

Appendix C

Transport Assessment for the 75 ppb SO₂ NAAQS

This section employs a weight of evidence approach which demonstrates that California does not contribute significantly to nonattainment or interfere with maintenance of the 75 ppb 1-hour SO₂ NAAQS in any state.

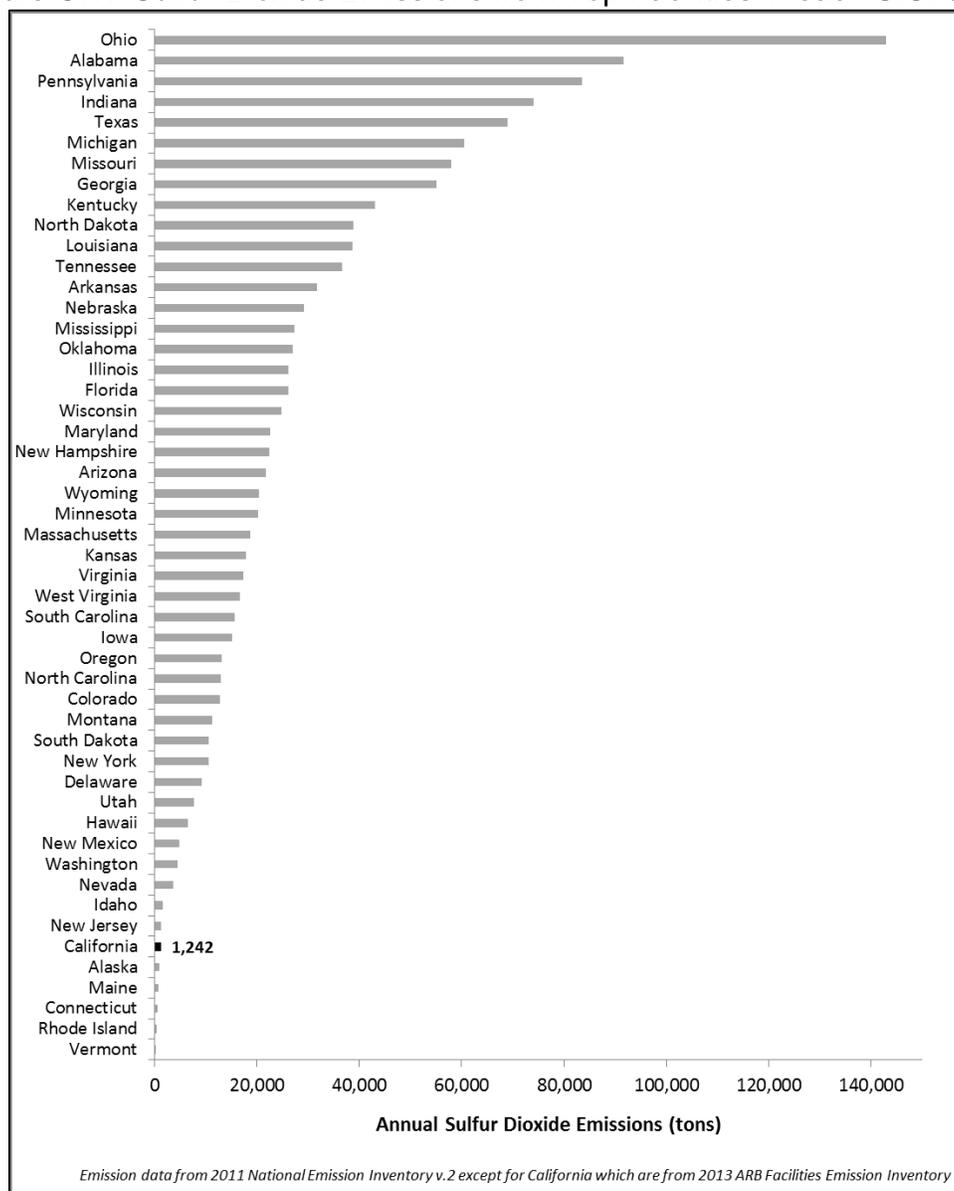
The U.S. EPA adopted the 75 ppb SO₂ NAAQS with a 1-hour averaging time to target protection of sensitive individuals, particularly children, the elderly and people with asthma, from respiratory effects associated with short-term (5 minutes to 24 hours) exposure to SO₂. Discussion in the final SO₂ rule, white papers, and subsequent guidance on implementing the SO₂ standard indicates that maximum concentrations are expected to be observed near large industrial sources. As such, the federal SO₂ standard is considered a near-source standard, similar to the federal lead (Pb) standard. Subsequently, implementation strategies and analyses used to support designation determinations recommended by U.S. EPA focus on emissions from large facilities.

