GOVERNOR GREG ABBOTT

February 28, 2018

The Honorable Scott Pruitt
Administrator
U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW, 1101A
Washington, D.C. 20460

Re: Ozone Designation for the San Antonio Metropolitan Area, EPA-HQ-OAR-2017-0548

Dear Administrator Pruitt:

I write in response to the Environmental Protection Agency's (EPA) letter of December 22, 2017, concerning EPA's designation of Bexar County under the National Ambient Air Quality Standard (NAAQS) for ozone. As an initial matter, the 2015 NAAQS is legally invalid, and it therefore cannot support a nonattainment designation.

Even if EPA applies the legally invalid 2015 NAAQS, I urge you to designate Bexar County as in attainment. In keeping with its impressive history of improving air quality, Bexar County is projected to meet the 2015 NAAQS by 2020 — sooner than would be required by a nonattainment designation — without the need for additional federal intervention.

Moreover, a nonattainment designation would unjustly reward foreign polluters and weaken the U.S. economy. A comprehensive review of Bexar County's situation demonstrates that a nonattainment designation would be not just unnecessary but counterproductive.[1]

I. The Legally Invalid 2015 NAAQS Cannot Support a Nonattainment Designation

As Texas has previously explained, the 2015 NAAQS is unlawful and should not be used to designate any Texas county as in nonattainment. *See* Letter from Gov. Abbott to Administrator Pruitt, Re: Request of the State of Texas Regarding County-Attainment Designations for the 2015 National Ambient Air Quality Standard for Ozone (Sept. 27, 2017). Indeed, Texas and others have challenged the rule in court. *See Murray Energy Corp., et al. v. EPA*, No. 15-1385 (D.C. Cir.) (consolidated with 15-1392, 15-1490, 15-1491 & 15-1494).

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[1] My recommendation concerning Atascosa, Bandera, Comal, Guadalupe, Kendall, Medina, and Wilson Counties remains the same—they should all be designated as in attainment or unclassifiable.

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EPA is considering whether to withdraw the 2015 NAAQS. In fact, EPA has requested and received an administrative stay in *Murray Energy* precisely because the agency is still considering whether to withdraw the rule. *See* Respondent EPA's Third Status Report, Doc. No. 1711911, *Murray Energy Corp., et al. v. EPA*, No. 15-1385 (D.C. Cir. Jan. 8, 2018) (consolidated with 15-1392, 15-1490, 15-1491 & 15-1494). A withdrawal should prevent further nonattainment designations under the 2015 NAAQS, but it should also render previous nonattainment designations void.

In the meantime, even if EPA is not yet fully convinced that the 2015 NAAQS is unlawful, the legal uncertainty surrounding the rule precludes a nonattainment finding. Because EPA cannot give effect to an unlawful rule, "available information" is insufficient to establish the 2015 NAAQS as "the national primary or secondary ambient air quality standard" for purposes of the the Clean Air Act (CAA), much less can "available information" show that Bexar County "is not meeting" the relevant standard. 42 U.S.C. § 7407(d)(1)(A)(iii). As a result, under no circumstances should Bexar County receive a designation worse than unclassifiable.

A nonattainment designation for Bexar County would exacerbate the legal infirmities of the 2015 NAAQS. As Texas and others explained in *Murray Energy*, the 2015 NAAQS is invalid on its face because it violates CAA and is arbitrary and capricious. *See* State Petitioners' Opening Brief at 19–44, 50–53, Doc. No. 1637822, *Murray Energy Corp., et al. v. EPA*, No. 15-1385 (D.C. Cir. Sept. 26, 2016) (consolidated with 15-1392, 15-1490, 15-1491 & 15-1494). Moreover, EPA has exploited its power to set the 2015 NAAQS at "any point between zero and a hair below the concentrations yielding London's Killer Fog," in violation of the Constitution's nondelegation doctrine. *American Trucking Ass'ns v. EPA*, 175 F.3d 1027, 1037 (D.C. Cir. 1999), *aff'd in part rev'd in part*, *Whitman v. American Trucking Ass'ns*, 531 U.S. 457 (2001). To designate Bexar County as nonattainment on the record explained below, EPA would have to go even further and apply the 2015 NAAQS in unlawful ways.

II. EPA Should Designate Bexar County as in Attainment of the 2015 NAAQS

If EPA continues to apply the 2015 NAAQS — despite its invalidity — the agency should nonetheless designate Bexar County as in attainment. Bexar County is projected to satisfy the 2015 NAAQS by 2020, and that projected compliance is sufficient to support an attainment designation. Moreover, a comprehensive review of Bexar County's situation confirms that a designation of nonattainment would harm both the environment and the economy.

A. EPA Should Conduct a Comprehensive Review

As an initial matter, I want to underscore the breadth of information that EPA can and should consider in designating Bexar County.

CAA defines "nonattainment" by reference to the designation process outlined in 42 U.S.C. § 7407(d). *See* 42 U.S.C. § 7501(2) ("The term 'nonattainment area' means, for any air pollutant, an area which is designated 'nonattainment' with respect to that pollutant within the meaning of section 7407(d) of this title."). Section 7407(d), in turn, establishes a two-step process that grants EPA significant discretion in making designations.

First, the governor of each state is invited to submit initial designations. *Id.* § 7407(d)(1)(A) ("[T]he Governor of each State shall . . . submit to the Administrator a list of all areas (or portions thereof) in the State, designating as" nonattainment, attainment, or unclassifiable.). Second, EPA considers those initial designations and "make[s] such modifications as the Administrator deems necessary." *Id.* § 7407(d)(1)(B)(ii). Although the statute asks "the Governor of each State" to make initial recommendations based on whether an area "meets" or "does not meet" the NAAQS, it gives no such direction to EPA. *Id.* § 7407(d)(1)(A). Instead, CAA gives EPA wide-ranging discretion to "make such modifications as the Administrator deems necessary." *Id.* § 7407(d)(1)(B)(ii). *See also id.* § 7407(d)(3)(C) (empowering EPA to "mak[e] such modifications as the Administrator may deem necessary" for redesignations).

Considering this same language, the D.C. Circuit has observed that § 4707(d) "is replete with the kinds of words that suggest a congressional intent to leave unanswered questions to an agency's discretion and expertise." *Catawba Cty., N.C. v. EPA*, 571 F.3d 20, 35 (D.C. Cir. 2009). The statute "authorizes EPA to revise state-submitted designations whenever it 'deems' such modifications 'necessary,' yet it says nothing of what precisely will render a modification 'necessary.' " *Id.*

Similarly, courts have recognized that EPA has "discretion to determine, based on available information, whether an area is in 'attainment' or 'nonattainment' with the [relevant] air quality standard, or whether the area is 'unclassifiable.'" *Sierra Club v. McCarthy*, No. 13-cv-3953, 2015 WL 889142, at *1 (N.D. Cal. Mar. 2, 2015), *aff'd sub nom. Sierra Club v. North Dakota*, 868 F.3d 1062 (9th Cir. 2017). *See also Miss. Comm'n on Envt'l Quality v. EPA*, 790 F.3d 138, 146 (D.C. Cir. 2015) (interpreting the "deems necessary" language to "give[] the EPA discretion to change a state's recommended designation, to alter a state's proposed geographic area or both").

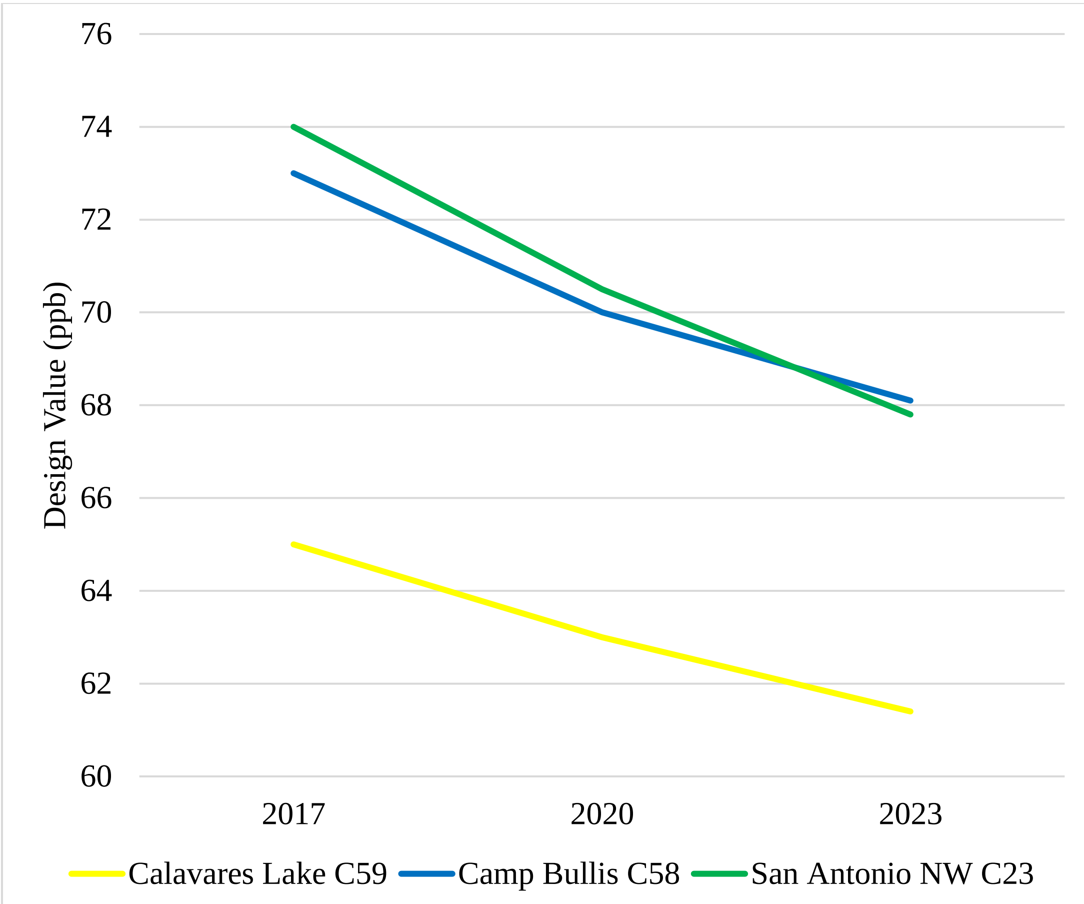
Thus, it is not true that EPA's designation decision is confined to reading the numbers on an air monitor. The statute vests the administrator with significant discretion to consider whatever information he deems "necessary."

B. Bexar County Is Projected to Meet the 2015 NAAQS by 2020

Exercising this discretion in the past, EPA has taken a forward-looking approach that considers likely future ozone levels, not just monitoring data about past ozone levels. As the Seventh Circuit has recognized, EPA's decision to make "designation[s] based on predicted (future) violations of air quality standards . . . has been upheld as reasonable and valid." *Wis. Elec. Power Co. v. Costle*, 715 F.2d 323, 330 (7th Cir. 1983). Similarly, the Sixth Circuit has upheld EPA's decision to make "attainment status designations" based on "predicted air quality." *PPG Indus., Inc. v. Costle*, 630 F.2d 462, 467 (6th Cir. 1980).

EPA should do the same here. Bexar County will meet the 2015 NAAQS by 2020, without a nonattainment designation. As the graph and table below demonstrate, all three regulatory monitors in Bexar County are projected to have design values lower than 71 ppb by 2020. By 2023, each regulatory monitor will be well below the 2015 NAAQS.[2]

Current and Projected 8-Hour Design Values (ppb) for Bexar County Regulatory Monitors



Regulatory Monitor	2017	2020	2023
Calavares Lake C59	65.0	63.0	61.4
Camp Bullis C58	73.0	70.0	68.1
San Antonio NW C23	74.0	70.5[3]	67.8

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[2] These projections are based on photochemical modeling analysis performed by the Alamo Area Council of Governments. *See* Appendix A, Ozone Analysis of the 2012 Ozone Season Photochemical Modeling Episode: Technical Report at 1-4, 4-8 (Nov. 2017).
[3] A design value of 70.5 ppb satisfies the 2015 NAAQS. *See* Implementation of the 2015 National Ambient Air Quality Standards for Ozone, 81 Fed. Reg. 81,276, 81,284 (Nov. 17, 2016) (defining the lowest category of nonattainment as including levels from 71 ppb up to 81 ppb).

This analysis is consistent with Bexar County's impressive history of reducing ozone pollution without a nonattainment designation. The 2017 values noted above — and 65 ppb, 73 ppb, and 74 ppb — represent a dramatic reduction in ozone levels since 2004, when those values were 79 ppb, 89 ppb, and 91 ppb, respectively.[4] This environmental accomplishment is all the more impressive because it coincided with Bexar County gaining more than 400,000 new residents.[5]

Additional monitoring data confirm the success of Bexar County's environmental efforts. Each of the non-regulatory monitors in the San Antonio Metropolitan Area has a design value below the 2015 NAAQS.[6] EPA has exercised its discretion to consider data from non-regulatory monitors in the past, and it should do so again here. *See, e.g.*, Determination of Attainment and Approval of Base Year Emissions Inventories for the Imperial County, California Fine Particulate Matter Nonattainment Area, 82 Fed. Reg. 13,392, 13,394 n.18 (Mar. 13, 2017) (consideringn data from a "non-regulatory monitor"); Approval and Promulgation of State Implementation Plan Revisions; Infrastructure Requirements for the 1997 8-Hour Ozone National Ambient Air Quality Standard; Utah, 76 Fed. Reg. 43,898, 43,904 (July 22, 2011) (relying on "data collected . . . using a non-regulatory monitoring method" to rebut a commenter's assertion of "violations of the 1997 ozone standard").

That Bexar County will meet the 2015 NAAQS by 2020 highlights the illogic of a nonattainment designation at this point. A nonattainment designation would require Bexar County to meet the 2015 NAAQS within "3 years from [the] effective date of designation." Implementation of the 2015 National Ambient Air Quality Standards for Ozone, 81 Fed. Reg. 81,276, 81,286 (Nov. 17, 2016). In other words, a nonattainment designation would be geared toward more slowly achieving a result that Bexar County will already achieve on its own without federal intervention.

But a nonattainment designation would be worse than unnecessary; it would be staggeringly expensive. According to a recent study by the Alamo Area Council of Governments, a nonattainment designation would cost the area between $3.2 billion and $36.2 billion. *See* Appendix B, Potential Cost of Nonattainment in the San Antonio Metropolitan Area at v (Mar. 29, 2017). As President Trump has made clear, "necessary and appropriate environmental regulations" must be "of greater benefit than cost." Presidential Executive Order on Promoting Energy Independence and Economic Growth § 1(e) (Mar. 28, 2017). Spending billions of dollars to achieve results that Bexar County is set to achieve on its own would be unjustifiable.

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[4] TCEQ, Compliance with Eight-Hour Ozone Standard, https://www.tceq.texas.gov/cgi-bin/compliance/monops/8hr_attainment.pl (last visited Feb. 8, 2018).

[5] Compare Census Bureau population estimate for Bexar County in 2016 (1,928,680 people), https://www.census.gov/data/tables/2016/demo/popest/counties-total.html (last visited Feb. 12, 2018), with Census Bureau population estimate for Bexar County in 2004 (1,500,919 people), https://www.census.gov/data/tables/time-series/demo/popest/intercensal-2000-2010-counties.html (last visited Feb. 12, 2018).

[6] TCEQ, Four Highest Eight-Hour Ozone Concentrations, https://www.tceq.texas.gov/cgi-bin/compliance/monops/8hr_4highest.pl (last visited Feb. 20, 2018).

C. A Nonattainment Designation Would Unfairly Reward Foreign Interests at Americans' Expense

If not for foreign emissions, Bexar County would have already met the 2015 NAAQS. EPA should consider the impact that these foreign emissions have on Bexar County.

CAA "does not expressly state the standards or methods by which areas are to be designated." *U.S. Steel Corp. v. EPA*, 605 F.2d 283, 292 (7th Cir. 1979). As the Seventh Circuit has recognized, there are multiple methods of making designations that would be consistent with the statutory text. "Although one method would be to designate the areas containing the principal offenders as nonattainment, another approach would be to look simply at the expected air quality throughout a region and designate noncomplying areas, regardless of the origin of the noncompliance, as 'nonattainment.'" *Id.*

In some circumstances, EPA has taken "the latter approach," considering air quality without regard to the origin of the emissions, *id.* at 292, and courts have deferred. *Id.* at 293 (citing *Red Lion Broadcasting Co. v. FCC*, 395 U.S. 367, 381 (1969)). But EPA has discretion to consider "the origin of the noncompliance" in appropriate cases. Applying the principles that underlie CAA, EPA should recognize that foreign emitters, not residents of Bexar County, are responsible for any failure to meet the 2015 NAAQS.

CAA reflects Congress' opposition to penalizing Americans for foreign emissions. For example, EPA must approve a state implementation plan if it "would be adequate to attain and maintain the relevant national ambient air quality standards by the attainment date . . . but for emissions emanating from outside of the United States." 42 U.S.C. § 7509a(a)(2).

Similarly, a foreign country cannot invoke CAA to prevent emissions in the United States that may affect that foreign country unless the foreign country "give[s] the United States essentially the same rights with respect to the prevention or control of air pollution occurring in that country." *Id.* § 7415(c). This provision reflects congressional interest in incentivizing foreign countries to reduce their own emissions. A foreign country cannot restrict American emissions unless it is willing to subject its own emissions to restrictions as well.

The principle that EPA should not penalize Americans for foreign emissions applies with special force to the designation of Bexar County. Recent photochemical modeling shows that emissions from foreign sources likely contribute 10–24 ppb of ozone to eight-hour ozone concentrations in Bexar County. Without these foreign emissions, Bexar County's ozone levels would be well below the 2015 NAAQS. *See* Appendix C, Review of Available Technical and Scientific Information on Air Quality in the San Antonio Area.

These scientific findings accord with common sense and EPA's previous analysis concerning the origins of background ozone. Because Bexar County is only 150 miles from an international border, there is little that it can do to avoid foreign emissions. As EPA has previously recognized, its "review of the science indicates the influence of international transport is likely to be largest in locations near the borders with Canada or Mexico."[7] It would be arbitrary and capricious for EPA to refuse to apply its previously recognized principles to Bexar County.

Further, designating Bexar County as in nonattainment would reward foreign countries for failing to control their emissions. Through CAA, Congress intended to incentivize foreign countries to lower their emissions. *See, e.g.*, 42 U.S.C. § 7415(c). But a nonattainment designation would trigger job- and industry-killing regulations in Bexar County that would push businesses to move elsewhere — penalizing the residents of Bexar County for emissions they cannot possibly control.

* * *

I encourage you to recognize the invalidity of the 2015 ozone NAAQS or, at the very least, designate Bexar County as "attainment" or "unclassifiable." A nonattainment designation would harm the environment, hinder economic growth and highlight the legal deficiency of the 2015 NAAQS.

Sincerely,

Greg Abbott
Governor

cc: Senator John Cornyn
Senator Ted Cruz
Congressman Will Hurd
Congressman Beto O'Rourke
Congressman Joaquin Castro
Congressman Henry Cuellar
Congressman Lloyd Doggett
Congressman Lamar Smith
Congressman Mike Conaway
Congressman Roger Williams
Anne Idsal, EPA Administrator for Region 6
Bryan W. Shaw, Chairman of TCEQ
Richard Hyde, Executive Director of TCEQ

[7] EPA, Tools for Addressing Background Ozone at 5, https://www.epa.gov/sites/production/files/2015-10/documents/20151001_background_ozone.pdf (last visited Feb. 8, 2018).

Appendix A

FY 2016 - FY 2017

Ozone Analysis of the 2012 Ozone Season Photochemical Modeling Episode

Technical Report

November 2017

Prepared by the Alamo Area Council of Governments

Title: Ozone Analysis of the 2012 Ozone Season Photochemical Modeling Episode	**Report Date:** November 2017	
Authors: AACOG Natural Resources Department	**Type of Report:** Technical Analysis	
Performing Organization Name & Address: Alamo Area Council of Governments 8700 Tesoro Drive Suite 700 San Antonio, Texas 78217	**Period Covered:** 2012, 2017, 2020, and 2023	
Sponsoring Agency Name: Alamo Area Metropolitan Planning Organization		
Supplementary Notes: N/A	**Date of Approval:**	**Reference No.:**

Abstract: Ozone concentrations measured in the San Antonio-New Braunfels eight-county MSA from 2015 to 2017 were high enough to place the area in violation of the federal National Ambient Air Quality Standards (NAAQS) based on the three-year calculations on which attainment status is determined. Ozone analysis is conducted using photochemical models that simulate actual high ozone episodes which prevailed in a region over the course of several days. Once complete, the June 2012 photochemical model was projected to 2017, 2020, and 2023 using forecasted changes in anthropogenic emissions. The predicted 2023 design value (DV) was 67.8 parts per billion (ppb) at C58, 68.1 ppb at C23, and 63.0 at C59 ozone monitoring sites. All regulatory-sited monitors meet the 70 ppb 8-hour ozone standard in 2023. A number of runs were conducted on the 2012 ozone season episode to assess the sensitivity of the model to changes in emission inventory and control strategy scenarios. The model was significantly more sensitive to changes in NOx emissions: 11.8 ppb reduction at C23 and 12.6 ppb reduction at C58. The lack of sensitivity to VOC emission reductions indicates VOC emission control strategies will have very little impact. The most effective control measure modeled was heavy-duty truck idling restriction. There was a reduction of 0.31 ppb at C23, 0.24 ppb at C58 and 0.10 ppb at C59 in this scenario. The OBDII inspection and maintenance control measure reduced the ozone design value at C23 by 0.23 ppb, C58 by 0.18 ppb, and 0.06 ppb at C59. There was a reduction of 0.16 ppb at C23, 0.03 ppb at C58, and 0.01 ppb at C59 for electric vehicle, telecommuting, and carpooling control measures. The 2012 ozone season projection case from April 16 to June 9, 2023 was run at the 4-km, 12-km, and 36-km grid sizes using the Anthropogenic Precursor Culpability Assessment (APCA). The greatest impact on ozone levels per ton of NO_X was area sources (0.201 ppb of ozone per ton of NO_X). Non-road (0.173 ppb of ozone per ton of NO_X) and on-road (0.146 ppb of ozone per ton of NO_X) also have a significant impact on ozone levels per ton. Although point sources had a significant impact overall, ppb per ton of emissions was only 0.059. San Antonio-New Braunfels MSA emissions had the greatest impact on peak 8-hour ozone (10.31 ppb or 17.6%) on days > 60 ppb. Texas was the largest contributor (34.5 percent) to peak 8-hour ozone on days > 60 ppb. This study found that emission reduction controls in Texas can be effective in reducing ozone levels at the regulatory monitors in San Antonio-New Braunfels MSA.

Related Reports:	**Distribution Statement:** Alamo Area Council of Governments, Natural Resources Department	**Permanent File:** Alamo Area Council of Governments, Natural Resources Department
No. of Pages: 174		

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the U.S. Department of Transportation,
the Texas Department of Transportation, and
the San Antonio-Bexar County Metropolitan Planning Organization

Executive Summary

Ground-level ozone is one of the most common air pollutants in the country as well as one of the six "criteria" pollutants for which the Environmental Protection Agency (EPA) established national standards. Ozone concentrations measured in the San Antonio-New Braunfels MSA from 2015 to 2017 were high enough to place the area in violation of the federal standard based on the three-year calculations on which attainment status is determined. While the area has not been designated by the EPA as a non-attainment region for ozone, local and state agencies are conducting air quality plans, models, and analyses which could provide support for local control strategy assessments to reduce local ozone levels.

Ozone analyses are conducted using photochemical models which simulate actual high ozone episodes that prevailed in a region over the course of several days. The modeling episode currently used for the San Antonio, Houston, Dallas, and Austin regions, which is undergoing refinement by the Alamo Area Council of Governments (AACOG), is based on the period of high ozone that occurred during the 2012 ozone season. This ozone season was chosen for the most recent modeling episode as it represents a variety of meteorological conditions that are commonly associated with ozone exceedance days. In addition to meteorological conditions, an important input to the model is an emissions inventory that spatially and temporally allocates emissions throughout the photochemical model domain. Detailed emissions inventories were developed by the Texas Commission on Environmental Quality (TCEQ) for the state Texas. Emission inventories were also developed by the EPA for other states in the modeling domain, as well as Mexico. Local updates to the San Antonio-New Braunfels MSA emission inventory included in the photochemical model were obtained from AACOG's emission inventories, TCEQ, Eastern Research Group (ERG), and Texas Transportation Institute (TTI).

Once complete, the June 2012 model was projected to 2017, 2020, and 2023 using forecasted changes in anthropogenic emissions. Since photochemical models simulate atmospheric and meteorological conditions that are conducive to high ozone values during a particular episode, an important advantage the models provide is the ability to test various scenarios, such as changes in emission rates, under these same meteorological conditions. Estimated NO_X emissions are significantly lower in 2023: emissions decreased from 196 tons per weekday in 2012 to 119 tons per weekday in 2023. VOC emissions decreased from 226 tons per weekday in 2012 to 172 tons per weekday in 2023. The largest source of NO_X emissions in 2012 are on-road vehicles at 92 tons per weekday, followed by point source at 59 tons per weekday, and non-road at 19 tons per weekday. By 2023, the largest sources of NO_X emissions will be point source at 47 tons per weekday, followed by on-road at 23 tons per weekday, and oil and gas at 23 tons per weekday.

Once the emission inventories, chemistry, and meteorological data were input into the CAMx photochemical model, the model was run to produce a base line and several projection case runs.

After the emission inventory was projected to 2020 and 2023 in the photochemical model, an attainment test was conducted on the modeling results. The model attainment test requires the calculation of a daily relative response factor (RRF). The design value was 67.8 ppb at C58, 68.1 ppb at C23, and 63.0 at C59 in 2023. All regulatory-sited monitors meet the 70 ppb 8-hour ozone standard in 2023.

A number of runs were conducted on the 2012 ozone season episode to assess the sensitivity of the model to changes in the emission inventory and control strategy scenarios. Control strategy runs included incremental removal of VOC and NOx precursor emissions and individual control strategy runs. The model was significantly more sensitive to changes in NOx emissions: 11.8 ppb in the ozone DV at C23 and 12.6 ppb in the ozone DV at C58 in 2023. The lack of sensitivity to VOC emission reductions indicates VOC emission control strategies will have very little impact in reducing the DV. The most effective control measure was heavy-duty truck idling restriction, where there was a reduction of 0.31 ppb at C23, 0.24 ppb at C58 and 0.10 ppb at C59. The OBDII inspection and maintenance control measure reduced ozone at C23 by 0.23 ppb, C58 by 0.18 ppb, and 0.06 ppb at C59. There was a reduction of 0.16 ppb at C23, 0.03 ppb at C58, and 0.01 ppb reduction at C59 for electric vehicle, telecommuting, and carpooling control measures.

The 2012 ozone season projection case from April 16 to June 28, 2023 was run at 4-km, 12-km, and 36-km grid sizes using the Anthropogenic Precursor Culpability Assessment (APCA). As expected, Bexar County emissions were the largest contributor to peak 8-hour ozone on days greater than 60 ppb at C58 (13.6 percent). Surprisingly, the second largest contribution came from Atascosa County at 1.3 percent. Other contributions were Guadalupe County at 1.0 percent, Wilson County at 0.4 percent, and Medina County at 0.2 percent. For every ton of NO_X emission emitted by anthropogenic sources in Bexar County, it is responsible for 0.15 ppb of ozone at C58 on days > 60 ppb. Wilson County (0.07 ppb of ozone per ton of NO_X), Guadalupe County (0.07 ppb of ozone per ton of NO_X), and Atascosa County (0.04 ppb of ozone per ton of NO_X) had a significant contribution per ton of NO_X emitted.

The largest local contribution to peak 8-hour ozone at C58 on days greater than 60 ppb was on-road sources at 3.12 ppb. Other large contributors to peak 8-hour ozone were point sources at 2.79 ppb, non-road sources at 1.93 ppb, and area sources at 1.28 ppb. The greatest impact on ozone levels per ton of NO_X emissions was area sources (0.201 ppb per ton of NO_X). Non-road (0.173 ppb per ton of NO_X) and on-road (0.146 ppb per ton of NO_X) also have a significant impact on ozone levels per ton. Although point sources had a significant impact overall, ppb per ton of emissions was only 0.059.

In the APCA run, San Antonio-New Braunfels MSA emissions had the greatest impact on peak 8-hour ozone (10.31 ppb) on days > 60 ppb. There was also a significant contribution, 1.59 ppb, from Houston in 2023. Other regions that had a significant impact were Corpus Christi (0.94 ppb), Temple/Waco area (0.89 ppb), and Austin (0.68 ppb). Texas emission sources were the largest contribution of peak 8-hour ozone on days > 60 ppb C58 (34.5 percent Table 8-1). International was the second largest contributor (32.5 percent). Emission reduction controls in Texas can be effective in reducing ozone levels at the regulatory monitors in San Antonio-New Braunfels MSA. There was also a significant contribution from offshore sources (9.9 percent) in 2023. From other regions, Louisiana (at 4.4 percent) had the highest contribution, followed by Alabama at 1.5 percent and Oklahoma at 1.4 percent. Other states that had a significant contribution to peak 8-hour ozone were Georgia (1.1 percent), Mississippi (1.1 percent), and Kentucky (0.8 percent).

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1 Background

The U.S. Environmental Protection Agency (EPA) is charged with the maintenance of regional air quality across the United States through a series of standards, the National Ambient Air Quality Standards (NAAQS). When regions fail to comply with these standards, the Clean Air Act requires that the state, in consultation with local governments, revise the state implementation plan (SIP) to address the violation. The SIP is a blueprint for the methodology that the region and state will follow to attain and maintain the federal air quality standards.[1]

1.1 Ozone Standard

Ground-level ozone is one of the most common air pollutants in the country as well as one of the six "criteria" pollutants for which the EPA established standards.

- The Federal Clean Air Act requires the Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment.
- The EPA has set NAAQS for six principal pollutants, which are called "criteria" pollutants.
- The Clean Air Act requires primary standards to be "requisite to protect public health with an adequate margin of safety," including the health of groups of people considered more at risk.
- The Clean Air Act bars EPA from considering cost in setting the NAAQS.

The current possible timeline for any potential nonattainment designations is below, while Figure 1-1 shows the AACOG region and potential nonattainment boundary.

Nov. 25, 2014:	The EPA released a proposal to update the NAAQS for Ground-Level Ozone as part of a court Order Requirement. The 8-hour ozone standard was set at 70 ppb.
Dec. 17, 2014	Rule is published in the Federal Register
Oct. 1, 2017:	Court order deadline for EPA determination of attainment or non-attainment for affected areas. EPA did not issue a determination on this date.
Oct. 1 2020:	SIP elements for non-attainment areas are due
Dec. 31, 2020:	Attainment deadline for "Marginal" areas
Dec. 31, 2023:	Attainment deadline for "Moderate" areas

[1] Environmental Protection Agency (EPA), "The Plain English Guide to the Clean Air Act." Available online: http://www.epa.gov/air/caa/peg/. Accessed 05/26/2017.

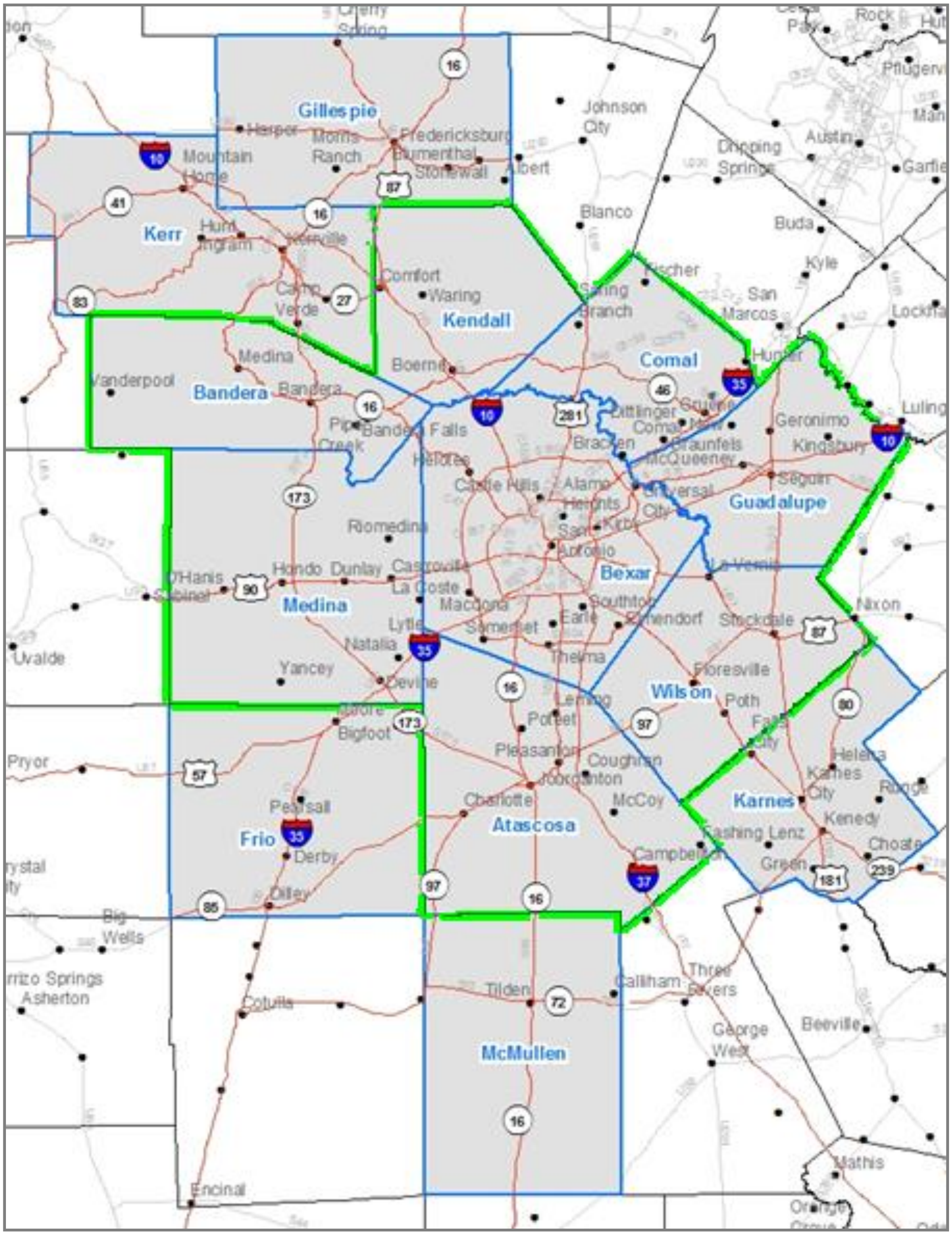


Figure 1-1: Possible Non-Attainment Boundary if the Region is declared in violation of the Ozone NAAQS. San Antonio – New Braunfels MSA: Atascosa, Bandera, Bexar, Comal, Guadalupe, Kendall, Medina, and Wilson Counties

On July 18, 2017, the U.S. House of Representatives voted 229 to 199 to approve H.R. 806, the Ozone Standards Implementation Act of 2017.[2] The bill in its current form will delay the promulgation of attainment designations under the 2015 ozone NAAQS by eight more years, or no later than October 26, 2025. The bill proposes amendments to the Clean Air Act, including a review of the NAAQS for each criteria pollutant every ten years, instead of the current five years, and adding “economic feasibility” as an indicator of reasonable further progress demonstrations. The bill also calls for the EPA Admininstrator to submit two reports to Congress: 1) regarding emissions originating from foreign sources and 2) on ozone formation with consultation from the states and from the National Oceanic and Atmospheric Administration (NOAA).

1.2 Design Value at Ozone Monitors in San Antonio

A region is in violation of the Clean Air Act if the annual fourth highest 8-hour average ozone concentration, averaged over three consecutive years, exceeds 70 parts per billion (ppb). This average is referred to as the ***design value***. The fourth highest 8-hour ozone averages and design values for the three most recent years (2014-2016) are listed in Table 1-1. There are two regulatory ozone monitors in the San Antonio-New Braunfels MSA that are currently exceeding the 70 ppb standard. Both C23 and C58 have a three year design value of 73 ppb.

Table 1-1: 4th Highest Ozone Values[3] and Design Values at San Antonio Regional Monitors, 2014-2016

CAMS	2014 (ppb)	2015 (ppb)	2016 (ppb)	**2014-2016 Design Value**
C23	**72**	**80**	69	**73**
C58	69	**79**	**71**	**73**
C59	63	68	62	64

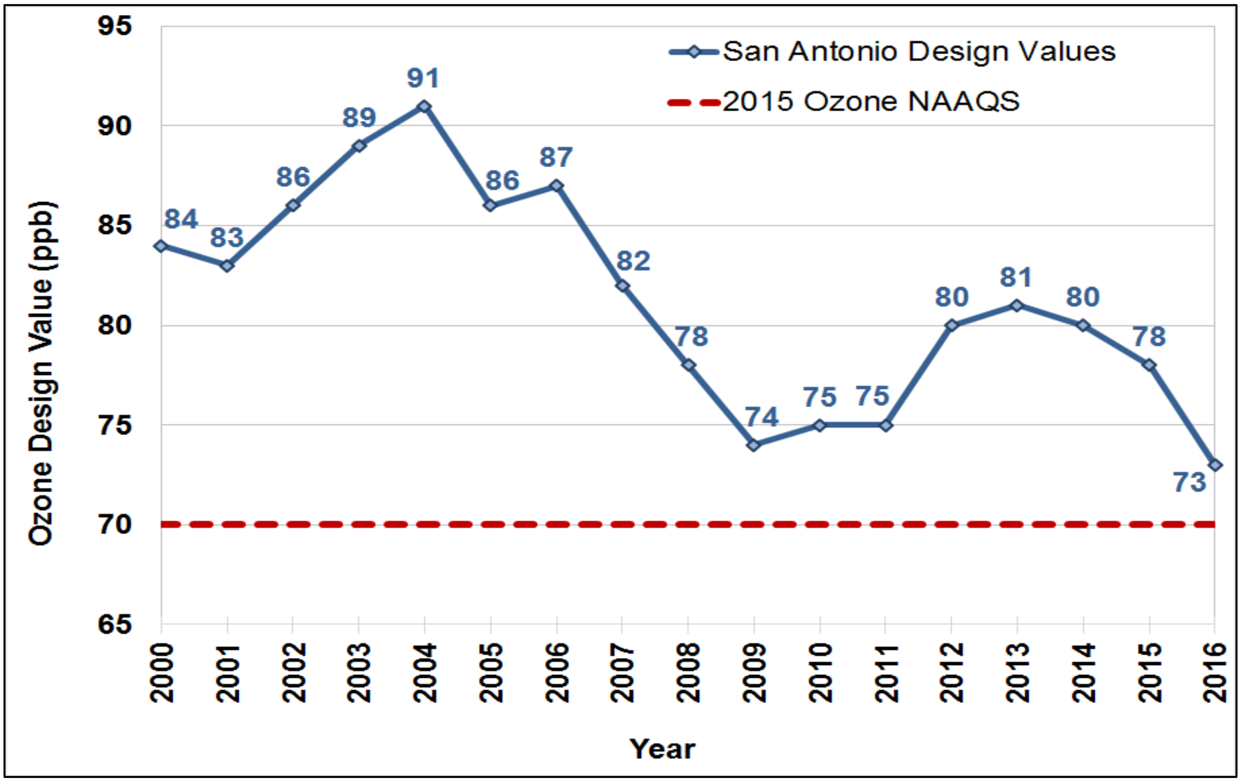
The initial 8-hour ozone design value for 2015 to 2017 is provided in Table 1-2. The San Antonio-New Braunfels MSA is showing readings in violation of the ozone standard at two regulatory monitors. Figure 1-2 shows the Design Value trend from 2000 to 2016. There has been a downward trend since 2013 at all monitors. There is a general decline in the region’s 8-hour ozone design values since 2004.

[2] Ozone Standards Implementation Act of 2017, H. 806, 115th Cong. (2017). Available online: https://www.congress.gov/bill/115th-congress/house-bill/806/text. Accessed 07/20/2017.
[3] Texas Commission on Environmental Quality (TCEQ). “Four Highest Eight-Hour Ozone Concentrations.“ Austin, Texas. Available online: https://www.tceq.texas.gov/cgi-bin/compliance/monops/8hr_4highest.pl. Accessed 05/26/2017.

Table 1-2: 4th Highest Ozone Values[4] and Design Values at San Antonio Regional Monitors, 2015-2017

CAMS	2015 (ppb)	2016 (ppb)	2017 (ppb)	**2015-2017 Design Value**
C23	**80**	69	**73**	**74**
C58	**79**	**71**	**72**	**73**
C59	68	62	65	65

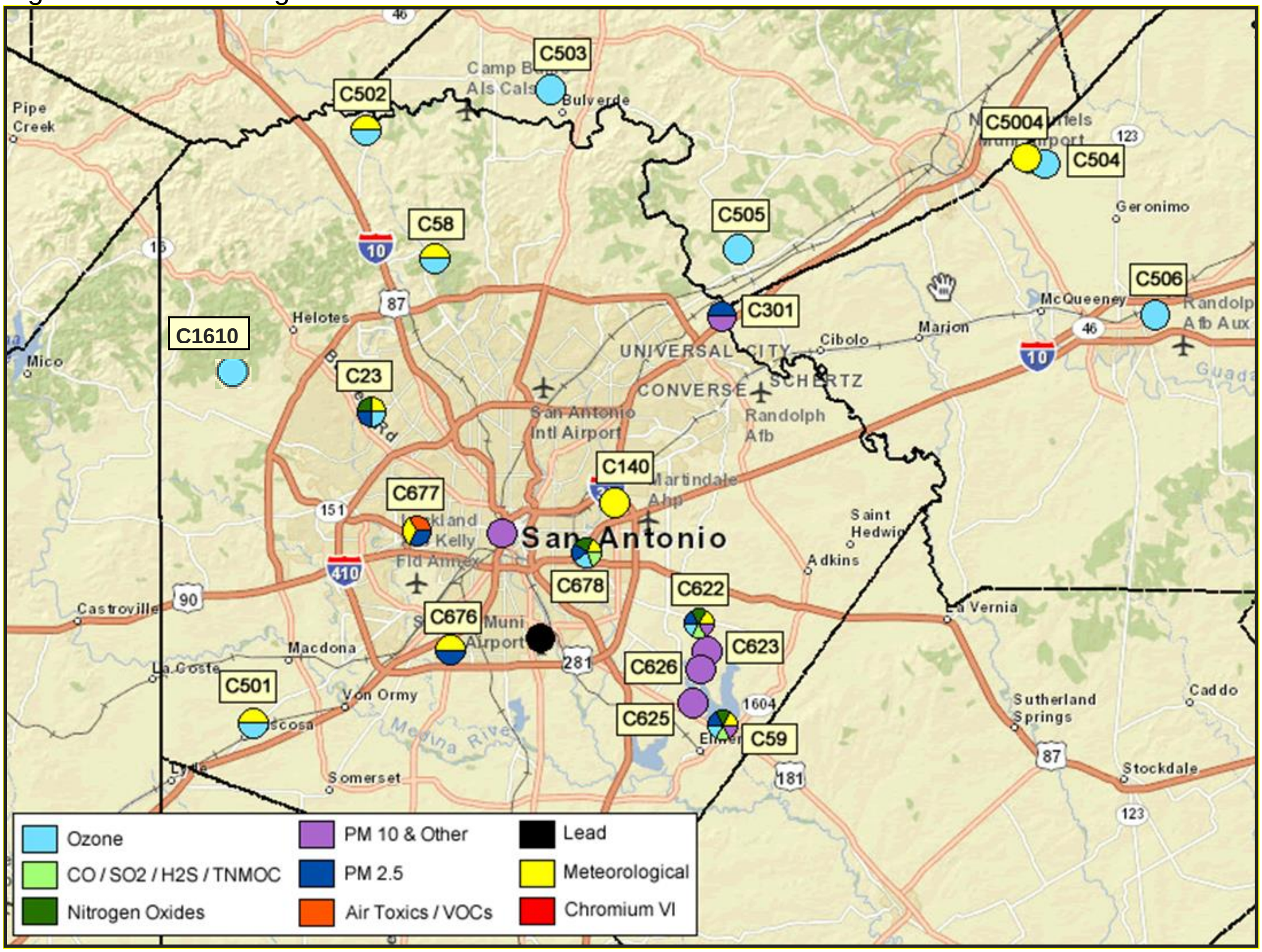
Figure 1-2: Design Value Trend for the San Antonio Region, 2000-2016



There are 18 regulatory and non-regulatory air quality monitors in the San Antonio region that record meteorological data and air pollutant concentrations, including ozone levels. The data collected at these sites is processed for quality assurance by the Texas Commission on Environmental Quality (TCEQ) and is accessible via the Internet. Figure 1-3 displays the location of the CAMS within the San Antonio region. Meteorological data measured at these sites includes temperature, wind speed, wind direction, precipitation, solar radiation, and relative humidity. Most stations measure one or more air pollutants including ozone (O_3), carbon monoxide (CO), nitrogen oxides (NO, NO_2), particulate matter equal to or less than 2.5 micrometers in diameter (PM2.5), particulate matter greater than 2.5 but less than 10 micrometers in diameter (PM10), and volatile organic compounds (VOCs).

