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# Central Valley Pilot Study for Monitoring Constituents of Emerging Concern (CECs) Work Plan

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*In consultation with:*

Other participating agencies including the City of Vacaville, City of Roseville, Central Valley Regional Water Quality Control Board, and State Water Resources Control Board

# 1 Introduction

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At the request of the Central Valley Regional Water Quality Control Board (Central Valley Water Board) and the State Water Resources Control Board (State Water Board), the Central Valley Clean Water Association (CVCWA) and several<sup>1</sup> Central Valley Municipal Separate Storm Sewer System (MS4) representatives (collectively “Stakeholders”) developed this Pilot Study for Monitoring Constituents of Emerging Concern (CECs) Work Plan (Work Plan), to be implemented through the Delta Regional Monitoring Program (Delta RMP), to monitor CECs in the Central Valley on a pilot basis, primarily in and around the Sacramento-San Joaquin Delta (Delta). If this Work Plan is not implemented through the Delta RMP, revisions would be necessary.

This Work Plan has been developed to address the targeted CEC study elements as described in the CECs Statewide Pilot Study Monitoring Plan developed by the State Water Board (2016 Statewide Monitoring Plan)<sup>2</sup>. The 2016 Statewide Monitoring Plan was created as part of a statewide effort to address CEC monitoring needs in reaction to public interest in this topic and employs a beneficial use protection assessment approach. CEC monitoring has already been implemented differently in several regions through regional monitoring programs, Surface Water Ambient Monitoring Program (SWAMP) funding, and individual discharger funded programs.

In addition to requests from the State Water Board and the Central Valley Water Board, the development and implementation of a pilot CEC monitoring program in the Delta will also address one of the Delta Stewardship Council’s Priority Science Actions recommended in the 2017 Science Action Agenda of the Delta Stewardship Council<sup>3</sup>.

A suggested list of CECs is described in the 2016 Statewide Monitoring Plan. This Work Plan has been adapted for the Central Valley to address most of the key CECs identified by the State Water Board. Exceptions include those CECs that are currently monitored in the Central Valley under separate programs or regulations, including a number of current-use pesticides, among them pyrethroids.

The State Water Board, Central Valley Water Board, and other California Regional Water Quality Control Boards convened a workshop on May 1 and 2, 2017 to share information regarding CEC monitoring completed to date in other regions in the State. Information presented and discussed at this workshop aided in the development of this Work Plan.

While the analytical methods necessary for this Work Plan can be performed by research laboratories and a select few commercial laboratories, any data collected in the program should

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<sup>1</sup> Approximately nine (9) out of a total of 143 MS4 agencies voluntarily participated in the Work Plan development that is intended to satisfy the Central Valley region-wide effort.

<sup>2</sup> Dawitt Tadesse, Office of Information Management and Analysis, State Water Resources Control Board. “Statewide Monitoring Plan. Constituents of Emerging Concern (CECs) Statewide Pilot Study Monitoring Plan.” January 2016.  
[https://www.waterboards.ca.gov/water\\_issues/programs/swamp/cec\\_aquatic/docs/oima\\_sw\\_cec\\_mon\\_plan.pdf](https://www.waterboards.ca.gov/water_issues/programs/swamp/cec_aquatic/docs/oima_sw_cec_mon_plan.pdf)

<sup>3</sup> Delta Stewardship Council, Delta Science Program. “Science Action Agenda: 2017-2021 A Collaborative Road Map for Delta Science.” September 2017.  
<http://scienceactionagenda.deltacouncil.ca.gov/sites/default/files/2017-2021-SAA-final-Sept2017.pdf>

be specifically evaluated to demonstrate or measure the extent the data are reliable (accuracy against a known standard), reproducible (precision of duplicates between multiple laboratories), and repeatable (precision by primary laboratory) before they are used for source management and regulatory enforcement decision making. Moreover, effects thresholds are not well known at the expected low concentrations with respect to additive or mitigating effects, and an established process should be developed when assessing beneficial use protection. Based on discussions with Central Valley Water Board staff during the coordination meeting held on September 18, 2017, the data gathered during this pilot study will be used to inform the statewide and Central Valley Water Board's CEC programs and will not be used for regulatory purposes.

The State Water Board and the Central Valley Water Board conditionally approved<sup>4</sup> the previous version of this Work Plan on February 16, 2018. The conditional approval requires the Work Plan to address seven comments in order to be deemed a final approved work plan. These comments have been addressed as part of this submittal.

## **1.1 DELTA REGIONAL MONITORING PROGRAM**

During early discussions, the use of the Delta Regional Monitoring Program (RMP) to implement the pilot study was favored and supported by publicly owned treatment works (POTW) and MS4 representatives and Central Valley Water Board management for numerous reasons, including the following:

- It capitalizes on the ongoing Delta RMP stakeholder-based process, including technical and peer review;
- It provides a better understanding of CEC presence in Central Valley waters than isolated receiving water data;
- It is consistent with the stated mission of the Delta RMP;
- It supports the growth of the Delta RMP, including enhancement of data assessment and communications; and
- It addresses one of the Delta Stewardship Council's Priority Science Actions to improve understanding of interactions between stressors and managed species and their communities (Action 4). Specifically, the CEC pilot monitoring program will provide the opportunity to develop initial information on the potential impacts of CECs on aquatic species in the Central Valley.

Ideally, the Central Valley CEC pilot monitoring program would begin in fiscal year 2018-2019, after July 1, 2018. This Work Plan should be implemented as a Delta RMP "Special Study" without extensive revision. While the Delta RMP does not have a specific process for approving special studies, the previously performed Pathogen Study<sup>5</sup> is an analogous approach whereby a

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<sup>4</sup> Creedon, Pamela, Central Valley Regional Water Quality Control Board and Greg Gearheart, State Water Board Office of Information Management and Analysis. *Conditional Approval of Central Valley Pilot Study for Monitoring Constituents of Emerging Concern (CECs) Work Plan*. Letter communication to MS4 and POTW Permittees (distribution list not specified). February 16, 2018.

