Identical Split Samples Collected from SAR @ Prado Dam

Analyte	% RSD		Mean Result	Median Result	OCWD Result (ng/L)	EUROFINS Result (ng/L)	Babcock Result (ng/L)
NEtFOSAA	Not Calculable		ND	ND	ND	ND	ND
NMeFOSAA	Not Calculable		ND	ND	ND	ND	ND
PFBS	9.9		12.3	12.5	12.5	13.4	11.0
PFDA	Not Calculable		Not Calculable	ND	ND	ND	1.9
PFDoA	Not Calculable		ND	ND	ND	ND	ND
PFHpA	10.5		4.95	5.2	5.2	5.2	4.3
PFHxS	6.0		9.0	9.1	9.5	8.4	9.1
PFHxA	22.0		27.8	29.7	29.7	32.8	21
PFNA	Not Calculable		Not Calculable	2.1	ND	2.1	2.2
PFOS	7.4		16.5	16	17.9	15.6	16.0
PFOA	4.3		17.6	17.5	18.5	17.5	17.0
PFTA	Not Calculable		ND	ND	ND	ND	ND
PFTrDA	Not Calculable		ND	ND	ND	ND	ND
PFuNA	Not Calculable		ND	ND	ND	ND	ND
GenX	Not Calculable		ND	ND	NA	ND	ND
11CLPF	Not Calculable		ND	ND	NA	ND	ND
9CLPF3	Not Calculable		ND	ND	NA	ND	ND
ADONA	Not Calculable		ND	ND	NA	ND	ND

RSD = Relative Standard Deviation (aka Coefficient of Variation); NA = Not Analyzed; ND = Not Detected

Appendix B:

Sampling and Laboratory Analysis Plan (SLAP)

for the

2019 Emerging Constituents Study

2019 Updated Sampling and Laboratory Analysis Plan (SLAP) for the

Emerging Constituents Sampling Program

in the Santa Ana River Watershed

The Santa Ana Watershed Project Authority's (SAWPA) Emerging Constituents (EC) Program Task Force originally submitted a water quality investigation workplan to the Santa Ana Regional Water Quality Control Board (RWQCB) to characterize selected ECs in wastewater effluents, surface waters and imported waters for calendar year 2010[1].The selected ECs include pharmaceuticals & personal care products (PPCPs), pesticides, herbicides, and industrial indicators of wastewater origin. The approved Sampling and Laboratory Analysis Plan (SLAP) was subsequently revised in 2012 to reflect the inclusion of four additional ECs, and further updated in response to the 2013 State Water Resources Control Board (SWRCB) Recycled Water Policy Amendment (RWPA).[2]

This 2019 update to the SLAP reflects the SAWPA EC Task Force's new focus on per- and polyfluoroalkyl substances (PFAS) and additional amendments to the Recycled Water Policy recently approved by the State Water Resources Control Board.[3] Occurrence of PFAS compounds in the Santa Ana Watershed (including surface water, groundwater, wastewater effluent, recycled water, and drinking water) has been documented via monitoring conducted by some local agencies through the United States Environmental Protection Agency (EPA) Unregulated Contaminant Monitoring Rule 3 (UCMR3) drinking water program and subsequent monitoring by the Orange County Water District (OCWD). In May 2016, EPA established a revised lifetime (drinking water) Health Advisory (HA) for two PFAS compounds, perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS), set at 70 nanograms per liter (ng/L) for combined PFOA + PFOS. In July 2018, the SWRCB Division of Drinking Water (DDW) established the following interim state drinking water Notification Levels (NLs) and a Response Level (RL) for these compounds: NL PFOA = 14 ng/L, NL PFOS = 13 ng/L, RL PFOA + PFOS = 70 ng/L); PFOA and PFOS were also added to the updated SWRCB RWPA adopted in December 2018 as health-based indicator compounds for potable reuse projects.

1. Sample Collection, Preservation, Storage and Holding Times

Sampling and laboratory analysis are intended to be carried out in August 2019. Sample locations, preservation and dechlorination requirements, and sample bottles and sample told time requirements are specified below in Tables 1.1, 1.2, and 1.3, respectively.

