

ATTACHMENT 1

Identification of Chemicals of Interest and Literature Review of Produced Water Beneficial Reuse in Irrigated Agriculture

SCOPE OF WORK FOR TASKS 1 AND 2

(7 June 2018)

Groups and Individuals identified in these tasks are as follows:

Permit Holders. The groups that use or supply oilfield produced water for irrigation of crops for human consumption under Waste Discharge Requirements adopted by the Central Valley Regional Water Quality Control Board (Central Valley Water Board) or have submitted Reports of Waste Discharge to use oilfield produced water to irrigate crops for human consumption.

Administrator. The representative of the Permit Holders.

Manager. The representative of the Central Valley Water Board.

Consultant. The party selected to do the work by the Administrator and approved by the Manager.

Scientific Advisor. The scientific advisor to the Central Valley Water Board and under contract to the Central Valley Water Board.

Food Safety Panel. Panel of food safety experts convened by the Central Valley Water Board.

Parties. The Permit Holders and Central Valley Water Board.

Background

Cawelo Water District, on behalf of interested stakeholders, is soliciting scientific support in the subject of water recycling and beneficial reuse in irrigated agriculture. Oilfield produced water (produced water) has been identified as a valuable alternative source of irrigation water in California and produced water has been blended with other conventional sources of water and used for irrigation in California. The purpose of this solicitation is to advance the scientific understanding of produced water beneficial reuse in agriculture by identifying chemicals that might be found in produced water, examining those chemicals in the context of irrigated agriculture, and examining current and past produced water beneficial reuse practices in the US and elsewhere by conducting a literature review.

Task 1: Selection of Chemicals of Interest for Further Evaluation Description and Objective

Task 1 is a preliminary hazard assessment of both naturally occurring crude oil constituents (e.g. radionuclides, volatile organic compounds, semi-volatile organic compounds, metals and general minerals) and the chemical additives used during the generation of produced water (collectively referred to as "Chemicals of Interest"). The lists of oil field production chemical additives provided by the Permit Holders in reports submitted to the Central Valley Water Board will be used to identify potential produced water chemical additives for consideration in Task 1.

[See the Food Safety Panel webpage:

https://www.waterboards.ca.gov/centralvalley/water_issues/oil_fields/food_safety/index.html]

ATTACHMENT 1 SCOPE OF WORK TASKS 1 AND 2

The objective of Task 1 is to identify and create a list of Chemicals of Interest for further evaluation in Task 2. The list of Chemicals of Interest will also identify the chemical additives used by the Permit Holders for which inadequate data are available to make an initial hazard assessment.

This initial assessment will be conducted using scientific information to characterize and rank the Chemicals of Interest for further evaluation in the context of beneficial water reuse for irrigation purposes. Suggested methods and criteria for selection of Chemicals of Interest are described below. The assessment will use publicly available data and information from reliable government organizations and peer-reviewed scientific journals. The draft list of Chemicals of Interest and associated information (Task 1 deliverables) will be subject to peer-review by Permit Holders, the Central Valley Water Board, the Food Safety Panel, and potentially other experts. The peer-reviewed list and associated peer-reviewed report will be shared publically and one or more presentations will be made to the public during meetings hosted by the Central Valley Water Board.

Suggested Approach

Chemical additives used at various stages of oil production and naturally occurring crude oil constituents may be present in produced water. Chemicals that are toxic, teratogenic, carcinogenic, or are known to be endocrine disruptors, etc. to mammals, plants, or aquatic organisms, are environmentally persistent, or are bioaccumulative may be hazardous or present risk in the context of produced water beneficial reuse for irrigation purposes. Some chemicals may have available screening criteria which can be used to identify the Chemicals of Interest for further evaluation.

The following can be used to determine whether these chemicals should be included on the Chemicals of Interest list for evaluation:

- Oral toxicity information/data (with priority given to chronic mammalian toxicity data);
- Dermal toxicity information/data;
- Carcinogenicity information/data;
- Teratogenicity information/data;
- Environmental persistence/degradation information/data including soil half-life;
- Degradation byproducts of the chemicals and their associated toxicities, carcinogenicity, teratogenicity, endocrine disrupting potential, etc.;
- Plant uptake information/data;
- Amounts and frequency of use in oil fields;
- Mass of chemicals used in oil fields;
- Chemicals that are considered to be persistent, bioaccumulative, and toxic as defined by the US Environmental Protection Agency [EPA] and other government or scientific organizations;
- Chemicals detected in any water quality analyses of irrigation water with maximum measured irrigation water concentrations above available risk-based water screening levels (for example, EPA drinking water screening levels or California Public Health Goals);
- Ambient, background concentrations in air and water that can result from agricultural practices and human activities unrelated to produced water reuse;
- Whether the chemical is naturally occurring in the environment;
- Other sources of the chemical in the environment and the specificity of the chemical to application of produced water for irrigation;

ATTACHMENT 1
SCOPE OF WORK
TASKS 1 AND 2

- Chemicals for which the above information is not available.

