Appendix C.

Peer Review Reports and Multimedia Workgroup Response to Peer Review Comments

External Peer Review of the Scientific Basis of the Multimedia Working Group's Assessment of the E15 Multimedia Evaluation

Prepared by:
Dr. Joshua S. Apte, PhD
Associate Professor
Department of Civil and Environmental Engineering &
Division of Environmental Health Sciences, School of Public Health
University of California, Berkeley

661 Davis Hall, UC Berkeley, Berkeley CA 94720
apte@berkeley.edu

Submitted: 28 May 2025

External Peer Review
The Scientific Basis of the Multimedia Working Group's Assessment of the E15 Multimedia Evaluation

Based on my expertise and experience, I am reviewing the findings, assumptions, or conclusions I agreed I could review with confidence, which include the:

1. Air emissions evaluation
3. Public health evaluation

For the public health evaluation, because my relevant expertise focuses principally on exposure assessment, I am focusing my review attention on issues related to exposure pathways / exposure assessment. I do not believe I am best qualified to comment on the toxicological aspects of the public health evaluation.

Summary: The Multimedia Working Group assessed the multimedia impacts on public health and the environment of using E15 motor vehicle fuel (85% gasoline by volume; 15% ethanol), as contrasted against the present practice of using E10 (i.e, 90% gasoline, 10% ethanol). I reviewed the portions of the report that correspond to my expertise on air emissions, air quality, and public health.

Overall, I found the report to be careful and thorough, using methods that align well with commonly accepted scientific practice. Based on the evidence provided in the report, the overarching conclusions in the areas I reviewed (air emissions, public health) were well supported and reasonable, and are based upon sound scientific knowledge, methods, and practices. I therefore am supportive of the conclusions presented here.

Minor comments and critiques:

Lifecycle perspective: One area where the multimedia evaluation could be strengthened has to do with the scope of the assessment. To my understanding, this assessment only considers activities associated with the distribution, dispensing and usage (combustion) of E15 fuel. Other important phases of the fuel cycle that may also have important atmospheric or public health implications include (but are not limited to) those related to the extraction, production, and refining of fuels.[1] I recognize that a complete multimedia life-cycle impact assessment that fully considers the full impacts of these and other

[1] Grand Challenges for Life-Cycle Assessment of Biofuels. T. E. McKone, W. W. Nazaroff, P. Berck, M. Auffhammer, T. Lipman, M. S. Torn, E. Masanet, A. Lobscheid, N. Santero, U. Mishra, A. Barrett, M. Bomberg, K. Fingerman, C. Scown, B. Strogen, and A. Horvath *Environmental Science & Technology* **2011** *45* (5), 1751-1756. DOI: 10.1021/es103579c

phases may be outside of the scope of the present assessment. Nonetheless, it may be worthwhile to provide a detailed but qualitative discussion of where these other components of the E10/E15 lifecycle might align with or deviate from the direction of the core analytical conclusions presented here.

Exhaust emissions testing: The extensive exhaust emissions testing undertaken at CE-CERT laboratories is impressive and is a clear strength of this study. As a very minor quibble, for considering lifecycle greenhouse gas impacts of biofuels, the tailpipe CO_2 emissions alone offer an insufficient perspective – in general, a major way that a higher share of ethanol blending would impact lifecycle GHG emissions would be from the different (and ideally lower) carbon intensity of biofuel feedstocks relative to petroleum feedstocks. It might be helpful to offer some context about this in Appendix C, section 3.A.2.ii (page 43 of the PDF).

Carbon intensity of E10 vs. E15: Tier 1 report, section 2.5, Pg. 7 (PDF page 79 of merged review document. I wish to comment on the following excerpt:

> *There are presently over 200 currently certified LCFS pathways for ethanol production with CI values ranging from 21.93 to 77.34 gCO2e/MJ. In comparison, CARBOB has a carbon intensity of 100.82 gCO2e/MJ. Thus, replacing CARBOB with ethanol will reduce carbon emissions from between roughly 20 to 80%, a significant reduction.*

As phrased, I found this statement in the Tier 1 report to have the potential to be misleading, because under the contemplated adoption of E15, only a small fraction of the fuel volume (~5%) would be replaced. Based on the stated statistics above, transitioning from E10 to E15 would likely lead to only a 1-4% reduction in the fuel carbon intensity. (Yes, the portion of the fuel that is being substituted would have a substantially lower carbon intensity, but that portion being substituted is very small).

Peer Review Report

Andrea De Vizcaya Ruiz, PhD

Professor

Department of Environmental and Occupational Health

Joe C. Wen School of Population and Public Health

University of California Irvine

May 26, 2025

"**SCIENTIFIC BASIS OF THE MULTIMEDIA WORKING GROUP'S ASSESSMENT OF THE E15 MULTIMEDIA EVALUATION**"

Based on my expertise and experience, I am reviewing the findings, assumptions, or conclusions I agreed I could confidently review the E15 Multimedia Evaluation that aims to provide information to assess whether the new E15 fuel specification would lead to any significant adverse impacts on public health or the environment. This assessment is based on determining if the scientific foundation of the proposed rule relies on sound scientific knowledge, methods, and practices. I am an inhalation toxicologist focusing on air pollution and environmental health, studying the impact of airborne particulate matter (PM) and other inhalant toxicants on respiratory health and disease. I am pleased to have had the opportunity to review this document and provide my technical perspective.

After reviewing the three attachments of the Request for External Peer Review of the Scientific Basis of the Multimedia Working Group's Assessment of the E15 Multimedia Evaluation and the Written Summary of the California Multimedia Evaluation of E15 Prepared by the Multimedia Working Group (MMWG) dated April 2025, I am confident that the review and methods are based on sound science and represent a thorough analysis of the scientific methods and results derived from the studies included. The document provides a thorough scientific analysis based on a relevant and adequate collection of peer-reviewed studies and data. It presents a well-reasoned and comprehensive evaluation of the research methods and outcomes.

I have summarized my findings and comments in the paragraphs below, starting with the three attachments of the Request_E15 Peer Review - Revised 04.28.2025 document and continuing with the Written Summary - Multimedia Evaluation of E15 document.

Request E15 Peer Review - Revised 04.28.2025 document

Attachment 1 – Plain English Summary of the E15 Multimedia Evaluation.

Well-written summary in clear, plain English that describes what E15 fuel blend is and how it is generated. It describes the expected content of the "*Written Summary: Multimedia Evaluation of E15*" which anticipates to include multiple appendices providing all the documentation supporting the summary and the Multimedia Working Group assessment of E15 multimedia evaluation and analysis, including the Tier III Report that anticipates that "E15, as considered within the scope of the evaluation will not cause a significant adverse impact on public health or the environment."

Comment: The Plain English Summary would benefit from briefly explaining the Tier process, as described in the "Guidance on the Scientific Information for California Fuels Environmental Multimedia Evaluations," version 4.0, March 6, 2016. Section 2.3, page 15, and Table 2.1, page 16, of this document describe the Summary of the Three Tiers of the Multimedia Risk Assessment Process. Here, the reader will understand that the multimedia process entitles a multi-step process: Tier I includes the fuel's origin, chemistry, and environmental behavior; Tier II provides information on key risk assessment elements; and Tier III focuses on multimedia risk assessment.

Attachment 2 – Description of Scientific Conclusions Anticipated to be Addressed by Peer Reviewers.

This attachment describes the MMWG's Conclusions from the *Written Summary: Multimedia Evaluation of E15*. I reviewed *Conclusion #1. Air Emissions Evaluation* and *Conclusion # 3. Public Health Evaluation*, so that I confirm they are based on sound scientific knowledge, methods, and practices.

Conclusion #1. Air Emissions Evaluation. California Air Resources Board (CARB) staff assessment indicates that with fuel specifications and requirements, E15, as specified in the multimedia evaluation and proposed regulation, does not pose a significant adverse impact on public health or the environment from potential air quality impacts. CARB staff completed a comparative air quality assessment of E15 fuel relative to E10 gasoline. CARB staff made conclusions based on their assessment of various emissions test results and air quality data, including regulated emissions, toxic air contaminants and evaporative air emissions.

Comment: Would this be true regardless of the age of the vehicle and temperature at the start of the fuel combustion process? Maybe add "in the general vehicle fleet in California under standard conditions", "after *emissions test results ….".*

Conclusion # 3. Public Health Evaluation. Office of Environmental Health Hazard Assessment (OEHHA) staff assessment indicates that the substitution of E15 for E10

shows a general decrease in levels of ozone-forming compounds, particulate matter, some volatile organic compounds (VOCs), and other contaminants of concern to human health. However, E15 use may increase tailpipe emissions of a few VOCs, such as ethanol and acetaldehyde. Overall, OEHHA did not find evidence of significant adverse impacts on human health from the use of E15 compared to E10. The Tier Reports support the approval of E15, based on significant environmental benefits, reduced greenhouse gas emissions, and no expected significant new public health risks compared to E10. OEHHA staff evaluated potential public health impacts from the use of E15 based on review of the Tier Reports, Final Tier I (published), Tier II (under review published) and Tier III Reports (under review) and focused on the comparison of toxicity between E15 and E10.

Comment: The consideration of revising long-term exposures and the impact on the general population and health equity should be incorporated and communicated within the conclusion. The comparisons of adverse effects on health between exposure to E10 and E15 are based on the available scientific evidence indicating minimal or no effects on short-term and single exposures. Providing *"E15 use may increase tailpipe emissions of a few VOCs, such as ethanol and acetaldehyde.*", long-term and cumulative exposures to E15 emissions have not yet been evaluated and are essential to be considered; this should be communicated to the public. The recommendation is to say in the conclusion that continued monitoring of ambient air concentrations of ethanol and acetaldehyde under real-world conditions will be carried out, as well as incorporate the evaluations of the health impacts on sensitive and disproportionate populations.

Attachment 3 – Authors, Researchers, Reviewers and Participants involved in the E15 Multimedia Evaluation (MME)

The list of California Government Agencies and individuals who participated in the E15 Multimedia Evaluation is described.

Comment: I found no issues and do not have comments on the information presented here. I appreciate including the note: * *No person may serve as an external scientific peer reviewer for the scientific portion of the multimedia evaluation if that person participated in the development of the scientific basis or scientific portion of the multimedia evaluation.*

Written Summary - Multimedia Evaluation of E15 document

The *Written Summary - Multimedia Evaluation of E15* is a clear and well-organized document containing reports on the E15 multimedia evaluation and potential impacts on public health and the environment. It includes the supporting documentation and summarizes a thorough review of the MMWG's assessment of the E15 multimedia evaluation conducted by Growth Energy and the Renewable Fuels Association (RFA), and the MMWG's analysis of the potential significant adverse impacts on public health

and the environment. The document presents a scientifically robust and methodologically sound review, incorporating an adequate and relevant body of peer-reviewed literature and data sources. It reflects a comprehensive and well-justified evaluation of the study methods and findings.

The document initiates with a short and concise Introduction in Chapter 1, which describes the identity and purpose of the document, explains the fuels multimedia evaluation, and outlines the multimedia evaluation process, including a brief explanation of the multi-step pier process and the multimedia working group. Additionally, it includes a brief overview of the Environmental Policy Council and the peer review process. The document continues with Chapters 2 and 3, where the Evaluation Summaries of the participating agencies and Conclusions, respectively, are presented.