[4] *Ibid*.

Figure 1-3: Monitoring Sites the San Antonio-New Braunfels MSA



Ozone is monitored at C23, C58, C59, C501, C502, C503, C504, C505, C506, C622, C678, and C1610. Other ambient air monitors include C27 (CO and NO_X), C140 (meteorological data), C301 (PM 2.5), C676 (meteorological data and PM 2.5), C677 (meteorological data, PM 2.5, and VOC sampling), and C5004 (meteorological data). In addition, there are three water quality monitors displayed on the map: C623, C625, and C626.

The Alamo Area Council of Governments conducts ozone analysis using photochemical models that simulate actual high ozone episodes which prevailed in the region over the course of several days. The modeling episode currently being refined and used for the San Antonio, Austin, Houston, and Dallas regions is based on the April 16 to September 30, 2012 ozone season. This episode covers most of the 2012 ozone season and includes multiple periods of high ozone across Texas.

Once complete, the June 2012 ozone season model was projected to 2017, 2020, and 2023 using forecasted changes in anthropogenic emissions. The projection year 2017 was selected because of the availability of an existing regional 2017 anthropogenic forecasted emission inventory from TCEQ. The other projection years were selected because 2020 is a potential attainment date for new marginal non-attainment areas and 2023 is a potential attainment date for new moderate non-attainment areas. Since photochemical models simulate the atmospheric and meteorological conditions that helped produce high ozone values during a particular episode, an important advantage the models provide is the ability to test various scenarios, such as changes in emission rates.

2 Meteorological and Photochemical Modeling Development

2.1 EPA Modeling Guidance

EPA modeling guidance provides a detailed process, from the planning stage through control strategy development and evaluation, for developing and analyzing photochemical modeling episodes. If a region fails to meet the National Ambient Air Quality Standards (NAAQS), EPA can declare the region in non-attainment. The region must submit a State Implementation Plan revision with an attainment demonstration designed to achieve attainment of the ozone NAAQS.

2.2 Model Selection

The EPA recommends that regions consider five factors as criteria for choosing appropriate air quality models:

1. "Documentation and Past Track Record of Candidate Models.
2. Advanced Technical Features.
3. Experience of Staff and Available Contractors.
4. Required vs. Available Time and Resources.
5. Consistency of a Proposed Model with Models Used in Adjacent Regions."[5]

An important component of selecting peer-reviewed meteorological and photochemical models includes evaluating these five factors and demonstrating that the models perform satisfactorily in similar applications.

WRF v3.7.1, released in August 14, 2015,[6] was used by TCEQ to calculate the meteorological inputs for the ozone season 2012 photochemical model. The "WRF Model is a next-generation mesoscale numerical weather prediction system designed to serve both operational forecasting and atmospheric research needs. It features multiple dynamical cores, a 3-dimensional variational (3DVAR) data assimilation system, and a software architecture allowing for computational parallelism and system extensibility. WRF is suitable for a broad spectrum of applications across scales ranging from meters to thousands of kilometers."[7]

CAMx is a non-proprietary model developed by ENVIRON to be used in analysis of pollutants, which include ozone, PM2.5, PM10, air toxins, and mercury. The model "is an Eulerian photochemical dispersion model that allows for an integrated 'one-atmosphere' assessment of gaseous and particulate air pollution over many scales ranging from sub-urban to continental. It is designed to unify all of the technical features required of state-of-the-science air quality models

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[5] EPA, April 2007. "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze." EPA -454/B-07-002. Research Triangle Park, North Carolina. p. 137. Available online: http://www2.mmm.ucar.edu/wrf/users/wrfv3.7/updates-3.7.1.html. Accessed 05/26/2017.

[6] UCAR. "WRF Model Version 3.7.1: UPDATES". Available online: http://www.mmm.ucar.edu/wrf/users/workshops/WS2010/presentations/session%201/1-1_wrf10.pdf. Accessed 05/26/2017.

[7] *Ibid*.

into a single system that is computationally efficient, easy to use, and publicly available."[8] The latest version of CAMx 6.31 was used in all the photochemical model runs performed by AACOG.

CAMx advanced technical features were used to model the ozone season 2012 episode and are described in the CAMx user guide.[9] The advanced CAMx features include:

1. Two-Way nested grid structure: for the 36-, 12-, and 4-km grid system
2. Plume-in-grid (PiG): to track chemistry and dispersion of large individual point source NO_X emission plumes
3. Horizontal advection solver: Piecewise Parabolic Method (PPM)[10]
4. Gas Phase Chemistry Mechanism: Carbon Bond Version 6 (CB6)[11]
5. Chemical Kinetics Solver: set to EBI[12]
6. Dry deposition Model set to Wesely89[13]

As recommended by TCEQ, the –Kieee flag was used to compile the CAMx model using Pacific Fortran complier 90. "The flag performs float and double divides in conformance with the IEEE 754 standard. This is done by replacing the usual in-line divide algorithm with a subroutine call, at the expense of performance. The default algorithm produces results that differ from the correctly rounded result by no more than 3 units in the last place."[14]

All the CAMx advanced settings used to simulate the extended 2012 ozone season episode are the same as settings that are being used to conduct SIP modeling for other areas in Texas. Both the CAMx and WRF models are being used to develop attainment demonstrations for multiple regions in Texas. Both WRF and CAMx met all of the EPA's recommendations regarding the selection of a model.

2.3 Modeling Domain

The modeling domain identifies the geographic boundaries of the study area, and these boundaries include: horizontal grid, vertical layers, and initial, top, and boundary conditions.

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[8] ENVIRON International Corporation, March 2016. "User's Guide: Comprehensive Air Quality Modeling with Extensions, Version 6.30". Novato, CA. Available online: http://www.camx.com/files/camxusersguide_v6-30.pdf. Accessed 05/23/2017.

[9] *Ibid*.

[10] Colella, P. and P.R. Woodward, 1984. "The Piecewise Parabolic Method (PPM) for Gas-Dynamical Simulations." Journal of Computation Physics. Volume 54, pp. 174-201. Available online: http://seesar.lbl.gov/anag/publications/colella/A_1_4_1984.pdf. Accessed: 05/30/2017.

[11] Yarwood. G, Whitten G. Z., Gookyoung, H, Mellberg, J. and Estes, M. 2010. "Updates to the Carbon Bond Mechanism for Version 6 (CB6)". Presented at the 9th Annual CMAS Conference, Chapel Hill, NC, October 11-13, 2010. Available online: http://www.cmascenter.org/conference/2010/abstracts/emery_updates_carbon_2010.pdf. Accessed 05/30/2017.

[12] Hertel O., R. Berkowicz, J. Christensen, and O. Hov (1993) "Test of two numerical schemes for use in atmospheric transport-chemistry models", Atmospheric Environment, 27A, 2591- 2611. Available online: http://www.sciencedirect.com/science/article/pii/096016869390032T. Accessed: 05/30/2017.

[13] Wesly, M.L. 1989. Parameterization of Surface Resistances to Gaseous Dry Deposition in Regional-Scale Numerical Models. Atmos. Environ., 23, 1293-1304. Available online: http://www.sciencedirect.com/science/article/pii/S1352231099004677. Accessed 05/30/2017.

[14] PGF90, Aug. 2003. "User Commands". Available online: http://www.dartmouth.edu/~rc/HPC/man/pgf90.html. Accessed 05/23/2017.

When selecting the modeling domain, all major upwind continental emission sources should be included in the model. The ozone season 2012 meteorological and photochemical modeling domains include all of the eastern and central U.S. as well as parts of southeastern Canada and northern Mexico. The modeling domains are large enough to capture major sources that would be upwind from San Antonio, as winds tend to arrive from the southeast, east, and northeast on ozone exceedance days.[15]

2.3.1 Photochemical Horizontal Grid

The photochemical modeling domain covers a much larger geographical area than southern Texas to reduce the influence of boundary conditions (Figure 2-1). The larger domain is necessary to simulate the effects of meteorological and atmospheric processes, including transport of precursors and background concentrations of ozone, on the San Antonio region. The 48-hour back trajectories for the 2012 ozone season episode originated as far away as Kansas, Oklahoma, and the Gulf of Mexico. Consequently, the 36-km and 12-km coarse grid used in the model simulation extends throughout the central and eastern U.S. in order to reduce the impact from boundary conditions on the 4-km grid.

The 4km grid includes ozone pre-cursor emissions from all major cities in Eastern Texas, and these cities include: San Antonio, Austin, Corpus Christi, Dallas, and Houston. The grid system used in the model is consistent with EPA's Regional Planning Organizations (RPO) Lambert Conformal Conic map projection with the following parameters:

- First True Latitude (Alpha): 33°N
- Second True Latitude (Beta): 45°N
- Central Longitude (Gamma): 97°W
- Projection Origin: (97°W, 40°N)
- Spheroid: Perfect Sphere, Radius: 6,370 km[16]

2.3.2 Vertical Layers

The vertical structures used in the WRF and CAMx models are listed in Table 2-1. The meteorological model has 42 vertical layers extending from the surface up to approximately 18.2 km, while the CAMx model uses 29 vertical layers. The surface layer is roughly 34-m thick.[17] The meteorological and photochemical model layers are finer at the surface. The fine layers are used to capture vertical gradients as the mixing height changes during the day and to model pollutant concentrations at the surface.

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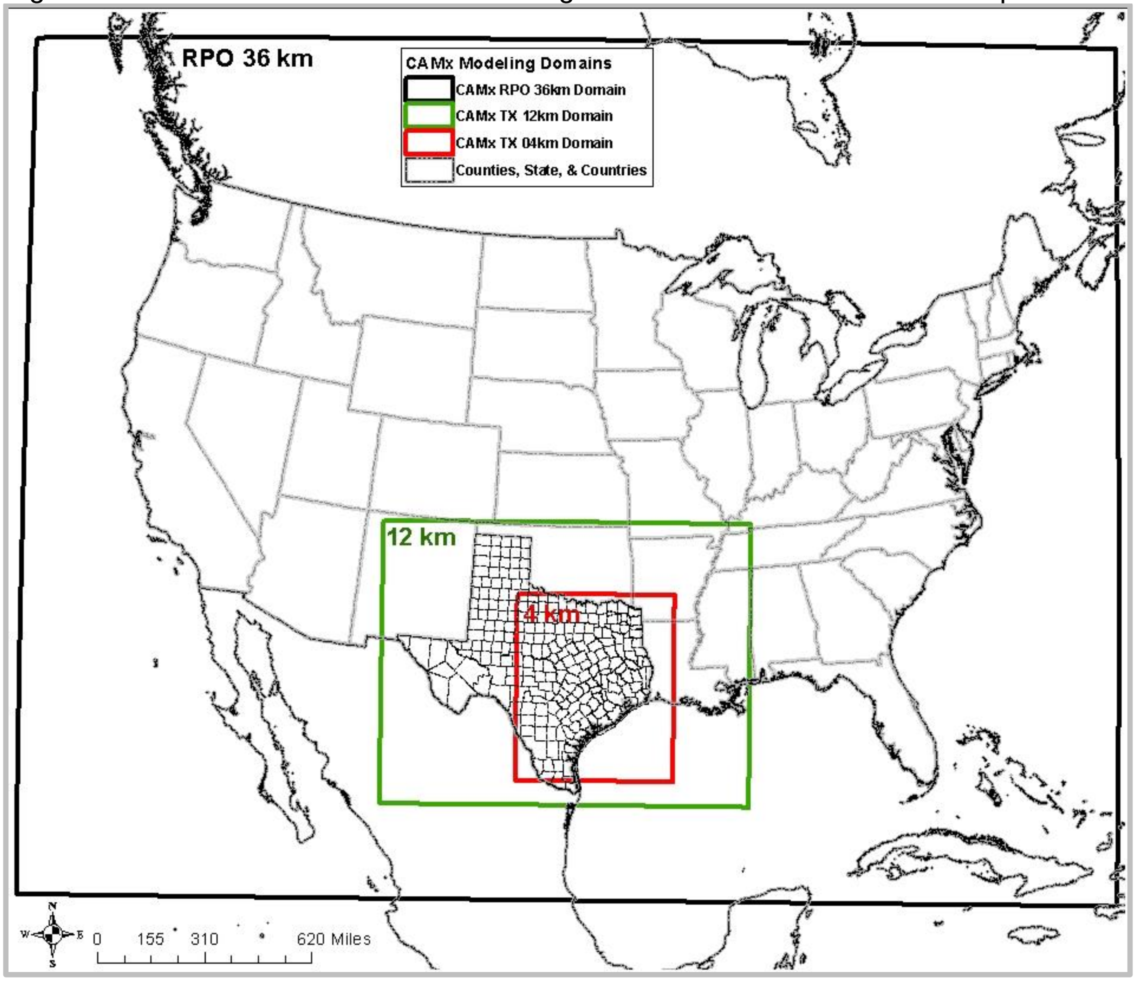
[15] AACOG, Oct, 23, 2015. "Conceptual Model: Ozone Analysis of the San Antonio Region Updates through Year 2014". San Antonio, Texas. Available online: https://www.aacog.com/DocumentCenter/View/34654. Accessed 05/24/2017.

[16] TCEQ. "Texas Air Quality Modeling – Domains". Austin, Texas. Available online: http://www.tceq.texas.gov/airquality/airmod/rider8/modeling/domain. Accessed 05/30/2017.

[17] Susan Kemball-Cook, Yiqin Jia, Ed Tai, and Greg Yarwood August 31, 2007. "Performance Evaluation of an MM5 Simulation of May 29-July 3, 2006." Prepared for Texas Commission on Environmental Quality. ENVIRON International Corporation, Novato, CA. p. 2-1. Available online: http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/mm/2006_MM5_Modeling_Final_Report-20070830.pdf. Accessed 05/30/2017.

Figure 2-1: Nested Photochemical Modeling Grids for Ozone Season 2012 Episode[18]



Coordinates from NW to SE corners:

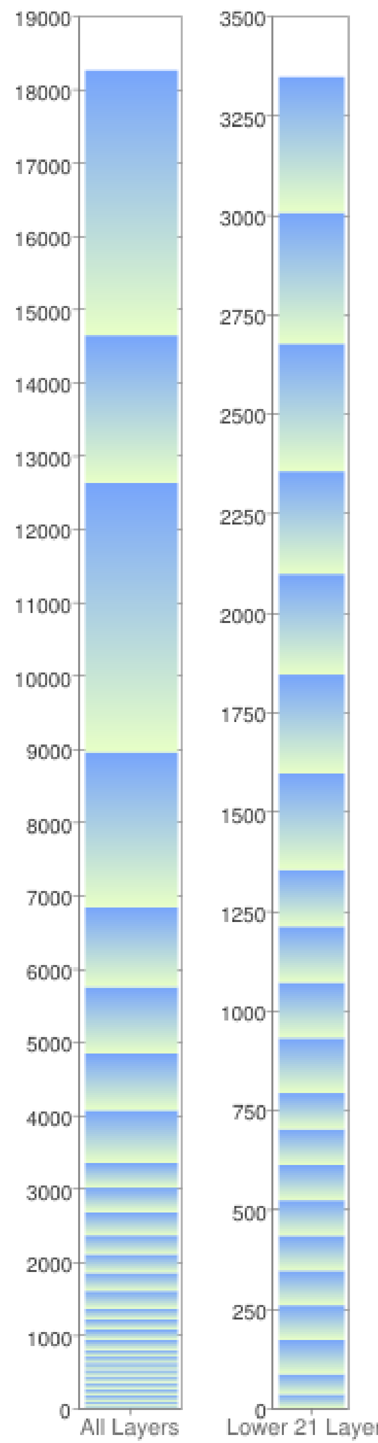
CAMx RPO 36-km	= 148 x 112	(-2,736, 1,944) to	(2,592, -2,088)
CAMx TX 12-km	= 149 x 110	(-984, -312) to	(804, -1,632)
CAMx TX 4-km	= 191 x 218	(-328, -644) to	(436, -1,516)

Plot Date: May 30, 2017
Map Compilation: June 10, 2013
Source: TCEQ.

[18] TCEQ. "Texas Air Quality Modeling – Domains". Austin, Texas. Available online: http://www.tceq.texas.gov/airquality/airmod/rider8/modeling/domain. Accessed 05/30/2017.

Table 2-1: WRF and CAMx Ozone Season 2012 Episode Vertical Layer Structure[19]

WRF Layer	CAMx Layer	Top (m AGL)	Center (m AGL)	Thickness (m)
42	29	18250	16445	3611
39	28	14639	13632	2015
37	27	12624	10786	3675
33	26	8949	7891	2115
30	25	6833	6289	1088
28	24	5746	5290	911
26	23	4835	4449	772
24	22	4063	3704	717
22	21	3346	3175	341
21	20	3005	2840	330
20	19	2675	2515	320
19	18	2355	2225	259
18	17	2096	1969	253
17	16	1842	1718	248
16	15	1595	1474	242
15	14	1353	1281	143
14	13	1210	1140	141
13	12	1069	1000	139
12	11	930	861	138
11	10	792	747	91
10	9	702	656	90
9	8	612	567	89
8	7	522	478	89
7	6	433	389	88
6	5	345	302	87
5	4	258	215	87
4	3	171	128	86
3	2	85	60	51
2	1	34	17	34



AGL - Above Ground Level.

Layer height data are averages of all episode days and over all cells in CAMx tx_4km domain.

[19] TCEQ, May 22, 2017. “Texas Air Quality Modeling - Domains”. Austin, Texas. Available online: https://www.tceq.texas.gov/airquality/airmod/data/domain. Accessed 05/24/2017.

2.3.3 *Initial, Top, and Boundary Conditions*

"Although our photochemical modeling is focused upon Texas, the modeling must account for emissions and the transport of pollutants from outside of Texas and United States. On the edges of the largest modeling domain, the concentrations of pollutants are defined as boundary conditions. The boundary conditions vary by hour for each specific modeling episode and are set vertically from the surface to the highest model layer many kilometers into the atmosphere."[20] "Top boundary conditions improve the characterization of chemicals entering vertically across the model top, which is particularly important for common stratospheric constituents such as ozone and nitrogen oxides."[21]

TCEQ obtains initial, top, and boundary conditions "from the output of global-scale chemical transport models such as Goddard Earth Observing System Chemistry model (GEOS-Chem) maintained by Harvard and NASA and Model for Ozone and Related chemical Tracers (MOZART) maintained by the National Center of Atmospheric Research."[22]

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[20] TCEQ, Nov. 3, 2016. "Introduction to Air Quality Modeling: Emissions Modeling". Austin, Texas. Available online: https://www.tceq.texas.gov/airquality/airmod/overview/am_ei.html#boundary. Accessed 05/24/2017.

[21] ENVIRON International Corporation, March 2016. "User's Guide: Comprehensive Air Quality Modeling with Extensions, Version 6.30". Novato, CA. Available online: http://www.camx.com/files/camxusersguide_v6-30.pdf. Accessed 05/23/2017.

[22] TCEQ, Nov. 3, 2016. "Introduction to Air Quality Modeling: Emissions Modeling". Austin, Texas. Available online: https://www.tceq.texas.gov/airquality/airmod/overview/am_ei.html#boundary. Accessed 05/24/2017.

3 Emissions Inventory

Four anthropogenic emission inventories were created for the ozone season 2012 modeling episode: 2012 base line inventory, 2017 projection case, 2020 projection case, and 2023 projection case. The model was run with each emission inventory to predict the impact of emissions changes over time – both quantitative and spatial – on ozone formation and dispersion. Model inputs account for the chemical and meteorological characteristics associated with the ozone season 2012 episode. The meteorological inputs, chemistry parameters, and biogenic emissions were identical for every model run.

Before the emission inventories were entered into the photochemical model, the emissions were pre-processed using the Emissions Processor version 3 (EPS3)[23] to allocate the data to the proper spatial and temporal resolutions used by the photochemical model. The Emissions Processor allocates emissions to account for monthly, weekly, and hourly variations in emission rates, assigns emissions to the appropriate grid cells, and disaggregates or speciates chemical compounds for the photochemical model's chemical mechanism. To accurately predict ozone formation, the photochemical model requires a detailed emission inventory for every grid used in the model.

3.1 Emission Inventory Parameters

CO, speciated NO_X, and speciated VOC emissions from all anthropogenic and biogenic sources were included in the model for all grid domains. Emissions data was processed through EPS3 for the following source categories:

1. Biogenic Sources
2. Point Sources
3. Area
4. Non-Road
5. Off-Road
6. Mobile Sources
7. Oil and Gas

The emissions for each of these categories were temporally allocated to the appropriate hours, week days, and seasons based on data obtained from surveys of local sources. In the absence of survey data, TCEQ existing data, EPA defaults, or other appropriate surrogates were used.

Spatial Allocation

The coarse 36km grid used in the photochemical model encompasses all anthropogenic and biogenic emissions in the continental United States, southern Canada, and northern Mexico. Emissions data was allocated to each grid cell for the entire domain; elevated point sources emissions and San Antonio International Airport (SAIA) aircraft operations were allocated both spatially and vertically.

[23] ENVIRON International Corporation, August 2009. "User's Guide Emissions Processor Version 3". Novato, CA. Available online: ftp://amdaftp.tceq.texas.gov/pub/HGB8H2/ei/EPS3_manual/EPS3UG_UserGuide_200908.pdf. Accessed 05/30/2017.

Local emissions were allocated spatially using Google Earth[24] and ArcGIS. These programs were used to calculate the fraction of county total emissions in each grid cell based on surrogate data. Local data included roadway types, truck stops, employment, population, navigable lake area, and data collected for industrial sites, landfills, quarries, and highway construction projects. When emission sources were insignificant or local data was not available, existing TCEQ data and EPA default spatial allocation factors were used.

Chemical Speciation

All VOC and NO_X emissions were chemically speciated based on the latest version of the carbon bond mechanism design, Carbon Bond 6 (CB6). This mechanism is critical because it provides the link between ozone precursors and ozone formation in the CAMx model. CB6 was developed in 2010 by ENVIRON and is now being used in SIP applications across the United States and by TCEQ.[25]

3.2 Quality Assurance

Equations, data sources, and methodologies were checked throughout the processing of each emission source. "Simple QA procedures, such as checking calculations and data input, can and should be implemented early and often in the process. More comprehensive procedures should target:

- Critical points in the process;
- Critical components of the inventory; and
- Areas or activities where problems are anticipated"[26]

Quality assurance (QA) procedures used to check emissions inventory preparation for the photochemical mode included:

- Examination of raw data files for inconsistencies in emissions and/or locations,
- Review of message files from EPS3 scripts for errors and warnings,
- Verification of consistency between input and output data, and
- Creation of output emissions tile plots for visual review.

Special emphasis was placed on critical components, such as on-road vehicles, local anthropogenic sources, and point sources, for quality checks.

All raw data files were checked to ensure emissions were consistent by county and source type. Any inconsistencies were noted, checked, and corrected. When running the EPS3 job scripts, several message files are generated from each script which record data inputs, results, and errors. As part of the QA procedure, modeling staff reviewed all error messages and corrected the input data accordingly.

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[24] Google. "Google Earth". Available online: http://www.google.com/earth/index.html. Accessed 05/30/2017.

[25] Greg Yarwood, Jaegun Jung, Gary Z. Whitten, Gookyoung Heo, Jocelyn Mellberg, and Mark Estes, Oct. 2010. "Updates to the Carbon Bond Mechanism for Version 6 (CB6)". Presented at the 9th Annual CMAS Conference, Chapel Hill, NC, October 11-13, 2010. p. 2. Available online: http://www.cmascenter.org/conference/2010/abstracts/emery_updates_carbon_2010.pdf. Accessed 05/30/2017.

[26] Eastern Research Group, Inc, Jan. 1997. "Introduction: The Value of QA/QC'. Quality Assurance Committee Emission Inventory Improvement Program, U.S. Environmental Protection Agency. p. 1.2-1. Available online: http://www.dep.wv.gov/daq/planning/inventory/Documents/EIIP%20V01%20Intro.pdf. Accessed 05/30/2017.

Errors can occur in EPS3 and go unnoticed by the built-in quality assurance mechanisms, therefore further QA methods were applied. Input and output emissions by source category were compared. If there were inconsistencies between values, input data was reviewed and any necessary corrections were made. Emission tile plots by source category were also developed and reviewed for inconsistencies in emissions and spatial allocation. When errors and omissions were identified, they were corrected and all documentation was updated with the corrections.

3.3 Base Case Inventory

Following EPA guidelines, the most critical emission inventory is the local San Antonio-New Braunfels MSA emissions inventory.[27] These emissions are emitted near San Antonio's regulatory ozone monitors, and previous modeling predicted that local emissions account for 32 percent of peak ozone on days greater than 70 ppb at C58.[28] Local emissions were calculated using the most current, accurate, and practical methods available.

Adjacent and nearby areas with large emission sources can also have a significant impact on local ozone monitors. Previous modeling and back trajectory analysis indicate that Austin, Houston, Dallas, Corpus Christi, and other large, southern United States cities can significantly influence local ozone readings.[29] Determining accurate emissions inventories for these areas are essential for good model performance. Detailed emissions inventories were developed by TCEQ for other counties in Texas.[30] Emission inventories were also developed by the EPA for other states in the modeling domain.[31] Since EPA lowered the ozone standard to an 8-hour 70 ppb threshold, the impact of long-range transport can have a greater impact on local ozone concentrations. Local emissions in the San Antonio-New Braunfels MSA were obtained from AACOG EI updates, TCEQ, ERG, and Texas Transportation Institute (TTI). Data sources for the modeled emissions inventory in the United States are listed in Table 3-1.

The 2017, 2020, and 2023 projection year emission inventories were based on generic ozone season days instead of day-specific emissions. The projection year emission inventory is based on weekday (Monday-Thursday), Friday, Saturday, and Sunday emission estimates.

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[27] EPA, April 2007. "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze," EPA -454/B-07-002. Research Triangle Park, North Carolina. p. 172. Available online: http://www.epa.gov/scram001/guidance/guide/final-03-pm-rh-guidance.pdf. Accessed 05/30/2017

[28] AACOG, Oct, 25, 2015. "Ozone Analysis: June 2006 Photochemical Modeling Episode". Alamo Area MPO. San Antonio, Texas. Available online: https://www.aacog.com/DocumentCenter/View/34698. Accessed 05/24/2017.

[29] *Ibid*.

[30] TCEQ, 2017. Available online: ftp://amdaftp.tceq.texas.gov/, Accessed 09/20/2017.

[31] EPA. Feb. 28, 2017. "Air Pollutant Emissions Trends Data". Available online: https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data. Accessed 05/30/2015.

Table 3-1: Emission Inventory Sources by Type for 2017, 2020, and 2023

Type	Sub Category	Source
Point	Electric Generating Units (EGU)	- Generic OSD emissions from TCEQ - Each modeling day has the same emissions - Local data for EGUs in the San Antonio-New Braunfels MSA for 2017, 2020, and 2023 (CPS Energy) - EGUs for other Texas counties and other states based on data from county totals from the Houston SIP for 2017 - EGUs for other Texas counties in 2020 and 2023 emissions are the same as 2017 - Canadian and Mexico EGU emissions are the same as the 2012 Base Line
	Non-Electric Generating Units (NEGU)	- Local data for Cement Kilns in the San Antonio-New Braunfels MSA and Austin–Round Rock–San Marcos MSA (Alamo Cement, Chemical Lime, Capitol Cement, TXI, and CEMEX) - Permit data for two new cement kilns in Bexar County (Alamo Cement and Capitol Cement) - NEGUs for other Texas counties and other states based on data from county totals from the Houston SIP for 2017 - Local NEGU emissions from TCEQ permit database
Area	Area Sources	- TexAER for Texas area sources for 2017 from the Houston SIP - Projected to 2020 and 2023 using EGAS - Local data for industrial and residential fuel combustion - NEI 2011 data from the Houston SIP for other states in 2017 - Other states projected to 2020 and 2023 using EGAS - Canadian and Mexico area sources remain the same as the 2012 base line
	Oil and Gas	- Oil and gas production and drill rig emissions for 2017 are from the Houston SIP - Includes all emissions from shale formations including the Eagle Ford, Barnett, Pearsall, Haynesville and Permian Basin -NEI 2011 for other states projected to 2017 from the Houston SIP -Production for formations remained the same for 2020 and 2023 - All controls were included in the 2020 and 2023 projection
Mobile	All Categories	- MOVES2014a model was used to estimate 2017 on-road emissions for all U.S. portions of the modeling domain from the Houston SIP - Within Texas, the vehicle miles traveled (VMT) estimates are based on the Highway Performance Monitoring System (HPMS) for more rural areas. - Emissions projected to 2020 and 2023 using MOVES2014a. - Local data for Extended Diesel Truck Idling

Type	Sub Category	Source
Non-Road	All Categories	- Emissions is 2017 from the Houston SIP using the TexN model - Emissions in Texas projected to 2020 and 2023 using the TexN model - Local data for construction equipment, quarry equipment, mining equipment, landfill equipment, lawn and garden equipment, agricultural tractors, and agricultural combines projected to 2018 using TexN model - Emissions for other states projected to 2020 and 2023 using NMIM Model
Off-Road	Locomotives	- Emissions for 2017 are from the Houston SIP and developed by ERG - Emissions were projected to 2020 and 2023 using ERG's report - NEI 2011 locos (switchers as points) for other states projected to 2017 in the Houston - Other states locomotive emissions projected to 2020 and 2023 using EPA's "Emission Factors for Locomotives"
	Marine	- 2017 Texas marine emissions inventory from the Houston SIP and developed by Ramboll Environ - Emissions were projected to 2020 and 2023 using ERG's Texas Statewide Commercial Marine Vessel Emissions Inventory - Emissions outside Texas remained the same for 2017, 2020, and 2023
	Aircraft	- 2017 Texas aircraft emissions from the Houston SIP - Texas emissions projected to 2020 and 2023 ERG study: Aircraft Emissions Inventory for Texas Statewide 2014 Air Emissions Reporting Requirements (AERR) Inventory and 2008 to 2014 Trend Analysis Years - New NEI 2011 aircraft for other states projected to 2017 from the Houston SIP - Other states aircraft emissions remained the same for 2020 and 2023 - Local data for San Antonio International Airport (SAIA)
Biogenic	All Categories	- Same emissions as 2012 for 2017, 2020, and 2023 - Emissions calculated using version 3.61 of the Biogenic Emission Inventory System (BEIS) within Sparse Matrix Operation Kernel Emissions (SMOKE) System version 3.7. - The Biogenic Emission Land use Database version 4.1 (BELD4.1) from EPA Modeling Platform 2011v6_v3 was regridded by TCEQ to create the grid-specific land-use input files. - The Weather Research and Forecasting (WRF) version 3.7.1 results were processed by TCEQ to generate the meteorological inputs to BEIS.

3.4 Biogenic Emissions

Biogenic emissions originate from natural sources due to chemical processes in vegetation and soil. These emissions include ozone precursor chemicals: NO_X, VOC and CO. TCEQ used version 3.61 of the Biogenic Emission Inventory System (BEIS)[32] within Sparse Matrix Operation Kernel Emissions (SMOKE) System version 3.7.[33] The Biogenic Emission Landuse Database version 4.1 (BELD4.1) from EPA Modeling Platform 2011v6_v3[34] was regridded by TCEQ to create the grid-specific land-use input files. "The Weather Research and Forecasting (WRF) version 3.7.1 results were processed by TCEQ with the Meteorology-Chemistry Interface Processor (MCIP) to generate the meteorological inputs to BEIS."[35]

Biogenic emissions are the same in the 2017, 2020, and 2023 projection as in the 2012 Base Case Inventory, following EPA guidance. Biogenic emissions remain consistent across modeled years so the photochemical model's response to changes in anthropogenic emissions can be measured.

3.5 Area Source Emissions

Area sources are small industrial, commercial, and residential sources that are widely distributed and include refueling, painting, asphalt, surface coating, landfills, and wastewater treatment emissions. Area source 2012 modeling estimates were based on data from the 2011 and 2014 periodic emissions inventories, which are available from Texas Air Emissions Repository (TexAER).[36] For the non-Texas U.S. areas of the modeling domain, area source emission estimates from the EPA NEI were used. To develop the non-Texas area source estimate, the 2011 area source NEI[37] was projected by TCEQ for 2012 and 2017.[38]

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32 Bash, J., Baker, K., Beaver, M., 2016. "Evaluation of Improved Land Use and Canopy Representation in BEIS v3.61 with Biogenic VOC Measurements in California", Geosci. Model Dev., 9, 2191–2207, 2016. Available online: http://www.geosci-model-dev.net/9/2191/2016/gmd-9-2191-2016.pdf. Accessed 05/30/2017.

33 Community Modeling and Analysis System (CMAS). "SMOKE". Available online: https://www.cmascenter.org/smoke/. Accessed 05/30/2017.

34 EPA. "2011 Version 6.3 Platform". Available online: https://www.epa.gov/air-emissions-modeling/2011-version-63-platform. Accessed 05/30/2017.

35 TCEQ, Dec. 16, 2016. "Appendix B: Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 2008 Eight Hour Ozone Standard". Project Number 2016-016-SIP-NR. p. B-106. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/HGB_2016_AD_RFP/AD_Adoption/HGB_AD_SIP_Appendix_B_Adoption.pdf. Accessed 05/30/2017.

36 *Ibid*. p. B-93.

37 EPA, April 5, 2017. "2011 National Emissions Inventory (NEI) Data ". Available online: https://www.epa.gov/air-emissions-inventories/2011-national-emissions-inventory-nei-data. Accessed 05/30/2017.

38 TCEQ, Dec. 16, 2016. "Appendix B: Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 2008 Eight Hour Ozone Standard". Project Number 2016-016-SIP-NR. p. B-97. Available online:

Area source emissions were projected to 2020 and 2023 from TCEQ's 2017 Projection Case using EPA's Economic Growth and Analysis System (EGAS) 5.0. Equation 3-1 was used to project area source emissions for Texas and other states.

Equation 3-1, Ozone season day area source emissions, 2020 or 2023

$E_{Local.FY.A.B} = E_{Local.17.A.B} \times (E_{EGAS.FY.A.B} / E_{EGAS.17.A.B})$

Where,

$E_{Local.FY.A.B}$ = Ozone season day 2020 or 2023 emissions in county A for SCC code B (NO_X, VOC, or CO)
$E_{Local.17.A.B}$ = Ozone season day 2017 emissions in county A for SCC code B (NO_X, VOC, or CO)
$E_{EGAS.FY.A.B}$ = EGAS 5.0 ozone season day 2020 or 2023 emissions in county A for SCC code B (NO_X, VOC, or CO)
$E_{EGAS.17.A.B}$ = EGAS 5.0 ozone season day 2017 emissions in county A for SCC code B (NO_X, VOC, or CO)

Sample Equation: 2023 VOC emissions from Wastewater Treatment in Bexar County, SCC code 2630020000

$E_{Local.FY.A.B}$ = 0.1014 tons of NO_X in 2017 x (0.1100 tons of VOC in 2023 / 0.1000 tons of VOC in 2017)
= 0.1115 tons of VOC per day from Wastewater Treatment in Bexar County, 2023

3.5.1 Industrial Fuel Usage

Emissions resulting from the industrial sector include the combustion of Natural Gas, Distillate Oil, Residual Oil, Liquefied Petroleum Gas (LPG), and Kerosene. Defined by the U.S. Energy Information Administration (EIA), the industrial sector includes Agriculture, Forestry, Fishing and Hunting, Mining, Construction, and Manufacturing industry sectors that are classified under the North American Industrial Classification System (NAICS).[39] Industrial sector processes use combustion to power machines which produce exhaust or emissions, which vary depending on the type of fuel and the intensity of the fuel usage.[40] Table 3-2 provides fuel combustion emissions by County for the local region.

https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/HGB_2016_AD_RFP/AD_Adoption/HGB_AD_SIP_Appendix_B_Adoption.pdf. Accessed 05/30/2017.

[39] Industrial Sector. Energy Information Administration (EIA). "Glossary" Available online: http://www.eia.gov/tools/glossary/index.cfm?id=I. Accessed 05/31/2017.

[40] AACOG, Aug. 30, 2015. "Area Source Industrial Fuel Combustion Emissions in San Antonio-New Braunfels Metropolitan Statistical Area for 2012 and 2018". San Antonio, Texas.

Table 3-2: Area Source Industrial Fuel Total Ozone Season Weekday Emissions in the San Antonio-New Braunfels MSA (tons per day), 2012.

County	FIPS	NOx	VOC	CO
Atascosa	48013	0.0763	0.0034	0.0569
Bandera	48019	0.0084	0.0004	0.0068
Bexar	48029	1.4812	0.0796	1.4865
Comal	48091	0.2906	0.0140	0.2226
Guadalupe	48187	0.2017	0.0108	0.2052
Kendall	48259	0.0299	0.0016	0.0266
Medina	48325	0.1100	0.0060	0.0923
Wilson	48493	0.0243	0.0013	0.0226
Total		2.2225	0.1172	2.1226

3.5.2 Residential Fuel Usage

AACOG allocated state-level fossil fuel consumption data collected from the EIA to each of the 13 counties in the AACOG region using a list of fossil fuels utilized in the residential sector, which includes: Natural Gas, LPG, Distillate, Kerosene, and Wood. The methods used by AACOG for calculating residential emissions for the 13- county AACOG Region rely on allocating statewide fuel consumption to a county level based on the number of households per county, and then appropriating emissions factors. Results show that within the AACOG region, Bexar and Comal counties have the highest VOC, NO_x and CO emissions that result from the combustion of natural gas and wood, as shown in Table 3-3. The largest source of VOC and CO emissions were found in wood combustion, and the largest source of NO_x was natural gas combustion. By comparison, residential emissions from LPG, distillate oil, and kerosene combustions were minimal.[41]

[41] AACOG, Sept. 30, 2017. "Residential Fuel Combustion Emissions Inventory for the AACOG Region for 2014, 2017, 2020, 2023, and 2025". San Antonio, Texas.

Table 3-3: San Antonio-New Braunfels MSA Residential Fuel Emissions

		2104009000 Wood (tons/year)			2104006000 Natural Gas (tons/year)		
County	FIPS	VOC	NOx	CO	VOC	NOx	CO
Atascosa	48013	34.59	3.30	217.07	0.23	6.99	1.91
Bandera	48019	129.17	12.31	810.53	0.04	0.95	0.28
Bexar	48029	255.77	24.37	1,604.90	26.49	830.82	224.53
Comal	48091	148.31	14.13	930.61	0.74	21.54	6.11
Frio	48163	16.93	1.61	106.22	0.12	3.79	1.02
Gillespie	48171	121.45	11.57	762.04	0.33	9.72	2.74
Guadalupe	48187	102.31	9.75	641.96	0.61	19.64	5.22
Karnes	48255	2.21	0.21	13.86	0.14	5.01	1.22
Kendall	48259	65.51	6.24	411.04	0.13	3.64	1.06
Kerr	48265	111.14	10.59	697.38	0.47	12.44	4.05
McMullen	48311	0.00	0.00	0.00	0.00	0.02	0.01
Medina	48325	56.31	5.37	353.31	0.20	8.82	2.49
Wilson	48493	43.06	4.10	270.18	0.07	5.63	1.58
Total		1,086.75	103.55	6,819.10	29.56	929.01	252.23

3.6 Oil and Gas Emissions

3.6.1 Oil and Gas Production

"Oil and gas production emission estimates were developed based on activity data from the Railroad Commission of Texas (RRC) multiplied by emission factors for specific operations and types of equipment from an Eastern Research Group (ERG) study, Characterization of Oil and Gas Production Equipment and Develop a Methodology to Estimate Statewide Emissions."[42] [43] "Activity data from the RRC specific to 2012 and 2014 were obtained for production of natural gas, crude oil, and condensate, along with additional parameters such as the total number of operational gas wells, operational oil wells, etc. These activity figures were multiplied by emission factors from the ERG study to obtain oil and gas production emission estimates. For example, compressor engine emissions are a function of natural gas production, so compressor engine emission rates were multiplied by total natural gas produced. Condensate storage tank emission

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[42] TCEQ, Dec. 16, 2016. "Appendix B: Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 2008 Eight Hour Ozone Standard". Project Number 2016-016-SIP-NR. p. B-61. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/HGB_2016_AD_RFP/AD_Adoption/HGB_AD_SIP_Appendix_B_Adoption.pdf. Accessed 05/30/2017.

[43] Eastern Research Group, Inc. Aug. 1, 2014. "Specified Oil & Gas Well Activities Emissions Inventory Update". Morrisville, NC. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/5821199776FY1426-20140801-erg-oil_gas_ei_update.pdf. Accessed 05/31/2017.

estimates were calculated as a function of condensate production. In a similar manner, emissions from crude oil storage tanks are a function of crude oil production."[44]

Future year 2017 emission estimates for oil and gas production were projected using 2014 RRC data, which is the latest full year available when this projection was done. Since upstream oil and gas production for the Houston-Galveston-Brazoria (HGB) area has been relatively stable over time, the 2014 production emissions were held constant and used as 2017 inputs. In accordance with the recently promulgated regulations for "green completions" issued by the U.S. EPA, NO_X and CO emissions associated with gas well completions for 2017 were reduced to zero.[45] Production levels were held constant for the 2020 and 2023 projection oil and gas production emission inventory. All non-road controls were included in these projection years.

3.6.2 Drill Rigs

"The 2017 drilling rig emission estimates were obtained by applying 2017 emission factors to the 2015 drilling activity. Different emission rates apply based on average well depth and whether conventional "vertical only" drilling is being done versus horizontal drilling commonly associated with fracturing. Since drilling rig equipment is subject to federal non-road emission standards, average emission rates decline over time due to fleet turnover."[46] Drilling rig emission rates for each year from 2012-2040 are summarized in Chapter 6: Emissions Factor Development of the 2014 Statewide Drilling Rig Emissions Inventory with Updated Trends Inventory ERG study.[47] Similar to production emissions, production levels were held constant for the 2020 and 2023 projection drill rig emission inventory. All non-road controls were included in these projection years.

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44 TCEQ, Dec. 16, 2016. "Appendix B: Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 2008 Eight Hour Ozone Standard". Project Number 2016-016-SIP-NR. p. B-61. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/HGB_2016_AD_RFP/AD_Adoption/HGB_AD_SIP_Appendix_B_Adoption.pdf. Accessed 05/30/2017.

45 TCEQ, Dec. 16, 2016. "Appendix B: Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 2008 Eight Hour Ozone Standard". Project Number 2016-016-SIP-NR. p. B-62. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/HGB_2016_AD_RFP/AD_Adoption/HGB_AD_SIP_Appendix_B_Adoption.pdf. Accessed 05/30/2017.

46 TCEQ, Dec. 16, 2016. "Appendix B: Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 2008 Eight Hour Ozone Standard". Project Number 2016-016-SIP-NR. p. B-64. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/HGB_2016_AD_RFP/AD_Adoption/HGB_AD_SIP_Appendix_B_Adoption.pdf. Accessed 05/30/2017.

47 Eastern Research Group, Inc. July 31, 2015. "2014 Statewide Drilling Rig Emissions Inventory with Updated Trends Inventories". Austin, TX. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/5821552832FY1505-20150731-erg-drilling_rig_2014_inventory.pdf. Accessed 05/31/2017.

3.7 Non-Road Emissions

Non-road sources are equipment used for off road purposes and include construction equipment, recreational marine vessels, industrial equipment, agricultural equipment, recreational vehicles, lawn and garden equipment, railroad maintenance equipment, and commercial equipment. Non-road emissions for Texas were calculated using the TexN 1.7.1 model. The "Texas NONROAD Model (TexN) provides emissions estimates for a large number of non-road equipment categories operating in Texas." "The TexN model calculates emissions estimates for the same equipment categories included in EPA's NONROAD model."[48] "The TexN model incorporates the unmodified NONROAD2005 model to generate its core emission estimates, utilizing region-specific adjustment factors in order to refine the NONROAD outputs for Texas. The model also incorporates geographic and equipment-specific improvements to the NONROAD model, reflecting the efforts of numerous TCEQ studies."[49]

All Diesel equipment in eastern Texas was adjusted to take into account Texas Low Emission Diesel (TxLED). Local updates were provided for Construction Equipment, Quarry, Landfill, and Mining Equipment, Agricultural Tractors and Combines, and Lawn and Garden equipment. Non-road NO, NO_2, Nitrous acid (HONO), VOC, and CO emissions in Texas were projected using Equation 3-2. The TexN Model run specifications were:

- Analysis Year = 2012, 2017, 2020, and 2023
- Max Tech. Year = 2023
- Met Year = Typical Year
- Period = Ozone season day
- Summation Type = Typical weekday
- Post Processing Adjustments = All
- Rules Enabled = All
- Regions = All Texas Counties
- Sources = All Equipment

All control strategies were selected in the model including Tier 1 to Tier 4 diesel rules, small spark ignition rule, large spark ignition rule, diesel recreation marine rule, small spark ignited (SI)/ SI Marine rule, and reformulated gasoline.