<sup>5</sup>Delta Regional Monitoring Program. "Monitoring Design Summary." Prepared for the Delta RMP Steering Committee. November 3, 2014. Revised June 16, 2015.  
[https://www.waterboards.ca.gov/centralvalley/water\\_issues/delta\\_water\\_quality/delta\\_regional\\_monitoring/wq\\_monitoring\\_plans/drmp\\_monitoring\\_design.pdf](https://www.waterboards.ca.gov/centralvalley/water_issues/delta_water_quality/delta_regional_monitoring/wq_monitoring_plans/drmp_monitoring_design.pdf)

specific monitoring and assessment need was identified through a stakeholder process which was then addressed through the Delta RMP with active involvement by the stakeholder group. Because this Work Plan was developed for a specific purpose by the Stakeholders and was specifically approved by the Central Valley Water Board and the State Water Board, no significant changes to the scope of the effort are intended. The Delta RMP Steering Committee<sup>6</sup> agreed to implement the Work Plan, pending funding appropriation and directed the Delta RMP Technical Advisory Committee (TAC) to proceed as follows:

- Form a CEC Technical Workgroup based on the Stakeholder group and other interested members
- Review the Work Plan to identify collaboration opportunities that would reduce cost or provide significant technical benefit
- Identify any significant sample collection method improvements that can be implemented without changes to the overall level of effort or increase in budget

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<sup>6</sup> Delta Regional Monitoring Program Steering Committee meeting, March 2, 2018.

## 2 Purpose

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The proposed Central Valley CEC pilot study would provide preliminary information to begin to address the Delta RMP management question, “Is there a problem or are there signs of a problem” through the stated question<sup>7</sup>, “Are CECs impacting Beneficial Uses in the Central Valley?”. This Work Plan will not directly answer this question, which would require significant science development and consideration of factors not included in this Work Plan. However, this Work Plan will provide incremental assessment of conditions through consideration of the 2016 Statewide Monitoring Plan monitoring questions that are compiled in **Table 1**.

Consistent with the current direction of the Delta RMP, the proposed Central Valley CEC pilot study is focused on development of information to understand the presence of a specific list of CECs in ambient waters, sediments, and, to a limited extent, tissues of locally gathered fish and bivalves. Evaluation of contributions from urban sources is also consistent with the “Sources and Pathways” Delta RMP Management Question.

A clear need exists to develop an understanding of the presence/absence and potential risks (i.e., a need for water quality standards for determination of beneficial use impairment) posed by CECs in the Central Valley. This will require significant expansion of effects research. This is best addressed at a national or statewide level and is not recommended as an element of the Central Valley CEC pilot monitoring effort.

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<sup>7</sup> Assessment question as stated by Regional Water Board staff at the December 7, 2017 Central Valley Regional Water Quality Control Board hearing.

**Table 1. Technical Approaches to Address Assessment Questions**

2016 Statewide Monitoring Plan Monitoring Questions	Technical Approach to Address Monitoring Questions
<b>POTWs</b>	
<ol style="list-style-type: none"> <li>1. Which CECs are detected in freshwaters and in which California watersheds are they detected?</li> <li>2. Can the CECs be shown to originate from the inland WWTP, or are they present at background concentrations?</li> <li>3. How quickly (i.e., at what distance) do the CECs attenuate once discharged?</li> <li>4. What are the concentrations and loadings of target CECs in the dry vs. wet seasons?</li> <li>5. Do the new occurrence data change the estimated monitoring trigger quotients (MTQs)?</li> <li>6. Which detected CECs have been found to accumulate in sediments and fish tissue?</li> </ol>	<ul style="list-style-type: none"> <li>• Monitor to determine detection of CECs at boundaries of the Delta and within the legal Delta over multiple years and conditions.</li> <li>• Compare observed concentrations at upstream boundaries or locations and downstream monitoring locations.</li> <li>• Perform a gradient study to evaluate concentrations at multiple locations downstream from discharges to evaluate CEC attenuation over distance.</li> <li>• Compare wet and dry season concentrations and loadings at individual source characterization and ambient sites.</li> <li>• Compare maximum detected ambient values to determine if site-specific MTQ is greater than or less than unity (1.0).</li> <li>• Compare of water column detected concentrations to paired sediment and tissue samples. Calculation of average accumulation ratios.</li> </ul>
<b>MS4s</b>	
<ol style="list-style-type: none"> <li>1. Which CECs are detected in waterways dominated by stormwater?</li> <li>2. What are their concentrations and loadings in the dry vs. wet seasons?</li> <li>3. What is the relative contribution of CECs in WWTP effluent vs. stormwater?</li> <li>4. What is the spatial and temporal variability in loadings and concentration (e.g. between storm variability during the wet season; in stream attenuation rate during low flow, dry season conditions)?</li> </ol>	<ul style="list-style-type: none"> <li>• Monitor to determine detection at the American River at Discovery Park monitoring location during wet weather conditions.</li> <li>• Compare wet and dry season concentrations and loadings at individual source characterization sites.</li> <li>• Compare wet and dry weather source characterization loading estimates for urban area runoff and POTW discharge relative to ambient flux.</li> <li>• There is insufficient sample collection included in the Work Plan to perform a robust variability assessment; however, significant trends may be detectable when evaluated with other (external) data and work by MS4s (e.g. statistical loading models).</li> </ul>

### 3 Pilot Study Scope

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The Central Valley CEC pilot study is proposed over a three-year period with phased study components and some (albeit limited) adaptive management elements. **Table 1** summarizes the technical approaches to address the State Water Board's 2016 Statewide Monitoring Plan monitoring questions. Year 1 includes ambient monitoring to assess the presence of the targeted CECs at specific locations in the Delta. After the first year of ambient monitoring, subsequent elements of the proposed CEC monitoring plan include continued ambient monitoring and source monitoring (POTW effluent and urban runoff characterization) during Year 2, and continuation of Year 2 source monitoring in addition to gradient studies upstream and downstream of POTWs and other identified sources during Year 3. Year 3 studies will be focused on those CECs detected at levels of interest. Sample collection during Year 3 may be modified to better address information needs based on the first two years of monitoring but will at least include the second year of source monitoring. Changes to the monitoring elements will be agreed upon by the Stakeholders through a Delta RMP technical review and budgeting process. It is recommended that the Stakeholders establish a CEC Technical Workgroup, as a Delta RMP Technical Advisory Committee (TAC) subcommittee, to implement the Work Plan through the Delta RMP.