[1] Phase-II Report of the Emerging Constituents Workgroup, approved by the Santa Ana Regional Water Quality Control Board on December 10th, 2009

[2] SWRCB Resolution NO. 2013-003: Adoption of an Amendment to the Policy for Water Quality Control for Recycled Water Concerning Monitoring Requirements for Constituents of Emerging Concern, Attachment A, January 22, 2013

[3] Res. No. 2018-0057 (Dec. 11, 2018)

Table 1.1 Sample Locations

2019 EC Sample Sites	
1	City of Beaumont WWTP No. 1
2	City of Corona WRF 1B
3	City of Corona WRF 2
4	City of Corona WRF 3
5	EMWD MV-RWRF
6	EMWD PV-RWRF
7	EMWD SJV-RWRF
8	EMWD TV-RWRF
9	EVMWD Horsethief Canyon
10	EVMWD Railroad Canyon WRP
11	EVMWD Regional WRP
12	IEUA Carbon Canyon WRF
13	IEUA RP1 (02 Outfall)
14	IEUA RP1 (1B Outfall)
15	IEUA RP5
16	IRWD Los Alisos Plant
17	IRWD Michelson Plant
18	City of Redlands WWTP
19	City of Rialto WWTP
20	City of Riverside RWQCP
21	RIX (Cities of San Bernardino & Colton)
22	WMWD: WRCWRA River Rd. Plant
23	YVWD WRF
24	State Project Water at Devil Canyon (by MWD)
25	Colorado River at San Jacinto West Portal (by MWD)
26	Santa Ana River - Reach 3 near MWD Crossing
27	Santa Ana River - Reach 3 near Prado Dam

Table 1.2 Sample Preservation and Dechlorination Agents

Analytical Method	Chemical and Concentration	Criteria
EPA 537.1	pH 7 Trizma Preset Crystals (1.25g/250mL)	Absence of Free Chlorine, less than 0.1mg/L and pH 7
CEC	Sodium Azide 1 g/L L-Ascorbic Acid 50 mg/L	
NDMA or EPA 521	sodium thiosulfate – 80-100 mg/L	Absence of Free Chlorine, less than 0.1mg/L
1,4-DIOXANE (Purge & Trap)	NO Preservative	NA
14DIOXANE - EPA 522	Sodium bisulfate approx. 1g/L Sodium sulfite 50mg/L	Absence of Free Chlorine, less than 0.1mg/L and pH 4

Table 1.3 Sample Bottles and Sample Hold Time

Analytical Method	Sample Bottle Materials	Storage Temperature	Holding Time for Samples (days)
EPA 537.1	250-mL polypropylene bottles fitted with polypropylene screw caps	$\leq 6^0$C	14 days
CEC	Amber glass bottles fitted with PTFE-lined screw caps	$\leq 6^0$C	14 days
NDMA (EPA 521 or other)	Amber glass bottles fitted with PTFE-lined screw caps	$\leq 6^0$C	14 days
1,4-DIOXANE – (Purge & Trap)	40 ml amber vials - fitted with an open top screw cap lined with Teflon.	$\leq 6^0$C	14 days
1,4-DIOXANE - EPA522	Amber glass bottles fitted with PTFE-lined screw caps	$\leq 6^0$C	28 days

Consistent with either EPA Method 537 Rev 1.1 or EPA Method 537.1 (see Section 2), each designated lab will provide their own sample bottles (250-mL polypropylene bottles fitted with polypropylene screw caps.) preserved with Trizma Preset Crystals, pH 7 (1.25g/250mL) (Sigma cat# T-7193 or equivalent), added to sample bottles before shipment to the sites. Sample bottles can be pre-labeled with site information, and will include date, sampling time, sampler, site location, and required testing. Bottles should include a label with the method's chemical preservatives. Sample bottles must be discarded after use.