Equation 3-2, Ozone season day non-road emissions in Texas, 2020 or 2023

$$E_{Local.FY.A.B} = E_{Local.17.A.B} \times (E_{TexN.FY.A.B} / E_{TexN.17.A.B})$$

Where,

$E_{Local.FY.A.B}$ = Ozone season day 2020 or 2023 emissions in county A for non-road equipment type B (NO, NO_2, HONO, VOC, or CO)

$E_{Local.17.A.B}$ = Ozone season day 2017 emissions in county A for non-road equipment type B (NO, NO_2, HONO, VOC, or CO)

[48] Eastern Research Group, Inc. July 19, 2015. "Texas NONROAD (TexN) 1.7.1 Model". Austin, Texas. Available online: ftp://amdaftp.tceq.texas.gov/pub/EI/nonroad/TexN/. Accessed 06/01/2017.

[49] *Ibid*.

$E_{TexN.FY.A.B}$ = TexN model ozone season day 2020 or 2023 emissions in county A for non-road equipment type B (NO_X, VOC, or CO)

$E_{TexN.17.A.B}$ = TexN model ozone season day 2017 emissions in county A for non-road equipment type B (NO_X, VOC, or CO)

Sample Equation: 2023 NO emissions from diesel construction pavers, SCC code 2270002003, in Bexar County

$E_{Local.FY.A.B}$ = 0.0504 tons of NO per day x (0.080 tons of NO_X per day in 2023 from TexN Model / 0.110 tons of NO_X per day in 2017 from TexN Model)

= 0.037 tons of NO per day from diesel construction pavers in Bexar County in 2023

For areas outside of Texas, the National Mobile Inventory Model (NMIM)[50] was used to project non-road emissions following the same formula listed above. NMIM "is a consolidated emissions modeling system for EPA's MOBILE6 and NONROAD models. It was developed to produce, in a consistent and automated way, national, county-level mobile source emissions inventories for the National Emissions Inventory (NEI) and for EPA rule making."[51]

3.8 Off-Road

Off-road emission sources consist of marine vessels, locomotives/switchers, and aircraft/GSE. Emissions from these sources are not included in the TexN model, NMIM model, or EPA's NonRoad model.

3.8.1 Commercial Marine Vessels

Emissions from marine vessels were split into 2 groups: in-port harbor vessels and ocean going marine vessels. "Commercial marine emission estimates were developed by Ramboll Environ and detailed in Implement Port of Houston's Current Inventory and Harmonize the Remaining 8-county Shipping Inventory for TCEQ Modeling.[52] The emission estimates were projected by TCEQ to 2012 and 2017 based on expected changes in shipping activity and reductions in emission rates from engine turnover."[53]

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50 EPA "National Mobile Inventory Model (NMIM) 2008". Available online: https://www.epa.gov/moves/national-mobile-inventory-model-nmim. Accessed 06/01/2017.

51 *Ibid*.

52 ENVIRON International Corporation, Aug. 18, 2010. "Implement Port of Houston's Current Inventory and Harmonize the Remaining 8-county Shipping Inventory for TCEQ Modeling". Novato, CA. Available online https://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/5820784006FY1005-20100818-environ-HGBShipsEI.pdf. Accessed 06/01/2017.

53 TCEQ, Dec. 16, 2016. "Appendix B: Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 2008 Eight Hour Ozone Standard". Project Number 2016-016-SIP-NR. p. B-102. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/HGB_2016_AD_RFP/AD_Adoption/HGB_AD_SIP_Appendix_B_Adoption.pdf. Accessed 05/30/2017.

Commercial Marine vessels in Texas were projected to 2020 and 2023 based on ERG's 2014 Texas Statewide Commercial Marine Vessel Emissions Inventory and 2008 through 2040 Trend Inventories.[54] Table 3-4 list the adjustment factors while Equation 3-3 was used to project the emissions.

Table 3-4: U.S. Commercial Marine Emissions and Adjustment Factors, 2017, 2020, and 2023.

Year	NO_X		VOC		CO	
	tons/year	factor	tons/year	factor	tons/year	factor
2017	20,942.16	1.0000	687.27	1.0000	5,418.36	1.0000
2020	19,059.03	0.9101	694.72	1.0108	5,702.46	1.0524
2023	18,059.33	0.8623	728.22	1.0596	6,259.56	1.1552

Equation 3-3, Texas ozone season daily marine vessel emissions, 2020 or 2023

$$E_{Local.FY.A} = E_{Local.17.A} \times (E_{ERG.FY} / E_{ERG.17})$$

Where,

$E_{Local.FY.A}$ = Ozone season day 2020 or 2023 emissions in county A (NO_X, VOC, or CO)
$E_{Local.17.A}$ = Ozone season day 2017 emissions in county A (NO_X, VOC, or CO)
$E_{ERG.FY}$ = EPA Annual 2020 or 2023 emissions from ERG (NO_X, VOC, or CO from Table 3-4)
$E_{ERG.17}$ = EPA Annual 2017 emissions from ERG (NO_X, VOC, or CO from Table 3-4)

Sample Equation: 2023 NO_X emissions from commercial marine vessels in Calhoun County

$E_{Local.FY.A}$ = 1.0428 tons of NO_X per day in 2017 x (18,059.33 tons of NO_X per year in 2023 from ERG / 20,942.16 tons of NO_X per year in 2017 from ERG)
= 0.8993 tons of NO_X per day from commercial marine vessels in Calhoun County, 2023

Commercial marine vessel emissions outside of Texas remained the same for the 2017, 2020, and 2023 projection years.

3.8.2 Locomotives

Texas locomotive emission estimates for 2012 and 2017 were calculated by TCEQ and based on an August 2015 ERG study, 2014 Texas Statewide Locomotive Emissions Inventory and 2008 through 2040 Trend Inventories.[55] "The linehaul emissions were spatially allocated to individual railway segments based on gross ton miles (GTM) activity data. The switcher emissions were

[54] Eastern Research Group, Inc., Aug. 26, 2015. "2014 Texas Statewide Commercial Marine Vessel Emissions Inventory and 2008 through 2040 Trend Inventories". Austin. Texas. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/582155149301FY15-20150826-erg-commercial_marine_vessel_2014aerr_inventory_trends_2008to2040.pdf. Accessed 06/01/2017.

[55] Eastern Research Group, Inc., Oct 16, 2015. "2014 Texas Statewide Locomotive Emissions Inventory and 2008 through 2040 Trend Inventories". Morrisville, NC. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/sip/elp/CO_LMP/AppendixE.pdf. Accessed 06/01/2017.

allocated to known rail yards."[56] Locomotive emissions were projected to 2020 and 2023 using the following equation:

Equation 3-4, Ozone season day railway emissions for Texas, 2020 or 2023

$$E_{Local.FY.A} = E_{Local.17.A} \times (E_{ERG.FY.A} / E_{ERG.17.A})$$

Where,

$E_{Local.FY.A}$ = Ozone season day 2020 or 2023 emissions in county A (NO_X, VOC, or CO)
$E_{Local.17.A}$ = Ozone season day 2017 emissions in county A (NO_X, VOC, or CO)
$E_{ERG.FY.A}$ = Annual 2020 or 2023 emissions in county A from ERG (NO_X, VOC, or CO)
$E_{ERG.17.A}$ = Annual 2017 emissions in county A from ERG (NO_X, VOC, or CO)

Sample Equation: 2023 NO_X emissions from line-haul locomotives in Bexar County

$E_{Local.FY.A}$ = 1.4501 tons of NO_X per day in 2017 x (679.19 tons of NO_X per year in 2023 from ERG / 817.8 tons of NO_X per year in 2017 from ERG)
= 1.2043 tons of NO_X per day from line-haul locomotives in Bexar County, 2023

"For the non-Texas U.S. areas of the modeling domain, locomotive emission estimates from the EPA 2011 NEI were used by TCEQ to project emissions to 2012 and 2017."[57] For 2020 and 2023, EPA's "Emission Factors for Locomotives" was used to project locomotives and switchers' emissions. Emissions were calculated separately for the following locomotive categories:

- Diesel Line Haul Locomotives: Class I operations
- Diesel Line Haul Locomotives: Class II/III
- Diesel Yard Operations"[58]

Table 3-5 lists the emission rates from each locomotive type and the adjustment factored used to project emissions. CO emissions stayed the same for each projection year. These adjustment factors were used in Equation 3-5, to project emissions to 2020 and 2023.

[56] TCEQ, Dec. 16, 2016. "Appendix B: Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 2008 Eight Hour Ozone Standard". Project Number 2016-016-SIP-NR. p. B-77. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/HGB_2016_AD_RFP/AD_Adoption/HGB_AD_SIP_Appendix_B_Adoption.pdf. Accessed 05/30/2017.

[57] TCEQ, Dec. 16, 2016. "Appendix B: Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 2008 Eight Hour Ozone Standard". Project Number 2016-016-SIP-NR. p. B-78. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/HGB_2016_AD_RFP/AD_Adoption/HGB_AD_SIP_Appendix_B_Adoption.pdf. Accessed 05/30/2017.

[58] Office of Transportation and Air Quality, U.S. Environmental Protection Agency, April 2009. "Emission Factors for Locomotives". EPA-420-F-09-025. p. 7-9. Available online: https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100500B.pdf. Accessed 06/01/2017.

Table 3-5: U.S. Locomotives Emission Rates and Adjustment Factors, 2017, 2020, and 2023

Source Category	Diesel Line Haul Locomotives: Class I operations		Diesel Line Haul Locomotives: Class II/III		Diesel Yard Operations	
SCC Code	2285002006		2285002007		2285002010	
Pollutant	NOx	HC	NOx	HC	NOx	HC
2017 (g/gal)	114	4.6	237	11.7	206	11.8
2020 (g/gal)	99	3.9	231	11.7	187	10.5
2023 (g/gal)	84	3.0	223	11.7	172	9.5
Adjustment Factor (2020)	0.868421	0.847826	0.974684	1.000000	0.907767	0.889831
Adjustment Factor (2023)	0.736842	0.652174	0.940928	1.000000	0.834951	0.805085

Equation 3-5, Ozone season day locomotive emissions for other states, 2020 or 2023

$$E_{Local.FY.A.B} = E_{Local.17.A.B} \times (E_{EPA.FY.B} / E_{EPA.17.B})$$

Where,

$E_{Local.FY.A.B}$ = Ozone season day 2020 or 2023 emissions in county A for railway type B (NO_X or VOC)

$E_{Local.17.A.B}$ = Ozone season day 2017 emissions in county A for railway type B (NO_X or VOC)

$E_{EPA.FY.B}$ = EPA Annual 2020 or 2023 emission rates for railway type B from EPA (NO_X or VOC from Table 3-5)

$E_{EPA.17.B}$ = EPA Annual 2017 emission rates for railway type B from EPA (NO_X or VOC from Table 3-5)

Sample Equation: 2023 NO_X emissions from large line-haul locomotives in Baldwin County, Alabama

$E_{Local.FY.A.B}$ = 0.7128 tons of NO_X per day in 2017 x (84 g/gal 2023 from EPA / 114 g/gal NO_X in 2017 from EPA)
= 0.5278 tons of NO_X per day from large line-haul locomotives in Baldwin County, Alabama, 2023

3.8.3 Aircraft Emissions

Airport emission estimates for 2012, 2017, 2020, and 2023 were based on an ERG study: Aircraft Emissions Inventory for Texas Statewide 2014 Air Emissions Reporting Requirements (AERR) Inventory and 2008 to 2014 Trend Analysis Years.[59] "At the time that the ERG work was performed, the latest version of the Emissions and Dispersion Modeling System (EDMS) from the Federal Aviation Administration (FAA) was used. For the past years, historical flight activity for

[59] Eastern Research Group, Inc., May 16, 2016. "Aircraft Emissions Inventory for Texas Statewide 2014 AERR Inventory and 2008 to 2040 Trend Analysis Years". Morrisville, NC. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/582155160603FY1508-20160516-erg-2014_AERR_Inventory_Aircraft_Revised.pdf. Accessed 06/01/2017.

each airport is inputted to the EDMS model. Future year flight activity is based on Terminal Area Forecast (TAF) datasets available from FAA. In addition to estimating emissions from aircraft activity, the EDMS model outputs estimates for auxiliary power units (APUs) and ground support equipment (GSE) at major airports."[60] Texas aircraft emissions in 2020 and 2023 were projected using the following equation.

Equation 3-6, Ozone season day aircraft emissions in Texas for 2020 and 2023

$$E_{Local.FY.A} = E_{Local.17.A} \times (E_{ERG.FY.A} / E_{ERG.17.A})$$

Where,

$E_{Local.FY.A}$ = Ozone season day 2020 or 2023 emissions for airport A (NO_X, VOC, or CO)
$E_{Local.17.A}$ = Ozone season day 2017 emissions for airport A (NO_X, VOC, or CO)
$E_{ERG.FY.A}$ = ERG annual 2020 or 2023 emissions for airport A from ERG (NO_X, VOC, or CO)
$E_{ERG.17.A}$ = ERG annual 2017 emissions for airport A from ERG (NO_X, VOC, or CO)

Sample Equation: 2023 NO_X emissions from general aviation aircraft HRL Valley International Airport, Harlingen, in Cameron County, Texas

$E_{Local.FY.A}$ = 0.1427 tons of NO_X in 2017 x (74.47 tons of NO_X in 2023 from ERG / 71.70 tons of NO_X in 2017 from ERG)
= 0.1482 tons of NO_X per day from general aviation aircraft in HRL Valley International Airport, Harlingen, in Cameron County, Texas, 2023

For the non-Texas U.S. areas of the modeling domain, airport emission estimates from the EPA 2011 NEI were projected to 2012 and 2017.[61] The emissions from airports outside of Texas remained the same for 2017, 2020, and 2023.

3.8.4 San Antonio International Airport

AACOG updated and expanded the following emission inventory categories for the San Antonio International Airport:

- Aircraft Operations (commercial, military operations, and general aviation)
- Ground Support Equipment (GSE)
- Parking Garages
- Aircraft Evaporative Loss
- Fuel Storage & Transfer

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[60] TCEQ, Dec. 16, 2016. "Appendix B: Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 2008 Eight Hour Ozone Standard". Project Number 2016-016-SIP-NR. p. B-72. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/HGB_2016_AD_RFP/AD_Adoption/HGB_AD_SIP_Appendix_B_Adoption.pdf. Accessed 05/30/2017.

[61] TCEQ, Dec. 16, 2016. "Appendix B: Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 2008 Eight Hour Ozone Standard". Project Number 2016-016-SIP-NR. p. B-74. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/HGB_2016_AD_RFP/AD_Adoption/HGB_AD_SIP_Appendix_B_Adoption.pdf. Accessed 05/30/2017.

- Stationary Sources
- Auxiliary Power Units (APU)
- Non-road Equipment (Lawn and Garden, Commercial, and Light Industrial)

To calculate emissions based on a “bottom-up” approach, local data from the above sources were collected. Emissions from aircraft landing and take-off (LTO) cycles at SAIA were calculated using the EDMS model, version 5.1.3.[62] The EDMS model uses EPA approved emission factors and methodologies to estimate emissions from aircraft operations.

3.9 On-Road Emissions

On-road emissions are mobile source emissions that are produced during operation of vehicles on urban and rural roadway networks. Due to their significant contribution to NO_X emissions, on-road emissions are regulated by the EPA and subject to federal standards and control. MOVES “is used to create emission factors or emission inventories for both onroad motor vehicles and nonroad equipment. The purpose of MOVES is to provide an accurate estimate of emissions from cars, trucks and non-highway mobile sources under a wide range of user-defined conditions. In the modeling process, the user specifies vehicle types, time periods, geographical areas, pollutants, vehicle operating characteristics, and road types to be modeled. The model then performs a series of calculations, which have been carefully developed to accurately reflect vehicle operating processes, such as running, starts, or hoteling, and provide estimates of total emissions or emission rates per vehicle or unit of activity.”[63]

3.9.1 MOVES 2014a Inputs

TTI “created on-road emissions inventories for every Texas County with the 2014 version of the Motor Vehicle Emissions Simulator (MOVES2014) model for the 2017 calendar year, and created a set of area source refueling process emissions inventories and total energy consumption estimates consistent with the on-road inventory analysis. Both school and summer season inventories were produced for the four day types — Weekday (Monday through Thursday), Friday, Saturday, and Sunday.”[64]

“The overall methodology, more specifically, was the detailed, MOVES rates-per-activity, HPMS virtual link-based, statewide, on-road mobile inventory method, which produces hourly emissions estimates by vehicle type, pollutant, and process for each county inventory scenario (i.e., period and day-type). MOVES emissions rates are modeled and combined externally with each virtual

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[62] FAA, Nov. 2010. “Emissions & Dispersion Modeling System”. Available online: https://aedt.faa.gov/. Accessed 06/01/2017.

[63] EPA, Nov. 2015. “MOVES2014a User Guide”. EPA-420-B-15-095. p. 1-2. Available online: https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100NNCY.txt. Accessed 06/01/2017.

[64] Transportation Modeling Program, Texas A&M Transportation Institute. Aug. 2015. “The Production of Statewide On-Road Mobile Source Emissions Inventories for 2017”. College Station, Texas. Available online: ftp://amdaftp.tceq.texas.gov/pub/EI/onroad/mvs14_trends/reports/. Accessed 06/01/2017.

link (specific HPMS road type and area type combination) VMT estimate to approximate roadway based emissions."[65]

"In addition to the VMT-based calculations of roadway-based emissions estimates, the TTI MOVES emissions inventory process uses off-network activity measures (i.e., starts, SHP, SHI, and APU hours). Associated emissions rates must be produced in these terms for the off-network emissions process calculations. Previous versions of MOVES provided the off-network start, evaporative, and extended idling rates only in 'per vehicle' units, not applicable to the TTI activity-based inventory process; TTI post-processing utilities were used to produce the MOVES off-network rates in the needed activity units."[66]

Table 3-6: MOVES2014a Source Use Type

Source Use Type ID	Source Use Type Description	Source Use Type Abbreviation
11	Motorcycle	MC
21	Passenger Car	PC
31	Passenger Truck	PT
32	Light Commercial Truck	LCT
41	Intercity Bus	IBus
42	Transit Bus	TBus
43	School Bus	SBus
51	Refuse Truck	RT
52	Single Unit Short-Haul Truck	SUShT
53	Single Unit Long-Haul Truck	SULhT
54	Motor Home	MH
61	Combination Short-Haul Truck	CShT
62	Combination Long-Haul Truck	CLhT

Age distribution and VMT mix by MOVES2014a vehicle class were based on data from TxDOT or the Texas Department of Motor Vehicles (TxDMV). The vehicle age distribution for TxDOT's San Antonio district is shown in Table 3-7 for 2012 and Table 3-8 for 2023.[67]

[65] *Ibid*.
[66] *Ibid*.
[67] *Ibid*.

Table 3-7: TxDOT's San Antonio District 2012 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
	11	21	31	32	41	42	43	51	52	53	54	61	62
0	0.03623	0.03557	0.02367	0.02367	0.04942	0.04942	0.04942	0.05882	0.10919	0.09911	0.05883	0.01609	0.03826
1	0.04078	0.04863	0.04831	0.04831	0.04533	0.05971	0.03503	0.03188	0.16194	0.13601	0.04383	0.02860	0.03098
2	0.03083	0.05122	0.03946	0.03946	0.04002	0.03655	0.03829	0.02526	0.06199	0.04725	0.03870	0.01296	0.01922
3	0.07815	0.04300	0.03323	0.03323	0.03355	0.03739	0.04561	0.03351	0.05504	0.04461	0.03244	0.02011	0.03344
4	0.09534	0.07310	0.06645	0.06645	0.04356	0.05274	0.05030	0.02602	0.12462	0.12800	0.04212	0.04245	0.04680
5	0.09676	0.08013	0.06910	0.06910	0.05708	0.05123	0.05212	0.09090	0.06655	0.07834	0.05503	0.05004	0.09874
6	0.08951	0.07019	0.06502	0.06502	0.05864	0.03695	0.06124	0.06807	0.08059	0.08649	0.05635	0.05719	0.07450
7	0.07275	0.07274	0.05848	0.05848	0.06062	0.05774	0.05456	0.06417	0.07287	0.07753	0.05825	0.06568	0.06429
8	0.05442	0.06866	0.06665	0.06665	0.05890	0.04734	0.05375	0.03844	0.04669	0.05467	0.05642	0.04379	0.04397
9	0.06337	0.06549	0.06094	0.06094	0.05459	0.04639	0.04628	0.03776	0.03985	0.04426	0.05229	0.02949	0.03689
10	0.05797	0.06164	0.06061	0.06061	0.05113	0.04702	0.04861	0.02737	0.02771	0.03482	0.04898	0.02502	0.03588
11	0.05371	0.05466	0.05711	0.05711	0.04916	0.05416	0.04436	0.03366	0.03100	0.03637	0.04695	0.03172	0.04942
12	0.04106	0.04955	0.04937	0.04937	0.04675	0.03664	0.04827	0.04601	0.02404	0.02938	0.04465	0.06390	0.06045
13	0.03083	0.04202	0.04263	0.04263	0.04545	0.03552	0.04466	0.06589	0.01936	0.02641	0.04327	0.06434	0.05301
14	0.02273	0.03180	0.03585	0.03585	0.03444	0.04169	0.03525	0.06057	0.00924	0.01239	0.02544	0.05809	0.04290
15	0.02003	0.02797	0.03664	0.03664	0.02802	0.03809	0.03283	0.02927	0.01265	0.01387	0.03916	0.03128	0.03308
16	0.01478	0.02092	0.02405	0.02405	0.02317	0.03509	0.02831	0.03797	0.00595	0.00800	0.02417	0.03843	0.03003
17	0.01165	0.02024	0.02528	0.02528	0.03011	0.02876	0.03617	0.04873	0.00721	0.00869	0.02852	0.04826	0.03814
18	0.00881	0.01548	0.02417	0.02417	0.02319	0.02508	0.01745	0.03421	0.00595	0.00570	0.02711	0.02726	0.02485
19	0.00540	0.01209	0.01664	0.01664	0.01909	0.02080	0.02084	0.01558	0.00316	0.00398	0.01865	0.02011	0.02235
20	0.00412	0.00932	0.01286	0.01286	0.01406	0.01806	0.01681	0.01387	0.00342	0.00281	0.01631	0.01251	0.01610
21	0.00469	0.00751	0.01089	0.01089	0.01593	0.01826	0.02146	0.02170	0.00304	0.00303	0.01213	0.06792	0.01775
22	0.00298	0.00609	0.00871	0.00871	0.01788	0.02673	0.02424	0.01540	0.00240	0.00293	0.01589	0.01609	0.01531
23	0.00455	0.00523	0.00908	0.00908	0.01773	0.02034	0.01383	0.02372	0.00253	0.00236	0.02047	0.01251	0.01189
24	0.00355	0.00382	0.00717	0.00717	0.01650	0.01601	0.01644	0.01365	0.00190	0.00194	0.01815	0.01072	0.00984
25	0.00213	0.00285	0.00438	0.00438	0.01715	0.01481	0.01666	0.01224	0.00025	0.00121	0.01773	0.01877	0.00808
26	0.00682	0.00242	0.00580	0.00580	0.01439	0.01248	0.01454	0.00626	0.00164	0.00146	0.01303	0.01251	0.00780
27	0.00583	0.00227	0.00566	0.00566	0.01256	0.01071	0.01248	0.00629	0.00139	0.00117	0.01383	0.01296	0.00711
28	0.00426	0.00199	0.00473	0.00473	0.00989	0.00835	0.00964	0.00516	0.00152	0.00097	0.01403	0.00715	0.00544
29	0.00440	0.00116	0.00320	0.00320	0.00390	0.00792	0.00352	0.00232	0.00152	0.00059	0.00906	0.00492	0.00248
30	0.03154	0.01225	0.02386	0.02386	0.00775	0.00802	0.00701	0.00530	0.01480	0.00565	0.00821	0.04915	0.02101

Table 3-8: TxDOT's San Antonio District 2017, 2020, and 2023 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	TBus	SBus	RT	SUShT	SULhT	MH	CShT	CLhT
	11	21	31	32	41	42	43	51	52	53	54	61	62
0	0.03526	0.03906	0.02900	0.02900	0.05555	0.05565	0.05556	0.06476	0.08376	0.08074	0.06493	0.02968	0.04401
1	0.05124	0.06815	0.04720	0.04720	0.04985	0.04995	0.04985	0.05827	0.11094	0.09798	0.05845	0.02717	0.04891
2	0.05802	0.06436	0.04461	0.04461	0.04601	0.04610	0.04601	0.05351	0.16374	0.15050	0.05367	0.02801	0.05049
3	0.03963	0.05639	0.04953	0.04953	0.04219	0.05570	0.03261	0.02900	0.12385	0.10489	0.03999	0.03052	0.03287
4	0.03210	0.05190	0.03924	0.03924	0.03725	0.03409	0.03565	0.02298	0.04649	0.03609	0.03530	0.01171	0.01774
5	0.07354	0.04253	0.03389	0.03389	0.03105	0.03468	0.04222	0.03032	0.04057	0.03401	0.02944	0.01798	0.03141
6	0.08394	0.07042	0.06518	0.06518	0.03999	0.04852	0.04618	0.02336	0.09124	0.09370	0.03793	0.04097	0.04364
7	0.08424	0.07380	0.06670	0.06670	0.05228	0.04701	0.04774	0.08143	0.05115	0.05769	0.04944	0.07776	0.09409
8	0.07957	0.06402	0.06191	0.06191	0.05340	0.03371	0.05578	0.06064	0.05620	0.06401	0.05035	0.06731	0.07068
9	0.06841	0.06543	0.05483	0.05483	0.05507	0.05256	0.04957	0.05705	0.04960	0.05757	0.05194	0.07525	0.06134
10	0.04747	0.05903	0.05994	0.05994	0.05350	0.04309	0.04884	0.03417	0.03504	0.04088	0.05031	0.04724	0.04112
11	0.05530	0.05543	0.05557	0.05557	0.04930	0.04198	0.04181	0.03338	0.02640	0.03301	0.04637	0.02508	0.03291
12	0.04641	0.04979	0.05390	0.05390	0.04607	0.04245	0.04380	0.02414	0.02038	0.02642	0.04333	0.02550	0.03244
13	0.04566	0.04345	0.05100	0.05100	0.04404	0.04861	0.03974	0.02953	0.02067	0.02747	0.04131	0.02885	0.04353
14	0.03662	0.03846	0.04289	0.04289	0.04178	0.03281	0.04314	0.04027	0.01679	0.02192	0.03920	0.06062	0.05252
15	0.02833	0.03105	0.03627	0.03627	0.04061	0.03181	0.03991	0.05768	0.01262	0.01970	0.03798	0.05727	0.04423
16	0.01733	0.02312	0.03090	0.03090	0.03060	0.03711	0.03131	0.05272	0.00563	0.00948	0.02221	0.04682	0.03712
17	0.01658	0.01979	0.03015	0.03015	0.02484	0.03383	0.02910	0.02542	0.00776	0.01022	0.03412	0.02676	0.02810
18	0.01251	0.01449	0.02031	0.02031	0.02041	0.03097	0.02495	0.03280	0.00417	0.00567	0.02094	0.02926	0.02590
19	0.00904	0.01352	0.02018	0.02018	0.02647	0.02532	0.03179	0.04199	0.00602	0.00604	0.02465	0.03721	0.03208
20	0.00784	0.01052	0.01936	0.01936	0.02026	0.02195	0.01525	0.02931	0.00398	0.00388	0.02330	0.01965	0.02087
21	0.00482	0.00805	0.01319	0.01319	0.01663	0.01816	0.01817	0.01332	0.00243	0.00275	0.01600	0.01798	0.01799
22	0.00422	0.00594	0.01002	0.01002	0.01225	0.01577	0.01465	0.01186	0.00204	0.00188	0.01399	0.01003	0.01287
23	0.00362	0.00492	0.00855	0.00855	0.01380	0.01586	0.01859	0.01845	0.00233	0.00217	0.01035	0.05518	0.01421
24	0.00332	0.00380	0.00698	0.00698	0.01545	0.02315	0.02095	0.01306	0.00136	0.00173	0.01352	0.01296	0.01257
25	0.00362	0.00336	0.00660	0.00660	0.01532	0.01761	0.01195	0.02012	0.00136	0.00144	0.01741	0.01045	0.00961
26	0.00332	0.00233	0.00527	0.00527	0.01417	0.01378	0.01413	0.01152	0.00126	0.00118	0.01536	0.01003	0.00786
27	0.00256	0.00186	0.00370	0.00370	0.01470	0.01272	0.01428	0.01030	0.00029	0.00068	0.01497	0.01296	0.00620
28	0.00512	0.00159	0.00463	0.00463	0.01233	0.01071	0.01246	0.00527	0.00058	0.00087	0.01100	0.00836	0.00608
29	0.00573	0.00143	0.00431	0.00431	0.01070	0.00914	0.01063	0.00526	0.00078	0.00076	0.01161	0.00878	0.00560
30	0.03466	0.01200	0.02420	0.02420	0.01415	0.01519	0.01339	0.00811	0.01058	0.00468	0.02068	0.04264	0.02103

The 2017 temperature distribution for TxDOT's San Antonio district is provided in Figure 3-1 while hourly relative humidity is provided in Figure 3-2. The diurnal temperature profile varies between 74 degrees and 94 degrees Fahrenheit. During the night, average humidity is above 80 percent, but in the afternoon, humidity varies between 37 and 49 percent.

Figure 3-1: Temperature Inputs to MOVES for Summer, San Antonio TxDOT District 2012

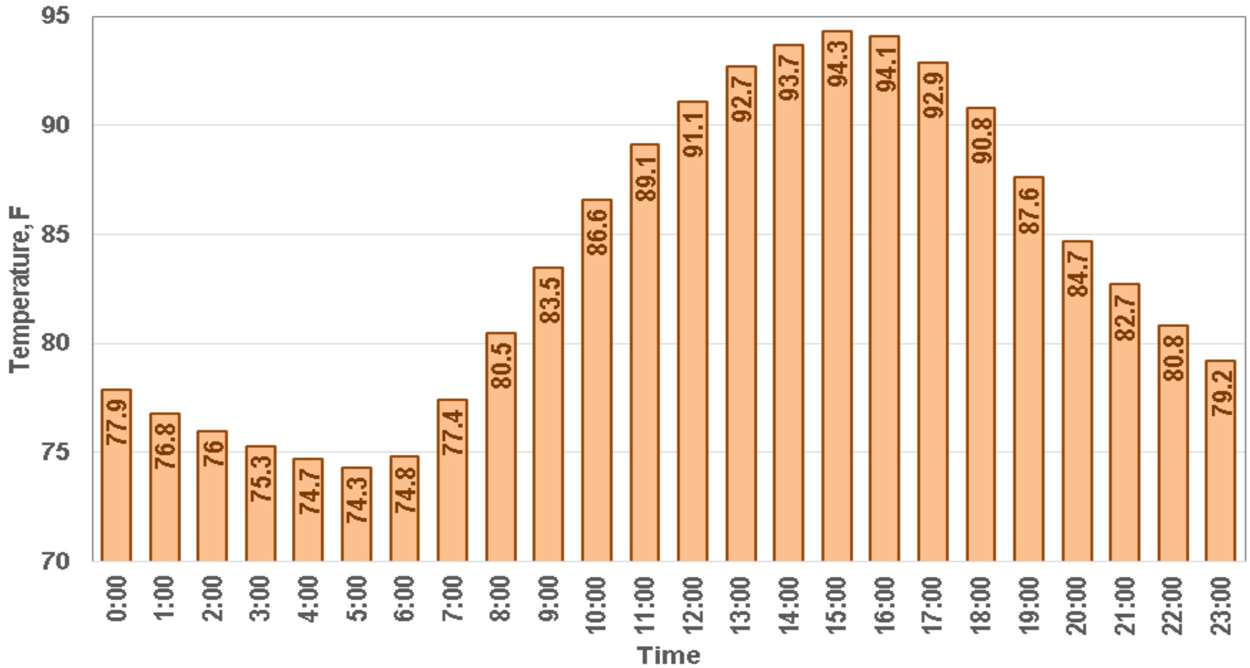
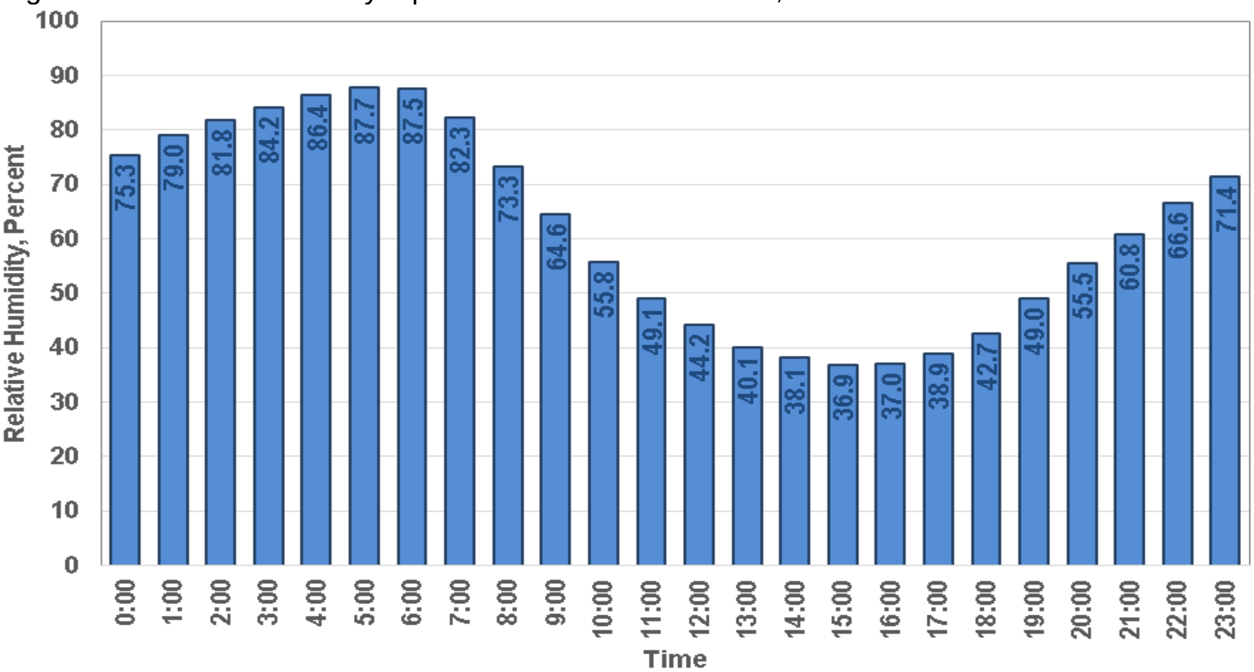
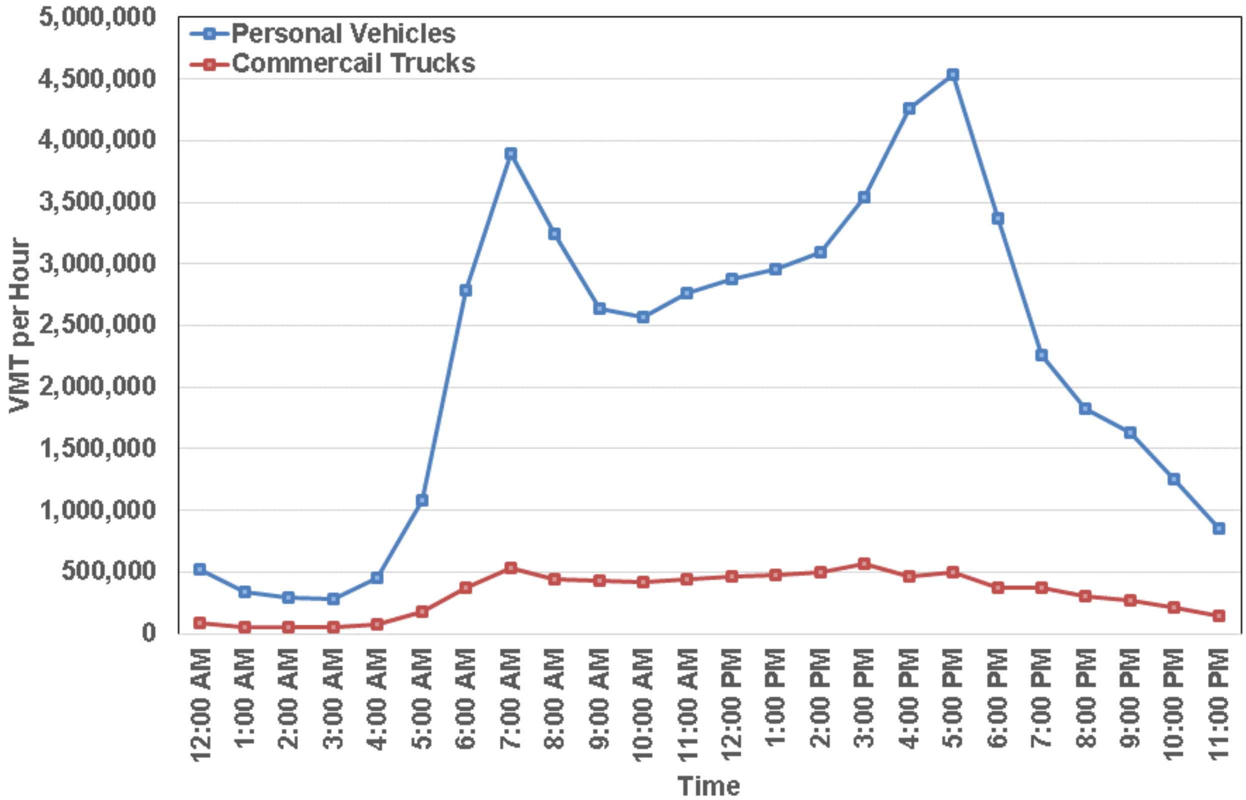


Figure 3-2: Relative Humidity Inputs to MOVES for Summer, San Antonio TxDOT District 2012



As shown in Figure 3-3, VMT varies greatly by hour of the day with a morning rush hour peak and afternoon rush hour peak. Personal vehicles contribute 87% of the 61,032,517 total daily VMT on an average summer weekday in the San Antonio-New Braunfels MSA. Light commercial trucks, refuse trucks, buses, short haul trucks, and long haul trucks have significantly lower VMT.

Figure 3-3: Weekday Hourly VMT by Vehicle Class, San Antonio-New Braunfels MSA, 2017



All federal requirements for vehicles and fuel were accounted for by the MOVES2014a runs. The Low Reid Vapor Pressure (RVP) gasoline control strategy for 95 counties in eastern Texas was included in the modeling.

3.9.2 <u>On-Road Vehicle Emissions</u>

NO_X emissions display a similar hourly pattern to VMT with morning and afternoon rush hour peaks (Figure 3-4). Although commercial trucks have low VMT compared to passenger vehicles, these trucks contribute 22 tons (52%) of total weekday on-road NO_X emissions. Passenger cars contribute 20 tons of weekday on-road NO_X emissions (Table 3-9). Hourly NO_X emissions, plotted in Figure 3-5, are similar between a weekday (Monday through Thursday) and a Friday with slightly higher emissions on Friday. Both Saturday and Sunday NO_X emissions have a different temporal profile with peak emissions occurring between noon and 3 pm.