The ambient sampling locations include entry points into the Delta, in-Delta waters, and ambient locations in the vicinity of POTW discharges and within the influence from urban runoff. Ambient monitoring to characterize background conditions was suggested in the State Water Board's 2016 Statewide Monitoring Plan.

The proposed Central Valley CEC pilot study will not address several other elements of the 2016 Statewide Monitoring Plan, including non-targeted assessment, bioanalytical or toxicity components. These components may be added to the Work Plan if additional external funding is available to support this work.

During the development of this Work Plan, preliminary evaluations were performed to identify and confirm appropriate sampling, sample extraction, analytical, sample handling, and quality assurance/quality control (QA/QC) methods to be used for each of the CECs on the target list to maintain consistency with other elements of the 2016 Statewide Monitoring Plan. The Delta RMP Quality Assurance Project Plan (QAPP) should be updated to address data quality and provide data usage qualification for the constituents included in this proposed pilot study. A sample collection plan should also be developed, either as an attachment to the QAPP or as a standalone Delta RMP document.

### 3.1 TARGET CECS

The list of CECS shown in **Table 2** will be monitored as part of this Work Plan, consistent with the list proposed in the State Water Board’s 2016 Statewide Monitoring Plan and/or recommended during the May 2017 workshop.

**Table 2. Target CECS and Matrices to Be Monitored During the Central Valley CEC Pilot Study**

Analyte [1]	Matrix		
	Water Column [2]	Sediment [3]	Tissue [4]
Estrone	✓	---	---
Ibuprofen	✓	---	---
Bisphenol A	✓	---	---
17-beta-estradiol	✓	---	---
Galaxolide (HHCB)	✓	---	---
Diclofenac	✓	---	---
Triclosan	✓	---	---
Triclocarban	✓	---	---
PBDE-47	---	✓	✓
PBDE-99	---	✓	✓
PFOS	✓	✓	✓ [5]
PFOA	✓	✓	✓ [5]

Notes:

[1] Sites may be modified to optimize logistics or costs. Any changes to the monitoring proposal will be approved by the Stakeholders under the Delta RMP. Additional constituents included in the method used will be reported in the data deliverable (CEDEN and appendix of results), but not included in the data report body.

[2] Filtered samples will be used to estimate the aqueous concentration

[3] Sediment sample collection may only be performed at wadeable streams or otherwise be coordinated with the State Water Board’s Stream Pollution Trends Monitoring Program (SPoT) or other programs with deeper water sediment collection.

[4] Tissue sample collection to be coordinated with Delta RMP mercury monitoring efforts, the Department of Water Resources (DWR), and other historic monitoring efforts. Sites may be modified based on logistical optimization and may not be coincidental with water column (aqueous) samples.

[5] Fish tissue only based on known limited concentrations in bivalves.

### 3.2 AMBIENT MONITORING – YEARS 1, 2 AND 3

The targeted list of CECS will be monitored at six (6) to eight (8) ambient sites located in the Delta and vicinity in water column, sediment and/or tissue matrices, according to the matrix shown in **Table 2** of this Work Plan. Tissues used in the Central Valley CEC pilot study will be fish and bivalve tissue samples obtained as part of the Delta RMP mercury monitoring efforts in 2018 or will be fish and bivalve tissues available from other tissue collection efforts in the Delta from the sites specified in **Table 3**.

Proposed in-Delta ambient monitoring sites are a subset of monitoring sites monitored by the Delta RMP for other parameters, consistent with Delta RMP efforts to leverage ongoing sampling efforts wherever possible. Proposed in-Delta sites include the Sacramento River at Hood and San Joaquin River at Vernalis. Should funds allow, the San Joaquin River at Buckley



Cove and Sacramento River at Freeport sites are also recommended as lower priority in-Delta locations.

The Sacramento River at Veterans Bridge, San Joaquin River at Vernalis, and American River at Discovery Park sites will be used as boundary sites to provide information on “background” levels of CECs in waters entering the Delta.

The locations of proposed ambient sites are summarized in **Table 3** and shown in **Figure 1**. Monitoring of ambient sites will be performed for three years, during both wet and dry seasons. The proposed frequency of ambient monitoring during each year is described in **Table 4** of this Work Plan. The frequency of ambient monitoring during Year 3 is contingent on interpretation of detected results and priority information needs from the first two years of monitoring.

**Table 3. Monitoring Locations for Central Valley CEC Pilot Study and Possible Coordination Opportunities**

<b>Location Description</b>	<b>Approximate Latitude/Longitude</b>	<b>Sample Collection</b>	<b>Sample Coordination Opportunities</b>
<b>Ambient Locations</b>			
Sacramento River at Veterans Bridge	38.680922, -121.626422	WC, FISH, BIV	BIV [2]
Sacramento River at Freeport [5]	38.457345, -121.504589	WC, FISH, BIV	WC, FISH, BIV [1,2]
Sacramento River at Hood	38.367116, -121.520419	WC, BIV	WC, BIV [2]
American River at Discovery Park	38.602103, -121.497311	WC, BIV, SED	WC, SED [4]
San Joaquin River at Vernalis	37.679107, -121.263181	WC, FISH, BIV	WC, FISH [1, 4]
San Joaquin River at Buckley Cove [5]	37.978041, -121.383336	WC, FISH, BIV	WC [6], BIV [3]
Dry Creek	38.733852, -121.315722 [7]	WC, SED	[8]
Old Alamo Creek	38.346428, -121.896835 [7]	WC, SED	[8]
<b>Source Locations</b>			
POTW Source No. 1	38.733899, -121.315051	WC	[8]
POTW Source No. 2	38.346617, -121.901601	WC	[8]
Sacramento Urban Runoff (UR3)	38.601271, -121.492956	WC	[8]
Roseville Urban Runoff	[7]	WC	[7]

Notes:

WC – water column, FISH – sport fish, BIV – bivalve, SED – sediment

[1] Delta RMP Methylmercury plans to collect water column (8-10 times annually) and largemouth bass (annually).

[2] Historic samples collected and frozen by Sacramento Regional County Sanitation District (SRCSD) may be available and substituted for some samples. Other historic preserved samples are available.