Comment: On page 7, under section *A. California Air Resources Board Evaluation - 1. Health-Relevant Air Emissions*, the report notes that emissions of acetaldehyde and ethanol increase by 32% and 77%, respectively, when comparing E15 to E10 as a function of ethanol content. Since these compounds are classified as unregulated air toxics, it would be recommended to implement continuous monitoring in focus areas where E15 emissions may be higher, such as near freeways or in heavily impacted communities. Such a plan would help determine ambient concentrations, assess the potential for accumulation, and evaluate their contribution to cumulative exposures or co-exposure risks alongside other pollutants. To be included in section 4. Recommendations.

On pages 10 and 11, under section *C. Office of Environmental Health Hazard Assessment Evaluation - 2. Summary of Findings on Comparative Toxicity*, the report concludes that based on animal inhalation studies and in vitro cell-based assays, E15 does not appear to be more toxic than E10. The available data support this conclusion. However, the report could be strengthened by recommending future research on the long-term, low-dose toxicological effects of chronic exposure to emissions from these fuel blends. In particular, studies aimed at elucidating mechanistic toxicity pathways remain limited and should be prioritized to better understand potential health risks over time. To be included in section 4. Recommendations.

On page 12, under *Section D. Department of Toxic Substances Control Evaluation*, the strategy for addressing the anticipated increase in ethanol production—encompassing processing, storage, transportation, and byproduct management—is outlined. A critical focus of this section is the need to secure substantially greater volumes of renewable organic feedstock to meet rising demand. This must be achieved through environmentally sustainable practices that avoid deforestation, land degradation, and other harmful agricultural impacts. To be included in section 4. Recommendations.

On page 15, *under Section D. Department of Toxic Substances Control Evaluation, Staff's evaluation focused on: (1) hazardous waste generation during production, use, and storage of E15 in California, and (2) cleanup of contaminated sites in cases of spills of E15.* Given the well-documented environmental persistence and toxicity of BTEX compounds, the generation of BTEX and methane in the context of E15 releases is a relevant discussion, particularly concerning the alteration in soil biodegradation rates of BTEX. Ethanol can serve as a preferred substrate for microbial communities, potentially inhibiting BTEX degradation due to competitive metabolic processes, thereby posing a long-term environmental risk. Furthermore, ethanol-fueled methanogenesis may accelerate under specific geochemical conditions, increasing the risk of greenhouse gas emissions and subsurface vapor intrusion, especially in urban areas with aging infrastructure. Therefore, the understanding that BTEX would degrade more slowly in the environment, leading to statistically longer benzene plumes as ethanol concentration rises compared to E10, suggests a need for new remediation outcomes, considering cleanup complexity and cost.

The document is finalized with the Appendices, which constitute the scientific basis, methods, and practices that support the MMWG's assessment of the E15 multimedia evaluation.

Appendix A. Proposed Fuel Specifications and Appendix B. Members of the Multimedia Working Group.

Comment: I concur with the information provided, found no issues, and do not have comments.

Appendix C. California Air Resources Board: Impact Assessment of E15 on Exhaust and Evaporative Emissions From Light-Duty Vehicles

Comment: On Section *A. Multimedia Evaluation of E15*, page 2, in the second paragraph, the reference to Table 1 from citation 7 should say Table 2.1.

The methods and results are thorough and well-supported, enabling the robust conclusions presented. An adequate discussion with studies published in indexed journals is used to support the results and to highlight warranted evaluations that would improve the findings. The tables describing the results show an extensive comparison of emissions of 20 vehicle makes and models from a wide range of years (Table 1, the driving cycle is shown, and Table 2 describes the difference of percentage in weighted emissions of E15 relative to E1, showing a general reduced percentage of regulated emissions, detailing the most relevant chemicals that are either toxic or GHGs.

The percentage derived from the FTP cycle is presented in mg/mile and is informative when considering the driving cycle comparing E10 to E15 emissions. However, to establish the impact on environmental and health effects, it is also necessary to know the concentration of the relevant chemicals emitted in the air per volume derived from E15 fuels.

In summary, it is recommended to continuously monitor the relevant chemicals, particularly ethanol and acetaldehyde, since their emission levels increased due to ethanol content. A significant difference from E10 to E15 may not be detectable initially, however, over the long term or in specific areas, the differences could have notable environmental and health impacts.

Appendix D. State Water Resources Control Board: E15 Multimedia Evaluation

Comment: This section does not fall under my expertise, and I do not have comments.

Appendix E. Office of Environmental Health Hazard Assessment: The Potential for Toxicity of E15 versus E10 Exhausts

Comment: A comprehensive discussion supported by up-to-date studies from indexed high-impact journals reinforces the findings used for the conclusion. The methods and results are detailed and well-supported. Studies included explore toxicological and mechanistic outcomes comparing E0 gasoline with other gasoline-ethanol content, E15, E85, or different ranges. This provides a comparative discussion, including a range of doses, times of exposure, and emission chemicals in different experimental models, cell-based assays, or animal models. Also, human and ecological risks are considered.

For Public Health impacts, a recommendation for conducting inhalation studies in animals that directly compare the toxicity of E15 and E10 is included. In this sense, an additional recommendation would be to conduct long-term inhalation toxicity studies in animals, where the cumulative and/or co-exposure toxicity implications would be evaluated. Exposing to E15 or higher ethanol-gasoline blends, as well as the emission products, ethanol and acetaldehyde. Additionally, evaluate toxicity outcomes from diseases beyond the lungs, such as cardiovascular and neurological conditions, as well as implications across generations. Furthermore, monitor health implications in sensitive populations, including children, the elderly, and individuals with asthma.

Appendix F. Department of Toxic Substances Control: Recommendation on Proposed E15 Fuel Specifications

Comment: I concur with the information provided.

In point 1 of the staff recommendation, I would emphasize that the critical focus of environmentally sustainable practices for ethanol production should be on renewable organic feedstock, avoiding land degradation, and mitigating other harmful agricultural impacts and deforestation. Strategies to manage this situation should be implemented as soon as possible.

Appendix G. California Multimedia Evaluation of E11-E15 Gasoline-Ethanol Blends Tier III Report by Renewable Fuels Association and Growth Energy

Comment: I concur with the information provided. This Appendix provides the supporting documents that satisfy the scientific foundation of knowledge, methods, and practices.

Peer Review of "California Multimedia Evaluation of E15"

(California Multimedia Working Group Evaluation of the Environmental and Health Effects of Using Gasoline Containing up to 15% Ethanol by Volume)

Review prepared by:

Professor Robert Harley, Ph.D.
Department of Civil and Environmental Engineering
University of California, Berkeley, CA 94720-1710

Date submitted:

May 27, 2025

Introduction

Based on my expertise and experience, I am reviewing the findings, assumptions, or conclusions I agreed I could review with confidence:

1. Air Emissions Evaluation
2. Water Evaluation
3. Public Health Evaluation

Studies of reformulated fuels and air emissions from motor vehicles are core areas of my expertise and experience. Therefore, my level of confidence in serving as a reviewer is highest for the air emissions evaluation. My comments on the water and public health evaluations are more limited in terms of level of detail and scope.

The overarching questions considered by the multimedia working group are the environmental and public health implications of increasing the amount of ethanol blended in California gasoline from 10 to 15% by volume (E10 and E15, respectively).

Comments on Air Emissions Evaluation

There are numerous air pollutants emitted by motor vehicles, from both tailpipe (exhaust) and non-tailpipe sources (e.g., leakage/evaporation of unburned fuel). There are additional upstream emissions associated with growing or extracting needed feedstocks (e.g., cornstarch and crude oil) and refining them into ethanol and gasoline.

Key pollutants of concern include greenhouse gases that contribute to climate change (e.g., carbon dioxide, methane and nitrous oxide), as well as volatile organic compounds, nitrogen oxides, and particulate matter that contribute to local and regional air pollution problems.

Appendix C of ref. 1 presents the California Air Resources Board (CARB) staff's evaluation of the impacts on air emissions of transitioning from E10 to E15. The following conclusions are noted (see ref. 1, p. 14 of main report):

"*Based on the relative comparison between E10 and E15, CARB staff concludes that with fuel specifications and requirements, E15, as specified in the multimedia evaluation and proposed regulation, does not pose a significant adverse impact on public health or the environment from potential air quality impacts. Staff also concludes that emissions of PM, THC and CO are reduced with the use of E15*."

Key cited references include a three-tiered multimedia evaluation of E11-E15 gasoline-ethanol blends (refs. 2-4), and laboratory studies comparing tailpipe exhaust (ref. 5) and evaporative (ref. 6) emissions from California motor vehicles using E10 and E15 fuels.

Need for Broader Discussion. There is only limited discussion in the staff report of multi-media assessment reports submitted by fuel applicants. Some summary and evaluation of findings and conclusions from fuel applicants' multi-media assessment (refs. 2-4) would be helpful. Most of the discussion of these reports that appears in Appendix C (pages 1-3) is about process rather than findings.

(a) What life-cycle effects on greenhouse gas emissions are expected from using E15 in place of E10 in California? See page 20 of ref. 4 where this issued is mentioned. A related question is whether increased ethanol usage will displace California gasoline produced from declining domestic crude oil supplies or rather offset increasing crude oil imports from other countries? Country-specific data for carbon intensities of crude oil produced in foreign countries may be lacking; this uncertainty should be acknowledged and is of increasing importance as California relies more and more heavily on foreign sources of crude oil.
(b) Fuel applicants' assessment reports (refs. 2-4) include discussion of other emission studies that may help clarify or strengthen findings presented in the staff report. The text in the staff report (Appendix C, see pages 3-12) focuses mostly on describing methods and results of CARB-sponsored emission studies (refs. 5 and 6).

CO2 Emissions and Fuel Consumption. Given a lower volumetric energy content of ethanol compared to the petroleum-derived hydrocarbons typically used in gasoline, it is expected that fuel consumption statewide would increase if California were to switch to E15 in place of E10 (ref. 4, page 13, notes a reduction of 1% in fuel economy, which would lead to a similar increase in fuel consumption). This may lead to a small increase in fuel costs for motorists. Other factors in California such as announced plans for refinery closures and increased reliance on imported crude oil may have greater influence on fuel costs and life-cycle greenhouse gas emissions.

Aromatic emissions.

Results for ethylbenzene (see ref. 1, Appendix C, top of page 9) are consistent with findings for the xylene isomers. The percent changes (9 to 11% reductions) and p-values (0.0498, 0.0504, and 0.0649) are similar. Ref. 4 (page 14) is more systematic in grouping these changes and describing them as similar.

The benzene fraction in tailpipe NMHC emissions (6.9 wt%) derived from Table 2 of the staff report (ref. 1) is higher than observed in on-road emission studies (refs. 7-9), for which benzene fractions of ~3.5 wt% are typical.

I agree that adding ethanol to gasoline will dilute its aromatic content. Do staff expect refiners to make other changes to gasoline properties due to the increased ethanol content? This might further reduce the aromatic content of California gasoline. Effects on vehicle emissions of potential gasoline reformulation are not captured by the splash-blended E15 fuel employed for the emission testing described in refs. 5 and 6.