ARB routinely updates a statewide inventory of oxides of sulfur (SO_x) emission sources; and U.S. EPA routinely publishes a National Emission Inventory (NEI) that includes SO₂ emissions for all facilities that emit more than 100 tons per year (tpy). ARB estimates that SO₂ comprises 97 percent of the SO_x inventory. Therefore, in this analysis, California SO_x emissions will be used to represent California SO₂ emissions.

U.S. EPA data indicate that, nationwide, the largest sources of atmospheric SO₂ emissions are fuel combustion electric generation facilities and industrial facilities. The 2008 Integrated Science Assessment for SO₂¹ noted that a strong west to east increasing gradient in SO₂ emissions is evident in the continental United States (U.S.), with the highest emissions in the east. In California, the facilities with the largest SO₂ emissions are petroleum refineries and cement production facilities. Figure C.1 shows the magnitude of SO₂ emissions from the top facilities in each state and indicates that emissions from the top facility in California are more than an order of magnitude lower than top facilities in most other states. In the eastern portion of the country, large electric generation facilities emit over 100,000 tpy of SO₂. In contrast, emissions from the largest facility in California are only 1,242 tpy.

¹ U.S. EPA, 2008 Final Report: Integrated Science Assessment (ISA) for Sulfur Oxides, September 2008. http://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=491274

Figure C.1: Sulfur Dioxide Emissions from Top Facilities in each U.S. State



U.S. EPA recently issued the final data requirements rule governing designations for the 75 ppb SO₂ standard indicating that agencies must characterize air quality around large sources, which are defined as facilities that emit 2,000 tpy or more. Based on this definition, no large SO₂ sources are located in California because all facility emissions reported in ARB’s 2013 Facility Emission Inventory² are below the 2,000 tpy threshold (Appendix F.2).

The final rule for the 2010 revision of the federal SO₂ standard requires three monitors in Core Based Statistical Areas (CBSA) with Population Weighted Exposure Index

² California Air Resources Board, Facility Search Engine, <http://www.arb.ca.gov/app/emsinv/facinfo/facinfo.php>

(PWEI) values of one million or more; two monitors in CBSAs with PWEI values less than one million but greater than 100,000; and one monitor in CBSAs with PWEI value greater than 5,000 but less than 100,000. Each of the three CBSAs in California with SO₂ monitoring requirements currently operate more than twice the required number of monitors (See the *2015 Annual Monitoring Network Report for Twenty-five Districts in California*³ for a detailed description of minimum monitoring requirements), and numerous monitors have been established throughout the State to characterize SO₂ air quality.

Sulfur Dioxide Air Quality and Emissions in California

California has been in attainment of both the revoked 24-hour and annual average SO₂ standards since the late 1980s. In addition, California's network of regulatory monitors in areas with the largest concentration of SO₂ facilities demonstrates that air quality levels have been persistently below the level of the federal 1-hour SO₂ standard for the last 20 years. For those monitoring sites with the historically highest SO₂ concentrations, concentrations have declined significantly due to the magnitude of emission reductions achieved from California control programs. Between 2000 and 2012, emissions from stationary, mobile, and areawide sources declined by 61 percent, 31 percent, and 68 percent, respectively.