[3] DWR ERM Benthic Site (also, Old River Upstream Clifton Court, Old River Upstream of Rock Slough, San Joaquin River at Bradford Island, Sacramento River Downstream of Rio Vista, Sacramento River at Sherman Island)

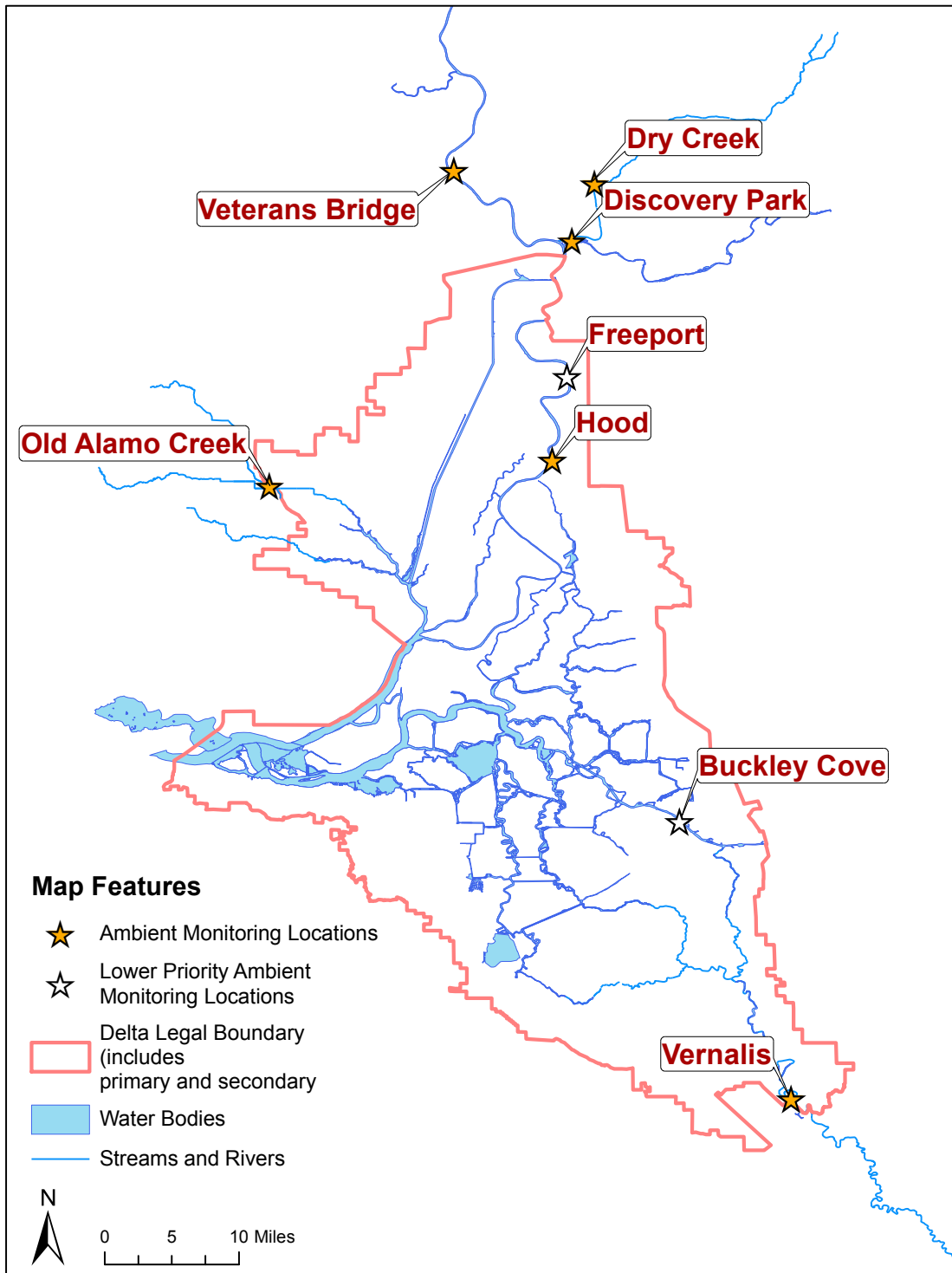
[4] SPoT sediment and water column monitoring location. Samples are also collected at Sacramento River at Clarksburg Marina between Freeport and Hood (approximates Hood downstream of SRCSD and Sacramento urban area)

[5] Identified as lower priority site

[6] Delta RMP Pesticide may include water column monitoring.

[7] C DPR historic location in Pleasant Grove Creek watershed to be field verified based on presence of urban runoff flow in storm drains. Possible locations include 38.80477, -121.32733; 38.802707, -121.338524; and 38.802599 -121.338787.

[8] Coordination with existing permit collection may be possible



**Figure 1. Central Valley CEC Pilot Study Ambient Monitoring Locations**

**Table 4. Monitoring Frequency Proposed for Central Valley CEC Pilot Study**

Year	Matrix	No. of Monitoring Sites	Samples/Year	Total Samples [1,3]
1	Water (ambient)	6-8	4	24-32
	Water (POTW)	0	0	0
	Water (MS4)	0	0	0
	Sediment (ambient) [2]	2-4	2	4-8
	Tissue (fish)	2-4	1-2	2-8
	Tissue (bivalve)	2-4	1-2	2-8
2	Water (ambient)	6-8	4	24-32
	Water (POTW)	2	4	8
	Water (MS4)	2	4	8
	Sediment (ambient) [2]	2-4	2	4-8
	Tissue (fish)	2-4	1-2	2-8
	Tissue (bivalve)	2-4	1-2	2-8
3	Water (ambient) [2]	10-18	2	20-36
	Water (POTW)	2	2	4
	Water (MS4)	2	2	4
	Sediment (ambient)	0	0	0
	Tissue (fish)	0	0	0
	Tissue (bivalve)	0	0	0

**Notes:**

[1] Total samples shown in this table do not include field-collected QA/QC samples (i.e., field blanks, field duplicates, and inter-laboratory split samples) that will be collected at some frequency for each monitoring event during the 3-year pilot study.

[2] Sediment sample collection limited based on recommendation in conditional approval letter (February 16, 2018).