Non-tailpipe emissions. Conclusions about effects on evaporative emission when switching from E10 to E15 are not adequately supported by the brief discussion appearing in the staff report (ref. 1, Appendix C, pp. 10-11).

The laboratory study of E15 impacts on vehicle evaporative emissions (ref. 6) provided useable results for four relatively new vehicles, as summarized in Table 4 (ref. 1, Appendix C, page 11).

- Units of measure are missing from Table 4.
- It may be appropriate to revise the baseline (E10) average result for the Nissan Rogue (see ref. 6) to exclude one anomalous high reading.
- Statistical significance of measured changes is reported individually for each vehicle. An assessment of fleet-average results should be added to compare overall emission rates from all vehicles combined for E10 versus E15 fuels.
- The ability to identify fuel effects on emissions is limited given the small sample (N=5 vehicles, one of which was excluded) tested in ref. 6.

Only diurnal and hot soak evaporative emissions were measured in ref. 6. This is standard practice for emission certification tests. However, potential impacts of fuel changes on other categories of evaporative emissions (i.e., running losses, permeation/resting losses, liquid fuel leakage and refueling emissions) have not been quantified or discussed.

- Are there other lines of evidence or discussion points that address impacts of fuel changes on these other categories of evaporative emissions?
- It would be helpful to mention what change is expected (if any) in fuel vapor pressure in the transition from E10 to E15.

Are there any concerns about increased fuel leakage due to use of E15 in pre-2001 motor vehicles or in off-road engines for which E15 may not be appropriate? More specifically, could fuel leaks occur due to changes in the swelling or sealing properties of elastomeric components in fuel systems of older vehicles and off-road engines?

Conclusions. In the conclusions paragraph quoted above (see also Appendix C of ref. 1, page 14), staff specifically highlight some pollutants for which significant tailpipe emission reductions were found (PM, THC and CO). If findings for specific pollutants are going to be called out in this way, findings of increased emissions of ethanol and acetaldehyde should be mentioned for balance. The finding of no significant increase in vehicular NOx emissions is more important than a decrease in CO emissions. Vehicle-related CO emissions have little relevance to contemporary air quality problems in California. More context is needed when highlighting the finding from ref. 5 that use of E15 decreases total hydrocarbon emissions. The quoted finding is not the whole story because it does not account for fuel effects (or a lack thereof) on non-tailpipe/evaporative emissions of hydrocarbons.

Comments on Water Evaluation

Appendix D of ref. 1 presents the State Water Resources Control Board's staff evaluation of E15 impacts on water quality. I am not an expert on aquatic toxicity, biodegradation or underground fuel storage tank design and certification. Therefore, I have not commented on issues such as older underground storage tanks, subsurface plume lengths, biodegradation rates of ethanol and other gasoline components, or ethanol toxicity to aquatic organisms.

In response to the staff conclusion about release scenarios for E15 being the same as for E10, I pose the question of whether fuel spillage or leakage rates may increase from older vehicles (i.e., pre-2001 model year) and off-road engines (e.g., watercraft operating on California lakes, reservoirs, and other waterways) under use cases where E15 has not been certified as appropriate.

Comments on Public Health Evaluation

Appendix E of ref. 1 presents the Office of Environmental Health Hazard Assessment (OEHHA) staff evaluation of the potential for toxicity of E15 versus E10 exhausts. I am not an expert in toxicology, so I have limited my comments and questions to emissions and exposure assessment-related issues in reviewing OEHHA's evaluation and conclusions.

On page 2 of Appendix E, there is a statement that evaporative emissions occur primarily from refueling emissions (e.g., from spills and direct vehicle emissions). This could be true for working losses (vapor displacement as liquid fuel is added to vehicle fuel tanks). However, there are other modes of evaporative emissions including diurnal/breathing losses and running losses, and these emissions occur elsewhere.

I don’t agree with the statement that evaporative emissions occur primarily at service stations, although service stations may still be an important source location in terms of human exposure to gasoline vapors.

At the top of page 7 of Appendix E, it is noted that the percent volumes of benzene in E15 and E10 are expected to be 1.04 and 1.10, respectively. I question whether these expectations are realistic specifically for California gasoline, for which a flat limit of 1.0 vol% on benzene content in gasoline was established in 1996. Measured benzene levels in California gasoline samples in prior studies indicate benzene levels well below 1% since 1996. For example, ref. 8 reports benzene levels of 0.6 wt% benzene in gasoline samples collected in 1996, 1999, and 2001. Ref. 10 reports benzene levels of 0.4 vol% in California gasoline with MTBE as the oxygenate in 1996 and 1997, and ref. 11 reports benzene levels of 0.46-0.56 wt% in three California gasoline samples from 1999 with differing levels of ethanol as the oxygenate. Benzene has a higher liquid density than gasoline overall, so benzene fractions reported in wt% units will decrease when converted to vol% units.

On Page 7, it is noted that use of E15 in place of E10 as fuel leads to 77 and 32% increases in tailpipe emissions of ethanol and acetaldehyde, respectively. It is further noted that both OEHHA and US EPA have cancer and non-cancer inhalation exposure standards for acetaldehyde, and that without additional information about projected changes in air concentrations, OEHHA is unable to assess the resulting change in risk to humans and the environment from the increase in acetaldehyde emissions. This is an unfortunate analytical gap in the overall assessment of E15. Added complexities arise in this case because acetaldehyde is not only emitted directly from vehicular and other sources but also forms as an atmospheric oxidation product of other organic compounds (e.g., ethane and propene). Therefore a 32% increase in tailpipe emissions of acetaldehyde does not mean that human exposure to acetaldehyde in inhaled air will increase by the same proportion.

References

(1) California Multimedia Evaluation of E15. Report by the Multimedia Working Group, State of California Environmental Protection Agency. April 2025.

(2) California Multimedia Evaluation of E11-E15 Gasoline-Ethanol Blends: Tier I Report. Renewable Fuels Association and Growth Energy, June 2020.

(3) California Multimedia Evaluation of E11-E15 Gasoline-Ethanol Blends: Tier II Report. Renewable Fuels Association and Growth Energy, June 2023.

(4) California Multimedia Evaluation of E11-E15 Gasoline-Ethanol Blends: Tier III Report. Renewable Fuels Association and Growth Energy, March 2024.

(5) Karavalakis, G., Durbin, T.D., & Tang, T. Comparison of Exhaust Emissions Between E10 CaRFG and Splash Blended E15. Report to the California Air Resources Board by UC Riverside College of Engineering Center for Environmental Research and Technology (CE-CERT), June 2022.

(6) Comparison of Evaporative Emissions Between E10 CaRFG and Splash Blended E15. Report to the California Air Resources Board by Automotive Testing and Development Services, Inc., January 2022.

(7) Gentner, D.R. et al. (2013). Chemical Composition of Gas-Phase Organic Carbon Emissions from Motor Vehicles and Implications for Ozone Production. *Environmental Science & Technology* **47**, 11837-11848.

(8) Harley, R.A. et al. (2006). Effects of Reformulated Gasoline and Motor Vehicle Fleet Turnover on Emissions and Ambient Concentrations of Benzene. *Environmental Science & Technology* **40**, 5084-5088.

(9) Kirchstetter, T.W. et al. (1999). Impact of California Reformulated Gasoline on Motor Vehicle Emissions. 2. Volatile Organic Compound Speciation and Reactivity. *Environmental Science & Technology* **33**, 329-336.

(10) Kirchstetter, T.W. et al. (1999). Impact of California Reformulated Gasoline on Motor Vehicle Emissions. 1. Mass Emission Rates. *Environmental Science & Technology* **33**, 318-328.

(11) Harley, R.A. et al. (2000). Relating Liquid Fuel and Headspace Vapor Composition for California Reformulated Gasoline Containing Ethanol. *Environmental Science & Technology* **34**, 4088-4094.

Review of “California Multimedia Evaluation of E15”

Reviewer: Christopher I. Olivares Martinez
Affiliation: University of California, Irvine

Date: May 29, 2025

CalEPA Peer Review Program,

Please find below my review of the California Multimedia Evaluation of E15.

Summary of expertise of reviewer: As an Assistant Professor of Civil & Environmental Engineering at the University of California-Irvine, I am an expert in remediation of organic contaminants, including benzene, toluene, ethyl-benzene, and xylenes (BTEX) and organic substrates, such as ethanol in the E10 and E15 gasoline blends. Based on this expertise, I provide my review of the findings for the California Multimedia Evaluation of E15.

1. Air Emissions Evaluation: While my expertise is not air quality, my expertise extends to physicochemical properties of organic chemical compounds, including those that compose E15 formulation. After reviewing the evaluation, I agree with the report that there are comparable emissions to existing E10 gasoline blends.

2. Water Evaluation: Water quality and remediation of organic compounds are my main areas of expertise. I concur with the findings that there are minimal added risks comparing E15 to E10 fuel blends. The report mentions potential elongation of groundwater contaminant plumes because of added ethanol content in E15. In my opinion, although a possibility, these impacts might be relevant only in very large accidental releases of E15.

3. Public Health Evaluation: While I am not a public health expert, my expertise on remediation of organic contaminants is based on general understanding of toxicological impacts of these pollutants. I concur with the report findings

identifying a potential slight increased exposure to formaldehyde formed during combustion of E15 (for example, tailpipe emissions). Like the report outlines, additional toxicological experiments would be beneficial to understand if these potential impacts are relevant to public health.

4. Soil and Hazardous Waste Evaluation: I am an expert in remediation of organic contaminants, which allows me to assess soil and hazardous waste management. I concur with the report findings that the increased ethanol might elongate groundwater plume because ethanol could act as a cosolvent for BTEX. Furthermore, while it is possible that degradation of E15 might be slightly faster than E10 because of the increased ethanol content, biodegradation of light fraction hydrocarbons in gasoline is widespread in most aerobic soils. The identified potential risk of methane release would only be relevant to very large accidental releases and under anaerobic conditions.

Regards,

Christopher I. Olivares Martinez, PhD
Assistant Professor, Civil & Environmental Engineering
Associate Director, UCI Water Energy Nexus Center
Samueli School of Engineering, University of California, Irvine

May 29, 2025

Dr. William C. Porter
Assistant Professor
Department of Environmental Sciences
University of California, Riverside

Peer Review Commencement Regarding the Scientific Basis of the Multimedia Working Group's Assessment of the E15 Multimedia Evaluation

Based on my expertise and experience, I am reviewing the findings, assumptions, or conclusions I agreed I could review with confidence:

Conclusion # 1: Air Emissions Evaluation

"Air Emissions Evaluation. California Air Resources Board (CARB) staff assessment indicates that with fuel specifications and requirements, E15, as specified in the multimedia evaluation and proposed regulation, does not pose a significant adverse impact on public health or the environment from potential air quality impacts."

The potential approval of E15 fuel represents an incremental change relative to the previously approved E10 ethanol mixture, increasing the relative proportion of fuel grade ethanol by roughly 50%. Considering the previous full evaluation and approval of E10 fuel, it would be reasonable to suppose that an increased fraction of ethanol would likewise be found to pose no significant threat of increases in harmful emissions. However, without comprehensive testing, the possibility could remain for unexpected interactions or non-linear changes in real world emissions. For this reason, the emissions testing described here fills a key knowledge gap with respect to the air quality changes that could be expected with the proposed increase in ethanol fraction in California fuel. Test procedures appear to be well-planned and thorough, using established best practices for testing on a diverse set of representative light duty vehicles.