As noted in Section II, over the years California has adopted numerous standards to lower the sulfur content in diesel fuel for on-road and off-road vehicles, railroad locomotives, and marine vessels. Ongoing emission control strategies are expected to continue to reduce SO_x emissions throughout the State. ARB emission inventory projections for 2015 indicate that stationary sources will account for approximately 68 percent of statewide SO_x emissions, whereas mobile and areawide sources will account for approximately 24 percent and 8 percent, respectively.⁴

ARB projects a decline in statewide mobile source SO_x emissions from 148 tons per day (tpd) in 2000 to 19 tpd in 2015, a decrease of nearly 88 percent. Improved emission controls and increasingly stringent permitting requirements have led to a decline in emissions from stationary sources in California. For stationary sources, ARB projects a decline in statewide emissions from 132 tpd in 2000 to 54 tpd in 2015, a decline of 59 percent. Further, area sources which include residential fuel combustion and managed burning and disposal are projected to decline from 9 tpd in 2000 to 6 tpd in 2015.

All regions in California are currently undesignated for the 1-hour SO₂ standard. However, in 2011, ARB recommended to the U.S. EPA that the entire State be designated as attainment for the 75 ppb federal SO₂ standard. Comprehensive five-factor analyses of each planning area evaluated jurisdictional boundaries,

³ ARB, Annual Monitoring Network Report, <http://www.arb.ca.gov/aqd/amnr/amnr.htm>

⁴ ARB, *The California Almanac of Emissions and Air Quality – 2013 edition*.
<http://www.arb.ca.gov/aqd/almanac/almanac13/almanac13.htm>

geography/topography, meteorology, emissions, and air quality data to support the recommendation for attainment designation. Since the submittal of the recommendation, SO_x emissions continue to decline and measured SO₂ concentrations at regulatory monitoring sites remain well below the SO₂ standard.

Weight of Evidence Justification and Methodology

U.S. EPA has identified SO₂ as a near-source pollutant. In the final rule for the 1-hour federal standard, published in the Federal Register in June 2010, U.S. EPA stated that:

A significant fact for ambient SO₂ concentrations is that stationary sources are the predominant emission sources of SO₂ and the peak, maximum SO₂ concentrations that may occur are most likely to occur nearer the parent stationary source.⁵

In this document, ARB staff used a weight of evidence approach to examine the potential for SO₂ emissions from California to contribute to nonattainment or interfere with maintenance of the 75 ppb SO₂ standard in neighboring states. As the federal 1-hour standard is considered a near-source standard, attainment strategies target emissions from large facilities. As illustrated in Figure C.2, all California facilities with SO_x emissions exceeding 300 tpy are located within 100 miles of the Pacific Coast. None of the facilities located in California have emissions that exceed the 2,000 tpy threshold for large sources identified in U.S. EPA Data Requirements Rule.⁶