Receiving water monitoring includes gradient monitoring at one location upstream and up to five locations downstream of two POTW discharges.

[3] Ranges of the number of monitoring locations and samples per year reflect the expected optimization effort to identify and use samples from existing efforts by the Delta RMP and others noted in the Coordination section of this Work Plan.

### 3.3 POTW EFFLUENT AND URBAN RUNOFF CHARACTERIZATION MONITORING – YEARS 2 AND 3

In Year 2, in addition to ambient monitoring, two POTW effluent(s) and two urban runoff characterization locations will be monitored. Because of the limited urban area within the Delta, upstream out-of-Delta urban runoff and POTW characterization locations may be monitored and are intended to generally characterize these sources throughout the Central Valley.

### 3.4 GRADIENT STUDIES – YEAR 3

In Year 3, two POTW gradients will be monitored. CECs monitored in the gradients will depend on those CECs detected in Year 2 POTW source monitoring. The gradient monitoring will consist of one upstream station and up to five downstream stations, as suggested in the State

Water Board’s 2016 Statewide Monitoring Plan. The decisions on the specific locations and number and spacing of gradient sites will be made during Year 2. After consultation with the Stakeholders, including the Central Valley Water Board and State Water Board, the gradient study may be reduced in scope or omitted if other information needs are higher priority given the available Delta RMP funding.

### **3.5 ANALYTICAL AND SAMPLE COLLECTION METHODS**

Research and commercial analytical methods are available for the targeted list of CECs in this Work Plan. Because of the low concentrations and potentially low effect levels, sample collection and analysis methods must be robust to avoid or otherwise quantify contamination and other systematic method biases. The possible laboratories and proposed analytical methods are shown in **Table 5**. These methods and laboratories were identified to optimize both logistics and cost to the program. Quality control samples should be collected to evaluate method and laboratory performance.

#### **3.5.1 Sample Collection and Handling**

The sampling methods, sample containers, holding times, and sample preservation methods for the proposed Central Valley CEC pilot study should be specified in a sample collection and analysis plan (SAP). Procedures and equipment specified in that plan should follow the recommendations provided in the 2015 Southern California Coastal Water Research Project (SCCWRP) QA/QC guidance document<sup>8</sup> and be consistent with Surface Water Ambient Monitoring Program (SWAMP) standards. The sample collection plan can be incorporated into the QAPP, this Work Plan, or as a standalone document. Specific sample collection methods (i.e., sample collection plan) will be developed by the CEC Technical Workgroup and should include the following considerations:

- Minimize sample contamination - direct bottle sample collection is likely necessary for some analytes to minimize contact with plasticizers and Teflon (PFOA and PFOS). Composite samples may not be possible through typical equipment currently used by POTWs and MS4s and the SAP should include equipment specifications.
- Sample compositing periods, if applicable, should be representative of typical conditions. Guidance for grab sample timing and methods should also be provided.
- Analytical laboratories selected for this study should be consulted as to sample containers, holding times, and sample preservation methods, as the SCCWRP QA/QC guidance on this topic may not be standard practice or suitable for all analytes and matrices included in this Work Plan
- All water column (aqueous) samples should be field filtered
- Tissue sample collection and preparation methods should be specified to detail size compositing and tissue type

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<sup>8</sup> Nathan G. Dodder, Alvine C. Mehinto, and Keith A. Maruya, “Monitoring of Constituents of Emerging Concern (CECs) in Aquatic Ecosystems – QA/QC Guidance” (Southern California Coastal Water Research Project Authority, 2015), [https://www.waterboards.ca.gov/water\\_issues/programs/swamp/cec\\_aquatic/docs/qaqc\\_guidance\\_final.pdf](https://www.waterboards.ca.gov/water_issues/programs/swamp/cec_aquatic/docs/qaqc_guidance_final.pdf).

**Table 5. Target CECs Laboratories and Analytical Methods**

<b>Constituent</b>	<b>Primary Laboratory Method [1]</b>	<b>Primary Laboratory [1]</b>	<b>Secondary Laboratory [1]</b>
<b>Water Column Aqueous Only</b>			
Estrone 17-beta-estradiol	EPA 1694M-APCI -LCMSMS-APCI+	WECK	AXYS
Ibuprofen Bisphenol A Diclofenac Triclosan	EPA 1694M-ESI- LCMSMS-ESI	WECK	AXYS
Galaxolide (HHCB)	EPA 1694M-ESI+ LCMSMS-ESI+	WECK	USGS NWQL
Triclocarban	AXYS MLA-075	AXYS	TBD
PFOS PFOA [2]	EPA 537M - LCMS/MS	WECK	AXYS
<b>Sediment and Tissue Only</b>			
PBDE-47 PBDE-99	EPA 1614M - GC/MS SIM	WECK	AXYS
PFOS PFOA [2]	EPA 537M - LCMS/MS	WECK	AXYS

Notes: [1] Primary and secondary laboratories identified for preliminary budgeting purposes. The California Department of Fish and Wildlife (CDFW) analytical laboratory and the USGS National Water Quality Laboratory (NWQL) may be considered during sampling and analysis plan development and as funding is available. Other qualified laboratories may be identified.  
[2] PFOS and PFOA will not be analyzed in bivalves.

### **3.5.2 Quality Assurance/Quality Control**

The CEC Technical Workgroup will implement the QA/QC methods for the proposed Central Valley CEC pilot study that will follow the methods outlined in the SCCWRP QA/QC guidance document and the QAPP. Field blank, field duplicate, and inter-laboratory duplicate samples will be included in the quality control sample collection schedule.

## **4 Data Analysis and Reporting**

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Data collected through implementation of this Work Plan implementation will be evaluated according to the Delta RMP Communication Plan and associated schedule. Pilot study ambient data (along with its associated QA/QC data) will be uploaded to the California Environmental Data Exchange Network (CEDEN). Source monitoring locations (POTW effluent and urban runoff characterization) will be identified within reports based on latitude and longitude but are not required to be designated as characterization of a specific POTW or MS4. Level of treatment and land uses may be attributed to the sites. Source monitoring data will not be uploaded to CEDEN. Electronic reporting of source monitoring data will be consistent permit provisions, if applicable.