Figure 3-4: Weekday Hourly NO_X Emissions by Vehicle Class, San Antonio-New Braunfels MSA, 2017

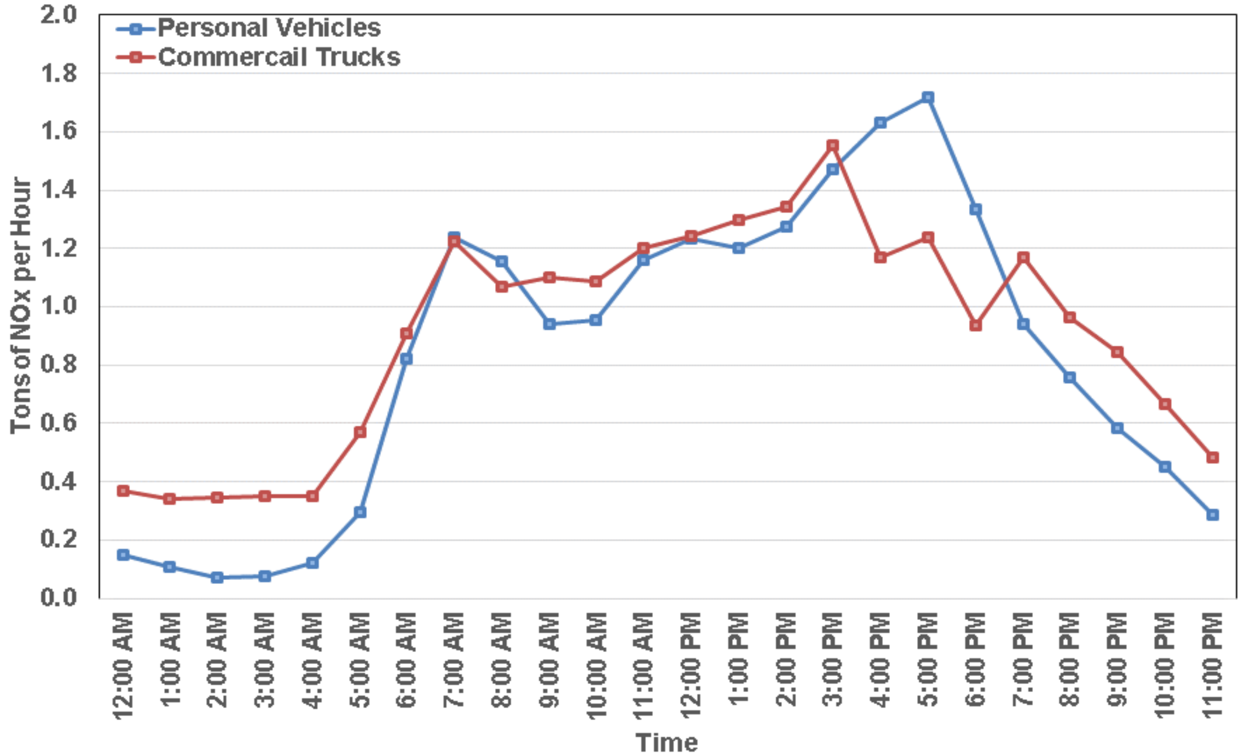


Figure 3-5: Hourly NO_X Emissions by Day of the Week, San Antonio-New Braunfels MSA, 2006

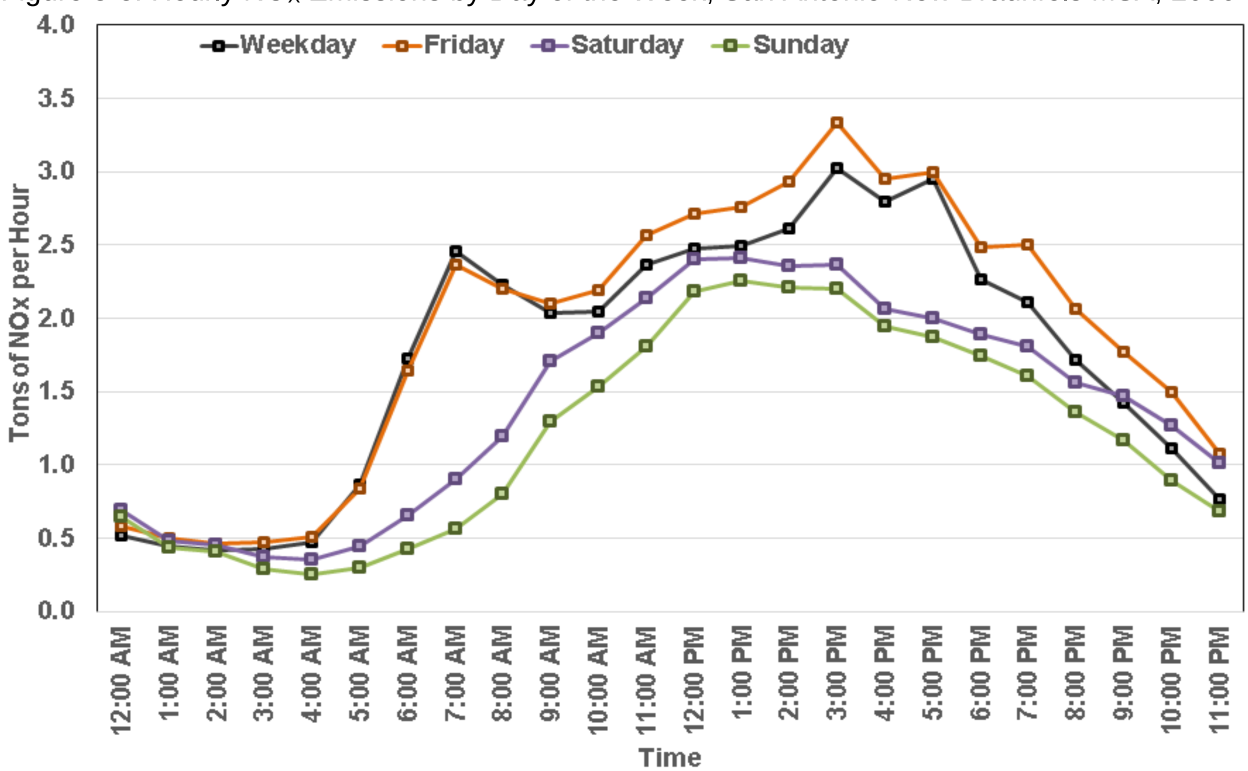


Table 3-9: VMT, NO_X and VOC emissions by Time of The Day, San Antonio-New Braunfels MSA, 2017

Time	Personal Vehicle			Light Comm./Refuse/Bus			Short Haul Truck			Long Haul Truck		
	VMT	Tons of NO_X	Tons of VOC	VMT	Tons of NO_X	Tons of VOC	VMT	Tons of NO_X	Tons of VOC	VMT	Tons of NO_X	Tons of VOC
12:00 AM	520,633	0.15	0.24	29,124	0.03	0.02	34,946	0.09	0.01	22,020	0.24	0.03
1:00 AM	339,478	0.11	0.23	18,991	0.02	0.02	22,787	0.06	0.01	14,358	0.26	0.04
2:00 AM	292,290	0.07	0.18	16,351	0.02	0.02	19,619	0.05	0.00	12,362	0.28	0.05
3:00 AM	283,020	0.08	0.19	15,832	0.02	0.02	18,997	0.05	0.01	11,970	0.28	0.05
4:00 AM	448,569	0.12	0.22	25,093	0.03	0.02	30,109	0.08	0.01	18,972	0.24	0.04
5:00 AM	1,078,399	0.29	0.34	60,326	0.07	0.03	72,385	0.19	0.02	45,611	0.31	0.02
6:00 AM	2,780,976	0.82	0.78	154,073	0.21	0.12	164,573	0.33	0.03	57,957	0.36	0.02
7:00 AM	3,895,172	1.24	1.25	215,803	0.29	0.15	230,508	0.45	0.05	81,177	0.48	0.03
8:00 AM	3,243,576	1.16	1.29	179,702	0.26	0.15	191,948	0.40	0.05	67,598	0.41	0.03
9:00 AM	2,637,780	0.94	1.00	151,607	0.22	0.11	195,069	0.41	0.04	77,913	0.47	0.03
10:00 AM	2,572,960	0.95	1.01	147,881	0.21	0.11	190,275	0.41	0.04	75,998	0.47	0.03
11:00 AM	2,758,744	1.16	1.16	158,559	0.25	0.13	204,014	0.45	0.04	81,486	0.50	0.03
12:00 PM	2,875,714	1.23	1.22	165,282	0.25	0.12	212,664	0.47	0.04	84,941	0.53	0.03
1:00 PM	2,957,146	1.20	1.15	169,962	0.26	0.13	218,686	0.49	0.04	87,346	0.55	0.03
2:00 PM	3,094,986	1.28	1.20	177,884	0.26	0.12	228,880	0.51	0.05	91,417	0.57	0.03
3:00 PM	3,538,734	1.47	1.33	203,389	0.32	0.16	261,696	0.59	0.05	104,524	0.64	0.03
4:00 PM	4,256,386	1.63	1.39	212,925	0.27	0.14	177,384	0.41	0.04	77,161	0.49	0.03
5:00 PM	4,530,195	1.72	1.51	226,622	0.29	0.16	188,795	0.43	0.04	82,124	0.51	0.03
6:00 PM	3,365,173	1.33	1.35	168,342	0.22	0.14	140,243	0.32	0.03	61,004	0.40	0.03
7:00 PM	2,255,520	0.94	1.06	126,175	0.18	0.10	151,396	0.41	0.03	95,397	0.59	0.03
8:00 PM	1,820,829	0.76	0.83	101,858	0.15	0.09	122,218	0.32	0.02	77,012	0.48	0.03
9:00 PM	1,634,069	0.58	0.62	91,411	0.12	0.06	109,683	0.29	0.02	69,113	0.44	0.03
10:00 PM	1,249,971	0.45	0.51	69,924	0.09	0.05	83,901	0.22	0.02	52,868	0.35	0.02
11:00 PM	852,936	0.28	0.40	47,714	0.05	0.03	57,251	0.15	0.01	36,075	0.28	0.03
Total	53,283,255	19.97	20.44	2,934,830	4.10	2.21	3,328,027	7.58	0.70	1,486,405	10.14	0.75

*Note: totals do not include long term idling emissions from long haul diesel combination trucks

As shown in Table 3-10, on-road emissions are projected to decrease rapidly from 2017 to 2023. NO_X emissions in the San Antonio-New Braunfels MSA are projected to decrease from 92 tons/weekday in 2012 to 23 tons/weekday in 2023. Similarly, weekday VOC emissions are projected to decrease from 33 tons to 14 tons. Emission reductions are occurring because of engine controls being placed on new cars that have significantly reduced emissions.

Table 3-10: Weekday NO_X Emissions, and VOC Emissions by County, San Antonio New Braunfels MSA, 2017, 2020, and 2023

County	Tons of NO_X				Tons of VOC			
	2012	2017	2020	2023	2012	2017	2020	2023
Atascosa	3.87	2.43	1.69	1.28	0.91	0.69	0.50	0.39
Bandera	0.00	0.43	0.31	0.22	0.00	0.28	0.21	0.17
Bexar	70.94	30.32	20.61	15.29	26.39	18.50	13.70	10.78
Comal	7.70	3.76	2.76	2.24	2.43	1.78	1.34	1.08
Guadalupe	7.23	3.40	2.39	1.78	2.28	1.65	1.23	0.97
Kendall	0.05	1.15	0.80	0.59	0.01	0.58	0.43	0.34
Medina	0.05	1.53	1.05	0.77	0.01	0.62	0.45	0.35
Wilson	2.35	1.05	0.72	0.53	0.83	0.58	0.43	0.33
Total	92.19	44.06	30.32	22.69	32.86	24.68	18.29	14.40

*Note: totals do not include long term idling emissions from long haul diesel combination trucks

AACOG processed the on-road emissions through EPS3 by SCC code. TCEQ has developed a custom SCC approach for MOVES for processing purposes in the photochemical model. The codes used in the process are listed below.

<u>“Fuel Types</u>

- GS - Gasoline
- DS - Diesel Fuel
- CN - Compressed Natural Gas
- LP - Liquefied Petroleum Gas
- ET - Ethanol
- EL - Electricity

<u>Source Use Type (SUT)</u>

- MC - Motorcycle
- PC - Passenger Car
- PT - Passenger Truck
- LC - Light Commercial Truck
- IB - Intercity Bus
- TB - Transit Bus
- SB - School Bus
- RT - Refuse Truck
- SS - Single-Unit Short-Haul Truck
- SL - Single-Unit Long-Haul Truck
- MH - Motor Home

- CS - Combination Short-Haul Truck
- CL - Combination Long-Haul Truck

Roadway Types

- OF - Off-Network
- RR - Rural Restricted Access
- RU - Rural Unrestricted Access
- UR - Urban Restricted Access
- UU - Urban Unrestricted Access
- RP - Ramp

Highway Performance Monitoring System (HPMS) Roadway Types

- 11 - Rural Interstate
- 13 - Rural Other Principal Arterial
- 15 - Rural Minor Arterial
- 17 - Rural Major Collector
- 19 - Rural Minor Collector
- 21 - Rural Local
- 23 - Urban Interstate
- 25 - Urban Other Freeways and Expressways
- 27 - Urban Other Principal Arterial
- 29 - Urban Minor Arterial
- 31 - Urban Collector
- 33 - Urban Local

Emission Processes

- RE - Running Exhaust
- CR - Crankcase Running Exhaust
- RX - Total Running Exhaust = Running Exhaust + Crankcase Running Exhaust
- SE - Start Exhaust
- CS - Crankcase Start Exhaust
- SX - Total Start Exhaust = Start Exhaust + Crankcase Start Exhaust
- IE - Extended Idle Exhaust
- CI - Crankcase Extended Idle Exhaust
- IX - Total Idle Exhaust = Extended Idle Exhaust + Crankcase Extended Idle Exhaust
- AX - Auxiliary Power Exhaust
- EP - Evaporative Permeation
- EL - Evaporative Fuel Leaks
- EV - Evaporative Fuel Vapor Venting”[68]

[68] TCEQ. “0ReadME_MOVES_Files”. Austin, Texas.

3.9.3 *Texas Low Emission Diesel Rule*

"Based on the EPA memorandum Texas Low Emission Diesel (LED) Fuel Benefits (September 27, 2001), a 4.8% NO_X TxLED reduction should be claimed for 2002-and newer diesel vehicles and a 6.2% NO_X TxLED reduction should be claimed for 2001-and older diesel vehicles. In order to determine the specific TxLED adjustment factors that should apply to each of the twelve diesel fuel source use types, MOVES2014a model runs were performed to determine NO_X emissions rates by model year. By using these data, the 4.8% and 6.2% TxLED reduction factors were weighted according to the model year specific diesel NO_X emission rates. The TxLED adjustment factors were incorporated by TTI into the on-road inventories by post processing the MOVES2014a diesel fuel source use type NOX emission rates."[69] TxLED adjustment factors are provided in Table 3-11 for each modeling year.

Table 3-11: TxLED NO_X Adjustment Factor for Diesel Fuel, 2012 and 2017

Source Use Type ID	Source Use Type Description	2012	2017
21	Passenger Car	0.9413	0.9483
31	Passenger Truck	0.9466	0.9492
32	Light Commercial Truck	0.9434	0.9465
41	Intercity Bus	0.9416	0.9431
42	Transit Bus	0.9420	0.9434
43	School Bus	0.9420	0.9433
51	Refuse Truck	0.9438	0.9462
52	Single Unit Short-Haul Truck	0.9496	0.9511
53	Single Unit Long-Haul Truck	0.9497	0.9510
54	Motor Home	0.9443	0.9462
61	Combination Short-Haul Truck	0.9456	0.9481
62	Combination Long-Haul Truck	0.9445	0.9474

3.9.4 *On-road emissions projections for 2020 and 2023*

San Antonio-New Braunfels MSA on-road emissions were projected to 2020 and 2023 using MOVES2014b (Equation 3-7). On-road emissions for NO, NO_2, HONO, VOC, or CO were projected by SCC code and county for each projection year.

Equation 3-7, Ozone season weekday on-road source emissions in the San Antonio-New Braunfels MSA, 2020 or 2023

$$E_{Local.FY.A.B} = E_{Local.17.A.B} \times (E_{MOVES.FY.A.B} / E_{MOVES.17.A.B})$$

Where,

$E_{Local.FY.A.B}$ = Ozone season day 2020 or 2023 emissions in county A for SCC code B (NO, NO_2, HONO, VOC, or CO)

[69] TCEQ, Dec. 16, 2016. "Appendix B: Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 2008 Eight Hour Ozone Standard". Project Number 2016-016-SIP-NR. p. B-51. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/HGB_2016_AD_RFP/AD_Adoption/HGB_AD_SIP_Appendix_B_Adoption.pdf. Accessed 05/30/2017.

$E_{Local.17.A.B}$ = Ozone season day 2017 emissions in county A for SCC code B (NO, NO_2, HONO, VOC, or CO)
$E_{MOVES.FY.A.B}$ = MOVES ozone season day 2020 or 2023 emissions in county A for SCC code B (NO, NO_2, HONO, VOC, or CO)
$E_{MOVES.17.A.B}$ = MOVES ozone season day 2017 emissions in county A for SCC code B (NO, NO_2, HONO, VOC, or CO)

Sample Equation: 2023 NO summer weekday emissions from gasoline motorcycles off network start exhaust emissions in Bexar County, SCC code MVGSMCOFSX

$E_{Local.FY.A.B}$ = 0.0012 tons of NO in 2017 x (1,944.0431 grams of NO in 2023 / 1,761.9024 grams of NO in 2017)
= 0.0014 tons of NO per day from gasoline motorcycles off network start exhaust in Bexar County, 2023

"On-road emission estimates for non-Texas states within the photochemical modeling domain were developed for both 2012 and 2017 using MOVES2014 model default runs. For 2012 and 2017, default on-road emissions were estimated for the July weekday option available with MOVES2014. These summer weekday emission totals were then adjusted with EPS3 to obtain inputs for the other season and day type combinations."[70] Once the emissions were projected to 2017 by TCEQ, AACOG projected other states on-road emissions to 2020 and 2023 using Equation 3-8.

Equation 3-8, Ozone season weekday on-road source emissions for other states, 2020 or 2023

$$E_{Local.FY.A.B} = E_{Local.17.A.B} \times (E_{MOVES.FY.B} / E_{MOVES.17.B})$$

Where,

$E_{Local.FY.A.B}$ = Ozone season day 2020 or 2023 emissions in County A and State B (NO, NO_2, HONO, VOC, or CO)
$E_{Local.17.A.B}$ = Ozone season day 2017 emissions in County A and State B (NO, NO_2, HONO, VOC, or CO)
$E_{MOVES.FY.B}$ = MOVES ozone season day 2020 or 2023 emissions in State B (NO_X, VOC, or CO)
$E_{MOVES.17.B}$ = MOVES ozone season day 2017 emissions in State B (NO_X, VOC, or CO)

Sample Equation: 2023 summer weekday NO emissions in Fairfield County, Connecticut

$E_{Local.FY.A.B}$ = 16.2873 tons of NO in 2017 x (44,243,011 grams of NO_X in 2023 / 80,906,574 grams of NO_X in 2017)
= 8.9066 tons of NO per day in Fairfield County, Connecticut, 2023

3.9.5 Heavy Duty Diesel Vehicles Idling Emissions

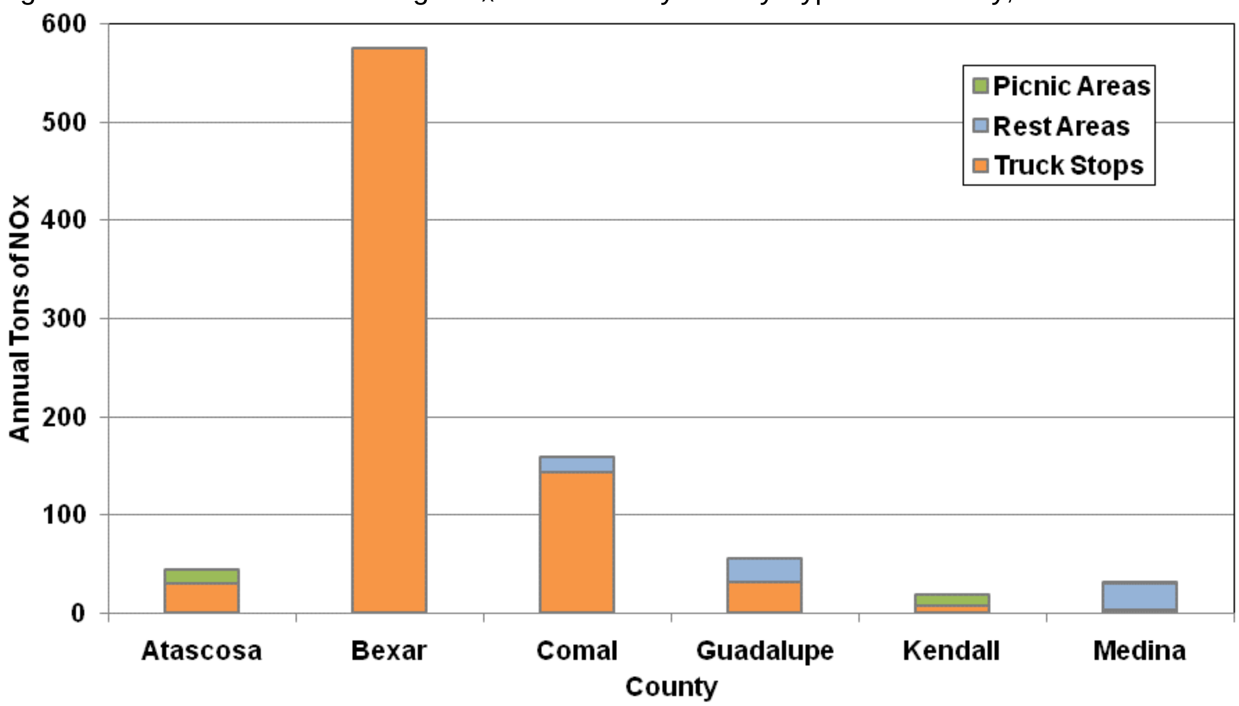
The trucking industry is a major contributor to North America's economy, transporting over 80% of the nation's goods, and truck traffic is growing rapidly. Department of Transportation requires

[70] TCEQ, Dec. 16, 2016. "Appendix B: Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 2008 Eight Hour Ozone Standard". Project Number 2016-016-SIP-NR. p. B-60. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/HGB_2016_AD_RFP/AD_Adoption/HGB_AD_SIP_Appendix_B_Adoption.pdf. Accessed 05/30/2017.

resting 10 hours after every 11 hours driving for property-carrying commercial motor vehicle (CMV) drivers. Since IH-35, IH-10, and other major highways converge in San Antonio, truck drivers frequently use truck stops, rest areas, picnic areas, and other facilities in the San Antonio area to comply with the mandatory rest breaks.

A survey was conducted between October 2010 and June 2011 that involved observing and documenting the incidence of extended (30 minutes or more) engine idling at truck stops and rest areas in the San Antonio-New Braunfels MSA. Survey results provided inputs that were used to estimate extended idling emissions for the combination (tractor/trailer) long-haul trucks, the only source use type within the current version of the EPA's Motor Vehicle Emission Simulator model (MOVES) for which extended idling emissions can be estimated. Combination long-haul trucks are classified in MOVES as trucks with a majority of their operation outside a 200-mile radius of home base. The primary input needed by MOVES to estimate idling emissions from long-haul trucks are the number of source hours operating (SHO) in extended idling mode by source type. Extended truck idling emission totals for each facility type and county is provided in Figure 3-6. Total annual NO_X emissions from extended truck idling in the San Antonio-New Braunfels MSA were estimated to be 883 tons per year while total VOC emissions were estimated to be 226 tons per year.

Figure 3-6: Extended Truck Idling NO_X Emissions by Facility Type and County, 2012*



*Bandera and Wilson County are not included because they do not have any significant truck parking facilities

3.10 Point Source Emissions

According to the Texas Administrative Code, "the owner or operator of an account or source in the State of Texas or on waters that extend 25 miles from the shoreline meeting one or more of the following conditions shall submit emissions inventories and/or related data as required in subsection (b) of this section to the commission on forms or other media approved by the commission:

(1) an account which meets the definition of a major facility/stationary source, as defined in §116.12 of this title (relating to Nonattainment Review Definitions), or any account in an ozone nonattainment area emitting a minimum of ten tons per year (tpy) volatile organic compounds (VOC), 25 tpy nitrogen oxides (NO_X), or 100 tpy or more of any other contaminant subject to national ambient air quality standards (NAAQS);
(2) any account that emits or has the potential to emit 100 tpy or more of any contaminant;
(3) any account which emits or has the potential to emit 10 tons of any single or 25 tons of aggregate hazardous air pollutants (HAPS); and
(4) any minor industrial source, area source, non-road mobile source, or mobile source of emissions subject to special inventories under subsection (b)(3) of this section. For purposes of this section, the term "area source" means a group of similar activities that, taken collectively, produce a significant amount of air pollution."[71]

Any sources that meet the Texas Administrative Code definition were processed in the photochemical model as point sources.

In the photochemical modeling files, point sources are categorized according to electric generating units (EGU) and non-electric generating units (NEGU). "Point source emissions and industrial process operating data are collected annually from sites that meet the reporting requirements of 30 Texas Administrative Code (TAC) §101.10. Subject entities, approximately 2000, are required to report emissions annually from all sources and emissions exhaust points with representative calculations of emission estimates. Descriptive information is also required on process equipment, including operating schedules, emission control devices, abatement device control efficiencies, and emission point discharge parameters such as location, height, diameter, temperature, and exhaust gas flow rate. All data submitted in the annual Emissions Inventory questionnaires (EIQs) are subjected to TCEQ quality assurance (QA) procedures. The TCEQ reports point source emissions data to the EPA for inclusion in the National Emissions Inventory (NEI)."[72]

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[71] "Texas Administrative Code: Title 30, Part 1, Chapter 101, Subchapter A, Rule §101.10". Available online: https://texreg.sos.state.tx.us/public/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=30&pt=1&ch=101&rl=10. Accessed 06/02/2017.

[72] TCEQ, Dec. 16, 2016. "Appendix B: Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 2008 Eight Hour Ozone Standard". Project Number 2016-016-SIP-NR. p. B-4. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/HGB_2016_AD_RFP/AD_Adoption/HGB_AD_SIP_Appendix_B_Adoption.pdf. Accessed 05/30/2017.

The 2012 NEGU EI for states outside of Texas was derived from the EPA's 2011 Modeling Platform. The 2011 Modeling Platform was used because it is the closest in year inventory to the base case, and it was not forecast to 2012. [73] Hourly emissions for EGUs were obtained for 2012 from the EPA's Air Markets Program Data (AMPD).[74]

The TCEQ uses the most complete and accurate data available at the time for the 2017 projection case emissions inventory development. "The 2017 future case emission inventory (EI) was developed using the most recent data sets available, 2014 and 2015, respectively. The future case EI provides the basis to determine if attainment has been reached and is the starting point for control strategy testing and/or future year sensitivity analyses. In general, projection base year emissions are grown to the attainment year and existing on-the-books controls (those that will be in place after the baseline year and prior to the future year) are applied."[75]

Point source regulations in the model include "the Mass Emissions Cap-and-Trade (MECT) program limits annual NOX emissions for applicable stationary point source equipment in Houston. In Harris County, HRVOC Emissions Cap-and-Trade (HECT) limits annual HRVOC emissions for certain point sources. Besides MECT and HECT, there are other regulations and agreements that affect certain NO_X sources in the state, some of which have compliance dates between the projection base years (2015 for Texas EGUs and 2014 for all other Texas point sources) and the attainment year of 2017. For most regulations, the compliance date has already passed and emissions are accurately modeled using the reported projection base year(s) emissions. Additionally, specific for the cement kilns in Dallas are capped (by site) by a NO_X emissions limit." [76] Emissions estimates for 2020 and 2023 remained the same as 2017 except for changes to local point source emissions

3.10.1 CPS Energy

Ozone season average daily NO_X emissions from CPS Energy in 2017, 2020, and 2023 were determined to be 23.17 tons, 14.25 tons, and 11.94 tons (Table 3-12).[77] Emission projections

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[73] TCEQ, Dec. 16, 2016. "Appendix B: Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 2008 Eight Hour Ozone Standard". Project Number 2016-016-SIP-NR. p. B-13. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/HGB_2016_AD_RFP/AD_Adoption/HGB_AD_SIP_Appendix_B_Adoption.pdf. Accessed 05/30/2017.

[74] EPA. April 9, 2017. "Air Markets Program Data". Available online: https://ampd.epa.gov/ampd/. Accessed 06/05/2017.

[75] TCEQ, Dec. 16, 2016. "Appendix B: Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 2008 Eight Hour Ozone Standard". Project Number 2016-016-SIP-NR. p. B-27. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/HGB_2016_AD_RFP/AD_Adoption/HGB_AD_SIP_Appendix_B_Adoption.pdf. Accessed 05/30/2017.

[76] TCEQ, Dec. 16, 2016. "Appendix B: Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 2008 Eight Hour Ozone Standard". Project Number 2016-016-SIP-NR. p. B-28. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/HGB_2016_AD_RFP/AD_Adoption/HGB_AD_SIP_Appendix_B_Adoption.pdf. Accessed 05/30/2017.

[77] CPS Energy, San Antonio, Texas. Email to Steven Smeltzer. 02/27/2017

may vary because of market demand. Since the current emission rates for CPS Energy are the most recent data available, however, they are considered the best estimates of future generation. It is not reasonable to base emissions estimates on an equal distribution of CPS Energy's annual permitted emissions because actual daily emissions fluctuate with some days that have higher generation and some days that have lower generation. CPS Energy complies with short-term and long-term emissions limitations; however multiplying daily figures by 365 days does not compare well with annual emissions rates.

Table 3-12: Ozone Season Emissions (ton/day) from CPS Energy Power Plant Units. 2017, 2020, and 2023

Year	NOx	VOC	CO
2017	23.17	0.22	12.94
2020	14.25	0.24	5.14
2023	11.94	0.27	5.15

3.10.2 Cement Kilns

There are 9 cement kilns operating in the San Antonio-New Braunfels MSA and Hays County. "Cement kilns are used for the pyroprocessing stage of manufacture of Portland and other types of hydraulic cement, in which calcium carbonate reacts with silica-bearing minerals to form a mixture of calcium silicates."[78] The main fuel for the cement kilns in the region is coal, but other sources of fuel such as natural gas, wood, and used tires are used.

Two new cement kilns are expected to be operating in the projection years: Alamo Cement and Capitol Cement. Alamo Cement Company filed a permit application with TCEQ during the latter half of 2015 to construct and operate a new kiln at their existing site. Kiln Line No. 2 is being designed for continuous operation to produce 1.2775 million tons of clinker and up to 1.4 million tons of cement annually. As part of the permit application, Alamo Cement Company is voluntarily requesting that the maximum allowable emission rate table (MAERT) of annual NO_X emission limits for Kiln No. 1 Air Permit be reduced from 2,772 tons/year (tpy) to 1,437.8 tpy (Table 3-13). Alamo Cement Company plans to operate Kiln No. 1 and 2, the new kiln, as separate cement production units. To achieve the emission reduction at the existing Kiln 1, Alamo Cement will voluntarily place the existing ammonia injection system into full-time service.

The cement plant manufactures Portland cement. "Portland cement manufacturing is an energy-intensive process that grinds and heats a mixture of raw materials such as limestone, clay, sand and iron ore in a rotary kiln. That product, called clinker, is cooled, grounded and then mixed with

[78] Wikipedia, May 31, 2015. "Cement kiln". Available online: http://en.wikipedia.org/wiki/Cement_kiln. Accessed 06/07/2017.

a small amount of gypsum to produce concrete."[79] Kilns commencing construction after June 16, 2008, are required to meet a limit of 1.50 pounds of NO_X per ton of clinker on a 30-operating day rolling average. A search of the EPA's RACT/BACT/LAER Clearinghouse (RBLC) for NO_X emissions from cement kilns returned 13 cement kilns permitted in the past 10 years. The NO_X Best Available Control Technology (BACT) determinations for these kilns ranged from 1.5 to 2.65 pounds per ton of clinker produced for a 30day rolling average.

Table 3-13: Baseline and Proposed NO_X emissions from Alamo Cement (tons per year)

ACCOUNT	COMPANY	SITE	Kiln	Actual 2013 Emissions[80]	Baseline Emissions (MAERT)	Proposed Emissions (MAERT)
BG0259G (6758/PSD-TX-145M1)	Alamo Cement Company	1604 Plant	1	2,246.6	2,360.81	1,437.80
			2	-	-	962.73
Total Emissions				2,246.6	2,360.81	2,400.53

Capitol Aggregates Inc. filed a permit application with TCEQ during the latter half of 2015 to construct and operate a new kiln at their existing site with a proposed production rate of 803,000 tons of clinker per year. Capitol Cement plans to combine the old and new kilns in the permit application. Table 3-14 shows the 2013 NO_X emissions from the existing kilns.

Table 3-14: Baseline and Proposed NO_X emissions from Capitol Cement (tons per year)

ACCOUNT	COMPANY	SITE	Kiln	Actual 2013 Emissions[81]	Baseline Emissions (MAERT)	Proposed Emissions (MAERT)
BG0045E (7369/ PSDTX120M3)	Capitol Aggregates Inc	Wetmore	1	576.6	976.51	1,075.91
			2 (KL-870)	-	-	
Total Emissions				576.6	976.51	1,075.91

In 2017, all cement kilns in the San Antonio-New Braunfels MSA emitted 23.08 tons of NO_X per day, while in 2020 and 2023 the NO_X emissions are 22.34 tons per day.

3.10.3 Other New Point Sources

Growth in NEGU point sources are based on new permitted point sources or major proposed facilities from 2017 to 2023. The databases used to collect data on the new point sources were obtained from:

- Public Utility Commission of Texas[82]

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[79] EPA, 2010. "Standards for Portland Cement Manufacturing". Available online: https://www3.epa.gov/airquality/cement/actions.html. Accessed 06/07/2017.
[80] TCEQ, March 21, 2017. "Detailed Data from the Point Source Emissions Inventory". Austin, Texas. Available online: https://www.tceq.texas.gov/airquality/point-source-ei/psei.html. Accessed 06/07/2017.
[81] TCEQ, Jan. 6, 2016. "Detailed Data from the Point Source Emissions Inventory". Austin, Texas. Available online: https://www.tceq.texas.gov/airquality/point-source-ei/psei.html. Accessed 01/14/2016.
[82] Public Utility Commission of Texas, January 23, 2013. "New Electric Generating Plants in Texas Since 1995 (excluding renewable)". Austin, Texas. Available online: http://www.puc.texas.gov/industry/maps/elecmaps/gentable.pdf. Accessed 06/07/2017.

- Electric Reliability Council of Texas (ERCOT)[83], and
- TCEQ document server for newly-permitted point sources[84]

Daily emissions from new proposed point sources in the San Antonio-New Braunfels MSA between 2017 and 2023 are 0.25 tons of NO_X, 0.03 tons of VOC, and 0.16 tons of CO.

3.11 Summary of the 2012, 2017, 2020, and 2023 Projection Year Emission Inventory Development

Projected NO_X and VOC emissions (tons/day) for the San Antonio-New Braunfels MSA region are provided in Figure 3-7 and Figure 3-8. As expected, anthropogenic emissions are lower on Saturday and Sunday compared to weekdays. Estimated NO_X emissions are significantly lower in 2023: emissions decreased from 196 tons per weekday in 2012 to 119 tons per weekday in 2023. VOC emissions are reduced from 226 tons per weekday in 2012 to 172 tons per weekday in 2023.

The largest source of NO_X emissions in 2012 are on-road vehicles (92 tons per weekday), followed by point (59 tons per weekday) and non-road (19 tons per weekday) (Table 3-15). By 2023, the largest sources of NO_X emissions are point sources (47 tons per weekday), followed by on-road (23.0 tons per weekday), and oil and gas (23 tons per weekday).

As expected, the largest contributors of VOC emissions are area sources: 95 tons per weekday in 2012 and 91 tons per weekday in 2023 (Table 3-16). Other significant sources of VOC emissions in the San Antonio-New Braunfels MSA are oil and gas (42 tons) and non-road (15 tons per weekday) in 2023. Off-road emissions are not a large contributor to emissions (5 tons of NO_X and 1 ton of VOC per day in 2023) in the San Antonio-New Braunfels MSA.

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[83] Electric Reliability Council of Texas. Available online: http://www.ercot.com/. Accessed 06/07/2017.
[84] TCEQ. “Document Server”. Available online: https://webmail.tceq.state.tx.us/gw/webpub. Accessed 06/07/2017.

Figure 3-7: NO_X Emissions (tons/day) by Day of the Week for the San Antonio-New Braunfels MSA, 2012, 2017, 2020, and 2023

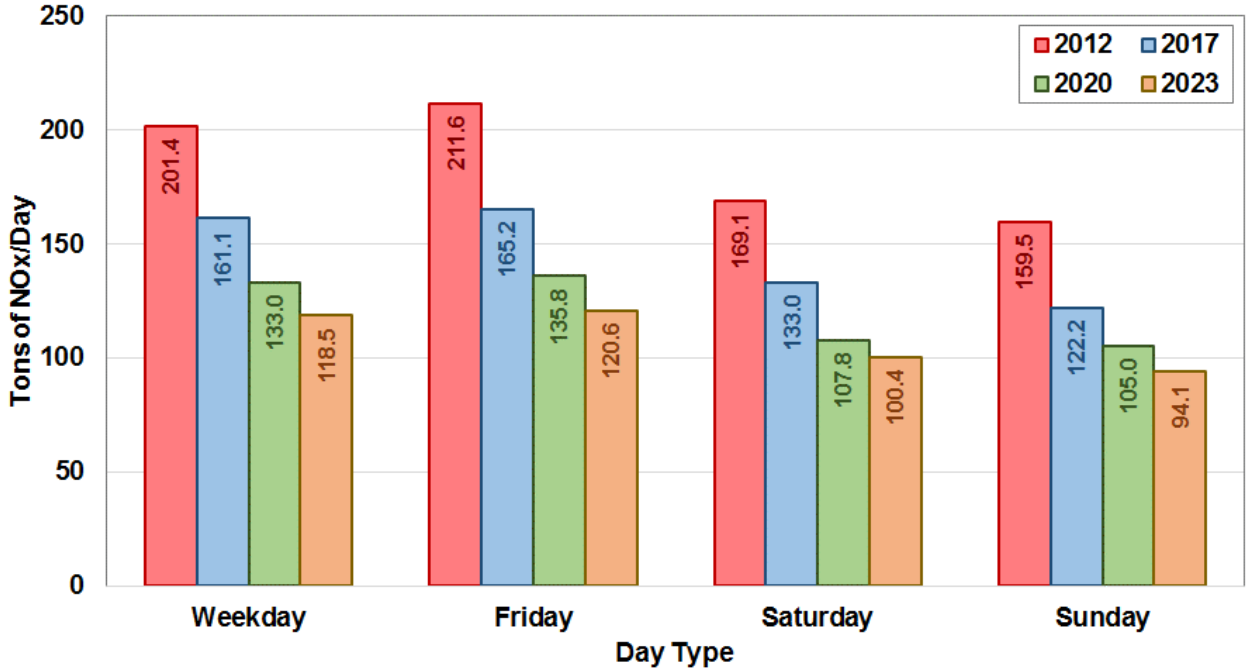

Figure 3-8: VOC Emissions (tons/day) by Day of the Week for the San Antonio-New Braunfels MSA, 2012, 2017, 2020, and 2023

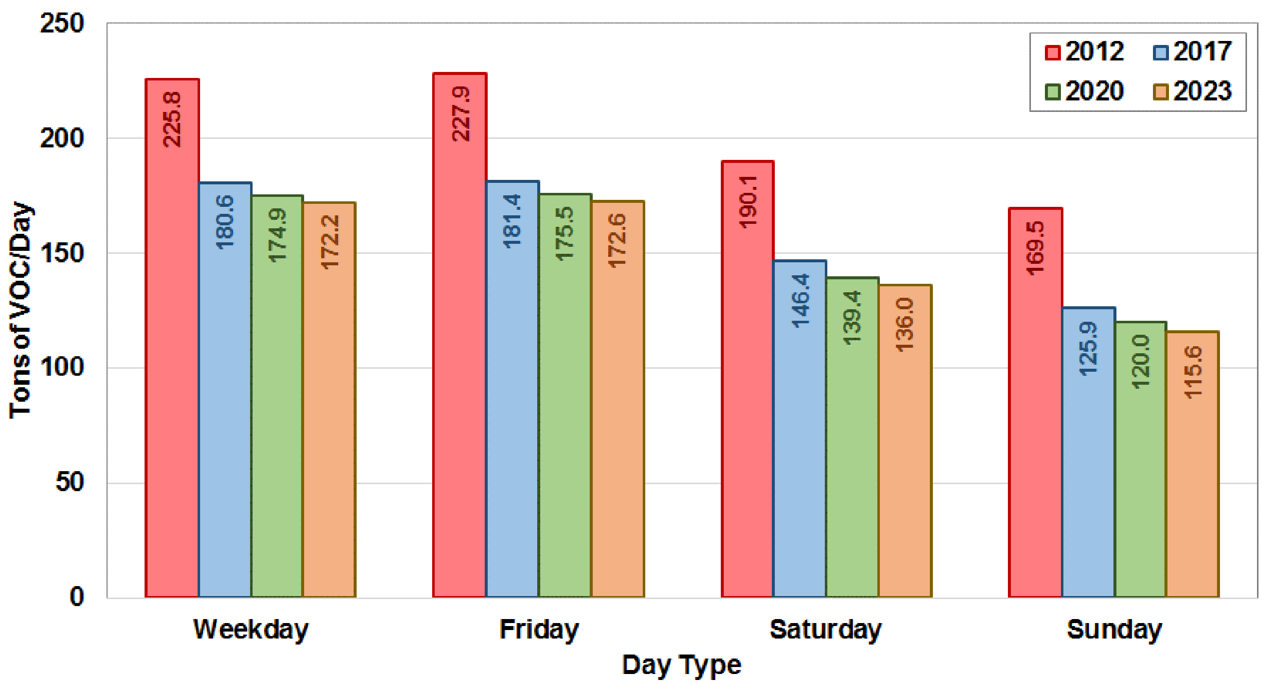

Figure 3-9: NO_X Emissions (tons/day) by Source Type for the San Antonio-New Braunfels MSA, 2012, 2017, 2020, and 2023

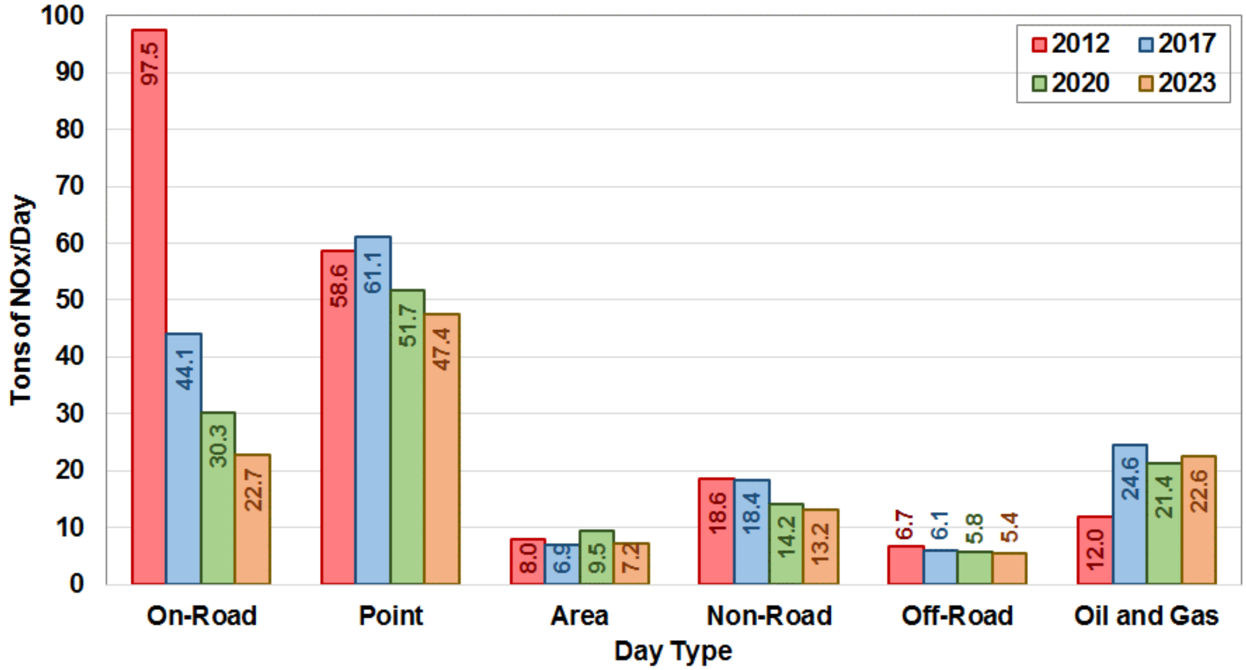

Figure 3-10: VOC Emissions (tons/day) by Source Type for the San Antonio-New Braunfels MSA, 2012, 2017, 2020, and 2023

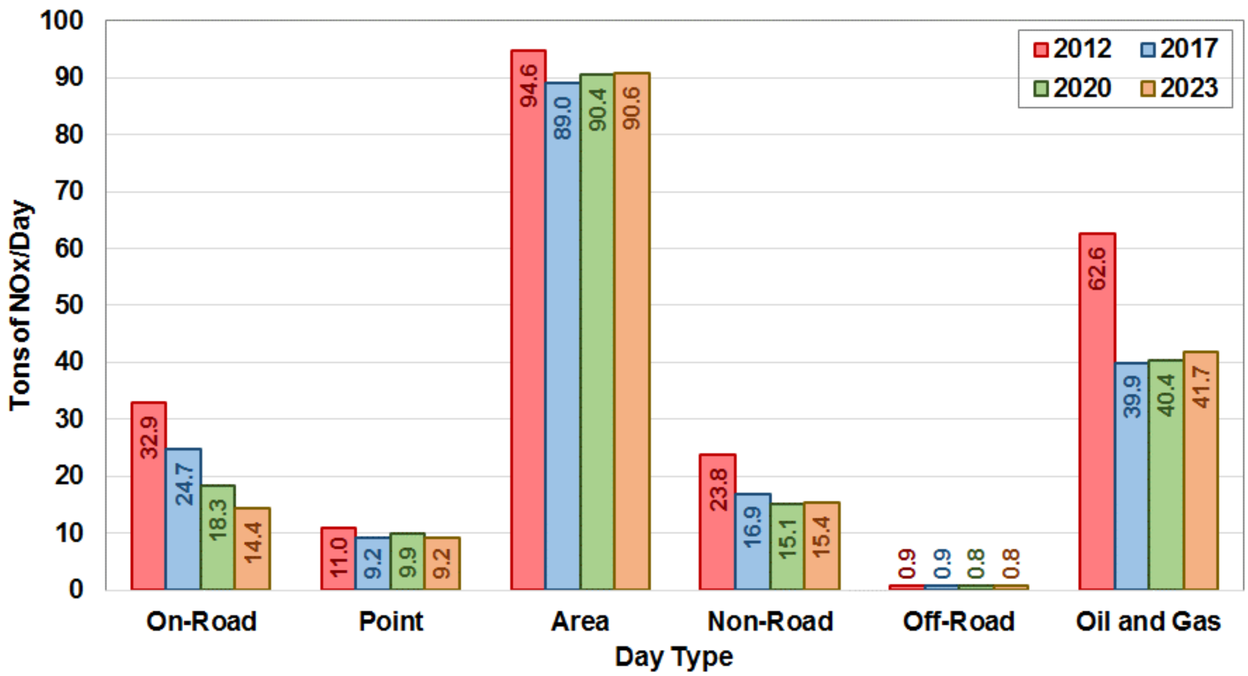

Table 3-15: NO_X Emissions (tons/day) for the San Antonio-New Braunfels MSA, 2012, 2017, 2020, and 2023

Year	Day of Week	On-Road	Point	Area	Non-Road	Off-Road	Oil and Gas	Total NOx
2012	Weekday	97.49	58.61	7.95	18.64	6.73	12.02	201.44
	Friday	107.63	58.61	7.95	18.64	6.73	12.02	211.58
	Saturday	83.99	58.61	6.19	6.67	1.63	12.02	169.11
	Sunday	76.55	58.61	4.43	6.23	1.63	12.02	159.47
2017	Weekday	44.06	61.1	6.91	18.4	6.05	24.60	161.12
	Friday	48.14	61.1	6.91	18.4	6.05	24.60	165.20
	Saturday	35.70	61.1	5.06	9.9	1.81	19.40	132.97
	Sunday	30.38	61.1	3.21	6.25	1.81	19.40	122.15
2020	Weekday	30.32	51.73	9.51	14.23	5.84	21.36	132.99
	Friday	33.14	51.73	9.51	14.23	5.84	21.36	135.81
	Saturday	24.49	51.73	3.14	6.84	1.97	19.64	107.81
	Sunday	20.81	51.73	5.8	5.03	1.97	19.64	104.98
2023	Weekday	22.69	47.44	7.21	13.19	5.42	22.57	118.52
	Friday	24.78	47.44	7.21	13.19	5.42	22.57	120.61
	Saturday	18.19	47.44	5.26	6.84	1.97	20.67	100.37
	Sunday	15.44	47.44	3.32	5.23	1.97	20.67	94.07

Table 3-16: VOC Emissions (tons/day) for the San Antonio-New Braunfels MSA, 2012, 2017, 2020, and 2023

Year	Day of Week	On-Road	Point	Area	Non-Road	Off-Road	Oil and Gas	Total VOC
2012	Weekday	32.86	11.05	94.64	23.77	0.92	62.58	225.82
	Friday	34.98	11.05	94.64	23.77	0.92	62.58	227.94
	Saturday	29.87	11.05	49.69	36.28	0.61	62.58	190.08
	Sunday	28.92	11.05	32.14	34.18	0.61	62.58	169.48
2017	Weekday	24.68	9.23	88.97	16.91	0.88	39.92	180.59
	Friday	25.53	9.23	88.97	16.91	0.88	39.92	181.44
	Saturday	22.27	9.23	48.99	25.62	0.66	39.66	146.43
	Sunday	21.38	9.23	31.19	23.77	0.66	39.66	125.89
2020	Weekday	18.29	9.87	90.40	15.12	0.84	40.37	174.89
	Friday	18.86	9.87	90.40	15.12	0.84	40.37	175.46
	Saturday	16.64	9.87	50.14	21.86	0.66	40.26	139.43
	Sunday	16.06	9.87	32.94	20.24	0.66	40.26	120.03
2023	Weekday	14.40	9.24	90.64	15.37	0.82	41.71	172.18
	Friday	14.82	9.24	90.64	15.37	0.82	41.71	172.60
	Saturday	13.19	9.24	50.14	21.12	0.66	41.63	135.98
	Sunday	12.75	9.24	31.84	19.46	0.66	41.63	115.58

3.12 Emission Inventory Tile Plots

The graphic software, Package for Analysis and Visualization of Environmental data (PAVE),[85] was used to display EPS3 formatted 4-km fine grid emissions by source type. Tile plots are used to visually verify the distribution of emissions in the photochemical model compared to actual locations. Also, hourly tile plots were checked to make sure there were no unusual patterns of emissions. Through the use of emission tile plots, the photochemical modeling emission inputs were evaluated spatially for accuracy.