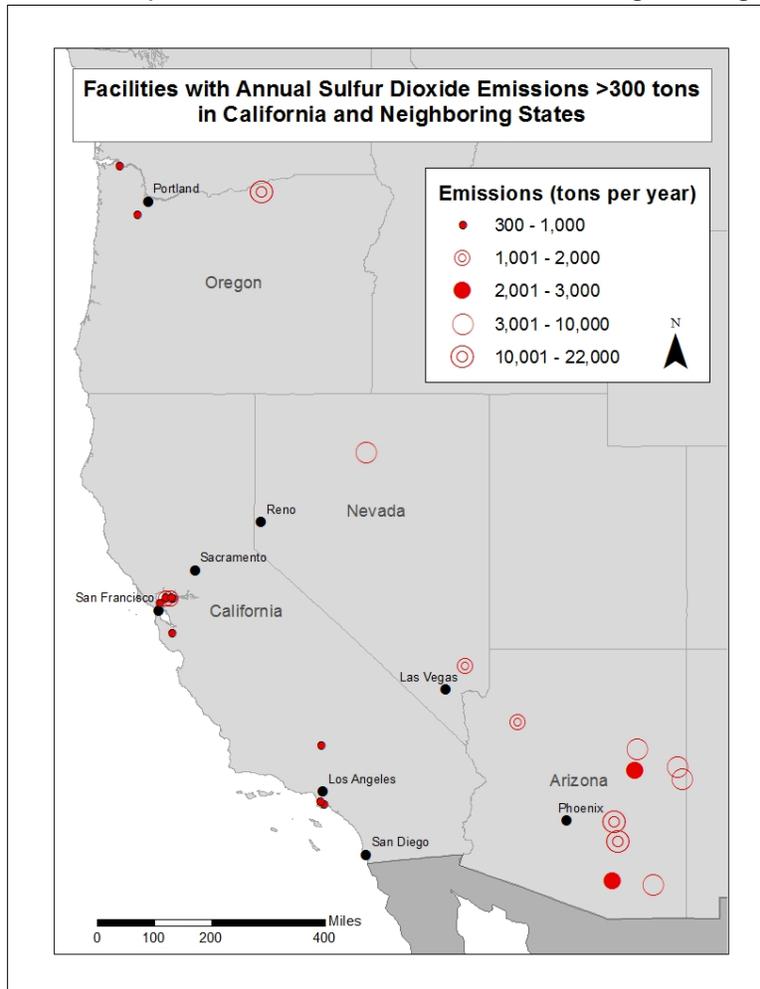
Given that SO₂ is a directly emitted pollutant with a short atmospheric residence time and U.S. EPA guidance indicates that maximum concentrations are expected to occur within one to two miles of most large sources, this assessment was limited to the three neighboring states that border California: Arizona, Nevada, and Oregon. The facility with the highest SO_x emissions in California is located 177 miles, 587 miles, and 361 miles from the borders with Nevada, Arizona, and Oregon, respectively. The shortest distance between this facility and borders with other western states ranges from 509 miles to the Idaho border to 701 miles to the Washington border.

Near-source pollutants, such as SO₂, are mainly derived from a single source or group of sources, maximum concentrations are localized, and the scale of monitoring is relatively limited. For the analyses presented here, specific downwind receptor sites were not identified because SO₂ monitoring data from neighboring states is limited and, with the exception of sites adjacent to large copper smelters in Arizona, concentrations are well below the federal 1-hour standard. Instead, this comprehensive weight of evidence focused on the location of facilities and the magnitude of their emissions, proximity of facilities to neighboring states, and air quality measured throughout California and neighboring states.

⁵ Primary National Ambient Air Quality Standard for Sulfur Dioxide, 75 FR 35520, June 22, 2010

⁶ Data Requirements Rule for the 2010 1-Hour Sulfur Dioxide (SO₂) Primary National Ambient Air Quality Standard (NAAQS), 80 FR 51052, August 21, 2015.

Figure C.2: Map of Facilities in California and Neighboring States



The specific data that were considered by ARB staff in this weight of evidence demonstration included:

- Attainment status in California and neighboring states;
- Facility emissions in California and neighboring states;
- 2014 design values for monitoring sites in California and neighboring states;
- Long-term SO₂ trends at key sites in California; and
- Distance between California facilities and neighboring states' borders.

Attainment Status in California and Neighboring States

In 2010, U.S. EPA adopted the new primary 1-hour SO₂ standard but has yet to complete the designation process. All of California, Nevada, Oregon, and parts of Arizona are currently undesignated. In their designation recommendations, Nevada and Oregon recommended that their states be designated as unclassifiable due to the limited spatial scale of monitoring.

In contrast, California has an extensive network of SO₂ monitoring sites. Between 2012 and 2014, 34 regulatory monitoring sites were operated, many of which had been in operation for many years. In addition, 21 special purpose monitoring sites were operated by refineries in the San Francisco Bay Area and by the ports in the South Coast Area. California has recommended that the entire State be designated as attainment because ambient SO₂ measurements throughout the network of regulatory monitoring sites are well below the 75 ppb standard.