Results of these emissions tests are consistent and unambiguous: an increase in ethanol fraction from E10 to E15 fuels would be expected to offer *no significant increases* in harmful air pollution related to exhaust or evaporative emissions. Several key species categories, including PM, CO, and THC, showed statistically significant reductions from the switch to E15 fuel, while others, such as NOx, showed no significant change. Emissions of ethanol and acetaldehyde showed higher emissions from E15 fuel, but these increases were offset by reductions to other VOCs, in particular the carcinogen benzene, making the switch a net improvement in terms of criteria pollutant precursors. To my knowledge there is no reason to believe that these increases in specific VOC species should be considered an air quality threat in the context of reductions to total VOC emissions.

In summary, I find Conclusion #1 to be justified and well supported.

Conclusion # 3: Public Health Evaluation

"Public Health Evaluation. Office of Environmental Health Hazard Assessment (OEHHA) staff assessment indicates that the substitution of E15 for E10 shows a general decrease in levels of ozone-forming compounds, particulate matter, some volatile organic compounds (VOCs), and other contaminants of concern to human health. However, E15 use may increase tailpipe emissions of a few VOCs, such as ethanol and acetaldehyde. Overall, OEHHA did not find evidence of significant adverse impacts on human health from the use of E15 compared to E10."

To further assess the potential for additional health risks resulting from this proposed fuel change, and as an extension from their previous assessment of E10 health risks, OEHHA has performed a thorough review of findings relevant to E15 ethanol increases. While I am not able to comment with authority on the strictly toxicological aspects of their report and conclusions related to exposure studies, I find their evaluation of expected impacts on primary and secondary criteria pollutants to be robust and well founded. Based on my understanding of atmospheric chemistry, relevant literature, and the forementioned emissions comparisons, I agree that a switch from E10 to E15 fuels would be expected to generally reduce both primary and secondary pollutants, all else being equal, and would not pose a threat to human health.

In summary, I find Conclusion #3 to be justified and well supported.

Additional notes

The four conclusions under review related to this proposal are all important and relevant to public and environmental health, and I greatly appreciate the care with which they have been made. I do note the absence though of other questions that have been previously examined with respect to the long-term sustainability of ongoing increases in bioenergy crop cultivation, including implications on land-use, irrigation, and fertilizer demands of said crops. While from a tailpipe emissions perspective the proposed increase in ethanol fuel fraction offers many benefits and no substantial drawbacks, I do remain concerned about the big picture of ethanol production increases and what they could mean for food security, water security, environmental justice, and a holistic accounting of climate change impacts (see for example Lark et al., 2022).

T.J. Lark, N.P. Hendricks, A. Smith, N. Pates, S.A. Spawn-Lee, M. Bougie, E.G. Booth, C.J. Kucharik, & H.K. Gibbs, Environmental outcomes of the US Renewable Fuel Standard, Proc. Natl. Acad. Sci. U.S.A. 119 (9) e2101084119, https://doi.org/10.1073/pnas.2101084119 (2022).

UNIVERSITY OF CALIFORNIA, DAVIS

BERKELEY • DAVIS • IRVINE • LOS ANGELES • MERCED • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

COLLEGE OF ENGINEERING

DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING
ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616
PHONE (530) 752-0586
FAX (530) 752-7872
http://cee.engr.ucdavis.edu/

28 May 2025

Carol Perkins
CalEPA External Scientific Peer Review Program Lead
Office of Research, Planning, and Performance
State Water Resources Control Board

Dear Ms Perkins:

I am writing in response to your email of April 29 authorizing my participation in the Peer Review of the Scientific Basis of the Multimedia Working Group's Assessment of the E15 Multimedia Evaluation. Based on my expertise and experience, I am reviewing the findings, assumptions, or conclusions I agreed I could review with confidence, those related to Conclusions 1 (Air Emissions Evaluation), 2 (Water Evaluation), and 4 (Soil and Hazardous Waste Evaluation).

To conduct my review, I carefully evaluated the Written Summary of the California Multimedia Evaluation of E15 prepared by the Multimedia Working Group. To further assess some of the findings, I also reviewed portions of the Tier 1, Tier 2, and Tier 3 reports, reviewed related literature, and drew on my 38 years of experience as a Professor of Environmental Engineering conducting research on the fate and effects of pollutants in air, water and soil systems and as an environmental regulator at the US Environmental Protection Agency working in the Office of Underground Storage Tanks.

Overall, I found that the scientific approach employed and the evidence provided is sound and is consistent with the overall conclusion of the Multimedia Working Group that "the use of E15 fuel in California, as specified in this multimedia evaluation and proposed regulation, does not pose a significant adverse impact on public health or the environment compared to E10." The scope of the multimedia evaluation is sufficient to capture the full range of potential environmental impacts to air, water and soil resources that can be reasonably anticipated based on current knowledge. The decision to formulate the evaluation relative to the current widespread use of E10 as a motor vehicle fuel in California is also sound as this represents an incremental change in

proportion of components in the fuel stream rather than the introduction of any constituents not currently in widespread use.

The scientific evidence clearly supports the significant air quality benefits of a potential transition from E10 toward E15 fuels. Significant reductions in emissions of total hydrocarbons (THC), nonmethane hydrocarbons (NMHC), particulate matter (PM) and carbon monoxide (CO), and important but less significant reductions in ethylbenzene and xylenes were measured when E15 fuels were used in vehicles representative of the current California fleet as part of this multimedia evaluation. Ozone formation potential was also noted to decrease when using E15, a significant finding given the proven human health consequences of elevated ozone levels. Since THC and CO convert to CO_2 in the atmosphere, a shift to E15 may indirectly lower CO_2 emissions by relatively minor amounts. Evaporative emissions of volatile organic compounds from vehicles were determined to be similar between the two fuel blends. The only observed air quality downsides to the use of E15 in comparison to E10 relate to increased releases of acetaldehyde and ethanol, but the calculation of potency weighted toxicity (PWT) of the measured gas phase components during the vehicle testing noted a small (but not statistically significant) decline in PWT (Tier III report, page 15). Collectively, these changes in air emissions could yield significant public health benefits and could contribute to extending the decline in the statewide gasoline-attributable cancer risk that began in the late 1990's as ethanol became the fuel oxygenate of choice (Tier I report, Fig 29). In addition to the potentially significant reductions in criteria air pollutant concentrations resulting from E15 implementation, the fact that ethanol is derived from renewable rather than fossil feedstocks provides important contributions to environmental sustainability and meeting the state's climate goals.

Potential water quality, soil, and hazardous waste impacts of a transition from E10 to E15 are more nuanced. The literature provides evidence of faster migration of subsurface plumes associated with leaks and spills of gasoline accompanied by faster overall degradation of most compounds found in those plumes, although there is some evidence for reduced rates of benzene, toluene, ethylbenzene and xylenes (BTEX) degradation in the presence of ethanol. When compared to E10 fuel releases, though, the impact of an E15 spill would be to increase the plume size by a fraction of a percent (Written Summary, page 13). The conclusion of State Water Board staff that the change from E10 to E15 will result in a proportional increase in the quantity of ethanol released to the environment, with a roughly proportional decline in the amount of petroleum released is consistent with scientific literature in this area. Given the lower overall toxicity and more rapid biodegradability of ethanol compared to major gasoline constituents, this change would be environmentally beneficial on balance. This conclusion hinges, however, on the assumption that the frequency and size of gasoline spills and leaks will be similar between E10 and E15. The primary reason to think that there might be a difference in release rates relates to concerns about the compatibility of E15 with the materials from which underground storage tanks (USTs) and piping are

constructed. At issue is any *difference* in material compatibility when comparing E10 to E15, but the Written Summary is unclear on this point and does not evaluate this concern as completely or conclusively as is needed.

The statement that introduces confusion is found both on page 9 of the Written Summary and in Appendix D: "UST regulations require the storage of substances not certified as compatible by an independent testing organization, typically Underwriters Laboratories (UL), if the manufacturer of the components provides affirmative statements of compatibility. Fiberglass USTs manufactured before April 1, 1990 (Xerxes) and July 1, 1990 (Owens Corning) cannot be certified by UL and both manufacturers only will certify compatibility with fuel blends containing 10 percent ethanol or methanol." This statement does not make clear whether newer tanks (post-1990) have compatibility problems and, if so, whether these are different for E15 compared with E10. It is also unclear whether these restrictions are based on publicly accessible testing results or simply on the reluctance of the manufacturers to assume liability for conditions that have not yet been sufficiently tested. Accepting, though, that some tanks and piping systems may not be compatible with E15 blends even though they are compatible with E10 blends, it is important to assess (if only qualitatively) the increased likelihood of releases because of material incompatibility. Administrative controls aimed at preventing storage of fuels in UST systems with which they are not compatible are contained in the state's misfueling mitigation plan (MMP). The MMP requires that "product transfer documents must accompany all transfers of fuels for E15 use" and "a survey of compliance at fuel retail dispensing facilities." (Written Summary page 4). To provide an assessment of the increased likelihood of subsurface releases of E15 compared to baseline rates with E10, it would be useful to obtain data on current misfuelling frequencies in California and a survey of known releases that could be traced to these events. Even if this data is sparse, acknowledging it and accounting for its potential seems to be an important part of assessing the water quality impacts of an E10 to E15 transition.

The Written Summary raises concerns about the increased generation and release of methane associated with the biodegradation of ethanol released to the environment through leaks and spills and discusses associated explosion hazards, noting the "potential for explosions in the case of advective methane flow" (page 13). Although methane formation can be a risk of ethanol releases, I do not know of any evidence (and the reports do not provide evidence) that allows estimation of the incremental amount of methane released when E10 fuels are replaced by E15 fuels. It may be helpful to assess the order of magnitude of this potential problem using anecdotal (or if possible, quantitative) information about methane releases associated with current spills and leaks of E10 to assess the extent and magnitude of increased methane production that might be anticipated from E15 releases.

Within the areas of my review noted above, I judge that the Written Summary document applies appropriate scientific procedures and methods and properly summarizes the existing knowledge base to derive valid conclusions regarding the environmental impacts associated with the proposed revised fuel standard. My review of the documents provided gives me confidence that the environmental multimedia impacts of the introduction of E15 fuels to California will be significantly positive for air quality and will have little to no important water, soil or hazardous waste impacts.

Submitted by
Thomas M. Young
Professor
Civil and Environmental Engineering
University of California, Davis

Multimedia Working Group Response to Peer Review Comments

The Multimedia Working Group (MMWG) appreciates the thorough written reviews submitted by the peer reviewers. The following is a summary of all comments provided by the peer reviewers, organized initially by those that do not require response by the MMWG and those that do require response. Comments requiring response are organized by topic and reproduced without corrections or alterations. Each peer reviewer self-identified which topic the comment would address. The MMWG corresponding response follows each comment. The citations included in the MMWG responses are referenced as footnotes at the bottom of the page.