Samplers and laboratory staff will be warned of low-level detection of PFAS and potential background sources caused by the sampling process. These personnel should be aware of the potential for interference from the use of target compounds monitored within this investigation Sampling and laboratory staff should follow these additional protocols to reduce the potential for sample contamination:

- Samples for PFAS analysis will be kept in coolers with wet ice. Blue ice is not acceptable for sample storage as it may contain PFAS compounds
- Do not use clothing or boots containing Gore Tex
- Do not use clothing that has been washed with fabric softener
- Do not use clothing chemically-treated for insect resistance or ultraviolet protection
- Do not use water-resistant, waterproof, or stain-treated clothing during PFAS sampling
- activities
- Do not use Tyvek suits during PFAS sampling activities
- Ensure clothing used during PFAS sampling activities has been washed a minimum of
- twice
- Do not use personal care products prior to or during PFAS sampling activities; these
- include but are not limited to insect repellant, sunscreen, makeup, etc.
- Do not use Post-it Notes during PFC sampling activities
- Minimize contact with and use of water-resistant notebooks
- After eating or drinking, always wash hands thoroughly and use new nitrile gloves

Each designated agency will ensure that these sampling guidelines are followed, and that qualified sampling staff are assigned to this investigation. Samplers will wear clean nitrile gloves at each site, and will follow the standard operating procedures outlined within their sampling programs.

Field Reagent Blanks (FRB) will be taken at each site and at the same time, where a similar sample volume of laboratory reagent water and preservative is transferred into an empty labeled FRB sample bottle (no preservative). For each sample site, each laboratory will provide the laboratory preserved reagent water for their field reagent blanks, an empty clean bottle and any other additional quality control samples required within their laboratory's analysis.

At least one site within each matrix group will be sampled as a duplicate, and noted within the chain of custody (COC) form. Field parameters will be measured and noted onto the COC – electrical conductivity, pH, temperature, dissolved oxygen, etc. Also, enough samples will be taken to ensure that matrix spike and matrix spike duplicates (50-100 ng/L for PFOA and PFOS) can be performed on at least 10% of the total samples analyzed by each lab.

Sample extraction holding time is 14 days and the extract analysis holding time 28 days. The laboratory should extract and process the PFAS samples as soon as possible after delivery. Samples should be transported on ice (bagged or blue ice) and delivered to the lab at <10°C. Samples are to be kept refrigerated (<6°C) until ready to be extracted.

One site location will be identified as a "split sample" and processed by all participating labs. It is recommended that the *SAR at Prado Dam* site be used for the split sample. This will represent the matrix split sample within the study. OCWD will collect, split, and distribute this sample to all participating laboratories.

2. Target Analytes

The PFAS target compounds for EPA Method 537.1 are provided in Table 3.1. Both methods include both PFOA and PFOS, the primary targets of interest for EC Task Force Monitoring. It should be noted that the four additional PFAS compounds included in EPA Method 537.1 can be unofficially added to Rev 1.1 Method.

3. QA/QC Procedures

Each lab will operate their methods according to their Standard Operating Procedure (SOP), and therefore have associated Quality Assurance/Quality Control (QA/QC) samples analyzed within their procedure to help confirm the reported values. However, general data quality objectives can be developed within this investigation. All laboratories should be able to meet the criteria listed below. In an effort to facilitate the comparison of data produced by multiple laboratories and to minimize the effects of sample interference, the Minimum Reporting Limit (MRL) are listed in Table 3.1. These MRLs are compatible with the MRLs specified for PFOA and PFOS in the December 2018 SWRCB RWPA. SAWPA's PFAS sampling report will use these MRLs for final reporting purposes. Each lab will provide their most recent method detection limit (MDL) value for each target reported to verify that they can determine results at the MRL level.

Two "Blind QC Samples" prepared by Environmental Resource Associates (ERA) will be sent directly to each participating lab. The first blind sample will be a mid-level check, where each target compound from SAWPA's target list is spiked between 25-200 ng/L except Sucralose is spiked between 500-2,000 ng/L and 1,4-Dioxane is spiked between 1,500-5,000 ng/L in a clean water matrix, the second blind sample will be a low-level check S-MRL Verification, where each target compound is spiked at a 100 – 200% of the S-MRL. These QA samples will be processed in a similar manner to all received study sites by each laboratory.

