CALIFORNIA
Water Boards

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SECRETARY FOR
ENVIRONMENTAL PROTECTION

State Water Resources Control Board

October 17, 2016

Robert Brownwood, P.E.
Assistant Deputy Director
Division of Drinking Water
1001 I Street, 24th Floor
Sacramento, CA 95814

SUBJECT: EXTERNAL PEER REVIEW OF TOPICS IDENTIFIED AS THE SCIENTIFIC PORTIONS OF DEVELOPING A MAXIMUM CONTAMINANT LEVEL FOR 1,2,3-TRICHLOROPROPANE (1,2,3-TCP):

- **PROPOSED BEST AVAILABLE TECHNOLOGY**
- **COST ESTIMATION METHOD**
- **THEORETICAL ANNUAL REDUCTION IN CANCER CASES ESTIMATION METHOD**
- **DETECTION LIMIT FOR PURPOSES OF REPORTING FOR TREATMENT OF 1,2,3-TCP**

Dear Mr. Brownwood:

This letter responds to the attached July 1, 2016 request for external scientific peer review for the subject noted above. The review process is described below. All steps were conducted in confidence. Reviewers' identities were not disclosed.

To begin the process for selecting reviewers, I contacted the University of California, Berkeley (University) and requested recommendations for candidates considered qualified to perform the assignment. This service is supported through an Interagency Agreement co-signed by CalEPA and the University. The University was provided with the July 1, 2016 request letter and attachments. No additional material was asked for. The University interviews each promising candidate.

Each candidate who was both qualified and available for the review period was asked to complete a Conflict of Interest (COI) Disclosure form and send it to me for review, with Curriculum Vitae. The cover letter for the COI form describes the context for COI concerns that must be taken into consideration when completing the form. "As noted, staff will use this information to evaluate whether a reasonable member of the public would have a serious concern about [the candidate's] ability to provide a neutral and objective review of the work product."

In subsequent letters to candidates approved as reviewers, I provided the attached January 7, 2009 Supplement to the CalEPA Peer Review Guidelines, which, in part, serves two purposes: a) it provides guidance to ensure confidentiality through the course of the external review, and b) it notes reviewers are under no objection to discuss their comments with third-parties after reviews have been submitted. We recommend they do not. All outside parties are provided opportunities to address a proposed regulatory action, or potential basis for such, through a well-defined rulemaking process.

Later, I sent letters to reviewers to initiate the review. These letters provided access instructions to a secure FTP site where all material to be reviewed was placed; and a list of these documents. The first document was your July 1, 2016 letter of request for review to me. Its Attachment 2 was highlighted as the focus for the review. Each reviewer was asked to address each topic, as expertise allows, in the order given. Thirty days were provided for the review. I also asked reviewers to direct enquiring third-parties to me after they have submitted their reviews.

Reviewers' names, affiliations, curriculum vitae, initiating letters and reviews are being sent to you now with this letter.

Your July 1, 2016 request reproduced with this response includes Attachments 1 through 5, hard copy and electronic copy. Attachments 6 and 7, extensive in page number, can be obtained by contacting Mark Bartson at mark.bartson@waterboards.ca.gov (916-449-5622). Where my response is provided electronically, all attachments can be accessed through the bookmark icon at the left of the screen.

Approved reviewers:

1. Ralph L. Kodell, Ph.D.
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If you have any questions, or require clarification from the reviewers, please contact me directly.

Regards,

Gerald W. Bowes

Gerald W. Bowes, Ph.D.
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Attachments:
(1) July 1, 2016 Request by Robert Brownwood for Scientific Peer Review
(2) Letters to Reviewers Initiating the Review
    (1) Ralph L. Kodell, Ph.D.
    (2) Shane A. Snyder, Ph.D. BCES
    (3) Helmut Zarbl, Ph.D.
(3) January 7, 2009 Supplement to Cal/EPA Peer Review Guidelines
(4) Curriculum Vitae
    (1) Ralph L. Kodell, Ph.D.
    (2) Shane A. Snyder, Ph.D. BCES
    (3) Helmut Zarbl, Ph.D.
(4) Reviews
    (1) Ralph L. Kodell, Ph.D.
    (2) Shane A. Snyder, Ph.D. BCES
    (3) Helmut Zarbl, Ph.D.

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State Water Resources Control Board
Division of Drinking Water

TO: Gerald W. Bowes, Ph.D
Manager, Cal/EPA Scientific Peer Review Program
OFFICE OF RESEARCH, PLANNING AND PERFORMANCE

FROM: Robert Brownwood, P.E.
Assistant Deputy Director
DIVISION OF DRINKING WATER

DATE: July 1, 2016

SUBJECT: REQUEST FOR EXTERNAL PEER REVIEW OF TOPICS IDENTIFIED AS THE SCIENTIFIC PORTIONS OF DEVELOPING A MAXIMUM CONTAMINANT LEVEL FOR 1,2,3-TRICHLOROPROPANE (1,2,3-TCP) - PROPOSED BEST AVAILABLE TECHNOLOGY, COST ESTIMATION METHOD, THEORETICAL ANNUAL REDUCTION IN CANCER CASES ESTIMATION METHOD, AND DETECTION LIMIT FOR PURPOSES OF REPORTING FOR TREATMENT OF 1,2,3-TCP

The State Water Resources Control Board (State Water Board), Division of Drinking Water (DDW) requests that reviewers be identified and assigned to provide external peer review of the proposed Best Available Technology (BAT), Cost Estimation Method, Method for estimating the theoretical annual reduction in cancer cases, and Detection Limit for Purposes of Reporting (DLR) for treatment of 1,2,3-Trichloropropane per the requirements of Health and Safety Code Section 57004.

The US Environmental Protection Agency has classified 1,2,3-Trichloropropane (1,2,3-TCP) as "likely carcinogenic to humans" and a public health goal (PHG) of 0.7 nanograms per liter in drinking water was established in 2009 by the Office of Environmental Health Hazard Assessment (OEHHA). 1,2,3-TCP has been detected at levels above the public health goal in multiple drinking water sources used by public water systems. The proposed regulations will set a maximum contaminant limit (MCL) for 1,2,3-TCP in drinking water, identify a BAT for the treatment of 1,2,3-TCP, include various notification language to be used by public water systems when a violation of the proposed MCL occurs, and identify a DLR for 1,2,3-TCP.

Pursuant to California Health and Safety Code Section 116365, the State Water Board shall adopt primary drinking water standards, including MCLs, based on the criteria set forth under 116365. Section 116365 requires that the State Water Board adopt MCLs as close to the PHG as is technically and economically feasible at the time of the MCL adoption. If a DLR for a contaminant in drinking water is set at a higher concentration than the PHG, then that DLR may represent a technical or economic limit which prevents an MCL for that same contaminant from being set at the PHG.

FELICIA MARCUS, CHAIR | THOMAS HOWARD, EXECUTIVE DIRECTOR

1350 Front Street, Room 2050, San Diego, CA 92101 | www.waterboards.ca.gov

Pursuant to California Health and Safety Code Section 116370, the State Water Board shall adopt a BAT for any contaminant with a MCL and adopt the BAT at the time of MCL adoption.

DDW recommends that reviewers be solicited with expertise in the following areas:

- Engineer or chemist with experience with drinking water standards and drinking water treatment, including granular activated carbon technologies.
- Chemist or other scientist with experience in analytical methods for detection of contaminants in drinking water.
- Toxicologist or other scientist with experience in human health risk estimation methodology.
- Environmental economist with experience in analyzing costs and benefits.

DDW requests that the reviewers provide comments within 30 days of receipt of this letter and supporting documents. The State Water Board will solicit public comments pursuant to the California Administrative Procedure Act in fall/winter of 2016, and intends to present the regulation to the State Water Board for adoption in early to mid-2017. The following supporting documents are included:

• Attachment 1:	Summary of the Draft Regulations
• Attachment 1A:	123 TCP MCL Process Flowchart
• Attachment 2:	Scientific Issues to be addressed by Peer Reviewers
• Attachment 2A:	123 TCP MCL Evaluation Example
• Attachment 3:	List of Participants
• Attachment 4:	Excerpts of California Health & Safety Code section 116365 and 116370
• Attachment 5:	Portions of Draft Regulations
• Attachment 6:	Corona Winton Cost and Treatment Analysis for 1,2,3-TCP
• Attachment 7(a - g):	State Water Board Engineering and Performance reports

If you have any questions, please contact me at (916) 341-5125 or via e-mail at robert.brownwood@waterboards.ca.gov. Thank you for your assistance.

cc: Cindy Forbes, DDW
Zachary Rounds, DDW
Mark Bartson, DDW
Conny Mitterhofer, DDW
Jerri Swoyer, OCC
Catherine Ewing, OCC

ATTACHMENT 1
SUMMARY OF DRAFT REGULATIONS

The State Water Resources Control Board (State Water Board) is adopting regulations to establish a maximum contaminant level (MCL) for 1,2,3-Trichloropropane (1,2,3-TCP) in drinking water, a Detection Limit for Purposes of Reporting (DLR) for 1,2,3-TCP, and a Best Available Technology (BAT) for the treatment of 1,2,3-TCP. The MCL development process for 1,2,3-TCP is shown in Attachment 1A and includes a cost estimation method which is detailed and included for peer review in Attachment 2. The statutes establishing the criteria by which the State Water Board adopts new MCLs and BATs for drinking water may be found in Health and Safety Code (H&SC) Sections 116365 and 116370 (Attachment 4).

1,2,3-TCP has been detected in numerous drinking water sources throughout California. There are water systems currently supplying water to their customers containing levels of 1,2,3-TCP above the Public Health Goal. 1,2,3-TCP has been found by the US EPA to likely be carcinogenic in humans, but there is no federal MCL for 123 TCP . In 2009, the Office of Environmental Health Hazard Assessment (OEHHA) established a Public Health Goal (PHG) for 1,2,3-TCP that is based on cancer risk. H&SC Section 116365 requires the State Water Board to evaluate MCLs for acutely toxic substances and carcinogenic or chronic disease causing substances;

The proposed regulations include five primary elements:

- Establish an MCL for 1,2,3-TCP as close to PHG as is technically and economically feasible;
- Incorporate language allowing for some “grandfathering” of organic chemical sample results (including 1,2,3-TCP results) collected prior to the adoption of a regulation into the drinking water regulations regarding initial sampling for organic chemicals;
- Establish a DLR for 1,2,3-TCP;
- Establish a BAT for 1,2,3-TCP;
- Incorporate health effects and typical origin of 1,2,3-TCP contamination information into public notification regulations.

The proposed MCL for 1,2,3-TCP of 0.000005 milligrams per liter (or 5 nanograms per liter) would set a limit on the allowable concentration of 1,2,3-TCP in drinking water supplied to consumers by any public water system thereby protecting public health consistent with State H&SC 116365(b)(3). The 1,2,3-TCP MCL would be placed in the existing organic chemicals MCL table in the California Code of Regulations, Title 22, Section 64444-A and be regulated as a synthetic organic chemical (SOC) in accordance with existing SOC regulations. The proposed MCL included in this peer review package is a preliminary staff recommendation and subject to change pending the comments from this peer review, public workshops and Board consideration. Provisions of applicable statute (HSC 116365) require the board to consider several different, and sometimes competing, technologic and economic feasibility concerns, as well as the avoidance of significant risk to public health. Thus a final adopted MCL for 1,2,3 TCP will be determined through the board’s exercise of this discretion, as provided by law, and which is not solely an exercise in determining and applying the current science.

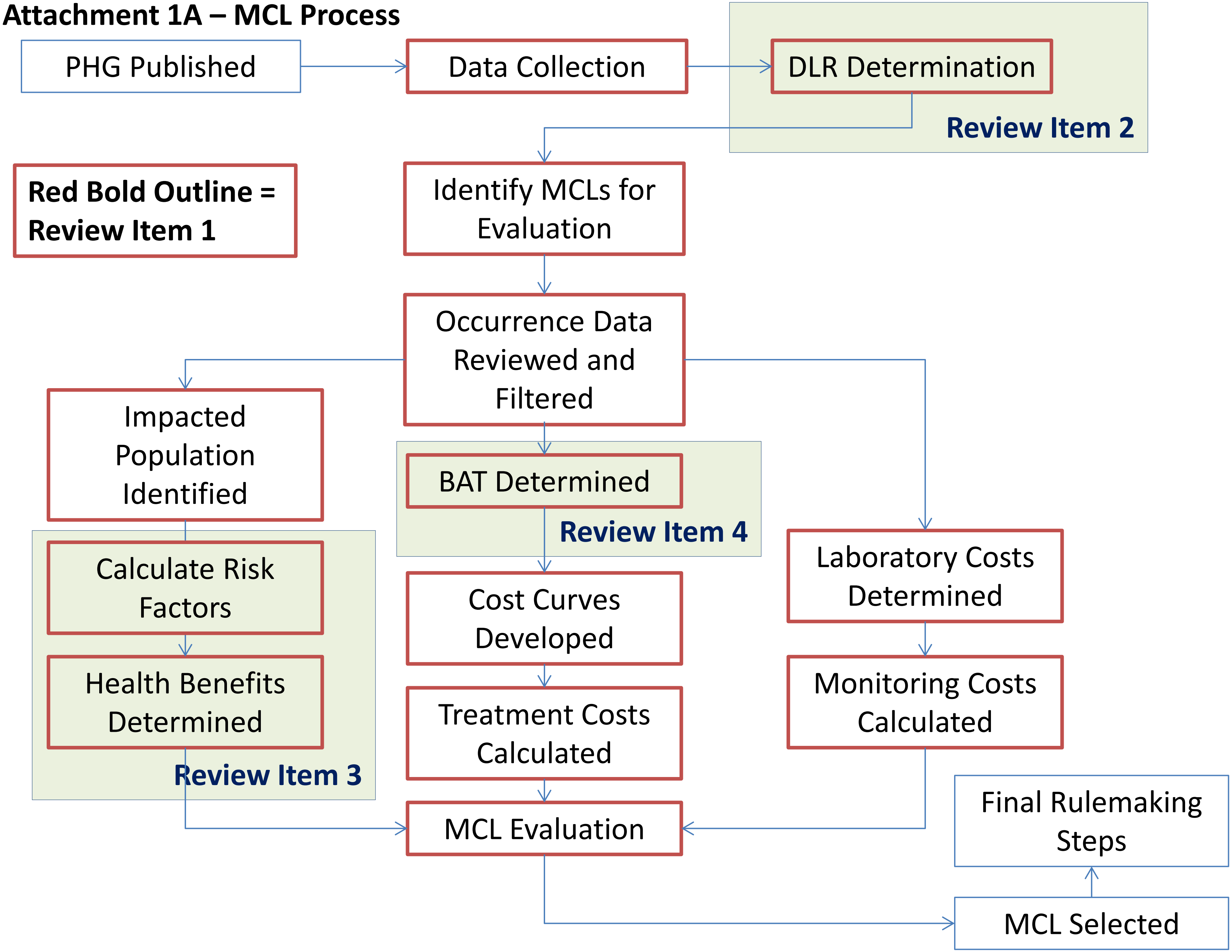
The proposed addition of language to California Code of Regulations, Title 22, Section 64445 would allow public water systems to submit sample results for any organic chemical samples collected within two years prior to the effective date of a new organic chemical MCL and have those sample results satisfy initial monitoring requirements for that organic chemical provided that the samples and analysis are performed in accordance with the existing regulations and proposed DLR requirements, aka “grandfathering”. This will encourage public water systems to perform early monitoring for 1,2,3-TCP prior to establishment of the MCL. The water systems will be encouraged to perform such early monitoring by increasing the likelihood that any sample analysis performed prior to the effective date of the new MCL will qualify to substitute for any required compliance monitoring.

The proposed DLR for 1,2,3-TCP of 5 nanograms per liter will set a minimum sensitivity for analysis of 1,2,3-TCP samples by ELAP-certified laboratories that provide analytical services to drinking water systems. Sample analyses which do not comply with the regulation would not be considered acceptable for compliance determination by the DDW The proposed DLR would be added to California Code of Regulations, Title 22, Table 64445.1-A in the subsection for SOCs.

The proposed BAT for 1,2,3-TCP is granular activated carbon (GAC). The proposed BAT regulation will add GAC (for the reduction of 1,2,3-TCP) to the BAT table in California Code of Regulations, Title 22, Table 64447.4-A. GAC has been found to provide adequate treatment for 1,2,3-TCP in existing installations. The State Water Board has evaluated the use of GAC for 1,2,3-TCP in determining the economic and technical feasibility of a new MCL. GAC is the only BAT proposed at this time as other treatment techniques have not been identified and proven both effective and reliable.

The proposed health effects and origin of contamination language are proposed as additions to California Code of Regulations, Title 22, Appendix 64465-F and Appendix 64481-A. The additions provide specific text to be used by public water systems when meeting a water system’s public notification requirements to the customers regarding detections of 1,2,3-TCP in drinking water supplies. The addition of this specific text is consistent with the approach taken by California in previous MCLs and by US EPA in adopting Federal drinking water regulations.

Attachment 1A – MCL Process



PHG Published

Data Collection

DLR Determination

Review Item 2

Red Bold Outline = Review Item 1

Identify MCLs for Evaluation

Occurrence Data Reviewed and Filtered

Impacted Population Identified

BAT Determined

Review Item 4

Laboratory Costs Determined

Calculate Risk Factors

Cost Curves Developed

Health Benefits Determined

Treatment Costs Calculated

Monitoring Costs Calculated

Review Item 3

Final Rulemaking Steps

MCL Evaluation

MCL Selected

Attachment 2
Scientific Issues to be Addressed by Peer Reviewers

The State Water Resources Control Board (State Water Board), Division of Drinking Water (DDW) requests review of the scientific portions of the draft regulations that support the adoption of a maximum contaminant level (MCL) for 1,2,3-Trichloropropane (1,2,3-TCP) (Draft Regulations) of 0.000005 milligrams per liter (or 5 nanograms per liter [ng/L]) included in the Peer Review Request Package as Attachment 5. Also included are the supporting documents that are the basis for those portions of the Draft Regulations. Online links to the supporting documents are provided within this document.

The statutory mandate for external scientific peer review (Health and Safety Code section 57004) triggers a scientific peer review of the scientific basis for any rule proposed for adoption by any board, department or office within the agency.

DDW requests that the completion of a scientific review and determination for each of the following assumptions, findings, and conclusions that constitute the scientific basis of the proposed regulatory action. An explanatory statement is provided for each assumption, finding, and conclusion to focus the review.

Health and Safety Code section 116365 establishes the process by which the State Water Board is to set primary drinking water standards, such as MCLs. Section 116365 requires the State Water Board adopt an MCL for a contaminant as close as technologically and economically feasible to the public health goal (PHG) published by the Office of Environmental Health Hazard Assessment (OEHHA), while maintaining a primary emphasis on protection of public health.

In evaluating technological and economic feasibility for 1,2,3-TCP, the State Water Board followed the steps detailed in Attachment 1A – 123-TCP MCL Process to evaluate selected MCLs. The steps are not necessarily performed in the order listed and additional details are provided in the items identified for peer review below.

The proposed MCL is constrained on the lower end of the range of considered MCLs by the current technically achievable and available laboratory detection limit for purposes of reporting (DLR) of 5 ng/L. The DLR is based on methods available to commercial laboratories, not on the most sensitive method that may be available to the research analytical community.