The MMWG includes staff from the California Air Resources Board (CARB), Office of Environmental Health Hazard and Assessment (OEHHA), State Water Resources Control Board (State Water Board), Department of Toxic Substances Control (DTSC), and consulting agencies including the State Fire Marshal. Based on the topic, the appropriate agency staff within the MMWG prepared a response to each comment.

Where appropriate, the comments by the peer review panel have been addressed in an update to the Staff Written Summary in preparation for the submittal of the E15 Multimedia Evaluation to the California Environmental Policy Council (CEPC).

Comments and Responses

A. General Comments of Approval

A-1. Comment: Overall, I found the report to be careful and thorough, using methods that align well with commonly accepted scientific practice. Based on the evidence provided in the report, the overarching conclusions in the areas I reviewed (air emissions, public health) were well supported and reasonable, and are based upon sound scientific knowledge, methods, and practices. I therefore am supportive of the conclusions presented here. (Apte, p 2)

A-2. Comment: After reviewing the three attachments of the Request for External Peer Review of the Scientific Basis of the Multimedia Working Group's Assessment of the E15 Multimedia Evaluation and the Written Summary of the California Multimedia Evaluation of E15 Prepared by the Multimedia Working Group (MMWG) dated April 2025, I am confident that the review and methods are based on sound science and represent a thorough analysis of the scientific methods and results derived from the studies included. The document provides a thorough scientific analysis based on a

relevant and adequate collection of peer-reviewed studies and data. It presents a well-reasoned and comprehensive evaluation of the research methods and outcomes. (Ruiz, p 1)

A-3. Comment: The *Written Summary – Multimedia Evaluation of E15* is a clear and well-organized document containing reports on the E15 multimedia evaluation and potential impacts on public health and the environment. It includes the supporting documentation and summarizes a thorough review of the MMWG's assessment of the E15 multimedia evaluation conducted by Growth Energy and the Renewable Fuels Association (RFA), and the MMWG's analysis of the potential significant adverse impacts on public health and the environment. The document presents a scientifically robust and methodologically sound review, incorporating an adequate and relevant body of peer-reviewed literature and data sources. It reflects a comprehensive and well-justified evaluation of the study methods and findings. (Ruiz, p 3-4)

A-4. Comment: Appendix G. California Multimedia Evaluation of E11-E15 Gasoline-Ethanol Blends Tier III Report by Renewable Fuels Association and Growth Energy.

I concur with the information provided. The Appendix provides the supporting documents that satisfy the scientific foundation of knowledge, methods, and practices. (Ruiz, p 7)

A-5. Comment: Overall, I found the scientific approach employed and the evidence provided is sound and is consistent with the overall conclusion of the Multimedia Working Group that "the use of E15 fuel in California, as specified in this multimedia evaluation and proposed regulation, does not pose a significant adverse impact on public health or the environment compared to E10." The scope of the multimedia evaluation is sufficient to capture the full range of potential environmental impacts to air, water and soil resources that can be reasonably anticipated based on current knowledge. The decision to formulate the evaluation relative to the current widespread use of E10 as a motor vehicle fuel in California is also sound as this represents an incremental change in proportion of components in the fuel stream rather than the introduction of any constituents not currently in widespread use. (Porter, p 1-2)

A-6. Comment: Within the areas of my review noted above, I judge that the Written Summary document applies appropriate scientific procedures and methods and properly summarizes the existing knowledge base to derive valid conclusions regarding the environmental impacts associated with the proposed revised fuel standard. My review of the documents provided gives me confidence that the environmental multimedia impacts of the introduction of E15 fuels to California will be

significantly positive for air quality and will have little to no important water, soil or hazardous waste impacts. (Porter, p 4)

General Comments of Approval with Responses

B-1. Comment: Lifecycle perspective: One area where the multimedia evaluation could be strengthened has to do with the scope of the assessment. To my understanding, this assessment only considers activities associated with the distribution, dispensing and usage (combustion) of E15 fuel. Other important phases of the fuel cycle that may also have important atmospheric or public health implications include (but are not limited to) those related to the extraction, production, and refining of fuels. I recognize that a complete multimedia life-cycle impact assessment that fully considers the full impacts of these and other phases may be outside the scope of the present assessment. Nonetheless, it may be worthwhile to provide a detailed but qualitative discussion of where these other components of the E10/E15 lifecycle might align with or deviate from the direction of the core analytical conclusions presented here. (Apte, p 2-3)

> Response: No changes to the E15 Written Summary were made in response to this comment. Health and Safety Code (HSC) section 43830.8 requires a multimedia evaluation (MME) be conducted before new fuel specifications are established. An MME is defined as the "identification and evaluation of any significant adverse impact on public health or the environment, including air, water, or soil, that may result from the production, use, or disposal of the motor vehicle fuel."[1] To meet these requirements , Fuel Applicants initiated an MME to identify any potential environmental or public health impacts from the use of gasoline containing up to 15 percent ethanol by volume (E15) in California. The impacts and risks associated with E15 are assessed as relative compared to E10 which is currently in use in California. (CARB)

B-2. Comment: Additional notes
The four conclusions under review related to this proposal are all important and relevant to public and environmental health, and I greatly appreciate the care with which they have been made. I do note the absence though of other questions that have been previously examined with respect to the long-term sustainability of ongoing increases in bioenergy crop cultivation, including implications on land-use, irrigation, and fertilizer demands of said crops. While from a tailpipe emissions perspective the proposed increase in ethanol fuel fraction offers many benefits and no substantial drawbacks, I do remain concerned about the big picture of ethanol production increases and what they could mean for food security, water security, environmental

[1] *Health and Safety Code, Division 26, Part 5, Chapter 4, Section 43830.8*.

justice, and a holistic accounting of climate change impacts (see for example Lark et al., 2022). (Young, p 2)

> **Response:** No changes to the E15 Written Summary were made in response to this comment. The comment addresses sustainability issues related to ethanol production and is outside the scope of this multimedia evaluation. Please see response for comment B-1 regarding the scope of the E15 multimedia evaluation. (CARB)

Air Quality

C-1. Comment: Exhaust emissions testing: The extensive exhaust emissions testing undertaken at CE-CERT laboratories is impressive and is a clear strength of this study. As a very minor quibble, for considering lifecycle greenhouse gas impacts of biofuels, the tailpipe CO_2 emissions alone offer an insufficient perspective – in general, a major way that a higher share of ethanol blending would impact lifecycle GHG emissions would be from the different (and ideally lower) carbon intensity of biofuel feedstocks relative to petroleum feedstocks. It might be helpful to offer some context about this in Appendix C, section 3.A.2.ii (page 43 of the PDF). (Apte, p 3)

> **Response:** No changes to the E15 Written Summary were made in response to this comment. The comment is outside the scope of this multimedia evaluation. Information on the lifecycle and fuel pathway analyses of ethanol produced from various feedstocks can be found on CARB's Low Carbon Fuel Standard webpages.[2,3] (CARB)

C-2. Comment: Carbon intensity of E10 vs. E15: Tier I report, section 2.5. Pg. 7 (PDF page 79 of merged review document. I wish to comment on the following excerpt:

> *There are presently over 200 currently certified LCFS pathways for ethanol production with CI values ranging from 21.93 to 77.34 gCO2e/MJ. In comparison, CARBOB has a carbon intensity of 100.82 gCO2e/MJ. Thus, replacing CARBOB with ethanol will reduce carbon emissions from between roughly 20 to 80%, a significant reduction.*

As phrased, I found this statement in the Tier I report to have the potential to be misleading, because under the contemplated adoption of E15, only a small fraction of the fuel volume (~5%) would be replaced. Based on the statistics stated above,

---

[2] California Air Resources Board. *Low Carbon Fuel Standard* webpage. *https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard*.

[3] California Air Resources Board. *LCFS Life Cycle Analysis Models and Documentation*. *https://ww2.arb.ca.gov/resources/documents/lcfs-life-cycle-analysis-models-and-documentation*.

transitioning from E10 to E15 would likely lead to only a 1-4% reduction in the fuel carbon intensity. (Yes, the portion of the fuel that is being substituted would have a substantially lower carbon intensity, but that portion being substituted is very small). (Apte, p 3)

> Response: No changes were made to the E15 Written Summary in response to this comment. Fuel applicants, Growth Energy and the Renewable Fuels Association, prepared the Tier I Report, which includes background fuel information, history, and data. The Tier I Report was reviewed by the MMWG and approved for external scientific peer review. Approval does not signify that the contents reflect either the views of CARB or the MMWG.
>
> Regarding the reviewer's comment on a statement in the Tier I Report, staff appreciates the comments that were provided regarding ethanol's carbon intensity (CI) as compared to CARBOB and the portion of the fuel being substituted. For more information on the lifecycle and fuel pathway analyses of ethanol, please refer to *Low Carbon Fuel Standard* program webpage.[4]

C-3. Comment: On page 7, under section *A. California Air Resources Board Evaluation 1. Health-Relevant Air Emissions*, the report notes that emissions of acetaldehyde and ethanol increase by 32% and 77%, respectively, when comparing E15 to E10 as a function of ethanol content. Since these compounds are classified as unregulated air toxics, it would be recommended to implement continuous monitoring in focus areas where E15 emissions may be higher, such as near freeways or in heavily impacted communities. Such a plan would help determine ambient concentrations, assess the potential for accumulation, and evaluate their contribution to cumulative exposures or co-exposure risks alongside other pollutants. To be included in section *4. Recommendations*. (Ruiz, p 4)

> Response: CARB staff appreciate the comment and a revision was added to the E15 Written Summary, as follows:
>
> > Through existing programs CARB staff will continue to monitor acetaldehyde and ethanol emissions. In the event that emissions data indicates the potential for significant risks to public health CARB will take appropriate action under its authority.

[4] California Air Resources Board. *Low Carbon Fuel Standard*. *https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard*.

CARB's Air Toxics Program aims to reduce exposure to air emissions of toxic chemicals in California.[5] Acetaldehyde is a known toxic air contaminant and is monitored statewide via CARB's air toxics network.[6]

CARB also oversees the Photochemical Assessment Monitoring Stations (PAMS)[7] program which provides enhanced monitoring of ozone and its precursors, including acetaldehyde as a priority compound and ethanol as an optional reportable compound. (CARB)

C-4. Comment: Appendix C. California Air Resources Board: Impact Assessment of E15 on Exhaust and Evaporative Emissions from Light-Duty Vehicles

Comment: On *Section A. Multimedia Evaluation of E15*, page 2, in the second paragraph, the reference to Table 1 from citation 7 should say Table 2.1.

The methods and results are thorough and well-supported, enabling the robust conclusions presented. An adequate discussion with studies published in indexed journals is used to support the results and to highlight warranted evaluations that would improve findings. The tables describing the results show extensive comparisons of emissions of 20 vehicle makes and models from a wide range of year (Table 1, the driving cycle is shown, and Table 2 describes the difference in percentage in weighted emissions of E15 relative to E1[0], showing a general reduced percentage of regulated emissions, detailing the most relevant chemicals that are either toxic or GHGs.

The percentage derived from the FTP cycle is presented in mg/mile and is informative when considering the driving cycle comparing E10 to E15 emissions. However, to establish the impact on environmental and health effects, it is also necessary to know the concentration of the relevant chemicals emitted in the air [emissions] per volume derived from E15 fuels.