Table 3.1: Chemicals to be Analyzed in 2019 Sampling Programs

	Analyte	Acronym	CAS#	MRL (ug/L)
EPA 537.1	N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6	0.004
	N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9	0.004
	Perfluorobutanesulfonic acid	PFBS	375-73-5	0.004
	Perfluorodecanoic acid	PFDA	335-76-2	0.004
	Perfluorododecanoic acid	PFDoA	307-55-1	0.004
	Perfluoroheptanoic acid	PFHpA	375-85-9	0.004
	Perfluorohexanesulfonic acid	PFHxS	355-46-4	0.004
	Perfluorohexanoic acid	PFHxA	307-24-4	0.004
	Perfluorononanoic acid	PFNA	375-95-1	0.004
	Perfluorooctanesulfonic acid	PFOS	1763-23-1	0.004
	Perfluorooctanoic acid	PFOA	335-67-1	0.004
	Perfluorotetradecanoic acid	PFTA	376-06-7	0.004
	Perfluorotridecanoic acid	PFTrDA	72629-94-8	0.004
	Perfluoroundecanoic acid	PFUnA	2058-94-8	0.004
	Hexafluoropropylene oxide dimer acid	GenX	13252-13-6	0.004
	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11CLPF	763051-92-9	0.004
	9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	9CLPF3	756426-58-1	0.004
	4,8-dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	0.004
CEC	Acetaminophen *(common brand name: Tylenol®)*	ACTMNP	103-90-2	0.010
	Gemfibrozil *(common brand name: Lopid®)*	GMFIBZ	25812-30-0	0.010
	Ibuprofen *(common brand name: Advil®)*	IBPRFN	15687-27-1 or 51146-56-6	0.010
	Iohexol *(common brand name: Omnipaque®)*	IOHEXL	66108-95-0	0.050
	Naproxen *(common brand name: Aleve®)*	NAPRXN	22204-53-1	0.010
	Sucralose *(common brand name: Splenda®)*	SUCRAL	56038-13-2	0.100
	Sulfamethoxazole *(common brand name: Bactrim®)*	SULTHZ	8064-90-2 or 732-46-6	0.010
NDMA EPA 521	N-Nitrosodimethylamine	NDMA	62-75-9	0.002
	N-Nitrosomorpholine	NMOR	59-89-2 or 67587-56-8	0.002
1,4-DIOXANE (Purge & Trap)	1,4-Dioxane	14DIOX	123-91-1	0.50
1,4-DIOXANE EPA 522	1,4-Dioxane	14DIOX	123-91-1	0.07

Table 3.2: Method Performance Checks for 537.1, NDMA, and 1,4-DIOXANE Analysis

Sample Description	**Specification &Frequency**	**Acceptance Criteria**	**Remedial Action**
Low-Level CCC at or below the MRL (RDL)	At the beginning of each analysis batch	50-150% target recovery and the SUR must be within 70-130% of the true value.	Instrument Maintenance and Check Standards
Mid-Level CCC	Each Analysis Run – after every 10 Field Samples	70-130% target recovery and the SUR must be within 70-130% of the true value.	Instrument Maintenance and Check Standards
Back Standards CCC (Mid or High Level CCC)	At the end of the analysis batch	70-130% target recovery and the SUR must be within 70-130% of the true value.	Instrument Maintenance and Check Standards
Quality Control Sample (QCS) – Second Source Standard	Analyze at least quarterly or when preparing new standards, new calibration	70-130% target recovery and the SUR must be within 70-130% of the true value.	Remake standard or open new standards
"RB" Reagent Blank	One LRB with each extraction batch of up to 20 Field samples.	All targets must be less than 1/3 of the MRL (RDL) If targets exceed 1/3 the MRL or if interferences are present, results for these subject analytes in the extraction batch are invalid.	Isolate Source of Contamination and Re-Extract
Low Laboratory Fortified Blank (LFB) Spiked Reagent Water at the MRL	One LFB is required for each extraction batch of up to 20 Field Samples Not Applicable for 1,4-Dioxane (Purge &Trap)	50-150% target recovery	Check SPE Cartridge Lots Verify Extraction Procedures and Re-extract
LFB – Spiked Reagent Water at mid or high level	One LFB is required for each extraction batch of up to 20 Field Samples. Rotate between medium and high amounts Not Applicable for 1,4-Dioxane (Purge &Trap)	70-130% target recovery	Check SPE Cartridge Lots Verify Extraction Procedures and Re-extract
Internal Standard (IS)	Internal standards are added to all standards and sample extracts, including QC samples.	***EPA 537.1*** Peak area counts for all ISs in all injections must be within ± 50% of the average peak area calculated during the initial calibration	Investigate Matrix Issues Check Standards and Re-Extract