On-Road NO_X emissions tile plots are provided in Figure 3-11 for 2017, 2020, and 2023, while VOC plots are provided in Figure 3-12. The largest concentrations of on-road emissions are in Dallas, Houston, Austin, and San Antonio. On-road emissions are also concentrated in other urban areas and along major highways including I-10 and I-35. There is a significant decrease in NO_X and VOC emissions from on-road sources in the 2023 projection emission inventory. The main reason for these decreases are emissions standards for both gasoline and diesel engines that are significantly stricter for cars built after 2009.[86]

Area source NO_X and VOC emissions are concentrated in the urban areas of Texas (Figure 3-13 and Figure 3-14). These plots show concentrations of high NO_X and VOC emissions in the population centers of Eastern Texas. The highest emissions are in Houston, Dallas, San Antonio, and Austin, while the less populated counties in west and south Texas tend to have the lowest emissions. When comparing projection years, area source emissions are similar from 2017 to 2023. Non-road NO_X emissions are presented in Figure 3-15 and non-road VOC emissions are provided in Figure 3-16. The largest concentrations of non-road emissions are in Dallas, Houston, and San Antonio. There is a slight decrease in NO_X and VOC emissions from non-road sources in the 2023 projection emission inventory.

As shown in Figure 3-17 and Figure 3-18, oil and gas emissions are concentrated in the traditional and shale plays of Texas. Emissions are similar for each projection year because of the uncertainty of future oil and gas production. Off-road emissions are concentrated along the railways and water shipping lanes of Texas (Figure 3-19 and Figure 3-20). Figure 3-21 and Figure 3-22 shows NO_X and VOC tile plots for point sources at low elevation for each modeling year. As shown on the three plots, point source emissions are highest in Houston, Beaumont, Dallas, and Corpus Christi. These urban areas have the highest concentrations of large industrial point sources. There are also numerous low level off-shore point sources in the 4km grid.

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[85] The University of North Carolina at Chapel Hill, UNC Institute for the Environment. "PAVE User's Guide - Version 2.3". Available online https://www.cmascenter.org/pave/documentation/2.3/EntirePaveManual.html. Accessed 05/26/2017.
[86] TCEQ. "Texas Natural Gas Vehicle Grant Program (TNGVGP)". Austin, Texas. Available online: https://www.tceq.texas.gov/assets/public/implementation/air/terp/tngvgp/NOX_emission_sheet.pdf. Accessed 06/26/2017.

Figure 3-11: On-Road NO_X Emissions 4-km Grid Tile Plots, June Weekday, 12:00PM – 1:00PM

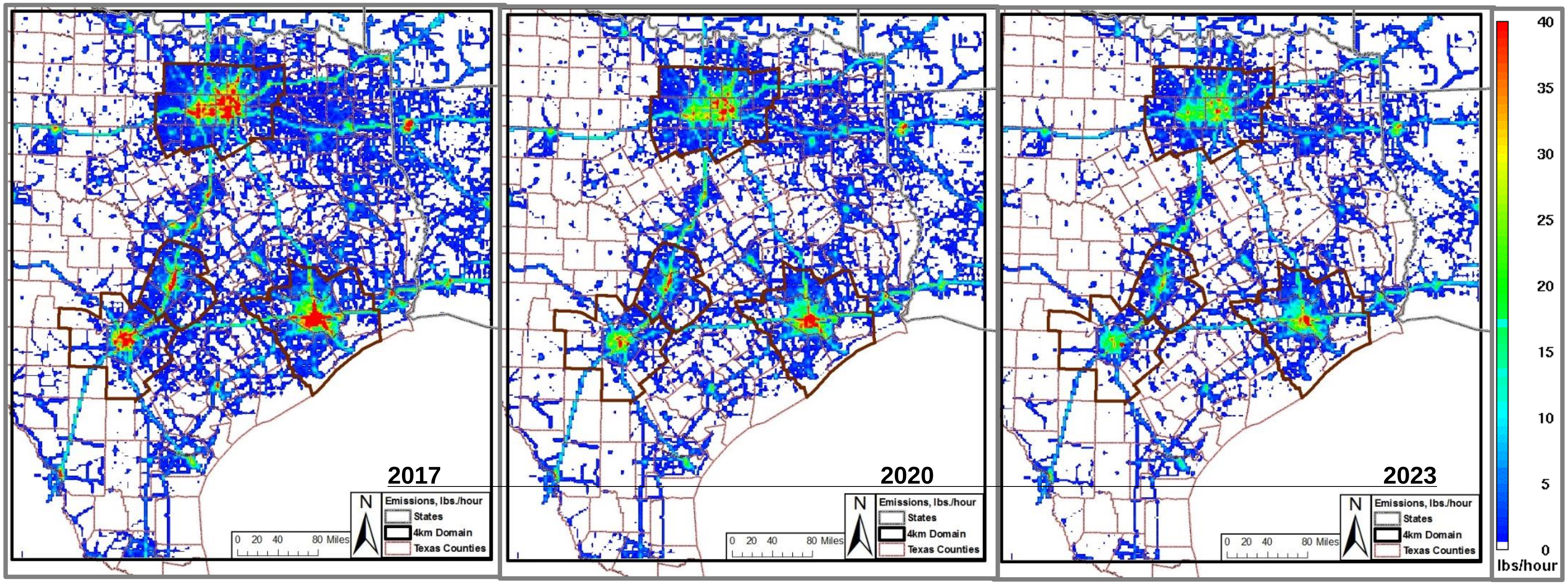


Figure 3-12: On-Road VOC Emissions 4-km Grid Tile Plots, June Weekday, 12:00PM – 1:00PM

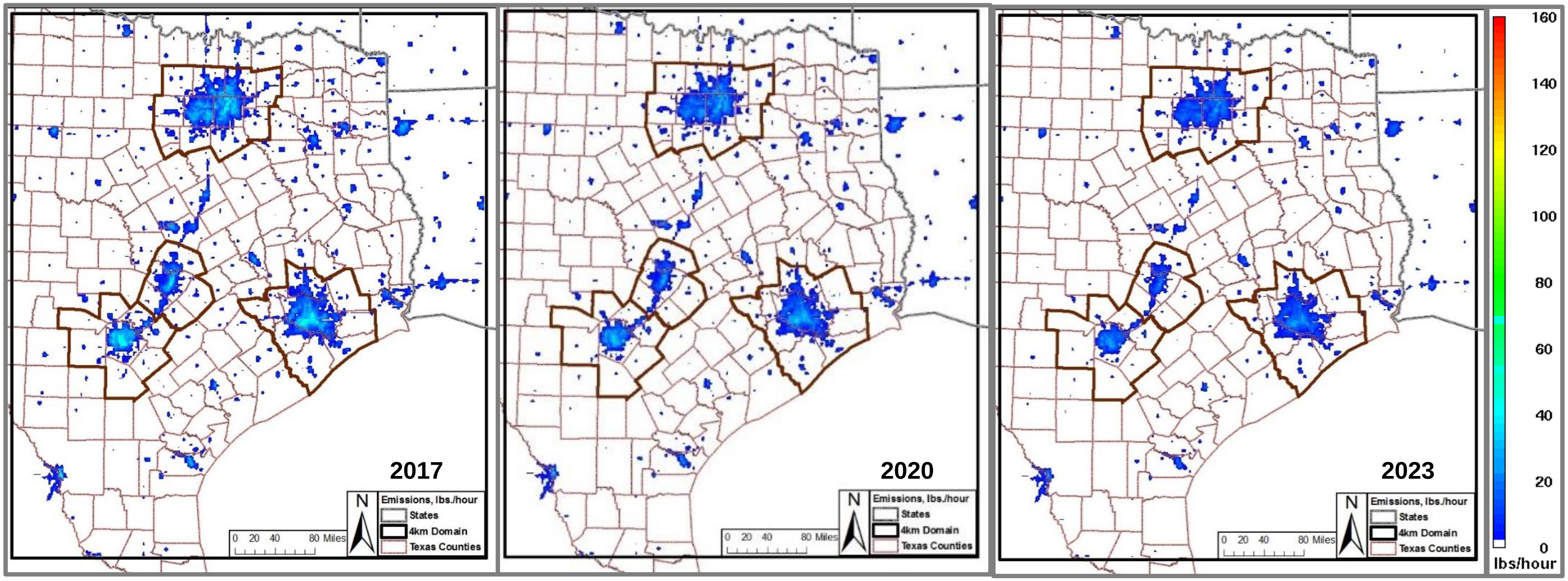


Figure 3-13: Area NO_X Emissions 4-km Grid Tile Plots, June Weekday, 12:00PM – 1:00PM

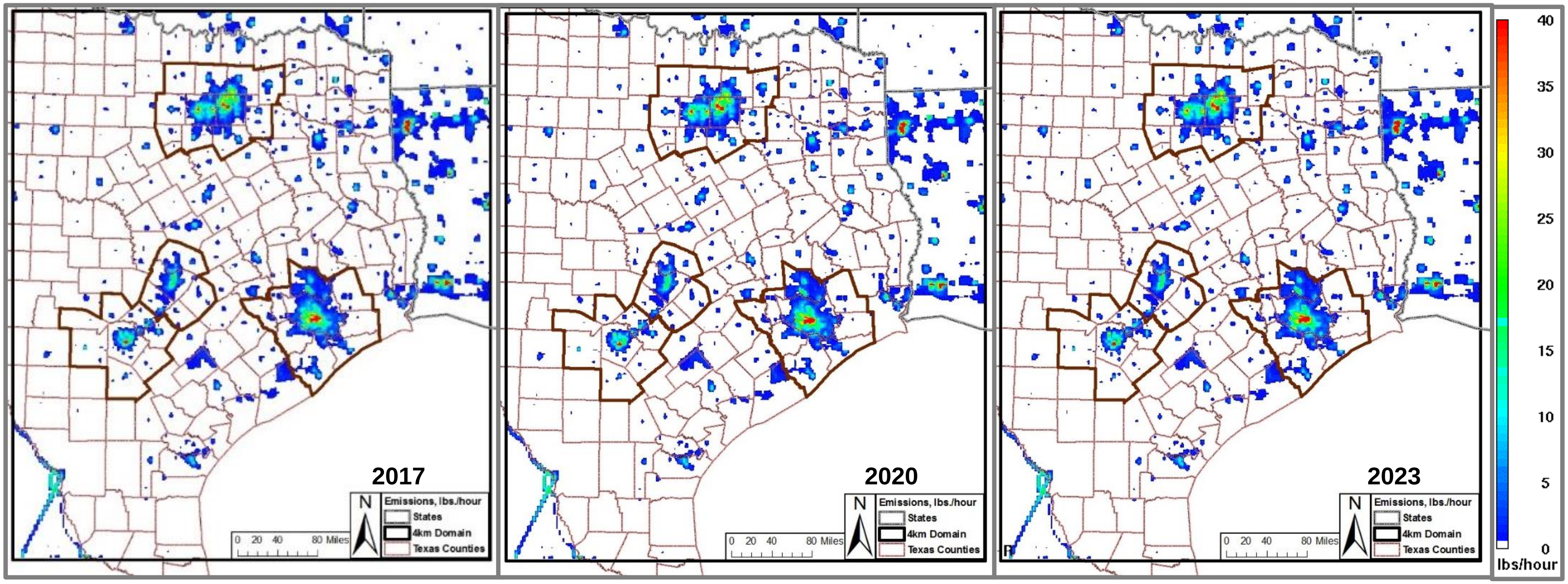


Figure 3-14: Area VOC Emissions 4-km Grid Tile Plots, June Weekday, 12:00PM – 1:00PM

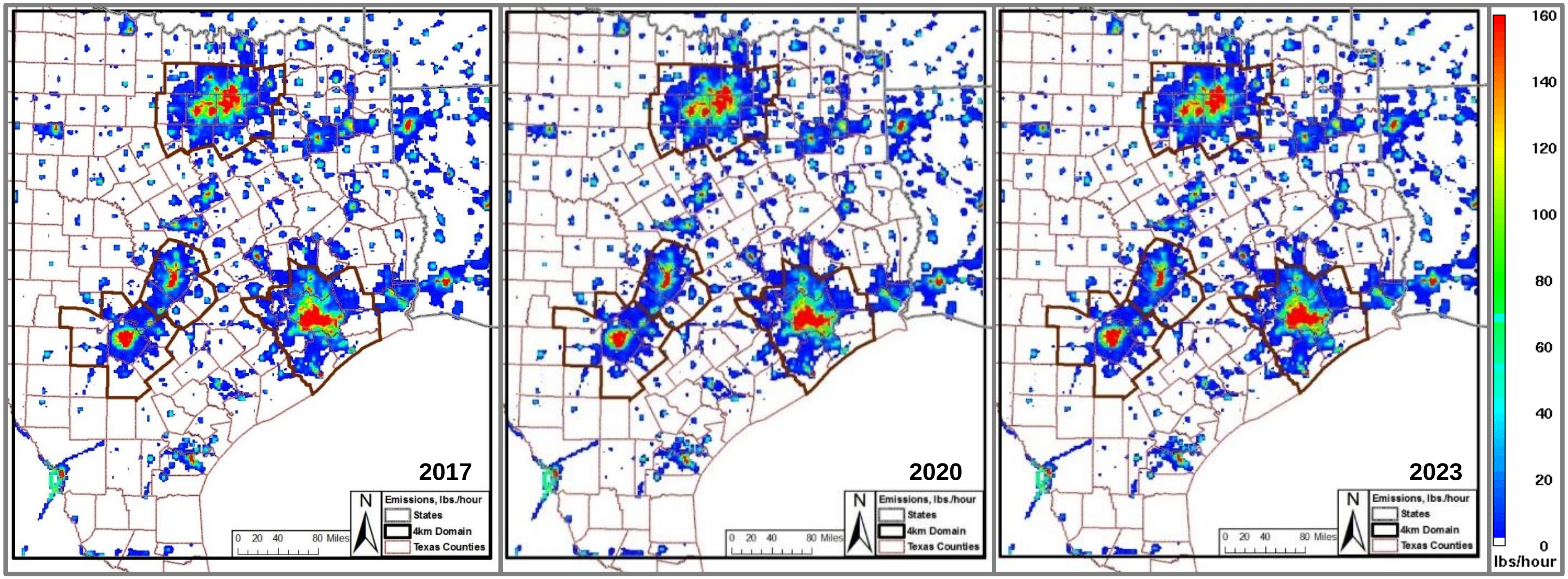


Figure 3-15: Non Road NO_X Emissions 4-km Grid Tile Plots, June Weekday, 12:00PM – 1:00PM

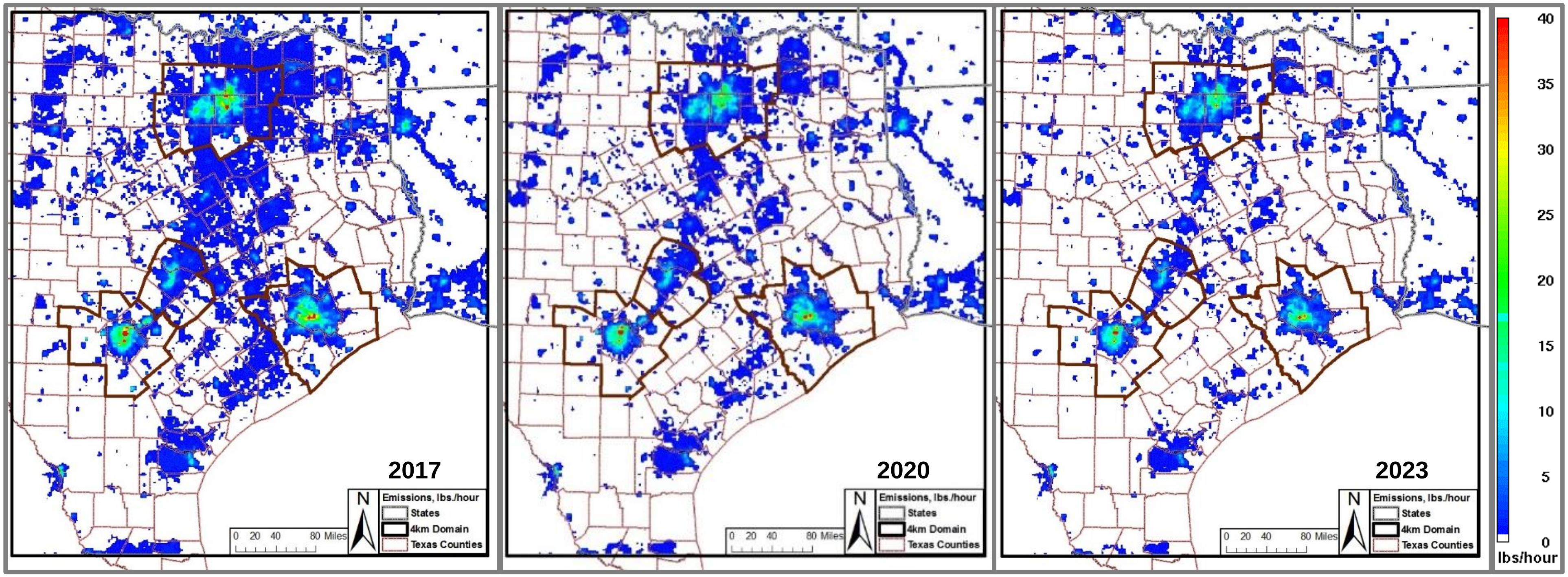


Figure 3-16: Non Road VOC Emissions 4-km Grid Tile Plots, June Weekday, 12:00PM – 1:00PM

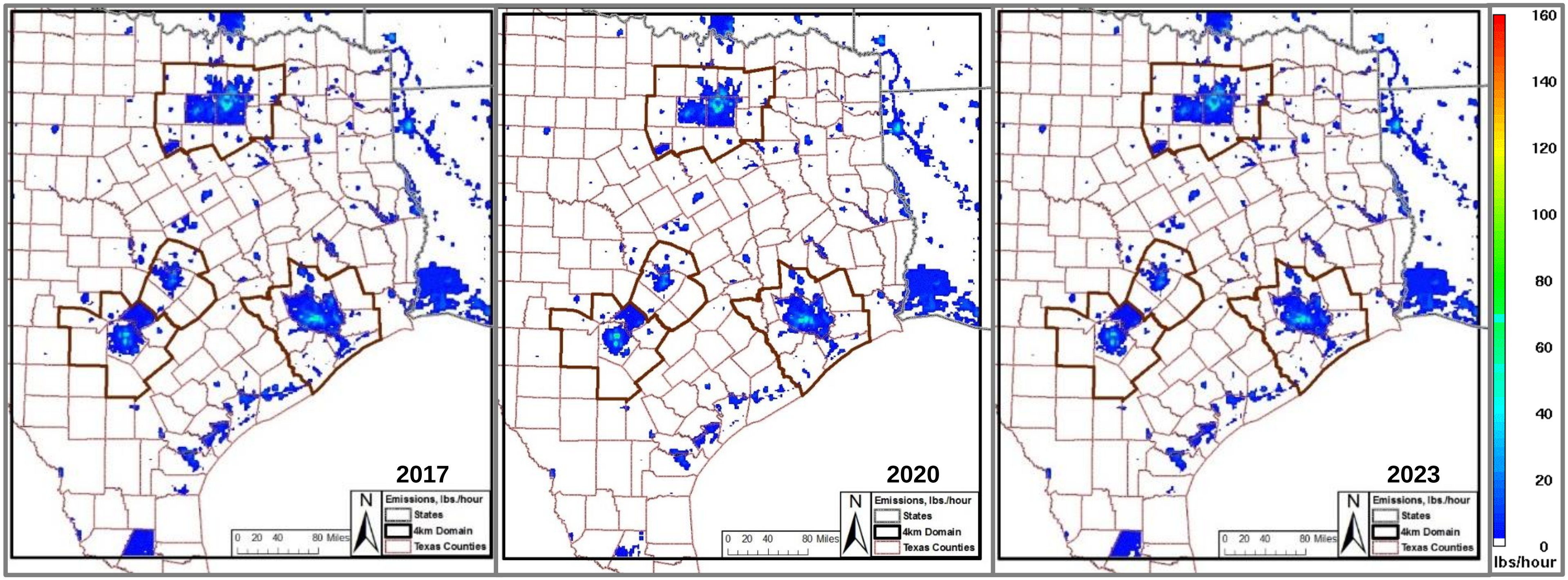


Figure 3-17: Oil and Gas NO_X Emissions 4-km Grid Tile Plots, June Weekday**,** 12:00PM – 1:00PM

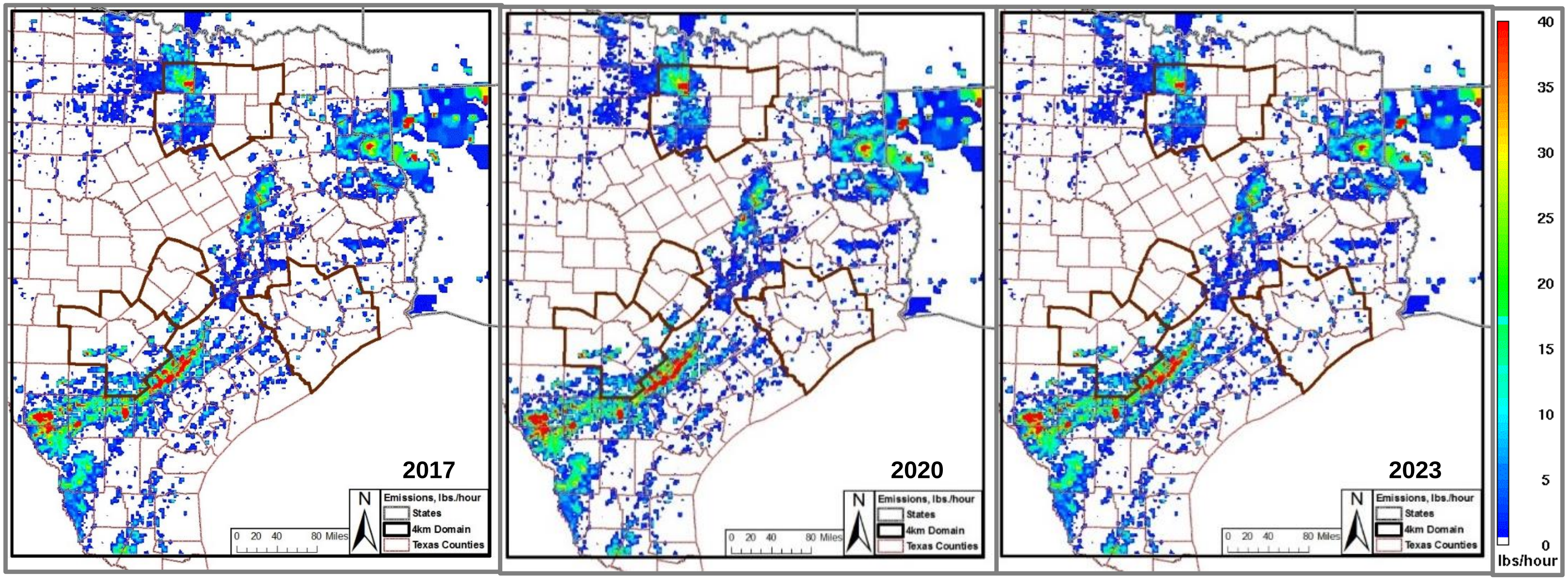


Figure 3-18: Oil and Gas VOC Emissions 4-km Grid Tile Plots, June Weekday, 12:00PM – 1:00PM

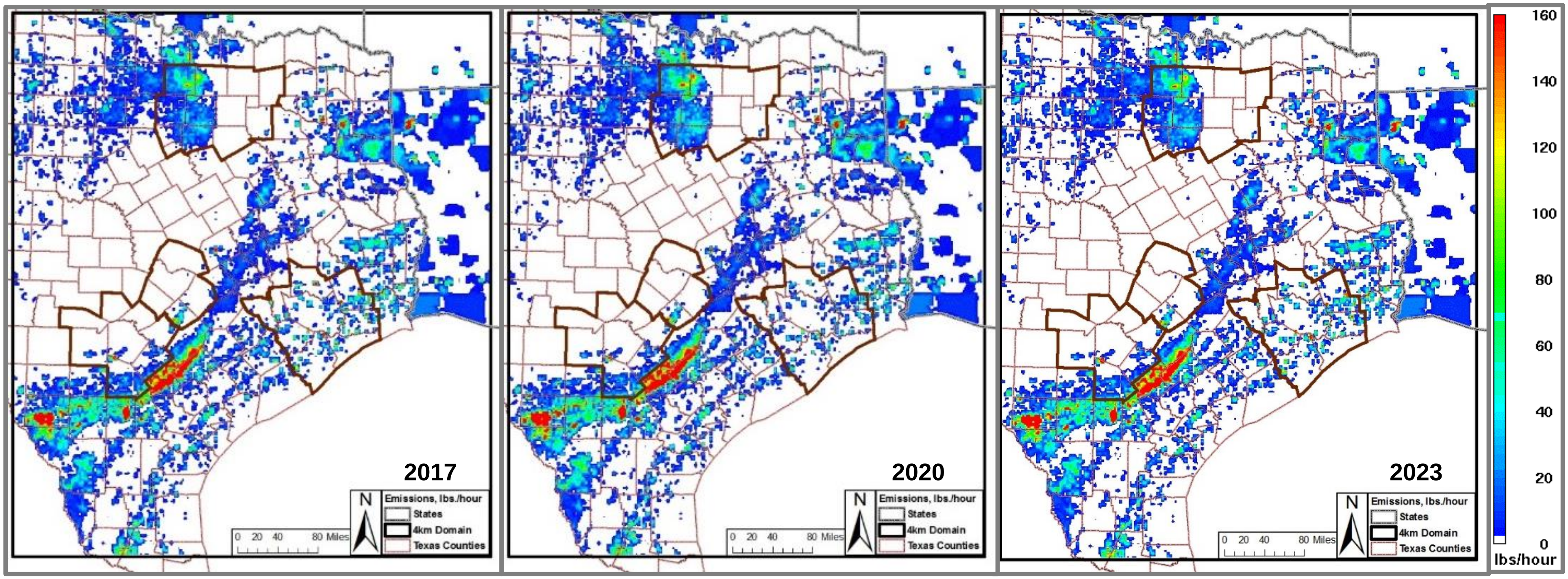


Figure 3-19: Off Road NO_X Emissions 4-km Grid Tile Plots, June Weekday, 12:00PM – 1:00PM

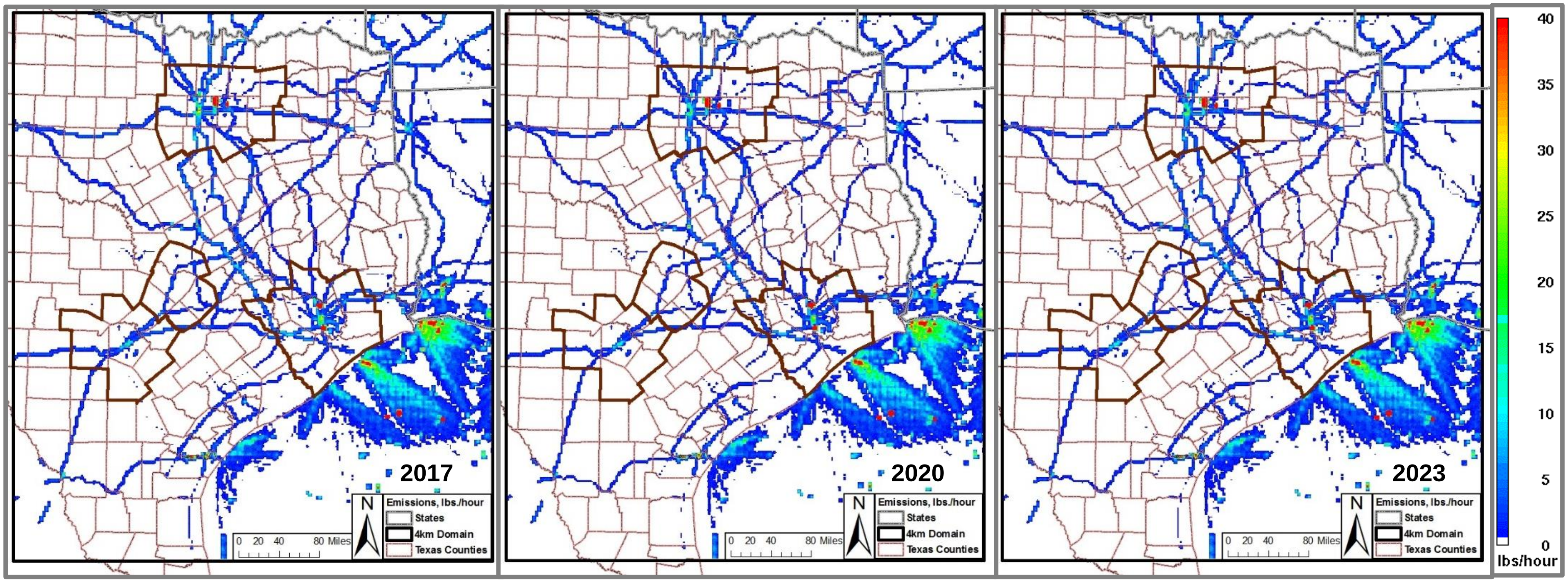


Figure 3-20: Off Road VOC Emissions 4-km Grid Tile Plots, June Weekday, 12:00PM – 1:00PM

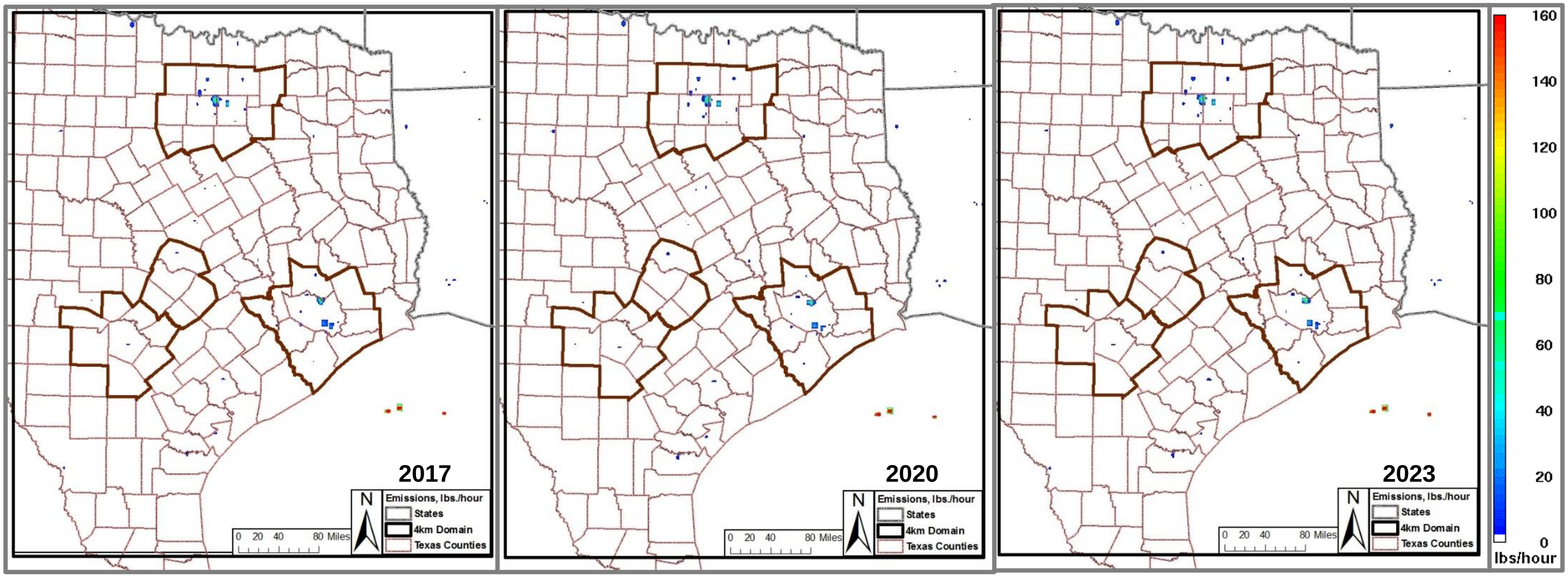


Figure 3-21: Low Point NO_X Emissions 4-km Grid Tile Plots, June Weekday, 12:00PM – 1:00PM

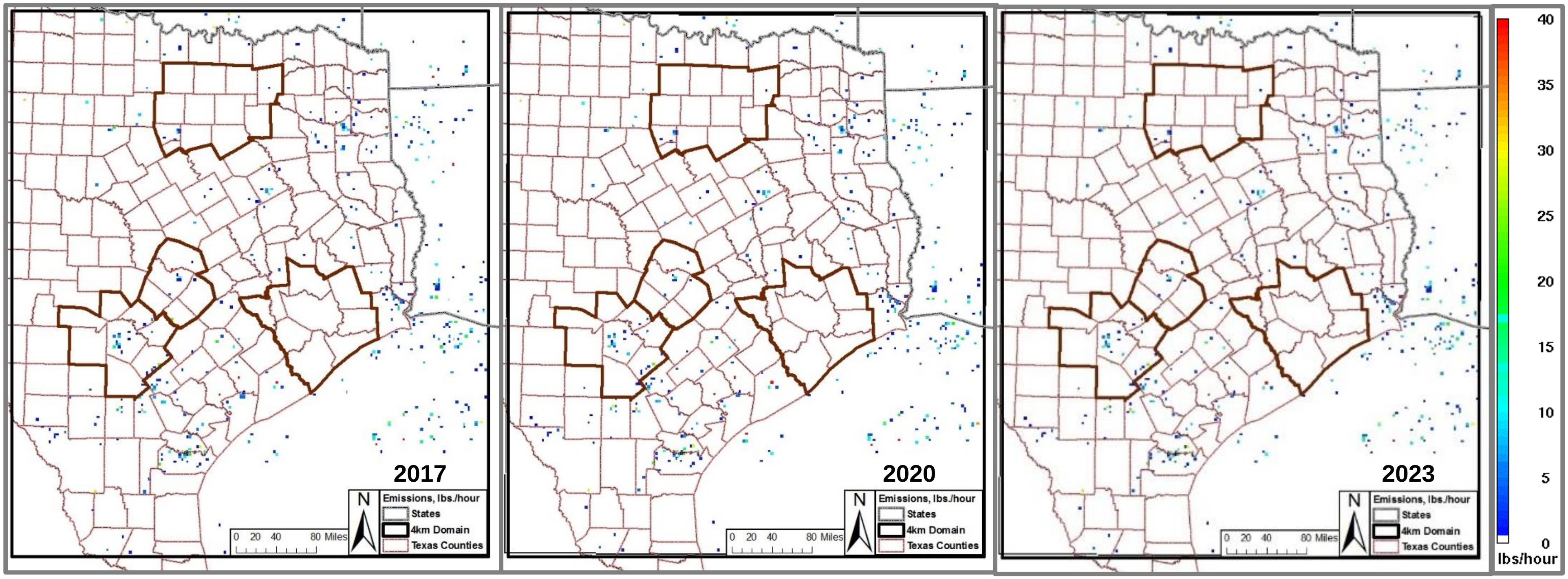
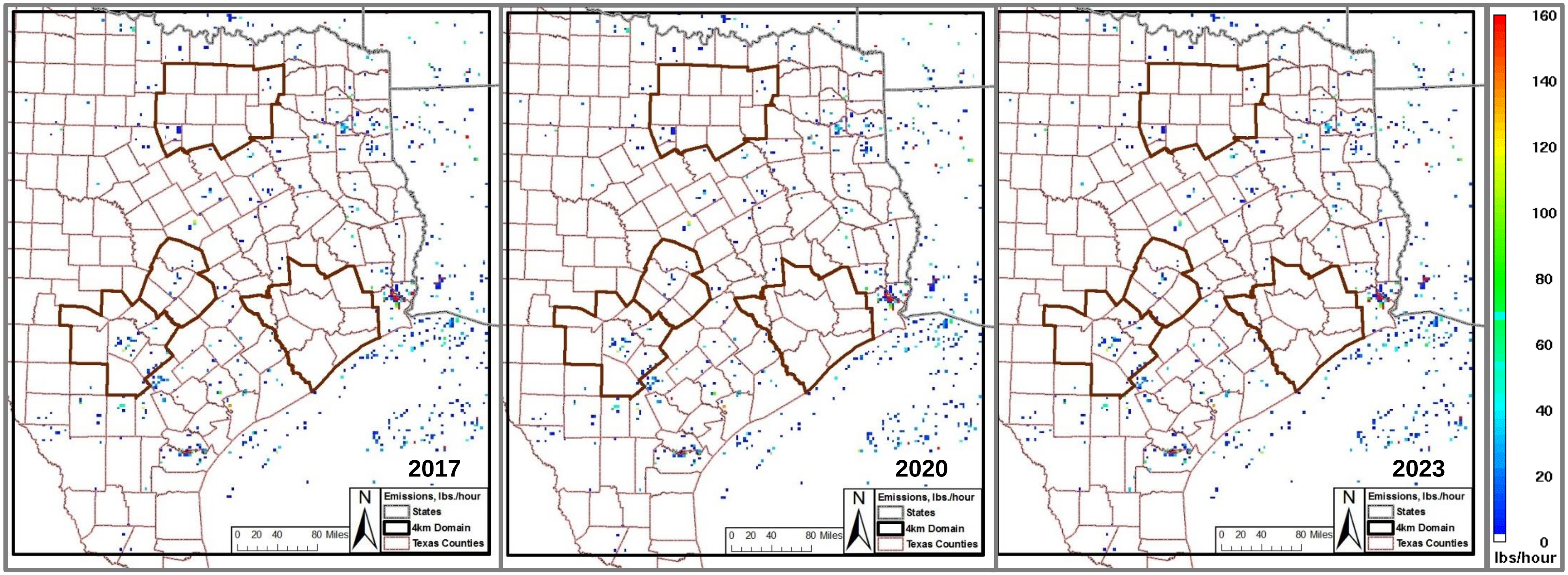


Figure 3-22: Low Point VOC Emissions 4-km grid Tile Plots, June Weekday, 12:00PM – 1:00PM



4 CAMx runs

4.1 CAMx Model Development

The base line CAMx simulation was developed for an elevated ozone episode in the San Antonio region that extended from April 16 to Sept. 30, 2012. The photochemical model was updated with 2017, 2020, and 2023 projected anthropogenic emission inventories to estimate future ozone concentrations under the same meteorological conditions as the 2012 base line. The projected emission inventories account for existing local, state, and federal air quality control strategies to determine whether such measures are sufficient to help the region meet the 2015 NAAQS 70 ppb 8-hour ozone standard. The 2020 and 2023 projection case were compared to the 2012 base line as well as the 2017 projection case to determine future ozone design values.

To simulate ozone formation, transport, and dispersion, CAMx required several inputs including:

- Three-dimensional hourly meteorological fields generated by WRF;
- Land use distribution fields;
- Three-dimensional hourly emissions generated by EPS3 by pollutant (latitude, longitude, and height);
- Initial conditions, top conditions, and boundary conditions (IC/BC);
- Photolysis rate inputs, including ultraviolet (UV) albedo, haze opacity, and total atmospheric ozone column fields.

4.1.1 <u>CAMx Configurations</u>

CAMx version 6.3 was used to model the 2012 ozone season episode to match the current TCEQ platform being developed for Texas. The configurations used for the episode were:

- Duration: April 16 – Sept. 30, 2012
- Time zone: CST (central standard time)
- I/O frequency: 1 hour
- Map projection: Lambert Conformal Conic
- Nesting: 2-way fully interactive 36/12/4-km computational grids
- Chemistry mechanism: CB6
- Chemistry solver: EBI (Euler-Backward Iterative)
- Advection solver: PPM (Piecewise Parabolic Method)
- Dry deposition model: WESELY89
- Plume-in-Grid model: On for large NO_X sources
- Probing Tools: None
- Dry deposition: On
- Wet deposition: On
- Asymmetric Convective Model 2 (ACM2) Diffusion: off
- TUV Cloud Adjustment
- Photolysis rate adjusted by cloud cover

The sampling grid was turned off during the model run because it is used solely to produce a graphical display of plume animation at the fine grid level and does not impact CAMx ozone predictions. These fine grid levels are typically less than 1 km and are smaller than the finest grid resolution, 4 km, used in this modeling application.

The photochemical model runs utilize the Plume-in-Grid sub-model (PiGs) to track individual plume sources and help reduce the artificial diffusion of point source emissions in the modeling grid. The PiGs accounts "for plume-scale dispersion and chemical evolution, until such time as puff mass can be adequately represented within the larger grid model framework."[87] All CAMx runs employed the PiGs option for large NO_X point sources using TCEQ PiGs threshold values.

4.2 CAMx Baseline and Projection Case Runs

Once all the data was inputted into CAMx, the model was run to produce several 2012 base line and projection case runs. All CAMx runs used WRF 3.7.1, CAMx 6.3, TCEQ photolysis rates, TCEQ ozone column, existing TCEQ supplied initial, top, and boundary conditions.

TCEQ 2012 Base line Run 1

- Existing merged 2012 TCEQ emission files

TCEQ 2017 Projection Case Run 2

- Existing merged 2012 TCEQ emission files

AACOG 2017 Projection Case Run 3

- 2017 regional TCEQ emission inventory
- Updated 2017 local point source emissions
- Local 2017 San Antonio-New Braunfels MSA emission data

AACOG 2020 Projection Case Run 4

- 2020 AACOG projected regional TCEQ emission inventory
- Updated 2020 local point source emissions
- Local 2020 San Antonio-New Braunfels MSA emission data

AACOG 2023 Projection Case Run 5

- 2023 AACOG projected regional TCEQ emission inventory
- Updated 2023 local point source emissions
- Local 2023 San Antonio-New Braunfels MSA emission data

4.3 Tile Plots – Ozone Concentration: 2012, 2017, 2020, and 2023

Tile plots can be used as a means of determining if there is an error in the input data or model performance. The plots are visual representations of the model output, displaying ozone

[87] ENVIRON International Corporation, May 2008. "User's Guide: Comprehensive Air Quality Modeling with Extensions, Version 6.30". Novato, CA.

concentrations by hour for the episode day or the maximum ozone by day. Ozone tile plots in Appendix E represent comparisons between the model results for 2012, 2017, 2020, and 2023 8-hour daily maximum ozone concentrations in the 4km grid for each high ozone day.

Peak ozone concentrations are predicted downwind of city centers and major point sources in these tile plots. In addition, the overall reduction in total NO_X, VOC, and CO emissions (local and regional) between 2012 and 2023 diminishes the magnitude of the urban plumes each day of the modeling episode. Likewise, the spatial extent of 8-hour ozone plumes greater than 75 ppb are significantly reduced for every exceedance day in the San Antonio region in 2023.

4.4 Modeled Attainment Demonstration

Consistent with EPA guidance for projecting design values in attainment demonstration modeling, AACOG calculated the projected design values (DV) for the San Antonio-New Braunfels ozone monitors using the June 2012 episode projected to 2020 and 2023.[88] Also, a second design value was calculated using the 2017 projection case to 2020 and 2023. The following calculations were performed in order to calculate the projected design values:

1. Calculation of baseline DVs.
2. Calculation of Relative Reduction Factor (RRF) denominators using the 10 highest modeled ozone levels at monitoring stations in the base year and the peak ozone concentration for each of these days within the 3 x 3 4km cell array around an ozone monitor.
3. Calculation of RRF numerators using the future year modeled ozone levels for the same grid cells on the same days used in the calculation of the RRF denominators.
4. Multiplication of baseline DVs by the RRFs to get projected 2020 DVs, and
5. Multiplication of baseline DVs by the RRFs to get projected 2023 DVs.