Two areas in Arizona have been classified as nonattainment and Arizona has recommended that the rest of that state be designated as unclassifiable due to lack of modeling studies. The designation recommendation letter submitted to U.S. EPA by Arizona in 2011 noted that the two nonattainment areas have monitored violations of the 75 ppb standard and are located in areas with “primary emission sources that likely contribute to those violations.”⁷ The primary emission sources referenced in the letter are the Asarco LLC Hayden Smelter and the Freeport McMoRan Inc. (FMMI) Miami Smelter, which are the facilities with the highest SO₂ emissions in the state.

Prior to submitting the designation recommendation to U.S. EPA, the Arizona Department of Environment Quality (AZDEQ) issued a draft of the recommended designations and received a comment from FMMI, the operator of the Miami Smelter, which was paraphrased by AZDEQ.

*The Hayden and Miami Copper smelters are the primary sources of sulfur dioxide (SO₂) emissions in their respective proposed nonattainment areas and experience with attaining the previous primary SO₂ standards demonstrates that the smelters have no effect on the other's SO₂ area. FMMI further stated that attainment of the previous primary SO₂ standards was achieved by permanent and enforceable control measures at the Miami smelter and maintaining the existing planning area boundaries provides consistency with proven boundaries.*⁸

Emissions in California and Neighboring States

Based on the 2013 ARB Emission Inventory⁹, 31 facilities in California emit more than 100 tons of SO_x annually. Of these facilities, two emit more than 1,000 tons of SO_x: Shell Martinez Refinery (1,230 tpy), a petroleum refinery, and the Phillips 66 Carbon Plant (1,242 tpy), a calcined pet coke plant. These two facilities are located in Contra Costa County, which is in the San Francisco Bay Area. None of the facilities located in

⁷ State of Arizona, Designation Recommendation for the 2010 Primary Sulfur Dioxide National Ambient Air Quality Standard, May 25, 2011. http://www3.epa.gov/so2designations/recletters/R9_AZ_rec_wtanalysis.pdf

⁸ Ibid

⁹ California Air Resources Board, Facility Search Engine, <http://www.arb.ca.gov/app/emsinv/facinfo/facinfo.php>

California have emissions that exceed the 2,000 tpy threshold for large sources identified in U.S. EPA Data Requirements Rule.¹⁰

2014 Design Values at Sites in California and Neighboring States

Design values calculated from ambient concentrations measured at regulatory sites in California range from 1 to 39 ppb, well below the SO₂ standard of 75 ppb set in 2010. As shown in Figure C.3, California has a statewide SO₂ monitoring network which in 2012 to 2014 included 34 sites operated by State or local monitoring agencies.

Arizona has a network of nine sites; however, only six met U.S. EPA data completeness criteria for calculation of the 2014 design values. Design values for sites in Arizona range from 2 to 282 ppb when all data are considered and 6 to 282 ppb when only sites with complete data are considered. The sites that have reported concentrations that exceed the SO₂ standard are located in nonattainment areas adjacent to the largest stationary SO₂ sources in the state, which are large copper smelting/refining facilities.

The 2014 design values for the two sites in Nevada are 6 ppb and 8 ppb; however, these sites did not meet the U.S. EPA's data completeness criteria. Nonetheless, the Nevada design values are presented here and in Figure C.4 for comparison with other states as they are representative of the low concentrations measured in that state. The 2014 design value for the single site in Oregon is 5 ppb.

In addition to the regulatory monitors in California, 15 source-oriented monitors are operated by refineries in the San Francisco Bay Area. These monitors are required by the Bay Area Air Quality Management District's facility operating permit regulations and are sited to measure near-source SO₂ concentrations derived from facility operations. The 2014 design values for sites operated by the San Francisco Bay Area refineries ranged from 5 to 50 ppb.