OEHHA is responsible for the development and adoption of PHGs. PHGs undergo peer review as part of the process of their adoption. The State Water Board is required by law to use the PHG when developing drinking water standards. For 1,2,3-TCP, OEHHA has established a PHG of 0.7 ng/L.

The preliminary staff recommendation for an MCL for 1,2,3-TCP of 0.000005 milligrams per liter (or 5 nanograms per liter) would set a limit on the allowable concentration of 1,2,3-TCP in drinking water supplied to consumers by a public water system. This recommendation is based on the protection of public health consistent with State H&SC 116365(b)(3)

The following sections discuss the scientific portions identified for the peer review (referred to in the text as Review Items 1 through 4). The proposed MCL for 1,2,3-TCP of 0.000005 milligrams per liter (or 5 nanograms per liter) would set a limit on the allowable concentration of 1,2,3-TCP in drinking water supplied to consumers by a public water system thereby protecting public health consistent with State H&SC 116365(b)(3)

Discussion of Scientific Portion of the Draft Regulations

1. Cost Estimation Method/Approach is appropriate

When adopting an MCL, the State Water Board must select an MCL as close to the PHG as economically and technologically feasible. To determine the economic feasibility of the preliminary MCL for 123-TCP, the State Water Board performed a comprehensive cost estimation evaluating six incremental potential MCLs for 123-TCP. These six values represent a range from the DLR (5 ng/l) to an upper value of 150 ng/l which represents an upper risk boundary of more than one theoretical lifetime cancer case per 10,000 people (based on the PHG). Additional MCLs may be evaluated if needed. Steps followed by the State Water Board to perform the cost estimation are shown in Attachments 1A and 2A, and described as follows:

1. Obtain drinking water system and source information from existing State Water Board databases, including but not limited to:

   a. All available detection data in drinking water sources in California for 123-TCP. The detection data is reviewed and filtered to eliminate data which is determined to be unusable, incorrect, or not applicable due to regulatory considerations. For example, a sample result from an agriculture-only well reported as less than 10 ng/L would be eliminated both because the detection limit was higher than the proposed DLR of 5 ng/L and because regulations do not require treatment of non-drinking water sources.

   b. Types of sources including activity status and water type (e.g., active, standby, groundwater, surface water).

   c. Statewide totals and details for all regulation-applicable public water systems (e.g., community and non-transient, non-community public water systems) and sources such as the number of service connections, population served by the water system, and location of the sources.

2. Determine the appropriate DLR to be proposed with the MCL, which is described in Review Item 2.

3. Establish a list of MCL concentrations for evaluation.

4. Develop a list of contaminated drinking water sources and accompanying relevant details for use in evaluating treatment costs, including the average concentration, the number of people served by each source, and the estimated water flow in gallons per minute.

5. Estimate the treatment and monitoring costs for each MCL evaluated by performing the following steps:

   a. Develop treatment cost curves for the BAT:

(1) Determine the possible BAT(s) to be used in 123-TCP treatment cost determination by performing a literature review and collecting data from any existing treatment plants sufficiently removing the contaminant to achieve compliance with an evaluated MCL. The BAT determination is described in Review Item 4.

(2) Determine the most cost effective treatment method capable of sufficiently removing 123-TCP for use in estimating treatment costs.

(3) Develop the cost curves for treatment installation, operations and maintenance using available cost information.

b. Use the cost curves to estimate the cost of treatment for any source with 123-TCP above an evaluated MCL. The estimated costs for each individual well for each impacted water system are then aggregated statewide to determine the estimated total cost of treatment for that evaluated MCL.

c. Estimate monitoring costs:

(1) Perform a survey of laboratories throughout CA for the cost of analyzing the contaminant at the proposed DLR. The quoted costs of analysis are then averaged.

(2) Determine the drinking water monitoring requirements for 123-TCP based on the type of water systems and source. The total cost is determined by multiplying the total number of samples by the average sample cost. The total sample counts are determined for at least two consecutive years to be more representative of the total range of these costs over time.

6. Determine the theoretical cancer case reduction. The method used in the development of the 1,2,3-TCP MCL is described in Review Item 3. Results of that per-source calculation are summed to determine a total reduction in theoretical cancer cases for each of the evaluated MCLs.

7. Consider the cost per avoided theoretical cancer case for each of the evaluated MCLs. The total annual combined treatment and monitoring costs are divided by the estimated total annual reduction in theoretical cancer cases to determine the cost of each annual avoided cancer case. The cost is determined for each MCL evaluated.

Attachment 2A is a reduced version of the process used to evaluate a possible MCL of 150 ng/L for 1,2,3-TCP – 150 ng/L is provided instead of the proposed MCL of 5 ng/L for ease of reading, and the methods used for both evaluations were identical. The attachment does not contain every data element gathered during the cost estimation as some elements are either too cumbersome to reduce for inclusion or not germane to this process (e.g. ownership details). The data presented in Attachment 2A are considered draft and provided to reviewers as an example to further illustrate the 123-TCP MCL development process. Attachment 2A also includes an example of the evaluated MCLs and their associated estimated costs and cancer-avoidance.

2. A DLR of 5 ng/L, is the most appropriate DLR with respect to available analytical methods and statutory requirements

The draft regulations specify a DLR of 5 ng/L for 1,2,3-TCP for sample analysis to be submitted to the State Water Board for purposes of achieving compliance with the proposed MCL. For compliance with the regulation, analytical results using a reporting level that is higher than the draft proposed DLR of 5 ng/L will not be considered valid sample results. Water systems are required to have drinking water samples analyzed by a laboratory that has been certified by the Environmental Laboratory Accreditation Program (ELAP) to use an appropriate analytical method.

The following analytical methods have been identified as analytical methods capable of achieving a minimum reporting level of 5 ng/L for 123-TCP that are commonly available at ELAP-certified commercial laboratories for the analysis of drinking water in California: SRL 524M-TCP, SRL 525M-TCP, and EPA Method 504.1. (SRL refers to the California Department of Public Health's (CDPH's) Sanitation and Radiation Laboratory, now the CDPH Drinking Water and Radiation Laboratory).

Other analytical methods capable of detecting 1,2,3-TCP at a level lower than the proposed DLR may exist but ELAP certification for those methods is not widespread in California for a lower DLR to be economically or technically feasible. A DLR does not prohibit laboratories from using more sensitive analytical methods provided the laboratory has been certified by ELAP for those methods. Results lower than the DLR obtained by a public water system using a laboratory that is not certified by ELAP for that method cannot be used for purposes of compliance with the regulation. The State Water Board may consider lowering the DLR in the future as part of the periodic MCL review process.

Information on the identified SRL analytical methods and ELAP requirements to be certified for EPA 504.1 at the DLR of 5 ng/L may be found at:
http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/123TCP.shtml

Information on EPA Method 504.1 may be found at:
https://www.nemi.gov/methods/method_summary/4825/

3. Method used to estimate reduction in annual theoretical cancer cases for each drinking water source that is contaminated with 1,2,3-TCP is appropriate.

The State Water Board used the PHG as a standard and the following method to estimate the per-source reduction in annual theoretical cancer cases at an evaluated MCL:

Note: Modified Reduction Definition Indicated in Red Below:

$$\text{Reduction} = \frac{[(\text{average of source monitoring results}) \times (\text{population exposed}) \times (\text{risk})]}{70 \text{ years}}$$

Definitions: Average of source monitoring results: an average of all *acceptable* sample results for a given source and for the sample set identified.

Population exposed: the number of people identified as being served by that same source. The population served by each source is approximated by dividing the total population of the water system by the number of sources that serve the water system.

Risk: PHG-identified potency factor of 1 excess cancer case per million people per 70 years divided by the PHG, or 0.00142857.

Sources not identified as having 123-TCP above an evaluated MCL are excluded from this estimation process.

This method does not take into account other potential variables such as the variations in age ranges, sensitive populations served by a specific water system or the amount of water consumed in a particular community. The PHG for 123-TCP does take into account more sensitive members of the population, as well as other types of water intake, such as inhalation and dermal adsorption, when it is appropriate to do so.

Information on the PHG for 1,2,3-TCP may be found at:
http://oehha.ca.gov/water/public-health-goal/final-public-health-goal-123-trichloropropane-drinking-water

4. **Granular activated carbon (GAC) is the best available technology (BAT) for the treatment of 1,2,3-TCP.**

To achieve compliance with the MCL, public water systems may choose to provide treatment of a drinking water source found to have 1,2,3-TCP concentrations above the MCL. The public water system would choose a technology capable of removing 1,2,3-TCP from drinking water to a concentration below the MCL. The water system would apply for a water system permit from DDW for any such proposed new facilities.

The California Safe Drinking Water Act requires that the State Water Board "adopt a finding of the best available technology [BAT]" when it adopts an MCL for 123-TCP. A BAT is a treatment technology or technologies designated by the State Water Board as being capable of sufficiently treating drinking water for a given contaminant, with consideration given to technologies which have been proven effective under full-scale field applications. The finding made by the State Water Board is required to "take into consideration consider the costs and benefits" of BAT "that has been proven effective under full-scale field applications." of those technologies during that designation. Alternative treatment technologies, either available currently or in the future, not included as BATs may be proposed by a public water system and such proposals would be further evaluated by DDW District Offices during the permitting process.

GAC has been identified as the best available technology capable of reliably removing 1,2,3-TCP from drinking water to a level below the proposed DLR. GAC was identified as the BAT after reviewing engineering reports from multiple water systems in California with permitted GAC treatment for 1,2,3-TCP removal and monitoring data which supports the conclusion that GAC is the appropriate technology. Other treatment technology capable of removing 1,2,3-TCP may exist but sufficient data does not exist to include those technologies as a BAT. Aeration is not being considered for BAT status for 1,2,3-TCP as monitoring data indicates that while aeration provides some removal of 1,2,3-TCP from drinking water, it does not reliably reduce the levels of 1,2,3-TCP to the very low levels being considered as potential MCLs.

A summary of the effectiveness of GAC as treatment for 1,2,3-TCP versus other treatment technologies can be found in the Corona Environmental Consulting report for the Winton Water and Sanitary District, *Winton Water and Sanitary District: Treatment Technologies and Costs to Treat 1,2,3-Trichloropropane*, pages 9-11 (Attachment 6).

Seven water systems in California are known to be currently using GAC to remove 1,2,3-TCP from contaminated drinking water sources. The following reports and excerpts on the effectiveness of GAC as treatment for 1,2,3-TCP can be found in Attachment 7.

The identification of GAC as the BAT in the Draft Regulation is needed to meet the statutory requirements of Health & Safety Code section 116370 and to serve as the BAT that accompanies an MCL for 1,2,3-TCP.

5. **The preliminary staff recommendation of a Maximum Contaminant Level of 0.000005 mg/l (or 5 nanograms per liter) would be protective of public health.**

   Provisions of applicable statute (HSC 116365) require the board to consider several different, and sometimes competing, technologic and economic feasibility concerns, as well as the avoidance of significant risk to public health. Thus a final adopted MCL for 1,2,3 TCP will be determined through the board's exercise of this discretion, as provided by law, and which is not solely an exercise in determining and applying the current science."

The Big Picture

Reviewers are not limited to addressing only the specific topics presented in this document, and are asked to consider the broader perspective.

(a) Are there any scientific issues not mentioned in this document that are part of the scientific basis of the draft regulations?

(b) Taken as a whole, is the scientific portion of the draft regulations based upon sound scientific knowledge, methods, and practices?

Reviewers should also note that some proposed actions may rely on professional judgment where available scientific data are not as extensive as desired to support the statutory requirement for absolute scientific rigor. In these situations, the proposed course of action is favored over no action.

The preceding guidance will ensure that reviewers have an opportunity to comment on all aspects of the scientific basis of the proposed action. At the same time, reviewers also should recognize that the State Water Board is required by law to consider and respond to the findings of the external scientific peer review entity. Because of this obligation, reviewers are encouraged to focus feedback on the scientific assumptions, findings, and conclusions that are relevant to the central regulatory elements being proposed.

Attachment 2A

District	County	System Name	Source Name	System No	Source No	# of sources	Population	Service Connections	Ground/Surface	"Less than?"	Finding	Unit	DLR	Sum Finding per Source	# Samples	Source Average
DISTRICT 12 - VISALIA	KERN	SAN JOAQU	WELL 01	CA1500575	001	1	165	61	GW		0.293	UG/L	0.5	0.609	2	0.3045
LPA50 - MADERA COUNTY	MADERA	Z FOODS/W	SOURCE M	CA2000909	001	1	250	1	GW		0.5	UG/L	0.005	0.5	1	0.5
DISTRICT 11 - MERCED	MERCED	LONGVIEW	WELL #1-S.	CA2400122	001	1	110	1	GW	<	0	UG/L	0.005	0.785	3	0.261667

This worksheet contains data that has already been downloaded and filtered to remove sources that are not active drinking water sources. Some data elements still present are later removed for ease of review.

This worksheet has been filtered to highlight small water sources with average source concentrations of 1,2,3-TCP of more than 150 ng/L. Small water sources (or SWS) are for this analysis water systems with <200 service connections, which is used as a separator in some regulations. In the full version of the cost-benefit analysis the filtering of concentration and service connections occurs later in the process, but for ease of understanding the source narrowing has been performed now.

This data set also includes a purge of any samples with "less than" results where the "less than" value is greater than 5 ng/L (e.g. <250). Remaining "less than" values were converted to zero; SWRCB compliance determinations typcially perform the same action.

Attachment 2A

System Name	Source Name	# of sources	Population	Service Connections	Ground/Surface	Source Average	Population/Source	Average Flow/Source (MGD)	Design Flow/Source (MGD)	Total Capital Cost	Annualized Capital Cost	O&M Cost	Total Capital Cost, 150 ppt	Annualized Capital Cost, 150 ppt	O&M Cost, 150 ppt
Z FOODS/WATER SYSTEM	SOURCE MAIN WELL	1	250	1	GW	0.5	250	0.0375	0.05625	$ 110,512	$ 10,432	$ 11,306	$ 110,512	$ 10,432	$ 11,306
SAN JOAQUIN ESTATES M	WELL 01	1	165	61	GW	0.3045	165	0.02475	0.037125	$ 103,140	$ 9,736	$ 9,051	$ 103,140	$ 9,736	$ 9,051
LONGVIEW MENNONITE	WELL #1-S.W. OF SCHOOL B	1	110	1	GW	0.261667	110	0.0165	0.02475	$ 2,454	$ 232	$ 7,836	$ 2,454	$ 232	$ 7,836
											Cost Sum		$ 216,106	$ 20,400	$ 28,193
											Source Count		3		

This worksheet shows the outcome of estimating the cost of treatment for each source with an average source contamination of 150 ng/L . This worksheet only contains sources from water systems with <200 service connections and no existing treatment for 1,2,3-TCP; similar worksheets exist for larger water systems and sources with existing 1,2,3-TCP treatment but for ease of review are not included .

Average flow and design flow were estimated using SWRCB regulations and estimates of per capita per day water usage for CA. The capital costs and O&M costs were estimated using cost curves developed from existing cost estimations and data. Finally, the source averages were compared against the evaluated MCL; in the full version of this worksheet the costs of multiple evaluated MCLs are estimated simultaneaously.

Some water systems, such as Longview Mennonite School in the above table, already have GAC treatment installed and therefore have significant reductions to their estimated capital costs.

MCL = 150 ppt

Excluding Sources with 1,2,3-TCP Treatment

# Service Connections	# of Sources	Total Capital Costs	Total Annualized Capital Costs	Total O&M Costs	Total Annual Costs
<200	3	$ 216,106	$ 20,400	$ 28,193	$ 48,594
>=200	13	$ 8,684,993	$ 819,863	$ 1,567,475	$ 2,387,338

Sources with 1,2,3-TCP Treatment

# Service Connections	# of Sources	Total O&M Costs
<200	0	0
>=200	4	$ 734,763

This worksheet summarizes data from the treatment worksheets (including large water systems and treated water systems) for readibility and comparison purposes. The final version contains similar tables for each evaluated MCL.

Sample Analysis	$ 132 /sample
Equations Used	
Initial Monitoring	
All system types	4 quarterly samples * $132 * per source
Standby Sources	1 sample (triennial) * $132 * per source (all standby sampling is assumed to occur in year 1)
Routine Monitoring	
<=3,300 pop	1 sample (triennial) * $132 / 3 years (to annualize) * per source
>3,300 pop	2 samples (triennial) * $132 / 3 years (to annualize) * per source
Increased Monitoring	
<=3,300 pop	4 quarterly samples/year * $132 * per source
>3,300 pop	(6 monthly samples + 2 quarterly samples)/year * $132 * per source Year 2+ = 4 quarterly samples/year * 132 * per source
Treated Monitoring	
All system types	(12 monthly treated samples + 4 quarterly raw samples)/year * $132 * per source

These equations represent regulatory requirements for applicable drinking water sources. The number of water sources for each category was multiplied by the sample analysis cost and the sample frequency to get a total cost.

Costs Applicable To All evaluated MCLs

Initial Monitoring - sources without detections

	# of Sources		Total Cost ($) (Year 1)	
Water type\# Service Connection	<200	>=200	<200	>=200
Groundwater	5048	5854	$ 2,665,344	$ 3,090,912
Surface Water	483	726	$ 255,024	$ 383,328

Initial Monitoring - standby sources

	# of Sources		Total Cost ($) (Year 1)	
Water type\# Service Connection	<200	>=200	<200	>=200
Groundwater	137	241	$ 18,084	$ 31,812
Surface Water	4	13	$ 528	$ 1,716

Routine Monitoring - sources without detections

	# of Sources		Total Cost ($) (Year 2+)	
Water type\# Service Connection	<200	>=200	<200	>=200
Groundwater <=3,300 pop	5016	1162	$ 220,704	$ 51,128
Groundwater >3,300 pop	32	4692	$ 2,816	$ 412,896
Surface Water <=3,300 pop	478	185	$ 21,032	$ 8,140
Surface Water >3,300 pop	5	541	$ 440	$ 47,608

This worksheet contains monitoring cost estimates. Monitoring requirements are regulation-specific and may contain more delineations than treatment considerations, and thus cannot be calculated using prior data filtering. Sources were separated into various groups based on a variety of criteria such as contamination status, presence of existing treatment, population, and source activity. For example, regulations for organic chemicals require more frequent monitoring if the water system has a population greater than 3,300 persons.

Some monitoring costs are also separated into the year of sampling, again primarily for regulatory reasons, with year 1 and following years having different values.

A limited survey of commercial laboratories was performed to get an average price of sample analysis for 1,2,3-TCP for CA. That average value was multiplied by the variety of sampling requirements to estimate the overall monitoring costs.

Note: Added text highlighted immediately above.