Three time periods were used to determine the baseline DVs needed for future year projections: 2010-2012, 2011-2013, and 2012-2014. These time periods cover a five-year period based around the 2012 model year. Using Equation 4-1, the average of the 4th highest value (Table 4-1) at each monitor in the analyzed region that was active during all five years was calculated. The periods are referred to as 2012, 2013 and 2014 respectively. The time period of 2015-2017 was used as well.

One deviation AACOG took from the guidance was to carry out the DV value to one decimal place, as opposed to truncating the value during this initial step of the process. This helps avoid "double-truncating" the future design value, since there are truncations done initially in the 3-year design value calculations and then again at the end of the projected future design value. Truncating these values at both ends of the process leads to lower projected design values.

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[88] EPA, Dec. 3, 2014. "Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze". Research Triangle Park, North Carolina. p. 39. Available online: http://www.epa.gov/scram001/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf. Accessed 02/17/2017.

Equation 4-1, the Design Value

$(DV)_I = [(OZONE)_{1.I} + (OZONE)_{2.I} + (OZONE)_{3.I}] / 3$

Where,

$(DV)_I$ = the baseline ozone modeling DV at site I (ppb)
$(OZONE)_{1.I}$ = the 4th highest ozone for Year 1 at site I (ppb)
$(OZONE)_{2.I}$ = the 4th highest ozone for Year 2 at site I (ppb)
$(OZONE)_{3.I}$ = the 4th highest ozone for Year 3 at site I (ppb)

Sample Equation: the 2012 Design Value for C23

$(DV)_I = [(72\ ppb) + (79\ ppb) + (81\ ppb)] / 3$
$= 77.3$ ppb design value at C23

Table 4-1: 4th Highest Ozone Value at CAMS 23, 58, and 59, 2010-2017

Monitor	2010	2011	2012	2013	2014	2015	2016	2017*
C23	72	79	81	76	69	79	71	73
C58	78	75	87	83	72	80	69	72
C59	67	71	70	69	63	68	62	65

* As of Oct. 20, 2017

The baseline ozone modeling design value was calculated using Equation 4-2. As determined by the EPA, the average DV methodology "has the desired effect of weighting the projected ozone base design values towards the middle year of a five year period".[89] "The 5-year weighted average value establishes a relatively stable value that is weighted towards the emissions and meteorological modeling year."[90]

Equation 4-2, the Baseline Design Site-Specific Modeling Design Value

$(DVB)_I = [(DV\ 2012)_I + (DV\ 2013)_I + (DV\ 2014)_I] / 3$

Where,

$(DVB)_I$ = the baseline ozone modeling DV at site I (ppb)
$(DV\ 2006)_I$ = the 2010-2012 baseline DV at site I (ppb) from Equation 4-1
$(DV\ 2007)_I$ = the 2011-2013 baseline DV at site I (ppb) from Equation 4-1
$(DV\ 2008)_I$ = the 2012-2014 baseline DV at site I (ppb) from Equation 4-1

Sample Equation: Baseline 2012 Design Site-Specific Design Value for C23

$(DVB)_I = [(77.3\ ppb) + (78.7\ ppb) + (75.3\ ppb)] / 3$
$= 77.1$ ppb baseline 2012 design site-specific modeling design value at C23

Sample Equation: Baseline 2017 Design Site-Specific Design Value for C23

$(DVB)_I = [(74.3\ ppb)] / 1$
$= 74.3$ ppb baseline 2017 design site-specific modeling design value at C23

As shown in Table 4-2, C58 had the highest baseline modeling DV at 80.8 ppb. The baseline modeling DVs at the other monitors were 77.1 ppb at C23 and 68.8 ppb at C59.

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[89] *Ibid*., p. 98.
[90] *Ibid*., p. 99.

Table 4-2: Calculated Baseline Modeling Design Values, 2012

Monitoring Site	2010-2012 DV, ppb	2011-2013 DV, ppb	2012-2014 DV, ppb	2012 Baseline Modeling DV ppb
C23	77.3	78.7	75.3	77.1
C58	80.0	81.7	80.7	80.8
C59	69.3	70.0	67.3	68.8

Table 4-3: Calculated Baseline Modeling Design Values, 2017

Monitoring Site	2015-2017 DV, ppb	2016-2018 DV, ppb	2017-2019 DV, ppb	2017 Baseline Modeling DV ppb
C23	74.3	-	-	74.3
C58	73.6	-	-	73.6
C59	65.0	-	-	65.0

The model attainment test requires the calculation of RRFs using baseline year and projection year. The ratio between future and baseline modeling 8-hour ozone predictions near each monitor was multiplied by the monitor-specific modeling DV. The area near a monitor was defined as the 3x3 array of 4-km grid cells surrounding the monitor.[91] The formula used to calculate the Future Design Value is:

Equation 4-3, Future Design Value Calculation

$(DVF)_I = (RRF)_I \, (DVB)_I$

Where,

$(DVF)_I$ = the estimated future ozone DV for the time attainment that is required (ppb)

$(RRF)_I$ = the relative response factor, calculated near site I

$(DVB)_I$ = the baseline ozone modeling DV at site I (ppb) - from Equation 4-2

Sample Equation: Future 2023 Design Value for at C23 (Based on 2012)

$(DVF)_I$ = (0.8772) (77.1 ppb)

= 67.6 ppb Future 2023 Design Value for at C23

The highest predicted 8-hour daily ozone was selected in the 3x3 array for each monitor for the 2020 or 2023 projection years. The peak ozone grid cell selected in the baseline year is the same cell that is used in the 2020 or 2023 projection. EPA's guidance calls for the top 10 modeled MDA8 values equal to or greater than 60 ppb to be used in average RRF calculations. The future site-specific DV for each monitor is provided in Table 4-4. The gray numbers are values that fall below the EPA requirement for design value calculations. When using the 2012 base case, the 2020 design value was 69.8 ppb at C23, 72.4 ppb at C58, and 63.0 ppb at C59. In 2023 the design values decreased to 67.6 ppb at C23, 70.5 ppb at C58, and 62.0 ppb at C59 (Figure 4-1). For the photochemical modeling scenario using the 2017 base case the design value was 67.8 ppb at C58, 68.1 ppb at C23, and 63.0 at C59 in 2023 (Figure 4-2). All regulatory-sited monitors meet the 70 ppb 8-hour ozone standard in 2023 when using the 2017 base case, however C23 is still above the standard in 2020.

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[91] *Ibid*., p. 102.

Table 4-4: Peak 8-hour Ozone (ppb) Predictions at C23, C58, and C59: 2012, 2017, 2020, and 2023 Modeled Cases, Based on 2012 Design Value.

CAMS	Year	Run Label	Episode days																	Design Value (Based on 2012)
			5/17	5/21	6/8	6/9	6/23	6/25	6/26	6/27	8/22	8/23	8/30	8/31	9/1	9/11	9/12	9/18	9/22	
C23	2012	Baseline	70.3	75.2	73.1	75.1	74.4	63.2	84.5	77.4	77.0	73.1	63.5	58.4	68.4	79.8	73.8	51.7	71.3	77.1
	2017	TCEQ	64.3	69.6	67.3	70.0	67.2	58.8	75.8	71.3	70.5	68.9	58.8	52.3	62.0	74.2	70.2	47.9	66.1	71.2
	2017	AACOG	65.8	72.8	67.4	73.3	68.4	58.7	77.8	72.2	71.5	72.5	59.2	52.9	64.4	74.6	73.3	48.5	71.5	73.1
	2020	AACOG	63.2	69.8	64.0	66.9	64.4	56.7	74.3	69.1	68.9	70.6	58.2	51.4	61.9	71.9	71.3	47.8	61.8	69.8
	2023	AACOG	61.5	66.8	61.9	64.0	61.8	55.5	72.0	66.8	67.3	69.3	60.1	55.3	60.3	70.2	69.3	47.1	62.6	67.6
C58	2012	Baseline	75.9	77.3	60.5	79.1	72.5	62.6	79.8	81.0	75.7	71.6	64.3	57.3	73.0	74.0	72.6	52.6	73.3	80.7
	2017	TCEQ	68.6	71.2	54.8	73.2	64.8	57.2	73.9	73.2	70.0	68.1	59.2	51.7	65.0	69.6	68.1	48.5	67.0	74.1
	2017	AACOG	70.1	74.8	54.9	74.1	65.8	56.6	75.7	74.7	71.1	71.6	59.7	52.2	67.5	69.9	71.3	49.1	71.1	76.3
	2020	AACOG	66.8	71.4	52.5	68.4	62.7	54.7	72.4	70.9	69.0	69.3	58.6	51.0	64.3	67.8	69.5	48.2	63.3	72.4
	2023	AACOG	64.4	68.8	51.0	65.1	61.1	53.4	70.8	68.6	67.5	68.0	60.7	55.3	62.3	66.8	68.2	47.5	63.4	70.5
C59	2012	Baseline	63.1	65.0	71.6	61.5	64.5	65.2	75.5	68.2	64.8	63.0	66.3	65.6	60.0	64.8	65.6	67.8	58.1	68.8
	2017	TCEQ	58.4	61.3	66.0	59.6	60.7	60.0	69.8	64.4	59.6	59.4	61.2	59.2	55.5	60.9	63.9	60.4	53.3	63.9
	2017	AACOG	58.9	63.0	65.3	59.3	60.5	60.8	70.4	64.4	60.2	63.1	62.2	60.2	55.8	60.6	67.6	61.0	60.2	64.7
	2020	AACOG	57.8	62.0	62.9	57.7	59.2	58.5	67.1	63.1	59.9	61.9	60.7	58.0	54.8	59.3	66.9	60.0	53.1	63.0
	2023	AACOG	56.9	61.9	60.4	57.8	58.2	56.6	63.9	62.7	58.8	60.8	62.7	55.2	53.9	59.5	66.8	59.2	53.2	62.0

Table 4-5: Peak 8-hour Ozone (ppb) Predictions at C23, C58, and C59: 2012, 2017, 2020, and 2023 Modeled Cases, Based on 2017 Design Value.

CAMS	Year	Run Label	Episode days 5/17	5/21	6/8	6/9	6/25	6/26	6/27	8/22	8/23	8/30	9/11	9/12	9/18	9/22	9/23	Design Value (Based on 2017)
C23	2017	Baseline	65.8	72.8	67.4	73.3	58.7	77.8	72.2	71.5	72.5	59.2	74.6	73.3	48.5	71.5	69.5	74.3
	2020	AACOG	63.2	69.8	64.0	66.9	56.7	74.3	69.1	68.9	70.6	58.2	71.9	71.3	47.8	61.8	67.2	70.5
	2023	AACOG	61.5	66.8	61.9	64.0	55.5	72.0	66.8	67.3	69.3	59.9	69.3	69.3	47.1	60.0	60.0	67.8
C58	2017	Baseline	70.1	74.8	54.9	74.1	56.6	75.7	74.7	71.1	71.6	59.7	69.9	71.3	49.1	71.1	69.1	73.6
	2020	AACOG	66.8	71.4	52.5	68.4	54.7	72.4	70.9	69.0	69.3	58.6	67.8	69.5	48.2	63.3	66.8	70.0
	2023	AACOG	64.4	68.8	51.0	65.1	53.4	70.8	68.6	67.5	68.0	60.1	68.2	68.2	47.5	61.3	61.3	68.1
C59	2017	Baseline	58.9	63.0	65.3	59.3	60.8	70.4	64.4	60.2	63.1	62.2	60.6	67.6	61.0	60.2	62.0	64.6
	2020	AACOG	57.8	62.0	62.9	57.7	58.5	67.1	63.1	59.9	61.9	60.7	59.3	66.9	60.0	53.1	60.6	63.0
	2023	AACOG	56.9	61.9	60.4	57.8	56.6	63.9	62.7	58.8	60.8	62.1	66.8	66.8	59.2	53.2	53.2	61.4

Figure 4-1: Change in San Antonio-New Braunfels MSA Eight-Hour Design Values with a 2012 Base Line, 2017, 2020, and 2023

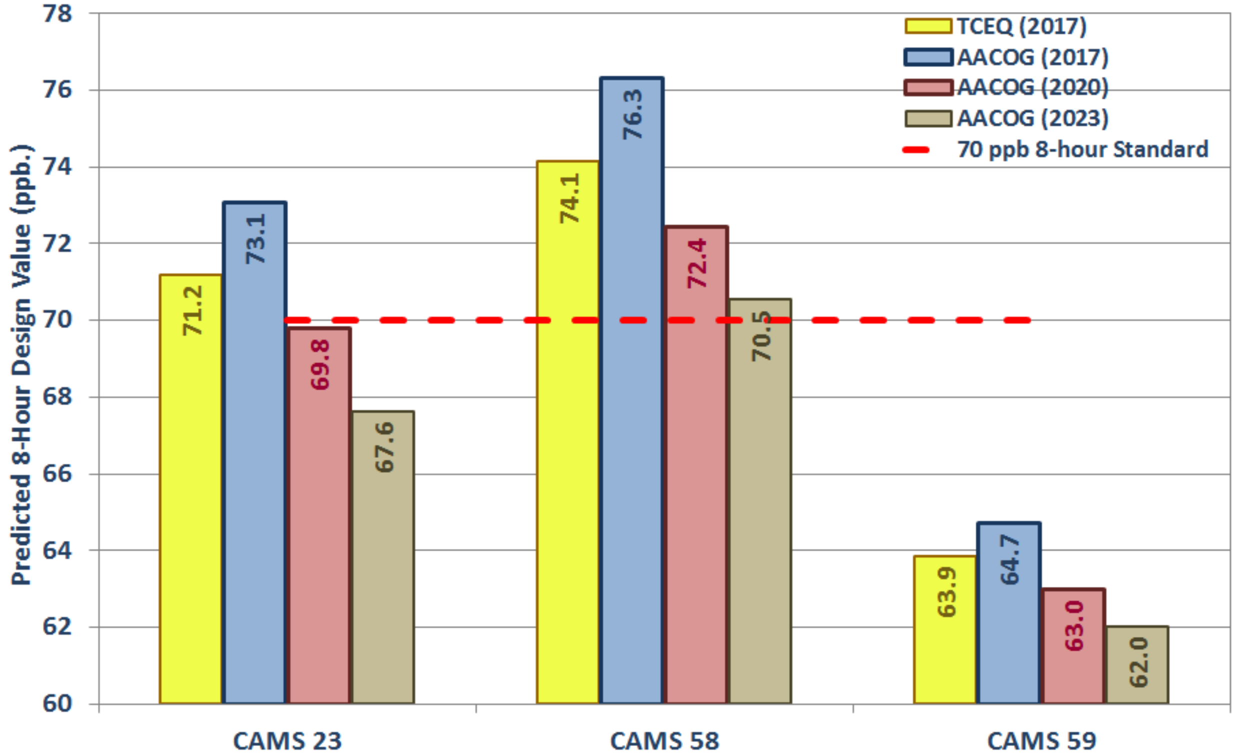
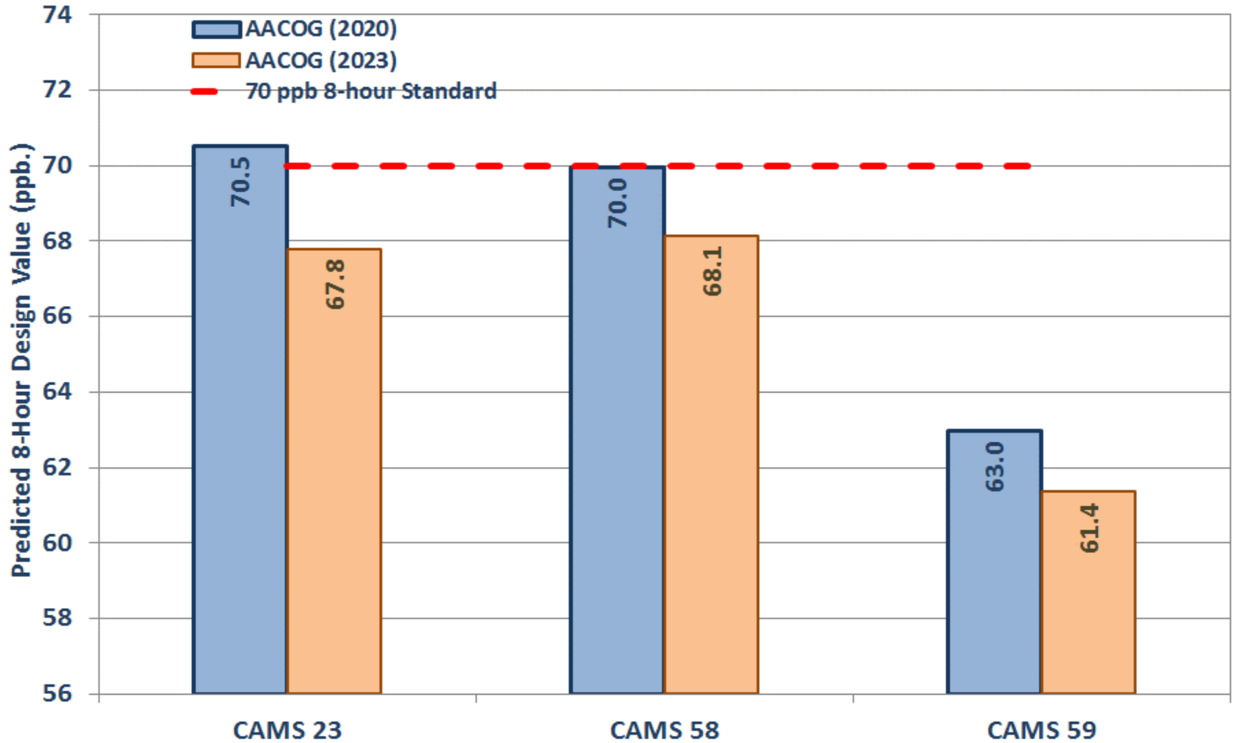


Figure 4-2: Change in San Antonio-New Braunfels MSA Eight-Hour Design Values with a 2017 Base Line, 2020 and 2023



5 Sensitivity and Control Strategy Modeling

A number of runs were conducted on the 2012 ozone season episode to assess the sensitivity of the model to changes in the emission inventory and control strategy scenarios. Control strategy runs included incremental removal of VOC and NOx precursor emissions and individual control strategy runs.

5.1 Incremental Removal of VOC and NOx Precursor Emissions

Across-the-board runs were conducted by removing 25%, 50%, 75%, and 100% of precursor emissions from the San Antonio-New Braunfels MSA in the 2023 projection. Figure 5-1 and Figure 5-3 provide the results of the across-the-board DV reduction runs for C23 and C58 for the 2023 projection year. The model runs were conducted from April 16 to July 30, 2023 projection case. The runs that were performed are:

- 25% reduction in NO_X
- 50% reduction in NO_X
- 75% reduction in NO_X
- 100% reduction in NO_X
- 25% reduction in VOC
- 50% reduction in VOC
- 75% reduction in VOC
- 100% reduction in VOC
- 25% reduction in NO_X and VOC
- 50% reduction in NO_X and VOC
- 75% reduction in NO_X and VOC
- 100% reduction in NO_X and VOC

All 3 regulatory monitors were significantly more sensitive to changes in NO_X emissions than changes in VOC Emissions. When VOC emissions were reduced by 100%, there was only a 0.5 ppb reduction in the 8-hour ozone DV at C23 and a 0.6 ppb reduction in the 8-hour ozone DV at C58 in 2013 (Table 5-1). The model was significantly more sensitive to changes in NOx emissions: 11.8 ppb in the 8-hour ozone DV at C23 and 12.6 ppb in the 8-hour ozone DV at C58 in 2023. The results for both VOC and NO_X reductions were similar to the NO_X only reductions. The lack of sensitivity to VOC emission reductions indicates VOC emission control strategies will have very little impact on changing the DV.

Figure 5-1: Predicted Ozone Design Value at C58 after Removing Local NO_X and VOC Emissions, 2023

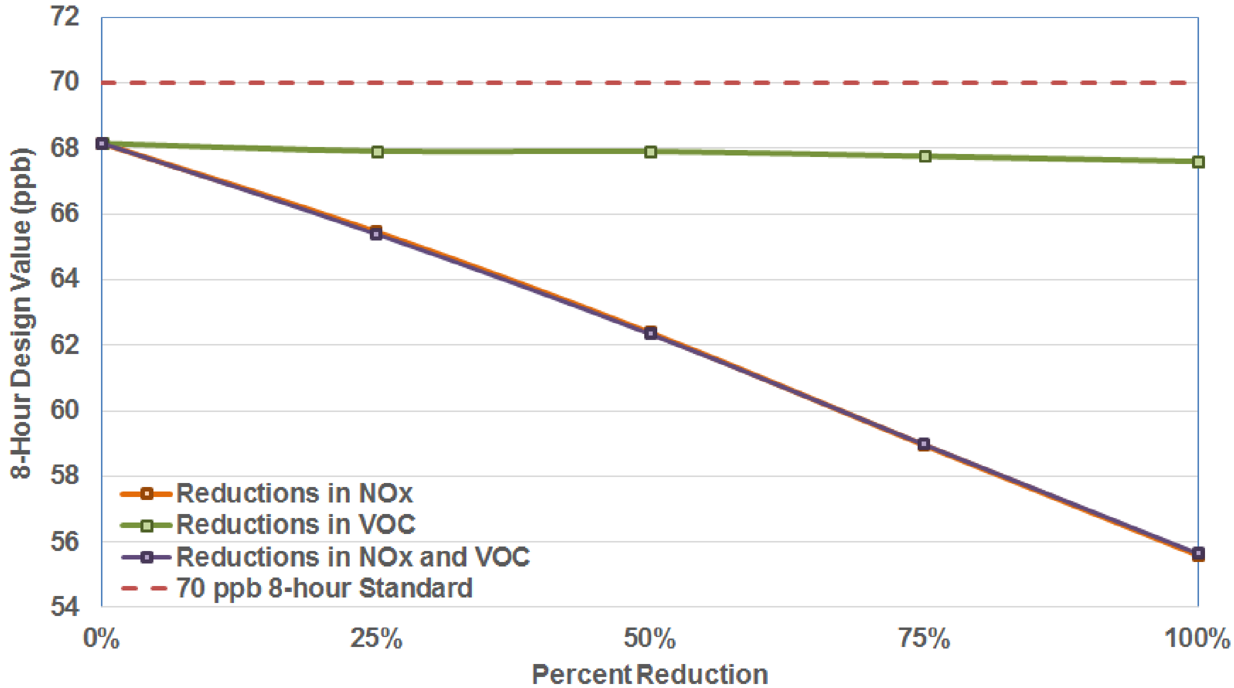


Figure 5-2: Predicted Ozone Design Value at C23 after Removing Local NO_X and VOC Emissions, 2023

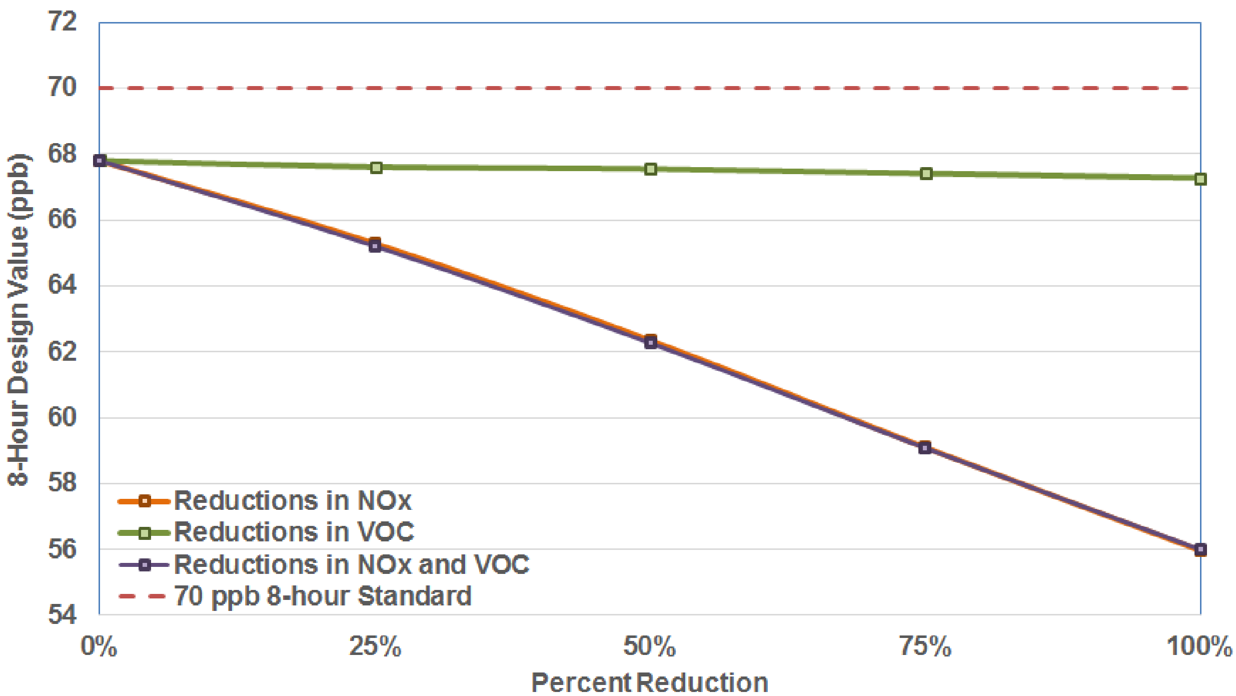


Figure 5-3: Predicted Ozone Design Value at C59 after Removing Local NO_X and VOC Emissions, 2023

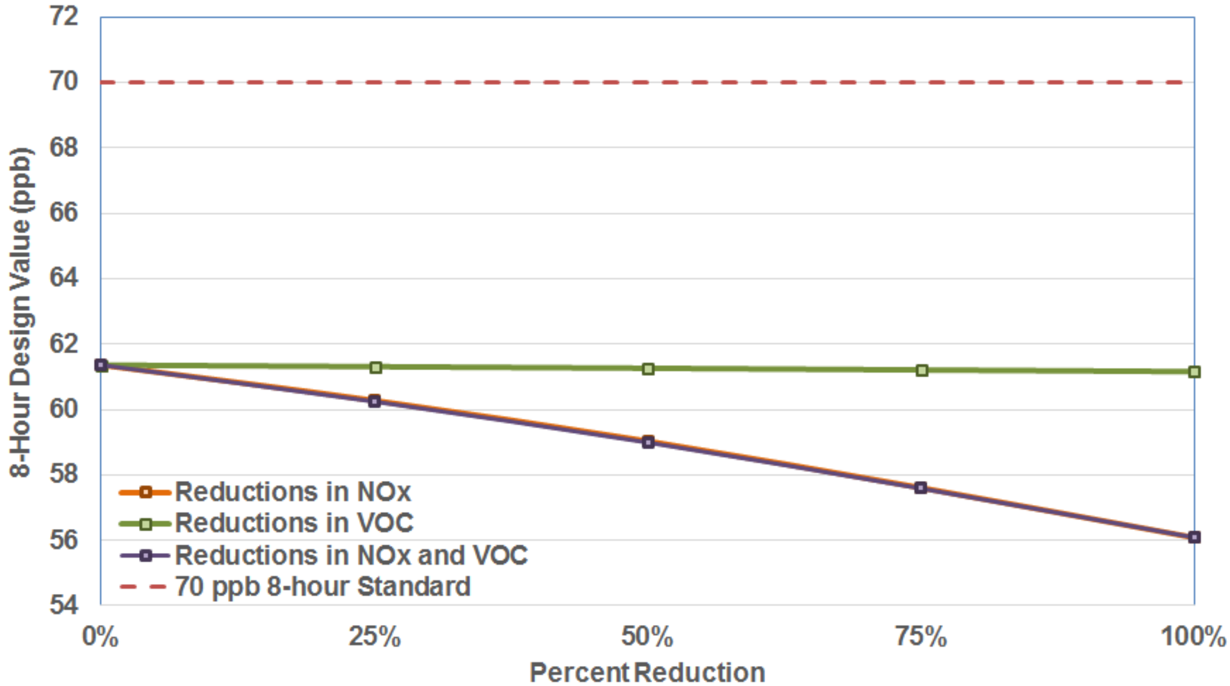


Table 5-1: Predicted Ozone Design Value at C23, C58, and C59 after Removing Local NO_X and VOC Emissions, 2023

Scenario	CAMS 23		CAMS 58		CAMS 59	
	Design Value	Reduction (ppb)	Design Value	Reduction (ppb)	Design Value	Reduction (ppb)
2023 Projection Case	67.80		68.15		61.36	
25 % Reduction in NO_X	65.28	-2.51	65.45	-2.70	60.27	-1.08
50 % Reduction in NO_X	62.35	-5.45	62.38	-5.77	59.03	-2.33
75 % Reduction in NO_X	59.10	-8.70	58.95	-9.20	57.61	-3.75
100 % Reduction in NO_X	55.97	-11.82	55.59	-12.55	56.09	-5.27
2023 Projection Case	67.80		68.15		61.36	
25 % Reduction in VOC	67.61	-0.19	67.91	-0.23	61.31	-0.05
50 % Reduction in VOC	67.55	-0.25	67.90	-0.24	61.26	-0.10
75 % Reduction in VOC	67.41	-0.39	67.76	-0.39	61.21	-0.15
100 % Reduction in VOC	67.27	-0.52	67.60	-0.55	61.16	-0.20
2023 Projection Case	67.80		68.15		61.36	
25% Reduction in NO_X and VOC	65.20	-2.59	65.38	-2.76	60.24	-1.12
50% Reduction in NO_X and VOC	62.27	-5.53	62.34	-5.81	58.99	-2.37
75% Reduction in NO_X and VOC	59.08	-8.72	58.97	-9.18	57.59	-3.77
100% Reduction in NO_X and VOC	56.00	-11.79	55.64	-12.50	56.09	-5.27

Table 5-2: Change in Ozone Design Value at C23, C58, and C59 after Removing Local NO_X and VOC Emissions, 2023

Monitor	Photochemical Model Run	n	Mean						Maximum Change	
			ppb	Percentage of 8-hour Ozone Design Value	Standard Deviation	Low	High	Confidence Level	ppb	Percentage of 8-hour Ozone Design Value
CAMS 23	25% red in NOx	6	2.51	-3.7%	0.56	2.06	2.97	0.45	3.43	-5.1%
	50% red in NOx	6	5.45	-8.0%	1.23	4.46	6.44	0.99	7.47	-11.0%
	75% red in NOx	6	8.70	-12.8%	2.25	6.90	10.50	1.80	12.51	-18.5%
	100% red in NOx	6	11.82	-17.4%	3.34	9.15	14.50	2.67	17.32	-25.6%
	25% red in VOC	6	0.19	-0.3%	0.19	0.03	0.35	0.16	0.56	-0.8%
	50% red in VOC	6	0.25	-0.4%	0.14	0.14	0.36	0.11	0.41	-0.6%
	75% red in VOC	6	0.39	-0.6%	0.21	0.22	0.56	0.17	0.63	-0.9%
	100% red in VOC	6	0.52	-0.8%	0.29	0.29	0.75	0.23	0.82	-1.2%
	25% red in NOx and VOC	6	2.59	-3.8%	0.59	2.12	3.06	0.47	3.57	-5.3%
	50% red in NOx and VOC	6	5.53	-8.2%	1.27	4.51	6.54	1.01	7.64	-11.3%
	75% red in NOx and VOC	6	8.72	-12.9%	2.27	6.90	10.54	1.82	12.57	-18.5%
	100% red in NOx and VOC	6	11.79	-17.4%	3.33	9.13	14.46	2.67	17.27	-25.5%
CAMS 58	25% red in NOx	5	2.70	-4.0%	0.34	2.40	3.00	0.30	3.20	-4.8%
	50% red in NOx	5	5.77	-8.6%	0.73	5.14	6.41	0.64	6.85	-10.2%
	75% red in NOx	5	9.20	-13.7%	1.38	7.99	10.41	1.21	11.15	-16.6%
	100% red in NOx	5	12.55	-18.7%	1.97	10.83	14.28	1.73	14.59	-21.7%
	25% red in VOC	5	0.23	-0.3%	0.19	0.07	0.40	0.16	0.47	-0.7%
	50% red in VOC	5	0.24	-0.4%	0.09	0.16	0.33	0.08	0.36	-0.5%
	75% red in VOC	5	0.39	-0.6%	0.15	0.26	0.52	0.13	0.59	-0.9%
	100% red in VOC	5	0.55	-0.8%	0.22	0.36	0.74	0.19	0.84	-1.3%
	25% red in NOx and VOC	5	2.76	-4.1%	0.32	2.48	3.05	0.28	3.25	-4.8%
	50% red in NOx and VOC	5	5.81	-8.6%	0.73	5.18	6.45	0.64	6.90	-10.3%
	75% red in NOx and VOC	5	9.18	-13.7%	1.37	7.98	10.38	1.20	11.16	-16.6%
	100% red in NOx and VOC	5	12.50	-18.6%	1.96	10.79	14.22	1.72	14.57	-21.7%

Monitor	Photochemical Model Run	n	Mean						Maximum Change	
			ppb	Percentage of 8-hour Ozone Design Value	Standard Deviation	Low	High	Confidence Level	ppb	Percentage of 8-hour Ozone Design Value
CAMS 59	25% red in NOx	5	1.08	-1.8%	0.78	0.40	1.77	0.69	1.84	-3.0%
	50% red in NOx	5	2.33	-3.8%	1.73	0.81	3.84	1.51	4.13	-6.8%
	75% red in NOx	5	3.75	-6.2%	2.85	1.26	6.25	2.50	7.05	-11.6%
	100% red in NOx	5	5.27	-8.7%	4.05	1.73	8.82	3.55	10.21	-16.8%
	25% red in VOC	5	0.05	-0.1%	0.08	-0.02	0.12	0.07	0.20	-0.3%
	50% red in VOC	5	0.10	-0.2%	0.17	-0.06	0.25	0.15	0.41	-0.7%
	75% red in VOC	5	0.15	-0.2%	0.27	-0.09	0.38	0.23	0.62	-1.0%
	100% red in VOC	5	0.20	-0.3%	0.36	-0.12	0.52	0.32	0.85	-1.4%
	25% red in NOx and VOC	5	1.12	-1.8%	0.82	0.40	1.84	0.72	1.98	-3.3%
	50% red in NOx and VOC	5	2.37	-3.9%	1.77	0.82	3.92	1.55	4.31	-7.1%
	75% red in NOx and VOC	5	3.77	-6.2%	2.86	1.26	6.28	2.51	7.13	-11.7%
	100% red in NOx and VOC	5	5.27	-8.7%	4.03	1.74	8.80	3.53	10.17	-16.7%

5.2 On-Road Control Strategies

Emission reductions from several on-road control strategies were calculated and put in the photochemical model. All CAMx control strategy runs used the same inputs as AACOG 2023 Projection Case Run 5.

Control Strategy Run for Anti-Idling

- 2023
- Same inputs as AACOG 2023 Projection Case Run 5
- Emission reductions from an anti-idling program for vehicles weighing 14,000 pounds or more within the 8-county San Antonio-New Braunfels MSA

Control Strategy Run 2 with OBDII inspection and Maintenance Program

- 2023
- Same inputs as AACOG 2023 Projection Case Run 5
- Emissions reduction from an On-Board Diagnostic system (OBDII) inspection and maintenance program

Control Strategy Run 3

- 2023
- Same inputs as AACOG 2023 Projection Case Run 5
- Emission reductions from the following on-road control strategies: 1,000 light commercial electric vehicles, 1,000 electric vehicles passenger cars, 10,000 workers telecommuting, carpooling based on 2,000,000 VMT reduced (1,900 workers), vanpooling based on 2,000 vehicles removed, and traffic re-signalization (39 lights), and railroad grade separation (1 crossing).

The most effective control measure photochemical model run was no idling. There was a reduction of 0.31 ppb at C23, 0.24 ppb at C58 and 0.10 ppb at C59. The OBDII inspection and maintenance control measure reduced ozone at C23 by 0.23 ppb, C58 by 0.18 ppb, and 0.06 ppb at C59. There was a reduction of 0.16 ppb at C23, 0.03 ppb at C58, and 0.01 ppb reduction at C59 for the electric vehicles, telecommuting, and carpooling control measures (Figure 5-4).

Figure 5-4: Predicted Ozone Design Value for Each Control Strategy, 2023

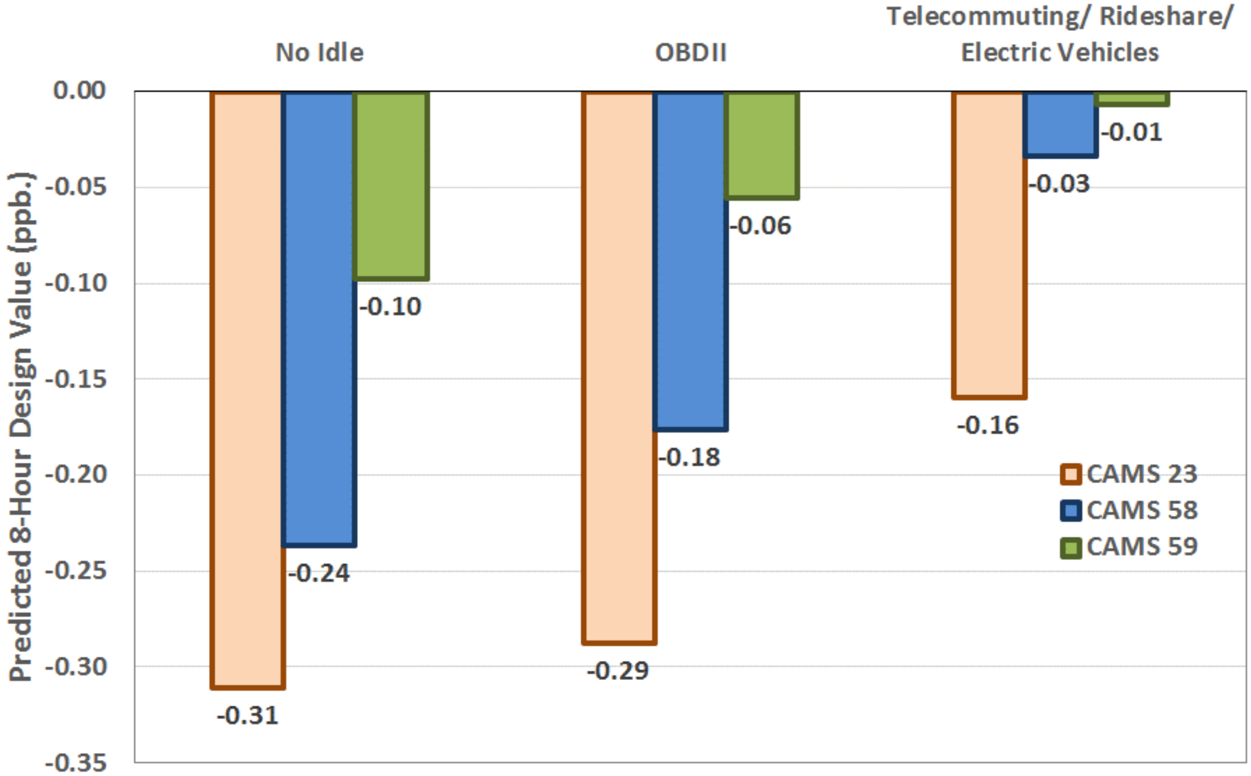


Table 5-3: Predicted Ozone Design Value for Each Control Strategy, 2023

Scenario	CAMS 23		CAMS 58		CAMS 59	
	Design Value	Reduction (ppb)	Design Value	Reduction (ppb)	Design Value	Reduction (ppb)
2023 Projection Case	68.37		67.73		61.24	
No Idle	68.06	-0.31	67.49	-0.24	61.15	-0.10
OBDII	68.08	-0.29	67.55	-0.18	61.19	-0.05
On-Road Control Strategy 3	68.21	-0.16	67.69	-0.03	61.24	-0.01

6 San Antonio-New Braunfels MSA Counties APCA Run

6.1 APCA Run Setup

"CAMx includes a source apportionment (SA) or attribution capability that estimates the contributions from multiple source areas, categories, and pollutant types to the spatial and temporal distribution of ozone in a single model run."[92] "SA uses sets of tracer species to track the fate of precursor emissions and the ozone compounds formed from these emissions. The tracers operate as "spectators" to the normal CAMx calculations so that the underlying relationships between total emissions and concentrations are not perturbed. SA tracers are not "passive": rather they track the effects of chemical reaction, transport, diffusion, emissions and deposition within a CAMx simulation and are thus referred to as "reaction tracers." A source can be defined in terms of geographical area (or region) and/or emission category (or group)."[93]

"All sources of precursors and ozone must be accounted for, so CAMx initial and boundary conditions are also tracked as separate source groups. The methodology is designed such that all ozone and precursor concentrations are attributed among the selected source regions/groups at all times and throughout all grids. The methodology also estimates the fractions of ozone formed en-route under VOC- or NO_X-limited conditions, indicating whether ozone at a particular time and location will respond to reductions in VOC or NO_X precursor emissions. An important feature of the reaction tracer approach is that the normal CAMx calculations are not perturbed; thus, SA estimates the same total ozone and precursor concentrations as CAMx."[94]

"An alternative ozone apportionment technique called Anthropogenic Precursor Culpability Assessment (APCA) differs from OSAT in recognizing that certain emission categories are not controllable (e.g., biogenic emissions) and that apportioning ozone production to these categories does not provide information that is relevant to development of control strategies. To address this, in situations where OSAT would attribute ozone production to non-controllable emissions, APCA re-allocates that ozone production to the controllable precursors that participated in ozone formation with the non-controllable precursor. For example, when ozone formation is due to biogenic VOC and anthropogenic NOx under VOC-limited conditions (a situation where OSAT would attribute ozone production to biogenic VOC), APCA attributes ozone production to the anthropogenic NOx present. Using APCA instead of OSAT results in more ozone formation attributed to anthropogenic NOx sources and less ozone formation attributed to biogenic VOC sources."[95] The latest version of SA was used for all APCA runs. ENVIRON made significant improvements to SA including improving the accuracy "by keeping track of the source(s) of ozone

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[92] ENVIRON International Corporation, March 2016. "User's Guide: Comprehensive Air Quality Modeling with Extensions, Version 6.30". Novato, CA. p. 149. Available online: http://www.camx.com/files/camxusersguide_v6-30.pdf. Accessed 05/23/2017.
[93] *Ibid*.
[94] *Ibid*.
[95] *Ibid*. p. 155.

removed by reaction with NO to form NO_2 and subsequently returned as ozone when NO_2 is destroyed by photolysis." [96]

The 2012 ozone season projection case from April 16 to June 28, 2023 was run at the 4-km, 12-km, and 36-km grid sizes using APCA. For the APCA run, the receptors defined in the run are the 3 regulatory monitors in the San Antonio-New Braunfels MSA: C23, C58, and C59. The APCA run was also divided into 9 geographical areas, initial conditions, and boundary conditions. Figure 6-1 shows the geographical regions at the 4-km grid level. The geographic source apportionment areas are:

- Atascosa County
- Bandera County
- Bexar County
- Comal County
- Guadalupe County
- Kendall County
- Medina County
- Wilson County
- All Other Regions
- Boundary conditions
- Initial Conditions

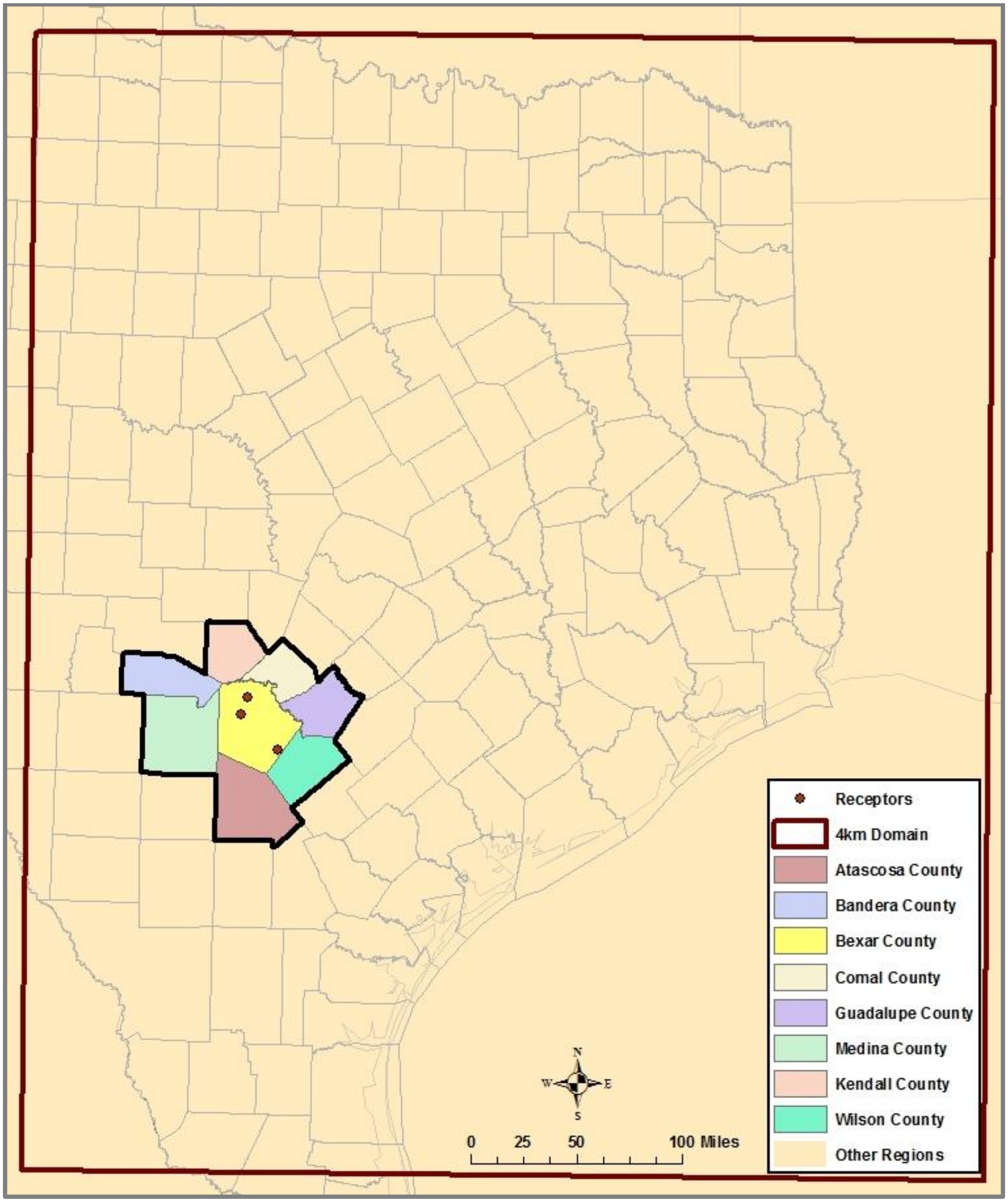
The analysis of the results was performed for all days during the modeling episode, days with predict peak 8-hour ozone in 2012 > 60 ppb, and days with predict peak 8-hour ozone in 2012 > 70 ppb. The days greater than 60 ppb for each monitor were used in the analysis are

- CAMS 23: May 9, 11, 14, 15, 17, 18, 20, 21, 22, June 1, 5, 6, 8, 9, 17, 18, 19, 22, 23, 24, 25, 26, 27, and 28
- CAMS 58: May 14, 17, 18, 20, 21, 22, June 1, 5, 6, 8, 9, 18, 19, 22, 23, 24, 25, 26, 27, and 28
- CAMS 59: May 9, 11, 14, 15, 16, 17, 21, June 8, 9, 22, 23, 25, 26, and 27

Data from April 16 to April 28 modeling day were not included in the analysis because these days were only run at the 36-km grid level.