In addition to emissions from facilities, emissions from port operations can also contribute to SO₂ in ambient air. The Ports of Long Beach and Los Angeles are among the busiest in the world. In 2006, the San Pedro Bay Ports (cumulatively the Ports of Long Beach and Los Angeles) adopted the Clean Air Action Plan (CAAP),¹¹ which established a comprehensive program aimed at reducing air pollution derived from port operations. As part of the CAAP, the Ports operate a network of six continuous SO₂ monitors; two are located at the Port of Long Beach and four are located at the Port of Los Angeles. The 2014 design values calculated from data collected at these sites ranged from 12 to 74 ppb with all but two sites below 30 ppb, as shown in Appendix F.2 (Table F.2.1).

¹⁰ Data Requirements Rule for the 2010 1-Hour Sulfur Dioxide (SO₂) Primary National Ambient Air Quality Standard (NAAQS), 80 FR 51052.

¹¹ San Pedro Bay Ports Clean Air Action Plan, 2006.
<http://www.cleanairactionplan.org/reports/documents.asp>

Figure C.3: Map of Regulatory Monitoring Sites

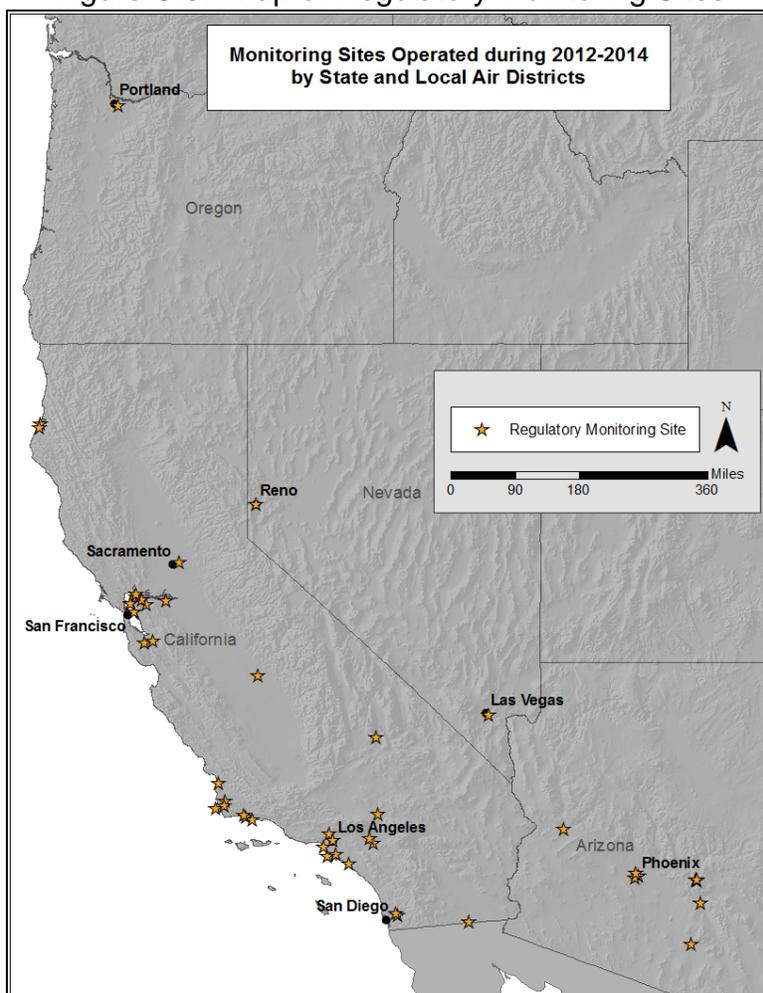
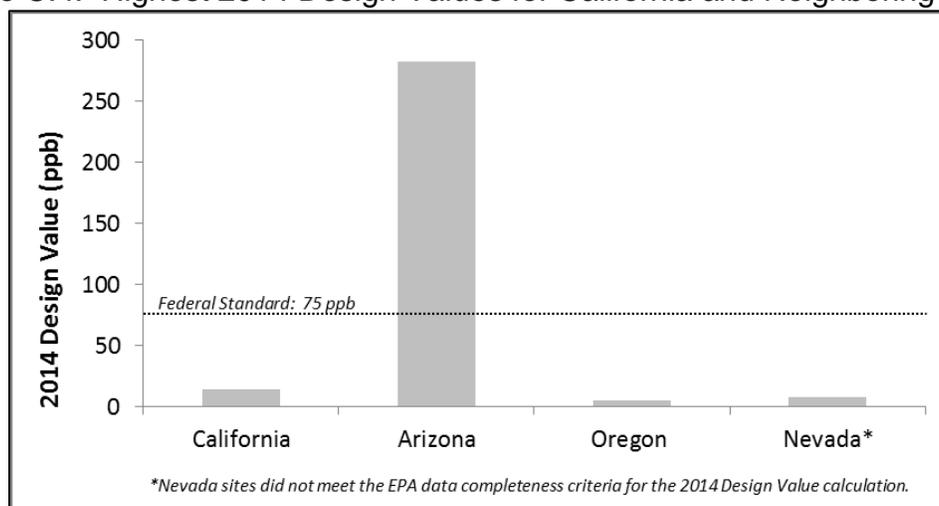