The elements of the Work Plan will be adaptively managed during the three year study through the Delta RMP CEC Technical Workgroup, TAC review, and annual budget review process. This will be necessary both due to budgetary considerations and new information acquired through the Pilot Study and will be based on technical justification agreed upon by the Stakeholders.

The interpretation of results by the Delta RMP will be performed after a process is established that considers the adequacy of the Work Plan technical assessment tools and known system variability to determine appropriate threshold values to assess beneficial use impacts. A draft interpretive report summarizing the work performed, methods, data analysis and conclusions will be prepared after the completion of the proposed Central Valley CEC pilot study. The draft report will follow adopted Delta RMP processes for report preparation. A final interpretive report will be prepared which addresses comments received by the Delta RMP TAC and Steering Committee on the draft report.

The ability to interpret data developed under the proposed pilot study is limited by the lack of available information for the target CECs regarding environmental effects. Threshold values in water, sediment and/or tissues largely do not exist or are not of sufficient quality to determine answers to the management question, “Is there a problem or signs of a problem?” This limitation must be clearly stated in the communication plan for this Work Plan monitoring effort. Care must be taken to avoid the use of “detection” as an indication of “problems” in the aquatic environment.

During and following Year 2 of this pilot study, the overall scope of Year 3 efforts will be adaptively managed based on a prioritization of information needs and agreement by the Stakeholders as informed by the CEC Technical Workgroup. The Delta RMP Steering Committee approves and allocates funds ultimately needed to implement this Work Plan.

## 5 Identified Coordination Opportunities

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The coordination opportunities below should be evaluated to reduce costs and provide consistency through common sample collection protocols. It may be possible with additional funding to have these programs expand or modify their activities to better match this Work Plan. Because this Work Plan is an initial pilot and screening effort, it should also consider modifications to locations and frequencies to leverage these coordination opportunities, especially if funding sources are not sufficient. A more detailed coordination plan will be developed as part of the QAPP.

- **Delta RMP Mercury Study** includes water column and fish tissue sample collection:
  - Water column sample collection eight to ten times per year
  - Annual fish tissue sample collection (largemouth bass)
  - Sacramento River at Freeport and San Joaquin River at Vernalis are only sites in common
  - May be possible to add locations or fish tissue events
  - Additional water quality samples could be collected in lieu of fish tissue samples
- **Delta RMP Pesticide Study** is under development for FY18-19 and may be able to accommodate water column sample collection.
- **Department of Water Resources Environmental Monitoring Program** benthic sample collection includes bivalve sample collection at one of the proposed Work Plan sites and may be able to provide additional in-kind funded services.
- **Stream Pollution Trends Monitoring Program (SPoT)** collects sediment samples statewide with historical locations at American River at Discovery Park, Sacramento River at Clarksburg, and San Joaquin River at Vernalis. Sample collection included sediment toxicity monitoring as well as contaminant concentration in sediments, including PBDE. These sites were anticipated in the 2018-2020 SPoT work plan<sup>9</sup>.
- **Source monitoring** may be coordinated with other sample collection through in-kind participation and if the schedules and locations coincide.

Sample collection protocols should be coordinated and adequately evaluated through quality control samples and adequate documentation of any variances from sample collection or handling protocols.

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<sup>9</sup> Email communication from Bryn Phillips, Department of Environmental Toxicology, University of California, Davis, Granite Canyon Laboratory (February 16, 2018). SPoT work plan development will not be confirmed until May 2018 and program development includes an April 4, 2018 SPoT Science Committee meeting.

## 6 Estimated Costs

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It is expected that the Delta RMP will fund the sample collection and analysis effort for all ambient waters, sediments, and tissues through existing participation fees and the addition of new ongoing and special study participating Delta RMP members. The Delta RMP may also leverage in-kind services from other monitoring programs. Stakeholders are actively seeking external fund sources. The scope of this proposed pilot study may be reduced, as necessary and agreed upon by the Stakeholders, to match available funding. The cost estimate includes data reporting and compilation costs, but not overall interpretative assessment reports. The planning level estimated costs for the proposed CEC pilot monitoring program are detailed in **Appendix A Table A-1** through **Table A-5** of this Work Plan.

### 6.1 ESTIMATED COST REDUCTIONS WITH ADDITIONAL COLLABORATION

The Cost estimates in **Appendix A Table A-1** through **Table A-5** assume minimal additional in-kind support by Delta RMP participants or other monitoring programs referenced in **Section 5** of this Work Plan.

The following are potential project modifications and the estimated change in total costs and are presented as planning assumptions to evaluate whether collaboration is feasible:

- Coordinate all ambient water column sample collection with Delta RMP Mercury and Pesticide sample collection, which would result in a reduction of monitoring locations and sample collection labor costs. These other Delta RMP efforts may need additional funding to offset labor costs, especially if sites are added to their efforts. It is assumed the additional funding would be provided for analytical costs. Cost reductions could exceed \$20,000 annually.
- Coordinate all fish tissue and bivalve tissue sample collection with historic Delta RMP Mercury, SRCSD historic, and DWR collection efforts. It may be necessary to add a fish collection cruise to augment the annual event or to add a location. There are limited number of 2016 frozen bivalve samples at Regional San. Cost reductions could exceed \$8,000 annually in both Year 1 and Year 2 depending on collaboration or reductions to the Work Plan.
- Coordinate river sediment and water column sample collection with the SWAMP SPoT program, which includes American River at Discovery Park and potentially other locations if identified through the SPoT 2018-2020 work plan development. Cost reductions could exceed \$10,000 annually in Year 1 and Year 2.
- Coordinate source characterization monitoring with California Department of Pesticide Regulation (DPR) Surface Water Protection Program monitoring in the Roseville urban area. Cost reductions could exceed \$5,000 annually.

While these and other opportunities to coordinate activities leverage resources, the overall sample collection approach should not be modified without Stakeholder review and Water Board input. Collaboration could introduce differences in sample collection methods, analytical methods, laboratories, and sample handling approaches. In this case, a more robust quality control program would be helpful to measure differences in methods. Additionally, a high level of collaboration will require additional program management costs and potentially delay data availability.