	Compare IS areas to the average IS area in the initial calibration and to the most recent CCC. If ISs do not meet this criterion, corresponding target results are invalid	**and** 70-140% from the most recent CCC ***1,4-Dioxane*** *(Purge &Trap)***)** Peak area counts for all ISs in all injections must be within ± 50% of the average peak area calculated during the initial calibration ***NDMA*** Peak area counts for all ISs in all injections must be within ± 50% of the average peak area calculated during the initial calibration ***EPA 521 and EPA 522*** Peak area counts for all ISs in all injections must be within ± 50% of the average peak area calculated during the initial calibration **and** 70-130% from the most recent CCC	
Surrogate Standards (SUR)	Surrogate standards are added to all Calibration standards and samples, including QC samples.	SUR recoveries must be 70-130% of the true value.	Investigate Matrix Issues Check Standards and Re-Extract
SAWPA Project Sample Duplicates	Each Analysis Run 10% minimum of total sample load	≤30% at mid and high levels of fortification and ≤50% near the MRL	Results Reported Re-Extract to confirm if possible
Matrix Spikes Matrix Spike Duplicates Spike/Spike Dup (MRL – Low Level)	Each Analysis Run 10% minimum of total sample load	Recoveries must be within 50-150 % and </= 50 % RPD If MS/MSD spike level is <50% of the ambient concentration acceptance limits are not relevant	Investigate Matrix Issues Check Standards and Re-Extract
Matrix Spikes Matrix Spike Duplicates Spike/Spike Dup (Mid and high levels)	Each Analysis Run 10% minimum of total sample load	Recoveries must be within 70-130 % and </= 30 % RPD If MS/MSD spike level is <50% of the ambient concentration acceptance limits are not relevant	Investigate Matrix Issues Check Standards and Re-Extract
Field Reagent Blank (FRB) Apply to EPA 537.1 ONLY	The FRB is processed, extracted and analyzed in exactly the same	If the method analyte(s) found in the Field Sample is present in the FRB at a concentration greater than	Sample must be recollected and reanalyzed.

	manner as a Field Sample.	1/3 the MRL, then all samples collected with that FRB are invalid	
Peak Asymmetry Factor Apply to EPA 537.1 ONLY	Calculate the peak asymmetry factor for the first two eluting chromatographic peaks in a mid-level CAL standard <u>every time a new calibration curve is generated.</u> and when chromatographic changes are made that affect peak shape.	Peak asymmetry factor of 0.8 – 1.5 See EPA 537.1 – Section 9.3.9 for the peak asymmetry factor calculation	Change the initial mobile phase conditions to higher aqueous content until the peak asymmetry ratio for each peak is 0.8 – 1.5. See EPA 537.1 – Section 10.2.4.1 Check the tubing connection to the analytical column
MS Tune	Demonstration of acceptable MS tune	EPA 522	Instrument Maintenance
Initial Calibration	Started Before Each Analysis Run Must use at least a 5-point calibration curve Lowest Standard must be at or below reportable detection level (RDL) Use IS calibration technique to generate a first or second order calibration curve. EPA537.1 This curve **<u>must always</u>** be forced through zero and may be concentration weighted, if necessary	When each CAL standard is calculated as an unknown using the calibration curve, the % recovery for each analyte must be 70-130% of the true value for all except the lowest standard, which must be 50-150% of the true value	Check Standard Lots and QC Recalibration or Open New Standards Instrument Maintenance

Table 3.3: Method Performance Checks for CEC Analysis

Laboratory Fortified Blank (LFB) is not required since this method utilizes procedural calibration standards, which are fortified reagent waters, there is no difference between the LFB and the Continuing Calibration Check (CCC) standard.