MCL = 150 - Additional Monitoring Costs

Increased Monitoring - sources not requiring treatment

	# of Sources		Total Cost ($) Year 1		Total Cost ($) Year 2+	
Water type\# Service Connection	<200	>=200	<200	>=200	<200	>=200
Groundwater <=3,300 pop	43	15	$ 22,704	$ 7,920	$ 22,704	$ 7,920
Groundwater >3,300 pop	0	365	$ -	$ 385,440	$ -	$ 192,720
Surface Water <=3,300 pop	1	0	$ 528	$ -	$ 528	$ -
Surface Water >3,300 pop	0	4	$ -	$ 4,224	$ -	$ 2,112

Increased Monitoring - sources requiring treatment

	# of Sources		Total Cost ($) Year 1		Total Cost ($) Year 2+	
Water type\# Service Connection	<200	>=200	<200	>=200	<200	>=200
Groundwater <=3,300 pop	3	0	$ 1,584	$ -	NA	NA
Groundwater >3,300 pop	0	13	$ -	$ 13,728	NA	NA
Surface Water <=3,300 pop	0	0	$ -	$ -	NA	NA
Surface Water >3,300 pop	0	0	$ -	$ -	NA	NA

Treated Monitoring - sources requiring treatment

	# of Sources		Total Cost ($) Year 1		Total Cost ($) Year 2+	
Water type\# Service Connection	<200	>=200	<200	>=200	<200	>=200
Groundwater <=3,300 pop	3	0	NA	NA	$ 6,336	$ -
Groundwater >3,300 pop	0	13	NA	NA	$ -	$ 27,456
Surface Water <=3,300 pop	0	0	NA	NA	$ -	$ -
Surface Water >3,300 pop	0	0	NA	NA	$ -	$ -

Increased Monitoring - treated sources

	# of Sources		Total Cost ($) Year 1		Total Cost ($) Year 2	
Water type\# Service Connection	<200	>=200	<200	>=200	<200	>=200
Groundwater <=3,300 pop	0	0	NA	NA	NA	NA
Groundwater >3,300 pop	0	4	NA	NA	NA	NA
Surface Water <=3,300 pop	0	0	NA	NA	NA	NA
Surface Water >3,300 pop	0	0	NA	NA	NA	NA

Treated Monitoring - treated sources

	# of Sources		Total Cost ($) Year 1		Total Cost ($) Year 2+	
Water type\# Service Connection	<200	>=200	<200	>=200	<200	>=200
Groundwater <=3,300 pop	0	0	$ -	$ -	$ -	$ -
Groundwater >3,300 pop	0	4	$ -	$ 8,448	$ -	$ 8,448
Surface Water <=3,300 pop	0	0	$ -	$ -	$ -	$ -
Surface Water >3,300 pop	0	0	$ -	$ -	$ -	$ -

System Name	Source Name	# of sources	Population	Service Connections	Ground/Surface	Source Average	Population/Source	Average Flow/Source (MGD)	Design Flow/Source (MGD)	Total Capital Cost	Annualized Capital Cost	O&M Cost	Population impacted, 150 ppt	Excess Cancer Reduced, 150ppt	
Z FOODS/WATER SYST	SOURCE MAIN WELL	1	250	1	GW	0.5	250	0.0375	0.05625	$ 110,512	$ 10,432	$ 11,306	250	0.002	
SAN JOAQUIN ESTATE	WELL 01	1	165	61	GW	0.3045	165	0.02475	0.037125	$ 103,140	$ 9,736	$ 9,051	165	0.001	
LONGVIEW MENNONI	WELL #1-S.W. OF SCHOOL BUILDINGS	1	110	1	GW	0.2616667	110	0.0165	0.02475	$ 2,454	$ 232	$ 7,836	110	0.000	
										Pop Sum			525	0.003	Cancer Reduction Sum
										Source Count		3	3		

This worksheet only contains sources associated with water systems with less than 200 service connections.

This worksheet estimates the number of people exposed to the contamination and the amount of excess cancer cases avoided per year for an MCL of 150 ng/L (the full version contains other evaluated MCLs). The method used to determine the excess cancer reduction results is described in detail in Attachment 2, Review Item 3 .

Three versions of this worksheet (Small Water Systems, Large Water Systems, and Treated Water Systems) are included to help better illustrate the final cost-benefit results.

System Name	Source Name	# of sources	Population	Service Connections	Ground/Surface	Source Average	Population/Source	Average Flow/Source (MGD)	Design Flow/Source (MGD)	Total Capital Cost	Annualized Capital Cost	O&M Cost	Population impacted, 150 ppt	Excess Cancer Reduced, 150ppt	
CHINO BAS	WELL 02	18	252041	201	GW	0.231184	14002.28	2.100342	3.150513	$ 2,281,133	$ 215,339	$ 308,665	14,002	0.023	
CHINO BAS	WELL 03	18	252041	201	GW	0.946295	14002.28	2.100342	3.150513	$ 2,281,133	$ 215,339	$ 308,665	14,002	0.228	
CITY OF LIV	WELL 09 - RAW	8	14894	3062	GW	0.209655	1861.75	0.279263	0.418894	$ 240,495	$ 22,703	$ 53,042	1,862	0.002	
CITY OF LIV	WELL 12 - RAW	8	14894	3062	GW	0.532798	1861.75	0.279263	0.418894	$ 240,495	$ 22,703	$ 53,042	1,862	0.015	
CITY OF LIV	WELL 14 - RAW	8	14894	3062	GW	0.743	1861.75	0.279263	0.418894	$ 240,495	$ 22,703	$ 53,042	1,862	0.023	
ARVIN CON	WELL 09 - RAW	7	19000	3703	GW	0.178333	2714.286	0.407143	0.610714	$ 301,715	$ 28,482	$ 74,322	2,714	0.002	
SHAFTER, (	WELL 12 - RAW	8	16928	4566	GW	0.159129	2116	0.3174	0.4761	$ 259,298	$ 24,478	$ 59,445	2,116	0.000	
WASCO, CI	WELL 11 - OAK - RAW	6	21170	4692	GW	0.177405	3528.333	0.52925	0.793875	$ 355,305	$ 33,541	$ 94,127	3,528	0.002	
BAKERSFIEI	WELL CBK 36-01 - RAW	56	138309	42384	GW	0.162855	2469.804	0.370471	0.555706	$ 284,692	$ 26,875	$ 68,275	2,470	0.001	
BAKERSFIEI	WELL CBK 14-01 - RAW	56	138309	42384	GW	0.241431	2469.804	0.370471	0.555706	$ 284,692	$ 26,875	$ 68,275	2,470	0.005	
SAN JOSE V	MERIDIAN WELL 05	112	998000	219571	GW	0.333333	8910.714	1.336607	2.004911	$ 1,764,501	$ 166,569	$ 210,267	8,911	0.033	
CITY OF LIV	WELL 08 - RAW	8	14894	3062	GW	0.445854	1861.75	0.279263	0.418894	$ 29,308	$ 2,767	$ 53,042	1,862	0.011	
SUNNY SLC	WELL 11	5	32427	6206	GW	0.150202	6485.4	0.97281	1.459215	$ 121,732	$ 11,492	$ 163,267	6,485	0.000	
											Pop Sum		64,146	0.344	Cancer Reduction Sum
											Source Cour	13	13		

This worksheet only contains sources associated with water systems with at least 200 service connections and is provided to better explain the extent of analysis.

This worksheet estimates the number of people exposed to the contamination and the amount of excess cancer cases avoided per year for an MCL of 150 ng/L (the full version contains other evaluated MCLs). The method used to determine the excess cancer reduction results is described in detail in Attachment 2, Review Item 3 .

Attachment 2A

7 - Treated Water System Health Effects

System Name	Source Name	# of sources	Population	Service Connections	Ground/Surface	Source Average	Population/Source	Average Flow/Source (MGD)	Design Flow/Source (MGD)	Total Capital Cost	Annualized Capital Cost	O&M Cost	Population impacted, 150 ppt	Excess Cancer Reduced, 150ppt
BURBANK-CITY, WATE	BURBANK (	14	105543	25549	GW	0.452546	7538.786	1.130818	1.696227	NA	NA	$ 183,691	7,539	0.047
BURBANK-CITY, WATE	BURBANK (	14	105543	25549	GW	3.262634	7538.786	1.130818	1.696227	NA	NA	$ 183,691	7,539	0.479
BURBANK-CITY, WATE	BURBANK (	14	105543	25549	GW	4.465006	7538.786	1.130818	1.696227	NA	NA	$ 183,691	7,539	0.664
BURBANK-CITY, WATE	BURBANK (	14	105543	25549	GW	0.736609	7538.786	1.130818	1.696227	NA	NA	$ 183,691	7,539	0.090
												Pop Sum	30,155	1.280 Cancer Reduction Sum
												Source Sum	4	

This worksheet only contains sources with existing treatment for 1,2,3-TCP and is included to better explain the extent of analysis.

This worksheet estimates the number of people exposed to the contamination and the amount of excess cancer cases avoided per year for an MCL of 150 ng/L (the full version contains other evaluated MCLs). The method used to determine the excess cancer reduction results is described in detail in Attachment 2, Review Item 3 .

MCL = 150	**Total Monitoring Costs (Year 2+)**		**Annualized Capital Costs**		**Annual O&M Costs**		**Total Annual Costs**	
	Groundwater	**Surface Water**	**Groundwater**	**Surface Water**	**Groundwater**	**Surface Water**	**Groundwater**	**Surface Water**
<200 service connection	$ 29,040	$ 528	$ 20,400	0	$ 28,193	0	$ 77,634	$ 528
>=200 service connection	$ 236,544	$ 2,112	$ 819,863	0	$ 2,302,238	0	$ 3,358,645	$ 2,112

Cost/source	**# Sources**	**Annual Cost/Source**
<200 service connection	3	$ 26,054
>=200 service connection	17	$ 197,692

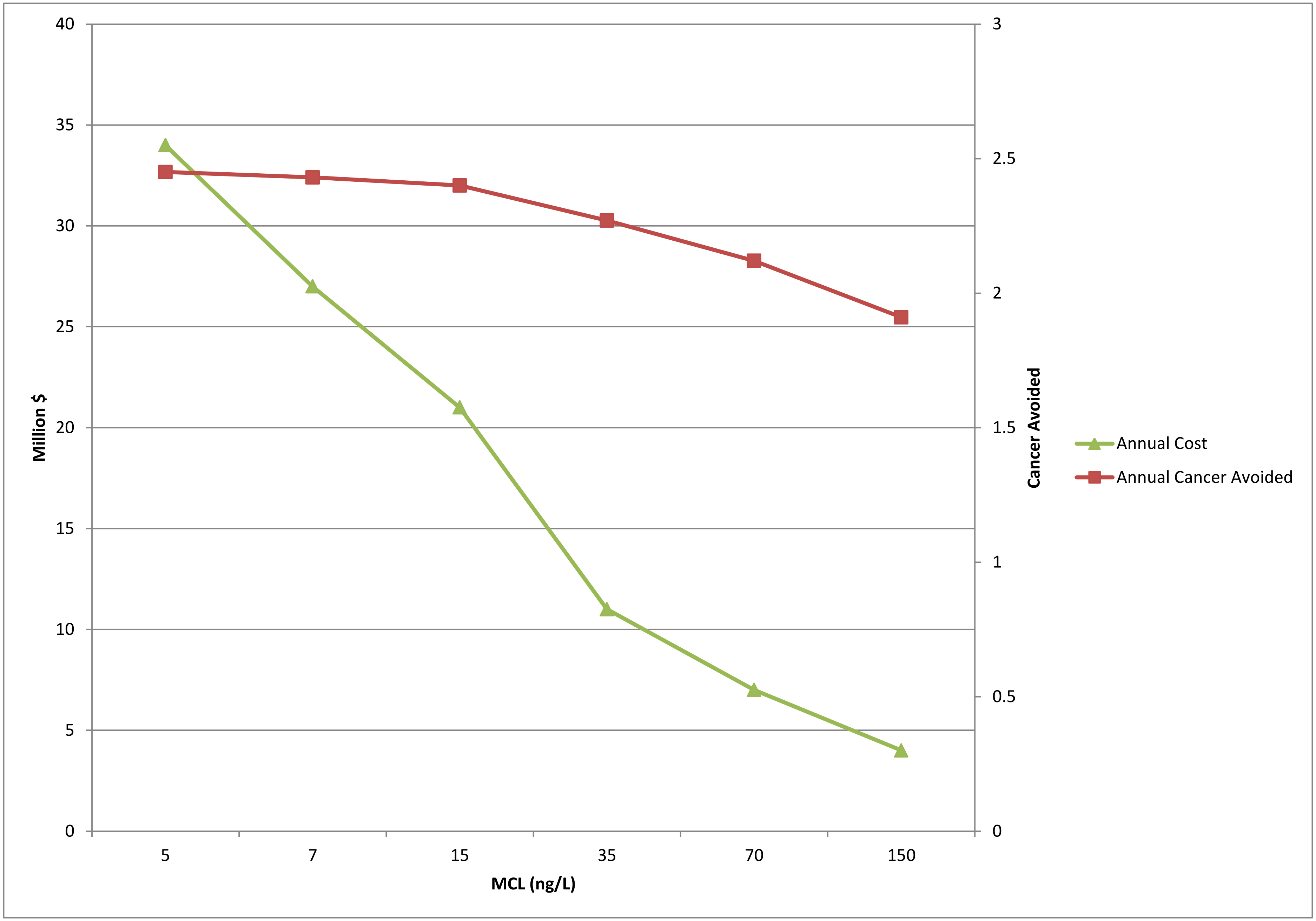
Cost/Svc Conn	**# Service Connection**	**Annual Cost/Svc Conn**
<200 service connection	63	$ 11,966
>=200 service connection	309,934	$ 107

Cost/System	**# Systems**	**Annual Cost/System**
<200 service connection	3	$26,054
>=200 service connection	9	$373,417

Cost-Benefit	**Est. Cancer Reduction**	**Est. Cost/Cancer Reduction**
<200 service connection	0.00	$ 18,771,730
>=200 service connection	1.91	$ 1,757,600

This worksheet collects all of the data from the previous worksheets and generates a variety of cost estimate values for the evaluated MCL. The final version contains similar comparisons for each evaluated MCL.

9 - cost estimate comparison



ATTACHMENT 3

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United States Environmental Protection Agency Staff

Any staff who has been involved with analysis or investigation of 1,2,3-Trichloropropane contamination, including involvement with the Third Unregulated Contaminant Monitoring Rule.

Public Water System Staff and Associates

All current and former employees and any current or former State Water Resources Control Board staff involved with any of the following public water systems:

City of Shafter
City of Bakersfield
City of Oceanside
City of Alhambra
City of Burbank Water Department
Valley County Water District
City of Glendale Water Department
City of Livingston
City of Tulare

Winton Water and Sanitation District

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Current and former employees and students of University of California, Davis

ATTACHMENT 4
HEALTH AND SAFETY CODE
SECTIONS 116365 & 116370

§116365. Criteria for primary standards.

(a) The state board shall adopt primary drinking water standards for contaminants in drinking water that are based upon the criteria set forth in subdivision (b) and shall not be less stringent than the national primary drinking water standards adopted by the United States Environmental Protection Agency. A primary drinking water standard adopted by the state board shall be set at a level that is as close as feasible to the corresponding public health goal placing primary emphasis on the protection of public health, and that, to the extent technologically and economically feasible, meets all of the following:

(1) With respect to acutely toxic substances, avoids any known or anticipated adverse effects on public health with an adequate margin of safety.

(2) With respect to carcinogens, or any substances that may cause chronic disease, avoids any significant risk to public health.

(b) The state board shall consider all of the following criteria when it adopts a primary drinking water standard:

(1) The public health goal for the contaminant published by the Office of Environmental Health Hazard Assessment pursuant to subdivision (c).

(2) The national primary drinking water standard for the contaminant, if any, adopted by the United States Environmental Protection Agency.

(3) The technological and economic feasibility of compliance with the proposed primary drinking water standard. For the purposes of determining economic feasibility pursuant to this paragraph, the state board shall consider the costs of compliance to public water systems, customers, and other affected parties with the proposed primary drinking water standard, including the cost per customer and aggregate cost of compliance, using best available technology.

(c)

(1) The Office of Environmental Health Hazard Assessment shall prepare and publish an assessment of the risks to public health posed by each contaminant for which the state board proposes a primary drinking water standard. The risk assessment shall be prepared using the most current principles, practices, and methods used by public health professionals who are experienced practitioners in the fields of epidemiology, risk assessment, and toxicology. The risk assessment shall contain an estimate of the level of the contaminant in drinking water that is not anticipated to cause or contribute to adverse health effects, or that does not pose any significant risk to health. This level shall be known as the public health goal for the contaminant. The public health goal shall be based exclusively on public health considerations and shall be set in accordance with all of the following:

(A) If the contaminant is an acutely toxic substance, the public health goal shall be set at the level at which no known or anticipated adverse effects on health occur, with an adequate margin of safety.

(B) If the contaminant is a carcinogen or other substance that may cause chronic disease, the public health goal shall be set at the level that, based upon currently available data, does not pose any significant risk to health.

(C) To the extent information is available, the public health goal shall take into account each of the following factors:

(i) Synergistic effects resulting from exposure to, or interaction between, the contaminant and one or more other substances or contaminants.

(ii) Adverse health effects the contaminant has on members of subgroups that comprise a meaningful portion of the general population, including, but not limited to, infants, children, pregnant women, the elderly, individuals with a history of serious illness, or other subgroups that are identifiable as being at greater risk of adverse health effects than the general population when exposed to the contaminant in drinking water.

(iii) The relationship between exposure to the contaminant and increased body burden and the degree to which increased body burden levels alter physiological function or structure in a manner that may significantly increase the risk of illness.

(iv)The additive effect of exposure to the contaminant in media other than drinking water, including, but not limited to, exposures to the contaminant in food, and in ambient and indoor air, and the degree to which these exposures may contribute to the overall body burden of the contaminant.

(D) If the Office of Environmental Health Hazard Assessment finds that currently available scientific data are insufficient to determine the level of a contaminant at which no known or anticipated adverse effects on health will occur, with an adequate margin of safety, or the level that poses no significant risk to public health, the public health goal shall be set at a level that is protective of public health, with an adequate margin of safety. This level shall be based exclusively on health considerations and shall, to the extent scientific data is available, take into account the factors set forth in clauses (i) to (iv), inclusive, of subparagraph (C), and shall be based on the most current principles, practices, and methods used by public health professionals who are experienced practitioners in the fields of epidemiology, risk assessment, and toxicology. However, if adequate scientific evidence demonstrates that a safe dose response threshold for a contaminant exists, then the public health goal should be set at that threshold. The state board may set the public health goal at zero if necessary to satisfy the requirements of this subparagraph.

(2) The determination of the toxicological endpoints of a contaminant and the publication of its public health goal in a risk assessment prepared by the Office of Environmental Health Hazard Assessment are not subject to the requirements of Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code. The Office of Environmental Health Hazard Assessment and the state board shall not impose any mandate on a public water system that requires the public water system to comply with a public health goal. The Legislature finds and declares that the addition of this paragraph by Chapter 777 of the Statutes of 1999 is declaratory of existing law.

(3)

(A) The Office of Environmental Health Hazard Assessment shall, at the time it commences preparation of a risk assessment for a contaminant as required by this subdivision, electronically post on its Internet web site a notice that informs interested persons that it has initiated work on the risk assessment. The notice shall also include a brief description, or a bibliography, of the technical documents or other information the office has identified to date as relevant to the preparation of the risk assessment and inform persons who wish to submit information concerning the contaminant that is the subject of the risk assessment of the name and address of the person in the office to whom the information may be sent, the date by which the information shall be received in order for the office to consider it in the preparation of the risk assessment, and that all information submitted will be made available to any member of the public who requests it.