In summary, it is recommended to continuously monitor the relevant chemicals, particularly ethanol and acetaldehyde, since their emission levels increased due to ethanol content. A significant difference from E10

---

[5] California Air Resources Board. *What is the Air Toxics Program?* *https://ww2.arb.ca.gov/resources/documents/what-air-toxics-program*

[6] California Air Resources Board. *Annual Toxics Summaries.* *https://www.arb.ca.gov/adam/toxics/statesubstance.html*

[7] U.S. EPA. Photochemical Assessment Monitoring Stations (PAMS). *https://www.epa.gov/amtic/photochemical-assessment-monitoring-stations-pams*

to E15 may not be detectable initially, however, over the long term or in specific areas, the differences could have notable environmental and health impacts. (Ruiz, p 5-6)

Response: *The figure title noted was corrected in the final Staff Written Summary Multimedia Evaluation of E15*, as follows:

> The multimedia evaluation process is summarized in ~~Table~~Figure 2.1 of the "*Fuels Multimedia Evaluation Guidance Document*".

Please refer to the response for comment C-3 regarding existing monitoring programs and revisions to *Chapter 4. Recommendations* regarding CARB air monitoring. (CARB)

C-5. Comment: *Need for Broader Discussion*. There is only limited discussion in the staff report of multimedia assessment reports submitted by fuel applicants. Some summary and evaluation of findings and conclusions from fuel applicants' multimedia assessment (refs. 2-4) would be helpful. Most of the discussion of these reports that appears in Appendix C (pages 1-3) is about process rather than findings.

(a) What life-cycle effects on greenhouse gas emissions are expected from using E15 in place of E10 in California? See page 20 of ref. 4 where this issued is mentioned. A related question is whether increased ethanol usage will displace California gasoline produced from declining domestic crude oil supplies or rather offset increasing crude oil imports from other countries? Country-specific data for carbon intensities of crude oil produced in foreign countries may be lacking; this uncertainty should be acknowledged and is of increasing importance as California relies more and more heavily on foreign sources of crude oil.

(b) Fuel applicants' assessment reports (refs. 2-4) include discussion of other emission studies that may help clarify or strengthen findings presented in the staff report. The text in the staff report (Appendix C, see pages 3-12) focuses mostly on describing methods and results of CARB-sponsored emission studies (refs 5 and 6). (Harley, p 2)

Response: (a) No changes to the E15 Written Summary were made in response to this comment. These comments address increased ethanol usage, declining domestic crude oil supplies, increased crude oil imports from other countries, and country-specific CI data, and are outside the scope of this multimedia evaluation. Please see response for comment B-1 regarding the scope of the E15 multimedia evaluation and response for comment C-1 regarding CI fuel pathway analyses.

(b) The studies and technical literature included in the tier reports only included emissions data comparisons for various federal gasoline specifications and not California reformulated gasoline (CaRFG). This was a knowledge gap that was identified in the Tier I Report and addressed through the *Comparison of Exhaust Emissions Between E10 CaRFG and Splash Blended E15* (Exhaust Emissions Study)[8], the results of which were included in the Tier II Report. This report was the primary study highlighted in the E15 Written Summary and the air quality evaluation since it was the only study that tested E15 compared to E10, but the fuel applicants' reports are included in the Written Summary and are a part of the basis of each agency's evaluation and conclusions. For more information regarding the requirements and scope of the E15 multimedia evaluation, please refer to the response for comment B-1. (CARB)

C-6. Comment: *CO2 Emissions and Fuel Consumption*. Given a lower volumetric energy content of ethanol compared to the petroleum-derived hydrocarbons typically used in gasoline, it is expected that fuel consumption statewide would increase if California were to switch to E15 in place of E10 (ref. 4, page 13, notes a reduction of 1% in fuel economy, which would lead to a similar increase in fuel consumption). This may lead to a small increase in fuel costs for motorists. Other factors in California such as announced plans for refinery closures and increased reliance on imported crude oil may have greater influence on fuel costs and life-cycle greenhouse gas emissions. (Harley, p 2)

Response: No changes to the E15 Written Summary were made in response to this comment. The comment is regarding fuel economy and fuel consumption which are outside the scope of this multimedia evaluation. (CARB)

C-7. Comment: *Aromatic emissions*.

Results for ethylbenzene (see ref. 1, Appendix C, top of page 9) are consistent with findings for the xylenes isomers. The percentage changes (9 to 11% reduction) and p-values (0.0498, 0.0504, and 0.0649) are similar. Ref. 4 (page 14) is more systematic in grouping these changes and describing them as similar.

The benzene fraction in tailpipe NMHC emissions (6.9 wt%) derived from Table 2 of the staff report (ref 1) is higher than observed in on-road emission studies (refs. 7-9), for which benzene fractions of ~3.5 wt% are typical.

---

[8] Karavalakis, G., Durbin T.D., & Tang, T. *Comparison of Exhaust Emissions Between E10 CaRFG and Splash Blended E15.* June 2022. *https://ww2.arb.ca.gov/sites/default/files/2022-07/E15_Final_Report_7-14-22_0.pdf*.

I agree that adding ethanol to gasoline will dilute its aromatic content. Do staff expect refiners to make other changes to gasoline properties due to the increased ethanol content? This might further reduce the aromatic content of California gasoline. Effects on vehicle emissions of potential gasoline reformulation are not captured by the splash-blended E15 fuel employed for the emission testing described in refs. 5 and 6. (Harley, p 3)

> Response: No changes to the E15 Written Summary were made in response to this comment. The comment is regarding potential gasoline reformulation and potential changes to gasoline properties due to the increased ethanol content which is outside the scope of this multimedia evaluation. Please refer to the response for comment B-1 regarding the requirements of a multimedia evaluation. (CARB)

C-8. Comment: *Non-tailpipe emissions*. Conclusions about effects on evaporative emission when switching from E10 to E15 are not adequately supported by the brief discussion appearing in the staff report (ref. 1, Appendix C, page 11).

The laboratory study of E15 impacts on vehicle evaporative emissions (ref. 6) provided useable results for four relatively new vehicles, as summarized in Table 4 (ref. 1, Appendix C, page 11). [To help improve the clarity of this comment, staff have added letters to each individual part of the comment.]

- [a] Units of measure are missing from Table 4.
- [b] It may be appropriate to revise the baseline (E10) average result for the Nissan Rogue (see ref. 6) to exclude one anomalous high reading.
- [c] Statistical significance of measured changes is reported individually for each vehicle. An assessment of fleet-averaged results should be added to compare overall emission rates from all vehicles combined for E10 versus E15 fuels.
- [d] The ability to identify fuel effects on emissions is limited given the small sample (N=5 vehicles, one of which was excluded) tested in ref. 6.

Only diurnal and hot soak evaporative emissions were measured in ref. 6. This is standard practice for emission certification tests. However, potential impacts of fuel changes on other categories of evaporative emissions (i.e., running losses, permeation/resting losses, liquid fuel leakage and refueling emissions) have not been quantified or discussed.

- [e] Are there other lines of evidence or discussion points that address impacts of fuel changes on these other categories of evaporative emissions?

- [f] It would be helpful to mention what change is expected (if any) in fuel vapor pressure in the transition from E10 to E15.

Are there any concerns about increased fuel leakage due to use of E15 in pre-2001 motor vehicles or in off-road engines for which E15 may not be appropriate? More specifically, could fuel leaks occur due to changes in the swelling or sealing properties of elastomeric components in fuel systems of older vehicles and off-road engines? (Harley, p 3-4)

Response:

(a) The title of Table contained in the E15 Written Summary and noted the comment was revised to include the units, as follows:

Table 4. Evaporative Emissions Results (grams).

(b) – (c) The results and analyses in the *Comparison of Evaporative Emissions Between E10 CaRFG and Splash Blended E15* (Evaporative Emissions Study)[9] report cannot be revised, including the exclusion of specific datasets.

(d) Five vehicles were selected for the Evaporative Emissions Study from the larger group of twenty vehicles used in the Exhaust Emissions Study, in accordance with the testing parameters and fuel applicant's available resources and funding.

(e) The Evaporative Emissions Study did not show any statistically significant differences in exhaust emissions between E15 and E10. Additionally, the literature included in the Tier I Report supports that evaporative emissions will not increase with the use of E15 compared to federal gasoline. The Tier I studies also suggest that the total mass of permeation emissions and their ozone-forming potential from E15 are statistically indistinguishable from those of federal fuels, indicating no significant impact on permeation emissions.[10]

Please also see the response for comment D-1 regarding the potential for increased fuel spillage or leakage from older vehicles and off-road engines. For further reference regarding current federal E15 vehicle and equipment lists, restrictions, and misfuelling guidance, please refer to the Department of

[9] Automotive Testing and Development Services, Inc. *Comparison of Evaporative Emissions Between E10 CaRFG and Splash Blended E15.* January 2022.

[10] Renewable Fuels Association, Growth Energy. *California Multimedia Evaluation of E11 - E15 Gasoline-Ethanol Blends: Tier I Report*. June 4, 2020. *https://ww2.arb.ca.gov/sites/default/files/2022-07/E15_Tier_I_Report_June_2020.pdf*

Energy's (DOE) Alternative Fuels Data Center (AFDC) E15 information website.[11]

(f) The Evaporative Emissions Study[12] did not assess the expected change in fuel vapor pressure in the transition from E10 to E15. (CARB)

C-9. Comment: *Conclusions*. In the conclusions paragraph quoted above (see also Appendix C of ref. 1, page 14), staff specifically highlight some pollutants for which significant tailpipe emission reductions were found (PM, THC and CO). If findings for specific pollutants are going to be called this way, findings of increased emissions of ethanol and acetaldehyde should be mentioned for balance. The finding of no significant increase in vehicular NOx emissions is more important than a decrease in CO emissions. Vehicle-related CO emissions have little relevance to contemporary air quality problems in California. More context is needed when highlighting the finding from ref. 5 that use of E15 decreases total hydrocarbon emissions. The quotes finding is not the whole story because it does not account for fuel effects (or a lack thereof) on non-tailpipe/evaporative emissions of hydrocarbons. (Harley, p 4)

Response: The conclusions section of the E15 Written Summary was revised, as follows:

Staff also ~~concludes that emissions of~~ makes the following general conclusions:

- E15 reduces PM, THC and CO exhaust emissions ~~are reduced with the use of E15~~.
- No statistically significant difference in NOx emissions compared to E10.
- E15 increases acetaldehyde and ethanol exhaust emissions. (CARB)

C-10. Comment: Air Emissions Evaluation. While my expertise is not air quality, my expertise extends to physicochemical properties of organic chemical compounds, including those that compose E15 formulation. After reviewing the evaluation, I agree with the report that they are comparable emissions to existing E10 gasoline blends. (Martinez, p 1)

Response: No changes were made to the E15 Written Summary in response to these comments. (CARB)

---

[11] U.S. Department of Energy. Alternative Fuels Data Center. *E15*. *https://afdc.energy.gov/fuels/ethanol-e15?os*.