Sample Description	Specification & Frequency	Acceptance Criteria	Remedial Action
Low-Level CCC at the MRL (RDL)	Each Analysis Run	50–150% target recovery	Instrument Maintenance & Check Standards
Mid-Level CCC	Each Analysis Run	70-130% target recovery	Instrument Maintenance & Check Standards
"RB" – Reagent Blank	Each Extraction Set	All targets must be less than 1/3 of the MRL (RDL)	Isolate Source of Contamination and Re-Extract
Matrix Spikes – Matrix Spike Duplicates Spike/Spike Dup (200 ng/L - SARMON)	Each Analysis Run – 10% minimum of total sample load	60–140% recovery <30%RPD If MS/MSD spike level is <50% of the ambient concentration acceptance limits are not relevant	Investigate Matrix Issues – Check Standards and Re-Extract
Field Sample	Run Analysis	Check Internal (Isotope) Recovery (compound independent)	Investigate Matrix Issues – Check Standards and Re-Extract
Back Standards Mid or High Level CCC	Each Analysis Run – Every 10 samples must be bracketed with a CCC std	70–130% target recovery	Instrument Maintenance & Check Standards
Initial Calibration	Started Before Each Analysis Run	Must use at least a 5-point calibration curve Lowest Standard must be at or below reportable detection level (RDL) Calib. Curve - <20% RSD	Check Standard Lots & QC – Re-shoot or Open New Standards Instrument Maintenance
SAWPA Project Sample Duplicates	Each Analysis Run – 10% minimum of total sample load	<30%RPD	Results Reported – Re-Extract to confirm if possible.
MDLs	Major Instrument Maintenance	The goal is for the calculated MDL to be 1/3 the RDL. The MDL must be lower than the RDL.	Instrument Maintenance, Extraction Procedures, & Check Standards

4. Data Assessment and Reporting

Data will be reviewed by each laboratory's procedure and potential re-extractions or re-analysis conducted. Any samples that fail specific QA/QC criteria, which require a re-sampling request, will be done and evaluated at each participating lab. A detailed description of the cause(s) of the request will be reviewed.

Laboratories will provide a copy of their detailed SOP within the support of this investigation. Final reports will provide all QA/QC information including spike recovery information, LFB recoveries, blanks, calibration check information, MDLs, and applied method techniques. Blanks and QC and MRL criteria referenced in Table 4.1 will be followed by all laboratories.

Table 4.1: Blanks and MRL Criteria for 2019 Analysis

Batch QC	QC result	Secondary check	Reporting qualifiers
Laboratory Reagent Blank (RB)	<1/3 MRL		OK to report
	>1/3MRL	Samples positive	Reprocess all positive samples
MRL - Check	<50%		Reprocess entire batch
	50-150%		Proceed
	>150%		Report if samples ND & note qualifier
Laboratory Fortified Blank (LFB) (spike must be <10x the MRL and should be representative of samples)	<70%		Reprocess entire batch
	70-130%		Proceed
	>130%		Report if samples ND & note qualifier

Additional QC Requirement for EPA 537.1 ONLY

Field QC	QC result	Secondary check	Reporting qualifiers
Field Reagent Blank (FRB)	< 1/3 MRL		Proceed
	>1/3 MRL	Sample positive	Field Contamination – Must be Resample and reanalyzed
	>1/3 and <1/2 MRL	Sample ND	Report ND & note qualifier