Figure C.4: Highest 2014 Design Values for California and Neighboring States

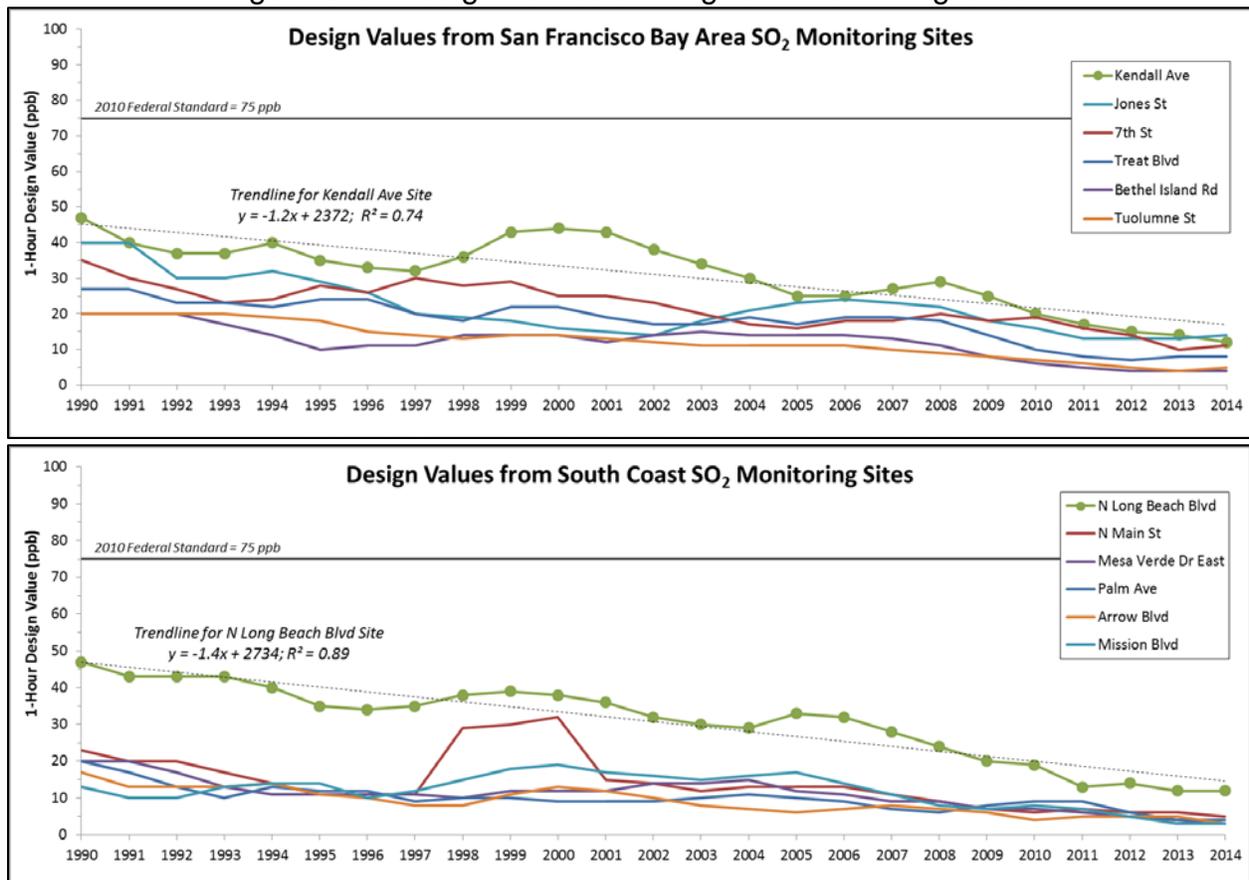


Long-term Design Value Trends at Sites in California

Measurements from regulatory monitors in California indicate that concentrations of SO₂ have been persistently below the 75 ppb standard for the last two decades. Long-term trends were examined by evaluating data from monitors in the San Francisco Bay Area and the South Coast Area. Data from regulatory sites that were operational in the last five years and had a data record spanning at least 15 years were considered. Using these criteria, six sites were identified in both the San Francisco Bay and South Coast Areas.

In 1990, 1-hour design values ranged from 20 to 47 ppb and 13 to 47 ppb for sites in the San Francisco Bay Area and South Coast Area, respectively. As illustrated in Figure C.5, from 1990 through 2014, at the sites with the historically highest concentrations in the San Francisco Bay Area and the South Coast Area, design values declined by more than 1 ppb each year. In 2014, 1-hour design values ranged from 3 to 12 ppb and 5 to 14 ppb at sites in the South Coast Area and San Francisco Bay Area, respectively.

Figure C.5: Design Values at Long-term Monitoring Sites



Distance between California Facilities and Borders with Neighboring States

SO₂ is a highly reactive gas and is readily removed from the atmosphere through wet and dry deposition processes. As a result, most SO₂ emissions are deposited locally through precipitation events or dryfall. Ambient measurements of SO₂ are expected to be the consequence of locally derived emissions. Spatial mapping tools in ESRI ArcGIS were used to determine the shortest distance from each California facility with annual SO_x emissions greater than 300 tons to the borders with neighboring states.