Potential open sources of data include, but are not limited to the Environmental Protection Agency, Agency for Toxic Substances and Disease Registry (ATSDR), the US National Library of Medicine's TOXNET (including the Hazardous Substances Data Bank [HSDB]), and the European Chemicals Agency (ECHA).

The nature of the chemical and other "real-world" factors should be considered for creating the list of potential Chemicals of Interest for evaluation in Task 2. For example; Is the chemical a petroleum-related compound that has been well characterized in the past or is already being addressed in current water management practices (i.e. monitoring, treatment, etc.)? Is it a common environmental contaminant and/or an inert chemical? Is the toxicity via inhalation exposures and not oral exposures; etc.? Screening criteria used in selecting chemicals for further evaluation should focus on actual and expected water use and potential chemical exposure associated with irrigation.

It is anticipated that the outcome of the selection of Chemicals of Interest will include the following:

- A focused list of Chemicals of Interest;
- A comprehensive report of findings, methods, and data sources;
- A detailed summary of knowledge gaps;
- A electronic compilation of available quantitative and/or qualitative information on the chemical's toxicological profile (e.g. LD50, ED50, etc.) and physical and chemical properties relevant for fate and transport evaluation (e.g., KOW, bioconcentration, half-life in soil and water, Henry's constant, etc.).

The development of a list of Chemicals of Interest (Task 1) should build on prior work of the Central Valley Water Board and the Food Safety Panel. It is anticipated that the final list of Chemicals of Interest include an identification of those chemicals that 1) may be at 'high' or detectable levels in irrigation water, 2) are chronically toxic to humans, 3) are persistent in the environment, and 4) may be taken into edible portions of plants.

It is recognized that there may be limited data for many of the Chemicals of Interest. In the cases of chemicals with missing critical data, it is an accepted practice by the California Department of Toxic Substances Control and other government agencies to consider toxicity and other environmental health data from "surrogate" chemicals to fill data gaps for evaluation of chemical hazards. Therefore, where appropriate and with sufficient justification, surrogate chemicals (for instance, structurally similar chemicals with available data) can be identified and used where possible to fill data gaps concerning evaluation of potential Chemicals of Interest.

It is recommended that a scoring system be developed and applied in order to rank chemicals taking into consideration the range of parameters identified above. Based on the results of the scoring system, a "cutoff" score shall be identified in order to list Chemicals of Interest for further evaluation in Task 2. As an example, the methodology used by EPA in identifying the Contaminant Candidate List (CCL) for the development of maximum contaminant levels (MCLs) under the Safe Drinking Water Act could serve as a model for this Scope of Work.

**ATTACHMENT 1
SCOPE OF WORK
TASKS 1 AND 2**

Deliverables Task 1

Draft list of Chemicals of Interest, including naturally occurring chemicals and chemical additives that meet reasonable criteria for a potential hazard in the context of beneficial reuse in irrigated agriculture. Draft report describing section criteria for inclusion on list, methods, and data sources. Final list and associated report incorporating and responding to comments from Permit Holders, the Central Valley Water Board, the Food Safety Panel, and potentially other experts. Presentations or attendance, by phone or in person, at meetings organized by the Central Valley Water Board.

Timetable and Budget

Budget should not exceed \$170,000 for Task 1.

Deliverable Task 1	Suggested Timetable
Draft list of Chemicals of Interest	Four months after execution of contracting
Draft report describing section criteria for inclusion on list, methods, and data sources	Four months after execution of contracting
Final list and associated report incorporating and responding to comments from the Permit Holders, the Central Valley Water Board, the Food Safety Panel, and potentially other experts	Two months after receipt of formal reviewer comments from Permit Holders, the Central Valley Water Board, and the Food Safety Panel
Presentations or attendance at Central Valley Water Board organized meetings	Up to one meeting per month on average over duration of project
Completion of all task deliverables	Within one year of execution of contract

ATTACHMENT 1
SCOPE OF WORK
TASKS 1 AND 2

Task 2: Literature Review for Produced Water Reuse in Agriculture

Description and Objective

The purpose of this task is to conduct a rigorous and thorough review of the available literature on produced water reuse in agriculture and the potential occurrence of chemical additives and petroleum-associated contaminants in food crops, in the context of irrigation with produced water. The literature review will include an evaluation of the Chemicals of Interest identified in Task 1, which may include both petroleum production chemical additives as well as known, naturally occurring constituents (e.g. heavy metals, aromatic hydrocarbons). The literature review shall focus on the Chemicals of Interest from Task 1 in the context of actual water use in California and expected potential chemical exposure associated with irrigation. The literature review shall provide a comprehensive summary of the state of knowledge for the chemicals potentially present in blended produced water used for irrigation. This shall include a discussion of the strengths and limitations of the existing knowledge and a summary of the knowledge gaps that exist.

The toxicity and hazard data compiled in Task 1, should be interpreted in the context of beneficial reuse in agriculture in Task 2. Although the literature review is not expected to be a comprehensive risk assessment, the literature review is expected to provide risk context for the potential hazards identified in Task 1. The literature review shall identify other potential sources of Chemicals of Interest in the environment other than produced water reuse and identify background levels for chemicals in the environment, as possible. Use of Chemicals of Interest in applications of herbicides, pesticides, fungicides and/or aquatic treatments (algae/fertilizers) shall be considered in the review. The literature review shall discuss the importance of the chemical in irrigation water in the context of the different potential sources of the chemical. The literature review should include a review of the transport and fate of Chemicals of Interest in the environment in the context of beneficial reuse in agriculture.

