ATTACHMENT 4

CALIFORNIA GOOD NEIGHBOR
STATE IMPLEMENTATION PLAN

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Introduction

The Good Neighbor Provision

Clean Air Act (CAA) section 110(a)(2)(D)(i)(I) requires each state to submit to U.S. EPA new or revised State Implementation Plans (SIPs) that "contain adequate provisions prohibiting, consistent with the provisions of this subchapter, any source or other type of emissions activity within the State from emitting any air pollutant in amounts which will contribute significantly to nonattainment in, or interfere with maintenance by, any other state with respect to any such national primary or secondary ambient air quality standard." U.S. EPA often refers to section 110(a)(2)(D)(i)(I) as the good neighbor provision and to SIP revisions addressing this requirement as Good Neighbor SIPs or interstate transport SIPs.

U.S. EPA's Regulatory Framework to Address the Good Neighbor Provision

Historically, interstate transport of emissions has been a significant concern for attainment of ozone standards in the eastern United States. Rulemaking to address such concerns includes the NO_x SIP Call of 1998[1] and the Clean Air Interstate Rule[2] (CAIR) of 2005. In a more recent effort to implement the requirements of the good neighbor provision, the U.S. EPA promulgated the Cross-State Air Pollution Rule[3] (CSAPR) in 2011. CSAPR addressed the 0.08 parts per million (ppm) 8-hour ozone standard. CSAPR targets upwind emissions of oxides of nitrogen (NO_x) following the assumption that NO_x emitted in upwind states can form ozone in downwind states. The U.S. EPA applied this framework in the original CSAPR rulemaking[4] to address the Good Neighbor provision for the 1997 ozone NAAQS and the 1997 and 2006 particulate matter ($PM_{2.5}$) NAAQS. The U.S. EPA again applied this framework in an update[5] to CSAPR (referred to as the CSAPR Update) to address the Good Neighbor provision for the 2008 ozone NAAQS.

These U.S. EPA interstate transport rulemakings focused solely on identifying linkages for eastern states. Not until 2015, in consideration of Good Neighbor requirements for the 0.075 ppm 8-hour ozone standard, was the CSAPR approach applied to western states. A brief description of the CSAPR paradigm follows.

CSAPR employs a multi-step approach to determine the extent to which a state must reduce its NO_x emissions pursuant to the good neighbor provision. In the first step,

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[1] U.S. EPA, NO_x Budget Trading Program, https://www.epa.gov/airmarkets/nox-budget-trading-program#tab-2, last accessed: August 10, 2018

[2] U.S. EPA, Clean Air Interstate Rule, http://archive.epa.gov/airmarkets/programs/cair/web/html/index.html, last accessed: August 10, 2018

[3] U.S. EPA, Cross-State Air Pollution Rule (CSAPR), https://www.epa.gov/csapr, last accessed: August 10, 2018

[4] Federal Implementation Plans: Interstate Transport of Fine Particulate Matter and Ozone and Correction of SIP Approvals, 76 FR 48208 (August 8, 2011)

[5] Cross-State Air Pollution Rule Update for the 2008 Ozone NAAQS, 81 FR 74504 (October 26, 2016)

U.S. EPA identifies upwind states that “contribute significantly” to one or more downwind state(s). If a downwind state’s receptor site is not in attainment and, if an upwind state contributes emissions equivalent to one percent of the NAAQS at that site, then that upwind state is deemed to have “contributed significantly” and thus has a linkage to the downwind receptor site. Any state that has at least one linkage is subject to CSAPR.

The states with a linkage identified are then subject to the second step of CSAPR. In the second step, U.S. EPA determines the emission reductions necessary for each upwind state with a linkage to comply with their good neighbor obligations to a level at which they are no longer making a significant contribution to a downwind receptor site. In response to linkages identified by the U.S. EPA following CSAPR, a state can either demonstrate that its actual contribution is below the screening threshold, or it could evaluate the scope of its transport obligation and identify measures to achieve any needed emission reductions.

In CSAPR and the CSAPR Update, U.S. EPA used a contribution screening threshold of one percent of the NAAQS to identify upwind states that may significantly contribute to downwind nonattainment and/or maintenance problems and which warrant further analysis to determine if emissions reductions might be required from each state to address the downwind air quality problem. U.S. EPA determined that one percent was an appropriate threshold to use in the analysis for those rulemakings because there were important, even if relatively small, contributions to identified nonattainment and maintenance receptors from multiple upwind states mainly in the eastern U.S. The agency has historically found that the one percent threshold is appropriate for identifying interstate transport linkages for states collectively contributing to downwind ozone nonattainment or maintenance problems because that threshold captures a high percentage of the total pollution transport affecting downwind receptors.

Based on the approach used in CSAPR and the CSAPR Update, upwind states that contribute ozone in amounts at or above the one percent of the NAAQS threshold to a particular downwind nonattainment or maintenance receptor would be considered to be ‘‘linked’’ to that receptor. This linkage occurs in step 2 of the CSAPR framework for purposes of further analysis in step 3 to determine whether and what emissions from the upwind state contribute significantly to downwind nonattainment and interfere with maintenance of the NAAQS at the downwind receptors.

For the 2015 ozone NAAQS, the value of a one percent threshold would be 0.70 parts per billion (ppb). The individual upwind state to downwind receptor ‘‘linkages’’ and contributions based on a 0.70 ppb threshold are identified in the AQM TSD for this notice. U.S. EPA notes that, when applying the CSAPR framework, an upwind state’s linkage to a downwind receptor alone does not determine whether the state significantly contributes to nonattainment or interferes with maintenance of a NAAQS to a downwind state.

While the one percent screening threshold has been traditionally applied to evaluate upwind state linkages in eastern states where such collective contribution was identified, U.S. EPA noted in the CSAPR Update that, as to western states, there may be geographically specific factors to consider in determining whether the one percent screening threshold is appropriate. For certain receptors, where the collective contribution of emissions from one or more upwind states may not be a considerable portion of the ozone concentration at the downwind receptor, U.S. EPA and states have considered, and could continue to consider, other factors to evaluate those states' planning obligation pursuant to the Good Neighbor provision.[6] However, where the collective contribution of emissions from one or more upwind states is responsible for a considerable portion of the downwind air quality problem, the CSAPR framework treats a contribution from an individual state at or above one percent of the NAAQS as significant, and this reasoning applies regardless of where the receptor is geographically located.

U.S. EPA's Four-Step Framework

Through the development and implementation of several previous rulemakings, including most recently the CSAPR Update,[7] U.S. EPA, working in partnership with states, established the following four-step framework to address the requirements of the good neighbor provision for the ozone NAAQS:

(1) Identify downwind air quality problems;
(2) Identify upwind states that contribute enough to those downwind air quality problems to warrant further review and analysis;
(3) Identify the emissions reductions necessary (if any), considering cost and air quality factors, to prevent an identified upwind state from contributing significantly to those downwind air quality problems; and
(4) Adopt permanent and enforceable measures needed to achieve those emissions reductions.

U.S. EPA notes that, in applying this framework or other approaches consistent with the CAA, various analytical approaches may be used to assess each step. U.S. EPA has undertaken several previous regional rulemakings applying this framework, and its analytical approaches have varied over time due to continued evolution of relevant tools and information, as well as their specific application.

U.S. EPA also notes that, in developing their own rules, states have flexibility to follow the four-step transport framework (using U.S. EPA's analytical approach or somewhat different analytical approaches within these steps); or alternative frameworks, so long as

[6] See, e.g., 81 FR 31513 (May 19, 2016) (approving Arizona Good Neighbor SIP addressing 2008 ozone NAAQS based on determination that upwind states would not collectively contribute to a considerable portion of the downwind air quality problem).
[7] *See* Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group Region for Purposes of Reducing Regional Transport of Ozone (also known as the NO_x SIP Call), 63 FR 57356 (October 27, 1998); Clean Air Interstate Rule (CAIR) Final Rule, 70 FR 25162 (May 12, 2005); CSAPR Final Rule, 76 FR 48208 (August 8, 2011); CSAPR Update for the 2008 Ozone NAAQS (CSAPR Update) Final Rule, 81 FR 74504 (October 26, 2016)

their chosen approach has adequate technical justification and is consistent with the requirements of the CAA.

California's Good Neighbor SIP for the 0.075 ppm 8-Hour Ozone Standard

In August 2015, U.S. EPA published air quality modeling results[8] for the entire U.S. that estimated each state's contribution to every other state and identified upwind states that made significant contributions to downwind nonattainment and maintenance areas using photochemical modeling analyses. An upwind state was linked to a downwind nonattainment or maintenance area if U.S. EPA's modeling projected that, absent reductions, the upwind state's contribution to the downwind receptor would exceed one percent of the 0.075 ppm 8-hour ozone standard. The approach for identifying nonattainment and maintenance sites and the methods for calculating upwind state contributions were consistent with the approach and methods used in the CSAPR.[9] In its August 2015 modeling memo, U.S. EPA suggested that the one percent threshold be considered nationwide as a starting point for evaluation.

U.S. EPA's modeling projected that two monitoring sites in the Denver area would be nonattainment in 2017 and two other Denver sites would be maintenance. The modeling also projected a maintenance site in the Phoenix area. Furthermore, it indicated the potential for contributions from California to those sites.

In February 2016, CARB submitted to the U.S. EPA a Good Neighbor SIP for a number of NAAQS, including the 0.075 ppm 8-hour ozone standard set in 2008. California's 2015 interstate transport SIP for ozone focused on potential contributions from California to the Denver (Colorado) and Phoenix (Arizona) nonattainment areas. Consideration of transport impacts to those two areas was triggered by U.S. EPA's modeling.

CARB staff conducted a comprehensive assessment to evaluate whether California impacted the maintenance or attainment of the 0.075 ppm 8-hour ozone standard in any other state as required by the CAA. This interstate transport ozone SIP relied on an extensive review of U.S. EPA's photochemical modeling, air quality data, downwind receptor sites, and CARB's emission control programs, as well as a fundamental investigation of the science driving the complex nature of transport among western states.

Detailed analysis by CARB staff indicated that some limited degree of transport of ozone or ozone precursor emissions may be possible, given favorable meteorological patterns. However, significant uncertainties persist in modeling transport of photochemical pollutants in the western states. CARB provided an assessment of wildfire impacts on ozone, ozone design value trends, meteorological conditions favoring transport, and an overview of California's regulatory controls. CARB staff concluded that neither the

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[8] Notice of Availability of the Environmental Protection Agency's Updated Ozone Transport Modeling Data for the 2008 Ozone National Ambient Air Quality Standard (NAAQS), 80 FR 46271 (August 4, 2015)
[9] Federal Implementation Plans: Interstate Transport of Fine Particulate Matter and Ozone and Correction of SIP Approvals, 76 FR 48208 (August 8, 2011)

modeling (if corrected to address wildfire and model performance concerns) nor other analyses indicate that California significantly contributes to nonattainment or interferes with maintenance in other states. Also, California's continued implementation of a comprehensive and aggressive emission control program would continue to deliver emission reduction benefits.

In February 2018, U.S. EPA proposed to approve California's 2015 Good Neighbor SIP, citing the "strength of CARB and the local air districts' emission control programs, especially for mobile and stationary sources of NO_x".[10]

U.S. EPA's Photochemical Modeling

Modeling Released in January 2017

In a Federal Register notice[11] published on January 6, 2017, U.S. EPA announced availability of preliminary interstate ozone transport modeling data for the 0.070 ppm 8-hour ozone standard. This information was provided to help states develop SIPs to address Good Neighbor requirements in the CAA applicable to the 2015 ozone NAAQS.

The January 2017 notice of data availability (NODA) included: (1) Emission inventories for 2011 and 2023, supporting data used to develop those emission inventories, methods and data used to process emission inventories into a form that can be used for air quality modeling; and (2) air quality modeling results for 2011 and 2023, base period (i.e., 2009–2013) average and maximum ozone design value concentrations, projected 2023 average and maximum ozone design value concentrations, and projected 2023 ozone contributions from state-specific anthropogenic emissions and other contribution categories to ozone concentrations at individual ozone monitoring sites. A docket was established to facilitate public review of the data and to track comments.

In the notice U.S. EPA stated the data was considered preliminary, recognizing states may choose to modify or supplement these data in developing their Good Neighbor SIPs; and/or U.S. EPA could update the data for the purpose of potential future analyses or regulatory actions related to interstate ozone transport for the 2015 ozone NAAQS.

For this transport assessment, U.S. EPA used a 2011-based modeling platform to develop base year and future year emissions inventories for input to air quality modeling. This platform included meteorology for 2011, base year emissions for 2011, and future year base case emissions for 2023. The 2011 and 2023 air quality modeling results were used to identify areas that are projected to be nonattainment or have problems maintaining the 2015 ozone NAAQS in 2023. Ozone source apportionment modeling for

[10] Approval and Promulgation of Air Quality State Implementation Plans; California; Interstate Transport Requirements for ozone, Fine Particulate Matter, and Sulfur Dioxide, 83 FR 5375, 5384 (February 7, 2018)
[11] Notice of Availability of the Environmental Protection Agency's Preliminary Interstate Ozone Transport Modeling Data for the 2015 Ozone National Ambient Air Quality Standard (NAAQS), 82 FR 1733 (January 6, 2017)

2023 was used to quantify contributions from emissions in each state to ozone concentrations at each of the projected nonattainment and maintenance receptors in that future year.

The January 2017 NODA featured a revised emission inventory. The 2011 base year emissions and projection methodologies used to create emissions for 2023 are similar to what was used in the final CSAPR Update (and which U.S. EPA termed the ‘ek’ inventory). The key differences between the ‘ek’ inventories and the inventories used for the 2015 ozone NAAQS preliminary interstate transport modeling (termed the ‘el’ inventory) include updates to mobile source and electric generating unit (EGU) emissions, the inclusion of fire emissions in Canada and Mexico, and updated estimates of anthropogenic emissions for Mexico. The key differences in methodologies for projecting non-EGU sector emissions (e.g., onroad and nonroad mobile, oil and gas, non-EGU point sources) to 2023 as compared to the methods used in the final CSAPR Update to project emissions to 2017 include (1) the use of data from the U.S. Energy Information Administration Annual Energy Outlook 2016 (AEO 2016) to project activity data for onroad mobile sources and the growth in oil and gas emissions, (2) additional general refinements to the projection of oil and gas emissions, (3) incorporation of data from the Mid- Atlantic Regional Air Management Association (MARAMA) for projection of non-EGU emissions for states in that region, and (4) updated mobile source emissions for California.

U.S. EPA used the Comprehensive Air Quality Model with Extensions (CAMx) v6.32 (which featured updated chemistry) for the 2011 base year and 2023 future base case air quality modeling to identify receptors and quantify contributions for the 2015 NAAQS transport assessment.

U.S. EPA used ozone predictions from the 2011 and 2023 CAMx model simulations to project 2009–2013 average and maximum ozone design values to 2023 following the approach described in the U.S. EPA’s draft guidance for attainment demonstration modeling.[12] Applying the approach in the final CSAPR Update to the 0.070 ppm 8-hour ozone standard, those sites with 2023 average design values of 71 ppb or greater, and that are currently measuring nonattainment, would be considered to be nonattainment receptors in 2023. Similarly, monitoring sites with a projected 2023 maximum design value of 71 ppb or greater would be projected to be maintenance receptors in 2023. In the CSAPR Update approach, maintenance-only receptors include both those monitoring sites where the projected 2023 average design value is below the NAAQS, but the maximum design value is above the NAAQS, and monitoring sites with projected 2023 average design values that exceed the NAAQS, but for which current design values based on measured data do not exceed the NAAQS.

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[12] The December 3, 2014 ozone, fine particulate matter, and regional haze SIP modeling guidance is available at https://www3.epa.gov/scram001/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf, last accessed: August 10, 2018

After identifying potential downwind air quality problems by projecting base period 2009-2013 average and maximum ozone design values to 2023 at monitoring sites nationwide, U.S. EPA next performed nationwide, state-level ozone source apportionment modeling using the CAMx Anthropogenic Precursor Culpability Analysis (APCA) technique[13] to provide information regarding the expected contribution of 2023 base case nitrogen oxides (NO_x) and volatile organic compound (VOC) emissions from all sources in each state to projected 2023 ozone concentrations at each air quality monitoring site. In the source apportionment model run, U.S. EPA tracked the ozone formed from each of the following contribution categories *(i.e.,* "tags"):

- States- anthropogenic NO_x and VOC emissions from each of the contiguous 48 states and the District of Columbia tracked individually (U.S. EPA combined emissions from all anthropogenic sectors in a given state);
- Biogenics - biogenic NO_x and VOC emissions domain-wide *(i.e.,* not by state);
- Initial and Boundary Concentrations- concentrations transported into the modeling domain from the latera l boundaries;
- Tribal Lands - the emissions from those tribal lands for which U.S. EPA has point source inventory data in the 2011 NEI (U.S. EPA did not model the contributions from individual tribes);
- Canada and Mexico - anthropogenic emissions from sources in those portions of Canada and Mexico included in the modeling domain (U.S. EPA did not separately model contributions from Canada or Mexico);
- Fires - combined emissions from wild and prescribed fires domain-wide *(i.e.,* not by state); and
- Offshore - combined emissions from offshore marine vessels and offshore drilling platforms *(i.e.,* not by state).

U.S. EPA performed the CAMx source apportionment model simulation for the period May 1 through September 30 using the 2023 future base case emissions and 2011 meteorology for this time period.

<u>Modeling Released in October 2017</u>

In an October 2017 memorandum[14], U.S. EPA provided projected ozone design values for 2023 based on U.S. EPA's updated nationwide ozone modeling with the stated primary goal of assisting states in completing good neighbor transport actions for the 0.075 ppm 8-hour ozone NAAQS. The updated modeling indicated there were no monitoring sites outside of California projected to have nonattainment or maintenance

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[13] "As part of this technique, ozone formed from reactions between biogenic VOC and NO_x with anthropogenic NO_x and VOC are assigned to the anthropogenic emissions", U.S. EPA TSD p14, December 2016

[14] The October 27, 2017 Memo and Supplemental Information is available at https://www.epa.gov/airmarkets/october-2017-memo-and-supplemental-information-interstate-transport-sips-2008-ozone-naaqs, last accessed: August 10, 2018

problems for the 0.075 ppm 8-hour ozone standard in 2023. This release did not include source apportionment modeling.

U.S. EPA's October 2017 modeling was the result of inventory and modeling updates based on comments received comments on the January 2017 transport modeling NODA. Following the close of the NODA public comment period, U.S. EPA began incorporating stakeholder feedback into its EGU and non-EGU emissions projections, and its modeling platform. Incorporating stakeholder input, U.S. EPA developed an updated version (termed the 'en' inventory) of the 2011 and projected 2023 emissions inventories. This 'en' inventory included specific changes to the oil and gas projection methodology[15], and changes to EGU emissions projections.[16] U.S. EPA also made changes to the modeling platform.

Regarding EGU emissions, U.S. EPA used the CSAPR Update budget-setting approach to develop a revised projection. The EGU projection begins with 2016 reported Part 75 sulfur dioxide (SO_2) and NO_x data for units reporting under the Acid Rain and CSAPR programs. U.S. EPA then extended these observed emissions levels forward to 2023, and made unit-specific adjustments to emissions to account for upcoming retirements, post-combustion control retrofits, coal-to-gas conversions, combustion controls upgrades, new units, CSAPR Update compliance, state rules, and Best Available Retrofit Technology (BART) requirements.[17] The resulting estimated EGU emissions values in the 'en' version of the inventory are based on the latest reported operational data combined with known and anticipated fleet and pollution controls changes.

Another important emissions inventory update includes a revised methodology for estimating 2023 emissions from the oil and gas sector. The projection factors used in the updated 2023 oil and gas emissions incorporate state-level factors based on historic growth from 2011-2015 and region-specific factors that represent the projected growth from 2015 to 2023. The 2011-2015 state-level factors were based on historic state oil and gas production data published by the EIA, while the 2015-2023 factors are based on projected oil and gas production in EIA's 2017 Annual Energy Outlook (AEO) Reference Case without the Clean Power Plan for the six EIA supply regions.

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[15] Additional Updates to Emissions Inventories for the Version 6.3, 2011 Emissions Modeling Platform for the Year 2023, p5, October 2017, available at https://www.epa.gov/sites/production/files/2017-11/documents/2011v6.3_2023en_update_emismod_tsd_oct2017.pdf, last accessed: August 9, 2018
[16] Additional Updates to Emissions Inventories for the Version 6.3, 2011 Emissions Modeling Platform for the Year 2023, p6, October 2017, available at https://www.epa.gov/sites/production/files/2017-11/documents/2011v6.3_2023en_update_emismod_tsd_oct2017.pdf, last accessed: August 9, 2018
[17] U.S. EPA uses the U.S. Energy Information Association (EIA) Form 860 as a source for upcoming controls, retirements, and new units.

U.S. EPA used the Comprehensive Air Quality Model with Extensions (CAMx v6.40) for modeling the updated emissions in 2011 and 2023.[18] CAMx v6.40 was the most recent public release version of CAMx at the time the U.S. EPA updated its modeling in fall 2017. As before, U.S. EPA used outputs from the 2011 and 2023 model simulations to project base period 2009-2013 average and maximum ozone design values to 2023 at monitoring sites nationwide. In addition, in light of comments on the January 2017 NODA and other analyses, U.S. EPA also projected 2023 design values based on a modified version of this approach for those monitoring sites located in coastal areas. In this alternative approach, U.S. EPA eliminated from the design value calculations those modeling data in grid cells not containing a monitoring site that are dominated by water (i.e., more than 50 percent of the land use in the grid cell is water).

Modeling Released in March 2018

In March 2018, U.S. EPA released a memorandum[19] with U.S. EPA's air quality modeling data for ozone for the year 2023 (previously released in October 2017 as described above), including newly available contribution modeling results.

U.S. EPA disclosed changes to its modeling methodology relative to quantification of contributions from states. In its January 2017 modeling, a minimum of the five highest ozone days in 2023 were used for determining state contributions at receptor sites. In subsequent modeling releases, the top ten modeled days in 2023 were used.

In this memorandum, U.S. EPA invited states consider using this latest round of national modeling to develop SIPs that address requirements of the good neighbor provision for the 2015 ozone NAAQS. U.S. EPA noted that states may supplement the information provided in that memorandum with any additional information that they believe is relevant to addressing the good neighbor provision requirements. States may also choose to use other information to identify nonattainment and maintenance receptors relevant to development of their good neighbor SIPs. If this is the case, states should submit that information along with a full explanation and technical analysis. U.S. EPA encouraged collaboration among states linked to a common receptor and among linked upwind and downwind states in developing and implementing a regionally consistent approach.

In addition, the memorandum was accompanied by "Attachment A", which provided a preliminary list of potential flexibilities in analytical approaches for developing a good neighbor SIP that may warrant further discussion between U.S. EPA and states.