C-11. Comment: The scientific evidence clearly supports the significant air quality benefits of a potential transition from E10 toward E15 fuels. Significant reductions in emissions of total hydrocarbons (THC), nonmethane hydrocarbons (NMHC), particulate matter (PM) and carbon monoxide (CO), and important but less significant reductions in ethylbenzene and xylenes were measured when E15 fuels were used in vehicles representative of the current California fleet as part of this multimedia evaluation. Ozone formation potential was also noted to decrease when using E15, a significant finding given the proven human health consequences of elevated ozone levels. Since THC and CO convert to CO2 in the atmosphere, a shift to E15 may indirectly lower CO2 emissions by relatively minor amounts. Evaporative emissions of volatile organic compounds from vehicles were determined to be similar between the two fuel blends. The only observed air quality downsides to the use of E15 in comparison to E10 relate to increased releases of acetaldehyde and ethanol, but the calculation of potency weighted toxicity (PWT) of the measured gas phase components during the vehicle testing noted a small (but not statistically significant) decline in PWT (Tier III report, page 15). Collectively, these changes in air emissions could yield significant public health benefits and could contribute to extending the decline in the statewide gasoline-attributable cancer risk that began in the late 1990's as ethanol became the fuel oxygenate of choice (Tier I report, Fig 29). In addition to the potentially significant reductions in criteria air pollutants concentrations resulting from E15 implementation, the fact that ethanol is derived from renewable rather than fossil feedstocks provides important contributions to environmental sustainability and meeting the state's climate goals. (Porter, p 2)

> Response: No changes were made to the E15 Written Summary in response to these comments. (CARB)

C-12. Comment: Conclusion #1: Air Emissions Evaluation

"Air Emissions Evaluation. California Air Resources Board (CARB) staff assessment indicates that with fuel specifications and requirements, E15, as specified in the multimedia evaluation and proposed regulation, does not pose a significant adverse impact on public health or the environment form potential air quality impacts."

The potential approval of E15 fuel represents an incremental change relative to the previously approved E10 ethanol mixture, increasing the relative proportion of fuel grade ethanol by roughly 50%. Considering the previous full evaluation and approval of E10 fuel, it would be reasonable to suppose that an increased fraction of ethanol would likewise be found to pose no significant threat of increases in harmful emissions. However, without comprehensive testing, the possibility could remain for unexpected interactions or non-linear changes in real world emissions. For this reason, the emissions testing described here fills a key knowledge gap with respect to the air quality changes that could be expected with the proposed increase in ethanol fraction

in California fuel. Test procedures appear to be well-planned and thorough, using established best practices for testing on a diverse set of representative light duty vehicles.

Results of these emissions tests are consistent and unambiguous: an increase in ethanol fraction from E10 to E15 fuels would be expected to offer *no significant increases* in harmful air pollution related to exhaust or evaporative emissions. Several key categories, including PM, CO, and THC, showed statistically significant reductions from the switch to E15 fuel, while others, such as NOx, showed no significant change. Emissions of ethanol and acetaldehyde showed higher emissions from E15 fuel, but these increases were offset by reductions to other VOCs, in particular the carcinogen benzene, making the switch a net improvement in terms of criteria pollutant precursors. To my knowledge there is no reason to believe that these increases in specific VOC species should be considered an air quality threat in the context of reductions to total VOC emissions.

In summary, I find Conclusion #1 to be justified and well supported. (Young, p 1)

> Response: No changes were made to the E15 Written Summary in response to these comments. (CARB)

Water Quality

D-1. Comment: Appendix D of ref. 1 presents the State Water Resources Control Board's staff evaluation of E15 impacts on water quality. I am not an expert on aquatic toxicity, biodegradation or underground fuel storage tank design and certification. Therefore, I have not commented on issues such as older underground storage tanks, subsurface plume lengths, biodegradation rates of ethanol and other gasoline components, or ethanol toxicity to aquatic organisms.

In response to the staff conclusion about release scenarios for E15 being the same as for E10, I pose the question of whether fuel spillage or leakage rates may increase from older vehicles (i.e., pre-2001 model year) and off-road engines (e.g., watercraft operating on California lakes, reservoirs, and other waterways) under use cases where E15 has not been certified as appropriate. (Harley, p 4)

> Response: No changes were made to the E15 Written Summary in response to these comments. The potential for increased fuel spillage or leakage from older vehicles and off-road engines is not anticipated because the evaluation and anticipated regulatory proposals do not consider that E15 would be approved for use in these applications. Accordingly, release scenarios are expected to be similar to E10 when used within approved vehicles and compatible

infrastructure. Please also refer to the response for comment C-8(e). (CARB, State Water Board)

D-2. Comment: Water Evaluation. Water quality and remediation of organic compounds are my main areas of expertise. I concur with the findings that there are minimal added risks comparing E15 to E10 fuel blends. The report mentions potential elongation of groundwater contamination plumes because of added ethanol content in E15. In my opinion, although a possibility, these impacts might be relevant only in very large accidental releases of E15. (Martinez, p 1)

Response: No changes were made to the E15 Written Summary in response to these comments. (State Water Board)

D-3. Comment: Potential water quality, soil, and hazardous waste impacts of a transition from E10 to E15 are more nuanced. The literature provides evidence of faster migration of subsurface plumes associated with leaks and spills of gasoline accompanied by faster overall degradation of most compounds found in those plumes, although there is some evidence for reduced rates of benzene, toluene, ethylbenzene and xylenes (BTEX) degradation in the presence of ethanol. When compared to E10 fuel releases, though, the impact of an E15 spill would be to increase the plume size by a fraction of a percent (Written Summary, page 13). The conclusion of the State Water Board staff that the change from E10 to E15 will result in a proportional increase in the quantity of ethanol released to the environment, with a roughly proportional decline in the among of petroleum released is consistent with scientific literature in this area. Given the lower overall toxicity and more rapid biodegradability of ethanol compared to major gasoline constituents, this change would be environmentally beneficial on balance. This conclusion hinges, however, on the assumption that the frequency and size of gasoline spills and leaks will be similar between E10 and E15. The primary reason to think that there might be a difference in release rates relates to concerns about the compatibility of E15 with the materials from which underground storage tanks (USTs) and piping are constructed. At issue is any *difference* in material compatibility when comparing E10 to E15, but the Written Summary is unclear on this point and does not evaluate this concern as completely or conclusively as is needed. (Porter, p 2-3)

Response: No changes were made to the E15 Written Summary in response to these comments. State Water Board staff expect that should E15 be approved for use, the number and frequency of E15 releases will be similar or decrease as compared to the historical release numbers of E10 due to infrastructure changes currently in progress. A disproportional number of E10 releases occurred from single-walled underground storage tanks (USTs). All single-walled USTs are required to be permanently closed by December 31, 2025, or will be made non operable through enforcement measures. This does

not however resolve the issue with the remaining 5,000 fiberglass double-walled underground storage tanks incompatible with E15. While compatibility failures are more likely to cause releases from the primary containment, the majority of those releases will be captured by the secondary containment and will not result in soil or groundwater impacts. (State Water Board)

D-4. Comment: The statement that introduces confusion is found both on page 9 of the Written summary and in Appendix D: "USE regulations require the storage of substances not certified as compatible by an independent testing organization, typically Underwriters Laboratories (UL), if the manufacturer of the components provides affirmative statements of compatibility. Fiberglass USTs manufactured before April 1, 1990 (Xerxes) and July 1, 1990 (Owens Corning) cannot be certified by UL and both manufacturers only will certify compatibility with fuel blends containing 10 percent ethanol or methanol." This statement does not make clear whether new tanks (post-1990) have compatibility problems and, if so, whether these are different for E15 compared with E10. It is also unclear whether these restrictions are based on publicly accessible testing results or simply on the reluctance of the manufacturers to assume liability for conditions that have not yet been sufficiently tested. Accepting, though, that some tanks and piping systems may not be compatible with E15 blends even though they are compatible with E10 blends, it is important to assess (if only qualitatively) the increased likelihood of releases because of material compatibility. Administrative controls aimed at preventing storage of fuels in UST systems with which they are not compatible are contained in the state's misfuelling mitigation plan (MMP). The MMP requires that "product transfer documents must accompany all transfers of fuels for E15 use" and "a survey of compliance at fuel retail dispensing facilities." (Written Summary page 4). To provide an assessment of the increased likelihood of subsurface releases of E15 compared to baseline rates with E10, it would be useful to obtain data on current misfuelling frequencies in California and a survey of known releases that could be traced to these events. Even if this data is sparse, acknowledging it and accounting for its potential seems to be an important part of assessing the water quality impacts of an E10 to E15 transition. (Porter, p 3)

Response: No changes were made to the E15 Written Summary in response to these comments. Fiberglass USTs manufactured after 1990 are compatible with all ethanol and methanol blends of up to 100 percent. The high-alcohol resin blend was available to UST owners and operators prior to 1990 but was rarely requested by owners that only intended to use the tanks for motor vehicle fuels. The State Water Board agrees with the commenter that obtaining and tracking misfuelling data would be useful in assessing potential water quality impacts. (State Water Board)

<u>Public Health</u>

E-1. Comment: On pages 10 and 11, under section *C. Office of Environmental Health Hazard Assessment Evaluation – 2. Summary of Findings on Comparative Toxicity*, the report concludes that based on animal inhalation studies and in vitro cell-based assays, E15 does not appear to be more toxic than E10. The available data support this conclusion. However, the report could be strengthened by recommending future research on the long-term, low-dose toxicological effects of chronic exposure to emissions from these fuel blends. In particular, studies aimed at elucidating mechanistic toxicity pathways remain limited and should be prioritized to better understand potential health risks over time. To be included in section 4. Recommendations. (Ruiz, p 4)

> Response: OEHHA revised the text to state: "While outside the scope of this study, future studies that are focused on low-dose toxicity assessments and mechanistic toxicity evaluations may be helpful to better understand the potential health risks of E15 versus E10." (OEHHA)

E-2. Comment: Appendix E. Office of Environmental Health Hazard Assessment: The Potential for Toxicity of E15 versus E10 Exhausts

A comprehensive discussion supported by up-to-date studies from indexed high-impact journals reinforces the findings used for the conclusion. The methods and results are detailed and well-supported. Studies included explore toxicological and mechanistic outcomes comparing E0 gasoline with other gasoline-ethanol content, E15, E85, or different ranges. This provides a comparative discussion, including a range of doses, times of exposure, and emission chemicals in different experimental models, cell-based assays, or animal models. Also, human and ecological risks are considered.

For Public Health impacts, a recommendation for conducting inhalation studies in animals that directly compare toxicity of E15 and E10 is included. In this sense, an additional recommendation would be to conduct long-term inhalation toxicity studies in animals, where the cumulative and/or co-exposure toxicity implications would be evaluated. Exposing to E15 or higher ethanol-gasoline blends, as well as the emission products, ethanol and acetaldehyde. Additionally, evaluate toxicity outcomes from diseases beyond the lungs, such as cardiovascular and neurological conditions, as well as implications across generations. Furthermore, monitor health implications in sensitive populations, including children, the elderly, and individuals with asthma. (Ruiz, p 6)

> Response: Please see the response for comment E-1 above for revisions incorporated into the text. (OEHHA)

E-3. Comment: Appendix E of ref. 1 presents the Office of Environmental Health Hazard Assessment (OEHHA) staff evaluation of the potential for toxicity of E15 versus E10 exhaust. I am not an expert in toxicology, so I have limited my comments and questions to emissions and exposure assessment-related issues in reviewing OEHHA's evaluation and conclusions.