5. Data Interpretation and Application

Because the analytical techniques used to support EC characterization studies are still in the process of development, great care must be exercised when using the results of such studies. To ensure that water quality monitoring data is used appropriately, EPA has established formal Data Quality Assurance requirements:

> *"EPA has developed a mandatory Agency-wide Quality System (or QA program) that requires all organizations performing work for EPA to assure that: environmental data collected are of the appropriate type and quality for their intended use...."*[4]

> *"Data Quality Objectives (DQOs) are statements of the level of uncertainty that a decision maker is willing to accept in results derived from environmental data, when the results are going to be used in a regulatory or programmatic decision (e.g., setting or revising a standard, or determining compliance). They are a tool that the permit writer may use to ensure that resources are being expended in the most efficient way, and that data collected are sufficient to support the decision making process and not extraneous to that process. To be complete, these quantitative DQOs must be accompanied by clear statements of: decisions to be made; why environmental data are needed and how they will be used; time and resource constraints on data collection; descriptions of the environmental data to be collected; specifications regarding the domain of the decision; calculations, statistical or otherwise, that will be performed on the data in order to arrive at a result. Without first developing DQOs, a QA program can only be used to document the quality of obtained data, rather than to ensure that the data quality obtained will be sufficient to support a permitting decision."*[5]

The most common use of water quality monitoring data is to evaluate compliance with relevant water quality standards. Therefore, DQOs are usually established in order to ensure that the resulting information is suitable for that intended regulatory purpose. The data quality criteria established in conjunction with California's 303(d) listing guidance is an example of such DQOs.[6]

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[4]U.S. EPA. EPA Requirements for Quality Management Plans; EPA QA/R-2; Nov., 1999.

[5]U.S. EPA. NPDES Permit Writer's Guide to Data Quality Objectives; Nov., 1990; p. 1-4 & 1-5.

[6]State Water Resources Control Board.Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List. Sept. 30, 2005; Section 6.1 @ pgs. 17-26. See also Final Functional Equivalent Document for Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List. Sept., 2004. Pgs. 232-235.

EPA has established standard methods for evaluating some, but not all, of the ECs that will be evaluated during the proposed study. However, the standard methods that have been promulgated by EPA have only been validated for use in analyzing finished drinking water not raw surface waters or treated wastewater where matrix interference is more likely to occur. Therefore, the data collected as part of this EC characterization study should be considered "provisional."[7] This is consistent with EPA's guidance:

> *...methods which will be used extensively for regulatory purposes or where significant decision must be based on the quality of the analytical data normally require more extensive validation and standardization than methods developed to collect preliminary baseline data.*[8]

The data quality objectives established in this Sampling and Analysis Plan (SLAP) are suitable for supporting a voluntary effort to characterize baseline EC concentrations in the Santa Ana watershed. However, the SLAP is not intended to meet the more rigorous QAPP requirements specified in the Recycled Water Policy.[9] As such, additional method validation in more complex water matrices may be necessary before the new data generated during the course of this study can be deemed suitable for some regulatory purposes (e.g. 303(d) listing decisions, antidegradation analyses or translating narrative criteria into numeric TMDL targets or effluent limits, compliance determinations, etc.).[10]

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[7] EPA's criteria for certifying a new standard method, pursuant to 40 CFR Part 136, requires a thorough demonstration of accuracy, precision, method detection levels, representativeness, ruggedness, comparability and availability for the proposed analytical procedure. See U.S. EPA. Availability, Adequacy, and Comparability of Testing Procedures for the Analysis of Pollutants Established Under Section 304(h) of the Federal Water Pollution Control Act - Report to Congress; EPA/600/9-87/030; September, 1988 for a more detailed discussion.

[8] U.S. EPA. Availability, Adequacy, and Comparability of Testing Procedures for the Analysis of Pollutants Established Under Section 304(h) of the Federal Water Pollution Control Act - Report to Congress; EPA/600/9-87/030; September, 1988; pg.3-5S

[9] State Water Resources Control Board Res. No. 2018-0057 as amended Dec. 11, 2018 (see pg. A-2)

[10] The SLAP has endeavored to meet the recommended Reporting Limits identified in Table 1 (pg. A-4) of the recently revised Recycled Water Policy (Res. No. 2018-0057).