[18] Air Quality Modeling Technical Support Document for the Updated 2023 Projected Ozone Design Values, p2, June 2018, available at https://www.epa.gov/sites/production/files/2018-06/documents/aq_modelingtsd_updated_2023_modeling_o3_dvs.pdf, last accessed: August 9, 2018
[19] The March 27, 2018 Memo and Supplemental Information is available at https://www.epa.gov/airmarkets/march-2018-memo-and-supplemental-information-regarding-interstate-transport-sips-2015, last accessed: August 9, 2018

U.S. EPA identified several guiding principles to consider when evaluating the appropriateness of the concepts introduced in this attachment, including:

- Encouraging collaboration among states linked to a common receptor and among linked upwind and downwind states in developing and applying a regionally consistent approach to identify and implement good neighbor obligations; and
- The potential value of considering different modeling tools or analyses in addition to U.S. EPA's, provided that any alternative modeling is performed using a credible modeling system which includes "state-of-the-science" and "fit for purpose" models, inputs, and techniques that are relevant to the nature of the ozone problem. The use of results from each alternative technique should be weighed in accordance with the scientific foundation, construct, and limitations of the individual techniques.

U.S. EPA Modeling Results for 2023

In releasing each round of modeling results, U.S. EPA invited states to use the results in their Good Neighbor SIPs for the 0.070 ppm 8-hour ozone standard. CARB staff has reviewed and assessed these results. This review informed CARB staff's conclusions about California's impacts on other states.

CARB staff reviewed the results of U.S. EPA's modeling runs released in January 2017, October 2017, and March 2018. Note: The October 2017 and March 2018 modeling releases had identical design values for 2023. However, while contribution modeling was not included in the October 2017 modeling, it was made available in the March 2018 release.

The details of U.S. EPA's contribution modeling are addressed in Step 2 of this analysis. Here, we present model results for monitoring sites that were projected either to be nonattainment or maintenance in either the January 2017 or the October 2017 modeling. For the few western state sites outside of California so identified by U.S. EPA, California contributions were small but still in excess of one percent of the current ozone standard (or greater than 0.70 ppb), which for interstate transport purposes in eastern states (CSAPR) is considered a significant impact when the downwind monitor is projected to be nonattainment or maintenance.

For those western states with current nonattainment areas for the 0.070 ppm 8-hour ozone standard (Arizona, Colorado, Nevada, Utah, and Wyoming), CARB staff reviewed U.S. EPA's interstate transport ozone modeling output. According to U.S. EPA's modeling, Nevada, Utah, and Wyoming did not have any nonattainment or maintenance sites in 2023. Therefore, CARB's evaluation of California's impacts on other states focused on potential contributions to Colorado and Arizona's sites as identified by U.S. EPA's photochemical modeling.

Table 1 below shows that for the January 2017 modeling (the 'el' modeling), there were no monitors in Colorado projected to be nonattainment. However, three Colorado monitors were projected to be maintenance.

For Arizona, the 'el' modeling did not project any monitors to have problems with nonattainment or maintenance of the 0.070 ppm 8-hour ozone standard.

The October 2017 modeling's 2023 ozone design value projections in Table 1 were higher than the projections from the 'el' modeling. At Colorado's sites, they differed by less than one ppb to about three ppb. These changes to projected ozone levels resulted in Colorado having three monitors with nonattainment problems and three with maintenance problems.

At Arizona sites, U.S. EPA's October 2017 modeling yielded design values that were from approximately 1 ppb to 1.5 ppb higher than projected in U.S. EPA's January 2017 release. These increases were sufficient to shift two sites from projected attainment to projected maintenance.

TABLE 1: U.S. EPA October 2017 Modeled Design Values at Receptor Sites

Site	*County*	*Ozone Monitor Designation AQS #*	*'el' modeling January 2017*		*'en' modeling October 2017*	
			Average 2023 DV (ppb)	*Maximum 2023 DV (ppb)*	*Average 2023 DV (ppb)*	*Maximum 2023 DV (ppb)*
COLORADO						
Chatfield	Douglas	08–035–0004	69.6	71.6	71.1	73.2
Rocky Flats North	Jefferson	08–059–0006	70.5	72.9	71.3	73.7
NREL	Jefferson	08–059–0011	69.7	72.7	70.9	73.9
Fort Collins West	Larimer	08–069–0011	68.6	70.4	71.2	73.0
Highland Reservoir	Arapahoe	08–005–0002	68.0	70.0	69.3	71.3
Weld Co. Tower	Weld	08–123–0009	67.2	68.3	70.2	71.4
ARIZONA						
West Phoenix	Maricopa	04–013–0019	67.9	70.0	69.3	71.4
North Phoenix	Maricopa	04–013–1004	68.7	69.8	69.8	71.0

Table 2 below summarizes the impact of modeling changes to projected attainment status at sites in Colorado and Arizona.

TABLE 2: Modeling Changes Impact on Number of Receptor Sites

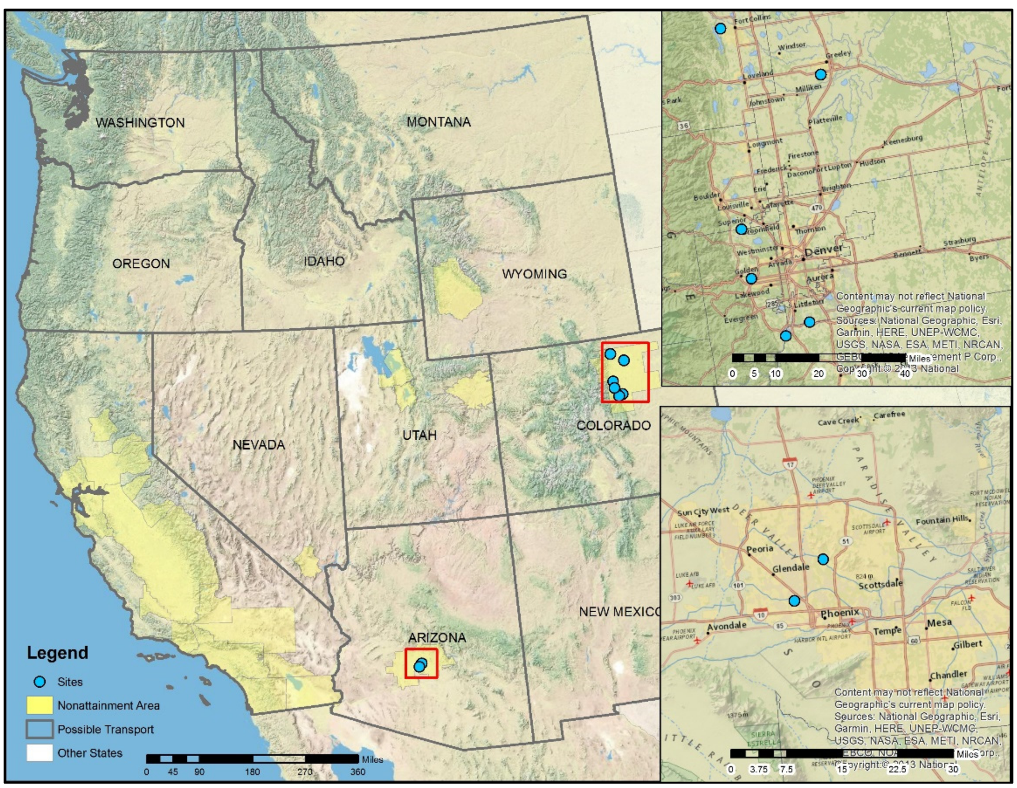
Impact of Modeling Update	*2023 'el' Modeling Results*		*2023 'en' Modeling Results*	
	Number of Nonattainment Sites	*Number of Maintenance Sites*	*Number of Nonattainment Sites*	*Number of Maintenance Sites*
Colorado	0	3	3	3
Arizona	0	0	0	2

As was the case with U.S. EPA's 'el' modeling, the 'en' modeling did not project nonattainment or maintenance problems in western states apart from California, Colorado and Arizona.

Step One & Two: Identify Downwind Receptors and Upwind Contributions

Figure 1 identifies the maintenance/nonattainment receptors addressed in this document and gives an idea of their proximity to California as well as their placement within their respective nonattainment areas.

FIGURE 1: State of California and Location of Maintenance Receptors for 0.070 ppm Ozone NAAQS



Transport Assessment for Colorado Receptors

In assessing the potential for transport impacts from California to Colorado receptors, CARB staff considered the following elements: the geographic setting of receptor sites in Colorado, including distances from California and intervening terrain which pollutants from California must traverse; meteorological conditions conducive to high ozone at receptor sites; trajectory analyses; and U.S. EPA's recent rounds of modeling. Modeling analyses also looked at the impact of wildfires on future year design values and differences in state contributions in recent rounds of modeling.

The Denver Metro/North Front Range nonattainment area was classified as a marginal nonattainment area in 2018 with an attainment deadline of 2021.

As of 2010, the Denver nonattainment area contained a population of 3.4 million people. The nonattainment area contains the counties of Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson, as well as portions of Larimer and Weld counties. This nonattainment area is smaller than the previous Denver-Boulder-Greeley-Ft Collins-Loveland nonattainment area designated for the 0.075 ppm 8-hour ozone standard, which also included Clear Creek, Elbert, Gilpin, and Park counties.

Geographically the Denver-Aurora-Lakewood Core Based Statistical Area (CBSA) is located at the base of the Front Range, or the eastern edge of the Rocky Mountains on a generally flat plateau at approximately 5,200 feet. With the Front Range running north-to-south and extending up to an altitude of 8,000 feet, it forms an abrupt barrier to air flow on the western side of the metropolitan area. The southern and southeastern end of the CBSA is bound by more gradually rising mountains, still reaching up to nearly 6,500 feet and also forming a significant barrier to air flow. To the east and north of the Denver area, there are gradually rising hills that rise a couple hundred feet above the city center elevation, but the region is generally open to airflow in those directions.

During the summer months, upper-level high pressure systems over the Rocky Mountains and Central Plains produce mostly sunny skies, temperatures around 90-95° F, and light winds in the Denver region, causing local wind flow patterns to be dominated by terrain and differential heating across the area. These conditions are conducive for the accumulation of local emissions and the formation of ozone.

Ideal ozone formation conditions involve surface high pressure to the east-northeast of the Denver area, which produce light east-northeasterly winds and push emissions into the foothill areas to the west-southwest portions of the region, which is where the National Renewable Energy Labs, Chatfield, and Rocky Flats North ozone monitoring sites are located. These monitoring sites typically have the highest ozone concentrations in the region. These sites are also located anywhere from 300 feet to 800 feet in elevation above Denver, putting them higher in the mixed layer of the atmosphere and away from most of the primary emission sources that can scavenge ozone from the air. This feature allows ozone concentrations to remain higher for more hours, leading to higher 8-hour averages.

Another local feature that can develop under broad high-pressure days is upslope and downslope flow in the foothill regions where several monitoring sites are located. During the day, heating of the foothills can lead to upslope winds that draw air from the metropolitan area toward the monitoring sites. At night, the air in the less populated and less developed foothill areas and over the mountain slopes cools and drains back into the metropolitan area. This diurnal recirculation pattern allows emissions and ozone concentrations to build up over multi-day periods, similar to what was seen from July 22-24, 2017, when two of the top five highest ozone days of the summer occurred. During the three days, 8-hour average ozone concentrations peaked at 0.078 ppm on July 24 and reached 0.077 ppm on July 23. The flow from the northeast propelled the air far enough into the Front Range gaps on July 24, that even the Aspen Park monitoring site, over 21 miles to the southwest of Denver, reached a 1-hour concentration of 0.075 ppm. This resulted in the site's second highest 8-hour average concentration in 2017 of 0.068 ppm.

Complicating issues in the region, wildfires across the western United States can also impact ozone in the Denver area. Large wildfires often occur during the late summer into fall months, generating massive amounts of smoke that can blanket vast skies many states downwind before fully dispersing. Occasionally, this smoke can be entrained within the mixing layer and brought down to the surface. When ample sunlight is able to reach this smoke, ozone can be generated and transported into an area, significantly increasing ozone values in the region. This occurred on September 04, 2017, when wildfires across five states in the northwestern U.S. generated a thick plume of smoke across Wyoming and southern Montana. Smoke was blown southward along the Front Range where an ample portion mixed down to the surface. During this event, 8-hour average ozone concentrations reached 0.078 ppm at the Rocky Flats North site and flowed through the National Renewable Energy Labs site and all the way to Aspen Park with 1-hour concentrations of 0.101 ppm and 0.098 ppm, respectively.

Modeled Receptors in Colorado

U.S. EPA's modeling showed impact from California at greater than the one percent threshold at six receptor sites in Colorado (Figure 2). Following is location information, receptor characterization, as well as 8-hour ozone design values for 2011-2013, the base year design values used in projections for 2023, for each of the receptors listed in Table 3.

FIGURE 2: Denver-Boulder-Greeley-Ft Collins-Loveland, CO Nonattainment Area

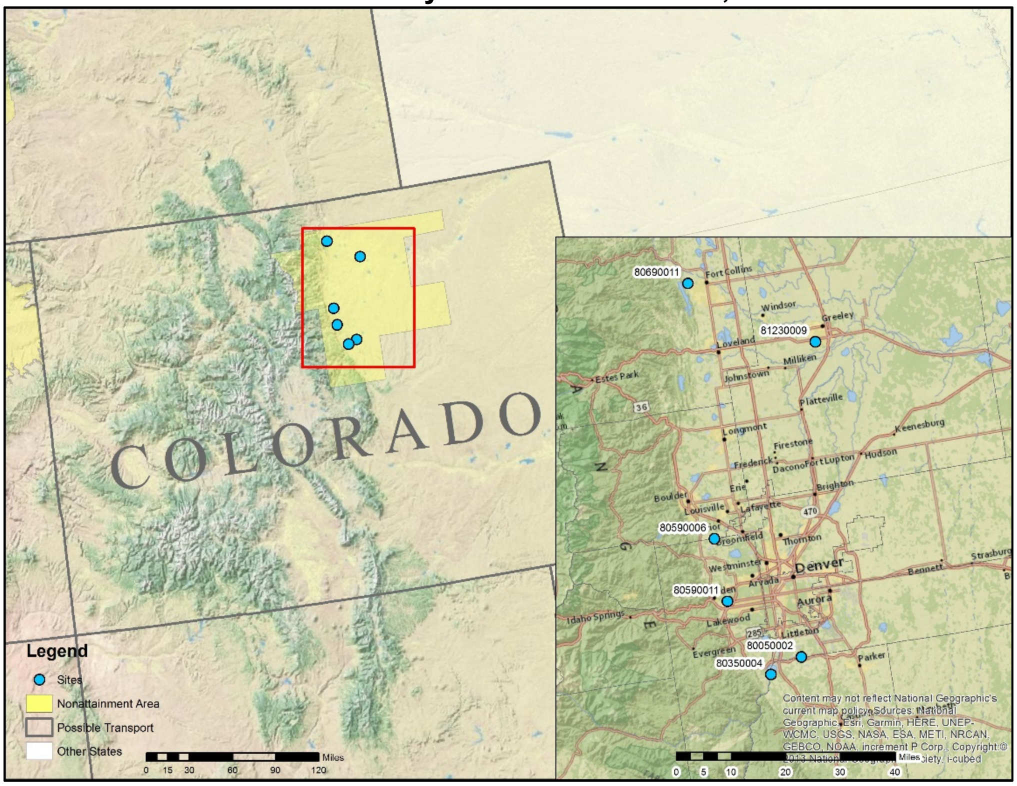


TABLE 3: Ozone Receptors in the State of Colorado

County	Site Name	AQS ID	8-Hr Design Value (ppm)			Receptor Type	Approximate Distance to California Border (miles)
			2011	2012	2013		
Douglas	Chatfield State Park	08-035-0004	0.077	0.082	0.083	Nonattainment	611
Jefferson	Rocky Flats - North	08-059-0006	0.078	0.080	0.083	Nonattainment	618
Larimer	Fort Collins - West	08-069-0011	0.076	0.078	0.080	Nonattainment	646
Arapahoe	Highland Reservoir	08-005-0002	0.074	0.077	0.079	Maintenance	618
Jefferson	National Renewable Energy Labs	08-059-0011	0.075	0.079	0.082	Maintenance	612
Weld	Greeley-Weld County Tower	08-123-0009	0.072	0.076	0.076	Maintenance	657

Modeled Nonattainment Receptors in Colorado

Chatfield State Park

Chatfield State Park is located in the southern portion of the Denver nonattainment area and roughly four miles from the foot of the Rocky Mountains at an elevation of about 5,500 feet. Additionally, the site is located about 15 miles south of the city of Denver. The Rocky Mountains run northwest to southeast through Douglas County.

Douglas County has the eighth highest population in the Colorado. The neighboring counties are Jefferson to the west and Arapahoe to the north.

Rocky Flats North

Rocky Flats North is located towards the western portion of the Denver nonattainment area and is located in the very northern part of Jefferson County. Roughly five miles from the foot of the Rocky Mountains, the monitor has an elevation of about 5,900 feet. Additionally, the site is located about 16 miles northwest of the city of Denver. The Rocky Mountains run northwest to southeast through Jefferson County.

Jefferson County has the fourth highest population in Colorado. The neighboring counties are Boulder to the north, Arapahoe and Denver to the east, and Douglas to the southeast.

Fort Collins West

Fort Collins West is located in the northern portion of the Denver nonattainment area within Larimer County. Furthermore, the monitor is located at an elevation of about 5,200 feet, approximately two miles from the foot of the Rocky Mountains and 59 miles north of the city of Denver. The Rocky Mountains run northwest to southeast through Larimer County.

Larimer County was the sixth most populated county in Colorado. The neighboring counties are Jacks to the west, Grand and Boulder to the south, and Weld to the east with the state of Wyoming to the north.

<u>Modeled Maintenance Receptors in Colorado</u>

Highland Reservoir

Highland Reservoir is located towards the southern portion of the Denver nonattainment area and is located in the southwestern part of Arapahoe County. It is located roughly 10 miles from the foot of the Rocky Mountains at an elevation of about 5,700 feet. Additionally, the site is located about 12 miles south of the city of Denver.

Arapahoe County has the third highest population in the state of Colorado. The neighboring counties are Adams to the north, Denver and Jefferson to the west, and Douglas to the south.

National Renewable Energy Labs (NREL)

NREL is located towards the western portion of the Denver nonattainment area and is in the northern portion of Jefferson County. NREL is located roughly three miles from the foot of the Rocky Mountains at an elevation of about 6,000 feet. Additionally, the site is located about 10 miles west of the city of Denver. The Rocky Mountains run northwest to southeast through Jefferson County.

Jefferson County has the fourth highest population in the Denver nonattainment area. The neighboring counties are Boulder to the north, Arapahoe and Denver to the east, and Douglas to the southeast.

Greeley-Weld County Tower

Greeley-Weld County Tower is located in the northern portion of the Denver nonattainment area and is located in the southwestern part of Weld County. It is located approximately 23 miles from the foot of the Rocky Mountains at an elevation of about 4,900 feet. Furthermore, the site is about 46 miles north of the city of Denver.

Weld County was the ninth largest county by population in Colorado. The neighboring counties are Larimer and Boulder to the west, Adams to the south, Morgan to the southeast, and Logan to the east with Wyoming to the north.

<u>Trajectory Analysis of Impact from California to Colorado</u>

Due to the large distance between California and Colorado and the widespread presence of complex terrain, CARB staff conducted a trajectory analysis. The goal of the trajectory analysis was to evaluate the potential for transport of ozone or ozone precursors from California to Colorado. In this analysis, CARB staff used the National Oceanic and Atmospheric Administration (NOAA) Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model for computing trajectories. The HYSPLIT model is an analytical tool that calculates the path of an air parcel either backward or forward in time. In addition, this tool allows one to examine air parcel movement from various altitudes above the ground. The web-based[20] version of the model was used for this analysis. Trajectory analysis cannot confirm transport but can provide insight on the potential for transport and the potential frequency of transport. Moreover, trajectory models represent movement of air parcels through space but do not confirm transport of emissions. Even if a parcel of air passed through a particular location, emissions intercepted by the parcel can vary markedly depending on chemical and physical properties of the local environment and the air parcel.

CARB staff computed backward trajectories from Colorado receptor sites on high ozone days in June and July. June and July were chosen by CARB staff because these months have most of the high ozone days. North American Mesoscale Forecast System (NAM) 12 km meteorological data were used for each trajectory run. Nine individual back trajectories were modeled for each site exceedance day corresponding to three altitude levels for the beginning hour, middle hour, and end hour of the daily maximum 8-hour ozone concentration. Trajectories were initiated from 10, 1000, and 2000 meters above

[20] http://ready.arl.noaa.gov/HYSPLIT.php

ground level with a duration of 96 hours. For back trajectories that reached from Colorado back to California, CARB staff noted whether the height of the beginning point in Colorado and the ending point in California were above or within the mixed layer, as determined by the HYSPLIT model. As defined by NOAA, "…the mixed layer is the part of the atmosphere that easily exchanges heat and momentum with the surface. It is well mixed due to the wind turbulence introduced by frictional effects of the surface and the surface heating induced thermals. Pollutants become well dispersed in this layer. It is usually capped by a temperature inversion (temperature increases with height at the top of the boundary layer limiting mixing)".

As a result of the analysis, only two percent of the nearly 500 backward trajectories indicated parcels may have traveled from a mixed layer within California to a mixed layer at the Colorado receptor sites. For this small number of back trajectories, forward trajectories from California were also run, starting at 10 meters above the ground. The objective of the 10 meter forward trajectory was to confirm that source emissions near the surface would be intercepted by the mixed layer at the receptor sites, thus verifying the backwards trajectory. The duration of the forward trajectories was 96 hours. For those trajectories that reached a Colorado receptor site, it was noted whether the trajectory end point was above or within the mixed layer and whether the forward trajectory was similar in duration to the backward trajectory. Only one forward trajectory from the mixed layer in California reached the mixed layer at a Colorado receptor site, suggesting that the complexity of the physical environment between California and Colorado limits the reproducibility of modeled transport and that considerable multi-faceted analyses would be necessary to explore transport mechanisms through areas of complex terrain.

Also, CARB staff reviewed NOAA 500 millibar charts and found that upper-level weather patterns and winds on days leading up to and on the days the back trajectories reached California were generally supportive and consistent. Generally, the patterns on the start day of the back trajectory were a Great Basin or Midwest high pressure combined with a western U.S. trough or trough off the western U.S. coast. Winds aloft during these patterns are generally from the southwest from California to Colorado, but may also curl in a clockwise direction when over the Great Basin. Subsequent days prior to the back trajectory start day, upper-level pressure patterns were located a bit further west each day back in time.

However, despite the upper-level weather patterns supporting flow along a path from California to Colorado for many of the trajectory days, the key finding was that the air was almost always above the mixed layer over California, Colorado, or both, meaning the air at the surface was decoupled from the aloft air. Without vertical mixing of the air between the mixed layer near the ground and the upper-level, little-to-no impact from transport of emissions or pollutants would be expected at the surface.

In summary, the trajectory analysis indicated that transport from California emission source areas to Colorado is possible, but is extremely unlikely on high ozone days at the six receptor sites in Colorado. In terms of frequency or establishing a firm understanding of mechanisms, there were very low percentages of back and forward trajectories where an air parcel within the mixed layer at the Colorado receptor sites had a trajectory back to the mixed layer within California. Given the distance (over 800 miles), complex terrain, and entrainment of ozone and precursors from other source regions along trajectory paths, there would be significant physical and chemical processing of transported air masses during transit. Thus, considerable multi-faceted analyses would be necessary to more accurately and confidently quantify California's contribution, if any, to ozone concentrations measured in Colorado, especially on exceedance days. Such further analysis is provided next.