(B) A draft risk assessment prepared by the Office of Environmental Health Hazard Assessment pursuant to this subdivision shall be made available to the public at least 45 calendar days before the date that public comment and discussion on the risk assessment are solicited at the public workshop required by Section 57003.

(C) At the time the Office of Environmental Health Hazard Assessment publishes the final risk assessment for a contaminant, the office shall respond in writing to significant comments, data, studies, or other written information submitted by interested persons to the office in connection with the preparation of the risk assessment. These comments, data, studies, or other written information submitted to the office shall be made available to any member of the public who requests it.

(D) After the public workshop on the draft risk assessment, as required by Section 57003, is completed, the Office of Environmental Health Hazard Assessment shall submit the draft risk assessment for external scientific peer review using the process set forth in Section 57004 and shall comply with paragraph (2) of subdivision (d) of Section 57004 before publication of the final public health goal.

(d) Notwithstanding any other provision of this section, any maximum contaminant level in effect on August 22, 1995, may be amended by the state board to make the level more stringent pursuant to this section. However, the state board may only amend a maximum contaminant level to make it less stringent if the state board shows clear and convincing evidence that the maximum contaminant level should be made less stringent and the amendment is made consistent with this section.

(e)

(1) All public health goals published by the Office of Environmental Health Hazard Assessment shall be established in accordance with the requirements of subdivision (c) and shall be reviewed at least once every five years and revised, pursuant to subdivision (c), as necessary based upon the availability of new scientific data.

(2) On or before January 1, 1998, the Office of Environmental Health Hazard Assessment shall publish a public health goal for at least 25 drinking water contaminants for which a primary drinking water standard has been adopted by the state board. The office shall publish a public health goal for 25 additional drinking water contaminants by January 1, 1999, and for all remaining drinking water contaminants for which a primary drinking water standard has been adopted by the state board by no later than December 31, 2001. A public health goal shall be published by the Office of Environmental Health Hazard Assessment at the same time the state board proposes the adoption of a primary drinking water standard for any newly regulated contaminant.

(f) The state board or Office of Environmental Health Hazard Assessment may review, and adopt by reference, any information prepared by, or on behalf of, the United States Environmental Protection Agency for the purpose of adopting a national primary drinking water standard or maximum contaminant level goal when it establishes a California maximum contaminant level or publishes a public health goal.

(g) At least once every five years after adoption of a primary drinking water standard, the state board shall review the primary drinking water standard and shall, consistent with the criteria set forth in subdivisions (a) and (b), amend any standard if any of the following occur:

(1) Changes in technology or treatment techniques that permit a materially greater protection of public health or attainment of the public health goal.

(2) New scientific evidence that indicates that the substance may present a materially different risk to public health than was previously determined.

(h) Not later than March 1 of every year, the state board shall provide public notice of each primary drinking water standard it proposes to review in that year pursuant to this section. Thereafter, the state board shall solicit and consider public comment and hold one or more public hearings regarding its proposal to either amend or maintain an existing standard. With adequate public notice, the state board may review additional contaminants not covered by the March 1 notice.

(i) This section shall operate prospectively to govern the adoption of new or revised primary drinking water standards and does not require the repeal or readoption of primary drinking water standards in effect immediately preceding January 1, 1997.

(j) The state board may, by regulation, require the use of a specified treatment technique in lieu of establishing a maximum contaminant level for a contaminant if the state board determines that it is not economically or technologically feasible to ascertain the level of the contaminant.

§116370. Best available technology.

On or before January 1, 1998, the department shall propose, hold a public hearing, and adopt a finding of the best available technology for each contaminant for which a primary drinking water standard has been adopted. Thereafter, the department shall adopt a finding of the best available technology for each contaminant for which a primary drinking water standard has been adopted at the time the standard is adopted. The finding of the department shall take into consideration the costs and benefits of best available treatment technology that has been proven effective under full-scale field applications.

ATTACHMENT 5
PORTIONS OF DRAFT REGULATIONS FOR 1,2,3-TRICHLOROPROPANE
July 2016

TITLE 22, CALIFORNIA CODE OF REGULATIONS
DIVISION 4, CHAPTER 15, ARTICLE 5.5

(1) Amend Section 64444 to read as follows:

§64444. Maximum Contaminant Levels – Organic Chemicals.

The MCLs for the primary drinking water chemicals shown in ~~T~~table 64444-A shall not be exceeded in the water supplied to the public.

Table 64444-A

Maximum Contaminant Levels

Organic Chemicals

Chemical	*Maximum Contaminant Level, mg/L*
(a) Volatile Organic Chemicals (VOCs)	
Benzene	0.001
Carbon Tetrachloride	0.0005
1,2-Dichlorobenzene	0.6
1,4-Dichlorobenzene	0.005
1,1-Dichloroethane	0.005
1,2-Dichloroethane	0.0005
1,1-Dichloroethylene	0.006
cis-1,2-Dichloroethylene	0.006
trans-1,2-Dichloroethylene	0.01
Dichloromethane	0.005
1,2-Dichloropropane	0.005
1,3-Dichloropropene	0.0005

Ethylbenzene	0.3
Methyl-*tert*-butyl ether	0.013
Monochlorobenzene	0.07
Styrene	0.1
1,1,2,2-Tetrachloroethane	0.001
Tetrachloroethylene	0.005
Toluene	0.15
1,2,4-Trichlorobenzene	0.005
1,1,1-Trichloroethane	0.200
1,1,2-Trichloroethane	0.005
Trichloroethylene	0.005
Trichlorofluoromethane	0.15
1,1,2-Trichloro-1,2,2-Trifluoroethane	1.2
Vinyl Chloride	0.0005
Xylenes	1.750*

(b) ~~Non-Volatile~~ Synthetic Organic Chemicals (SOCs)

Alachlor	0.002
Atrazine	0.001
Bentazon	0.018
Benzo(a)pyrene	0.0002
Carbofuran	0.018
Chlordane	0.0001
2,4-D	0.07
Dalapon	0.2
Dibromochloropropane	0.0002
Di(2-ethylhexyl)adipate	0.4
Di(2-ethylhexyl)phthalate	0.004
Dinoseb	0.007
Diquat	0.02
Endothall	0.1

Endrin	0.002
Ethylene Dibromide	0.00005
Glyphosate	0.7
Heptachlor	0.00001
Heptachlor Epoxide	0.00001
Hexachlorobenzene	0.001
Hexachlorocyclopentadiene	0.05
Lindane	0.0002
Methoxychlor	0.03
Molinate	0.02
Oxamyl	0.05
Pentachlorophenol	0.001
Picloram	0.5
Polychlorinated Biphenyls	0.0005
Simazine	0.004
Thiobencarb	0.07
Toxaphene	0.003
1,2,3-Trichloropropane	0.000005
2,3,7,8-TCDD (Dioxin)	3 x 10^{-8}
2,4,5-TP (Silvex)	0.05

*MCL is for either a single isomer or the sum of the isomers.

(3) Amend Section 64445.1 to read as follows:

§64445.1. Repeat Monitoring and Compliance – Organic Chemicals.

(a) For the purposes of this article, detection shall be defined by the detection limits for purposes of reporting (DLRs) in ~~T~~table 64445.1-A:

Table 64445.1-A

Detection Limits for Purposes of Reporting (DLRs)

for Regulated Organic Chemicals

Chemical	*Detection Limit for Purposes of Reporting (DLR) (mg/L)*
(a) All VOCs, except as listed	0.0005
Methyl-*tert*-butyl ether	0.003
Trichlorofluoromethane	0.005
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.01
(b) SOCs	
Alachlor	0.001
Atrazine	0.0005
Bentazon	0.002
Benzo(a)pyrene	0.0001
Carbofuran	0.005
Chlordane	0.0001
2,4-D	0.01
Dalapon	0.01
Dibromochloropropane (DBCP)	0.00001
Di(2-ethylhexyl)adipate	0.005

Di(2-ethylhexyl)phthalate.	0.003
Dinoseb.	0.002
Diquat.	0.004
Endothall.	0.045
Endrin.	0.0001
Ethylene dibromide (EDB).	0.00002
Glyphosate.	0.025
Heptachlor.	0.00001
Heptachlor epoxide.	0.00001
Hexachlorobenzene.	0.0005
Hexachlorocyclopentadiene.	0.001
Lindane.	0.0002
Methoxychlor.	0.01
Molinate.	0.002
Oxamyl.	0.02
Pentachlorophenol.	0.0002
Picloram.	0.001
Polychlorinated biphenyls (PCBs) (as decachlorobiphenyl).	0.0005
Simazine.	0.001
Thiobencarb.	0.001
Toxaphene.	0.001
1,2,3-Trichloropropane.	0.000005
2,3,7,8-TCDD (Dioxin).	5 x 10^{-9}
2,4,5-TP (Silvex).	0.001

(b) When organic chemicals are not detected pursuant to ~~T~~table 64445.1-A.

(1) A water system which has not detected any of the VOCs on ~~T~~table 64444-A during the initial four quarters of monitoring, shall collect and analyze one sample annually. After a minimum of three years of annual sampling with no detection of a

VOC in ~~T~~table 64444-A, a system using groundwater may reduce the monitoring frequency to one sample during each compliance period. A system using surface water shall continue monitoring annually.

(2) A system serving more than 3,300 persons which has not detected an SOC on ~~T~~table 64444-A during the initial four quarters of monitoring shall collect a minimum of two quarterly samples for that SOC in one year during the year designated by the State Board of each subsequent compliance period. The year will be designated on the basis of historical monitoring frequency and laboratory capacity.

(3) A system serving 3,300 persons or less which has not detected an SOC on ~~T~~table 64444-A during the initial four quarters of monitoring shall collect a minimum of one sample for that SOC during the year designated by the State Board of each subsequent compliance period. The year will be designated on the basis of historical monitoring frequency and laboratory capacity.

(c) When organic chemicals are detected pursuant to ~~T~~table 64445.1-A.

(1) Prior to proceeding with the requirements of paragraphs ~~(c)~~(2) through (7), the water supplier may first confirm the analytical result, as follows: Within seven days from the notification of an initial finding from a laboratory reporting the presence of one or more organic chemicals in a water sample, the water supplier shall collect one or two additional sample(s) to confirm the initial finding. Confirmation of the initial finding shall be shown by the presence of the organic chemical in either the first or second additional sample, and the detected level of the contaminant for compliance purposes shall be the average of the initial and confirmation sample(s). The initial finding shall be disregarded if two additional samples do not show the presence of the organic chemical.

(2) If one or both of the related organic chemicals heptachlor and heptachlor epoxide are detected, subsequent monitoring shall analyze for both chemicals until there has been no detection of either chemical for one compliance period.

(3) A groundwater sampling site at which one or more of the following chemicals has been detected shall be monitored quarterly for vinyl chloride: trichloroethylene, tetrachloroethylene, 1,2-dichloroethane, 1,1,1-trichloroethane, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, or 1,1-dichloroethylene. If vinyl chloride is not detected in the first quarterly sample, the sampling site shall be monitored once for vinyl chloride during each compliance period.

(4) If the detected level of organic chemicals for any sampling site does not exceed any shown in ~~T~~table 64444-A, the water source shall be resampled every three months and the samples analyzed for the detected chemicals. After one year of sampling an approved surface water system or two quarters of sampling a groundwater system, the State Board will consider allowing the water supplier to reduce the sampling to once per year upon request, based on a review of previous sampling data. Systems shall monitor during the quarter(s) which previously yielded the highest analytical results.

(5) If the detected level of an organic chemical for any sampling site exceeds that listed in ~~T~~table 64444-A, the water supplier shall report this information to the State Board within 48 hours of receipt of the result. Unless use of the contaminated source is discontinued, the water supplier shall resample the contaminated source and compliance shall be determined as follows:

(A) Water systems serving more than 3,300 persons shall sample monthly for six months and shall submit the results to the State Board as specified in ~~S~~section 64469. If the average concentration of the initial finding, confirmation sample(s), and six subsequent monthly samples does not exceed the MCL shown in ~~T~~table 64444-A the water supplier may reduce the sampling frequency to once every three months. If the running annual average or the average concentration of the initial finding, confirmation sample(s), and six subsequent monthly samples exceeds the MCL shown in ~~T~~table 64444-A, the water system shall be deemed to be in violation of ~~S~~section 64444.

(B) Water systems serving 3,300 persons or less shall sample quarterly for a minimum of one year and shall submit the results to the State Board as specified in ~~S~~section 64469. If the running annual average concentration does not exceed the MCL in ~~T~~table 64444-A, the water supplier may reduce the sampling frequency to once every year during the quarter that previously yielded the highest analytical result. Quarterly monitoring shall resume if any reduced frequency sample result exceeds the MCL. If the running annual average concentration exceeds the MCL in ~~T~~table 64444-A, the water system shall be deemed to be in violation of ~~S~~section 64444.

(C) If any sample would cause the running annual average to exceed the MCL, the water system is immediately in violation. If a system takes more than one sample in a quarter, the average of all the results for that quarter shall be used when calculating the running annual average. If a system fails to complete four consecutive quarters of monitoring, the running annual average shall be based on an average of the available data.

(6) If any resample, other than those taken in accordance with paragraph ~~(c)~~(5) ~~of this section~~, of a water sampling site shows that the concentration of any organic chemical exceeds a MCL shown in ~~T~~table 64444-A, the water supplier shall proceed in accordance with paragraphs ~~(c)~~(1) and ~~(c)~~(4), or paragraph ~~(c)~~(5).

(7) If an organic chemical is detected and the concentration exceeds ten times the MCL, the water supplier shall notify the State Board within 48 hours of the receipt of the results and the contaminated site shall be resampled within 48 hours to confirm the result. The water supplier shall notify the State Board of the result of the confirmation sample(s) within 24 hours of the receipt of the confirmation result(s).

(A) If the average concentration of the original and confirmation sample(s) is less than or equal to ten times the MCL, the water supplier shall proceed in accordance with ~~subsection~~paragraph ~~(c)~~(5).

(B) If the average concentration of the original and confirmation samples exceeds ten times the MCL, use of the contaminated water source shall immediately be discontinued, if directed by the State Board. Such a water source shall not be returned to service without written approval from the State Board.

(4) Amend Section 64447.4 to read as follows:

§64447.4. Best Available Technologies (BAT) – Organic Chemicals.

The technologies listed in ~~T~~table 64447.4-A are the best available technology, treatment technologies, or other means available for achieving compliance with the MCLs in ~~T~~table 64444-A for organic chemicals.

Table 64447.4-A

Best Available Technologies (BATs)

Organic Chemicals

Chemical	*Best Available Technologies*		
	Granular Activated Carbon	Packed Tower Aeration	Oxidation
(a) Volatile Organic Chemicals (VOCs)			
Benzene	X	X	
Carbon Tetrachloride	X	X	
1,2-Dichlorobenzene	X	X	
1,4-Dichlorobenzene	X	X	
1,1-Dichloroethane	X	X	
1,2-Dichloroethane	X	X	
1,1-Dichloroethylene	X	X	
cis-1,2-Dichloroethylene	X	X	
trans-1,2-Dichloroethylene	X	X	
Dichloromethane		X	
1,2-Dichloropropane	X	X	
1,3-Dichloropropene	X	X	
Ethylbenzene	X	X	

Methyl-*tert*-butyl ether		X
Monochlorobenzene	X	X
Styrene	X	X
1,1,2,2-Tetrachloroethane	X	X
Tetrachloroethylene	X	X
Toluene	X	X
1,2,4-Trichlorobenzene	X	X
1,1,1-Trichloroethane	X	X
1,1,2-Trichloroethane	X	X
Trichlorofluoromethane	X	X
Trichlorotrifluoroethane	X	X
Trichloroethylene	X	X
Vinyl Chloride		X
Xylenes	X	X
(b) Synthetic Organic Chemicals (SOCs)		
Alachlor	X	X
Atrazine	X	
Bentazon		X
Benzo(a)pyrene	X	
Carbofuran	X	
Chlordane	X	
2,4-D	X	
Dalapon	X	
Di(2-ethylhexyl)adipate	X	X
Dinoseb		X
Diquat	X	
1,2-Dibromo-3-chloropropane	X	X
Di(2-ethylhexyl)phthalate	X	
Endothall	X	
Endrin	X	

Ethylene Dibromide	X	X	
Glyphosate			X
Heptachlor	X		
Heptachlor epoxide	X		
Hexachlorocyclopentadiene	X	X	
Lindane	X		
Methoxychlor	X		
Molinate	X		
Oxamyl	X		
Pichloram	X		
Pentachlorophenol	X		
Polychlorinated Biphenyls	X		
Simazine	X		
Thiobencarb	X		
Toxaphene	X	X	
1,2,3-Trichloropropane	X		
2,3,7,8-TCDD (Dioxin)	X		
2,4,5-TP (Silvex)	X		

CALIFORNIA
Water Boards

Edmund G. Brown Jr.
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SECRETARY FOR
ENVIRONMENTAL PROTECTION

State Water Resources Control Board

September 6, 2016 **VIA EMAIL ONLY**

Ralph L. Kodell, Ph.D.
Professor Emeritus
Department of Biostatistics
Fay W. Boozman College of Public Health
University of Arkansas for Medical Sciences
COPH 3218
4301 W. Markham Street
Little Rock, AR 72205

SUBJECT: EXTERNAL PEER REVIEW OF TOPICS IDENTIFIED AS THE SCIENTIFIC PORTIONS OF DEVELOPING A MAXIMUM CONTAMINANT LEVEL FOR 1,2,3-TRICHLOROPROPANE (1,2,3-TCP):

- **PROPOSED BEST AVAILABLE TECHNOLOGY**
- **COST ESTIMATION METHOD**
- **THEORETICAL ANNUAL REDUCTION IN CANCER CASES ESTIMATION METHOD**
- **DETECTION LIMIT FOR PURPOSES OF REPORTING FOR TREATMENT OF 1,2,3-TCP**

Dear Professor Kodell,

My letter today is intended to initiate the external review.

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Attachment 2:	Scientific issues (assumptions, findings and conclusions) to be addressed by Peer Reviewers **The foregoing are the focus for review. As expertise allows, comment on subjects in the order listed.**

Note: The scope of Conclusion #5 is considerable. At the same time, it is similar to the provision afforded reviewers in the Big Picture section following the conclusion: "(b) Taken as a whole….". Reviewers are encouraged to address this aspect of the proposal.

Attachment 2A:	1,2,3-TCP MCL Evaluation Example **Modest changes have been added to Attachments 2 and 2A and indicated in red.**
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Attachment 5:	Portions of Draft Regulations
Attachment 6:	Corona Winton Cost and Treatment Analysis for 1,2,3-TCP
Attachment 7: (a – g)	State Water Board Engineering and Performance reports

Seven water systems in California are known to be currently using GAC to remove 1,2,3-TCP from contaminated drinking water sources. The reports

and excerpts from four of those water systems in Attachment 7a-g discuss and document the effectiveness of GAC as treatment for 1,2,3-TCP.

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Please send your reviews to me on September 30, 2016 to ensure I receive all on the same day.

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Your acceptance of this review assignment is most appreciated.