[96] *Ibid*. p. 153.

Figure 6-1: APCA Regions for San Antonio-New Braunfels MSA Counties at the 4-Km grid Level, 2023



Plot Date: Sept. 10, 2015
Map Compilation: June 15, 2017
Source: APCA run Setup for the San Antonio MSA

6.2 Contribution by Source Region

As expected, Bexar County emissions were the largest contribution of peak 8-hour ozone on days > 60 ppb at C58 (13.6 percent in Table 6-1). Surprisingly, the second largest contribution came from Atascosa County, 1.3 percent. Other contributions were Guadalupe County at 1.0 percent, Wilson County, at 0.4 percent, and Medina County at 0.2 percent. The results for C23 are very similar to C58 except there was an even higher contribution from Bexar County (14.7 percent). At C59, both Bexar County, 6.6 percent, and Guadalupe County, 2.5 percent, had a significant impact on peak 8-hour ozone on days > 60 ppb.

Interquartile range (ICQ) plots in Figure 6-2 show Bexar County's contribution on design value days has a wide range of values at C58. "The interquartile range of an observation variable is the difference of its upper and lower quartiles. It is a measure of how far apart the middle portion of data spreads in value."[97] The ICQ plots also include the maximum and minimum values. The maximum impact of Bexar County is 18.2 ppb at C58 monitor and 16.3 ppb at C23 monitor on days > 60 ppb. Guadalupe County's maximum contribution was 3.6 ppb at C58 and 3.0 ppb at C23. Medina County had a maximum contribution of 0.8 ppb, Wilson County had a maximum contribution of 0.6 ppb, and Comal County had a maximum contribution of 0.5 ppb. These results shows local emission sources can have a significant impact on ozone recorded at local regulatory monitors.

[97] Dr. Chi Yau, 2015. "Interquartile Range". Available online: http://www.r-tutor.com/elementary-statistics/numerical-measures/interquartile-range. Accessed: 08/12/15.

Table 6-1: APCA results for C58, C23, C59 by San Antonio-New Braunfels MSA Counties, 2023

Monitor	Region	All Hours		Daily Maximum (all Days)		Daily Maximum (Days > 60 ppb)		Daily Maximum (Days > 70 ppb)	
		ppb	%	ppb	%	ppb	%	ppb	%
C58	Initial Conditions	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Boundary	17.02	46.1%	22.90	45.2%	17.60	30.7%	15.97	24.3%
	Other Regions	16.94	45.9%	21.20	41.9%	30.27	52.7%	36.36	55.2%
	Atascosa	0.42	1.1%	0.94	1.9%	0.73	1.3%	0.59	0.9%
	Bandera	0.00	0.0%	0.00	0.0%	0.01	0.0%	0.01	0.0%
	Bexar	2.17	5.9%	4.99	9.9%	7.80	13.6%	11.36	17.3%
	Comal	0.03	0.1%	0.05	0.1%	0.09	0.16%	0.06	0.1%
	Guadalupe	0.20	0.5%	0.33	0.7%	0.58	1.0%	1.05	1.6%
	Kendall	0.01	0.0%	0.02	0.0%	0.02	0.0%	0.01	0.0%
	Medina	0.03	0.1%	0.04	0.1%	0.09	0.15%	0.05	0.1%
	Wilson	0.08	0.2%	0.15	0.3%	0.23	0.4%	0.35	0.5%
	Total	36.91	100.0%	50.63	100.0%	57.42	100.0%	65.84	100.0%
C23	Initial Conditions	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Boundary	17.52	45.9%	22.94	44.6%	18.40	31.4%	14.89	23.4%
	Other Regions	17.47	45.8%	21.29	41.4%	29.84	51.0%	36.93	58.0%
	Atascosa	0.34	0.9%	0.74	1.4%	0.58	1.0%	0.77	1.2%
	Bandera	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.01	0.0%
	Bexar	2.41	6.3%	5.67	11.0%	8.59	14.7%	10.00	15.7%
	Comal	0.04	0.1%	0.08	0.1%	0.08	0.1%	0.08	0.1%
	Guadalupe	0.26	0.7%	0.48	0.9%	0.75	1.3%	0.60	0.9%
	Kendall	0.01	0.0%	0.02	0.0%	0.01	0.0%	0.01	0.0%
	Medina	0.02	0.0%	0.03	0.0%	0.04	0.1%	0.08	0.1%
	Wilson	0.09	0.2%	0.16	0.3%	0.25	0.4%	0.34	0.5%
	Total	38.16	100.0%	51.40	100.0%	58.54	100.0%	63.70	100.0%

Monitor	Region	All Hours		Daily Maximum (all Days)		Daily Maximum (Days > 60 ppb)		Daily Maximum (Days > 70 ppb)	
		ppb	%	ppb	%	ppb	%	ppb	%
C59	Initial Conditions	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Boundary	15.81	46.7%	22.85	46.6%	14.89	25.6%	11.84	19.5%
	Other Regions	16.71	49.3%	23.41	47.7%	36.80	63.4%	40.07	66.1%
	Atascosa	0.24	0.7%	0.51	1.0%	0.40	0.7%	0.17	0.3%
	Bandera	0.00	0.0%	0.00	0.0%	0.01	0.0%	0.00	0.0%
	Bexar	0.65	1.9%	1.37	2.8%	3.81	6.6%	5.91	9.7%
	Comal	0.02	0.1%	0.04	0.1%	0.10	0.2%	0.08	0.1%
	Guadalupe	0.24	0.7%	0.47	1.0%	1.45	2.5%	2.09	3.4%
	Kendall	0.00	0.0%	0.00	0.0%	0.01	0.0%	0.01	0.0%
	Medina	0.01	0.0%	0.01	0.0%	0.03	0.1%	0.04	0.1%
	Wilson	0.21	0.6%	0.41	0.8%	0.56	1.0%	0.42	0.7%
	Total	33.89	100.0%	49.07	100.0%	58.06	100.0%	60.62	100.0%

Figure 6-2: ICQ plots for C58, C23, and C59 for Peak 8 hour Ozone on All Day by San Antonio-New Braunfels MSA Counties, 2023

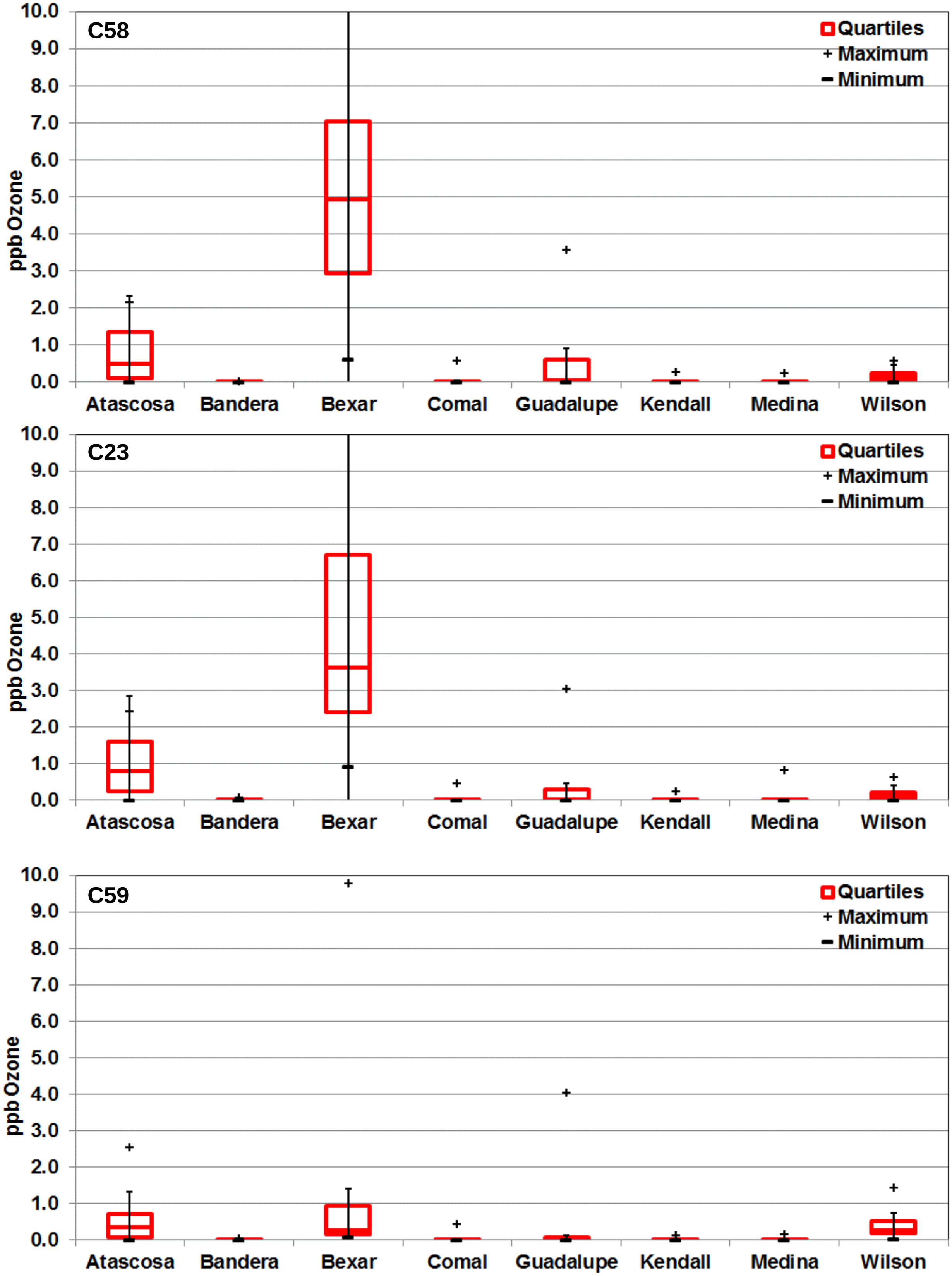


Figure 6-3: ICQ plots for C58, C23, and C59 for Peak 8 hour Ozone on Days > 60 ppb by San Antonio-New Braunfels MSA Counties, 2023

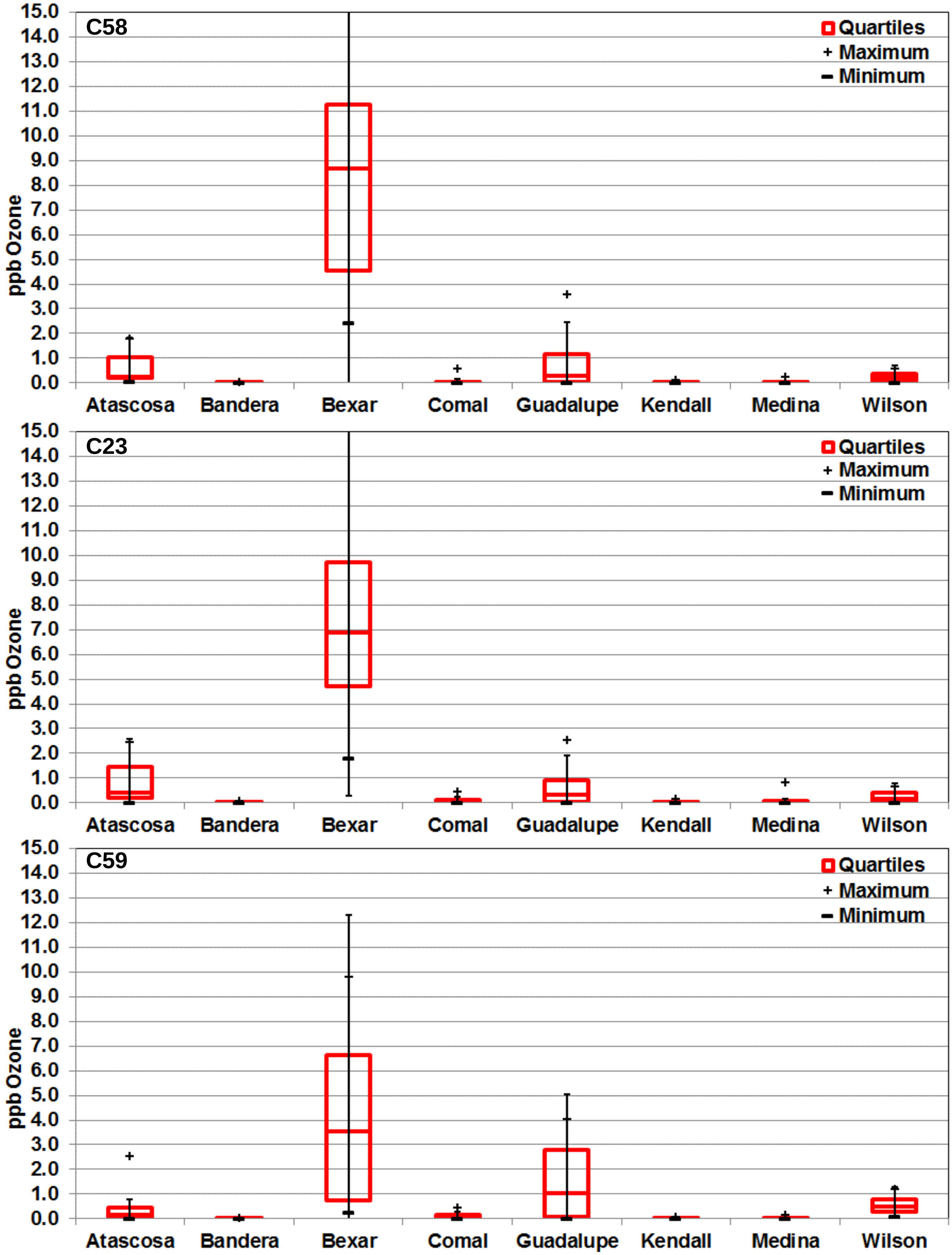


Figure 6-4: Pie Chart for C58 for Average Peak 8-Hour Ozone on Days > 60 ppb by San Antonio-New Braunfels MSA Counties, 2023

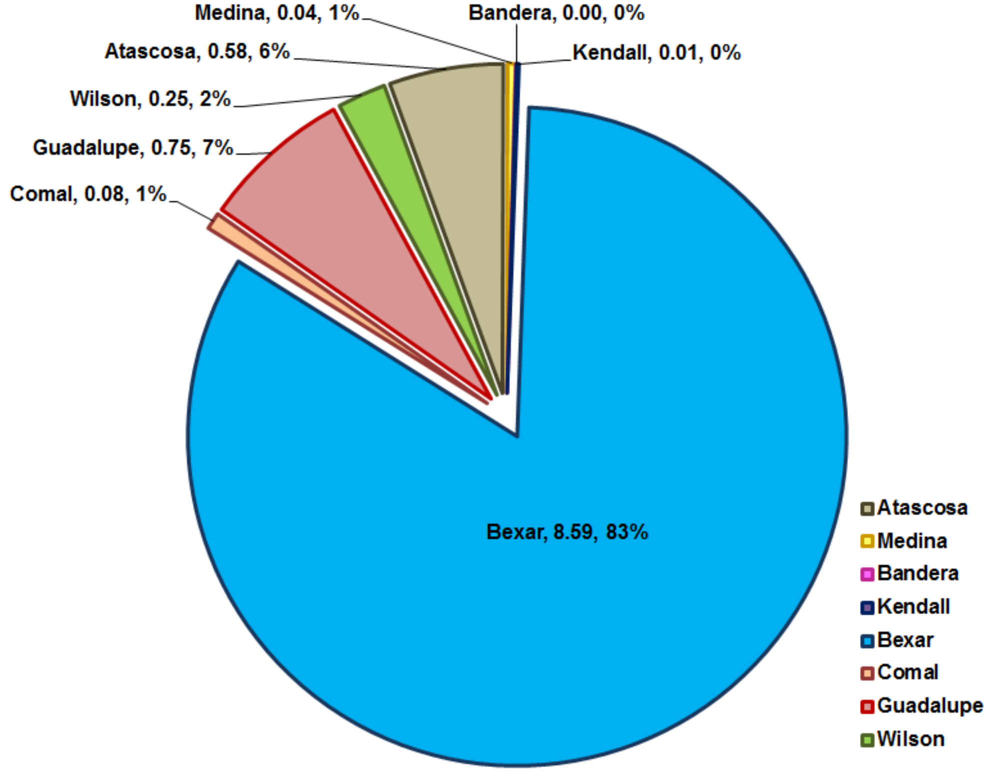


Figure 6-5: Pie Chart for C23 for Average Peak 8-Hour Ozone on Days > 60 ppb by San Antonio-New Braunfels MSA Counties, 2023

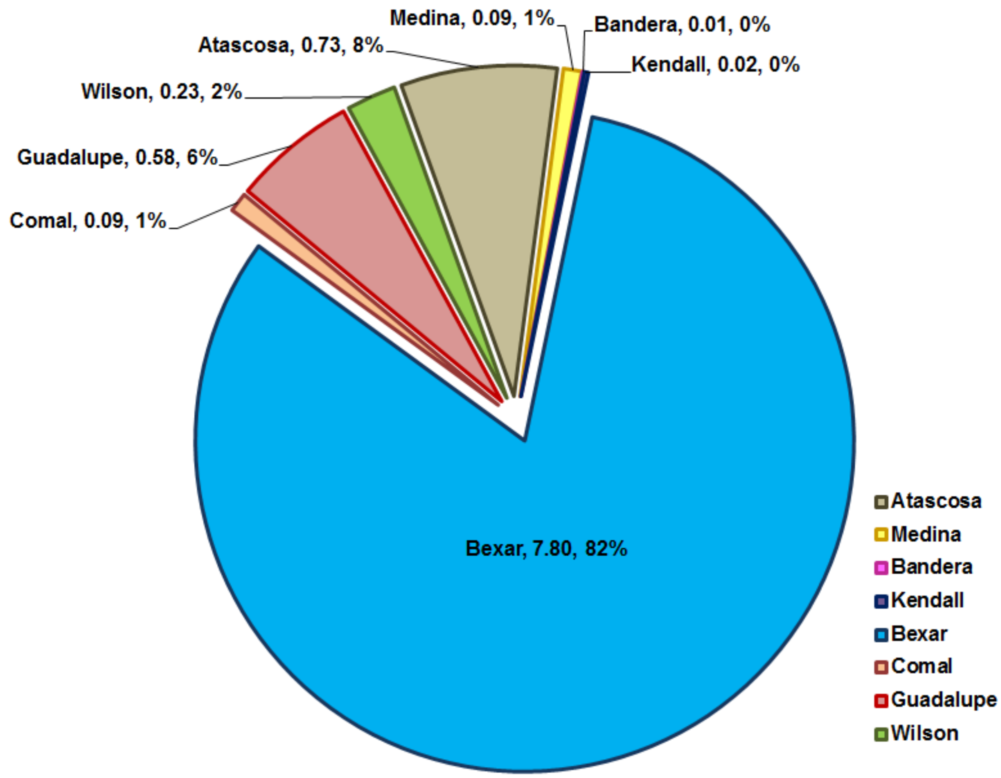
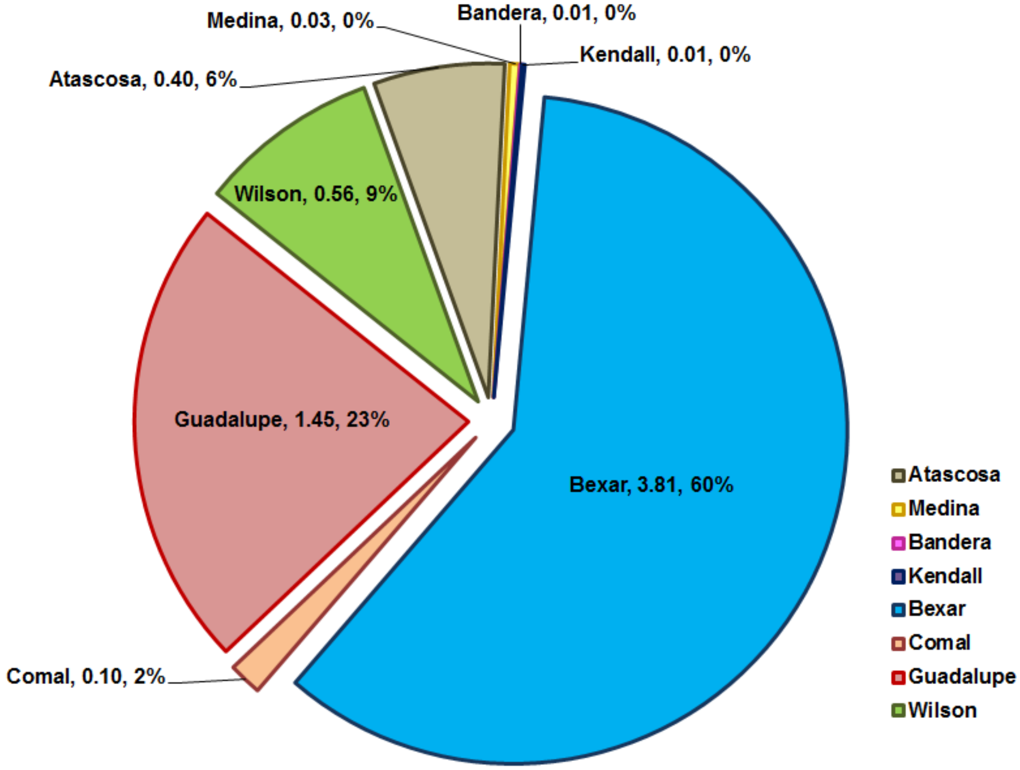


Figure 6-6: Pie Chart for C59 for Average Peak 8-Hour Ozone on Days > 60 ppb by San Antonio-New Braunfels MSA Counties, 2023



Average Ozone Concentrations from each county per ton of anthropogenic NO_X emissions emitted are provided in Figure 6-7. Results are based on taking peak ozone and diving the results by total anthropogenic emissions emitted by each county (Equation 6-1).

Equation 6-1, Parts per billion of ozone for each ton of anthropogenic NO_X emissions emitted, 2023

$$OZONE_I = APCA_I / TON_I$$

Where,

$OZONE_I$ = Parts per billion of ozone for each ton of anthropogenic NOX emissions emitted, 2023, 2023, for region or source I

APCA = ppb of ozone, 2023, for region or source I (from APCA run results)

TON_I = tons of daily NOx emissions, 2023, for region or source I (from 2023 projection emission inventory)

Sample Equation: Parts per billion of ozone for each ton of Bexar County anthropogenic NO_X emissions emitted, 2023

$OZONE_I$ = 8.59 ppb of Ozone / 58.43 tons of NO_X

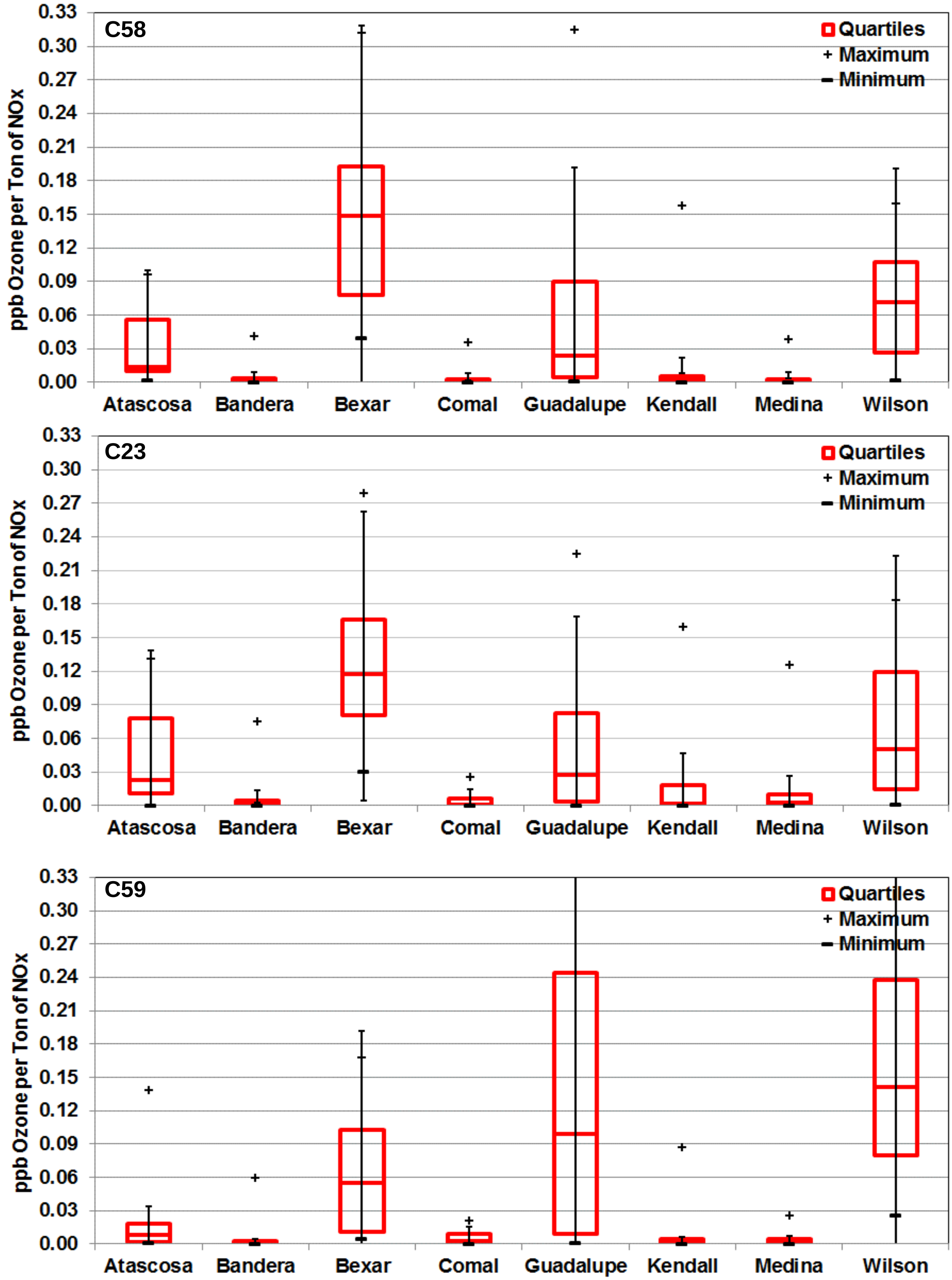
= 0.147 ppb of ozone for each ton of Bexar County daily anthropogenic NO_X emissions emitted, 2023

For every ton of NO_X emission emitted by anthropogenic sources in Bexar County is responsible for 0.15 ppb of ozone at C58 on days > 60 ppb (Table 6-2). Wilson County (0.07 ppb of ozone per ton of NO_X), Guadalupe County (0.07 ppb of ozone per ton of NO_X), and Atascosa County (0.03 ppb of ozone per ton of NO_X) also had a significant contribution per ton of NO_X emitted. The maximum impact for Bexar County was 0.31 ppb per ton of NO_X emissions followed by Guadalupe County at 0.31 ppb, Wilson County at 0.16 ppb, and Atascosa County at 0.10 ppb (Figure 6-7).

Table 6-2: APCA results for Each Ton of NO_X by San Antonio-New Braunfels MSA Counties, 2023

Monitor	County	Tons of NO_X per weekday	All Hours	Daily Maximum (all Days)	Daily Maximum (Days > 60 ppb)	Daily Maximum (Days > 70 ppb)
C58	Atascosa	18.57	0.023	0.051	0.039	0.032
	Bandera	0.92	0.003	0.005	0.008	0.007
	Bexar	58.43	0.037	0.085	0.134	0.195
	Comal	18.24	0.002	0.003	0.005	0.004
	Guadalupe	11.36	0.018	0.029	0.051	0.093
	Kendall	0.98	0.010	0.015	0.020	0.013
	Medina	6.53	0.004	0.006	0.013	0.007
	Wilson	3.51	0.024	0.044	0.066	0.101
C23	Atascosa	18.57	0.018	0.040	0.031	0.041
	Bandera	0.92	0.003	0.003	0.004	0.007
	Bexar	58.43	0.041	0.097	0.147	0.171
	Comal	18.24	0.002	0.004	0.005	0.005
	Guadalupe	11.36	0.023	0.042	0.066	0.053
	Kendall	0.98	0.013	0.018	0.012	0.007
	Medina	6.53	0.002	0.004	0.006	0.011
	Wilson	3.51	0.025	0.046	0.070	0.098
C59	Atascosa	18.57	0.013	0.027	0.022	0.009
	Bandera	0.92	0.001	0.002	0.006	0.004
	Bexar	58.43	0.011	0.023	0.065	0.101
	Comal	18.24	0.001	0.002	0.006	0.004
	Guadalupe	11.36	0.021	0.042	0.128	0.184
	Kendall	0.98	0.003	0.005	0.009	0.006
	Medina	6.53	0.001	0.002	0.005	0.005
	Wilson	3.51	0.059	0.117	0.159	0.120

Figure 6-7 ICQ plots for C58, C23, and C59 for Average Ozone Contribution (ppb) per tons of NO_X Emissions, San Antonio-New Braunfels MSA Counties Days > 60 ppb



6.3 Contribution by Emission Group

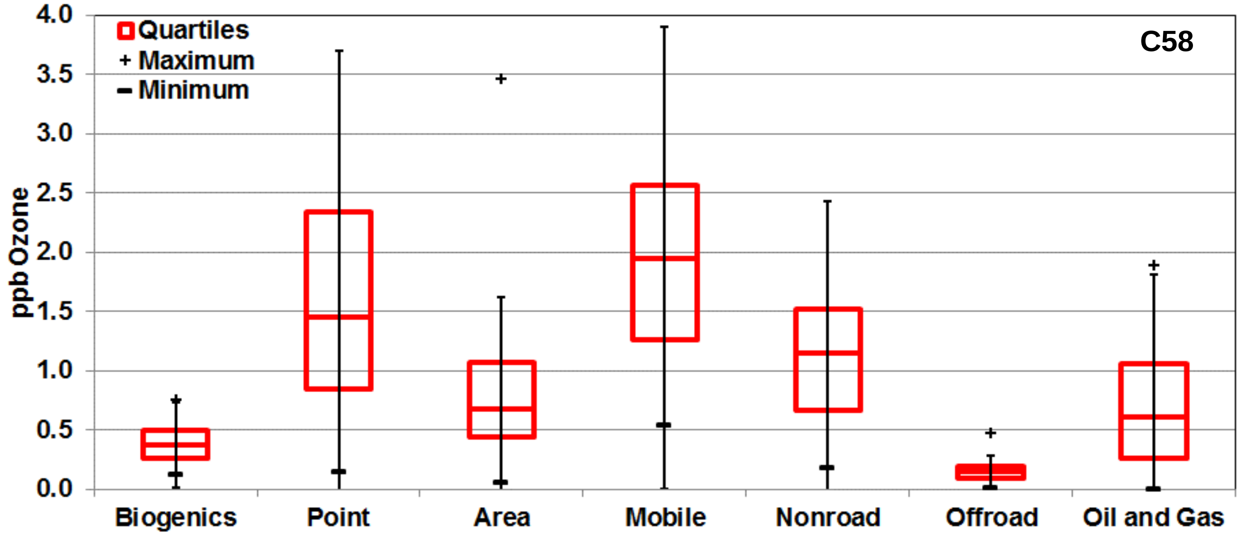
The largest local contribution to peak 8-hour ozone at C58 on days > 60 ppb was on-road sources at 3.12 ppb (Table 6-3). Other large contributors to peak 8-hour ozone was Point sources at 2.79 ppb, Non-road sources at 1.93 ppb, and area sources at 1.28 ppb. Local biogenic emissions (0.47 ppb) and Off-road sources (0.27 ppb) had less of a significant impact on local ozone levels. When looking at the maximum impact with point sources being the largest at 7.69 ppb. On-road (5.83 ppb), non-road sources (4.48 ppb), and area sources (3.47 ppb) had the next highest maximum impact.

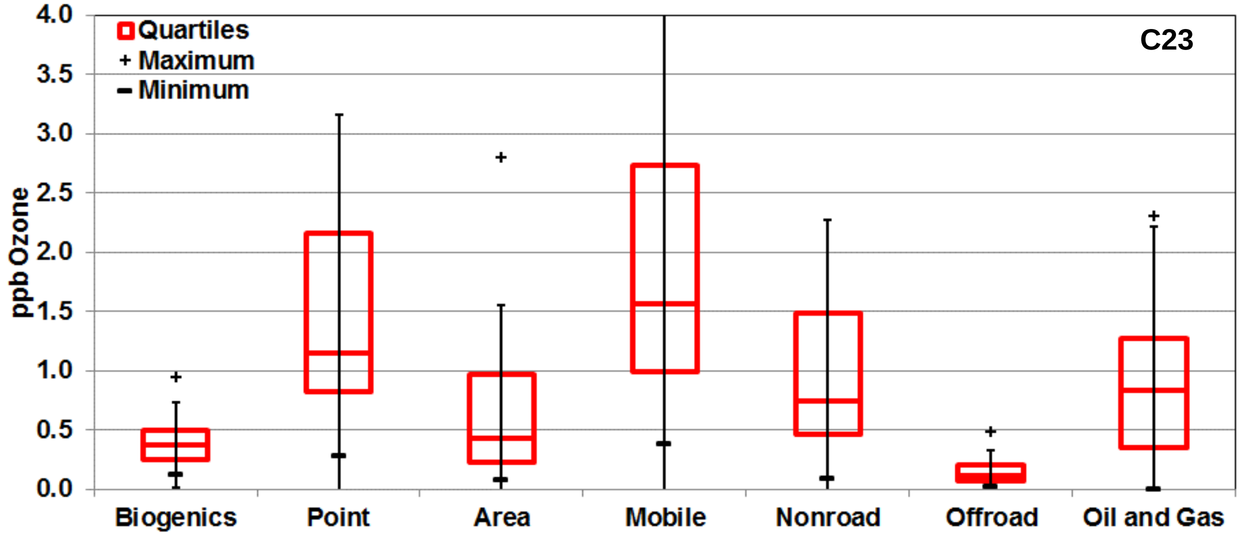
Average Ozone Concentrations from each county per ton of emission group is provided in Figure 6-7. The greatest impact on ozone levels per ton of NO_X emissions was area sources (0.201 ppb per ton of NO_X). Non-road (0.173 ppb per ton of NO_X) and On-road (0.146 ppb per ton of NO_X) also have a significant impact on ozone levels per ton. Although Point sources had a significant impact overall, ppb per ton of emissions was only 0.059. Off-road, and oil and gas sources has had less of an impact at 0.060 ppb and 0.031 ppb per ton of NO_X.

Table 6-3: APCA results for C58, C23, C59 by San Antonio-New Braunfels MSA Emission Group, 2023

Monitor	Region	All Days		Days > 65 ppb		Design Value Days (Average)		Design Value Days (Peak 1-hour)	
		ppb	%	ppb	%	ppb	%	ppb	%
C23	Biogenics	0.19	6.5%	0.42	4.9%	0.50	5.1%	0.59	4.6%
	Point	0.73	24.6%	2.13	25.2%	2.55	25.7%	3.23	25.5%
	Area	0.31	10.4%	0.92	10.9%	1.13	11.4%	1.48	11.7%
	Mobile	0.84	28.6%	2.51	29.7%	2.95	29.8%	3.81	30.1%
	Nonroad	0.45	15.1%	1.38	16.3%	1.68	17.0%	2.18	17.2%
	Offroad	0.06	2.2%	0.21	2.4%	0.25	2.5%	0.33	2.6%
	Oil and Gas	0.37	12.6%	0.88	10.4%	0.84	8.5%	1.04	8.2%
	Total	2.95	100.0%	8.44	100.0%	9.90	100.0%	12.64	100.0%
C58	Biogenics	0.19	5.8%	0.42	4.5%	0.47	4.5%	0.58	4.1%
	Point	0.80	25.3%	2.42	26.1%	2.79	26.5%	3.89	27.6%
	Area	0.37	11.6%	1.07	11.5%	1.28	12.2%	1.79	12.7%
	Mobile	0.92	28.9%	2.76	29.7%	3.12	29.6%	4.09	29.0%
	Nonroad	0.53	16.8%	1.69	18.2%	1.93	18.3%	2.57	18.3%
	Offroad	0.07	2.2%	0.23	2.5%	0.27	2.5%	0.36	2.6%
	Oil and Gas	0.30	9.4%	0.70	7.5%	0.68	6.5%	0.80	5.7%
	Total	3.17	100.0%	9.29	100.0%	10.54	100.0%	14.08	100.0%
C59	Biogenics	0.20	14.4%	0.43	10.4%	0.61	8.8%	0.56	6.1%
	Point	0.45	32.8%	1.53	37.2%	2.90	42.0%	3.61	38.9%
	Area	0.08	5.6%	0.26	6.2%	0.54	7.8%	0.98	10.6%
	Mobile	0.25	18.2%	0.76	18.5%	1.34	19.4%	2.05	22.1%
	Nonroad	0.13	9.6%	0.41	9.9%	0.73	10.6%	1.16	12.5%
	Offroad	0.03	2.0%	0.08	2.0%	0.17	2.4%	0.27	2.9%
	Oil and Gas	0.24	17.4%	0.65	15.7%	0.63	9.1%	0.65	7.0%
	Total	1.37	100.0%	4.11	100.0%	6.91	100.0%	9.27	100.0%

Figure 6-8: ICQ plots for C58, C23, and C59 for Peak 8 hour Ozone by Emission Group on All Day, 2023





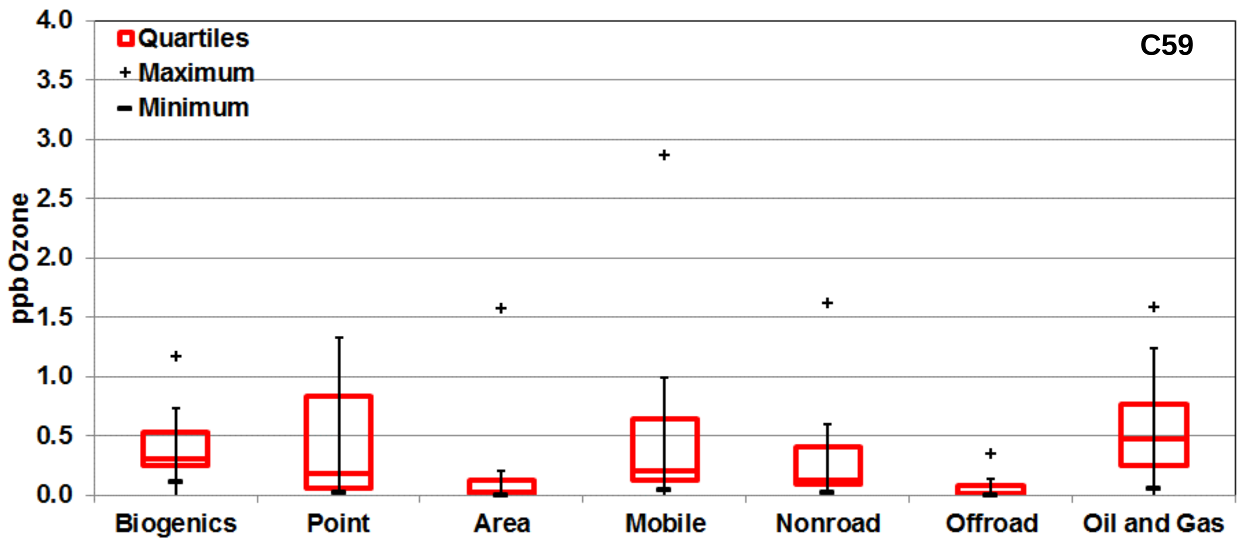


Figure 6-9: ICQ plots for C58, C23, and C59 for Peak 8 hour Ozone by Emission Group on Days > 60 ppb, 2023

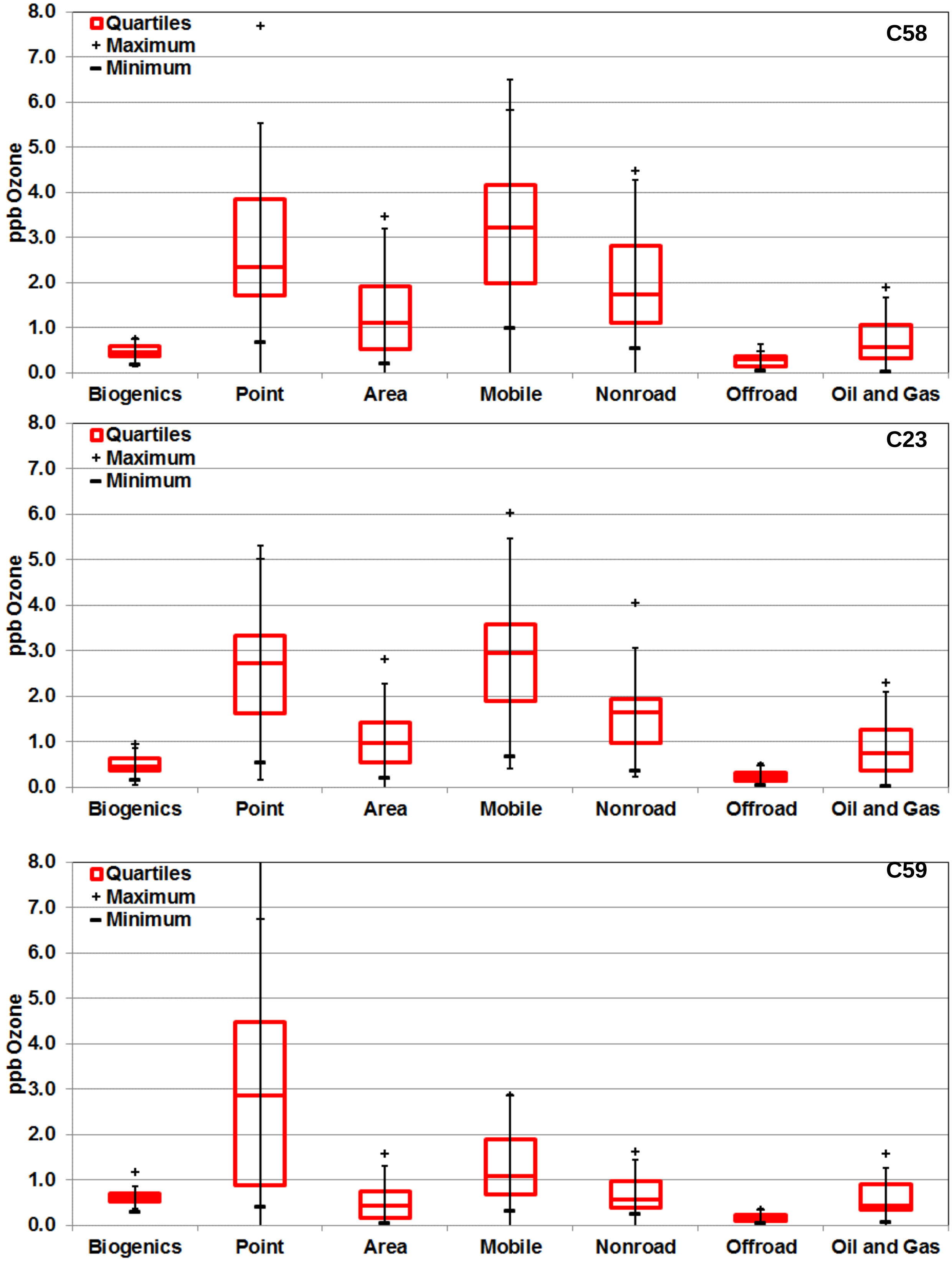


Figure 6-10: Pie Chart for C58 for Average Peak 8-Hour Ozone on Days > 60 ppb by Emission Group, 2023