CARB's analysis generally comports with Colorado's conceptual model for the Denver Metro/North Front Range attainment SIP for the 0.075 ppm 8-hour ozone standard. The following text in that SIP's Weight of Evidence analysis from Section 5.11.3 is excerpted below.

Colorado's Conceptual Model in its 0.075 ppm Attainment SIP

High ozone events are typically associated with specific meteorological conditions that favor optimal ozone photochemistry and limited dispersion. A key objective of the weight of evidence analysis is to determine if the modeled high–concentration events are representative of a range of conditions known to be associated with high concentrations in the region. In the recent paper by Reddy and Pfister (2016) that explores the relationships between meteorology and ozone, it is concluded that increases in upper level high pressure strength "lead to high July ozone in much of the western U.S., particularly in areas of elevated terrain near urban sources with high emissions of NO2 and other ozone precursors. In addition to bringing warmer temperatures, upper level ridges in this region reduce westerlies at the surface and aloft and allow cyclic terrain–driven circulations to reduce transport away from sources. Upper level ridges can also increase background concentrations within the ridge. Ozone and NO2 concentrations build locally, and deeper vertical mixing in this region provides a potential mechanism for recapture of ozone in layers aloft. Ozone precursors and reservoir species in large–scale basin drainage flows can be brought back to source areas and nearby mountains by daytime, thermally driven upslope flows."

The key elements of a conceptual model for high–concentration episodes along the Front Range include:

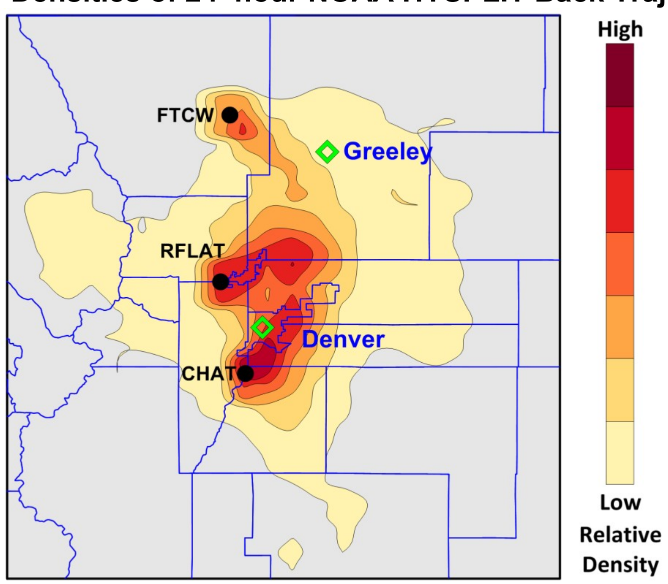
1) The presence of an upper–level high pressure system or ridge,
2) Reduced westerly winds, especially during the day,
3) Thermally–driven upslope flow towards the Continental Divide during the day and downslope drainage flows into the Platte Valley at night. This diurnal cycle of winds enhances the potential for the accumulation of ozone

precursors and ozone within the region, especially when this cyclic pattern recurs over a period of days.

Figure 23 (adapted from Reddy and Pfister, 2016) shows the source regions for the four highest 8–hour concentrations each year at Fort Collins West, Rocky Flats North, and Chatfield for 2006 through 2008. The source region patterns are based on the relative densities of 24–hour National Oceanic and Atmospheric Administration (NOAA) (Hybrid Single–Particle Lagrangian Integrated Trajectory (HYSPLIT) back trajectories[23,24] for each hour contributing to the maximum 8–hour concentrations. These patterns show that high ozone concentrations at Fort Collins West, Rocky Flats, and Chatfield are associated with thermally–driven upslope flow from the southeast, east–northeast, and northeast respectively.

[23] Draxler, R., and G. Rolph (2014), HYSPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectory) model access via NOAA ARL READY website. [Available at http://www.arl.noaa.gov/HYSPLIT.phpNOAA Air Resources Laboratory, College Park, MD.]
[24] Rolph, G. D. (2014), Real-time Environmental Applications and Display sYstem (READY) website. [Available at http://www.ready.noaa.govNOAA Air Resources Laboratory, College Park, MD.]

Figure 23 – Source Regions for Four Highest 8–hour Concentrations Based on Relative Densities of 24–hour NOAA HYSPLIT Back Trajectories



Colorado's ozone SIP for the 0.075 ppm 8-hour ozone standard included in its weight of evidence (WOE) analysis a treatment of the days flagged as exceptional events and their impact on future year ozone projections. U.S. EPA found this analysis compelling and approved Colorado's SIP. Next, we first describe Colorado's approach; and then we apply it to U.S. EPA's modeling results for Colorado for the 0.070 ppm 8-hour ozone standard.

Supplemental Analysis in Colorado's Ozone Attainment Plan for the 0.075 ppm Standard

The 2016 attainment SIP for the Denver Metro/North Front Range (DM/NFR) moderate ozone nonattainment area included in its WOE section a number of supplemental modeling analyses. In this Good Neighbor SIP for California, we highlight one such analysis which U.S. EPA viewed favorably[21] when approving the 2016 attainment SIP for the 0.075 ppm 8-hour ozone standard. That analysis addressed what Colorado considered to be the undue impact of exceptional events (such as wildfires) on modeled projections of attainment year ozone levels. The DM/NFR attainment SIP shows the area would attain by 2017 if the undue impact of catastrophic Colorado wildfires in 2010-2013 were removed from modeling projections.

Colorado had flagged a number of high ozone concentrations as natural event qualifiers in EPA's AQS database during the period 2009–2013. Because those events would not affect design values in the area's attainment year, Colorado did not develop or submit official exceptional events demonstrations to U.S. EPA. Later, Colorado consulted with its EPA regional office (Region 8) and conducted supplemental analyses excluding flagged days from the base year design value calculations to determine the impact on base year and future year design values.

Colorado removed daily ozone concentrations from these flagged exceptional events from the monitoring data used to calculate base year design values for modeling. This lowered the base year design values by 1–2 ppb at each of the four monitoring sites that were otherwise projected to exceed the 0.075 ppm 8-hour ozone standard in attainment modeling for 2017. The results as they appeared in Table 4 of Colorado's SIP are presented below:

[21] Approval and Promulgation of State Implementation Plan Revisions; Colorado; Attainment Demonstration for the 2008 8-Hour Ozone Standard for the Denver Metro/North Front Range Nonattainment Area, and Approval of Related Revisions, 83 FR 31068 (July 3, 2018)

TABLE 4: Design Value Calculations for Select Sites with Flagged Events Removed 4th Maximum Values, 2009–2013 (from Colorado SIP)

Year	4th Maximum Ozone Values (ppb) Chatfield	Rocky Flats–North	NREL	Fort Collins–West
2009	71	79	68	73
2010	78	76	74	74
2011	81	81	83	80
2012	79	79	77	76
2013	83	81	82	80
3–Year Design Values with flagged data Excluded				
DV: 2009–2011	76	78	75	75
DV: 2010–2012	79	78	78	76
DV: 2011–2013	81	80	80	78
Average Design Values (2009–2013)				
Flagged Data Excluded	**78.7**	**78.7**	**77.7**	**76.3**
Flagged Data Included	*80.7*	*80.3*	*78.7*	*78.0*

Colorado's attainment SIP then presented in Table 5 (below) the impact on projected future year design values of removing flagged data from the base year design values. Future year design values were similarly projected to be reduced by 1–2 ppb. Colorado pointed out that this analysis further supported Colorado's weight of evidence attainment demonstration.

TABLE 5: Modeled Attainment Test for All DM/NFR Ozone Monitoring Locations (RRFs for Top 10 Modeled Days Excluding Flagged Days (4 km)) (from Colorado SIP)

Monitor	County	Base Year (2011) DV (ppb)	Exceptional Events Omitted 3x3 Grid Array (4 km)			Exceptional Events Omitted 7x7 Grid Array (4 km)		
			RRF	2017 DV (ppb)	Final 2017 DV (ppb)	RRF	2017 DV (ppb)	Final 2017 DV (ppb)
Chatfield	Douglas	78.7	0.9453	74.4	74	0.9391	73.9	73
Rocky Flats North	Jefferson	78.7	0.9493	74.7	74	0.9441	74.3	74
NREL	Jefferson	77.7	0.9591	74.5	74	0.9442	73.4	73
Fort Collins West	Larimer	76.3	0.9179	70.0	70	0.9098	69.4	69

Table 5 also addresses impacts of using a larger modeling grid of 49 cells instead of 9 cells to predict future year ozone levels. We utilized a different analytical approach in CARB's WOE.

As mentioned above, U.S. EPA approved Colorado's attainment demonstration in the Denver Metro/North Front Range moderate ozone SIP for the 0.075 ppm 8-hour ozone standard. In its proposed approval notice[22], U.S. EPA noted that Colorado also evaluated high ozone days from 2009 to 2013 that were likely influenced by atypical activities such

[22] Promulgation of State Implementation Plan Revisions; Colorado; Attainment Demonstration for the 2008 8-Hour Ozone Standard for the Denver Metro/North Front Range Nonattainment Area, and Approval of Related Revisions, 83 FR 14807 (April 6, 2018)

as wildfire or stratospheric intrusion, but were included in the calculation of the 2011 baseline ozone design value. While Colorado did not submit formal demonstrations under the Exceptional Events Rule[23] for these days because they do not affect the attainment status, which is evaluated based on 2015–2017 monitoring data, these days do affect the baseline design value and thus affect the model projected future design value for 2017. U.S. EPA notes that all future design values when using a revised 2011 baseline design value are below the 0.075 ppm 8-hour ozone standard when data possibly influenced by atypical activities are excluded in the calculation of the 2011 design values. U.S. EPA concurred with Colorado's assessment that the model was properly configured, met its performance requirements, and was appropriately used in its application. U.S. EPA made a finding that the WOE analysis supports a determination that the area will attain the 0.075 ppm 8-hour ozone standard by 2017.

Impact of Excluding Flagged Exceptional Events on Most Recent Modeling for 2023

One of the potential flexibilities that U.S. EPA itemized in Attachment A to its March 28, 2018 memo, and under the heading "Consideration of model performance," was the option to consider removal of certain data from modeling analysis for the purposes of projecting design values and calculating the contribution metric where data removal is based on model performance and technical analyses support the exclusion.

Here, we further develop and apply the exceptional event theme that Colorado relied on in its attainment SIP WOE, and which U.S. EPA considered valid. The approach is now applied to modeling for future year 2023. Future year modeling for 2023 shares the same base year of 2011 as was used in Colorado's attainment SIP for the 0.075 ppm 8-hour ozone standard. The approach described below is consistent with the WOE analysis that Colorado submitted for the Denver Metro/North Front Range moderate ozone SIP for the 0.075 ppm 8-hour ozone standard, which U.S. EPA approved. It also meets the following guiding principles identified by U.S. EPA in Attachment A, "Consistency with respect to EPA's SIP actions" and "collaboration among states linked to a common receptor and among linked upwind and downwind states in developing and applying a regionally consistent approach".

In this exercise, we include exceptional events flagged by Colorado for two additional sites (Highland Reservoir in Arapahoe County and Weld Co. Tower in Weld County), which are considered maintenance sites in 2023. The table below shows base year design values for the six sites; as well as base year maximum design values for the six sites. (With Good Neighbor SIP modeling, average design values are used to project whether a site would be nonattainment in the future year; and maximum design values are used to project whether a site would be maintenance in the future year. Maximum design values are not used in attainment SIP modeling, so the Colorado SIP did not include mention of these.)

[23] Treatment of Air Quality Monitoring Data Influence by Exceptional Events, 40 CFR 50.14

TABLE 6: Base Year Design Value Calculations for Select Sites, 2009–2013

4th Maximum Ozone Values (ppb) with Flagged Data Included						
Year	***Chatfield***	***Rocky Flats-North***	***NREL***	***Fort Collins-West***	***Highland Reservoir***	***Weld Co. Tower***
2009	71	79	68	73	69	67
2010	79	76	74	75	75	73
2011	82	81	83	80	78	77
2012	86	84	81	80	80	80
2013	83	85	84	82	79	73
3–Year Design Values with Flagged Data Included (ppb)						
DV: 2009–2011	77	78	75	76	74	72
DV: 2010–2012	82	80	79	78	77	76
DV: 2011–2013	83	83	82	80	79	76
2009-2013 Average Design Value (ppb)*						
	80.7	80.3	78.7	78.0	76.7	74.7
2009-2013 Maximum Design Value (ppb)						
	83	83	82	80	79	76

*While the official design values are expressed in whole numbers without a decimal, EPA guidance recommends portraying the average design values to one decimal point so that subtle or small changes in calculations are not lost during the subsequent analysis process.

The following table shows revised base year design values when data flagged by Colorado is excluded. Average base year design values dropped by 1-2 ppb at all six sites, consistent with the four sites considered in Colorado's attainment SIP weight of evidence, and maximum base year design values dropped by 2-3 ppb.

TABLE 7: Design Value Calculations for Select Sites with Flagged Events Excluded, 2009–2013

4th Maximum Ozone Values (ppb) with Flagged Data Excluded						
Year	***Chatfield***	***Rocky Flats-North***	***NREL***	***Fort Collins-West***	***Highland Reservoir***	***Weld Co. Tower***
2009	71	79	68	73	69	67
2010	78	76	74	74	75	73
2011	81	81	83	80	78	77
2012	79	79	77	76	76	74
2013	83	81	82	80	78	72
3–Year Design Values with Flagged Data Excluded (ppb)						
DV: 2009–2011	76	78	75	75	74	72
DV: 2010–2012	79	78	78	76	76	74
DV: 2011–2013	81	80	80	78	77	74
2009-2013 Average Design Value (ppb)*						
Flagged Data Excluded	78.7	78.7	77.7	76.3	75.5	73.3
Flagged Data Included	*80.7*	*80.3*	*78.7*	*78.0*	76.7	74.7
2009-2013 Maximum Design Value (ppb)						
Flagged Data Excluded	81	80	80	78	77	74
Flagged Data Included	*83*	*83*	*82*	*80*	*79*	*76*

* While the official design values are expressed in whole numbers without a decimal, EPA guidance recommends portraying the average design values to one decimal point so that subtle or small changes in calculations are not lost during the subsequent analysis process.

Next, to ensure consistency with Colorado's approach, we attempted to replicate the Colorado SIP's WOE calculations for revised future year design values that excluded flagged data in the base year. The table below shows results consistent with those in the Colorado SIP. Results are for 2017 modeling using the 'eh' version of the emission inventory, which was the latest available version released by U.S. EPA at the time Colorado developed its attainment SIP. For the Highland Reservoir site, the change in base year design value was not sufficient to cause a change in the future year design value after rounding, per U.S. EPA guidance. The Weld County Tower site's 2017 design value dropped by 1 ppb.

TABLE 8: 2017 'eh' Modeling Results for Select Monitoring Locations (RRFs for Top 10 Modeled Days Include Flagged Days)

Monitor	*Flagged Exceptional Events Not Excluded*			*Flagged Exceptional Events Excluded*		
	Base Year (2009-2013 Average) DV (ppb)	*RRF*	*2017 Average DV (ppb)]**	*Base Year (2009-2013 Average) DV (ppb)*	*RRF*	*2017 Average DV (ppb)*
Chatfield	80.7	0.9453	**76.2**	78.7	0.9453	74.4
Rocky Flats North	80.3	0.9493	**76.2**	78.7	0.9493	74.7
NREL	78.7	0.9591	75.4	77.7	0.9591	74.5
Fort Collins West	78.0	0.9179	71.5	76.3	0.9179	70.0
Highland Reservoir	76.7	0.9517	72.9	75.7	0.9517	72.0
Weld Co. Tower	74.7	0.9422	70.3	73.3	0.9422	69.1

* Bold indicates nonattainment site

The two highlighted rows in Table 8 above are for the two additional sites that we considered in our Good Neighbor SIP. Note that Colorado used identical relative reduction factors (RRFs) for each site regardless of whether some days had been excluded as exceptional events. To be consistent with Colorado's approach and U.S. EPA's approval, we applied the same methodology.

<u>Application to January 2017 Modeling Results for 2023</u>

CARB staff then tabulated results of U.S. EPA's Good Neighbor SIP modeling released in January 2017, for the six Colorado sites in 2023. This modeling used the 'el' version of the emission inventory. Results are shown for both average and maximum future year design values. These are used to determine whether any sites would be nonattainment or maintenance in the future year. Table 9 below uses base year design values that do not exclude exceptional events data flagged by Colorado. Not all the data in this table was released by U.S. EPA. The last column ("Inferred RRF") was derived by dividing average 2023 design values by base year average design values for each site.

TABLE 9: 2023 'el' Modeling Results for Select Monitoring Locations (RRFs for Top 10 Modeled Days Include Flagged Days; Flagged Exceptional Events Not Excluded from Base Year Design Values)

Monitor	*Base Year (2009-2013 Average) DV (ppb)*	*2009-2013 Maximum DV (ppb)*	*2023 Average DV (ppb)*	*2023 Maximum DV (ppb)**	*Inferred RRF***
Chatfield	80.7	83	69.6	**71.6**	0.8625
Rocky Flats North	80.3	83	70.5	**72.9**	0.8800
NREL	78.7	82	69.7	**72.7**	0.8856
Fort Collins West	78.0	80	68.6	70.4	0.8795
Highland Reservoir	76.7	79	68.0	70.0	0.8866
Weld Co. Tower	74.7	76	67.2	68.3	0.8996

* Bold indicates maintenance site
** Inferred RRF = (2023 Average DV)/(Base Year 2009-2013 Average DV)

Average design values revised, as described above, dropped by 1-2 ppb, and maximum design values dropped 2 ppb across the board at the six sites.

TABLE 10: 2023 'el' Modeling Results for Select Monitoring Locations (RRFs for Top 10 Modeled Days Include Flagged Days; Flagged Exceptional Events Excluded from Base Year Design Values)

Monitor	*Base Year (2009-2013 Average) DV (ppb)*	*2009-2013 Maximum DV (ppb)*	*RRF**	*2023 Average DV (ppb)*	*2023 Maximum DV (ppb)*
Chatfield	78.7	81	0.8625	67.9	69.9
Rocky Flats North	78.7	80	0.8800	69.3	70.4
NREL	77.7	80	0.8856	68.8	70.8
Fort Collins West	76.3	78	0.8795	67.1	68.6
Highland Reservoir	75.7	77	0.8866	67.1	68.3
Weld Co. Tower	73.3	74	0.8996	65.9	66.6

* Same as Inferred RRF for case in which Flagged Exceptional Events are not excluded from Base Year Design Values

Table 10 shows the calculation of these same values upon applying revised base year design values, as described previously. The result is that all six sites came into attainment. There were no nonattainment sites and no maintenance sites in Colorado as summarized in Table 11.

TABLE 11: Colorado Sites After Flagged Values Removed

Impact of Wildfires on Future Year Design Values for Colorado's Six Highest Ozone Monitors	*2023 'el' Modeling Results*	
	Number of Nonattainment Sites	*Number of Maintenance Sites*
Flagged Exceptional Events Not Excluded from Base Year Design Values	0	3
Flagged Exceptional Events Excluded from Base Year Design Values	0	0

Application to October 2017 Modeling Results for 2023

CARB staff performed similar analysis on the impacts of flagged exceptional events using the later ‘en’ version of modeling results released by U.S. EPA in October 2017. That analysis proceeded along similar lines to the analysis using the ‘el’ version of modeling described above. Table 12 below presents results of U.S. EPA’s ‘en’ modeling for the six Colorado sites. Note that in this version of the modeling, three of the six sites were projected to have nonattainment problems, another three were projected to have maintenance problems.

TABLE 12: 2023 ‘en’ Modeling Results for Select Monitoring Locations (RRFs for Top 10 Modeled Days Include Flagged Days; Flagged Exceptional Events Not Excluded from Base Year Design Values)

Monitor	*Base Year (2009-2013 Average) DV (ppb)*	*2009-2013 Maximum DV (ppb)*	*2023 Average DV (ppb)**	*2023 Maximum DV (ppb)***	*Inferred RRF****
Chatfield	80.7	83	**71.1**	73.2	0.8810
Rocky Flats North	80.3	83	**71.3**	73.7	0.8879
NREL	78.7	82	70.9	**73.9**	0.9009
Fort Collins West	78.0	80	**71.2**	73.0	0.9128
Highland Reservoir	76.7	79	69.3	**71.3**	0.9035
Weld Co. Tower	74.7	76	70.2	**71.4**	0.9398

* Bold indicates nonattainment site
** Bold indicates maintenance site
*** Inferred RRF = (2023 Average DV)/(Base Year 2009-2013 Average DV)

Using the inferred RRFs for each site with base year design values revised as previously described, we calculated revised ozone design values for 2023 (Table 13). Revised average design values dropped from 0-2 ppb (with the NREL site unchanged) and revised maximum design values dropped from 1-2 ppb.

TABLE 13: 2023 ‘en’ Modeling Results for Select Monitoring Locations (RRFs for Top 10 Modeled Days Include Flagged Days; Flagged Exceptional Events Excluded from Base Year Design Values)

Monitor	*Base Year (2009-2013 Average) DV (ppb)*	*2009-2013 Maximum DV (ppb)*	*RRF**	*2023 Average DV (ppb)*	*2023 Maximum DV (ppb)***
Chatfield	78.7	81	0.8810	69.3	**71.4**
Rocky Flats North	78.7	80	0.8879	69.9	**71.0**
NREL	77.7	80	0.9009	70.0	**72.1**
Fort Collins West	76.3	78	0.9128	69.6	**71.2**
Highland Reservoir	75.7	77	0.9035	68.4	69.6
Weld Co. Tower	73.3	74	0.9398	68.9	69.5

* Same as Inferred RRF for case in which Flagged Exceptional Events are not excluded from Base Year Design Values
** Bold indicates maintenance site

Although these changes in projected design values were slight, they impacted the status of these sites. The ‘en’ modeling originally projected three sites as nonattainment and three as maintenance in 2023. With flagged exceptional events excluded from consideration in the ‘en’ modeling, Colorado had no projected nonattainment sites in 2023, and four maintenance sites (Table 14).

TABLE 14: Colorado Sites After Flagged Values Removed

Impact of Wildfires on Future Year Design Values for Colorado’s Six Highest Ozone Monitors	*2023 ‘en’ Modeling Results*	
	Number of Nonattainment Sites	*Number of Maintenance Sites*
Flagged Exceptional Events Not Excluded from Base Year Design Values	3	3
Flagged Exceptional Events Excluded from Base Year Design Values	0	4

The significant shift in status for so many sites is indication of how close to the 0.070 ppm 8-hour ozone standard all six sites were projected to be in 2023 in U.S. EPA’s modeling. The modeling results and their implications are sensitive to small changes in inputs such as changes to the base year design value to address exceptional events.

In summary, in this portion of the Good Neighbor SIP CARB staff utilized the results of both sets of U.S. EPA modeling. Utilizing the same analysis that Colorado undertook in its attainment SIP for the 0.075 ppm 8-hour ozone standard, the impact of wildfire influenced days were removed in the base year. U.S. EPA’s January 2017 modeling results when revised remove the impact of exceptional events and project no nonattainment or maintenance receptors. U.S. EPA’s October 2017 results, when similarly revised, projected no nonattainment and four maintenance receptors in 2023.

To better judge between versions of U.S. EPA modeling results, CARB staff went on to analyze U.S. EPA’s contribution modeling released in January 2017 and March 2018.