Sincerely,

Gerald W. Bowes

Gerald W. Bowes, Ph.D.
Manager, Cal/EPA Scientific Peer Review Program
Office of Research, Planning and Performance
State Water Resources Control Board
1001 “I” Street, MS-16B
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CALIFORNIA
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EDMUND G. BROWN JR.
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ENVIRONMENTAL PROTECTION

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September 6, 2016 **VIA EMAIL ONLY**

Shane A. Snyder, Ph.D. BCES
Professor and Co-Director
University of Arizona
Department of Chemical & Environmental Engineering
1133 E. James E. Rogers Way; Harshbarger 108
Tucson, AZ 85721-0011

SUBJECT: EXTERNAL PEER REVIEW OF TOPICS IDENTIFIED AS THE SCIENTIFIC PORTIONS OF DEVELOPING A MAXIMUM CONTAMINANT LEVEL FOR 1,2,3-TRICHLOROPROPANE (1,2,3-TCP):

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- **COST ESTIMATION METHOD**
- **THEORETICAL ANNUAL REDUCTION IN CANCER CASES ESTIMATION METHOD**
- **DETECTION LIMIT FOR PURPOSES OF REPORTING FOR TREATMENT OF 1,2,3-TCP**

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September 6, 2016 **VIA EMAIL ONLY**

Helmut Zarbl, Ph.D.
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Robert Wood Johnson Medical School
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170 Freylinghuysen Road, Room 426
Piscataway, NJ 08854

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Attachment 7b: Valley County Water District 2010 Annual Technical Performance Report for Lante Plant, March 2011, Stetson Engineers, Inc., Pages II-12 through 15, III-3.

Attachments 7c: DHS Cover Letter dated March 26, 2001 regarding Amended Domestic Water Supply Permit for City of Glendale; Amended Permit Report, DHS, March 2001, pages as labeled in the document, Pages 4, 11, 14-16.

Attachment 7d: City of Glendale Water Quality Data, Pages 7, 26, 46, 59, 74 (using results on 9/8/2004).

Attachment 7e: CDPH Sanitary Survey Report, City of Shafter, June 2014, Page 12.

Attachment 7f: City of Shafter Annual Report for Well 14, Granular Activated Carbon (GAC) Plant Operations for 2015, April 14, 2016, Entire document.

Attachment 7g: State Water Board Sanitary Survey Report, City of Burbank, January 2, 2015, Pages 15, 21.

B. **January 7, 2009 Supplement to the CalEPA Peer Review Guidelines.** This Supplement provides guidance to ensure the review is kept confidential through its course. The Supplement notes reviewers are under no obligation to discuss their comments with third-parties after reviews have been submitted. We recommend they do not. All outside parties are provided opportunities to address a proposed regulatory action through a well-defined regulatory process. Please direct third parties to me.

Please send your reviews to me on September 30, 2016 to ensure I receive all on the same day.

Questions about the review should be for clarification, in writing – email is fine, and addressed to me. My responses will be in writing also. I subsequently will forward all reviews together to Robert Brownwood with reviewers' Curriculum Vitae. All this information will be posted at the State and Regional Water Boards' Scientific Peer Review website.

Your acceptance of this review assignment is most appreciated.

Sincerely,

Gerald W. Bowes

Gerald W. Bowes, Ph.D.
Manager, Cal/EPA Scientific Peer Review Program
Office of Research, Planning and Performance
State Water Resources Control Board
1001 "I" Street, MS-16B
Sacramento, California 95814

Telephone: (916) 341-5567
Facsimile: (916) 341-5284
Email: GBowes@waterboards.ca.gov

January 7, 2009

Supplement to Cal/EPA External Scientific Peer Review Guidelines – "Exhibit F" in Cal/EPA Interagency Agreement with University of California

Gerald W. Bowes, Ph.D.

Guidance to Staff:

1. Revisions. If you have revised any part of the initial request, please stamp "Revised" on each page where a change has been made, and the date of the change. Clearly describe the revision in the cover letter to reviewers, which transmits the material to be reviewed. The approved reviewers have seen your original request letter and attachments during the solicitation process, and must be made aware of changes.

2. Documents requiring review. All important scientific underpinnings of a proposed science-based rule must be submitted for external peer review. The underpinnings would include all publications (including conference proceedings), reports, and raw data upon which the proposal is based. If there is a question about the value of a particular document, or parts of a document, I should be contacted.

3. Documents not requiring review. The Cal/EPA External Peer Review Guidelines note that there are circumstances where external peer review of supporting scientific documents is not required. An example would be "A particular work product that has been peer reviewed with a known record by a recognized expert or expert body." I would treat this allowance with caution. If you have any doubt about the quality of such external review, or of the reviewers' independence and objectivity, that work product – which could be a component of the proposal - should be provided to the reviewers.

4. Implementation review. Publications which have a solid peer review record, such as a US EPA Criteria document, do not always include an implementation strategy. The Cal/EPA Guidelines require that the implementation of the scientific components of a proposal, or other initiative, must be submitted for external review.

5. Identity of external reviewers. External reviewers should not be informed about the identity of other external reviewers. Our goal has always been to solicit truly independent comments from each reviewer. Allowing the reviewers to know the identity of others sets up the potential for discussions between them that could devalue the independence of the reviews.

6. Panel Formation. Formation of reviewer panels is not appropriate. Panels can take on the appearance of scientific advisory committees and the external reviewers identified through the Cal/EPA process are not to be used as scientific advisors.

7. Conference calls with reviewers. Conference calls with one or more reviewers can be interpreted as seeking collaborative scientific input instead of critical review. Conference calls with reviewers are not allowed.

Guidance to Reviewers from Staff:

1. Discussion of review.

Reviewers are not allowed to discuss the proposal with individuals who participated in development of the proposal. These individuals are listed in Attachment 3 of the review request.

Discussions between staff and reviewers are not permitted. Reviewers may request clarification of certain aspects of the review process or the documents sent to them.

Clarification questions and responses must be in writing. Clarification questions about reviewers' comments by staff and others affiliated with the organization requesting the review, and the responses to them, also must be in writing. These communications will become part of the administrative record.

The organization requesting independent review should be careful that organization-reviewer communications do not become collaboration, or are perceived by others to have become so. The reviewers are not technical advisors. As such, they would be considered participants in the development of the proposal, and would not be considered by the University of California as external reviewers for future revisions of this or related proposals. The statute requiring external review of science-based rules proposed by Cal/EPA organizations prohibits participants serving as peer reviewers..

2. Disclosure of reviewer Identity and release of review comments.

Confidentiality begins at the point a potential candidate is contacted by the University of California. Candidates who agree to complete the conflict of interest disclosure form should keep this matter confidential, and should not inform others about their possible role as reviewer.

Reviewer identity may be kept confidential until review comments are received by the organization that requested the review. After the comments are received, reviewer identity and comments must be made available to anyone requesting them.

Reviewers are under no obligation to disclose their identity to anyone enquiring. It is recommended reviewers keep their role confidential until after their reviews have been submitted.

3. Requests to reviewers by third parties to discuss comments.

After they have submitted their reviews, reviewers may be approached by third parties representing special interests, the press, or by colleagues. Reviewers are under no obligation to discuss their comments with them, and we recommend that they do not.

All outside parties are provided an opportunity to address a proposed regulatory action during the public comment period and at the Cal/EPA organization meeting where the proposal is considered for adoption. Discussions outside these provided avenues for comment could seriously impede the orderly process for vetting the proposal under consideration.

4. Reviewer contact information.

The reviewer's name and professional affiliation should accompany each review. Home address and other personal contact information are considered confidential and should not be part of the comment submittal.

BIOGRAPHICAL SKETCH

Provide the following information for the key personnel and other significant contributors in the order listed on Form Page 2.
Follow this format for each person. DO NOT EXCEED **TWO PAGES.**

NAME Ralph L Kodell	POSITION TITLE Professor, Retired
eRA COMMONS USER NAME (credential, e.g., agency login) RLKODELL	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
University of the Ozarks, Clarksville, AR	B.S.	1969	Mathematics
Stephen F. Austin State University, Nacogdoches, TX	M.S.	1971	Mathematics
Texas A&M University, College Station, TX	Ph.D.	1974	Statistics

A. Positions and Honors.

Positions and Employment

1974-1975	Assistant Professor, Department of Mathematics and Statistics, University of Nebraska, Lincoln, NE.
1975-1991	Mathematical Statistician (GS-15, 1989-1991; GS-14, 1982-1989; GS-13, 1977-1982; GS-12, 1975-1977), Biometry Staff, National Center for Toxicological Research (FDA), Jefferson, AR.
1982	Visiting Research Associate, Department of Biostatistics, Harvard School of Public Health, Boston, MA.
1985	Visiting Consultant and Vice President, K.S. Crump and Co., Inc., Ruston, LA.
1991-1996	Deputy Director (GM-15), Division of Biometry and Risk Assessment, National Center for Toxicological Research (FDA), Jefferson, AR.
1996-2006	Director (SBRS), Division of Biometry and Risk Assessment, National Center for Toxicological Research (FDA), Jefferson, AR (Acting Director, 1996).
2007-2015	Professor, Department of Biostatistics, University of Arkansas for Medical Sciences, Little Rock, AR.

Honors

1973	W.S. Connor Award, Outstanding Graduate Student, Institute of Statistics, Texas A&M University.
1980	Food and Drug Administration Group Award of Merit for ED_{01} Study.
1983	H.O. Hartley Award for Outstanding Service to Statistics by a Former Texas A&M Student.
1988	Food and Drug Administration Award of Merit for Research.
1992	Fellow, American Statistical Association.
1994	Distinguished Achievement Medal, Section on Statistics and the Environment, ASA.
1994	Member (by election), International Statistics Institute.
1995	Certified for Senior Biomedical Research Service (SBRS).
1996	Don Owen Award for Excellence in Research, Editorial Activities and Service.
1996	Scientific Achievement Award in Analytical Science, NCTR, FDA.
2000	Fellow, Academy of Toxicological Sciences.
2003	Academy of Distinguished Former Students, College of Science, Texas A&M University.
2006	FDA Distinguished Career Service Award.
2013	Notable Alumnus, Department of Statistics, Texas A&M University. In: *Strength in Numbers: The Rising of Academic Statistics Departments in the U.S.* Springer: New York, 2013

B. Selected peer-reviewed publications (in chronological order, from 174 peer-reviewed publications).

1. Gaylor DW and Kodell RL. Linear interpolation algorithm for low-dose risk assessment of toxic substances. J. Environ. Pathol. Toxicol. 4: 305-312, 1980.
2. Kodell RL, Gaylor DW and Chen JJ. Using average lifetime dose rate for intermittent exposure to carcinogens. *Risk Anal.* 7: 339-345, 1987.

3. Kodell RL, Krewski D and Zielinski JM. Additive and multiplicative relative risks in the two-stage clonal expansion model of carcinogenesis. *Risk Anal.* 11: 483-490, 1991.
4. Kodell RL and West RW. Upper confidence limits on excess risk for quantitative responses. *Risk Anal.* 13: 177-182, 1993.
5. Kodell RL, Chen JJ and Gaylor DW. Neurotoxicity modeling for risk assessment. *Regul. Toxicol. Pharmacol.* 22: 24-29, 1995.
6. Kodell RL and Ahn H. An age-adjusted trend test for the tumor incidence rate for multiple-sacrifice experiments. *Biometrics* 53: 1467-1474, 1997.
7. Kodell RL and Gaylor DW. Combining uncertainty factors in deriving human exposure levels of noncarcinogenic toxicants. Ann. New York Acad.Sci. 895: 188-195, 1999.
8. Kodell RL, Young JF, Delongchamp RR, Turturro A, Chen JJ, Gaylor DW, Howard PC and Zheng Q. A mechanistic approach to modeling the risk of liver tumors in mice exposed to fumonisin B_1 in the diet. *Food Add. Contamin.* 18: 237-253, 2001.
9. Kodell RL, Chen JJ, Delongchamp RR and Young JF. Hierarchical models for probabilistic dose-response assessment. *Regul. Toxicol. Pharmacol.* 45: 265-272, 2006.
10. Kodell RL and Chen JJ. Is premarket identification of hepatotoxic drugs and sensitive patients possible based on high-dimensional ‘omic data? *Person. Med*. 7: 171-178, 2010.
11. Kodell RL, Zhang C, Siegel ER and Nagarajan R. Selective voting in convex-hull ensembles improves classification accuracy. *Artif. Intel. Med.* 54: 171-179, 2012.
12. Kodell RL and Chen JJ. Quantitative benefit-risk analysis for evaluating drug therapies. *J. Biopharm. Statist.* 23: 231-238, 2013.
13. Zhang C and Kodell RL. Subpopulation-specific confidence designation for more informative biomedical classification. *Artif. Intel. Med.* 58: 155-163, 2013.
14. Moon H, Kim S, Chen JJ, George N and Kodell RL. Model uncertainty and model averaging in the estimation of infectious doses for microbial pathogens. *Risk Anal.* 33: 220-231, 2013.
15. Kodell RL, Haun RS, Siegel ER, Zhang C, Trammel AB, Hauer-Jensen M and Burnett AF. Novel use of proteomic profiles in a convex-hull ensemble classifier to predict gynecological cancer patients’ susceptibility to gastrointestinal mucositis as a side effect of radiation therapy. *J. Proteo. Bioinf.* 8: 149-154, 2015.

C. Research Support.

Completed

1R01CA152667-03 Kodell RL (PI) 07/01/2010 – 06/30/2014
NIH/NCI
Goal: Develop algorithms for individualized cancer predictions.
Role: Principal Investigator.

HHSO100201100045C Hauer-Jensen M (PI) 10/01/2011 – 09/30/2015
BARDA
Goal: Establish SOM230 as a radiation mitigator.
Role: Statistical expert.

13GRNT16960043 Miller G (PI) 07/01/2013 – 06/30/2015
American Heart Association
Goal: Improving pediatric anticoagulant therapy.
Role: Co-investigator.

Ongoing

RE03701 Boerma M (PI) 06/01/2014 – 05/31/2017
NASA/NSBRI
Goal: Study Cardiac and vascular effects of space radiation.
Role: Co-investigator.

1I01RX001203-01 Dennis R (PI) 06/01/2014 – 05/31/2018
Veterans Administration
Goal: Study adaptations to resistance exercise in older adults.
Role: Co-investigator

Shane A. Snyder, Ph.D. BCES
Professor and Co-Director
University of Arizona
Department of Chemical & Environmental Engineering
1133 E. James E. Rogers Way; Harshbarger 108
Tucson, AZ 85721-0011
ph. (520) 621-2573 Email: snyders2@email.arizona.edu

Professional Preparation:

Michigan State University	Environmental Toxicology/Zoology	Ph.D., 2000
Thiel College	Chemistry	B.A., 1994

Appointments:

July 2010 – Present	Professor, Chemical & Environmental Engineering, University of Arizona
July 2011 - Present	Visiting Professor, National University of Singapore
August 2014-Present	Co-Director, Water & Energy Sustainable Technology Center (WEST)
January 2014-Present	Editor in Chief, *Chemosphere* (international environmental science & engineering journal)

Professional Activities:

2003 - Present	Water Environment Federation
2000 – Present	American Water Works Association
2000 – Present	International Ozone Association
2000 – Present	International Water Association
1997 – Present	American Association for the Advancement of Science
1995 – Present	Society of Environmental Toxicology and Chemistry
1991 – Present	American Chemical Society

Recent Professional Activities:

1. US Environmental Protection Agency – Board of Scientific Counselors: Member of the Safe and Sustainable Water Resources Subcommittee, 2014-Present
2. Co-Editor in Chief. *Chemosphere* – an Elsevier journal with an impact factor of 3.3 (http://www.journals.elsevier.com/chemosphere/), 2013-Present
3. World Health Organization: Member of WHO Drinking Water Advisory Group and Water Reuse Guideline Development Expert Panel, 2013-Present
4. US Environmental Protection Agency – Science Advisory Board's Drinking Water Committee: Member of expert panel to advise the EPA Administrator on technical issues underlying EPA policies and decision making. 2012-Present
5. International Water Association – Water Reuse Specialty Group: Vice-Chair, 2011-Present
6. WateReuse Association: Member of the Board of Directors, 2010-2013
7. WateReuse Research Foundation: Research Advisory Council (RAC) member, 2008-2013
8. National Academy of Science – National Research Council: Member of Water Reuse expert panel, 2008-2012
9. American Water Works Association: Appointed Trustee of the Water Science & Research Division, 2008-2011

Ten-Representative Peer-Reviewed Publications (from 185 published):

1. Park, M.; Anumol, T.; Snyder, S. A., Modeling approaches to predict removal of trace organic compounds by ozone oxidation in potable reuse applications. *Environmental Science: Water Research & Technology* **2015,** *1*, 699-708.
2. Merel, S.; Anumol, T.; Park, M.; Snyder, S. A., Application of surrogates, indicators, and high-resolution mass spectrometry to evaluate the efficacy of UV processes for attenuation of emerging contaminants in water. *J. Hazard. Mater.* **2015,** *282*, 75-85.

3. Jia, A.; Escher, B. I.; Leusch, F. D. L.; Tang, J. Y. M.; Prochazka, E.; Dong, B.; Snyder, E. M.; Snyder, S. A., In vitro bioassays to evaluate complex chemical mixtures in recycled water. *Water Res.* **2015,** *80* (0), 1-11.
4. Clarke, B. O.; Anumol, T.; Barlaz, M.; Snyder, S. A., Investigating landfill leachate as a source of trace organic pollutants. *Chemosphere* **2015,** *127* (0), 269-275.
5. Anumol, T.; Sgroi, M.; Park, M.; Roccaro, P.; Snyder, S. A., Predicting Trace Organic Compound Breakthrough in Granular Activated Carbon using Fluorescence and UV Absorbance as Surrogates. *Water Res.* **2015,** (0).
6. Snyder, S. A., Emerging Chemical Contaminants: Looking for Better Harmony. *J. Am. Water Work Assoc.* **2014,** *106* (8), 38-52.
7. Pisarenko, A. N.; Stanford, B. D.; Yan, D. X.; Gerrity, D.; Snyder, S. A., Effects of ozone and ozone/peroxide on trace organic contaminants and NDMA in drinking water and water reuse applications. *Water Res.* **2012,** *46* (2), 316-326.
8. Mawhinney, D. B.; Vanderford, B. J.; Snyder, S. A., Transformation of 1H-Benzotriazole by Ozone in Aqueous Solution. *Environ. Sci. Technol.* **2012,** *46* (13), 7102-7111.
9. Mawhinney, D. B.; Young, R. B.; Vanderford, B. J.; Borch, T.; Snyder, S. A., Artificial Sweetener Sucralose in U.S. Drinking Water Systems. *Environ. Sci. Technol.* **2011,** *45* (20), 8716-8722.
10. Bruce, G. M.; Pleus, R. C.; Snyder, S. A., Toxicological Relevance of Pharmaceuticals in Drinking Water. *Environ. Sci. Technol.* **2010,** *44* (14), 5619-5626.