On page 2 of Appendix E, there is a statement that evaporative emissions occur primarily from refueling emissions (e.g., from spills and direct vehicle emissions). This could be true for working losses (vapor displacement as liquid fuel is added to vehicle fuel tanks). However, there are other modes of evaporative emissions including diurnal/breathing losses and running losses, and these emissions occur elsewhere. I don't agree with the statement that evaporative emissions occur primarily at service stations, although service stations may still be an important location in terms of human exposure to gasoline vapors. (Harley, p 4-5)

> Response: The comment provides a clarification regarding the different modes of evaporative emissions beyond refueling losses. While service stations remain a significant source of human exposure to gasoline vapors, recognizing diurnal/breathing and running losses broadens the scope of the emissions assessment.
>
> OEHHA revised the text to state, "Evaporative emissions occur through various pathways, including refueling activities (e.g., spills and direct vehicle emissions) and diurnal/breathing and running losses. These emissions apply to occupational and public exposures (e.g., at retail service stations or during accidental spill events)." (OEHHA)

E-4. Comment: At the top of page 7 of Appendix E, it is noted that the percent volumes of benzene in E15 and E10 are expected to be 1.04 and 1.10, respectively. I question whether these expectations are realistic specifically for California gasoline, for which a flat limit of 1.0 vol% on benzene content in gasoline was established in 1996. Measured benzene levels in California gasoline samples in prior studies indicate benzene levels well below 1% since 1996. For example, ref. 8 reports benzene levels of 0.6 wt% benzene in gasoline samples collected in 1996, 1999, and 2001. Ref. 10 reports benzene levels of 0.4 vol% in California gasoline with MTBE as the oxygenate in 1996 and 1997, and ref. 11 reports benzene levels of 0.46-0.56 wt% in three California gasoline samples from 1999 with differing levels of ethanol as the oxygenate. Benzene has a higher liquid density than gasoline overall, so benzene fractions reported in wt% units will decrease when converted to vol% units. (Harley, p 5)

> Response: No changes were made to the E15 Written Summary in response to these comments. The percent volumes of benzene cited, 1.04 and 1.10,

originated in the Tier I Report, which was reviewed and finalized in 2020. As indicated in footnote *a* of Table 13 in the Tier I Report, the value shown for E10 is the maximum allowable limit under the CaRFG Regulations. Consistent with the reviewer's comment, measured benzene levels are below the maximum allowable limits. Regarding the E15 benzene value cited in Appendix E, the Tier I Report specifies that the data shown in Table 13 for E15 is assumed to be a proportional value based on E10.[13] (OEHHA, CARB)

E-5. Comment: On Page 7, it is noted that use of E15 in place of E10 as fuel leads to 77% and 32% increases in tailpipe emissions of ethanol and acetaldehyde, respectively. It is further noted that both OEHHA and US EPA have cancer and non-cancer inhalation exposure standards for acetaldehyde, and that without additional information about projected changes in air concentrations, OEHHA is unable to assess in the resulting change in risk to humans and the environment from the increase in acetaldehyde emissions. This is an unfortunate analytical gap in the overall assessment of E15. Added complexities arise in this case because acetaldehyde is not only emitted directly from vehicular and other sources but also forms as an atmospheric oxidation product of other sources but also forms as an atmospheric oxidation product of other organic compounds (e.g., ethane and propene). Therefore a 32% increase in tailpipe emissions of acetaldehyde does not mean that human exposure to acetaldehyde in inhaled air will increase by the same proportion. (Harley, p 5)

Response: OEHHA initially stated, "Increased ethanol and acetaldehyde emissions (by 77% and 32%, respectively) were also measured. While the use of E15 will reduce tailpipe emissions of many pollutants overall, it is important to note that both OEHHA and US EPA have non-cancer and cancer inhalation exposure standards for acetaldehyde, and without additional information about projected changes in air concentrations, OEHHA is unable to assess the change in risk to humans and the environment. Figure 29 in the Tier I Report shows cancer risk due to air toxics including benzene, 1,3-butadiene, formaldehyde, and acetaldehyde in California, and demonstrates that the increase in acetaldehyde concentrations due to increased ethanol use did not result in increased risk as ethanol was phased in after 1999."

However, the comment identifies a potential for additional future study, particularly concerning the potential impacts of increased acetaldehyde emissions on human exposures, associated health risks, and environmental conditions. Thus, OEHHA staff revised the text to state: "Increased ethanol and

[13] Renewable Fuels Association, Growth Energy. *California Multimedia Evaluation of E11-E15 Gasoline-Ethanol Blends: Tier I Report*. June 4, 2020. *https://ww2.arb.ca.gov/sites/default/files/2022-07/E15_Tier_I_Report_June_2020.pdf*. p 80.

acetaldehyde emissions (77% and 32%, respectively) were also measured. However, human exposure to acetaldehyde will not necessarily increase by the same proportion, especially considering its multiple sources (i.e. direct emissions and formation through atmospheric oxidation reactions). Without additional information, OEHHA is unable to assess the change in risk to humans and the environment…" (OEHHA)

E-6. Comment: Public Health Evaluation: While I am not a public health expert, my expertise on remediation of organic contaminants is based on general understanding of toxicological impacts of these pollutants. I concur with the report findings identifying a potential slight increased exposure to formaldehyde during combustion of E15 (for example, tailpipe emissions). Like the report outlines, additional toxicological experiments would be beneficial to understand if these potential impacts are relevant to public health. (Martinez, p 1-2)

Response: No changes were made to the E15 Written Summary in response to these comments. (OEHHA)

E-7. Comment: Conclusion #3: Public Health Evaluation

"Public Health Evaluation. Office of Environmental Health Hazard Assessment (OEHHA) staff assessment indicates that the substitution of E15 for E10 shoes a general decrease in levels of ozone-forming compounds, particulate matter, some volatile organic compounds (VOCs), and other contaminants of concern to human health. However, E15 use may increase tailpipe emissions of a few VOCs, such as ethanol and acetaldehyde. Overall, OEHHA did not find evidence of significant adverse impacts on human health form the use of E15 compared to E10."

To further assess the potential for additional health risks resulting this proposed fuel change, and as an extension from their previous assessment of E10 health risks, OEHHA has performed a thorough review of findings relevant to E15 ethanol increases. While I am not able to comment with authority on the strictly toxicological aspects of their report and conclusions related to exposure studies, I find their evaluation of expected impacts on primary and secondary criteria pollutants to be robust and well founded. Based on my understanding of atmospheric chemistry, relevant literature, and the forementioned emissions comparisons, I agree that a switch from E10 to E15 fuels would be expected to generally reduce both primary and secondary pollutants, all else being equal, and would no pose a threat to human health.

In summary, I find Conclusion #3 to be justified and well supported. (Young, p 2)

Response: No changes were made to the E15 Written Summary in response to these comments. (OEHHA)

Soil and Hazardous Waste

F-1. Comment: On page 12, under *Section D. Department of Toxic Substances Control Evaluation*, the strategy for addressing the anticipated increase in ethanol production – encompassing processing, storage, transportation, and byproduct management is outlined. A critical focus of this section is the need to secure substantially greater volumes of renewable organic feedstock to meet rising demand. This must be achieved through environmentally sustainable practices that avoid deforestation, land degradation, and other harmful agricultural impacts. To be included in section 4. Recommendations. (Ruiz, p 4)

Response: No changes were made to the E15 Written Summary in response to these comments. DTSC is unable to provide this recommendation. DTSC's mission statement and agency mandate under statute and regulations are generally limited to the management of hazardous waste. Please also see response for comment B-1 regarding the scope of the E15 multimedia evaluation. (DTSC)

F-2. Comment: On page 15, under *Section D. Department of Toxic Substances Control Evaluation*, *Staff's evaluation focused on: (1) hazardous waste generation during production, use, and storage of E15 in California, and (2) cleanup of contaminated sites in cases of spills of E15*. Given the well-documented environmental persistence and toxicity of BTEX compounds, the generation of BTEX and methane in the context of E15 releases is a relevant discussion, particularly concerning the alteration in soil biodegradation rates of BTEX. Ethanol can serve as a preferred substrate for microbial communities, potentially inhibiting BTEX degradation due to competitive metabolic processes, thereby posing a long-term environmental risk. Furthermore, ethanol-fueled methanogenesis may accelerate under specific geochemical conditions, increasing the risk of greenhouse gas emission and subsurface vapor intrusion, especially in urban areas with aging infrastructure. Therefore, the understanding that BTEX would degrade more slowly in the environment, leading to statistically longer benzene plumes as ethanol concentration rises compared to E10, suggests need for new remediation outcomes, considering cleanup complexity and cost. (Ruiz, p 5)

Response: No changes were made to the E15 Written Summary in response to these comments. Cleanup goals are generally decided based on various factors, and differ from site to site. (DTSC)

F-3. Comment: Appendix F. Department of Toxic Substances Control: Recommendation on Proposed E15 Fuel Specifications.

I concur with the information provided.

In point 1 of the staff recommendation, I would emphasize that the critical focus of environmentally sustainable practices for ethanol production should be on renewable organic feedstock, avoiding land degradation, and mitigating other harmful agricultural impacts and deforestation. Strategies to manage this situation should be implemented as soon as possible. (Ruiz, p 7)

> Response: No changes were made to the E15 Written Summary in response to these comments. Please also see the response for comment F-1. (DTSC)

F-4. Comment: Soil and Hazardous Waste Evaluation*:* I am an expert in remediation of organic contaminants, which allows me to assess soil and hazardous waste management. I concur with the report findings that the increased ethanol might elongate groundwater plume because ethanol could act as an cosolvent for BTEX. Furthermore, while it is possible that degradation of E15 might be slightly faster than E10 because of the increased ethanol content, biodegradation of light fraction hydrocarbons in gasoline is widespread in most aerobic soils. The identified potential risk of methane release would only be relevant to very large accidental releases and under anaerobic conditions. (Martinez, page 2)

> Response: No changes were made to the E15 Written Summary in response to these comments. Staff also agrees that potential release concerns and outcomes are theoretical and may differ from site to site under various conditions. The initial language was written to be broadly responsive to even the largest accidental releases, and we concur that this methane release would be limited in most cases. (DTSC)

F-5. Comment: The Written Summary raises concerns about the increased generation and release of methane associated with the biodegradation of ethanol released to the environment through leaks and spills and discusses associated explosion hazards, noting the "potential for explosions in the case of advective methane flow" (page 13). Although methane formation can be a risk of ethanol releases, I do not know of any evidence (and the reports do not provide evidence) that allows estimation of the incremental amount of methane released when E10 fuels are replaced by E15 fuels. It may be helpful to assess the order of magnitude of this potential problem using anecdotal (or if possible, quantitative) information about methane releases associated with current spills and leaks of E10 to assess the extent and magnitude of increased methane production that might be anticipated from E15 releases. (Porter, page 3)

> Response: No changes were made to the E15 Written Summary in response to these comments. We agree that the potential for adverse effects due to

increased methane is speculative and dependent on a very large magnitude of release, and that further study in this area may be needed to identify the difference in methane production as ethanol concentration increases. (DTSC)