Assessment of U.S. EPA’s Contribution Modeling for Colorado

U.S. EPA’s modeling for 2023 indicated states with the largest contributions to ozone at projected nonattainment and maintenance receptor sites in Colorado. For both versions of modeling that U.S. EPA released in 2017 (the ‘el’ and ‘en’ versions), five states contributed levels of ozone above a one percent threshold: California, New Mexico, Texas, Utah, and Wyoming. Two other western states, Arizona and Nevada, had contributions at levels about half the one percent threshold.

The tables below show results of U.S. EPA’s modeling for 2023 at projected high ozone sites in Colorado. Contributions are presented for Colorado and the seven contributing states mentioned above. Also shown are contributions from all upwind states, which includes the seven as well as contributions from Kansas, Nebraska, Washington, Oregon, Montana, and Idaho. The "Other" category is comprised of contributions associated with Tribal, Canada and Mexico, Offshore, Fire, and Biogenic emissions, as well as Initial and Boundary contributions.

TABLE 15: 2023 'el' Modeling Results for Select Colorado Monitoring Locations

Monitor	2023 Ave. DV (ppb)	2023 Max. DV (ppb)	Contribution from States (ppb)									Other (ppb)
			Select States								All Upwind States	
			AZ	CA	CO	NV	NM	TX	UT	WY		
Chatfield	69.6	**71.6**	0.31	1.34	22.81	0.38	0.17	0.33	1.32	0.92	6.04	40.58
Rocky Flats North	70.5	**72.9**	0.32	2.03	20.07	0.43	0.35	0.50	1.05	0.85	6.35	43.90
NREL	69.7	**72.7**	0.32	1.48	23.18	0.37	0.41	1.03	1.10	0.80	6.87	39.45
Fort Collins West	68.6	70.4	0.36	0.95	17.96	0.20	0.49	0.63	0.62	1.12	5.72	44.76
Highland Reservoir	68.0	70.0	0.32	1.04	22.41	0.39	0.15	0.30	1.50	1.22	6.26	39.18
Weld Co. Tower	67.2	68.3	0.31	0.78	21.03	0.12	0.88	1.50	0.34	0.47	5.22	40.75

TABLE 16: 2023 'en' Modeling Results for Select Monitoring Locations in Colorado

Monitor	2023 Ave. DV (ppb)	2023 Max. DV (ppb)	Contribution from States (ppb)									Other (ppb)
			Select States								All Upwind States	
			AZ	CA	CO	NV	NM	TX	UT	WY		
Chatfield	71.1	73.2	0.38	1.27	24.71	0.32	0.22	0.36	1.08	1.00	5.94	40.48
Rocky Flats North	71.3	73.7	0.49	1.32	25.52	0.31	0.70	1.02	0.83	0.81	7.06	38.75
NREL	70.9	73.9	0.30	1.50	24.72	0.38	0.38	0.94	1.04	1.03	6.98	39.17
Fort Collins West	71.2	73.0	0.46	1.55	21.74	0.37	0.52	0.40	1.05	0.88	6.33	43.21
Highland Reservoir	69.3	71.3	0.29	1.20	22.94	0.33	0.22	0.30	1.23	1.04	5.98	40.45
Weld Co. Tower	70.2	71.4	0.49	0.95	24.44	0.24	0.77	1.05	0.54	0.58	5.63	40.18

Table 17 below displays differences in ozone levels projected between the 'el' and 'en' modeling runs.

TABLE 17: Change from 2023 'el' to 'en' Modeling Results for Select Colorado Monitoring Locations

Monitor	2023 Ave. DV (ppb)	2023 Max. DV (ppb)	Contribution from States (ppb)									Other (ppb)
			Select States								All Upwind States	
			AZ	CA	CO	NV	NM	TX	UT	WY		
Chatfield	1.5	1.6	0.07	-0.07	1.9	-0.06	0.05	0.03	-0.24	0.08	-0.1	-0.10
Rocky Flats North	0.8	0.8	0.17	-0.71	5.45	-0.12	0.35	0.52	-0.22	-0.44	0.71	-5.15
NREL	1.2	1.2	-0.02	0.02	1.54	0.01	-0.03	-0.09	-0.06	0.23	0.11	-0.28
Fort Collins West	2.6	2.6	0.10	0.65	3.78	0.17	0.03	-0.23	0.43	-0.24	0.61	-1.55
Highland Reservoir	1.3	1.3	-0.03	0.16	0.53	-0.06	0.07	0	-0.27	-0.18	-0.28	1.27
Weld Co. Tower	3.0	3.1	0.18	0.17	3.41	0.12	-0.11	-0.45	0.20	0.11	0.41	-0.57

Colorado's contribution to itself went up across the board in the 'en' modeling, compared to in the 'el' modeling. These increases were substantial (ranging from about 1.5 - 5.5 ppb) at five of the six sites. Meanwhile, California's contribution was lowered in 'en' modeling at two sites (those being two of the three highest ozone sites). At three other sites California's contribution went up slightly. For the Highland Reservoir site, at which

California's contribution increased moderately, the increase in Colorado's contribution was much larger by comparison.

Significant differences between 'el' and 'en' inventories could be expected to result in changes in design values. Variable changes in states' emissions between the inventory versions would also result in shifting ozone contributions between states. An increase in Colorado's emissions in 2023 between the 'el' and 'en' inventory versions could factor into that state's increased contribution to ozone levels at the six Colorado sites of interest.

Changes to NO_x emission inventories in eight states are shown in Table 18 below. Colorado's NO_x emission inventory increased by about five percent for 2023 in the 'en' version, compared to the 2023 estimate in the 'el' version.

TABLE 18: U.S. EPA Inventories for NO_x by State in Recent Modeling Efforts

Annual Tons of NO_x -- State Totals, No Biogenics, No PtFires

State	2011		2023		2023 change from el to en	2023 % change from el to en	State's change compared to total el, %
	el	en	el	en			
AZ	240,712	240,712	112,781	111,613	-1168	-1.04%	-0.06%
CA	697,478	697,477	366,363	368,007	1644	0.45%	0.08%
CO	291,621	291,621	190,434	200,088	9654	5.02%	0.49%
NV	99,180	99,180	47,403	44,798	-2605	-5.50%	-0.13%
NM	202,920	202,920	125,629	130,604	4975	3.96%	0.25%
TX	1,238,586	1,238,589	857,360	831,106	-26254	-3.06%	-1.34%
UT	174,251	174,250	120,952	99,678	-21274	-17.59%	-1.09%
WY	206,280	206,280	134,313	136,532	2219	1.65%	0.11%
Total for 8 States	**3,151,027**	**3,151,028**	**1,955,235**	**1,922,428**	**-32,807**	**-1.68%**	**-1.68%**

For VOCs, Colorado's inventory increased by over 50 percent. These increased emissions contributed in part to Colorado's higher ozone design values in the 'en' version of U.S. EPA's modeling.

TABLE 19: U.S. EPA Inventories for VOC by State in Recent Modeling Efforts

Annual Tons of VOC -- State Totals, No Biogenics, No PtFires

State	2011		2023		2023 change from el to en	2023 % change from el to en	State's change compared to total el, %
	el	en	el	en			
AZ	166,733	166,733	113,644	113,355	-289	0.25%	-0.01%
CA	612,257	612,257	448,516	449,813	1,297	0.29%	0.05%
CO	460,693	460,693	315,086	481,489	166,403	52.81%	6.09%
NV	68,885	68,885	47,002	46,827	-175	-0.37%	<-0.01%
NM	206,502	206,502	131,642	214,000	82,358	62.56%	3.01%
TX	1,679,838	1,679,838	1,416,745	1,729,313	312,568	22.06%	11.43%
UT	209,470	209,470	156,015	183,951	27,936	17.91%	1.02%
WY	166,769	166,769	105,969	143,622	37,653	35.53%	1.38%
Total for 8 States	**3,571,147**	**3,571,147**	**2,734,619**	**3,362,372**	**627,753**	**22.96%**	**22.96%**

U.S. EPA documents changes made to emission inventories in a Technical Support Document (TSD) released in October 2017[24]. In that document, Table 2-2 describes platform sectors for which 2011 emissions are unchanged since the original 2011v6.3 emissions modeling platform. Table 2-2 describes changes made to the Nonpoint source category for oil and gas emissions, which U.S. EPA terms "np_oilgas". U.S. EPA discloses that nonpoint sources from oil and gas-related processes were subject to specific adjustments based on comments received. U.S. EPA further notes that 2011 "np_oilgas" emissions are unchanged. Nonpoint oil and gas emissions, along with oil and gas emissions from point sources, for the 'el' and 'en' inventories are presented in Table 20 below. The large change in Colorado's nonpoint oil and gas emissions accounts for that State's over 50 percent increase in total VOC emissions between the two inventory versions.

TABLE 20: U.S. EPA 2023 Oil and Gas Inventories for VOC by State in Recent Modeling Efforts

Annual Tons of VOC -- State Totals, No Biogenics, No PtFires

State	2023 Nonpoint Oil and Gas		2023 Point Oil and Gas		2023 Total Oil and Gas		2023 Total change from el to en	2023 % Total change from el to en
	el	en	el	en	el	en		
AZ	49	69	91	96	140	165	25	17.86%
CA	12,810	15,209	3,791	3,976	16,601	19,185	2584	15.57%
CO	137,343	305,879	61,764	62,342	199,107	368,221	169,114	84.94%
NV	527	311	59	59	586	370	-216	-36.86%
NM	78,540	160,310	4,731	5,445	83,271	165,755	82,484	99.05%
TX	826,898	1,147,192	26,992	26,362	853,890	1,173,554	319,664	37.44%
UT	93,196	121,332	438	461	93,634	121,793	28,159	30.01%
WY	59,131	96,880	14,798	14,673	73,929	111,553	37,624	50.89%
Total for 8 States	**1,208,494**	**1,847,182**	**112,665**	**113,415**	**1,321,159**	**1,960,597**	**639,438**	**48.40%**

Colorado's Air Quality Control Commission adopted rules controlling oil and gas industry emissions in 2014, and further strengthened these in late 2017. The November 16, 2017 rulemaking was intended to meet U.S. EPA's Control Techniques Guidelines (CTG) for the Oil and Natural Gas Industry, set in October 2016. The 2017 rulemaking set more stringent controls in the Denver Metro North Front Range moderate ozone nonattainment area. Other new but less stringent controls will apply elsewhere in Colorado. Colorado plans to implement these regulations despite U.S. EPA's proposed withdrawal of the CTG for the Oil and Gas Industry. Reductions of VOC emissions from Colorado's 2017 updates to its oil and gas regulations appear to have occurred too recently to be incorporated into U.S. EPA's 'el' and 'en' inventories[25] or modeling. Therefore, the projected 85 percent increase in VOC emissions from oil and gas sources in Colorado in

[24] "Additional Updates to Emissions Inventories for the Version 6.3, 2011 Emissions Modeling Platform for the Year 2023" is available here https://www.epa.gov/air-emissions-modeling/2011-version-63-platform
[25] Technical Support Document (TSD), Additional Updates to Emissions Inventories for the Version 6.3, 2011 Emissions Modeling Platform for the Year 2023, October 2017, U.S. EPA, page 93.

2023 would reflect new growth but not new controls, and would overstate the increased emissions from this category.

The differences in Colorado's in-state contributions assigned by U.S. EPA's modeling runs appear consistent with changes between the 'el' and 'en' emission inventories. If further revised inventories and modeling reflecting the benefits of Colorado's 2017 rulemaking are prepared, projected 2023 design values in Colorado could be lowered.

As previously mentioned, in the 'el' modeling for 2023 three of the Colorado sites were projected to be maintenance, and three were projected to be attaining. With the 'en' modeling, three sites are projected to be nonattainment, and three maintenance. Table 21 below provides additional breakout on how modeling projections for the six Colorado sites changed from 'el' to 'en' modeling runs. For each of the monitors, the increase in projected average design values and maximum design values is shown. Columns to the right then display the amount these design value projections would need to increase for the site to change status and be considered nonattainment or maintenance. Next, the table indicates the impact of each monitor's projected status based on the modeling update. Last, the changes in contributions at each site are shown for California, Colorado, all upwind states combined (including California), and "Other" changes. This "Other" category is comprised of changes to Tribal, Canada and Mexico, Offshore, Fire, Initial and Boundary, and Biogenic contributions between the 'el' and 'en' model runs.

TABLE 21: Change from 2023 'el' to 'en' Modeling Results for Select Colorado Monitoring Locations

Monitor	*Increase in 2023 Ave. DV (ppb)*	*Increase in 2023 Max. DV (ppb)*	*Increase in 'el' Ave. 2023 DV Sufficient for Site to become Nonattainment (ppb)*	*Increase in 'el' Max. 2023 DV Sufficient for Site to become Maintenance (ppb)*	*Impact to Attainment Projection of Increase in 2023 DV from 'el' to 'en' Modeling*	*Change in Contribution from States (ppb)*			*Other (ppb)*
						Select States		*All Upwind States*	
						CA	*CO*		
Projected Maintenance Sites in 2023 in 'el' Modeling									
Chatfield	1.5	1.6	1.4	-	From Maintenance to Nonattainment	-0.07	1.9	-0.1	-0.1
Rocky Flats North	0.8	0.8	0.5	-	From Maintenance to Nonattainment	-0.71	5.45	0.71	-5.15
NREL	1.2	1.2	1.3	-	Stays Maintenance	0.02	1.54	0.11	-0.28
Projected Attaining Sites in 2023 in 'el' Modeling									
Fort Collins West	2.6	2.6	2.4	0.6	From Attaining to Nonattainment	0.65	3.78	0.61	-1.55
Highland Reservoir	1.3	1.3	3.0	1.0	From Attaining to Maintenance	0.16	0.53	-0.28	1.27
Weld Co. Tower	3.0	3.1	3.8	2.7	From Attaining to Maintenance	0.17	3.41	0.41	-0.57

As can be seen, in the 'en' model run Colorado's contributions to ozone at the six sites increased substantially. At five of the six sites, these increases in Colorado contributions were greater than the increase sufficient to result in a worse attainment projection for a site. For example, the average design value at the Chatfield site increased by 1.5 ppb in the 'en' modeling. An increase of 1.4 ppb at that site would be sufficient for the site's projection to change from maintenance in the 'el' modeling to nonattainment in the 'en' modeling. Consequently, Chatfield is projected to be a nonattainment site in U.S. EPA's latest modeling. Additional information provided in U.S. EPA's modeling, and summarized in Table 21 above, indicates that Colorado's contribution to the Chatfield monitor increased by 1.9 ppb, while California's contribution dropped.

This pattern of the home state's contributions increases being sufficient to change the projected attainment status recurred at the Rocky Flats North, NREL, Fort Collins West, and Weld Co. Tower sites. However, the attainment status at NREL did not change because "Other" contributions dropped sufficiently to negate the impacts of Colorado increased contributions. Consequently, the NREL monitor remained maintenance. The remaining site with an impacted attainment projection is the Highland Reservoir monitor. Here, changes to Colorado and other states' (including California) contributions were small enough not to negatively impact the attaining status of the monitor. On the other hand, "Other" contributions increased to a greater extent. As a result the Highland Reservoir monitor, previously projected as attaining, is now projected to be maintenance.

To summarize, consistent with invitations extended to states by U.S. EPA to use its modeling in developing Good Neighbor SIPs, CARB staff reviewed both recent versions of U.S. EPA's contribution modeling results. Model projections for Colorado range between having no nonattainment and no maintenance problems (using 'el' modeling adjusted to exclude exceptional events) to having three nonattaining and three maintenance sites (using 'en' modeling, and not adjusting for exceptional events). To better understand the variability in U.S. EPA's modeling results, we compared model outputs with a focus on contributions. We found that U.S. EPA's improvements to its emission inventory between 'el' and 'en' versions resulted in modest changes in NO_x but large changes to VOC inventories (both for 2023). The versions of the inventory did not change in the base year of 2011. California's NO_x and VOC inventories were relatively unchanged between 'el' and 'en' versions. Colorado's total NO_x increased by 5 percent, and total VOC increased by over 50 percent. By far the greatest contributor to Colorado's VOC inventory change in 2023 was an increase in projected oil and gas sector emissions of about 85 percent.

CARB recognizes that inventory changes between 'el' and 'en' were not the sole contributor to differences in model output. The later model's use of the top ten highest ozone days in 2023 rather than a minimum of the top five days provided a broader basis for quantifying upwind state contributions. Our assessment showed increases in Colorado's in-state contributions consistent with changes between 'el' and 'en' inventories.

In evaluating results of U.S. EPA's 'el' and 'en' modeling, CARB staff observes that the 'en' results use a more up-to-date emission inventory and modeling methodology. This more recent version of modeling also yields higher ozone concentrations in 2023 than does the earlier version. The more health-protective approach would be to lean more heavily on 'en' results. CARB takes this conservative approach. Consequently, on the basis of the 'en' results as adjusted to remove exceptional event impacts, California is linked to maintenance sites in Colorado. Similarly, on the basis of ‘en’ results not adjusted for exceptional events, California would be linked to nonattainment and maintenance sites in Colorado. As such, the increased Colorado contributions to sites in that state were by far the leading factor in higher design values in ‘en’ at five of six sites, and finished second to “Other” contributions at the remaining site, Highland Reservoir. The increase in design values between the ‘el’ exceptional event adjusted results (no nonattainment and no maintenance problems) and the ‘en’ exceptional event adjusted results (no nonattainment and four maintenance receptors) does not appear to stem from California impacts on Colorado.

Colorado Summary

CARB’s analysis of the Denver Metro/North Front Range nonattainment area with specific focus on regional topography effects, distances from California, local and regional meteorology, modeled trajectories, and evolution of transported leading up to high ozone days show that it is an exceptionally rare occurrence for emissions originating in California to reach the Colorado receptors and contribute on high ozone days. The Rocky Mountains provide a strong barrier along the western, southern, and southeastern sides of the nonattainment area that often restricts airflow through the region. Periods of high ozone tended to rely on local emissions or transported emissions with light east-northeasterly winds, upper-level high pressure, hot temperatures, and clear skies. Additionally, local ozone can also build up along the foothills over multiple days with repeated diurnal upslope-downslope light winds. Trajectory analysis found that while there were many occasions where air from California may have reached Colorado, only one backward and forward trajectory pairing indicated that emissions in the California mixed layer should have reached the mixed layer at a Colorado receptor site. Further, additional understanding and analysis is necessary to account for the physical and chemical processing that the transported air mass would undergo during transit to Colorado.

The availability of two recent sets of modeling performed by U.S. EPA provides insights into the extent of California’s contributions to ozone in the Denver Metro/North Front Range area. By comparing the two versions of U.S. EPA’s modeling – especially the changes to both the average and maximum design values and to itemized contributions at all six sites of interest – it is evident that the modeling changes resulting in increased design values for six sites are not due to increased contributions from California. CARB’s assessment of U.S. EPA contribution modeling, and assessments of conditions that result in high ozone in Denver, concur in pointing away from transport of ozone from California as being a significant contributor to the area’s elevated ozone levels on non-fire impacted days.

Based on these analyses, CARB staff finds it reasonable to conclude that emissions from California do not significantly interfere with attainment/maintenance of the 0.070 ppm 8-hour ozone NAAQS at the modeled ozone receptors in Colorado.

Transport Assessment for Arizona Receptors

The U.S. EPA modeling released in January 2017 did not project any nonattainment or maintenance receptors in Arizona. However, the more recent modeling from October 2017 identified two potential maintenance receptors in Arizona. These are the West Phoenix and North Phoenix monitoring sites located in the Phoenix-Mesa nonattainment area which contains portions of Maricopa and Pinal Counties. The Phoenix-Mesa area is currently classified as a marginal nonattainment area. However, U.S. EPA recently proposed to reclassify the area to moderate due to failing to attain the 0.075 ppm 8-hour ozone standard by the 2014 ozone season.

As of 2010, the Phoenix-Mesa nonattainment area contained a population of 3.8 million. The Phoenix-Mesa-Scottsdale CBSA is located in central Arizona, at an elevation of approximately 1,100 feet, in what is also referred to as the “Valley of the Sun.” The Phoenix Metropolitan Area is mostly flat, but is surrounded by multiple mountain chains of varying heights. To the southwest of Phoenix are the Sierra Estrella Mountains extending up to roughly 4,500 feet in elevation at the highest peak; to the west are the White Tank Mountains reaching 4,100 feet; to the north and northeast are the Bradshaw Mountains and multiple other ridges ranging from 6,000 to 8,000 feet at the highest peaks; to the east are the Superstition Mountains, with peaks up to nearly 8,000 feet. The southern side of the metropolitan area is bounded by the South Mountains, extending up to 2,300 feet, and to the southeast is desert that gradually slopes up in elevation. As a result, the Phoenix region is within a large topographic bowl and the terrain significantly limits the flow of air through the area during non-stormy periods.

Situated in the northeast portion of the Sonoran Desert, the Phoenix area experiences mostly clear skies, warm to hot temperatures, and very little rainfall during most of the year. In the summer months, upper-level high pressure systems over the western U.S., typically centered over the “Four Corners” region, produce temperatures easily over 100° F on most days, limit cloud formation, and generally lead to light winds in the Phoenix region. Local wind flow patterns are dominated by differential heating across the area and can be quite variable, but due to constraints by the mountain chains around the region, air masses within the Phoenix area tend to flow from west to east in the afternoon and stay within the “bowl.” Cooling in the evening also allows the air to flow back downslope from east to west at night, transporting the day’s emissions and pollutants back into the metropolitan area.

One key weather pattern that does impact the Phoenix region is the summer monsoon, which transports clouds and moisture from the south/southeast, often leading to the formation of thunderstorms, heavy rains, and very strong winds that can produce major dust storms. Because of the monsoon, more rain falls during the summer months than during the rest of the year. These conditions also inhibit the formation and buildup of ozone in Phoenix on the many days each year with active monsoon weather.

Other than during the monsoon period, the generally dry climate in Arizona allows for strong, shallow temperature inversions to form on most nights, trapping emissions and pollutants near the ground or in a residual layer aloft. However, afternoon temperatures are often very hot, especially during the month of July. As a result, mixing heights in Phoenix can be several thousand feet deep, thus allowing the atmosphere to mix deeply. As was the case in 2016, the top two days were in August when average temperatures were slightly lower than in July, with calm/variable winds in the morning and light to moderate westerly winds in the afternoon producing ideal conditions for high ozone to the east of Phoenix. Then in 2017, three of the six highest ozone concentration days occurred in June with calm/variable winds in the morning and light to moderate southerly winds producing maximum ozone at the North Phoenix site at the foot of Phoenix Mountain. In all cases, the monitoring sites with the highest ozone concentrations were downwind of the Phoenix Metropolitan area, indicating that clear skies, hot temperatures (greater than 102° F), and calm/variable winds in the morning and light to moderate winds outward from the downtown metropolitan area in the afternoon produce ideal conditions for high ozone in central Arizona.