Select Honors and Awards:

2016 International Water Association (IWA): Appointment as Fellow of the IWA
2015 Dr. Pankaj Parekh Research Innovation Award from the Water Research Foundation
2014 American Academy of Environment Engineers & Scientists: Board Certified Environmental Scientist (BCES)
2013 LuxResearch Top Academics and Institutions in Water Research – Included among “30 Leading Water Researchers”
2012 Best Paper Award – Journal of the American Water Works Association

Recent Presentations (Invited Examples Only):

December 2015 Tokyo, Japan – University of Tokyo: Invited presentation as part of visiting scholar program. “Exploring the Composition and Toxicity of Complex Environmental Mixtures”

November 2015 Salt Lake City, Utah – SETAC Conference: Invited Presentations, “Environmental Determinants of Disease Susceptibility” and “Identification and Characterization of Glucorticoid Agonists in the Aquatic Environment.”

October 2015 Orange County, California: State Water Resources Control Board – Invited Opening Presentation, “Overview: State of the science of CEC monitoring”

October 2015 Kaohsiung, Taiwan – Invited Plenary Presentation “The Impact of Emerging Contaminants on Water Sustainability”

August 2015 San Diego, California – Invited Presentation “Toilet to Tap: Is it Safe?” (Conference on Small Molecule Science – CoSMos)

July 2015 Harbin, China – Invited Presentation on Sensor Technologies and Bioassays for Ensuring Potable Reuse Safety (International Water Association – Water Reuse)

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Zarbl, Helmut

eRA COMMONS USER NAME *(credential, e.g., agency login)*: hzarbl

POSITION TITLE: Professor of Environmental and Occupational Health

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Marianopolis College, Montreal, Canada	D.C.S	1973-1975	Health Sciences
McGill University, Montreal, Canada	B.Sc.	1975-1978	Biochemistry
McGill University, Montreal, Canada	Ph.D.	1978-1983	Biochemistry
NIH - Frederick Cancer Research Facility, MD	Post-doc	1983-1985	Cancer Biology
Clinical Research Institute of Montreal, Canada	Post-doc	1985-1987	Cancer Genetics

Positions and Employment

1987-1992	Assistant Professor, Department Applied Biological Sciences, Massachusetts Institute of Technology, Cambridge, MA
1992-1994	Associate Professor, Division of Toxicology, Whitaker College of Health Sciences and Technology Massachusetts Institute of Technology, Cambridge, MA
1993-1994	Associate Director, M.I.T. Center for Environmental Health Sciences
1994-2006	Member, Divisions of Human Biology & Public Health Sciences, Fred Hutchinson Cancer Research Center (FHCRC), Seattle, WA
1995- 2006	Member, Center for Ecogenetics and Environmental Health, UW, Seattle, WA
1996-	Affiliate Professor, Departments of Environmental and Occupational Health & Pathology, University of Washington, Seattle, WA
1998-2002	Scientific Director, DNA Microarray Shared Resource, FHCRC, Seattle, WA
1998-2002	Director, Public Health Sciences Core Laboratory, FHCRC, Seattle, WA
2002-2004	Director, Industrial Liaison Program, FHCRC, Seattle, WA
2000-2006	Director, NIEHS - FHCRC/UW Toxicogenomics Research Consortium, Seattle, WA
2000-	Visiting Professor of Genetics, China Medical University, Shenyang, China
2006-2015	Professor, Environmental and Occupational Medicine, Robert Wood Johnson Medical School, Environmental and Occupational Health Sciences Institute, Rutgers University, Piscataway, NJ
2007-	Director, Rutgers NIEHS Center for Environmental Exposures and Disease.
2008-2013	Associate Director, Division of Public Health Sciences, Rutgers Cancer Institute of New Jersey, New Brunswick, NJ
2015-	Professor of Environmental and Occupational Health, School of Public Health, Rutgers University, Piscataway, New Jersey
2016-	Affiliate Professor of Pharmacology, Department of Chemical Biology, Ernest Mario School of Pharmacy. Rutgers University, Piscataway, New Jersey.

Other Experience

2004-2015	Co-Founder, Impedagen, LLC. Biotechnology start-up. Snoqualmie, WA
2012-	Founding President, GeneAssess, Inc. Piscataway, NJ.

Honors and Awards

1988-1989	Robert A. Swanson Endowed Assistant Professor in Life Sciences.
2008-2010	Founding Chair, Society of Toxicology Disease Prevention Task Force
2010-2013	Vice President (elect), Vice President and President, Carcinogenesis Specialty Section, Society for Toxicology
2011	NIEHS Extramural Paper of the Month. “Urinary mycoestrogens, body size and breast development in New Jersey girls. Bandera EV, Chandran U, Buckley B, Lin Y, Isukapalli S,

	Marshall I, King M, Zarbl H. (Sci Total Environ 409(24):5221-5227, 2011)
2012	Women in Toxicology Mentoring Award from the Society of Toxicology
2015	Excellence in Research Award, New Jersey Health Foundation.
2015	Outstanding Paper Award. International Conference on Food and Nutrition Science. Asian Pacific Chemical Biological and Environmental Engineering Society. Bangkok, Thailand.
2008-	Fellow of the Academy of Toxicological Sciences

Advisory Boards, Panels and Committees

1998- 2001	FHCRC Liason to the Scientific Advisory Board of Rosetta Inpharmatics*, ex officio* member,
2001-2002	External Scientific Advisory Board of Arcturus Engineering, Inc.
2004-2005	National Research Council: Committee on Applications of Toxicogenomics to Predictive Toxicology
2008	EPA-IRIS Peer Review Panel: Toxicological Review of 1,2,3-Trichlropropane
2009	NIEHS Superfund Basic Research Program, External Advisory Panel.
2010	External Scientific Advisory Board, Department of Environmental Sciences and Engineering. Gillings School of Public Health. University of North Carolina, Chapel Hill, NC
2009-2015	External Scientific Advisory Board, Superfund Basic Research Program University of North Carolina. Chapel Hill, NC
2009-2015	Member, National Academy of Sciences, National Research Council Standing Committee on “Emerging Science for Environmental Health Decisions”
2009-2016	Member, the National Academy of Sciences, National Research Council Standing Committee on Emerging Science for Environmental Health Decisions
2009-2015	External Scientific Advisory Board, Superfund Basic Research Program University of North Carolina, Chapel Hill, North Carolina
1999-	External Scientific Advisory Board Member Research Center for Minority Institutions, Clark Atlanta University, Atlanta, GA
2005-	Chair, External Scientific Advisory Board, Center for Cancer Research and Therapeutic Development. Clark Atlanta University, Atlanta, GA
2009-	External Scientific Advisory Board, NIEHS Center, University of Michigan, Ann Arbor, MI
2012-2014	Reviewer for Health Effects Institute Advanced Collaborative Study (ACES) on missions from 2007 compliant diesel engines.
2015-	External Scientific Advisory Board, NIEHS Center, Emory University, Atlanta, GA
2015-	External Scientific Advisory Board, NIEHS Center, University of Cincinnati

Editorial Boards

2006-2008	Editor-In Chief, Biological Procedures Online
2008-	Editorial Board of The Open Toxicology Journal
2002-2004	Associate Editor, Environmental Health Perspectives: Toxicogenomics
2000-2002	Associate Editor, Cancer Research (AACR)
2011-	Editorial Board, Frontiers in Toxicogenomics
2010-	Editorial Board, Toxicology and Applied Pharmacology

Memberships

- American Association for Cancer Research Member
- Society of Toxicology Member
- American Association for the Advancement of Science Member

Complete List of My Published Work Can be found in MyBibliography:
http://www.ncbi.nlm.nih.gov/pubmed/?term=Zarbl%2C+H

Patents

- US Patent # 6,939,712 . Muting Gene Activity Using a Transgenic Nucleic Acid 09/07/2005
- US Provisional Patent # 61/419,975 12/06/2010
  PCT /US2011/063553 filed in 2011. Novel Method of Cancer Diagnosis and Prognosis and Prediction of Response to Therapy.

Ralph L. Kodell
Professor, Retired
Department of Biostatistics
University of Arkansas for Medical Sciences
4301 W. Markham St.
Little Rock, Arkansas 72205

September 30, 2016

Peer Review of Topics Identified as the Scientific Portions of Developing a Maximum Contaminant Level for 1,2,3-Trichloropropane (1,2,3-TCP) – Proposed Best Available Technology, Cost Estimation Method, Theoretical Annual Reduction in Cancer Cases Estimation Method, and Detection Limit for Purposes of Reporting for Treatment of 1,2,3-TCP

General Comments:

I have provided commentary below on each of Review Items 1-5 as well as on the Big Picture. However, I have placed most emphasis on Review Item 3, given that expertise in human health risk assessment methodology is the primary expertise that I bring to this review.

Specific Comments:

Review Item 1: Cost Estimation Method/Approach is appropriate.

For a given candidate MCL, the steps followed in the cost estimation approach diagrammed in Attachment 1A and illustrated in Attachment 2A appear to be appropriate, although I did not examine these steps in minute detail. However, it is not clear why, in the present case, six incremental potential MCLs for 1,2,3-Trichloropropane (1,2,3-TCP), from 5 ng/L to 150 ng/L, were evaluated. It is stated that California Health and Safety Code Section 116365 requires that the State Water Board adopt MCLs as close to the public health goal (PHG) as is technically and economically feasible at the time of the MCL adoption. Given that the PHG is 0.7 ng/L, and that, while levels lower than 5 ng/L may be detectable by certain select methods, 5 ng/L is the lowest level considered reliably detectable by analytical methods that are commonly available, it seems that consideration of DLRs and MCLs much greater than 5 ng/L is not warranted (certainly, not as high as 150 ng/L).

Review Item 2: A DLR of 5 ng/L is the most appropriate DLR with respect to available analytical methods and statutory requirements.

The DLR of 5 ng/L appears to be appropriate in the sense that several commonly available analytical methods at ELAP (Environmental Laboratory Accreditation Program)-certified commercial laboratories have been identified as being capable of achieving a minimum reporting level of 5 ng/L for 1,2,3-TCP. It is stated that ELAP certification for methods that may be capable of detecting 1,2,3-TCP at levels below 5 ng/L is not widespread in California. Thus, it is argued that a lower level than 5 ng/L for a DLR is not economically or technically feasible. This conclusion appears to be justified.

Review Item 3. Method used to estimate reduction in annual theoretical cancer cases for each drinking water source that is contaminated with 1,2,3-TCP is appropriate.

The modified definition of the reduction in annual theoretical cancer cases for each contaminated source is given in Attachment 2 as

$$\text{Reduction} = \frac{[(\text{average of source monitoring results}) \times (\text{population exposed}) \times (\text{risk})]}{70 \text{ years}}$$

In an earlier version of Attachment 2 that was sent to potential reviewers prior to their selection as reviewers, the definition was given as

$$\text{Reduction} = \frac{[(\text{average of source monitoring results} - \text{evaluated MCL}) \times (\text{population exposed}) \times (\text{risk})]}{70 \text{ years}}$$

I believe the latter expression (the original one) is correct, in that it represents a *reduction* in cases, i.e., the difference between the number of cases estimated based on current exposure levels and the number estimated if the MCL were put into effect (assuming the MCL would be lower than the current average exposure level). To me, the revised definition would actually give only the theoretical annual number of cases occurring under current exposure levels, i.e., it would *not* give the *reduced* number of cases.

Using the average of source monitoring results from all acceptable samples from a given source as a representative contamination level of 1,2,3-TCP for that source seems justified.

Approximating the population served by a source within a water system using the average over all sources in the system inherently assumes that all sources serve the same number of people. Apparently, population-served-per-source data are not available. However, wording used under Step 4 of Review Item 1, "the number of people served by each source," indicates that such data are available. If these data are available, they ought to be used so that the per-source calculation will be more accurate. However, once all reductions are summed, as outlined in Step 6 of Review Item 1, it shouldn't make any difference.

The public health goal (PHG) value of 0.7 ng/L that is used here to calculate the "risk" (actually, the *slope*: see next paragraph) is based on having linearity at least up to an excess risk level of 0.1 (Public Health Goal for 1,2,3-Trichloropropane in Drinking Water, OEHHA 2009, http://oehha.ca.gov/water/public-health-goal/final-public-health-goal-123-trichloropropane-drinking-water), so the assumed linearity would easily apply up to the proposed MCL of 5 ng/L, and would apply to average source monitoring results above 5 ng/L as long as those results would not greatly exceed 5 ng/L.

As mentioned above, I believe the "risk" that appears in the formula is actually meant to represent the *slope* of a line used for linear extrapolation instead of actual *risk*, where risk is defined as the probability of occurrence of an event (cancer, in this case). The ratio of excess cancer risk at the PHG to the PHG itself is really the *cancer potency factor* based on low-dose, linear extrapolation from a 0.1 excess risk level (OEHHA, 2009). The PHG of 0.7 ng/L established by OEHHA in 2009 for drinking water (after making appropriate conversions) corresponds to a lifetime excess individual cancer risk of 1 in 1 million (equivalently, 1 excess cancer case per million people each of whom lives 70 years). So, 1 lifetime excess cancer case per million people is the *risk* (10^{-6}), and the *potency factor* is the *slope*, i.e., the excess risk divided by the PHG (in this case, 10^{-6}/0.7 ng/L). Thus, I would use either *potency factor* or *slope* in the reduction formula in place of the word *risk*. Perhaps, more importantly, I calculate a different value for the potency factor from the value of 0.00142857 given in Attachment 2. If I am correct in dividing 10^{-6} by 0.7 to get the potency factor, then the potency factor for 1,2,3-TCP expressed in ng/L units should be 0.00000142857, not 0.00142857. So, either my calculation is too low by a factor of 1000 or the proposed value in Attachment 2 is too high by a factor of 1000.

Review Item 4. Granulated activated carbon (GAC) is the best available technology (BAT) for the treatment of 1,2,3-TCP.

The selection of GAC as the BAT relies in part on the 2015 Corona Environmental Consulting report for the Winton Water and Sanitary District, *Winton Water and Sanitary District: Treatment Technologies and Costs to Treat 1,2,3=Trichloropropane,* pages 9-11 (Attachment 6). Relative to UV Based processes, Ozone Based Oxidation, and Aeration, GAC Adsorption was argued to be more reliable and more cost effective in achieving levels below the DLR of 5 ng/L.

It is stated that GAC was identified as the BAT after reviewing engineering reports from multiple water systems in California with permitted GAC treatment for 1,2,3-TCP removal and monitoring data. Attachments 7a-7g have been provided as reports and excerpts on the effectiveness of GAC as treatment for 1,2,3-TCP.

Attachment 7b for the Lante Plant shows that there was only a single mild excursion above 5 ng/L (actually, 5.2) during the period sampled. Attachment 7e for the City of Shafter indicated no detections at or above 5 ng/L. Attachment 7g for the City of Burbank indicated that after GAC treatment, all sampled values were below 0.005 µg/L = 5 ng/L. However, even though Attachment 7c for the City of Glendale indicates a reporting limit of 50 ppt, Attachment 7d appears to show many values of 1,2,3-TCP at 0.5 µg/L. Perhaps I am reading the table wrong in Attachment 7d, or the concentration units are incorrectly reported.

Review Item 5: The preliminary staff recommendation of a Maximum Contaminant Level of 0.000005 mg/L (or 5 nanograms per liter) would be protective of public health.

Because the PHG of 0.7 ng/L corresponds to an excess cancer risk of 10^{-6}, i.e., one expected additional cancer case per million 70-year lifetimes, the assumption that risk is linearly related to exposure at the 1,2,3-TCP levels of concern implies that the lifetime cancer risk at 5 ng/L would be about 7×10^{-6}. The PHG is presumed, to the extent possible, to account for differential sensitivities among subgroups of the population. Thus, significant risk to public health would appear to be avoided by achieving an MCL of 5 ng/L.

The Big Picture

(a) I am not aware of any scientific issues not mentioned in this document that are part of the scientific basis of the draft regulations.

(b) Although the scientific portion of the draft regulations appears to be based upon sound scientific knowledge, methods, and practices, I believe there are several issues that need to be addressed before the regulations are finalized. These issues are discussed in my comments above, and are summarized here.

   i. Review Item 1. Regarding the cost estimation approach, given that it is a requirement that the MCL for 1,2,3-TCP be as close to the PHG for 1,2,3-TCP as is technically and economically feasible, I believe that a rationale for considering levels as high as two orders of magnitude above the PHG needs to be provided. Otherwise, this exercise may not be very useful.

   ii. Review Item 3. Regarding the method used to estimate the reduction in annual cancer cases achieved by imposing the MCL for 1,2,3-TCP, I have outlined in my above comments two places in the reduction formula where I believe corrections are needed. In one place, the MCL needs to be subtracted just as it was in the original formula, in order to achieve a *reduction* in cases. In another place the word *risk* needs to be replaced by either *potency factor* or *slope*. Also, I have identified a calculated potency value that I believe is incorrect. In addition, using an average population served per source may suffice, but if population-served-per-source data are available, they ought to be used.

   iii. Review Item 4. Regarding adoption of GAC as the BAT, I believe that clarification of the monitoring data provided in Attachment 7d for the City of Glendale is needed in order to give assurance, along with the other evidence in Attachment 7, of achieving levels of 1,2,3-TCP below 5 ng/L with GAC treatment.

PEER REVIEW REPORT

OF

SHANE A. SNYDER, Ph.D. BCES

At the request of the California State Water Resources Control Board

Peer Review of Topics Identified as the Scientific Portions of Developing a Maximum Contaminant Level for 1,2,3-Trichloropropane (1,2,3-TCP) – Proposed as Best Available Technology, Cost Estimation Method, Theoretical Annual Reduction in Cancer Cases Estimation Method, and Detection Limit for Purposes of Reporting for Treatment of 1,2,3-TCP

8th October 2016

Shane A. Snyder, Ph.D. BCES
Professor
Chemical & Environ. Engineering
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PEER REVIEW REPORT
OF
SHANE A. SNYDER
FOR
California State Water Resources Control Board

September 2016

1.0 INTRODUCTION

My name is Shane A. Snyder. I am a Professor in the Chemical & Environmental Engineering Department of the College of Engineering at the University of Arizona (UA). I also Co-Direct the Water & Energy Sustainable Technology (WEST) Center and the Arizona Laboratory of Emerging Contaminants (ALEC). The SWRCB engaged me to analyze the provided documents and to provide expert opinions on the conclusions reached in the development of an MCL for 1,2,3-TCP. I have expertise in organic contaminant analyses and in water treatment technologies.

Beyond the materials provided by the SWRCB, I relied upon manuscripts from published literature, government reports, various water association reports, and professional experience to generate this peer review report. All the opinions stated herein are to a reasonable degree of scientific certainty, and are the product of basic scientific principles and methods which have been reliably applied to the facts of this review.

1,2,3–Trichloropropane (TCP, Figure 1), also known as glycerol trichlorohydrin, has been used in a variety of industrial and agricultural applications. For the industrial use, TCP has been applied as a paint and varnish remover, cleaning and degreasing agent, and as a chemical intermediate. As a pesticide, TCP uses include dichloropropenes used a soil fumigant. The physico-chemical properties of TCP can lead to water and air contamination (Table 1). In animal models, TCP can induce tumor formation and thus is generally considered a probable human carcinogen.