The facilities in California with SO_x emission greater 300 tpy are mainly located along the Pacific Coast; refineries are clustered in the San Francisco Bay Area and the South Coast. Two cement facilities, California Portland Cement and Mitsubishi Cement, are located inland in Kern and San Bernardino Counties, respectively. As shown in Table C.1, all facilities with SO_x emissions greater than 300 tpy are located more than 160 miles from the nearest state border, which is well beyond the one to two mile threshold where maximum concentrations are expected to be observed.

Table C.1: Distance Between California Facilities and Borders with Neighboring States

Facility Name	SO _x Emissions (tpy)	Nevada (miles)	Arizona (miles)	Oregon (miles)
PHILLIPS 66 CARBON PLANT	1242	177	587	361
SHELL MARTINEZ REFINERY	1230	170	579	361
LEHIGH SOUTHWEST CEMENT COMPAN	912	206	554	421
CALIFORNIA PORTLAND CEMENT CO.	804	176	254	630
TESORO REFINING & MARKETING CO	572	167	577	360
TESORO REFINING & MARKETING CO, LLC	509	246	246	721
EXXONMOBIL OIL CORPORATION	481	246	254	714
PHILLIPS 66 COMPANY - SAN FRAN	409	177	589	359
CHEVRON PRODUCTS COMPANY	339	190	593	368
SOLVAY USA INC	324	169	580	359

**California data are SO_x emissions from 2013 ARB Facilities Emission Inventory.*

Routine interstate transport of SO₂ emissions from California is unlikely given the large distance between facilities and neighboring states and ready deposition of SO₂. With the exception of the monitors in designated nonattainment areas of Arizona, design values for monitoring sites in neighboring states are well below the SO₂ standard; therefore, California emissions are not expected to hinder attainment or maintenance of the standard in neighboring states.