Through review by other Delta RMP potential collaborators, additional study components and modifications were identified that are outside the conditionally approved Work Plan. For the purpose of future study development and tracking, these technical comments are compiled in **Appendix B**.

## **Appendix A. Planning Cost Estimates**

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**Table A-1. Analytical Methods, Method Detection Limits, and Cost Based on Laboratory Selection**

Constituents	Laboratory Analytical Grouping	Lab	Method	Cost/ Sample	MDL	Units	Notes
<b>Water Column</b>							
Estrone	Hormones	Weck	EPA 1694M-APCI - LCMSMS-APCI+	\$ 200	0.2	ng/L	Additional constituents would be included in data deliverable.
17-beta-estradiol					0.31	ng/L	
Ibuprofen	Pharmaceuticals and Personal Care Products (PPCP)	Weck	EPA 1694M-ESI- LCMSMS-ESI-	\$ 200	0.39	ng/L	
Bisphenol A					0.27	ng/L	
Diclofenac					0.26	ng/L	
Triclosan					1.2	ng/L	
Galaxolide (HHCB)		Weck	EPA 1694M-ESI+ LCMSMS-ESI+	\$ 250	3.0	ng/L	Additional constituents would be included in data deliverable.
Triclocarban		AXYS	AXYS MLA-075	\$ 350	36	ng/L	Ibuprofen, Bisphenol A, and Triclosan also included
Total Suspended Solids	Ancillary	Weck		\$ 25	5	mg/L	
<b>Sediment and Tissue</b>							
PBDE-47	Polybrominated Diphenyl Ethers	Weck	EPA 1614M - GC/MS SIM	\$ 225	2.5	µg/kg	Additional constituents would be included in data deliverable.
PBDE-99					2.5	µg/kg	
PFOS	Perfluorinated Compounds	Weck	EPA 537M - LCMS/MS	\$ 250	2.5	µg/kg	
PFOA					2.5	µg/kg	
Total Organic Carbon	Ancillary	Weck		\$ 95	200	mg/kg	Sediment only
Total Moisture	Ancillary	Weck		\$ 20	0.10	% w/w	Tissue only
Total Lipid Content	Ancillary	Weck		\$ 95	0.05	% w/w	Tissue only

**Table A-2. Year 1 Program Cost Estimate**

Annual Costs							
Year 1							
Number of Sites			Labor	Direct	Laboratory	Total	Notes
Ambient water column	8	Pre-Project	\$ 24,000	\$ 150	\$ -	\$ 24,150	ASC estimate \$23K for QAPP
Source water column	0	Preparation	\$ 9,600	\$ 640	\$ -	\$ 10,240	Equipment and coordination
Sediment	4	Ambient samples	\$ 35,200	\$ 9,600	\$ 41,000	\$ 85,800	Grab sample collection
Tissue	4	Source samples	\$ -	\$ -	\$ -	\$ -	
<b>Number of Events</b>		Sediment samples	\$ 8,800	\$ 2,400	\$ 6,850	\$ 18,050	Wadeable sample collection
Ambient water column	4	Tissue samples	\$ 13,200	\$ 400	\$ 6,850	\$ 20,450	
Source water column	0	Compilation & Reporting	\$ 28,800	\$ -	\$ -	\$ 28,800	Data report only
Sediment	2	<b>TOTAL</b>	<b>\$ 119,600</b>	<b>\$ 13,190</b>	<b>\$ 54,700</b>	<b>\$ 187,490</b>	
Tissue	2						
<p>Notes:</p> <ul style="list-style-type: none"> <li>•Costs are estimates based on expected level of effort and interpretation of work plan and document guidance.</li> <li>•Costs include total program costs, and some labor may be provided in-kind or as part of other programs.</li> </ul> <p>Assumed Unit Rates                      Field Scientist \$175/hour                      Field Technician \$125/hour                      Monitoring Manager \$200/hour                      QC rate 25% (one QC sample for every four environmental samples)</p>							

**Table A-3. Year 2 Program Cost Estimate**

<b>Year 2</b>							
<b>Number of Sites</b>			<b>Labor</b>	<b>Direct</b>	<b>Laboratory</b>	<b>Total</b>	<b>Notes</b>
Ambient water column	8	Preparation	\$ 18,000	\$ 640	\$ -	\$ 18,640	Equipment and coordination
Source water column	4	Ambient samples	\$ 35,200	\$ 9,600	\$ 41,000	\$ 85,800	Grab sample collection
Sediment	4	Source samples	\$ 17,600	\$ 2,800	\$ 20,500	\$ 40,900	Grab samples
Tissue	4	Sediment samples	\$ 8,800	\$ 2,400	\$ 6,850	\$ 18,050	Wadeable sample collection
<b>Number of Events</b>		Tissue samples	\$ 13,200	\$ 400	\$ 6,850	\$ 20,450	
Ambient water column	4	Compilation & Reporting	\$ 38,400	\$ -	\$ -	\$ 38,400	Data report only
Source water column	4	<b>TOTAL</b>	<b>\$ 131,200</b>	<b>\$ 15,840</b>	<b>\$ 75,200</b>	<b>\$ 222,240</b>	
Sediment	2						
Tissue	2						
<p>Notes:</p> <ul style="list-style-type: none"> <li>•Costs are estimates based on expected level of effort and interpretation of work plan and document guidance.</li> <li>•Costs include total program costs, and some labor may be provided in-kind or as part of other programs.</li> </ul> <p>Assumed Unit Rates                      Field Scientist \$175/hour                      Field Technician \$125/hour                      Monitoring Manager \$200/hour                      QC rate 25% (one QC sample for every four environmental samples)</p>							