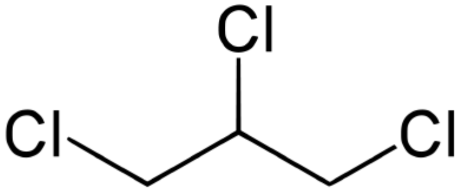

Figure 1. Molecular Structure of 1,2,3-TCP

Only sparse data are available in published literature regarding 1,2,3-TCP treatment processes for water remediation. A keyword search (1,2,3-trichloropropane) in Web of Science resulted in an ironic 123 articles. Of these, relatively few were related specifically to water treatment or analytical measurements.

Table 1. General Properties of TCP

Property	Value
CAS No.	96-18-4
Chemical formula	$C_3H_5Cl_3$
Molecular weight	147.43
Melting point	14.7°C
Boiling point	156.85°C
Density	1.3888 g/cm^3 @ 25°C
Solubility in water	1.75 g/L @ 25°C
Solubility in organic solvents	Soluble in ethyl alcohol, chloroform, ethyl ether, benzene
Vapor pressure	3.1/3.69 mm Hg @ 25°C
Henry's Law constant	3.17/3.43x10^{-4} atm-m^3/mol @ 25°C 22.83x10^{-4} Pa-m^3/mol @ 25°C 0.013 dimensionless (K_{aw})
Absorption to organic carbon	77-95
Octanol-water partition coefficient	Log K_{ow} = 1.99; 2.54; 2.27
Conversion factor	1 ppm = 6.1 mg/m^3 @ 20°C, 101.3 kPa 1 mg/m^3 = 0.16 ppm

2.0 BACKGROUND

CONCLUSIONS TO BE CONSIDERED:

1. Cost Estimation/Method is Appropriate
2. A Detection Limit for the Purposes of Reporting (DLR) of 5 ng/L is the Most Appropriate DLR with Respect to Available Analytical Methods and Statutory Requirements
3. Method Used to Estimate Reduction in Annual Theoretical Cancer Cases for Each Drinking Water Source that is Contaminated with 1,2,3-TCP is Appropriate (*this conclusion is not addressed in my peer-review as this topic is outside my core expertise*)
4. Granular Activated Carbon (GAC) is the Best Available Technology (BAT) for the Treatment of 1,2,3-TCP
5. The Preliminary Staff Recommendation of a Maximum Contaminant Level of 0.000005 mg/L (or 5 Nanograms per Liter) Would be Protective of Public Health

3.0 PRINCIPAL OPINIONS OF CONCLUSIONS PROVIDED

OPINION 1: Cost-estimations provided based on existing systems in California appear to be accurate; however, additional data would be helpful to better optimize 1,2,3-TCP attenuation and minimize operational costs.

OPINION 2: Analytical methods are currently available from laboratories that are certified by the Environmental Laboratory Accreditation Program (ELAP) are capable achieving a Detection Limit for the Purposes of Reporting (DLR) of 5 ng 1,2,3-TCP/Liter of water; however, some questions remain as to the reliability of these methods in natural aqueous matrices.

OPINION 3: Granular activated carbon (GAC) is likely to be the best available technology (BAT) for reducing 1,2,3-TCP concentrations in water to less than 5 ng/L; however, other technologies should have been considered and not all scenarios for advanced oxidation processes (AOPs) were evaluated.

OPINION 4: The preliminary staff recommendation of an MCL of 5 ng/L for 1,2,3-TCP would be protective of public health, but implementation of an MCL of 5 ng/L may be challenging using currently approved analytical methods.

4.0 BASIS FOR OPINIONS

4.1 Opinion 1: *Cost-estimations provided based on existing systems in California appear to be accurate; however, additional data would be helpful to better optimize 1,2,3-TCP attenuation and minimize operational costs.*

Cost-estimation data provided for GAC seems reasonable considering the limited data available. Assumptions of bed volume lifespans should be viewed as preliminary estimates. Cost-estimations were relatively thorough for GAC; however, comparisons to costs for other viable technologies is sparse at best. A discussion of alternative technologies for 1,2,3-TCP is provided in Opinion 3 of this report. For GAC, only a few water qualities have been considered and only a few carbon types are considered. Ideally, additional information would be provided that demonstrates the efficacy of differing carbon types, differing empty-bed contact times (EBCTs), and under a range of water qualities. While full-scale testing of these variables is not always feasible, preliminary testing using rapid small-scale column tests (RSSCTs) is highly advisable. Using RSSCTs, water agencies can more quickly gauge the performance of various carbons and EBCTs before moving into pilot or full-scale designs (Crittenden et al., 1991; Redding et al., 2009; Anumol et al., 2015). Overall, I believe that the cost-estimation provided by SWRCB in relation to GAC is reasonable and reliable within the constraints of the very limited data available; however, cost-estimations for other technological solutions is largely absent within the documents provided by SWRCB.

4.2 **Opinion 2**: ***Analytical methods are currently available from laboratories that are certified by the Environmental Laboratory Accreditation Program (ELAP) are capable achieving a Detection Limit for the Purposes of Reporting (DLR) of 5 ng 1,2,3-TCP/Liter of water; however, some questions remain as to the reliability of these methods in natural aqueous matrices.***

Several analytical methods have been utilized in order to identify and quantify trace levels of 1,2,3-TCP in water. Generally, gas chromatography (GC) is used to separate mixtures of volatile and semi-volatile organic substances, including 1,2,3-TCP, isolated from environmental samples. The US Environmental Protection Agency (EPA) has developed and published methods that include 1,2,3-TCP among other constituents. Methods promulgated by the EPA include various revisions of method 504.1, method 524.2, and method 524.3. The State of California Department of Public Health has developed methods specifically optimized for 1,2,3-TCP, including SRL 524M-TCP, SRL 525M-TCP, and a recently published method. These methods will be discussed in detail in the following sections.

US Environmental Protection Agency Methods:

Using liquid-liquid extraction (LLE) using hexane, followed by GC with electron capture detection (ECD), method 504.1 (revision 1.1) claims a method detection limit (MDL) of 0.02 ug/L (parts per billion) (EPA, 1995a). However, because of the relatively non-selective nature of ECD, method 504.1 also states that "Confirmatory evidence should be obtained for all positive results." Confirmation under method 504.1 requires the use of either a second GC analytical column of dissimilar phases or (when concentrations are great enough) GC coupled to mass spectrometry (GC-MS). Within method 504.1 revision 1.1, the EPA demonstrates that with seven replicate samples fortified to 100 ng/L with 1,2,3-TCP, a mean recovery of 91.9% with a relative standard deviation (RSD) of 13.88% may be achieved (EPA, 1995a).

Method 524.2 relies on a purge and trap interface (PTI), which sweeps organic substances from water samples using an inert gas then trapping the volatized organics on a stationary phase (EPA, 1995b). The stationary phase (trap) is then rapidly heating to re-volatize and introduce the focused organics into the GC instrument. The EPA demonstrates this method using a fortification level of 100 ng/L, which results in a mean accuracy of 96% with a %RSD of 6.5 which was used to calculate an MDL of 30 ng/L for 1,2,3-TCP.

In August of 2009, EPA published Method 524.3, which as a newer method that targets 76 volatile organic compounds (VOCs), including 1,2,3-TCP. This method increases the number of internal standards from 1 to 3, and the number of surrogate standards from 2 to 3. Instead of preservation by pH suppression, method 524.3 uses maleic and ascorbic acid. The QA/QC requirements of method 524.3 also changed, particularly in how the calibration curve is evaluated and the requirement of Minimum Reporting Level confirmation criteria. Method 524.3 was specified in the US EPA's Unregulated Contaminant Monitoring Rule 3 (UCMR3) with an MRL of 0.03 ug/L (30 ng/L) {EPA, 2016 #5351}. As of July 2016, the EPA reported that only 253 of 36,532 results received were above the MRL and only 65 public water systems (PWSs) of 4,905 tested at 1,2,3-TCP concentrations above the MRL of 30 ng/L.

California Department of Public Health Methods:

The State of California Department of Public Health (DPH) developed at least three analytical methods capable of report limits for 1,2,3-TCP at, or below, 5 ng/L. Unlike the aforementioned EPA methods, the California DPH methods are specific to 1,2,3-TCP and do not include other analytes. The methods employed are purge and trap GC-MS (PTI-GC-MS) (Okamoto et al., 2002b), continuous LLE GC-MS (Okamoto et al., 2002a), and a combined solid-phase extraction (SPE) PTI-GC-MS (Liao et al., 2016). Of these, according to my review of available literature, only the PTI-GC-MS (SRL 524M-TCP) and LLE-GC-MS (SRL 525M-TCP) are used under the Environmental Laboratory Accreditation Program (ELAP) required for regulatory purposes.

The PTC-GC-MS (SRL 524M-TCP) method uses a linear calibration range from 5 to at least 500 ng/L and is not recommended for higher concentrations (Okamoto et al., 2002b). Both single quadrupole and ion-trap mass spectrometers were used in the development of the method; however, the authors note that those using ion-trap mass spectrometers "are cautioned that quantifying TCP at the 5 ng/L level may not be achievable." Yet, the authors note that ion-trap mass spectrometers have superior selectivity for compound identification. It seems that triple-quadrupole (QQQ) mass spectrometers were not evaluated, which may have provided both superior sensitivity and selectivity. A deuterium labeled internal standard, 1,2,3-trichloropropane-D_5 (TCP-D_5), is added at the same concentration to all samples and standards. It should be noted that many laboratories, including some EPA methods, would consider the addition of an isotopically-labeled standard to the sample as a surrogate standard (as opposed to an internal standard). Regardless, the recovery of TCP-D_5 is used to normalize the recovery of 1,2,3-TCP in samples. The authors note that, depending on the analytical column used, some substances can interfere with 1,2,3-TCP quantification if present (for instance, in environmental samples and/or leaching from analytical equipment). The method requires laboratory fortified blanks (LFBs) containing 1,2,3-TCP at 20-50 ng/L be replicated seven times to achieve a mean recovery between 80-120% and an RSD of 20%. The method further requires an MDL study "preparing and analyzing a minimum of seven replicates of a 5.0 ng/L TCP standard over a period of three days, or more." It is not entirely clear, though implied, that the MDL study is performed in laboratory (purified) water. The reporting limit should be no less than 3x the MDL. The method provides detailed quality assurance and quality control (QA/QC) measures, including ions used for mass spectrometry and guidance regarding observations of skewed ion abundances. The method calls for "taking appropriate action", in needed, to correct for interfering compounds; however, it is unclear what appropriate action is specifically recommended. The authors claim demonstrated MDLs of 0.9 and 2.3 ng/L for quadrupole and ion-trap mass spectrometers, respectively. These data would suggest that ion-trap was not successful in achieving a reporting limit of 5 ng/L using a 3x the MDL reporting limit calculation. ***In my professional opinion, this method using a quadrupole mass spectrometer is barely adequate to obtain a DLR of 5 ng/L. It is concerning that the lowest calibration point is at the desired DLR. Moreover, MDLs are calculated from statistical methods were replication is more important that***

sensitivity. That said, the verification of the MDL with 5 ng/L standards is promising; however, specific details on whether this would be successful in a true environmental matrix is absent and risks of interferences are known. Another consideration is that while reproducibility is good, the recovery of an isoptically-labeled surrogate is used to normalize for 1,2,3-TCP recovery. Since the lowest point in the calibration curve is 5 ng/L, any variation in recovery could result in a false negative (or positive) which may have implications for regulatory compliance.

The other method used by the State of California, and used in ELAP laboratories, uses continuous LLE with GC-MS detection (SRL 525M-TCP). This method also is specific to 1,2,3-TCP and also uses a linear calibration range of 5 to at least 500 ng/L (Okamoto et al., 2002a). In general, the analytical method is similar to that of SRL 524M-TCP with the significant exception of the sample extraction and introduction methodology. Continuous LLE is achieved with SRL 525M-TCP by extraction a 1L water sample for approximately 16 hours (overnight) with dichloromethane (DCM). The resulting DCM extract is dried (to remove residual water), then evaporated to 1 mL using nitrogen gas. Analysis is performed by injecting 2 uL of the final extract into a GC-MS system. As described previously, TCP-D_5 is added to both samples and standards for isotope-dilution quantification. The method was demonstrated using reagent grade (purified) water fortified to 5 ng/L of 1,2,3-TCP and replicated eight times, resulting in an MDL of 0.8 ng/L with a mean recovery of 111% and RSD of 4.8%. The authors estimate a reporting limit of 5 ng/L for 1,2,3-TCP. It is unclear if natural/environmental waters fortified at the estimated MRL to evaluate the potential impact of a background matrix. However, six groundwater samples were tested by both the LLE and the PTI methods with resulting 1,2,3-TCP concentrations ranging from 8 to 77 ng/L with good comparability. Yet, it seems that no natural waters with less than 8 ng/L were evaluated nor is any mention of potential interferences discussed. ***In my professional opinion, SRL 525M-TCP also is barely adequate for the desired DLR of 5 ng/L of 1,2,3-TCP in environmental waters. The method description speaks to an MDL study "by preparing and analyzing a minimum of seven replicates of a 5.0 ng/L TCP standard over a period of three days, or more." It is unclear to me if the method requires fortification of a reagent water samples to 5 ng/L or if this is simply analysis of an analytical standard. If the latter, it must be erroneous as analytical standards specified in this method are in ug/L concentrations. Regardless, in my opinion, an MRL (or DLR) for an analytical method to be used for environmental compliance should be higher than the lowest point in the calibration curve (equated to water assuming 100% recovery). Since the lowest point in the calibration curve is 5 ng/L, any variation in recovery could result in a false negative (or positive) which may have implications for regulatory compliance.***

More recently, the State of California Department of Public Health, Drinking Water and Radiation Laboratory Branch, has published in peer-reviewed literature a more sensitive method for 1,2,3-TCP using a combination of SPE and PTI to achieve an MRL of 0.30 ng/L (Liao et al., 2016). This is a highly unique method, which the authors' claim "the two sample preparation methods have never been used in combination." This unlikely coupling seems to have quite promising results; however, seems very labor intensive and time consuming as currently applied. The method also relies on isotope-dilution quantification using TCP-D_5 as a surrogate/internal standard. The published manuscript does provide results of a single matrix spike at 1 ng/L with a recovery of 87% and shows good replication for two environmental samples. Considering that this method is not likely to have ELAP "approval" at this point in time, further critique will not be provided. However, the method, though seemingly labor intensive, does show good promise for 1,2,3-TCP identification and quantification, as demonstrated by a water treatment process sampling where "raw" water is reported at 5.8 ng/L and "finished" water was less than detection. ***From my review, this published method has not been recommended for regulatory application; however, I believe it shows promise in achieving a desired MRL of 5 ng/L, or lower, based on the data available.***

4.3 **Opinion 3**: ***Granular activated carbon (GAC) is likely to be the best available technology (BAT) for reducing 1,2,3-TCP concentrations in water to less than 5 ng/L; however, other technologies should have been considered and not all scenarios for advanced oxidation processes (AOPs) were evaluated.***

The primary means of removing organic chemicals from water are oxidation, physical removal, and biological degradation. The review of technologies considered granular activated carbon (GAC), which is a means of physical removal and relocation of 1,2,3-TCP, as the BAT for treatment. There was meager consideration of advanced oxidation processes (AOPs) and aeration (another form of physical removal). In fact, relatively few published manuscripts regarding the treatment of water for 1,2,3-TCP could be located using Web of Science literature searching conducted in late September, 2016. Based on my review of the documents provided by the SWRCB, review of published literature, and review of grey literature using Google search engine, I am in agreement that GAC is the BAT for removing 1,2,3-TCP in groundwater to less than 5 ng/L/; however, other technologies are likely to also be successful if optimized. However, only GAC appears to have been proven successful for field applied treatment using DLR of 5 ng/L or less.

While data available do support that GAC is appropriately considered as BAT for 1,2,3-TCP removal to 5 ng/L, or less, other technologies could likely achieve this level of efficacy as well. For instance, powdered activated carbon (PAC) is not considered in the materials provided by SWRCB and quite likely would by highly successful for 1,2,3-TCP. PAC has been successfully used for a diversity of organic contaminant removal from water and offers the advantage of continuously fresh carbon surfaces and can be used when needed and turned off if not needed (Yoon et al., 2003; Ziska et al., 2016). However, for the groundwater scenarios described by the SWRCB, it is unlikely that occurrence of 1,2,3-TCP will be highly variable and PAC is generally more appropriate for surface water systems. Nevertheless, there may be situations where PAC is more appealing for 1,2,3-TCP depending on the particular water quality and existing treatment train.

Generally, 1,2,3-TCP is not amenable to biodegradation. However, some laboratory studies have shown promise using genetically engineered or naturally optimized bacterial strains (Bowman et al., 2013; Dvorak et al., 2014; Samin et al., 2014). At current, biological systems do not appear to be BAT for 1,2,3-TCP. Additional work would be necessary to determine if larger scale biological systems could be optimized for required efficacy.

Because 1,2,3-TCP is a halogenated aliphatic organic molecule, the quantum yield from direct photolysis is expected to be low and a hydroxyl radical promoter (such as hydrogen peroxide) would be needed for efficient oxidation in a UV system. While one report provided by SWRCB suggested that 1,2,3-TCP had been evaluated at bench-scale using UV-advanced oxidation process (UV-AOP), details are extremely sparse. The report does not provide information on what hydroxyl radical promotor was used nor is any information regarding concentration of the promotor provided. This cursory discussion regarding UV-AOP efficacy is not sufficient alone to dismiss UV-AOP as a BAT. In California, UV-AOP is used in at least two full-scale potable water reuse systems for oxidation of post-RO water, particularly for relatively resilient constituents like 1,4-

dioxane. More recently, the use of chlorine in UV-AOP also has shown great promise for oxidation of resilient contaminants (Pisarenko et al., 2013). From my own experience in evaluation UV-AOP technologies, I believe this technology could be successful for 1,2,3-TCP remediation to <5 ng/L; however, I have been unable to locate any literature to demonstrate successful in-field application for 1,2,3-TCP nor am I aware of any cost estimates specific for 1,2,3-TCP.

Other oxidative techniques such as ozone-peroxide and Fenton-based processes also show promise for 1,2,3-TCP removal (Hunter, 1997; Khan et al., 2009; EPA, 2014). Again, the lack of detailed application data would limit cost-estimation and appropriate consideration as BAT.

Zero-valent iron and zero-valent zinc have also shown promise for 1,2,3-TCP attenuation (Salter-Blanc et al., 2012; Noubactep, 2013). These types of reductive processes show excellent potential for 1,2,3-TCP attenuation and field trials have been performed for zero-valent zinc demonstrated feasibility (Salter-Blanc et al., 2012). Regardless, data are relatively sparse as compared to GAC processes, thus cost estimations would be far more challenging and applications to more diverse water qualities would be advised.

Air-stripping processes would be expected to have moderate efficacy for 1,2,3-TCP attenuation; however, full-scale data provided by the SWRCB suggest that as currently operated, air-stripping will not be sufficient to reach the 5 ng/L DLR. Further work would be required to fully understand the feasibility of air-stripping technologies, but considering the available data, I do not believe air-stripping should be considered as BAT for the purposes of a draft MCL for 1,2,3-TCP.