The literature review report from Task 2 will be subject to peer-review by Permit Holders, the Central Valley Water Board, the Food Safety Panel, and potentially other experts. The peer-reviewed literature review report will be shared publically and one or more presentations will be made to the public during meetings hosted by the Central Valley Water Board.

Suggested Procedure

The literature review shall include, at a minimum, the following components:

- A review of scientific literature, including government reports and peer-reviewed technical documents concerning the use of produced water in agricultural irrigation;
- A list of chemicals of potential concern likely to occur in produced water used for irrigation;
- A compilation of information on sources of these chemicals in the environment, including other uses in agriculture not associated with produced water reuse;
- A compilation of available information on ambient concentrations in soils, air and water;
- A compilation of available data on potential natural sources of the chemicals (e.g. chemical products synthesized by plants, mold and animals);
- A compilation of information on occurrence of these chemicals in foodstuffs, including information on normal and low-risk levels in foods;
- A compilation of available chronic oral toxicity data for each of the chemicals of potential concern, focusing, where possible, on studies relevant to human health;

**ATTACHMENT 1
SCOPE OF WORK
TASKS 1 AND 2**

- A compilation of available quantitative and/or qualitative information on the chemical's persistence and degradation in the environment;
- A compilation of available quantitative and/or qualitative information on chemical plant uptake properties, ideally for the specific food crops grown in the areas that receive irrigation water blended with oilfield produced water;
- A summary of knowledge gaps;
- An annotated citation list.

The literature review shall also include a review and discussion of other uses of the Chemicals of Interest, especially concerning their use during the drilling of domestic and/or agricultural water supply wells; maintenance of water systems; their uses related to agricultural horticultural sprays (fertilizer, herbicide, fungicide, pesticide, etc.); and other land application practices that could result in environmental releases. In addition, the literature review may include an evaluation of relevant epidemiological investigations, as appropriate.

The contracted party must have a means of accessing the relevant research and technical publications from appropriate sources, including peer-reviewed journals. Use of citation management software that maintains a database of pdf copies of articles is desirable.

Deliverables

Coordination with Task 1 activities. Interim Report identifying and listing sources of literature and references. Second Interim Report identifying and listing sources of literature and references. Draft Final Literature Review Report. Final Literature Review Report incorporating and responding to comments from Permit Holders, the Food Safety Panel, the Central Valley Water Board, and potentially other experts. Presentations or attendance, by phone or in person, at meetings organized by the Central Valley Water Board.

Timetable and Budget

Budget should not exceed \$245,000 for Task 2.

Deliverable Task 2	Suggested Timetable
Coordination with Task 1 activities.	On-going for first six months of contract (minimum)
Interim Report identifying and listing sources of literature and references	Four months after execution of contracting
Second Interim Report identifying and listing sources of literature and references	Six months after execution of contracting or two months after receipt of Final list of Chemicals of Interest from Task 1
Draft Final Literature Review Report	Eight months after execution of project or two months after receipt of Final list of Chemicals of Interest from Task 1

ATTACHMENT 1
SCOPE OF WORK
TASKS 1 AND 2

Deliverable Task 2	Suggested Timetable
Final Literature Review Report incorporating and responding to comments from Permit Holders, the Central Valley Water Board, the Food Safety Panel	Three months after receipt of formal reviewer comments from Permit Holders, the Food Safety Panel, and the Central Valley Water Board.
Presentation or attendance at Central Valley Water Board organized meetings	Up to one meeting per month on average over duration of project
Completion of all task deliverables	Within one year and six months of execution of contract

The Parties have agreed upon this Scope of Work as evidenced by the following signatures of authorized representatives of the Parties:

FOR THE CENTRAL VALLEY WATER QUALITY CONTROL BOARD

Date: 6/8/18 By: Clay L. Rodgers
for Patrick Pulupa, Executive Officer

FOR North Kern Water Storage District:

Date: _____ By: _____
Richard A. Diamond, General Manager

FOR California Resources Production Corporation:

Date: _____ By: _____
Chad Jones, Vice President of Operations

FOR Kern Tulare Water District:

Date: _____ By: _____
Steven C. Dalke, General Manager

FOR Cawelo Water District:

Date: _____ By: _____
David Ansolabehere, General Manager

ATTACHMENT 1
SCOPE OF WORK
TASKS 1 AND 2

FOR Chevron U.S.A. Inc.:

Date: _____

By: _____
Carla Musser, Attorney-in-Fact

FOR Jasmin Ranchos Mutual Water Company:

Date: _____

By: _____
Shae Lehr, Secretary/Treasurer

FOR Hathaway, LLC:

Date: _____

By: _____
Chad Hathaway, President/Chief Executive Officer

FOR Sherwood Hills, LLC:

Date: _____

By: _____
Jeffery Yurosek, Managing Member