Compounding ozone issues in the region, the same hot, dry near-surface conditions that promote high ozone concentrations around Phoenix can also lead to wildfires within Arizona and surrounding states. The dry near-surface conditions can cause monsoonal thunderstorms to be “dry” with little to no precipitation reaching the ground. However, the lightning from these storms may ignite wildfires in dry areas, with smoke rapidly spreading downwind. This wildfire smoke can undergo photochemical processes and increase ozone concentrations when entrained within the surface boundary layer. Wildfire smoke influence is frequent across the region during peak ozone season, sometimes naturally boosting ozone levels well beyond the ozone standard. While there is a process to remove wildfire smoke driven concentrations through the U.S. EPA’s Exceptional Events process, the requirement that the event must have a “regulatory impact” allows wildfire event concentrations to be included in modeling, thus causing artificially higher design values.

U.S. EPA’s interstate transport modeling for 2023 released in January and October 2017 showed that all sites in Arizona would meet the 0.070 ppm 8-hour ozone standard. However, the October 2017 modeling also indicated that the North Phoenix site (Site ID 04-013-1004) and West Phoenix site (Site ID 04-013-0019) in the Phoenix-Mesa nonattainment area would be near enough to the standard to be considered maintenance.

<u>Modeled Receptors in Arizona</u>

U.S. EPA’s modeling results from March 2018 (which have identical design values as released in October 2017, but also have breakouts quantifying projected contributions from states at each receptor site) showed impacts from California at greater than the one percent threshold at two receptor sites in Arizona (Figure 3). Following is location information, receptor characterization, as well as 8-hour ozone design values for 2011-

2013, the base year design values used in projections for 2023, for each of the receptors listed in Table 22.

FIGURE 3: Phoenix-Mesa, AZ Nonattainment Area

TABLE 22: Ozone Receptor in the State of Arizona

County	Site Name	AQS ID	8-Hr Design Value (ppm)			Approximate Distance to California Border (miles)
			2011	2012	2013	
Maricopa	West Phoenix	04-013-0019	0.073	0.078	0.079	126
Maricopa	North Phoenix	04-013-1004	0.077	0.081	0.081	128

<u>Modeled Maintenance Receptors in Arizona</u>

West Phoenix

The West Phoenix receptor site is located in the center of the Phoenix-Mesa nonattainment area and is located in the central portion of Maricopa County. The site is located roughly five miles northwest of downtown Phoenix, at an elevation of about 1,100 feet. Additionally, the site is situated about seven miles southwest of the Phoenix Mountains and nine miles north of the South Mountains. The Phoenix Mountains run northwest to southeast through the center of the Phoenix metropolitan area. Figure 3 above shows West Phoenix's location in comparison to Phoenix, the Phoenix Mountains and the South Mountains.

North Phoenix

The North Phoenix receptor site is located in the center of the Phoenix-Mesa nonattainment area and is located in the central portion of Maricopa County. It is located roughly eight miles north of downtown Phoenix, at the foot of the Phoenix Mountains. The monitor has an elevation of roughly 1,250 feet. Figure 3 shows North Phoenix's location in comparison to Phoenix and the Phoenix Mountains.

Figure 4 and Table 23 show the design value trends at the potential receptor sites from 2008 to 2017. The most significant reductions were seen in 2008 to 2009, which coincided with a national recession. As the economy recovered, design values climbed between 2009 and 2013. Since 2013, the design values have been decreasing each year by an average of 1.7 percent.

FIGURE 4: Ozone 8-hour Design Values, West Phoenix and North Phoenix Receptors

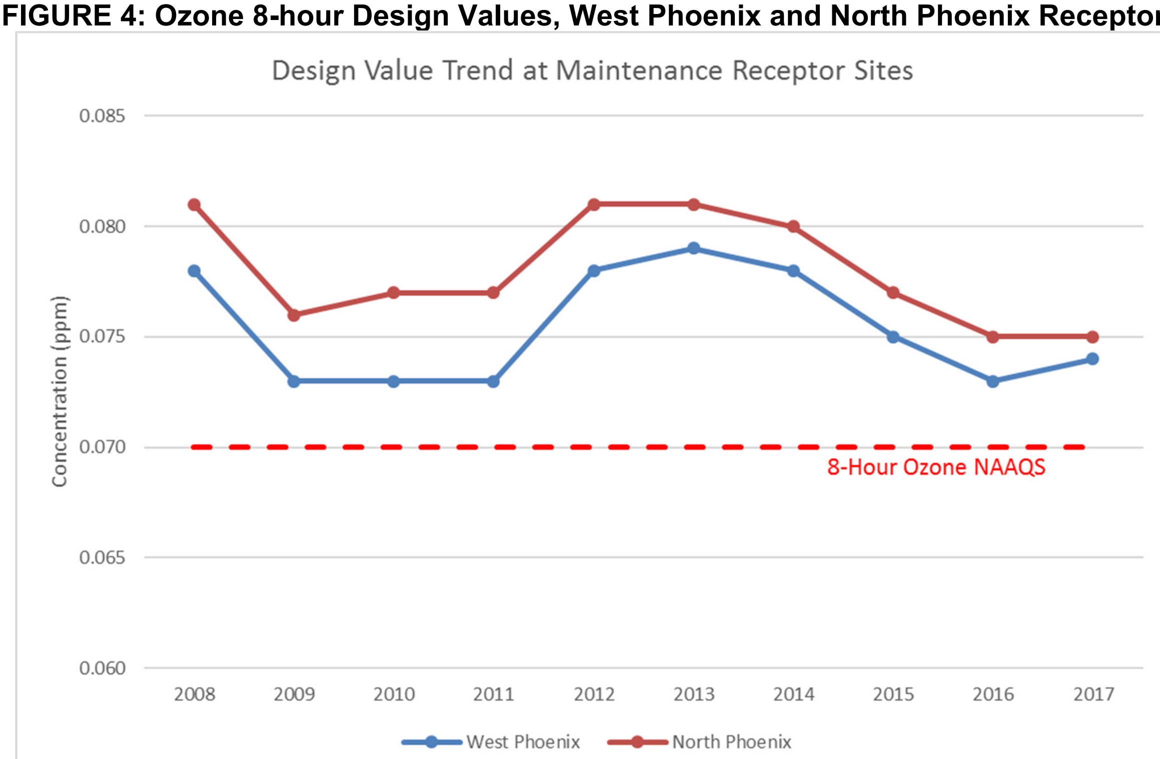


TABLE 23: Ozone 8-hour Design Values (ppm)

Site Name	*AQS ID*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*
West Phoenix	04-013-0019	0.078	0.073	0.073	0.073	0.078	0.079	0.078	0.075	0.073	0.074
North Phoenix	04-013-1004	0.081	0.076	0.077	0.077	0.081	0.081	0.080	0.077	0.075	0.075

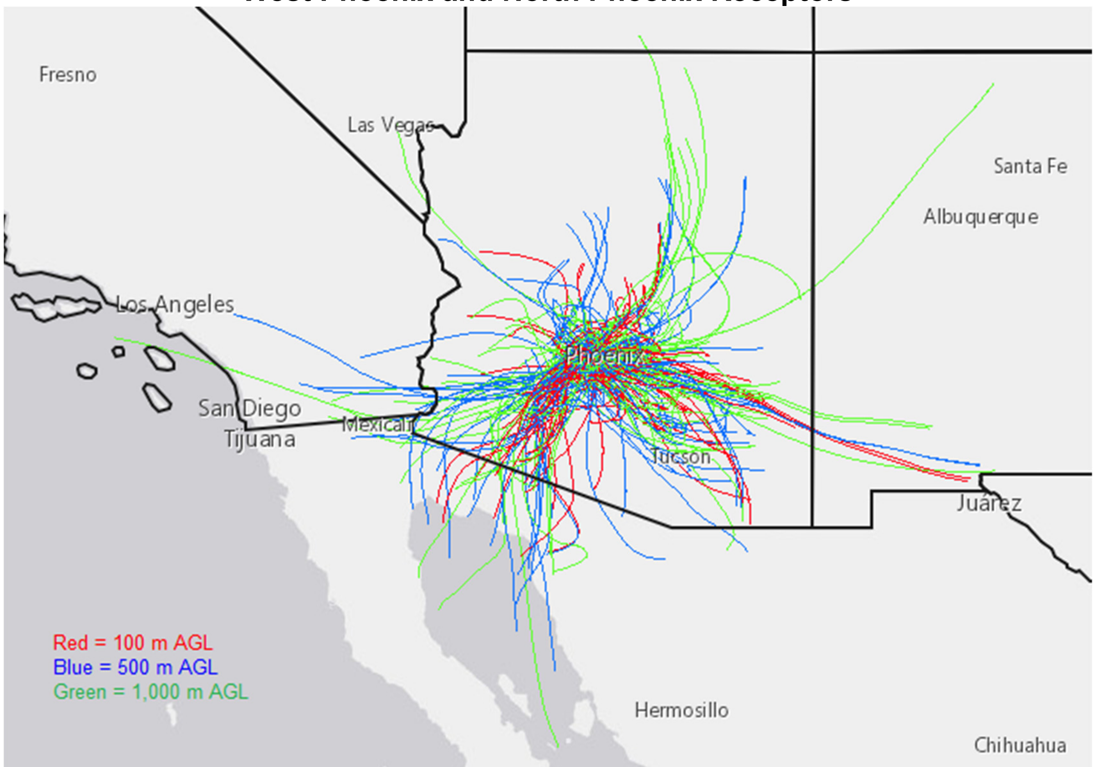
Trajectory Analysis of Impact from California to Arizona

Due to the complex terrain but relatively short distances between major California ozone source regions and the Phoenix-Mesa nonattainment area, CARB staff conducted a simplified, short-ranged trajectory analysis. The goal of the trajectory analysis was to evaluate the potential for transport of ozone or ozone precursors from California to the Phoenix potential receptor sites. In this analysis, CARB staff utilized the U.S. EPA Ozone Designations Mapping Tool[26] to view HYSPLIT model trajectories for the West Phoenix and North Phoenix sites. This tool allows one to examine pre-compiled backward trajectories 24 hours in length at starting heights of 100, 500, and 1000 meters above ground level, on all observed exceedance days at the selected site(s). While this trajectory analysis cannot confirm transport, it can provide insight on the potential for transport and the potential frequency of transport. Even if a parcel of air passed through a particular location, emissions intercepted by the parcel can vary markedly depending on chemical and physical properties of the local environment and the air parcel.

The analysis of backward trajectories in Figure 5 shows that air is typically from within the Phoenix area for the lower level trajectories (100 and 500 meters). Meanwhile, higher level trajectories (1,000 meters) are most frequently from the north-northeast, southeast, or southwest. Only a few trajectories extend from California, suggesting that air from California is unlikely to be a significant factor contributing to higher ozone values in Phoenix when exceedances occur.

[26] Ozone Designations Mapping Tool may be accessed at the Ozone Designations Guidance and Data page on U.S. EPA's website (https://www.epa.gov/ozone-designations/ozone-designations-guidance-and-data#C, last accessed: August 10, 2018).

FIGURE 5: HYSPLIT Backward Trajectories on Ozone Exceedance Days in 2015-2016, West Phoenix and North Phoenix Receptors



Assessment of U.S. EPA Modeling Runs for Arizona Receptor Sites

U.S. EPA's modeling for 2023 indicated which states had the largest contributions to ozone at projected nonattainment and maintenance receptor sites in Arizona. For both versions of modeling that U.S. EPA released in 2017 (the 'el' and 'en' versions), only one state, California, contributed levels of ozone above a one percent threshold. Four other western states, Nevada, Texas, New Mexico and Utah had contributions at levels of one-quarter the one percent threshold or even less.

TABLE 24: 2023 'el' Modeling Results for Select Monitoring Locations in Arizona

Monitor	*Average 2023 DV (ppb)*	*Maximum 2023 DV (ppb)*	*Contribution from States (ppb)*									*Other (ppb)*
			Select States								*All Upwind States*	
			AZ	*CA*	*CO*	*NV*	*NM*	*TX*	*UT*	*WY*		
West Phoenix	67.9	70.0	23.36	2.08	0.00	0.11	0.01	0.02	0.03	0.00	2.35	42.09
North Phoenix	68.7	69.8	25.18	2.25	0.02	0.16	0.05	0.14	0.08	0.00	2.87	40.53

Comparing the two versions of modeling results for Arizona, one can see that Arizona's design values increased by 1-2 ppb from the 'el' (Table 24) to the 'en' (Table 25) modeling. At this level of breakout, Arizona's contribution to its own ozone levels increased and appears to be the main driver for the increase in design values.

California's contribution dropped, overall upwind state contributions changed very little, and other contributions decreased slightly from 'el' to 'en.'

TABLE 25: 2023 'en' Modeling Results for Select Monitoring Locations in Arizona

Monitor	Average 2023 DV (ppb)	Maximum 2023 DV (ppb)	Contribution from States (ppb)									Other (ppb)
			Select States								All Upwind States	
			AZ	CA	CO	NV	NM	TX	UT	WY		
West Phoenix	69.3	71.4	25.19	1.87	0.03	0.09	0.09	0.22	0.06	0.01	2.55	41.47
North Phoenix	69.8	71.0	27.40	2.03	0.02	0.14	0.04	0.11	0.06	0.00	2.58	39.75

Table 26 below confirms that design values went up at the Phoenix monitors by a range of 1.1-1.4 ppb, when transitioning from 'el' to 'en' modeling. Arizona's contribution went up from 1.8-2.2 ppb. The balance of the difference between Arizona's contributions and changes to the overall design value came from a category titled 'Other,' which had a declining impact.

TABLE 26: Change from 2023 'el' to 'en' Modeling Results for Select Monitoring Locations in Arizona

Monitor	Average 2023 DV (ppb)	Maximum 2023 DV (ppb)	Contribution from States (ppb)									Other (ppb)
			Select States								All Upwind States	
			AZ	CA	CO	NV	NM	TX	UT	WY		
West Phoenix	1.4	1.4	1.83	-0.21	0.03	-0.02	0.08	0.20	0.03	0.01	0.20	-0.62
North Phoenix	1.1	1.2	2.22	-0.22	0.00	-0.22	-0.01	-0.03	-0.02	0.00	-0.29	-0.78

The following tables show a further breakout of 'Other' emissions into its constituent subcategories of Tribal, Canada and Mexico, Offshore, Fire, Initial and Boundary, and Biogenic contributions. The 'el' modeling (Table 27) had a substantial contribution from Canada and Mexico, which we can assume represents the impact of pollution from Mexico.

TABLE 27: 2023 'el' Modeling Contribution Results with Breakout of Other Categories at Select Arizona Monitors

Monitor	Average 2023 DV (ppb)	Maximum 2023 DV (ppb)	AZ (ppb)	All Upwind States (ppb)	Other (ppb)					
					Tribal	Canada+ Mexico	Offshore	Fire	Initial & Boundary	Biogenic
West Phoenix	67.9	70.0	23.36	2.35	0.03	1.89	0.37	0.11	37.76	1.93
North Phoenix	68.7	69.8	25.18	2.87	0.07	2.74	0.35	0.17	34.93	2.27

A similar breakout of contributions is shown for the updated modeling using U.S. EPA's 'en' inventory (Table 28).

TABLE 28: 2023 ‘en’ Modeling Contribution Results with Breakout of Other Categories at Select Arizona Monitors

Monitor	*Average 2023 DV (ppb)*	*Maximum 2023 DV (ppb)*	*AZ (ppb)*	*All Upwind States (ppb)*	*Other (ppb)*					
					Tribal	*Canada+ Mexico*	*Offshore*	*Fire*	*Initial & Boundary*	*Biogenic*
West Phoenix	69.3	71.4	25.19	2.55	0.06	3.29	0.37	0.49	34.74	2.52
North Phoenix	69.8	71.0	27.40	2.58	0.06	2.70	0.34	0.56	33.85	2.24

Differences between contributions associated with ‘el’ and ‘en’ modeling are shown below in Table 29. Note the significant increase in Mexico impacts at the West Phoenix site, and fire impacts at both sites.

TABLE 29: Change from 2023 ‘el’ to ‘en’ Modeling Results with Breakout of Other Categories at Select Arizona Monitors

Monitor	*Average 2023 DV (ppb)*	*Maximum 2023 DV (ppb)*	*AZ (ppb)*	*All Upwind States (ppb)*	*Other (ppb)*					
					Tribal	*Canada+ Mexico*	*Offshore*	*Fire*	*Initial & Boundary*	*Biogenic*
West Phoenix	1.4	1.4	1.83	0.20	0.03	1.40	0.00	0.38	-3.02	0.59
North Phoenix	1.1	1.2	2.22	-0.29	-0.01	-0.04	-0.03	0.39	-1.08	-0.03

As previously mentioned, in the ‘el’ modeling for 2023 all of the Arizona sites were projected to be attaining. With the ‘en’ modeling, two sites are projected to be maintenance. Table 30 below provides additional breakout on how modeling projections for the two Arizona sites changed from ‘el’ to ‘en’ modeling runs. For each of the monitors, the increase in projected average design values and maximum design values is shown. Columns to the right then display the amount these design value projections would need to increase for the site to change status and be considered nonattainment or maintenance. Next, the table indicates the impact of each monitor’s projected status based on the modeling update. Last, the changes in contributions at each site are shown for Arizona, California, and prominent subcategories of “Other.” The “Other” category is comprised of Tribal, Canada and Mexico, Offshore, Fire, Initial and Boundary, and Biogenic contributions. In the table below, changes in contributions between the 2023 ‘el’ and ‘en’ model runs from Canada and Mexico and Fire are featured. The remaining subcategories of “Other” are grouped under the heading “Rest of Other.”

TABLE 30: Change from 2023 'el' to 'en' Modeling Results for Select Arizona Monitors

Monitor	Increase in Ave. 2023 DV (ppb)	Increase in Max. 2023 DV (ppb)	Increase in 'el' Ave. 2023 DV Sufficient for Site to become Nonattainment (ppb)	Increase in 'el' Max. 2023 DV Sufficient for Site to become Maintenance (ppb)	Impact to Attainment Projection of Increase in 2023 DV from 'el' to 'en' Modeling	Change in Contribution from Select States (ppb)		Other (ppb)		
						AZ	CA	Canada + Mexico	Fire	Rest of Other
West Phoenix	1.4	1.4	3.1	1.0	From Attaining to Maintenance	1.83	-0.21	1.40	0.38	-1.00
North Phoenix	1.1	1.2	2.3	1.2	From Attaining to Maintenance	2.22	-0.22	-0.04	0.39	-1.17

As can be seen, in the 'en' model run Arizona's contributions to ozone at the two sites increased significantly. At both sites, these increases in Arizona contributions were greater than the increase sufficient to result in a worse attainment projection for a site. For example, the maximum design value at the West Phoenix site increased by 1.4 ppb in the 'en' modeling. An increase of 1.0 ppb at that site would be sufficient for the site's projection to change from attainment in the 'el' modeling to maintenance in the 'en' modeling. Consequently, West Phoenix is projected to be a maintenance site in U.S. EPA's latest modeling. Information provided in U.S. EPA's modeling, and summarized in the table above, indicates that Arizona's contribution to the West Phoenix monitor increased by 1.83 ppb. Meanwhile, California's contribution dropped. Note that contributions from Mexico increased substantially at the West Phoenix site. Fire impacts also increased at both sites.

A similar situation is projected to occur at the North Phoenix site. California impacts declined here too and, as mentioned, fire impacts increased by about the same amount as at West Phoenix. At this site, though, the impact from Mexico was reduced slightly. However, the home state's contribution grew by 2.22 ppb. An increase of 1.2 ppb at this site would be sufficient for this site to become a maintenance monitor, and a 2.3 ppb increase would be sufficient for North Phoenix to have a projected nonattainment problem. Consequently, North Phoenix is projected to be a maintenance site in U.S. EPA's latest modeling.

U.S. EPA's more recent 'en' modeling, which resulted in two maintenance receptors in the Phoenix area, did include an increased impact from fires. At the West Phoenix site, this increased contribution of 0.38 ppb was not large enough by itself for that site to become a maintenance site. Had the fire contribution not increased, West Phoenix's design value would still have risen by 1.02 ppb, and an increase of 1 ppb was enough for that site to switch from attainment to maintenance. As CARB has previously commented to U.S. EPA, the fire contribution estimates in U.S. EPA's modeling are very likely underestimate, and under the right circumstances it could be appropriate to modify the Phoenix base year design values to properly account for wildfire impacts in monitored values. Unfortunately, Arizona's SIP for the 0.075 ppm 8-hour ozone standard did not include a WOE analysis of wildfire impacts on base year design values (unlike Colorado's SIP for the Denver Metro/North Front Range moderate ozone SIP). Neither did Arizona flag suspected wildfire influenced days as exceptional events. Therefore, this interstate transport SIP does not include a treatment of exceptional events for Phoenix, as was done for Denver area receptors.

Arizona Summary

To put the modeling results in perspective: if Arizona were to develop an attainment SIP for Phoenix for the 0.070 ppm 8-hour ozone standard using either the 'el' or the 'en' version, the area would be projected to attain by 2023. (This is because attainment demonstrations use average future year design value projections alone, and do not consider maximum design value projections.) At issue in the Good Neighbor SIP discussion for Arizona, then, is the certainty of maintaining the standard rather than merely meeting it.

With regard to maintenance projections, U.S. EPA's 'el' modeling did not indicate any sites in Phoenix with maintenance or nonattainment problems in 2023. However, the updated 'en' modeling yielded projections indicated two sites would be maintenance in that year. Taking a conservative approach, we rely more heavily on the 'en' version. Accordingly, California is linked to two maintenance sites in Arizona. However, by comparing the two versions of U.S. EPA's modeling – especially the changes to both the maximum design values and to itemized contributions – it is evident that the modeling changes resulting in maintenance projections for the two Phoenix sites are not due to increased contributions from California (which declined).

In consideration of the trajectory analysis, intervening terrain, and the effect of local meteorological conditions conducive to the formation of ozone in Phoenix, as well as the modeling analyses described above, CARB staff finds it is reasonable to conclude that emissions from California do not significantly interfere with maintenance of the 0.070 ppm 8-hour ozone standard at the modeled ozone receptors in Arizona.

Step Three - California's Current Control Programs

CARB agrees that California is linked to downwind sites in Colorado and Arizona as shown in U.S. EPA's 'en' modeling. However, on the basis of analysis discussed earlier in this report, CARB staff concludes that California does not contribute significantly to downwind air quality problems (either nonattainment or maintenance) in other states.

Step Three of U.S. EPA's Four-Step Framework applies to upwind states with linkages to downwind receptors in other states. In this step, upwind states are to identify the emission reductions necessary (if any), considering cost and air quality factors, to prevent an identified upwind state from contributing significantly to downwind air quality problems in other states.

Specifically, for those states that are linked to downwind receptors with air quality problems, U.S. EPA's framework calls for further inquiry into whether the contributions are significant and whether there are cost-effective controls that can be employed to reduce emissions. Thus, we now review and evaluate California's emission control measures.

Background

CARB's current mobile source programs, coupled with efforts at the local and federal level, have achieved tremendous success in reducing emissions, resulting in significantly cleaner vehicles and equipment in operation today. Current control programs will reduce NOx emissions in 2030 by over 50 percent from today's levels. These programs provide a significant down payment on the needed emission reductions. Nonetheless, meeting all of our air quality goals will require large reductions beyond those occurring under existing programs.

In recognition of California's early efforts and extent of air quality challenges, the State's authority to regulate emissions from some source categories more stringently than the federal government has been uniquely preserved under the CAA's Section 209(b) waiver provision. While U.S. EPA has primary authority for interstate trucks, aircraft, ships, locomotives, and some farm and construction equipment, this waiver provision allows California to seek a waiver from U.S. EPA to continue to enact more stringent emission standards for passenger vehicles, heavy duty trucks, and certain off-road vehicles and engines.