**Table A-4. Year 3 Program Cost Estimate**

<b>Year 3</b>							
<b>Number of Sites</b>			<b>Labor</b>	<b>Direct</b>	<b>Laboratory</b>	<b>Total</b>	<b>Notes</b>
Ambient water column	18	Preparation	\$ 6,600	\$ 720	\$ -	\$ 7,320	Equipment and coordination
Source water column	4	Ambient samples	\$ 39,600	\$ 2,800	\$ 46,125	\$ 88,525	May reduce number of sites
Sediment	0	Source samples	\$ 8,800	\$ 1,400	\$ 10,250	\$ 20,450	Grab samples
Tissue	0	Sediment samples	\$ -	\$ -	\$ -	\$ -	
<b>Number of Events</b>		Tissue samples	\$ -	\$ -	\$ -	\$ -	
Ambient water column	2	Compilation & Reporting	\$ 26,400	\$ -	\$ -	\$ 26,400	Data report only
Source water column	2	<b>TOTAL</b>	<b>\$ 81,400</b>	<b>\$ 4,920</b>	<b>\$ 56,375</b>	<b>\$ 142,695</b>	
Sediment	0						
Tissue	0						
<p>Notes:</p> <ul style="list-style-type: none"> <li>•Costs are estimates based on expected level of effort and interpretation of work plan and document guidance.</li> <li>•Costs include total program costs, and some labor may be provided in-kind or as part of other programs.</li> </ul> <p>Assumed Unit Rates                      Field Scientist \$175/hour                      Field Technician \$125/hour                      Monitoring Manager \$200/hour                      QC rate 25% (one QC sample for every four environmental samples)</p>							

**Table A-5. Total Program Cost Estimate**

<b>TOTAL ESTIMATED COST</b>					
	<b>Labor</b>	<b>Direct</b>	<b>Laboratory</b>	<b>Total</b>	<b>Notes</b>
Pre-Project	\$ 24,000	\$ 150	\$ -	\$ 24,150	QAPP/SAP
Preparation	\$ 34,200	\$ 2,000	\$ -	\$ 36,200	Logistics and mobilization
Ambient samples	\$ 110,000	\$ 22,000	\$ 128,125	\$ 260,125	Includes boat rental
Source samples	\$ 26,400	\$ 4,200	\$ 30,750	\$ 61,350	
Sediment samples	\$ 17,600	\$ 4,800	\$ 13,700	\$ 36,100	
Tissue samples	\$ 26,400	\$ 800	\$ 13,700	\$ 40,900	Collected with ambient
Compilation & Reporting	\$ 93,600	\$ -	\$ -	\$ 93,600	Data report only
<b>TOTAL</b>	<b>\$ 332,200</b>	<b>\$ 33,950</b>	<b>\$ 186,275</b>	<b>\$ 552,425</b>	
<p>Notes:</p> <ul style="list-style-type: none"> <li>•Costs are estimates based on expected level of effort and interpretation of work plan and document guidance.</li> <li>•Costs include total program costs, and some labor may be provided in-kind or as part of other programs.</li> </ul> <p>Assumed Unit Rates                      Field Scientist \$175/hour                      Field Technician \$125/hour                      Monitoring Manager \$200/hour                      QC rate 25% (one QC sample for every four environmental samples)</p>					

## **Appendix B. Technical Considerations for Additional Work Outside of Work Plan Scope [revised July 2, 2018]**

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Throughout the Pilot Study for Monitoring Constituents of Emerging Concern (CECs) Work Plan (Work Plan) development and review, additional program elements were identified by Stakeholders and external reviewers as potentially beneficial. In general, these suggestions broadened the intended focus of the pilot study and required additional funding. CECs are a broad class of constituents with complex effects on aquatic life such that the research and study areas are dynamic, and the assessment methods are evolving quickly. Comments are summarized below for planning future studies beyond this Work Plan:

- Addition of non-targeted analysis (NTA) as included in the State Water Board Monitoring Plan in sections outside of the MS4 and POTW specific tasks and monitoring questions. NTA can provide a broad range scan of tentatively identified compounds, but not quantitative values of individual concentrations. NTA can capture a snapshot of transitory conditions for many compounds and the degradates. NTA can be useful when paired with bioanalytical, toxicity, and other exposure assessments, however, in isolation of other information NTA does not inform exposure effects or threshold conditions for beneficial use assessments. The Science Advisory Panel convened by the State Water Board<sup>10</sup> recently concluded that “NTA remains highly complex, labor and capital cost intensive” and recommended that NTA “be attempted and/or applied with clear goals (e.g. as guided by the responses from bioanalytical tools) on a voluntary basis as part of investigative type studies”. The cost per sample can exceed \$2,000 when considering follow-up interpretation, reporting, and the level of detail (range)of the NTA. NTA could be performed in future studies or as funding is available but was not part of the Conditional Approval.
- Addition of bioanalytical and toxicity testing as included in the State Water Board Monitoring Plan in sections outside of the MS4 and POTW specific tasks and monitoring questions. Bioanalytical methods can be useful but are not readily performed by commercial laboratories and are more appropriate for research activities for most all of the marker types. If funding and sample administration support became available, bioanalytical work could be considered to be added to the Pilot Study but was not part of the Conditional Approval.
- Addition of a wider range of constituents, including microplastics and constituents with more urban runoff considerations based on other study reports (SFEI and TAC comment). Though not included in this Work Plan, a number of additional constituents could be analyzed as part of the specified analytical methods, including the chlorinated phosphates, caffeine, and other hormones, personal care products, and pharmaceuticals. The Work Plan includes CECs based on the State Water Board Monitoring Plan and SCCRWP Guidance Document. Significant

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<sup>10</sup> Jörg E. Drewes<sup>1</sup>, Paul Anderson, Nancy Denslow, Walter Jakubowski, Adam Olivieri, Daniel Schlenk, and Shane Snyder. Science Advisory Panel convened by the State Water Resources Control Board. Monitoring Strategies for Constituents of Emerging Concern (CECs) in Recycled Water Recommendations of a Science Advisory Panel. April 2018 Southern California Coastal Water Research Project Technical Report 1032

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deviations change the narrower focus of this pilot study. However, findings from this and other studies could be used to inform future CEC work plan development.

- Addition of a downstream site that aggregates Delta flows would be valuable to any future modeling efforts as a downstream boundary (SFEI comment).
  - Addition of PFOA/PFOS in water column which have previously been found in Bay Area work, while removing PFOA/PFOS in bivalve tissue because it is infrequently detected (SFEI comment). The Work Plan was annotated to include this modification.
  - Addition or replacement of a site with the Marsh Creek at East Cypress Crossing location that is included in the SPoT Work Plan. This site represents a tributary to the Delta with influence from both agricultural and urban runoff sources. Consideration of this site was suggested by the State Board (Dawit Tadesse).
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