From the data I have reviewed, and in consideration of SWRCB policy that requires listing of a BAT with promulgation of an MCL, I agree that GAC should be considered the BAT for the purposes of a draft MCL for 1,2,3-TCP. The SWRCB has provided sufficient full-scale data to indicate that GAC can be successful for attenuating 1,2,3-TCP to the DLR of 5 ng/L. However, it should be noted that there are a limited number of groundwater facilities and it is possible that other water qualities could be more challenging, especially if a surface water was found to contain 1,2,3-TCP above the MCL, yet this is unexpected.

4.4 **Opinion 4**: ***The preliminary staff recommendation of an MCL of 5 ng/L for 1,2,3-TCP would be protective of public health, but implementation of an MCL of 5 ng/L may be challenging using currently approved analytical methods.***

The production of absolutely pure water is not only impractical; it is virtually impossible. Moreover, "pure" water is actually corrosive and not healthy for consumption. Considering the ubiquity of anthropogenic chemicals in the environment and the propensity for these chemicals to contaminate drinking water, rigorous regulations have been imposed to protect consumers from excessive health risks through ingestion of contaminants in drinking water. I did not review in any detail the toxicological data that became the foundation of the Public Health Goal (PHG) used in part as the basis for the suggested MCL for 1,2,3-TCP. My review was focused on BAT and DLR aspects of the proposed regulation. With the assumption that the PHG and risk assessment calculations are correct, I have no reason to believe that an MCL of 5 ng/L would not be protective of public health. I also believe that the BAT of GAC was appropriately selected based on full-scale operations in the State of California and considering the regulatory framework of the state. My only concern from the review of materials provided to me, and my own review of available literature, is the establishment of a reliable DLR of 5 ng/L. While it appears that laboratories are able to provide calculated MRLs at or below 5 ng/L, questions remain as to potential interferences, intrinsic method variability, and method performance within the diversity of water qualities that would be regulated by the proposed MCL. In my professional opinion, it would be far preferable to have MRLs well below the MCL. Essentially, a DLR at the MCL means that any positive result is a potential violation of the MCL. Considering that analytical methods employed often have variability of up to 20%, it is concerning to me that the MCL and DLR would be the same. Moreover, remediation performance modeling of 1,2,3-TCP to be compliant with an MCL of 5 ng/L will be challenged by analytical data of insufficient sensitivity. In summary, I see no overt issues with the establishment of an MCL of 5 ng/L for 1,2,3-TCP aside from previously discussed issues surrounding the accuracy and precision of the analytical methods suggested.

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External Peer Review of Topics Identified as the Scientific Portions of Developing a Maximum Contaminant Levels for 1,2,3-Trichloropropoane (1,2,3-Trichloropropane)

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Background

This review was prepared in response to a request for peer review from the California Water Resources Control Board, Division of Drinking Water. The board is adopting regulations for the man-made chemical, 1,2,3-Trichoropropane (1,2,3-TCP) in state drinking water. These regulations would establish, 1) maximum contaminant levels (MCL), 2) a detection limit that would require that a report be filed with the state (DLR), and 3) the best available technology (BAT) for reducing of 1,2,3-TCP contamination to levels below the MCL.
The proposed MCL and DLR for 1,2,3-TCP in drinking water are both set at 5 nanograms per liter (5 ng/l) or 0.000005 milligrams per liter. The proposed BAT for removal of 1,2,3-TCP is filtration through granular activated charcoal columns. The statutes by which the Board establishes new MCLs and BATs stipulate that scientific portions of the proposal be evaluated by external peer review. The Board identified the four areas addressed below as those requiring independent, external evaluation and assessment. In addition, reviewers were asked to comment on whether the proposed MCL would be protective of human health.

1. Cost Estimation Method/ Approach is Appropriate

The proposal provides a thorough and detailed analysis of the cost associated with the installation and operation of Granular Activated Charcoal filtration that could reduce 1,2,3-TCP levels in drinking water below the proposed MCL and DLR. As required, the cost estimates were done over a range of different MCLs. The estimated cost associated with each MCL is then compared to the predicted reduction in excess cancers in the exposed populations (Appendix 2A). The method used to calculate costs was estimated assuming wells with a source concentration of 150 nanograms/liter.

The comparison of cost analyses across a variety of MCLs in relation to possible reduction in cancer risk is presented in in the graph form (*note: a detailed Figure legend should be provided in the final version of the proposal*). The results of the cost comparison indicates an almost linear increase in costs as the proposed MCL decreases, with a possible increase slope as the proposed MCL is reduced to 15 ng/l or lower. The estimates of annual cancer avoided decrease less dramatically as the MCL decreases, and appears to become asymptotic as the proposed MCL drops below 15 ng/l. These estimates would tend to indicate that below an MCL of 15 ng/l, the cost benefit ratio increases significantly, with little additional decrease in cancer risk while cost rise significantly. This observation is, however based on the data as presented in the proposal. Since there was no statistical analysis of the estimates (no error bars or confidence limits presented on the graph), it is difficult to assess whether changes in the slope of the line are real or perceived. It would be helpful to estimate the confidence intervals for both the cost estimates and the annual cancer avoided calculations. Nonetheless, the data presented indicated that decreasing the MCL from 15 to 5 ng/l increases costs significantly. The proposal indicates that based on an abundance of caution and sensitivity of currently availability, accredited technologies to accurately determine the level of contamination, the state should mandate a MCL of 5 ng/l,. Although fairly conservative, the proposed MCL is not unreasonable and is in line with those set by other states (e.g., New Jersey).

It is important note to that the cost estimates presented are an underestimate of the costs that would be incurred if sampling and analysis were to be performed using approaches standard in analytical chemistry. The reports and cost estimated all indicate that when water samples are taken, they comprise a single one liter aliquot of the drinking water. Repeated samples are only done of there is a level of 1,2,3-TCP above the MCL. This is problematic for several reasons. While the commercial certified laboratories no doubt perform the analysis in triplicate, these represent technical replicates. The standard practice in analytical chemistry is to also perform sampling in triplicate. This not only allows for statistical analysis of the variance, but controls for difference in levels due to sampling and handling of the samples. This is particularly important when the level of contamination is close to the MCL or DLR. As will be discussed in Review Item #2 below, the proposed MCL and DLR of 5 ng/l are at the limit of quantitation by the approved methods (EPA 504.1). In this case the variance around the detection limit is crucial, as a single value could be below the DLR due to experimental parameter including but not limited to, actual variations in samples taken, sample extraction efficiency, sample handling, sampling errors, laboratory contamination.

Moreover, it is possible that contaminant levels could vary across the day as water flow changes. It might therefore also be useful to take the samples at different times of the day. The net effect of performing cost analyses using a single sample is a three-fold underestimate in the cost of performing the chemical analysis. A justification for performing single sample analyses should therefore be provided.

2. A DLR of 5ng/l is the most appropriate DLR with respect to available analytic methods and statutory requirements.

1,2,3-TCP, a probable **human** carcinogen (IARC), has been detected in numerous drinking water wells in California and is therefore a health concern. Although both the EPA and the State are in the process of developing regulations, there is currently no Federal standard for acceptable levels in drinking water. The USEPA considers 1,2,3-TCP to be a carcinogenic VOC and is therefore included in the included in the unregulated included in the unregulated carcinogenic volatile organic compound rule (UCMR3). The current reporting level at the national level is set at 30 ng/l. However, the State is required to use the public health goal of 0.7 ng/l set by the California Office of Environmental Health and Standards Assessment in establishing a MCL and DLR for 1,2,3-TCP. The state is mandated to set the MCL and DLR at levels as close as possible to the level set by the COEHSA as possible, given prevailing quantitation limits available using approved methods available from ELAP-certified commercial laboratories.

Given that 1,2,3-TCP is a probable carcinogen, it is appropriate to reduce the amount present in drinking water. At the present time, the limit of quantitation using EPA approved methods in ELAP certified commercial analytical laboratories is 5 ng/l. It is therefore logical to use this as the DLR for reporting to the State, so that appropriate actions can be taken to mitigate levels in drinking water. However, it is important that an adequate number of replicate water samples are analyzed to ensure that the levels detected are reproducible and are subjected to appropriate statistical analysis. This would eliminate the possibility of samples that are at or exceed the DLR from being classified as acceptable.

There is also a problem inherent in setting the DLR at the limit of quantitation. Any levels that are even marginally below the limit of quantitation are assumed to be outside the range where measurements are accurate. If levels close to the DLR are detected, it might be useful top repeat the analysis on a larger sample volume. At a minimum, the reproducibility of the result should be verified by statistical analysis of levels detected in multiple samples. It might also be useful to sample the water at different times of the day when usage is significant different. Alternatively, facilities might voluntarily report and replace GAC when 1,2,3-TCP levels approach the DLR at the 75% sampling port in the GAC column. This approach was in fact used by one of the facilities for which operating reports were provided in the proposal.

It should also be noted that more sensitive assays are currently available for measuring 1,2,3-TCP in drinking water, some of which can quantify 1,2,3-TCP at the PHG recommended level. Since these are currently not available in commercial ELAP-certified laboratories, the current proposal is not to accept data from these analyses. This seems counterproductive. As long as the laboratories performing the analyses follow accepted procedures for Quality Control and Quality Assurance, the results generated should be considered, at least for the purposes of triggering further evaluation in certified laboratories.

Grandfathering of test results performed prior to the establishment of the sate MCL and DLR is appropriate, as long as the results were obtained in an accredited laboratory using approved methods.

3. Methods used to estimate reduction in annual theoretical cancer cases for each drinking water source contaminated with 1,2,3-TCP is appropriate

The method used for estimating the reduction in cancer risk for each drinking water source contaminated with 1,2,3-TCP is driven by the PHG level of 0.7 ng/l. The PHG takes into account exposures from other sources including inhalation during showers and other household water uses. The calculation averages all source monitoring results for each well. While this is a reasonable approach the data indicated that the levels in some wells have actually been increasing. Using the average of past contamination levels, without modeling the effects of increasing trends may actually underestimate to reduction in cancer risk for those wells moving forward.

Since the calculations exclude wells whose levels of the contaminant are below the MCL, the total number of exposed individuals could be significantly underestimated. Including wells with lower levels would increase the size of the exposed population. Including individuals exposed to lower levels would be appropriate, since the PHG guidance suggests that the goal is approximately 7-fold below the MCL (small attributable risk in large population). By contrast, the focus on wells above the MCL could overestimate the reduction in the population receiving the highest doses. While this would seem to be a laudable goal, the affected population size above the MCL actually very small relative to the desired reduction in caners per million persons exposed for 70 years (large attributable risk in a small population). It is therefore unclear if estimating reduction in cancer risk using only those exposed to levels above the MCL provides an accurate estimate of the population risk across all wells. However, given the dearth of certified data at levels below the DLR, the method used may be the only method using simple calculations. Nonetheless, it might be useful to model the reductions in the entire fraction of the populations that receives the bulk of their drinking water from wells assuming different levels of contamination at the source, beginning at the PHG.

The calculated reduction also fails to take into account any population or exposure specific variables such as the age of those exposed and actual amounts consumed in specific communities. Give the relatively small number of individuals served by any specific well, failure to consider these variables could skew the results for individual wells.

The risk parameter was calculated using the PHG-derived potency factor of one excess cancer per million persons per 70 years divided by the PHG (0.00142857). This is reasonable.

4. Granular activated charcoal (GAC) is the best available technology (BAT) for the removal of 1,2,3-TCP

The report evaluated three methods that can be used to reduce the level of 1,2,3-TCP in water from contaminated wells. These include the use of blending water supplies to reduce levels below the DRL, use of air strippers and filtration through GAC columns. Based on the characteristics and limitations of each (see below), it was concluded that GAC was the only viable method for drinking water treatment. The proposed use of Granular Activated Charcoal for treatment of 1,2,3-TCP contaminations in well water is appropriate, with certain limitations and caveats.

- **Blending.** The use of water supply blending to reduce 1,2,3-TCP levels below the DLR is not a viable method of mitigating contamination. While blending can reduce levels in drinking water to approach to meet regulatory requirements and reduce individual exposures, it does not address the issue of contamination. Hence, blending should only be used in special cases, and then only as a short-term measure. The problem is that there is a potentially false sense of security in reducing the levels of the contaminant below the DLR. Regulatory standards such as MCLs or DLRs are not a magic number below which there is no risk. The standards are based on risk assessments using estimates of hazard and exposures derived from the best data available at the time. They are designed to limit the incidence of a particular disease endpoint to a designated level, in this case, no more than one additional cancer per million people exposed. Blending to meet regulatory requirements would only distribute the risk over a larger population. Moreover, the most of the contaminant would presumably be returned to the environment.

  As an example, the 2010 Performance Report for the Lante Plant in Baldwin, CA, indicated that 1,2,3-TCP uses a combination of air stripping, GAC and blending to ensure that the levels of 1,2,3-TCP are below the DLR of 5.0 ng/l. In 2010, 1,2,3-TCP was detected at a level of 5.2 nanograms/liter. This prompted a report to the Sate Water Board, precipitating a shutdown and remediation of the GAC facility. However, if the level had for example been 4.8 ng/l, there would have been no requirement for reporting to the State. This is problematic because in reality the 4.8 and 5.2 are probably within the error of the assays used to measure the 1,2,3-TCP levels (this issue is addressed in greater detail in the response to Review Item #2 below). A recent calculation at a water facility estimated that reaching the DLR by blending would have required a 17-fold dilution, which was not feasible. In summary, while blending is in general acceptable, its sole purpose should not be to reduce 1,2,3-TCP to levels below the DLR.

- **Air Stripper**

Air strippers are an efficient method for removal of volatile organic compounds. The basic principle is the differential solubility of the compound in water versus air. As water moves down a column with a countercurrent of air, volatile compounds exchange from water into the gas phase, reducing the levels in water. Disadvantages of this method include the need to then remove contaminants from the air before release into the environment, particularly in the case of carcinogens, and the differential efficiency in removal of volatile organic based on Henry's Law. Compounds with low solubility in water are removed efficiently while those with relatively higher solubility are poorly removed. A typical stripper removes approximately 50% of 1,2,3-TCP dissolved in water. Thus, even ten air stripper columns were used in series would only reduce the 1,2,3-TCP to 0.01% of the original levels. This level of reduction would be inadequate if 1,2,3-TCP were present at the levels detected in the wells evaluated in the proposal.

Granular Activated Charcoal. GAC columns, especially those derived from coconut shells, are a highly effective and efficient method for removal of 1,2,3-TCP from drinking water. Real world studies of functioning wells evaluated in the proposal clearly demonstrated the ability of a single column (30 feet tall and 10 feet in diameter) to reduce 1,2,3-TCP levels in well water that are significantly above the DLR, down to levels that are not detectable using approved analytical methods. Moreover, the GAC method can be combined in series with other methods including air strippers, ion exchange columns and LEUV systems to remove other contaminants.

Although the GAC is clearly the best available method for removal of 1,2,3-TCP, it does have operational limitations and potential problems, all of which were addressed in the addressed in the proposal and were, for the most part, included in the cost estimates. These include the following:

1. GAC has the ability to concentrate nitrates, which will elute during the first 90 minutes of restarting the system. These contaminants must be monitored, captured and mitigated before allowing filtered water to enter the drinking water supply. This requires capture basins and the costs they incur.
2. Charcoal beds are prone to microbial contaminations that must be monitored, and appropriate disinfection applied when microbes are present at specified levels.
3. GAC will also remove other organic contaminants with high efficiency. Many will have higher binding affinities than 1,2,3-TCP, leading to saturation of charcoal beds and necessitating their frequent replacement. Studies presented in the proposal indicated that use of air strippers up front greatly reduces the presence of VOCs and extends

the bed life of GAC columns. This combination is highly recommended for other sites with multiple organic contaminants.

4. The level of contamination in the well water may vary over time depending on the season, water use and drought conditions. It is therefore useful to monitor the GAC bed for saturation, so that replacement occurs prior to contaminant breakthrough.

5. The preliminary staff recommendation of a Maximum Contaminant Level of 0.000005 milligrams per liter (or 5 nanograms per liter) would be protective of human health.

The International Agency of Cancer Research has classified 1,2,3-TCP as a probable human carcinogen (type 2A) based largely on animal data. Although there is inadequate human data, there is a large body of evidence for carcinogenicity at multiple sites and in multiple species of experimental animals. It is therefore reasonable to assume that this man-made genotoxic chemical will also be carcinogenic in humans. An abundance of caution should therefore be used in setting guidelines that minimize human exposures. 1,2,3-TCP has been detected in numerous wells in the state of California. After evaluating recently data, the California OEHSA has determined that minimizing cancer risk due to 1,2,3-TCP in drinking water requires reduction of this carcinogen to levels below 0.7 ng/l. This PHG is expected to reduce to number of additional tumors due to 1,2,3-TCP in drinking water to less than one per million persons exposed over 70 years. This is a very stringent requirement that should adequately protect the populations using contaminated wells for drinking water.

While analytical methods for detection of 1,2,3-TCP at and below the PHG are currently available, they are primarily used in research setting. In setting an MCL and DLR for a chemical, regulators must take into account the sensitivity of the assays currently available in commercial ELAP-certified testing laboratories. Using EPA-approved protocols, the limit of quantitation is currently set at 5 ng/l. This level of 1,2,3-TCP was proposed as the MCL and DLR for drinking water from underground wells in California. The same MCL is being used in other states other states including New Jersey. By contrast the United States EPA has proposed a DLR of 30 ng/l. Thus, the proposed MCL and DLR are 6-fold below the USEPA reporting level and 7-fold higher than the PHG for California. The question is whether this intermediate MCL provides any additional reduction in cancer risk relative to the USEPA target. According the graph showing calculated number of cancer avoided as a function of the MCL (presented in Attachment 2A), there would appear to be a slight reduction in excess cancer by reducing the MCL from 30 to 5 ng/l), albeit at almost twice the cost. As already indicated in the Review Items above, these calculations are probably underestimating the costs of testing, while possibly overestimating the health benefit by only considering the populations with the highest potential exposures. The calculations presented do not include any confidence limits, making it difficult to discern potential variability in the cost and potential benefits.

The report also proposed Granular Activated Charcoal as the only viable method for removing 1,2,3-TCP from contaminated well water. This conclusion is strongly supported by engineering and technical performance reports from individual wells. Although no specific data were presented, it is likely that well water treated with GAC with no detected 1,l2,3-TCP (ND) may actually have levels below the MCL and the PHG level. Assuming this is the case, it is valid to ask how many additional cancers would be prevented if GAC actually reduced levels well <u>below</u> the MCL. Based on a simple extrapolation of the graph provided in

Attachment #2, the effect would not appear to be large due to the asymptotic shape of the curve. If this is indeed the case, then setting the MCL at 5ng/l would be almost as effective as attaining the PHG.

The findings on the whole support the conclusion that the use of BAC to reduce 1,2,3-TCP levels in drinking water to a MCL of 5ng/l, with a DRL of 5 ng/l would provide adequate protection of populations who obtain drinking water from contaminated wells. A caveat of this interpretation is again the lack of confidence limits in the calculated values used to estimate costs and reduction of excess cancers. In addition, BAC may have the additional benefit of reducing levels of other organic compounds that have adverse health effects.

**The opinions and conclusion presented in this report were developed through my own scholarly capacity after examination of all documents provided and other reference materials. The statements and opinions expressed in this document in no way reflect the opinions of, or imply agreement, endorsement or support from any members or components of Rutgers University or the National Institute of Environmental Health Sciences.*