Over nearly five decades, CARB has obtained waivers and authorizations for over 100 of its new motor vehicle and other mobile source regulations. CARB's history of progressively strengthening standards as technology advances, coupled with the waiver process requirements, ensures that California's regulations remain the most protective of public health in the nation, and that necessary emission reductions from the mobile sector continue.

The Section 209(b) waiver provision preserves a critical role for California in the control of emissions from new motor vehicles; it recognizes California's service as a "laboratory" to facilitate development of better, more stringent motor vehicle emission standards. For example, CARB's Low-emission vehicle (LEV) I, LEV II, and the Zero-emission vehicle (ZEV) programs have resulted in the production and sales of hundreds of thousands of ZEVs in California since first adopted in 1990, helping advance vehicle technology.

Under State law, CARB has the responsibility to develop SIP strategies for cars, trucks and other mobile sources to meet federal requirements. Statewide, about 12 million Californians live in communities that exceed the federal ozone standards. Two areas of the State have the most critical air quality challenges – the South Coast and the San Joaquin Valley. These regions are the only two areas in the nation with an Extreme classification for the federal ozone standard. As a result of ongoing control programs, considerable air quality progress has occurred in both areas.

Twenty-five years ago, the current 0.070 ppm 8-hour ozone standard was exceeded across the entire South Coast and San Joaquin Valley. Peak ozone levels were more than two and half times the standard at the time in the South Coast and nearly 40 percent above the standard in the San Joaquin Valley. Today, significant portions of both regions meet the standard and peak ozone concentrations in the South Coast are within 49 percent of the standard. Moreover, peak levels in the San Joaquin Valley are now within 38 percent of the standard, and the region is on track to meet federal ozone standards based on the ongoing benefits of the current control programs.

Both NO_x and VOCs are precursors to ozone. Table 31 shows the percentage of California NO_x and VOC emissions that come from mobile, stationary, and area sources, based on the 2011 NEI and the 2023 emission projections. As emphasized by the values in Table 31, ozone control considerations conclude that a NO_x control strategy would be most effective for reducing regional scale ozone transport. Thus, the primary focus herein is on NO_x from large stationary sources. To a lesser extent, VOCs from consumer products are also addressed. This approach is consistent with the CSAPR Update and prior interstate transport rulemakings, where U.S. EPA has historically focused control measure reviews on sources of NO_x rather than VOCs.

TABLE 31: California Emissions in 2011 and 2023 by Sector

Modeled Emissions by Sector	***NO_x***			***VOCs***		
	Mobile	***Stationary***	***Area***	***Mobile***	***Stationary***	***Area***
2011 NEI Emissions (% of annual emissions)	78.4%	11.2%	10.4%	34.8%	6.5%	58.7%
2023 Projected Emissions (% of annual emissions) [27]	67.1%	26.9%	6.0%	28.6%	29.3%	42.1%

The California SIP has hundreds of prohibitory rules that limit the emission of NO_x and VOCs, including district rules and measures on stationary and area sources, and CARB regulations on consumer products. Many of these rules were developed by the local air districts and CARB to reduce ozone concentrations in the numerous areas that were designated nonattainment for the 1979 1-hour ozone and 1997 8-hour ozone NAAQS, including the Severe (i.e., Coachella Valley, Sacramento Metro, and Western Mojave Desert for both NAAQS, and Ventura County for the 1-hour ozone NAAQS) and Extreme (i.e., Los Angeles-South Coast and San Joaquin Valley) nonattainment areas. These planning requirements associated with the numerous California ozone nonattainment areas, coupled with the increased control requirement stringency for areas classified Severe and worse (e.g., lower major source thresholds and increasing permit offset ratios), have served to limit emissions of NO_x and VOCs from California that might affect other states.

[27] 2023 Projected Emissions from the U.S. EPA's CSAPR Update Modeling

Mobile Source Controls

ARB's current mobile source control programs have achieved tremendous success in reducing NO_x emissions. Ongoing implementation of these programs will result in substantial further reductions through 2031, providing a significant down payment for meeting not only current, but future air quality standards.

ZEV commercialization in the light-duty sector is well underway. New vehicle technologies are being rolled out to the public at an increasing pace. Longer-range battery electric vehicles are coming to market that are cost-competitive with gasoline fueled vehicles, fuel cell vehicles are now for sale, and battery costs are declining at faster rates than projected a few years ago. Autonomous and connected vehicle technologies are being installed on an increasing number of new car models. This technology has the potential to deliver enormous gains in safety, while also reducing traffic congestion and improving fuel efficiency. DC fast charging stations are expanding in California, a growing network of retail hydrogen stations is now available, and California is the first state in the nation to certify a station for retail hydrogen fuel sales.

In the heavy-duty market, zero-emission technologies are commercially available for some uses, and these technologies are increasingly being demonstrated in a range of applications. We are also seeing growing market demand for increasingly clean renewable fuels, with formerly non-regulated entities such as airlines expressing interest in voluntarily opting into the renewable fuels market programs operated by CARB.

<u>Emission Reductions from Current Programs</u>

Ongoing implementation of current control programs is projected to reduce NO_x emissions in the South Coast from today's levels by 153 tpd in 2023 and 184 tpd by 2031. Achieving the benefits projected from the current control program will continue to require significant efforts for implementation and enforcement and thus represents an important element of the overall strategy.

In the light-duty sector, currently adopted programs reduce NO_x emissions from today's levels almost 80 percent by 2031. Key regulations include CARB's LEV fleet emission standards, which have driven the ongoing clean-up of combustion technology. The Smog Check program has ensured clean in-use performance, and the continued lower in-use performance assessment will do so even more effectively in the future. California's reformulated gasoline standard requires fuel producers to meet increasingly stringent standards, which has reduced NO_x, ROG, and toxic emissions from gasoline. CARB's ZEV regulation continues to deliver NO_x and ROG emission reductions.

In the heavy-duty sector, currently adopted programs reduce NO_x emissions by nearly 70 percent by 2031. The Truck and Bus Regulation is one of the most significant rules addressing the legacy heavy-duty truck fleet. Since 2012, it has phased in diesel PM emission controls for nearly all vehicles operating in California, and by 2023 nearly all vehicles will be required to meet 2010 model year engine emissions levels. For municipal and public fleets, the 2005 Fleet Regulation for Public Agencies and Utilities reduces emissions of NO_x and diesel PM from federal, State, county, and city government fleets, as well as those fleets operated by universities, airports, school districts, ports, and special districts such as water, utility, and irrigation districts, by phasing-in requirements for emission control equipment in on-road heavy-duty diesel-fueled fleets. Diesel fuel requirements have further reduced emissions from diesel engines operating in California.

NO_x emissions from off-road equipment are projected to decrease approximately 45 percent by 2031 as a result of CARB programs to establish more stringent engine standards, in-use fleet rules, idling limits, and increasing electrification of smaller equipment. CARB's Cleaner In-Use Off-Road Equipment Regulation (Off-Road Regulation) reduces emission from large diesel off-road equipment that remains in use for long periods of time. The Off-Road Regulation accelerates the penetration of the cleanest equipment and will significantly reduce emissions of NO_x and toxic diesel PM from the over 150,000 in-use off-road diesel vehicles that operate in California by requiring modernized fleets and exhaust retrofits.

Overall, NO_x emissions from sources that are primarily regulated by the federal government, such as ocean-going vessels (OGVs), aircraft, and locomotives, have been reduced as a result of federal activity, although not at the same pace as has been achieved in some other sectors. In aggregate, these sources are projected to remain fairly constant through 2031. While emissions from locomotives continue to decline, emissions from OGVs and aircraft are projected to increase. Although CARB does not have primary regulatory authority over many of these sources, CARB has nonetheless adopted two major regulations to reduce emissions from OGVs, including the OGV Shore Power Regulation, which reduces emissions from diesel auxiliary engines on container ships, passenger ships and refrigerated-cargo ships at-berth at California ports, and the comprehensive OGV Clean Fuel Regulation, which requires vessel operators to use cleaner distillate fuels in their main engines, auxiliary engines, and auxiliary boilers within 24 nautical miles of the California coastline and islands.

Stationary Source Controls

While CARB has primary authority over consumer products, the primary authority over stationary sources and small local businesses resides with California's 35 air districts, who place stringent rules on these sources in order to improve air quality and meet CARB's increasingly strict control requirements. Stationary source controls are generally implemented through a combination of prohibitory rules that set emissions limits by facility type, and facility permits that specify equipment use and other operating parameters, including accommodating industrial growth while mitigating environmental impacts. Many district rules reflect established emission control technologies, while others reflect some of the newest and state-of-the-art technologies. In combination, district rules cover a wide range of sources including refineries, manufacturing facilities, cement plants, refinishing operations, electrical generation and biomass facilities, boilers, and generators, and are among the most stringent in the nation.

Table 32 highlights three measures adopted by CARB and approved into the California SIP by the U.S. EPA. These measures are a sample of the wide array of NO_x and VOC control measures employed at the state level for California.

TABLE 32: Sample List of California State Rules for Ozone

Rule Description	*Pollutant or Precursor Emission Controlled*	*Rule/California Code of Regulations (CCR) Number*	*Federal Register (FR) Citation*
Exhaust Emission Standards for 2008 and Later Model-Year Heavy Duty Gasoline Engines and the Adoption of Amendments to the Low Emission Vehicle Regulations	HC, NO_x	13 CCR 1956.1, 1956.8, 1961, 1965, 1978, 2065	75 FR 70237
Spark-Ignition Marine Engine and Boat Regulations	HC, NO_x	13 CCR 2111-2112, 2139, 2147, 2440-2443.3, 2444.1-2444.2, 2445.1, 2445.2, 2446, 2474	80 FR 26032
Truck and Bus Regulation	PM, NO_x	13 CCR 2025	77 FR 20308

Table 33 highlights 29 measures recently adopted by local air districts and approved into the California SIP by the U.S. EPA. These measures are representative of the wide array of NO_x and VOC control measures employed by the local air districts. For example, Ventura County Air Pollution Control District (APCD) adopted rules limiting NO_x emissions from boilers, water heaters, and process heaters, and Santa Barbara County APCD and South Coast AQMD adopted rules limiting NO_x emissions from certain types of central furnaces and water heaters. San Joaquin Valley APCD adopted a rule to limit VOC emissions from composting operations, and Sacramento Metropolitan AQMD adopted a rule to limit VOC emissions from automotive and related equipment coatings and solvents.

TABLE 33: List of California Local Air District Rules for Ozone

Rule Description	*Pollutant or Precursor Emission Controlled**	*Rule/Regulation Number*	*Federal Register (FR) Citation*
Architectural Coatings– limit the VOC content of architectural coatings used in the District or to allow the averaging of such coatings, as specified, so their actual emissions do not exceed the allowable emissions if all the averaged coatings had complied with the specified limits.	VOC	South Coast AQMD, Rule 1113	78 FR 18244

Rule Description	*Pollutant or Precursor Emission Controlled**	*Rule/Regulation Number*	*Federal Register (FR) Citation*
Graphic Arts– limit ink, coating, fountain solution, or solvent containing Reactive Organic Compounds (ROC) above a certain amount from being applied, manufactured, or supplied for use in a graphic arts operation in the District.	ROC	Ventura County APCD, Rule 74.19	78 FR 58459
Organic Material Composting Operations– limit emissions of volatile organic compounds (VOC) from composting operations.	VOC	San Joaquin Valley Unified APCD, Rule 4566	77 FR 71130
Emissions Reductions from Greenwaste Composting Operations– reduce fugitive emissions of VOC and ammonia occurring during greenwaste composting operations.	VOC, NH3	South Coast AQMD, Rule 1133.3	77 FR 71129
Automotive, Mobile Equipment and Associated Parts and Components– limit the emission of VOC into the atmosphere from coatings and solvents associated with the coating of motor vehicles, mobile equipment and associated parts and components.	VOC	Sacramento Metropolitan AQMD, Rule 459	77 FR 47536
Graphic Arts Operations– limit the emissions of VOC from continuous web or single sheet fed graphic arts printing, processing, laminating or drying operations and digital printing operations.	VOC	San Diego County APCD, Rule 67.16	77 FR 58313
Natural Gas-Fired Fan-Type Central Furnaces and Small Water Heaters– limit oxides of nitrogen from any natural gas-fired fan-type central furnaces or water heaters manufactured, supplied, sold, offered for sale, installed, or solicited for installation within the District.	NO_x	Santa Barbara County APCD, Rule 352	78 FR 21543
Wood Products Coating Operations– limit VOC from all new wood products coating operations.	VOC	San Diego County APCD, Rule 67.11	78 FR 21537
Surface Coating of Aerospace Vehicles and Components– limit reactive organic compounds (ROC) as applicable to any person who manufactures any aerospace vehicle coating or aerospace component coating for use within the District, as well as any person who uses, applies, or solicits the use or application of any aerospace vehicle or component coating or associated solvent within the District.	ROC	Santa Barbara County APCD, Rule 337	78 FR 21537
Polyester Resin Operations– limit VOC from solvent cleaning machines and operations, coating of metal parts and products and polyester resin operations.	VOC	Santa Barbara County APCD, Rule 349	79 FR 4821

Rule Description	*Pollutant or Precursor Emission Controlled**	*Rule/Regulation Number*	*Federal Register (FR) Citation*
Adhesives and Sealants– limit VOC from adhesives and sealants and is applicable to any person who supplies, sells, offers for sale, distributes, manufactures, solicits the application of, or uses any adhesive product, sealant product, or associated solvent for use within the District.	VOC	Santa Barbara County APCD, Rule 353	78 FR 53680
Gasoline Transfer and Dispensing– limit VOC and oxides of nitrogen emissions from gas-fired fan-type central furnaces, small water heaters, and the transfer and dispensing of gasoline. This rule applies to the transfer of gasoline from any tank truck, trailer, or railroad tank car into any stationary storage tank or mobile fueler, and from any stationary storage tank or mobile fueler into any mobile fueler or motor vehicle fuel tank.	VOC, NO_x	South Coast AQMD, Rule 461	78 FR 21543
Adhesives– limit emissions of VOC from the application of commercial and industrial adhesive or sealant products, and from related solvents and strippers.	VOC	Placer County APCD, Rule 235	78 FR 53680
Graphic Arts Operations– limit the emissions of VOC from graphic arts operations.	VOC	Placer County APCD, Rule 239	79 FR 14178
Liquefied Petroleum Gas Transfer and Dispensing– reduce emissions of VOC associated with the transfer and dispensing of liquefied petroleum gas (LPG).	VOC	South Coast AQMD, Rule 1177	79 FR 364
Large Water Heaters and Small Boilers– regulate emissions of oxides of nitrogen (NO_x) and carbon moNO_xide (CO) from natural gas fired water heaters, boilers, steam generators, and process heaters.	NO_x, CO	Ventura County APCD, Rule 74.11.1	79 FR 28613
Boilers, Water Heaters and Process Heaters– regulate emissions of oxides of nitrogen (NO_x) and carbon moNO_xide (CO) from boilers, steam generators, and process heaters.	NO_x, CO	Ventura County APCD, Rule 74.15.1	79 FR 28613
Aerospace Assembly and Component Manufacturing Operations– establish ROC limits for industrial sites engaged in the manufacturing, assembling, coating, masking, bonding, paint stripping, and surface cleaning of aerospace components and the cleanup of equipment associate with these operations. It also describes related recordkeeping requirements and test methods.	ROC	Ventura County APCD, Rule 74.13	79 FR 37222

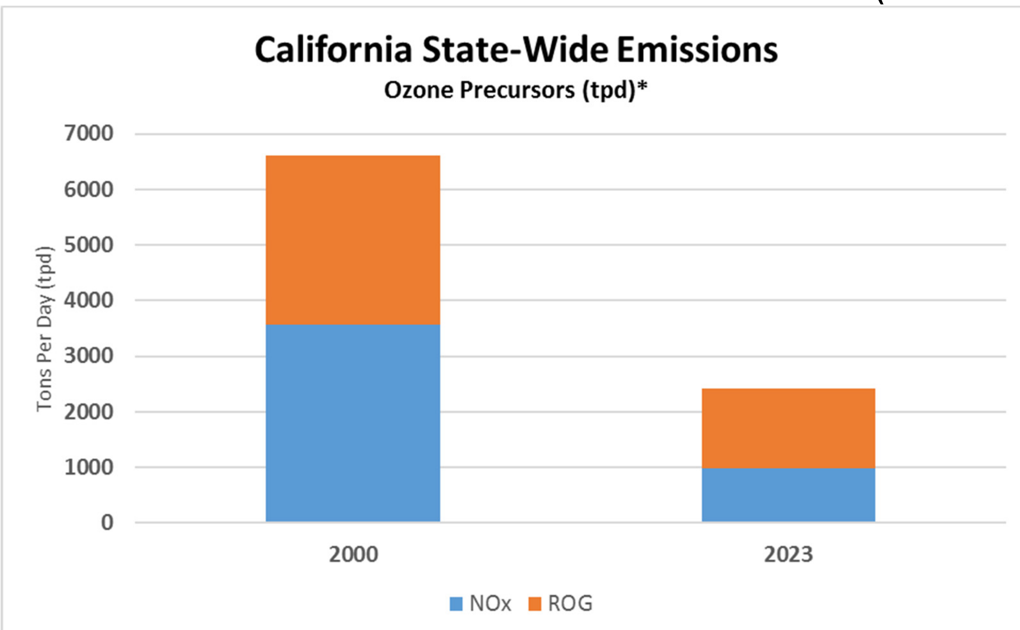
Rule Description	*Pollutant or Precursor Emission Controlled**	*Rule/Regulation Number*	*Federal Register (FR) Citation*
Marine Coating Operations– establish ROC limits for application, use, and supply of coatings for marine and fresh water vessels, drilling vessels, and navigational aids, and their parts or components, including any parts subjected to unprotected shipboard conditions. It also includes requirements for add-on control equipment, surface preparation and cleanup solvents, recordkeeping, and test methods.	ROC	Ventura County APCD, Rule 74.24	79 FR 37222
SIP Credit for Emission Reductions Generated Through Incentive Programs– provide an administrative mechanism for the District to receive credit towards State Implementation Plan requirements for emission reductions achieved in the San Joaquin Valley Air Basin through incentive programs administered by the District, NRCS, or CARB.	Varies by plan	San Joaquin Valley Unified APCD, Rule 9610	80 FR 19020
Surface Preparation and Clean-up Solvents– limit the emissions of VOC from surface preparation and clean-up, and from the storage and disposal of materials used for surface preparation and clean-up.	VOC	Feather River AQMD, Rule 3.14	80 FR 22646
Vehicle and Mobile Equipment Coating Operations– establish limits on the emission of VOC from vehicle and mobile equipment coating operations (VMECO).	VOC	Feather River AQMD, Rule 3.19	80 FR 33195
Wood Products Coating Operation– To establish limits on the emission of VOC from coatings and strippers used on wood products.	VOC	Feather River AQMD, Rule 3.20	80 FR 22646
Petroleum Refinery Coking Operations– reduce emissions from atmospheric venting of coke drums. This rule applies to all petroleum refineries equipped with delayed coking units.	VOC	South Coast AQMD, Rule 1114	80 FR 2609
Solvent Cleaning and Degreasing– reduce VOC emission from operations associated with solvent cleaning and degreasing. It is also designed to reduce VOC emission from operations associated with the use of organic solvents. It also regulates the disposal and evaporation of photochemically reactive organic solvents or compounds into the atmosphere. And lastly, it limits VOC emissions from operations associated with solvent degreasing.	VOC	Yolo Solano AQMD, Rule 2.31	80 FR 23449

Rule Description	*Pollutant or Precursor Emission Controlled**	*Rule/Regulation Number*	*Federal Register (FR) Citation*
Natural Gas-Fired Water Heaters, Small Boilers, and Process Heaters– limit the emissions of oxides of nitrogen (NO_x) from the use of natural gas-fired water heaters, small boilers and process heaters.	NO_x	Placer County APCD, Rule 247	79 FR 60347
Boilers, Steam Generators, and Process Heaters-0.075 MMBtu/hr to less than 2.0 MMBtu/hr– limit emissions of oxides of nitrogen from boilers, steam generators, process heaters, and water heaters.	NO_x	San Joaquin Valley Unified APCD, Rule 4308	80 FR 7803
Metalworking Fluids and Direct-Contact Lubricants– limit emission of reactive organic compounds contained in fluids used for metalworking including, but not limited to, metal removal, metal forming, metal treating, or lubricating operations where the metalworking fluid or direct-contact lubricant come into contact with products or parts including, but not limited to, blanking, broaching, coining, cutting, drilling, drawing, forming, forging, grinding, heading, honing, lapping, marquenching, milling, piercing, quenching, roll forming, rolling, stamping, tapping, threading, turning, and wire drawing. It also applies to reactive organic compounds contained in fluids used for metal protection, including rust and corrosion prevention and inhibition.	ROC	Ventura County APCD, Rule 74.31	80 FR 16289
Gasoline Dispensing Facilities– limit displaced gasoline vapors from storage tanks and transport vessels.	VOC	Feather River AQMD, Rule 3.8	80 FR 38959

** NO_x = oxides of nitrogen; CO = carbon monoxide; VOC = volatile organic compounds, ROC = reactive organic compounds, NH_3 = Ammonia*

Figure 6 is an evidence of the efficacy of both State and district rules put into place which have resulted in drastically reduced levels of ozone precursor emissions statewide.

FIGURE 6: California State-Wide Emissions for Ozone Precursors (2000 to 2023)



* CEPAM: 2016 Ozone SIP v 1.05, Summer, Grown and Controlled

Stationary Sources - EGUs

For stationary controls, it is common practice throughout the nation to target the large stationary sources, particularly electricity generating units (EGUs), for NO_x control analyses and strategies. EGUs have often been targeted for further control strategies, given their historic potential to produce large, cost-effective emission reductions. Therefore, it is desirable to review California EGUs and their NO_x emission controls. The following is an evaluation of EGUs and controls in California.

Emissions monitoring data for 2016 indicate that 242 of the 244 EGUs in California that reported ozone season NO_x emissions to U.S. EPA emitted NO_x at rates less than or equal to 0.061 lb/MMBtu. The remaining two EGUs, Greenleaf One unit 1 and Redondo Beach unit 7, emitted at rates higher than 0.061 lb/MMBtu. Greenleaf One unit 1 emitted less than 11 tons of NO_x in the 2016 ozone season and is therefore unlikely to have significant cost-effective emission reduction opportunities. Applied Energy Services plans to retire its Redondo Beach units, including unit 7, no later than December 31, 2019, to comply with California regulations on the use of cooling water in certain power plant operations.

The largest collection of EGU facilities emitting over 100 tons per year (tpy) of NO_x, per the 2011 NEI, are found in the San Joaquin Valley, Bay Area, and South Coast air districts. These sources are subject to district rules limiting NO_x emissions that have been approved into the California SIP. At least two of these facilities in the San Joaquin Valley APCD have shut down since 2011. Otherwise, the largest NO_x-emitting EGU facility in 2011 was the ACE Cogeneration coal-fired power plant in Trona (Mojave Desert AQMD). It emitted 620 tpy of NO_x and was the only EGU facility in California that emitted more than 250 tpy of NO_x. However, as discussed in the ACE Cogeneration Company's 2014 petition to the California Energy Commission to decommission this facility, the company had signed an agreement with Southern California Edison (the regional utility) to terminate operation of the facility in December 2014 and, in fact, ceased operation on October 2, 2014.