6. Definitions

Blind QC Samples – An unknown quality control sample, which is spiked with the study's target compounds in a reagent water matrix. QC samples are provided by a method Proficiency Testing (PT) vendor – Environmental Resource Associates (ERA). Two QC samples are provided within this study – a mid level calibration check (25-200 ng/L) except Sucralose is spiked between 500-2,000 ng/L and 1,4-Dioxane is spiked between 1,500-5,000 ng/L and an S-MRL check (100-200% of each target's S-MRL). QC samples are sent directly to participating labs by the PE vendor for analysis.

CCC – ***Continuing Calibration Check*** – a method required standard to verify the calibration curve – most labs will run verification at the mid-level of the calibration – and at the reportable detection level - RDL (minimum reporting level – MRL).

QCS **QUALITY CONTROL SAMPLE (QCS) – A solution of method analytes of known concentrations that is obtained from a second source and different from the source of calibration standards.**

COC - Chain of Custody – document that provides field and site information and conditions. COC information is transferred into the lab's database, includes basic field parameters. This is a legally required lab document.

FRB **Field Reagent Blank – EPA 537.1 Only -** A quality control sample used to monitor/verify sampling conditions at the site. The field blank is processed by pouring laboratory preserved reagent water into an empty sample container for the required method. The process mimics the sampling techniques for the site sample; tested to ensure that none of the targets determined within the sample are coming from the process of sampling.

LFB/LCS (low/high) -Laboratory Fortified Blank/Laboratory Control Sample – is a laboratory reagent water sample, which is spiked with the method targets, and extracted within each method batch of samples. Processed just like a sample. This quality control sample insures that the method is generating acceptable data. Labs may run both an MRL/RDL level LFB (low) as well as a mid-level LFB (high).

MBLK / BLK/ RB – Method Blank/ Blank / Reagent Blank – is a method quality control sample consisting of laboratory reagent water and extracted and analyzed identically to all samples within each analytical batch. It monitors the laboratory method and techniques for any sources of contamination or interference.

MDLs – Method Detection Levels – are a statistical calculated value for each target analyzed by the laboratory's method. MDLs are performed by processing seven or more spiked replicates samples at a low-level, and analyzed over a three or more day period under method conditions. MDLs represent the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The MDLs goal is to be 3x lower than the laboratory established RDL/MRL.

MRL/RDL – Minimum Reporting Limit/ Reportable Detection Level - Represents the minimum quantifiable concentration level for a target analyte within the method. It usually represents the lowest calibration level within the standard curve. The MRL/RDL must be higher than the statistically calculated MDL.

MS/MSD - Matrix Spike / Matrix Spike Duplicate – are quality control samples processed within each analytical batch. They represent field samples that have been spiked with a known concentration of target analytes and processed within the entire method along with all samples. These QC samples are used to monitor the impact of sample matrix on the accuracy and precision of the results.

RPD – Relative Percent Difference – is a quality control value calculated from the MS/MSD samples (as well as other QC duplicates) as a measure of the precision of the method. RPD = ((X1-X2) / ((X1+X2)/2))*100

MRL – Minimum Reporting Limit – The lowest concentration level at which each target within this study will be quantified and reported as in Table 3.1

SOP – Standard Operating Procedure – the laboratory document that provides detailed directions as to the steps and procedures within the method of analysis. Procedure followed by laboratory technicians and chemists so as to produce consistent reliable results. SOPs are also used by field staff.

SPE – Solid Phase Extraction – analytical technique used within the lab to extract and process samples. Disks and cartridges are used to retain the targets of interest during the extraction process – eluted with appropriate solvents and then concentrated for final analysis.

Split Sample – Split Sample – is a quality assurance control, which is an actual field sample that is sent to multiple labs for analysis. The split samples provide a comparison of quality analysis between different labs on actual matrices and are more useful than LFBs for assessing overall accuracy.