To investigate the potential for further NO_x emission reductions from EGUs, in 2016, the U.S. EPA assessed the cost-effectiveness of reducing NO_x emissions from fossil fuel-fired EGUs in each of the 48 contiguous states by estimating the amount of NO_x that would be emitted at certain levels of NO_x control stringency. These were represented by uniform regional cost thresholds from $800 per ton of NO_x removed up to $6,400 per ton. The CSAPR Update finalized EGU emission budgets for 22 eastern states based on a cost threshold of $1,400 per ton since that level of cost-effective control would achieve sufficient reductions to partially address ozone transport in the eastern U.S. The NO_x emission level for California was flat at 1,905 tons across the cost threshold scenarios until the $5,000 per ton scenario, where the California ozone season NO_x emission level would be reduced to 1,810 tons. In other words, additional NO_x reductions from EGUs in California on top of already strict local regulations would cost more than three times the amount that the U.S. EPA determined to be cost-effective to partially address ozone transport obligations in the eastern U.S. under the CSAPR Update.

While it is customary to investigate EGUs in California, due to strict and comprehensive emissions regulations on emissions, EGUs do not appreciably contribute to NO_x such that the emissions could significantly contribute to ozone formation in another state.

Stationary Sources - Non-EGUs

Non-EGU sources are also subject to stringent rules that limit NO_x emissions and have been approved into the California SIP. Per the 2011 NEI, non-EGU stationary sources emitted 6.7 times more NO_x (61,074 tpy) than EGUs (9,159 tpy) in California, which represents 5.2 percent of the total 2011 NO_x inventory for California. In light of the overall control of such sources, for the small number of large non-EGU sources that are either subject to NO_x control measures that have not been submitted for approval into the California SIP, or fall outside the geographic jurisdiction of the applicable district rules, further emission controls would be unlikely to reduce any potential impact on downwind states' air quality because such sources comprise no more than 0.8 percent of the total NO_x emitted in California in 2011. Therefore, despite emitting more NO_x than EGUs, non-EGUs also do not emit sufficient NO_x to impact air quality in other states.

Consumer Products

As was previously mentioned, California has the most stringent consumer product control program in the nation. Chemically formulated consumer products such as personal care products, household care products, and automotive care products are a significant source of reactive organic gas (ROG) emissions, a subset of VOCs, and have been regulated as a source of ROG in numerous rulemakings since 1989. As part of the State's effort to reduce air pollutants, in 1988 the Legislature added section 41712 to the CAA in the Health and Safety Code. Along with subsequent amendments, this section requires CARB to adopt regulations to achieve the maximum feasible reduction in ROG emissions from consumer products. Prior to adopting regulations, CARB must determine that adequate data exist to establish that the regulations are necessary to attain State and federal ambient air quality standards. Commercial and technological feasibility of the regulations must also be demonstrated. The CAA further stipulates that regulations adopted must not eliminate any form of product, and recommendations from health professionals must be considered when developing ROG control measures for health benefit products.

For almost 30 years, CARB has taken actions pertaining to the regulation of consumer products. Three regulations have set ROG limits for 129 consumer product categories. The most recent amendments to these three regulations were approved for adoption on September 26, 2013. The regulations will cumulatively reduce ROG emissions by about 50 percent.

Aerosol coating products are also regulated, under a reactivity-based regulation. This regulation limits the ozone formation potential of all aerosol coating product emissions. Tables of Maximum Incremental Reactivity have also been adopted to implement the Aerosol Coating Products Regulation.

In order to ensure the ROG emission reductions are based on the state-of-science, CARB staff periodically conducts mandatory Consumer and Commercial Surveys (Survey) to assess the volume of sales of consumer products sold in California and the ingredients within those products. Over the past 25 years CARB has conducted at least seven of these data collection efforts. CARB staff is currently conducting a Survey on consumer products sold into California during the years 2013 to 2015. CARB staff expects to use this data to assess future regulatory directions for the Consumer Products Program. Staff will conduct a Survey for Aerosol Coatings in 2018 to determine emissions and reformulation trends.

Summary

In summary, once a determination is made that a state's pollution is linked to nonattainment or maintenance receptors in another state, the next step is to determine what if any mitigation can be effected by the upwind state. At this point the stringency of emission reduction controls in the upwind state becomes a focus of attention. In the case of California, the State's emission reduction control system leads the nation in stringency for most sectors of emission sources. California's programs have paved the way for a number of federal programs that have since been implemented nationwide. This added level of control applicable to California emission sources was implemented to expedite attainment of air quality standards within California. To the extent that polluted air is transported from California to neighboring states, these stringent programs are helpful in mitigating any downwind impacts.

California continues to build and strengthen its air pollution control program. What U.S. EPA found true with respect to the 0.075 ppm 8-hour ozone standard is equally valid concerning the 0.070 ppm 8-hour ozone standard. California's emission reduction programs adequately prohibit the emission of air pollutants in amounts that will significantly contribute to nonattainment, or interfere with maintenance, of the 0.070 ppm 8-hour ozone standard in any downwind state.

Step Four – Adopt Permanent and Enforceable Measures if Warranted

Step Four in U.S. EPA's Four-Step framework calls for states contributing significantly to ozone problems at downwind receptors in other states to adopt permanent and enforceable measures needed to achieve emission reductions.

Although linked to other western states with projected air quality problems in 2023, California is not significantly contributing to nonattainment or maintenance problems in any other states. This is in large part due to the stringency of California's air pollution control program. Therefore, no further reductions or measures are necessary for Good Neighbor SIP purposes.

As such, the ongoing implementation and further planned strengthening of California's air pollution control program underway will continue to benefit other states while improving air quality within California. These benefits would occur for two reasons: by further reducing the already insignificant levels of ozone California may contribute to other states; and, much more prominently, by providing examples of proven and highly effective air pollution control measures from which other states may choose to adopt and implement within their borders. Below, we further describe the regulatory paradigm established by Congress, which makes possible both the elements described above.

The combination of factors that result in California's poor air quality – climate conducive to ozone formation, topography supportive of ozone retention, and a very large and growing population with its attendant pollution sources – are unique to this State. Out of necessity, California has in many instances developed pioneering approaches to reduce emissions and improve air quality.

Congress also made provision for nonattainment areas that would need to implement mobile source control techniques more stringent than those developed by U.S. EPA. California's authority to develop programs of greater stringency than existing national programs is preserved in the CAA's provision for waivers and authorizations. Absent these provisions, U.S. EPA would need to undertake programs to provide for clean air in California.

U.S. EPA has not seen fit to adopt nationwide controls at a stringency level that would provide attainment in California. The air quality challenge faced by California has therefore not been fully met by U.S. EPA's nationwide programs. However, U.S. EPA has granted waiver and authorization requests by California.

In their efforts to further reduce locally measured ozone levels from non-mobile sources, states are not constrained by the level of control set in U.S. EPA regulations and guidance. This willingness to take further actions as necessary to attain the health based air quality standards is the approach taken by California in response to a combination of climate and topography that both form and keep ozone at elevated levels.

In fact, California's regulations have served as a model for other states seeking to take additional measures to improve their air quality. In many cases, downwind states have opted in to California's more stringent control levels. Such a self-help approach by transport-impacted states enables them to lower their own emissions, thereby benefitting their air quality beyond the levels otherwise provided by national programs. This also reduces the extent to which U.S. EPA needs to ratchet down NO_x emission budgets for eastern states subject to CSAPR.

To summarize, California has already adopted and implemented permanent and enforceable measures of sufficient stringency to ensure that this State does not contribute significantly to downwind ozone problems, whether they be nonattainment or maintenance, in other states. As California continues to implement its programs, other states will reap benefits.

Weight of Evidence Analysis

In this WOE analysis, we first describe U.S. EPA's contribution modeling when grouping upwind states' contributions. The results show stark differences in the significance of transport in the eastern and western U.S. We then consider reasons for why transport impacts are much less significant in the western states. Finally, we consider reasons for why California so minimally contributes to other neighboring states despite its size and population.

Differences in Modeled Collective Contributions Across Regions

In its Good Neighbor SIP submission for the 0.075 ppm 8-hour ozone standard, CARB stressed that transport relationships are fundamentally different between the eastern and western states. Transport relationships among CSAPR states are well understood and have been studied and managed over many years. Modeling performed by U.S. EPA shows that in eastern states, transport contributions overwhelm local emission controls and there are often multiple upwind states impacting individual receptor sites. In contrast, receptor sites in the western states are primarily impacted by local emissions and transport is responsible for a much smaller portion of total impact from all sources. The complex terrain, long distances, greater land area, and other issues for western states documented in the staff report all contribute to fundamentally different transport scenarios at play in each region of the country.

These differences are borne out in U.S. EPA's modeling. Below, we provide summaries of U.S. EPA's 'en' modeling released in March 2018. The tables below first group and then compare the levels of in-state and upwind state contributions at nonattainment and maintenance receptor sites in both western and eastern states. Clearly, the role of interstate transport in western states, when considering the collective impact of all upwind states, is a very small portion of projected design values. Perhaps equally significant for western states the collective contribution from upwind states is much smaller than the in-state contribution. These findings are indicators that interstate transport in western states is in most cases not significant.

TABLE 34: 2023 'en' Modeling Results for Projected Nonattainment and Maintenance Monitors in Western States

State	*# Monitors*	*2023 Average DV (ppb)*	*In-State Contributions*	*Collective Contribution from All Upwind States*	*Percent of 2023 Average DV from Upwind States*
AZ	2	69.6	26.30	2.51	3.6%
CO	6	70.7	24.01	6.11	8.6%
Average for Western States Excluding CA		70.4	24.58	5.21	7.4%

TABLE 35: 2023 ‘en’ Modeling Results for Projected Nonattainment and Maintenance Monitors in Eastern States

State	*# Monitors*	*2023 Average DV (ppb)*	*In-State Contribution*	*Collective Contribution from All Upwind States*	*Percent of 2023 Average DV from Upwind States*
CT	4	70.7	6.54	39.55	55.9%
MD	1	70.9	22.60	25.87	36.5%
MI	2	69.0	11.86	30.25	43.8%
NY	2	72.1	15.83	29.74	41.2%
TX	6	71.5	25.74	10.51	14.7%
WI	2	72.0	11.24	34.55	48.0%
Average for Eastern States		71.1	16.53	25.66	36.1%

TABLE 36: Comparison of 2023 ‘en’ Modeling Results for Projected Nonattainment and Maintenance Monitors in Western and Eastern States

Region	*# Monitors*	*2023 Average DV (ppb)*	*In-State Contribution*	*Collective Contribution from All Upwind States*	*Percent of 2023 Average DV from Upwind States*
Western States Excluding California	8	70.4	24.58	5.21	7.4%
Eastern States	17	71.1	16.53	25.66	36.1%

This finding is neither new nor unexpected. If it were not so, and interstate transport was recognized as a problem in the West, U.S. EPA would have extended existing rulemaking such as CSAPR to western states. The very existence of federal interstate transport mitigation rulemakings such as CSAPR and its predecessors (such as the Clean Air Interstate Rule and the NO_x SIP Call) that apply regionally, and not to western states, is testament to the fact that U.S. EPA does not regard interstate transport of ozone to be a western states issue of concern.

Previously conducted rounds of photochemical modeling performed by U.S. EPA to date show there are very few transport-impacted areas in western states. This was the case with the ‘eh’ version of interstate transport modeling released by U.S. EPA and used in California’s Good Neighbor SIP for the 0.075 ppm 8-hour ozone standard. Previous rounds of modeling also indicated, for western states, relatively few upwind contributing states impacting those areas; and that most of the ozone in these areas comes not from other states but from sources from within the impacted state.

Outside California, almost all areas in the West are projected to meet the 0.070 ppm 8-hour ozone standard by 2023. Modeling by U.S. EPA shows fewer yet areas identified as being impacted by transport from other states. This transport situation is very different from the situation in eastern states. In that portion of the country, U.S. EPA’s modeling shows that contributions from many midwestern and eastern states may combine to provide substantial levels of ozone. In such transport-impacted states, the ratio of a state's own contributions to combined impacts from other states is small. The significance of combined impacts of other states is not a new phenomenon, and has been the impetus for regulations to curb interstate transport impacts.

Reasons for Differences in the Role of Transport in Eastern and Western States

Efforts taken by Congress and U.S. EPA to address interstate transport of ozone have historically focused on Eastern states. This focus of the impacts Eastern states have on each other's air quality is not surprising, given the following:

- Large populations in eastern states, which implies large quantities of ozone forming emissions;
- Elevated levels of ozone in many areas of the eastern states, translating to numerous nonattainment areas;
- Relatively small size of eastern states, with a resulting high population density, density of ozone forming emissions (per land area), per capita emissions density;
- Close proximity of sources of air pollution in upwind states to receptors in downwind states; and
- Numerous metropolitan areas (and therefore, numerous nonattainment areas) that straddle state lines.

Table 37 below provides rankings for states in terms of population, land area and population density. Population values are from the 2010 U.S. Census.

TABLE 37: State Population, Land Area, and Population Density

Rank	*By Population*		*By Land Area (square miles)*		*By Population Density*	
	All United States	308,745,538	All United States	3,537,438.44	All United States	79.6
1	California	37,253,956	Alaska	571,951.26	Washington, D. C.	9,856.50
2	Texas	25,145,561	Texas	261,797.12	New Jersey	1,195.50
3	New York	19,378,102	California	155,959.34	Rhode Island	1,018.10
4	Florida	18,801,310	Montana	145,552.43	Massachusetts	839.4
5	Illinois	12,830,632	New Mexico	121,355.53	Connecticut	738.1
6	Pennsylvania	12,702,379	Arizona	113,634.57	Maryland	594.8
7	Ohio	11,536,504	Nevada	109,825.99	Delaware	460.8
8	Michigan	9,883,640	Colorado	103,717.53	New York	411.2
9	Georgia	9,687,653	Wyoming	97,100.40	Florida	350.6
10	North Carolina	9,535,483	Oregon	95,996.79	Pennsylvania	283.9
11	New Jersey	8,791,894	Idaho	82,747.21	Ohio	282.3
12	Virginia	8,001,024	Utah	82,143.65	California	239.1
13	Washington	6,724,540	Kansas	81,814.88	Illinois	231.1
14	Massachusetts	6,547,629	Minnesota	79,610.08	Hawaii	211.8
15	Indiana	6,483,802	Nebraska	76,872.41	Virginia	202.6
16	Arizona	6,392,017	South Dakota	75,884.64	North Carolina	196.1
17	Tennessee	6,346,105	North Dakota	68,975.93	Indiana	181
18	Missouri	5,988,927	Missouri	68,885.93	Michigan	174.8

Rank	*By Population*		*By Land Area (square miles)*		*By Population Density*	
19	Maryland	5,773,552	Oklahoma	68,667.06	Georgia	168.4
20	Wisconsin	5,686,986	Washington	66,544.06	Tennessee	153.9
21	Minnesota	5,303,925	Georgia	57,906.14	South Carolina	153.9
22	Colorado	5,029,196	Michigan	56,803.82	New Hampshire	147
23	Alabama	4,779,736	Iowa	55,869.36	Kentucky	109.9
24	South Carolina	4,625,364	Illinois	55,583.58	Wisconsin	105
25	Louisiana	4,533,372	Wisconsin	54,310.10	Louisiana	104.9
26	Kentucky	4,339,367	Florida	53,926.82	Washington	101.2
27	Oregon	3,831,074	Arkansas	52,068.17	Texas	96.3
28	Oklahoma	3,751,351	Alabama	50,744.00	Alabama	94.4
29	Connecticut	3,574,097	North Carolina	48,710.88	Missouri	87.1
30	Iowa	3,046,355	New York	47,213.79	West Virginia	77.1
31	Mississippi	2,967,297	Mississippi	46,906.96	Vermont	67.9
32	Arkansas	2,915,918	Pennsylvania	44,816.61	Minnesota	66.6
33	Kansas	2,853,118	Louisiana	43,561.85	Mississippi	63.2
34	Utah	2,763,885	Tennessee	41,217.12	Arizona	56.3
35	Nevada	2,700,551	Ohio	40,948.38	Arkansas	56
36	New Mexico	2,059,179	Kentucky	39,728.18	Oklahoma	54.7
37	West Virginia	1,852,994	Virginia	39,594.07	Iowa	54.5
38	Nebraska	1,826,341	Indiana	35,866.90	Colorado	48.5
39	Idaho	1,567,582	Maine	30,861.55	Maine	43.1
40	Hawaii	1,360,301	South Carolina	30,109.47	Oregon	39.9
41	Maine	1,328,361	West Virginia	24,077.73	Kansas	34.9
42	New Hampshire	1,316,470	Maryland	9,773.82	Utah	33.6
43	Rhode Island	1,052,567	Vermont	9,249.56	Nevada	24.6
44	Montana	989,415	New Hampshire	8,968.10	Nebraska	23.8
45	Delaware	897,934	Massachusetts	7,840.02	Idaho	19
46	South Dakota	814,180	New Jersey	7,417.34	New Mexico	17
47	Alaska	710,231	Hawaii	6,422.62	South Dakota	10.7
48	North Dakota	672,591	Connecticut	4,844.80	North Dakota	9.7
49	Vermont	625,741	Delaware	1,953.56	Montana	6.8
50	Washington, D. C.	601,723	Rhode Island	1,044.93	Wyoming	5.8
51	Wyoming	563,626	Washington, D. C.	61.4	Alaska	1.2

By comparison, there has been little focus on transport impacts between western U.S. states until recent years. In 2015, U.S. EPA first released modeling for interstate transport in the West. Though a significant undertaking on U.S. EPA's part, this effort has not culminated in a backstop regulation for western states. Rather, states are required to assess their impacts (using U.S. EPA's modeling or other equivalent tools) and ensure they address potential impacts on downwind impacted states. By not promulgating a version of the CSAPR in the West, U.S. EPA could be viewed as tacitly acknowledging a disparity in the significance of interstate transport of ozone between western and eastern states.

Conditions in the western U.S. differ markedly from those in the East. Apart from California, western states have few nonattainment areas. One would reasonably expect insignificant levels of interstate transport in the West for a number of reasons.

First, California's air quality challenges are unique and are in part due to the State's population, climate, and topography. California is by far the nation's most highly populated state. The State has both large metropolitan nonattainment areas and rural nonattainment areas located downwind of those large metropolitan areas. Mountain ranges keep locally-generated emissions and pollution substantially within California and result in high ozone concentrations in many parts of the State. By the same coin, these mountain ranges also prevent much transport of ozone or ozone precursor emissions from California to other states.

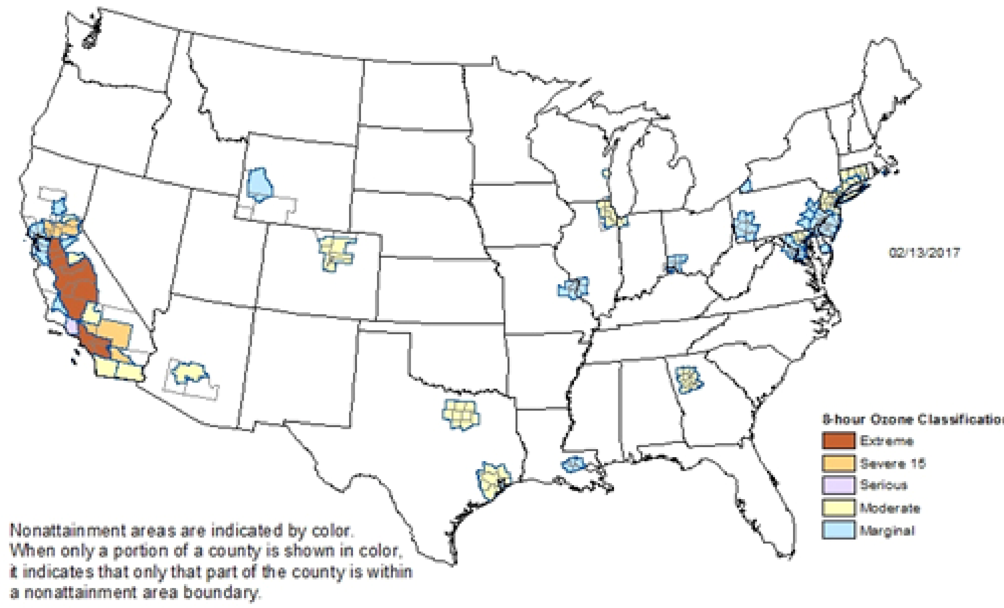
The relief map in Figure 7 shows how topography differs between eastern and western portions of the nation. Besides forming a barrier to the transport of pollution, complex topography makes air quality modeling yet more challenging because the underlying meteorological modeling is difficult both to perform reliably and to validate.

FIGURE 7: Map of United States Topography

Next, apart from those in California, there are few ozone nonattainment areas in the western states. Like California, other western states have large land areas; but unlike California, they are generally sparsely populated. The few nonattainment areas in these western states projected to have ozone problems in 2023 (Denver-Boulder-Greeley-Ft. Collins-Loveland, Colorado, and Phoenix-Mesa, Arizona) are large metropolitan areas in which activities of local populations generate significant emissions of ozone precursors. While many rural areas in California experience high ozone, this is not the case for rural communities in other western states. Ozone transported from California is therefore not considered to impact rural areas in other western states.

The map in Figure 8 shows locations of nonattainment areas for the 0.075 ppm 8-hour ozone standard. Merely noting distances of nonattainment areas from state boundaries, one could anticipate lesser interstate transport impacts in the West than in the East.

FIGURE 8: 8-Hour Ozone Nonattainment Areas (2008 Standard)



For the Ozone-8Hr (2008) Cincinnati, OH-KY-IN nonattainment area, the Ohio portion was redesignated on December 16, 2016.
The Kentucky and Indiana portions have not been redesignated.
The entire area is not considered in maintenance until all states in a multi-state area are redesignated.

This last finding is not surprising, because a combination of great distances and large physical obstacles in the form of mountain ranges that must be traversed by air pollutants transported between western states. For the most part large cities in the West – and correspondingly, nonattainment areas – do not straddle state boundaries and are often far removed from neighboring states. As can be seen in Figure 9 below, the eastern part of the country has numerous large urbanized areas located near state borders; the western part of the country does not.

FIGURE 9: Urbanized Areas and Urban Clusters: 2010

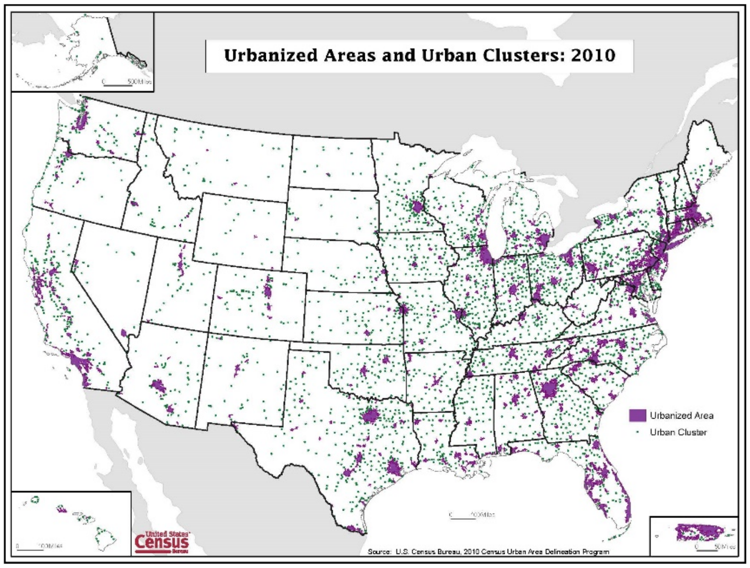
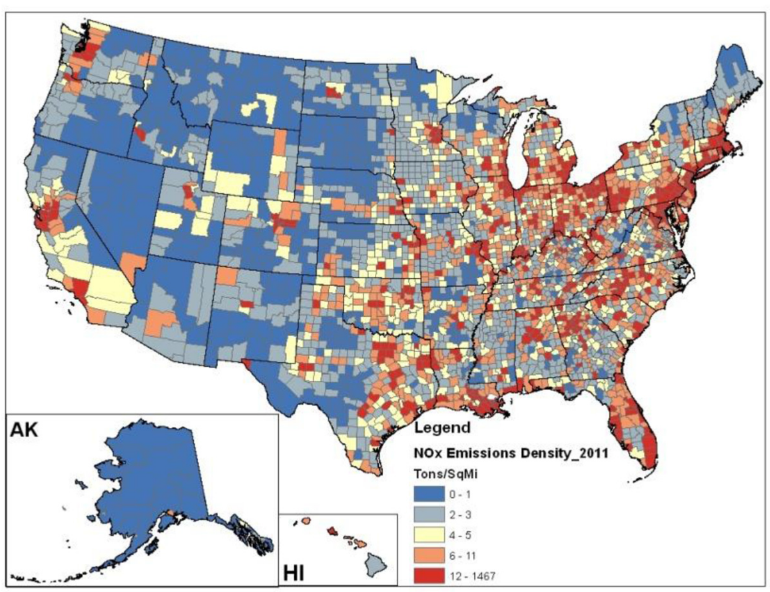


Figure 10 is an emission density map for the ozone precursor NO_x. This map shows areas with high and low emissions densities, and underscores the correlation between populated areas and high emissions densities. It is evident that large metropolitan areas that are nonattainment areas and are distant from other nonattainment areas or emissions sources are likely to be overwhelming contributors to their own ozone problem.

FIGURE 10: Profile of the 2011 National Air Emissions Inventory
(U.S. EPA 2011 NEI Version 1.0, April 2014)



Emissions estimates are from U.S. EPA's dataset (termed the 'en' version of the 2011 NEI inventory) used in its most recent round of interstate ozone modeling and released in October 2017 and March 2018.

Also, because western states are relatively large, emission sources in other upwind western states may not be in close proximity to large downwind metropolitan areas with high concentrations of ozone. This is certainly true of California, which does not have urbanized areas or high emission density areas on or near its eastern border (facing neighboring states).

Given the above, it is not surprising that historically, interstate transport of ozone has not been considered a problem in the western states.

As stated above, the size of states and their populations, and the location of state borders and distance to populations, are factors that define the extent of transport impacts between states. These factors are based on the nation's history and development. The country grew from east to west as additional land was added to the U.S. and populations migrated towards the Pacific Ocean.

Clearly, the nation's first 13 states are different in size, shape, and population from those states that have achieved statehood since[28]. The 48 contiguous states are similar in that they almost all have at least one border drawn in the east-west direction along lines of latitude. These defined the northern and southern boundaries of territories and states. However, eastern and western states differ regarding the shapes of their eastern and western borders. In the East, those borders were set along existing physical barriers such as rivers and mountain ridges. In the West, many such borders were set using lines of longitude. Additionally, western states are on average much larger than their eastern counterparts.

As Congress refined borders of territories in the West, ultimately forming states, it followed a pattern proposed by Thomas Jefferson in 1784[29] and set generally rectilinear boundaries. This meant a departure from using rivers as borders; since rivers do not flow straight along lines of latitude or longitude, the borders Congress set for western states typically do not follows bodies of water. Supplies of fresh water being necessary to sustain life, human settlements occur along bodies of water, and often adjacent to rivers. As a result, western state borders typically do not cross major population centers.

The distance between emission sources and impacted receptors is a highly significant factor in determining the influence an upwind source may have on downwind air quality. Because sources of anthropogenic emissions closely track with population centers, the very shape of western states tends to curtail the impact one state's ozone-forming emissions may have on ozone levels in neighboring states.

The size of a state also impacts the degree of influence one state's emissions may have on a neighboring state. Western states are on average significantly larger than those in

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[28] Stein, Mark, *How the States Got Their Shapes, Smithsonian Books/Collins, 2008.*
[29] "Report from the Committee for the Western Territory to the United States Congress". *Envisaging the West: Thomas Jefferson and the Roots fo Lewis and Clear.* University of Nebraska-Lincoln and University of Virginia. March 1, 1784. Retrieved August 19, 2013.

the East. The greater size of states in the West translates to greater distances between emission sources and receptors. The greater size of western states is an outcome of Congress utilizing a population threshold of 60,000 people as a qualification for statehood[30]. Migration of settlers westward to occupy newly acquired lands occurred at variable rates (related to ease of travel and perceived attractions of a given destination) and did not result in even dispersion of settlers throughout the West. Apart from California, many western states have relatively low populations even compared to national averages. For such western territories to qualify as states, they were necessarily large in area.

Congress' establishment of large western states with borders that typically do not follow along rivers has the effect of minimizing ozone transport between western states. On the other hand, states in the East are characteristically smaller, with reduced proximity between emissions sources and receptors; have higher populations living on or near borders with other states; and have greater population density and emissions density. Not surprisingly, interstate transport of criteria pollutants is much more of a problem in the East. Congress' recognition of this has led to a number of federal regulatory programs targeting emission sources that impact receptors in eastern states.

California's Role in Transport

Given a prevailing wind flow from west to east, California is upwind of many other western states. California also has by far the nation's highest population, and therefore also has relatively large emissions of ozone precursors. Might it then be reasonable to anticipate that California has a significant transport impact on neighboring states?

A number of factors play an important role in the extent to which one state's emissions may affect another's air quality. These include distance from emission sources to receptors, climate, topography, and level of control of emissions.

California's warm, sunny climate and its topography are perfect for forming and trapping air pollutants. Most California cities are built on plains or in valleys surrounded by mountains. These areas are natural bowls that trap air pollution and prevent the air from circulating. On hot, sunny days, nitrogen oxides and volatile organic compounds emitted by vehicles, industry, and many products react with each other to form ozone. On some days temperature inversions, where the air closer to the ground becomes cooler than the air above, act as lids which trap air pollutants close to the ground. This prevents vertical mixing, where cleaner air aloft could otherwise mix with polluted air nearer the ground level, and the dispersion of pollutants. The resulting poor air quality within California is well recognized.

Less well recognized is another necessary outcome: that little transport of ozone occurs from California to neighboring states. Stated otherwise, the very mountains that keep

[30] "Northwest Ordinance". http://loc.gov/rr/program/bib/ourdocs/northwest.html, Library of Congress.

ozone within California's nonattainment areas also keeps that ozone away from other neighboring states. Further, the existence of numerous ozone nonattainment areas within California, as well as their associated classifications reflecting the severity of concentrations, in combination with very few nonattainment areas in other western states (except for those in large metropolitan areas), is strong evidence that other western states do not have an interstate ozone transport problem. Therefore, California has little impact on ozone levels outside its borders.

Regarding distances, California's eastern border is about 800 miles from Denver and over 150 miles from the Phoenix nonattainment areas. Additionally, California's eastern border is far removed from significant emission sources within this State. In particular, California's border with Nevada is east of the crest of the Sierra Nevada. Not only do those mountains form a barrier to airflow out of California to the East, but land within California to the east of the Sierra is only lightly populated. The portions of California south of the Sierra Nevada and west of the Arizona border in San Bernardino, Riverside, and Imperial Counties are also lightly populated.

Last, we consider the impacts of California's emission control program. To better gauge the level of stringency across source categories we consider each state's per-capita emissions and emissions per land area with the 2011 NEI data used in U.S. EPA's modeling. These metrics (Table 38) provide a snapshot of a state's potential to impact neighboring states, and also capture nuances that speak to whether a contributing state may have already met its obligations as a good neighbor.

TABLE 38: Comparison of NO_x emissions by state totals, by area density, and per capita

Rank	*By NO_x Emissions*		*By NO_x Emissions/Land Area*		*By NO_x Emissions/Person*	
1	All United States	13,830,455	Washington, DC	153.15	Wyoming	0.3660
2	Texas	1,238,589	New Jersey	25.74	North Dakota	0.2402
3	California	697,477	Rhode Island	21.45	Nebraska	0.1177
4	Florida	588,329	Massachusetts	17.47	Louisiana	0.1154
5	Pennsylvania	562,071	Maryland	16.91	Montana	0.1122
6	Ohio	546,382	Delaware	15.10	Kansas	0.1115
7	Louisiana	523,289	Connecticut	15.05	Oklahoma	0.1085
8	Illinois	505,603	Ohio	13.34	New Mexico	0.0985
9	Indiana	443,991	Pennsylvania	12.54	West Virginia	0.0933
10	Michigan	443,494	Indiana	12.38	South Dakota	0.0909
11	Georgia	413,061	Louisiana	12.01	Iowa	0.0783
12	Oklahoma	407,085	Florida	10.91	Arkansas	0.0759
13	New York	388,232	Illinois	9.10	Kentucky	0.0748
14	Missouri	368,799	New York	8.22	Alabama	0.0722
15	North Carolina	365,841	Kentucky	8.17	Indiana	0.0685
16	Alabama	345,246	Virginia	7.85	Mississippi	0.0671
17	Kentucky	324,385	Michigan	7.81	Utah	0.0630
18	Tennessee	320,149	Tennessee	7.77	Missouri	0.0616
19	Kansas	318,237	North Carolina	7.51	Colorado	0.0580
20	Virginia	310,958	West Virginia	7.18	Minnesota	0.0578
21	Minnesota	306,487	Georgia	7.13	Idaho	0.0577

Rank	By NO_x Emissions		By NO_x Emissions/Land Area		By NO_x Emissions/Person	
22	Colorado	291,621	South Carolina	6.86	Tennessee	0.0504
23	Washington	274,605	Alabama	6.80	Texas	0.0493
24	Wisconsin	268,150	Oklahoma	5.93	Ohio	0.0474
25	Arizona	240,712	Missouri	5.35	Wisconsin	0.0472
26	Iowa	238,678	Wisconsin	4.94	Maine	0.0450
27	Arkansas	221,219	Texas	4.73	Michigan	0.0449
28	Nebraska	214,898	California	4.47	All United States	0.0448
29	South Carolina	206,479	Iowa	4.27	South Carolina	0.0446
30	Wyoming	206,280	Arkansas	4.25	Pennsylvania	0.0442
31	New Mexico	202,920	Mississippi	4.24	Georgia	0.0426
32	Mississippi	199,009	Washington	4.13	Washington	0.0408
33	New Jersey	190,892	New Hampshire	4.07	Illinois	0.0394
34	Utah	174,250	All United States	3.91	Virginia	0.0389
35	West Virginia	172,950	Kansas	3.89	Oregon	0.0385
36	Maryland	165,257	Minnesota	3.85	North Carolina	0.0384
37	North Dakota	161,523	Colorado	2.81	Arizona	0.0377
38	Oregon	147,351	Nebraska	2.80	Nevada	0.0367
39	Massachusetts	136,940	North Dakota	2.34	Delaware	0.0328
40	Montana	111,018	Wyoming	2.12	Vermont	0.0313
41	Nevada	99,180	Utah	2.12	Florida	0.0313
42	Idaho	90,418	Vermont	2.12	Maryland	0.0286
43	South Dakota	73,980	Arizona	2.12	New Hampshire	0.0277
44	Connecticut	72,894	Maine	1.94	New Jersey	0.0217
45	Maine	59,792	New Mexico	1.67	Rhode Island	0.0213
46	New Hampshire	36,517	Oregon	1.53	Massachusetts	0.0209
47	Delaware	29,491	Idaho	1.09	Connecticut	0.0204
48	Rhode Island	22,413	South Dakota	0.97	New York	0.0200
49	Vermont	19,615	Nevada	0.90	California	0.0187
50	Washington, DC	9,404	Montana	0.76	Washington, DC	0.0156

As evident from Table 38 above, California ranks as the cleanest among the contiguous states in terms of NO_x per capita. This indicates that despite California's large population, this State's impacts on others have been mitigated by the nation's most stringent emissions control program.

U.S. EPA's modeling of state contributions bears out the expectation that California's impacts on other states would be very small.

SIP Summary and Conclusions

Background

- When the more health-protective 0.070 ppm (or 70 ppb) 8-hour ozone standard was set on October 1, 2015, it triggered a requirement for states to submit Interstate Transport SIPs within three years. Also known as a Good Neighbor SIPs, such plans function to ensure that upwind states do not significantly contribute to nonattainment or prevention of maintenance of good air quality at downwind locations in other states.

- California submitted a Good Neighbor SIP for the 0.075 ppm 8-hour ozone standard in early 2016. That SIP addressed potential impacts to Colorado and Arizona. U.S. EPA proposed to approve this SIP in February 2018, citing the "strength of CARB and local air districts' emission control programs, especially for mobile and stationary sources of NO_x."

Framework for Addressing Good Neighbor Obligations

- U.S. EPA has outlined a Four-Step process for states to follow when developing their Good Neighbor SIPs.

  - The first step consists of identifying sites projected to have high ozone problems in the future year of interest. A site can have a problem with meeting the standard (nonattainment sites) or with continuing to meet it (maintenance sites).

  - For those sites projected to have ozone problems in 2023, if an upwind state is found to transport ozone at levels above a threshold of one percent of the standard (or 0.70 ppb), the upwind contributing state is considered to have a transport linkage to the downwind receptor. Determination of such linkages is established in the second step.

  - In the third step, and if necessary, upwind states then determine what if any cost-effective measures they can implement to improve air quality at the downwind receptor.

  - The fourth step consists of the upwind state adopting permanent and enforceable measures to achieve those emission reductions.

Tools and Further Guidance Provided by U.S. EPA

- To support states in their preparation of Good Neighbor SIPs for the 0.070 ppm 8-hour ozone standard, U.S. EPA released two rounds of modeling that project ozone design values in 2023 and quantify ozone contributions from upwind states at downwind monitoring sites. These future year design values are used to project whether downwind receptors will have problems meeting the ozone standard (nonattainment sites) or continuing to meet the standard (maintenance sites). These two recent rounds of modeling, released in 2017-2018, differed in terms of emission inventory for 2023 and varied in terms of the number of days used to quantify upwind state contributions.

- States were invited by U.S. EPA to use each of its modeling releases when preparing their Good Neighbor SIPs. Besides this flexibility, U.S. EPA also indicated it could be willing to entertain additional potential flexibilities. For example, states could use a threshold of significance of one ppb instead of one percent of the standard, when determining whether linkages existed between states. Another potential flexibility would, pending U.S. EPA approval, enable states to exclude exceptional event data (such as high ozone resulting from wildfires) from data used in projecting future ozone levels. U.S. EPA disclosed guiding principles for granting flexibility to states. One principle encouraged states linked to a common receptor to apply regionally consistent approaches to identifying good neighbor obligations.

- The more recent modeling featured emission inventory updates for NO_x emissions from EGUs and VOC emissions from oil and gas operations.

Step 1 for Colorado

- In the first round of modeling, there were no western states apart from California with projected nonattainment problems in 2023. However, three Colorado sites in the Denver metropolitan area were projected to have maintenance problems.

- In the second round of modeling, ozone levels were higher at most sites in western states. Colorado now had three nonattainment sites and three maintenance sites.

- To corroborate U.S. EPA's modeling, CARB staff performed an analysis of conditions under which high levels of ozone are formed in the Denver area. A conceptual model was developed outlining meteorological conditions that contribute to ozone episodes. Numerous geographic features were considered, such as topography, both in the Denver area and in the roughly 800 miles separating Denver from California. For high ozone days, we also developed back trajectories to trace the movement of air parcels back from Denver to source areas. It was found that when Denver has high ozone concentrations, it also has stagnant or re-circulating airflow, often from the east. CARB staff found it extremely unlikely that California would contribute to ozone concentrations measured in Colorado on high ozone days there.

- A conceptual model developed for Denver's SIP for the 0.075 ppm 8-hour ozone standard similarly described conditions conducive to high ozone in that area.

- CARB staff reviewed both rounds of U.S. EPA's modeling and utilized the more recent set of results, which projected higher ozone levels and was the more protective of public health. CARB assessed the impacts to 2023 design values of removing from consideration exceptional events data in 2010-2013 which Colorado had flagged. Replicating the technique employed by Colorado in its attainment SIP for the 0.075 ppm 8-hour ozone standard, and which U.S. EPA found valid when approving Colorado's SIP, CARB projected revised 2023 design values for Colorado. The Denver area was still projected to have four maintenance sites. Earlier modeling results, when similarly modified, yielded no air quality problems in Colorado.

Step 2 for Colorado

- Changes in modeling output were compared between the earlier and later model runs. Design values went up at all the high ozone sites in Colorado in the later modeling. In general, the increase in design values stemmed from increased contributions from the home state. This increase in locally formed ozone is consistent with the significant increase in Colorado's EGU NO_x emissions, compared to the inventory used in the previous modeling; and with the very large oil and gas increase in VOC emissions from previous inventory projection for 2023 to the updated version.

- Our conceptual model does not rule out the possibility that California could make very small contributions (over one percent of the standard) to Colorado. The levels of contribution projected by U.S. EPA's modeling are indeed very small, but they are over the one percent threshold used for establishing linkage. Given the projection of four maintenance sites even with our revisions to the more recent modeling results, CARB staff considers California and Colorado linked.

- Based on these analyses, CARB staff finds it reasonable to conclude that emissions from California do not significantly contribute to nonattainment or interfere with maintenance of the 0.070 ppm 8-hour ozone standard in Colorado.

Step 1 for Arizona

- Arizona did not have any projected ozone problems in the first round of U.S. EPA modeling. However in the more recent modeling Arizona had two maintenance sites in the Phoenix area.

- To corroborate U.S. EPA's modeling, CARB staff developed a conceptual model for the Phoenix area. This analysis, including back trajectories, showed that air parcels under episodic conditions usually circulate around the Phoenix area. In this pattern, locally generated emissions would predominate in ozone formation. Still, given the very low threshold of contributions of one percent of the standard, or even up to one ppb, some very low levels of transport from California cannot be ruled out.

Step 2 for Arizona

- In this instance, CARB did not revise design values to remove wildfire impacted high ozone data, as Arizona had not flagged any wildfire-related days. CARB's comparison of the two rounds of modeling for Arizona showed that locally formed ozone increased, while California's, and combined upwind states' contributions declined. This supports the viewpoint that Arizona's worsening air quality projections do not stem from increased California impacts. Utilizing the more recent modeling (which projects two maintenance areas) to be conservative, CARB staff considers California and Arizona linked for transport of ozone.

- Based on these analyses, CARB staff finds it reasonable to conclude that emissions from California do not significantly contribute to nonattainment or interfere with maintenance of the 0.070 ppm 8-hour ozone standard in Arizona.

Step 3

- Proceeding to the third step in U.S. EPA's framework for addressing interstate transport, CARB staff considered the stringency of California air pollution control programs at both the state and partner air districts.

- U.S. EPA's interstate transport rule applies to eastern states and focuses on EGUs as these sources typically emit large quantities of NO_x and have high stacks that are capable of releasing pollutants aloft that can traverse large distances. While we reviewed a broad range of sources, our focus rested on EGUs in California. We concurred with a recent review performed by U.S. EPA of such California sources. That review found that requiring California's already very clean EGUs to further reduce NO_x emissions would cost over three times the amount U.S. EPA has determined to be cost effective in eastern parts of the country subject to the Cross-State Air Pollution Rule.

- California's mobile source program, being the first of its kind in the nation, has achieved tremendous success in reducing ozone precursor emissions.

- California continues to build and strengthen its air pollution control program. California's emission reduction control system leads the nation in stringency for most sectors of emission sources.

- While California is linked to other western states with projected air quality problems in 2023, California is not significantly contributing to nonattainment or maintenance problems in any other states. This is in large part due to the stringency of California's air pollution control program.

- What U.S. EPA found true with respect to the 0.075 ppm 8-hour standard is equally valid concerning the 0.070 ppm 8-hour ozone standard. California's emission reduction programs adequately prohibit the emission of air pollutants in amounts that will significantly contribute to nonattainment, or interfere with maintenance, of the 0.070 ppm 8-hour ozone standard in any state.

Step 4

- California has already adopted and implemented permanent and enforceable measures of sufficient stringency to ensure that this State does not contribute significantly to downwind ozone problems, whether they be nonattainment or maintenance, in other states.

- As California continues to implement these programs, other downwind states will receive the benefits.

Weight of Evidence Analysis

The WOE analysis addressed differences in the significance of ozone transport in the eastern and western United States. First, we discuss U.S. EPA's modeling results which underscore these regional differences. Next, we outline reasons for these differences. Finally, we consider factors for why California so minimally transports ozone to other states.

- Modeling performed by U.S. EPA shows that in eastern states, transport contributions overwhelm local emission controls and there are often multiple upwind states impacting individual receptor sites.

- In contrast, receptor sites in the western states are primarily impacted by local emissions and transport is responsible for a much smaller portion of total impact from all sources.

- Conditions in the western U.S. differ markedly from those in the East. Apart from California, western states have few nonattainment areas. Contributing factors in those areas are: low population density, low emissions density and great distances between large urbanized areas.

- The fact that nonattainment areas in other western states are typically found in large metropolitan areas and not in rural areas indicates that transport of ozone and ozone precursors has a much smaller impact in these western states.

- Western states are on average significantly larger than those in the East. The greater size of states in the West translates to greater distances between emission sources and receptors.

- The distance between emission sources and impacted receptors is a highly significant factor in determining the influence an upwind source may have on downwind air quality.

- Congress' establishment of large urban states with borders that typically do not follow along rivers results in western state borders that typically do not cross major population centers. Because sources of anthropogenic emissions closely track with population centers, the very shape of western states has the effect of minimizing interstate ozone transport in the West.

- California's warm, sunny climate and its topography are perfect for forming and trapping air pollutants. Most California cities were established in plains or valleys surrounded by mountains. These areas are natural bowls that trap air pollution and prevent the air from circulating.

- The very mountains that keep ozone within California's nonattainment areas also keeps that ozone away from other neighboring states.

- The existence of numerous ozone nonattainment areas within California, as well as their associated classifications reflecting the severity of concentrations, in combination with very few nonattainment areas in other western states (except for those in large metropolitan areas), is further evidence that western states do not have an ozone transport problem; therefore, California has little impact on ozone levels outside its borders.

- Distances from California's eastern border to locations in western states projected to have air quality issues in 2023 are great.

- Additionally, California's eastern border is far removed from significant emission sources within this State.

- We also considered California's stringent emission control program. California ranks as the cleanest among the contiguous states in terms of NO_x per capita. This indicates that despite California's large population, this State's potential impacts on other states have been mitigated by the nation's most stringent emissions control program.

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