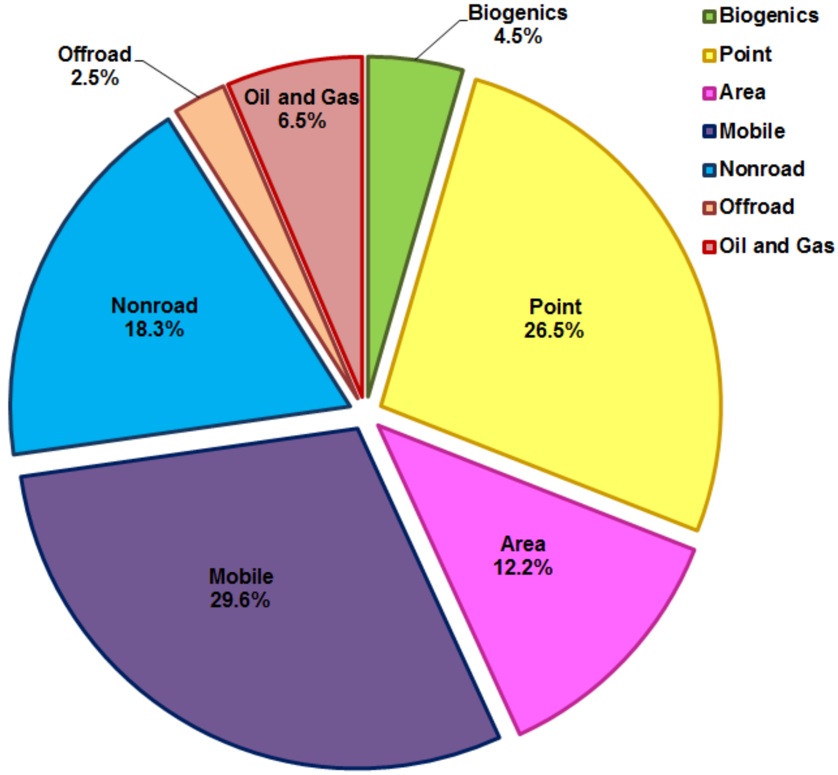


Figure 6-11: Pie Chart for C23 for Average Peak 1-Hour Ozone Days > 60 ppb by Emission Groups, 2023

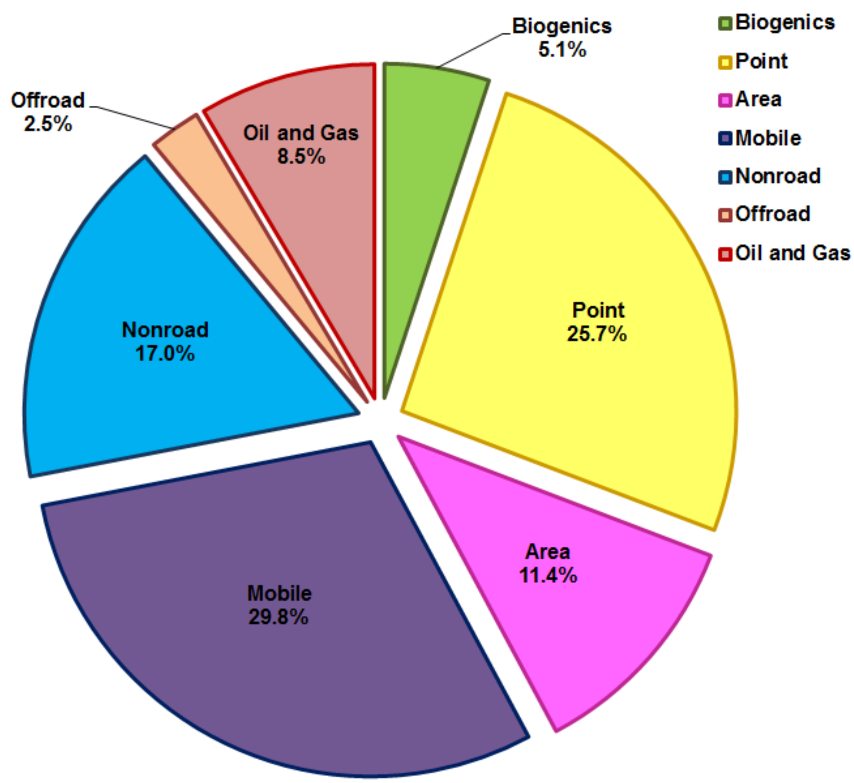


Figure 6-12: Pie Chart for C59 for Average Peak 8-Hour Ozone on Days > 60 ppb by Emission Groups, 2023

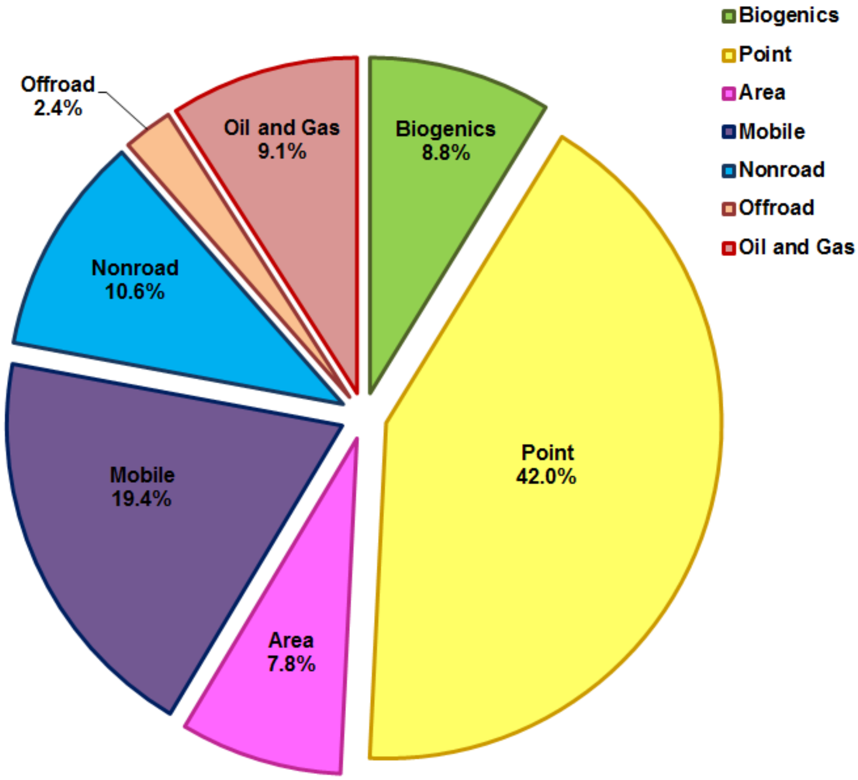
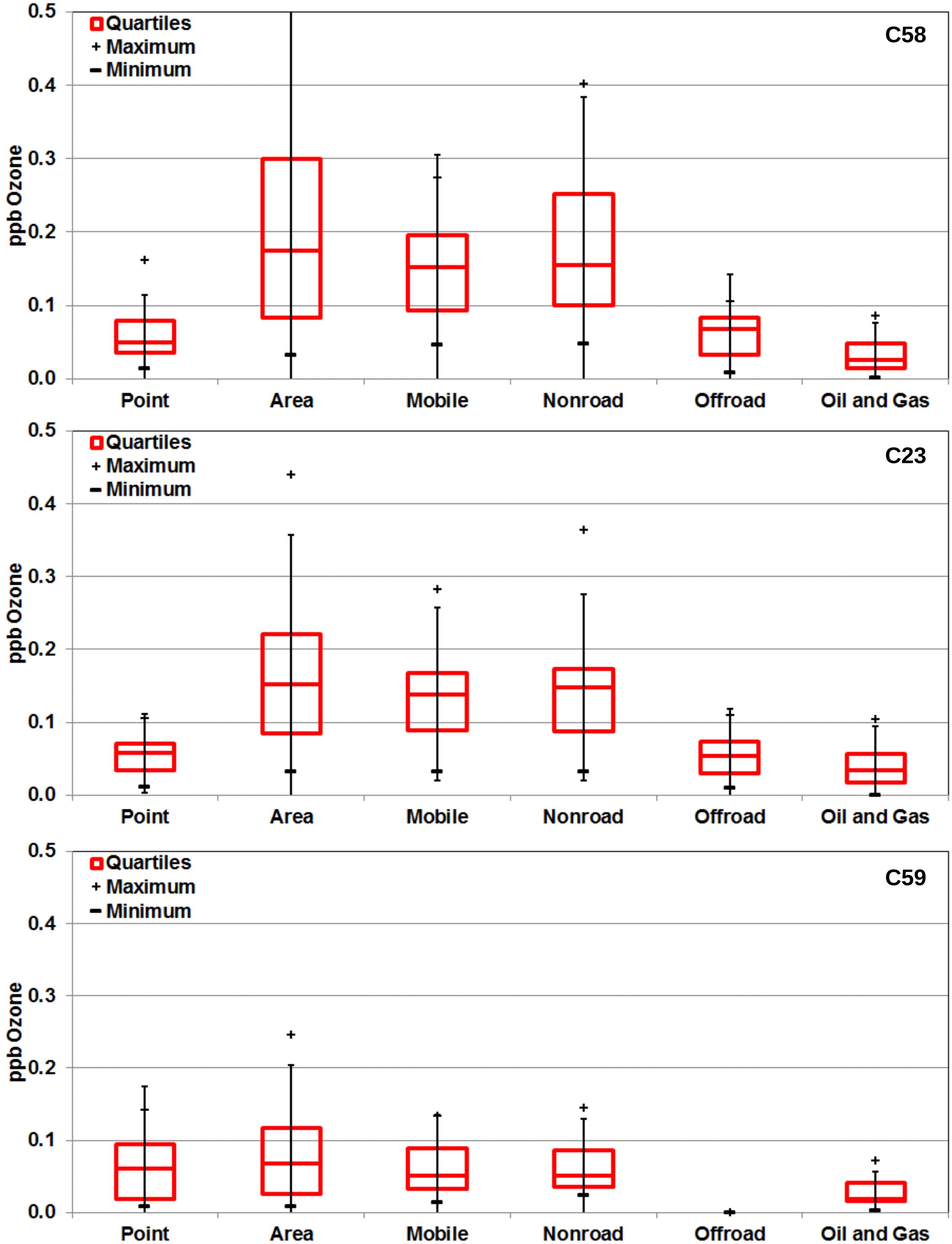


Table 6-4: APCA results for Each Ton of NO_X by Emission Group, 2023

Monitor	County	Tons of NOX per day	All Hours	Daily Maximum (all Days)	Daily Maximum (Days > 60 ppb)	Daily Maximum (Days > 70 ppb)
C23	Point	47.44	0.015	0.034	0.054	0.068
	Area	6.38	0.048	0.108	0.177	0.232
	Mobile	21.31	0.040	0.092	0.138	0.179
	Nonroad	11.15	0.040	0.095	0.151	0.195
	Offroad	4.43	0.014	0.035	0.056	0.074
	Oil and Gas	22.03	0.017	0.038	0.038	0.047
C58	Point	47.44	0.017	0.039	0.059	0.082
	Area	6.38	0.058	0.133	0.201	0.281
	Mobile	21.31	0.043	0.102	0.146	0.192
	Nonroad	11.15	0.048	0.116	0.173	0.231
	Offroad	4.43	0.016	0.039	0.060	0.082
	Oil and Gas	22.03	0.013	0.030	0.031	0.036
C59	Point	47.44	0.009	0.022	0.061	0.076
	Area	6.38	0.012	0.026	0.085	0.154
	Mobile	21.31	0.012	0.025	0.063	0.096
	Nonroad	11.15	0.012	0.026	0.066	0.104
	Offroad	4.43	0.006	0.013	0.037	0.060
	Oil and Gas	22.03	0.011	0.024	0.029	0.029

Figure 6-13 ICQ plots for C58, C23, and C59 for Average Ozone Contribution (ppb) per tons of NO_X Emissions, San Antonio-New Braunfels MSA Days > 60 ppb



6.4 Contribution by NO_X and VOC Emissions

Figure 6-14 and Figure 6-15 provides the average hourly contribution to ozone from VOC and NO_X emissions. For both all days and days > 60 ppb., VOC emissions did not have a significant impact on hourly ozone.

Figure 6-14 Average Hourly Contributions by San Antonio-New Braunfels MSA NO_X and VOC Emissions on All Days

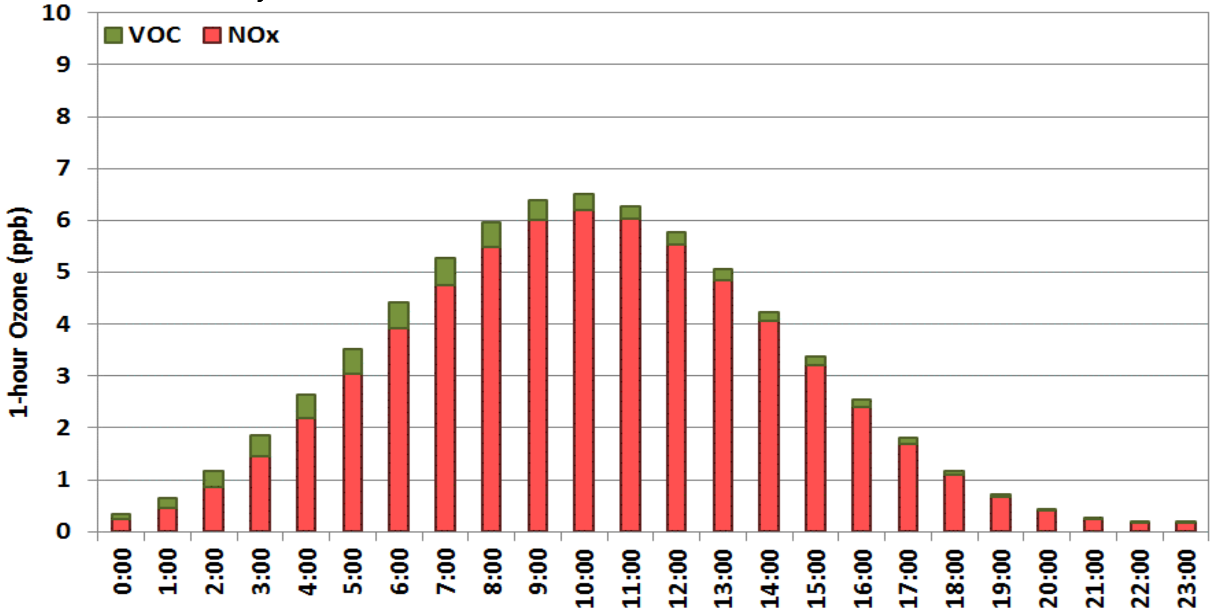
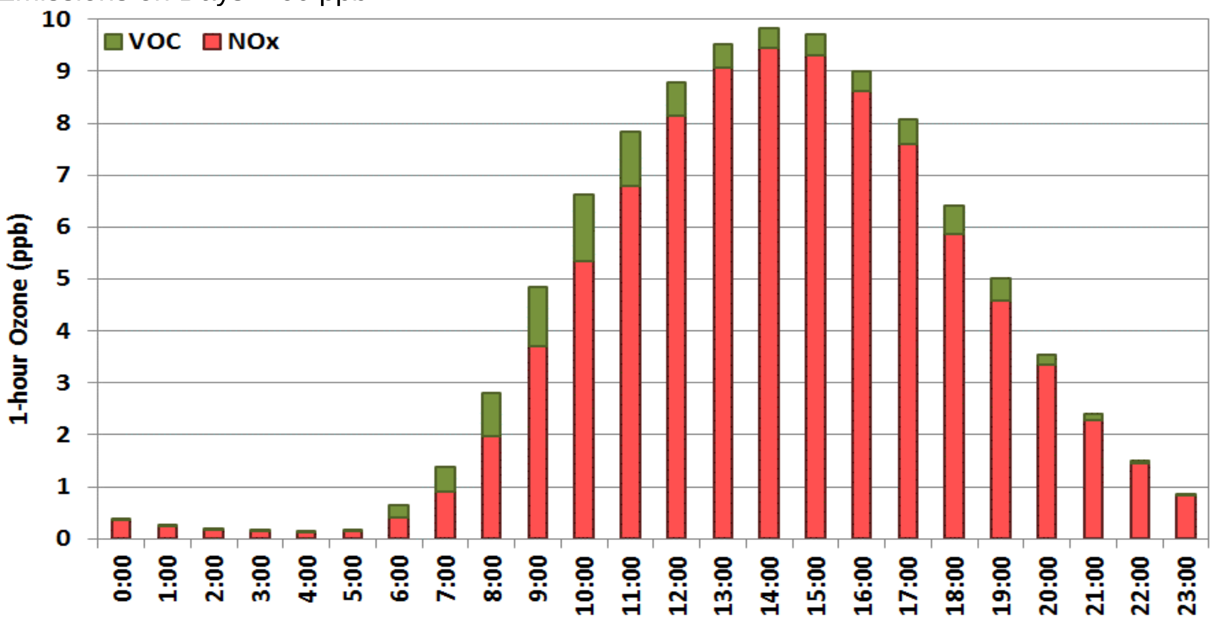


Figure 6-15 Average Hourly Contributions by San Antonio-New Braunfels MSA NO_X and VOC Emissions on Days > 60 ppb



7 Texas Regions APCA Run

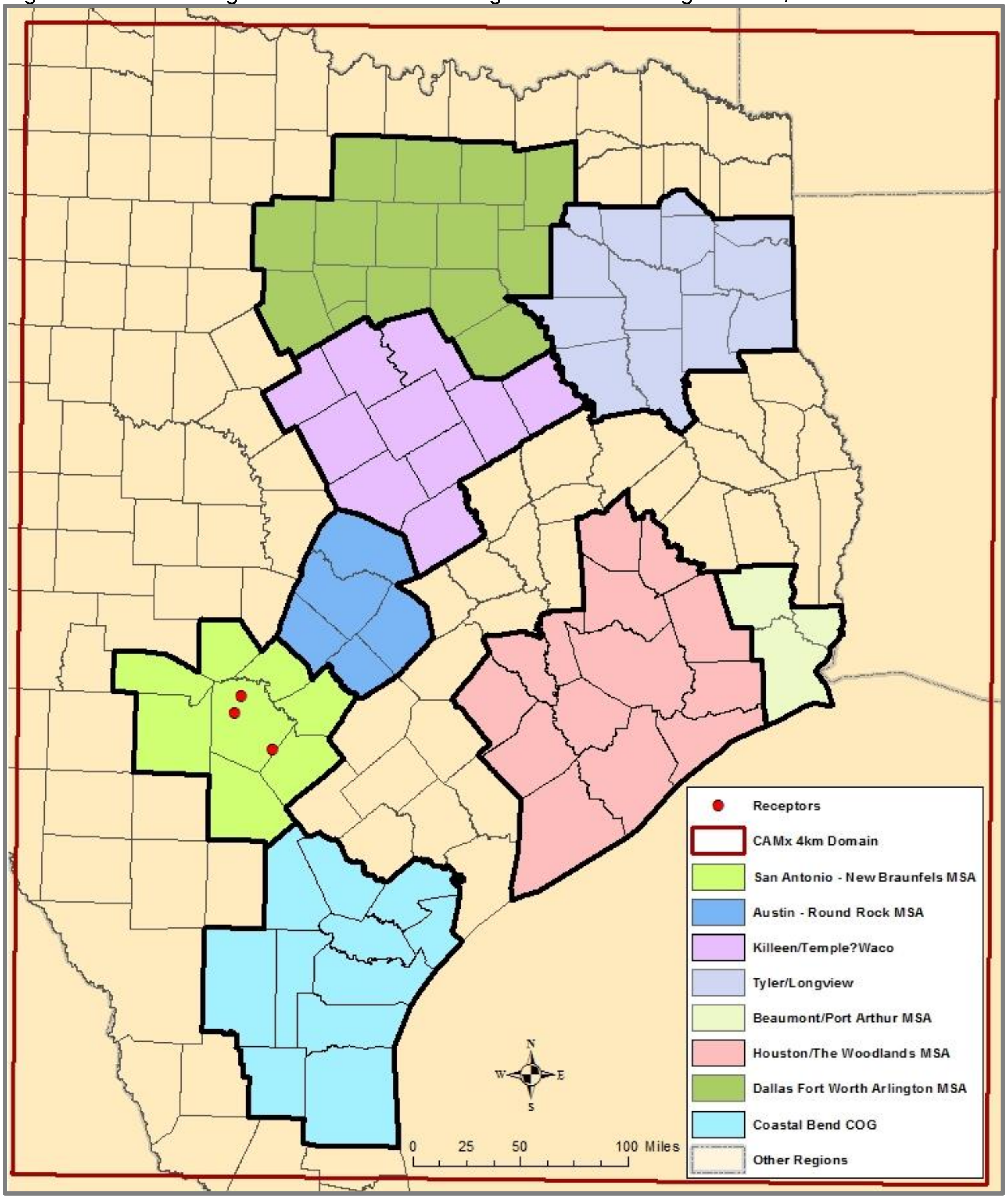
7.1 APCA Run Setup

An APCA was also run at the 4-km, 12-km, and 36-km grid sizes to analyze the impact of other regions in Texas on ozone recorded at regulatory monitors in the San Antonio-New Braunfels MSA. For the APCA run, the receptors defined in the run are the 3 ozone regulatory monitors in the San Antonio-New Braunfels MSA: C23, C58, and C59.

The APCA run was divided into 9 geographical areas, initial conditions, and boundary conditions (Figure 8-1). The geographic source apportionment areas are:

- San Antonio –New Braunfels MSA
- Killeen/Temple/Waco
- Beaumont/Port Arthur MSA
- Dallas/Fort Worth/Arlington MSA
- All Other Regions
- Initial Conditions
- Austin/Round Rock MSA
- Tyler/Longview
- Houston/The Woodlands/Sugar Land MSA
- Coastal Bend COG
- Boundary conditions

Figure 7-1: APCA Regions for Other Texas Regions at the 4-Km grid Level, 2023



Plot Date: June 15, 2017
Map Compilation: June 15, 2017
Source: APCA run Setup for Texas Regions

7.2 Contribution by Source Region

In the APCA run, San Antonio-New Braunfels MSA emissions had the greatest impact on ozone levels at C58 on days > 60 ppb (10.31 ppb in Table 8-1). There was also a significant contribution, 1.59 ppb, from the Houston in 2023. Other regions that had a significant impact were Corpus Christi (0.94 ppb), Temple/Waco area (0.89 ppb), and Austin (0.68 ppb).

The results for C23 are very similar to C58 except there was a slightly less contribution from the local region (8.89 ppb) and from Houston (1.46 ppb). At C59, San Antonio-New Braunfels MSA contribution to peak 8-hour ozone (5.54 ppb) was significantly less than at the other two monitors because this monitor is often upwind of the San Antonio urban core and other large local emission sources on high-ozone days. Houston (2.30 ppb), Austin (1.23 ppb), and Beaumont (1.21 ppb) have a greater impact on local ozone at this monitor.

Table 7-1: APCA results for C58, C23, C59 by San Antonio-New Braunfels MSA County, 2023

Monitor	Region	All Days		Daily Maximum (all Days)		Daily Maximum (Days > 60 ppb)		Daily Maximum (Days > 70 ppb)	
		ppb	%	ppb	%	ppb	%	ppb	%
C23	Initial Conditions	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Boundary	17.07	46.2%	23.04	45.5%	17.59	30.6%	14.87	23.4%
	All Others	13.99	37.8%	17.02	33.6%	24.75	43.1%	29.17	45.8%
	San Antonio	2.84	7.7%	6.26	12.4%	8.89	15.5%	11.89	18.7%
	Austin	0.41	1.1%	0.32	0.6%	0.72	1.3%	0.79	1.2%
	Temple/Waco	0.39	1.0%	0.42	0.8%	0.91	1.6%	1.22	1.9%
	Tyler/Longview	0.20	0.5%	0.26	0.5%	0.46	0.8%	1.15	1.8%
	Beaumont	0.22	0.6%	0.39	0.8%	0.90	1.6%	0.56	0.9%
	Houston	0.50	1.3%	0.75	1.5%	1.46	2.5%	2.99	4.7%
	Dallas	0.32	0.9%	0.40	0.8%	0.79	1.4%	0.31	0.5%
	Corpus Christi	1.05	2.8%	1.73	3.4%	0.95	1.7%	0.74	1.2%
	Total	36.98	100.0%	50.60	100.0%	57.42	100.0%	63.70	100.0%
C58	Initial Conditions	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Boundary	17.57	46.0%	23.07	44.9%	18.38	31.4%	15.96	24.2%
	All Others	14.44	37.8%	17.03	33.1%	24.44	41.7%	29.70	45.1%
	San Antonio	3.09	8.1%	6.99	13.6%	10.31	17.6%	13.50	20.5%
	Austin	0.44	1.1%	0.38	0.7%	0.68	1.2%	0.54	0.8%
	Temple/Waco	0.42	1.1%	0.46	0.9%	0.89	1.5%	1.09	1.7%
	Tyler/Longview	0.22	0.6%	0.28	0.5%	0.50	0.9%	1.14	1.7%
	Beaumont	0.19	0.5%	0.31	0.6%	0.35	0.6%	0.47	0.7%
	Houston	0.51	1.3%	0.75	1.5%	1.59	2.7%	2.44	3.7%
	Dallas	0.34	0.9%	0.43	0.8%	0.46	0.8%	0.32	0.5%
	Corpus Christi	1.02	2.7%	1.67	3.3%	0.94	1.6%	0.67	1.0%
	Total	38.23	100.0%	51.37	100.0%	58.54	100.0%	65.84	100.0%

Monitor	Region	All Days		Days > 65 ppb		Design Value Days (Average)		Design Value Days (Peak 1-hour)	
		ppb	%	ppb	%	ppb	%	ppb	%
C58	Initial Conditions	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Boundary	15.87	46.7%	23.00	46.9%	14.89	25.6%	11.84	19.5%
	All Others	13.70	40.3%	18.27	37.3%	29.27	50.4%	27.94	46.1%
	San Antonio	1.27	3.8%	2.60	5.3%	5.54	9.5%	8.71	14.4%
	Austin	0.34	1.0%	0.38	0.8%	1.23	2.1%	1.91	3.2%
	Temple/Waco	0.30	0.9%	0.38	0.8%	1.16	2.0%	1.91	3.1%
	Tyler/Longview	0.18	0.5%	0.26	0.5%	0.77	1.3%	2.03	3.3%
	Beaumont	0.20	0.6%	0.38	0.8%	1.21	2.1%	0.92	1.5%
	Houston	0.55	1.6%	0.87	1.8%	2.30	4.0%	4.53	7.5%
	Dallas	0.28	0.8%	0.38	0.8%	1.03	1.8%	0.28	0.5%
	Corpus Christi	1.27	3.7%	2.48	5.1%	0.67	1.2%	0.55	0.9%
	Total	33.96	100.0%	48.99	100.0%	58.06	100.0%	60.62	100.0%

Figure 7-2: ICQ plots for C58, C23, and C59 for Peak 8 hour Ozone by Texas Regions on All Day, 2023

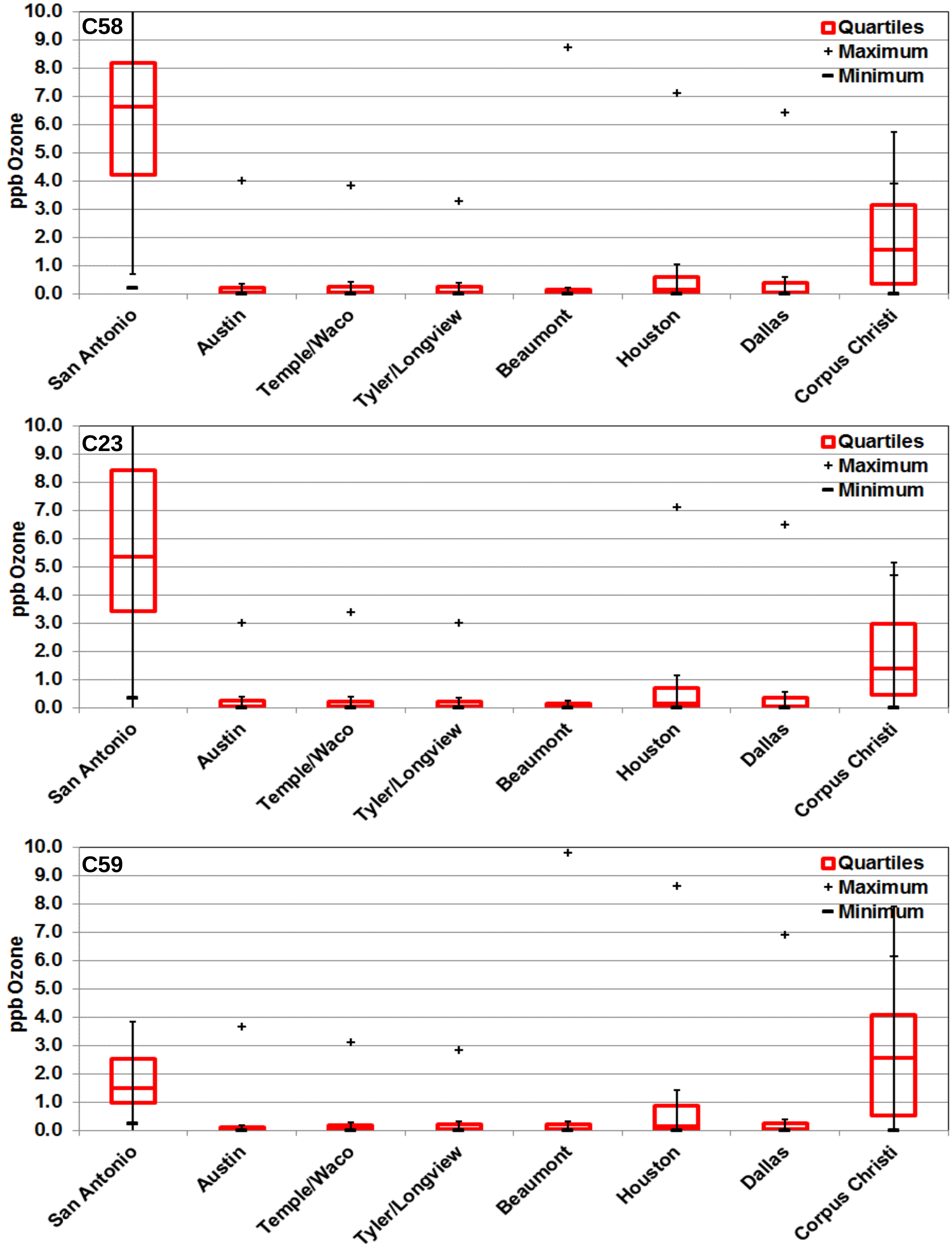


Figure 7-3: ICQ plots for C58, C23, and C59 for Peak 8 hour Ozone by Texas Regions on Days > 60 ppb, 2023

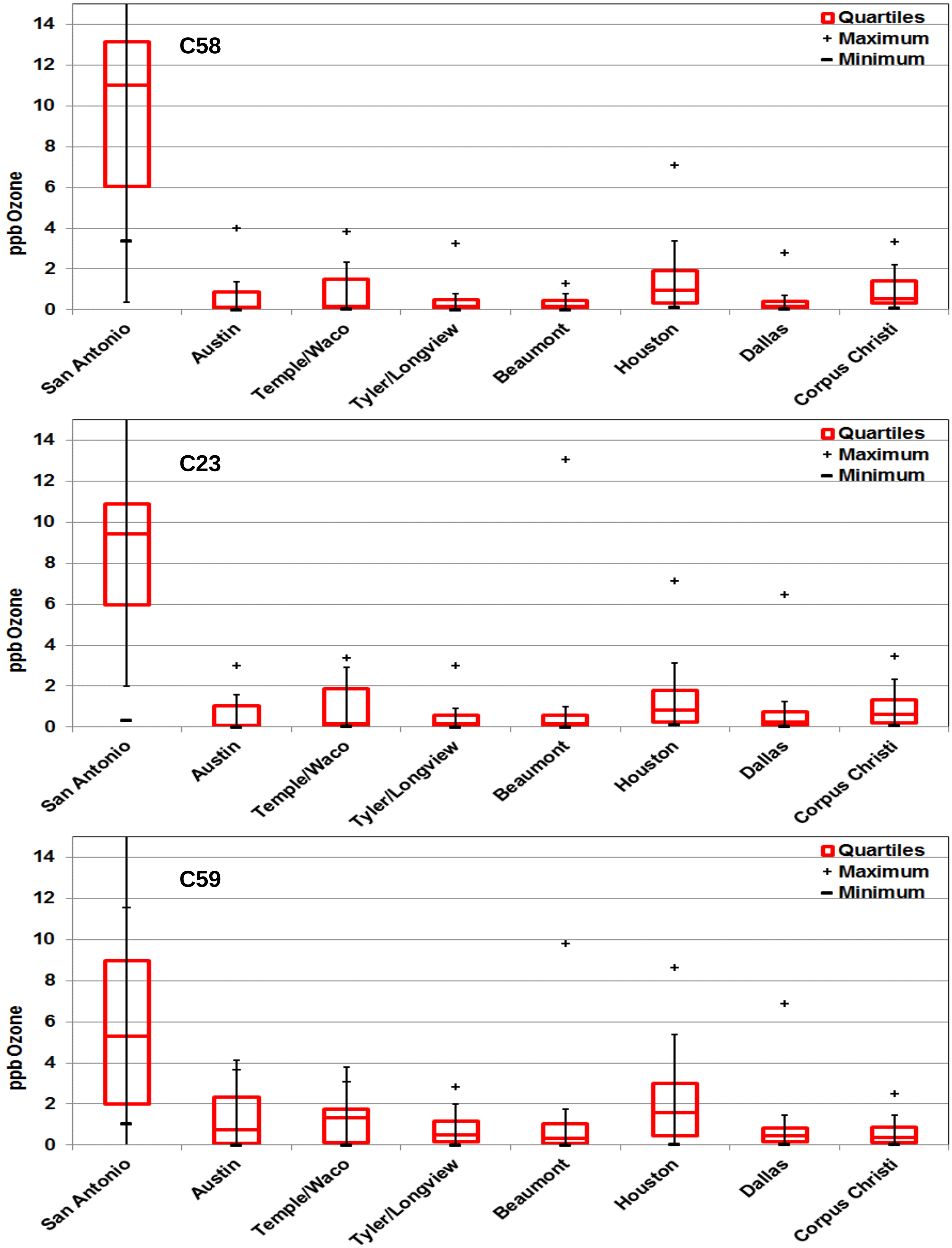


Figure 7-4: Pie Chart for C58 for Average Peak 8-Hour Ozone by Texas Regions on Days > 60 ppb, 2023

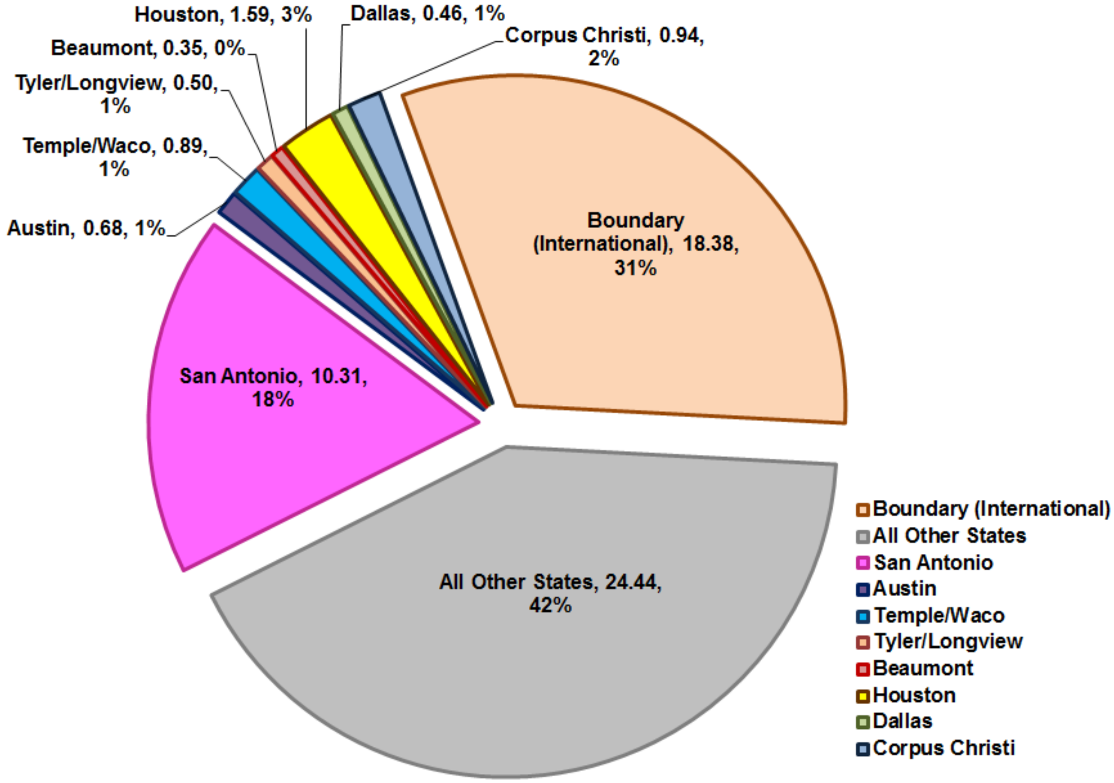


Figure 7-5: Pie Chart for C23 for Average Peak 8-Hour Ozone by Texas Regions on Days > 60 ppb, 2023

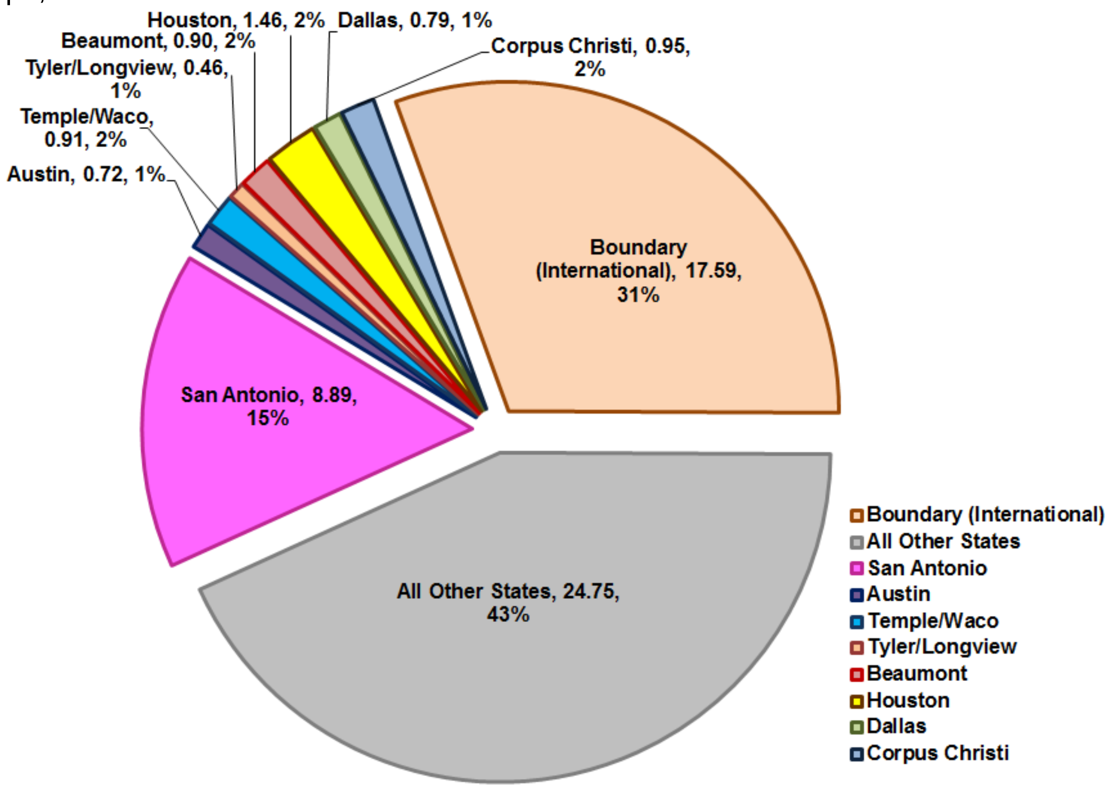
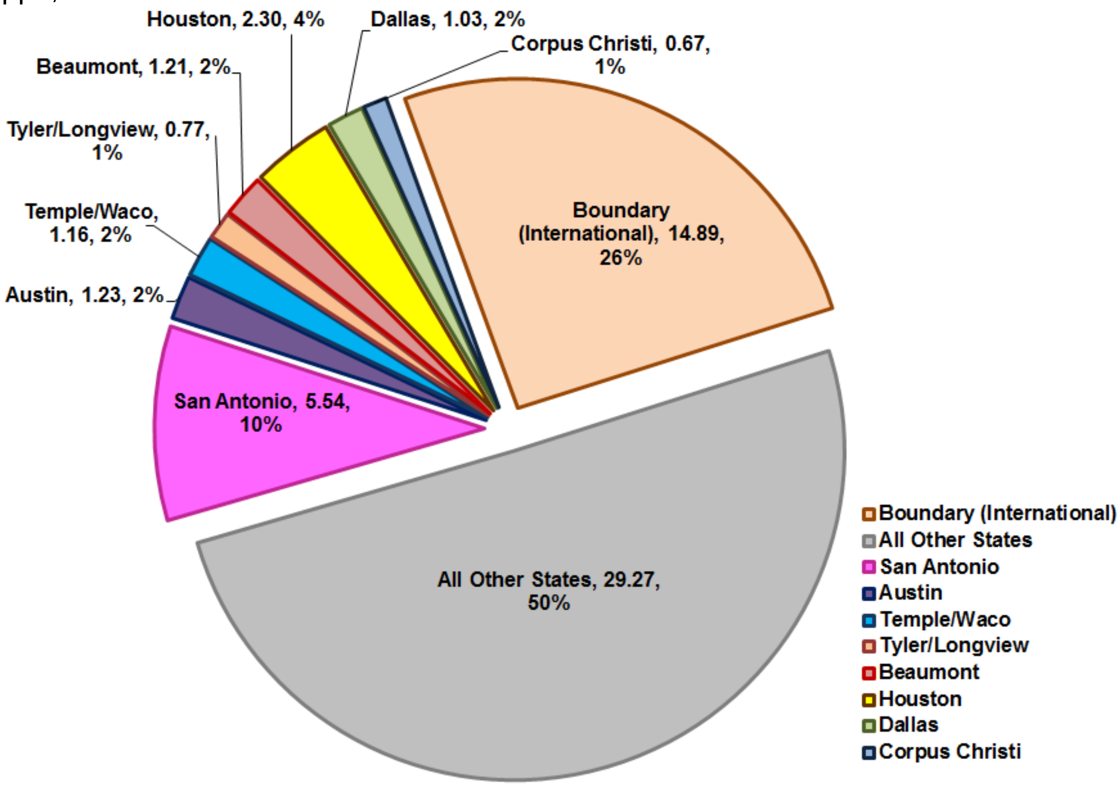


Figure 7-6: Pie Chart for C59 for Average Peak 8-Hour Ozone by Texas Regions on Days > 60 ppb, 2023



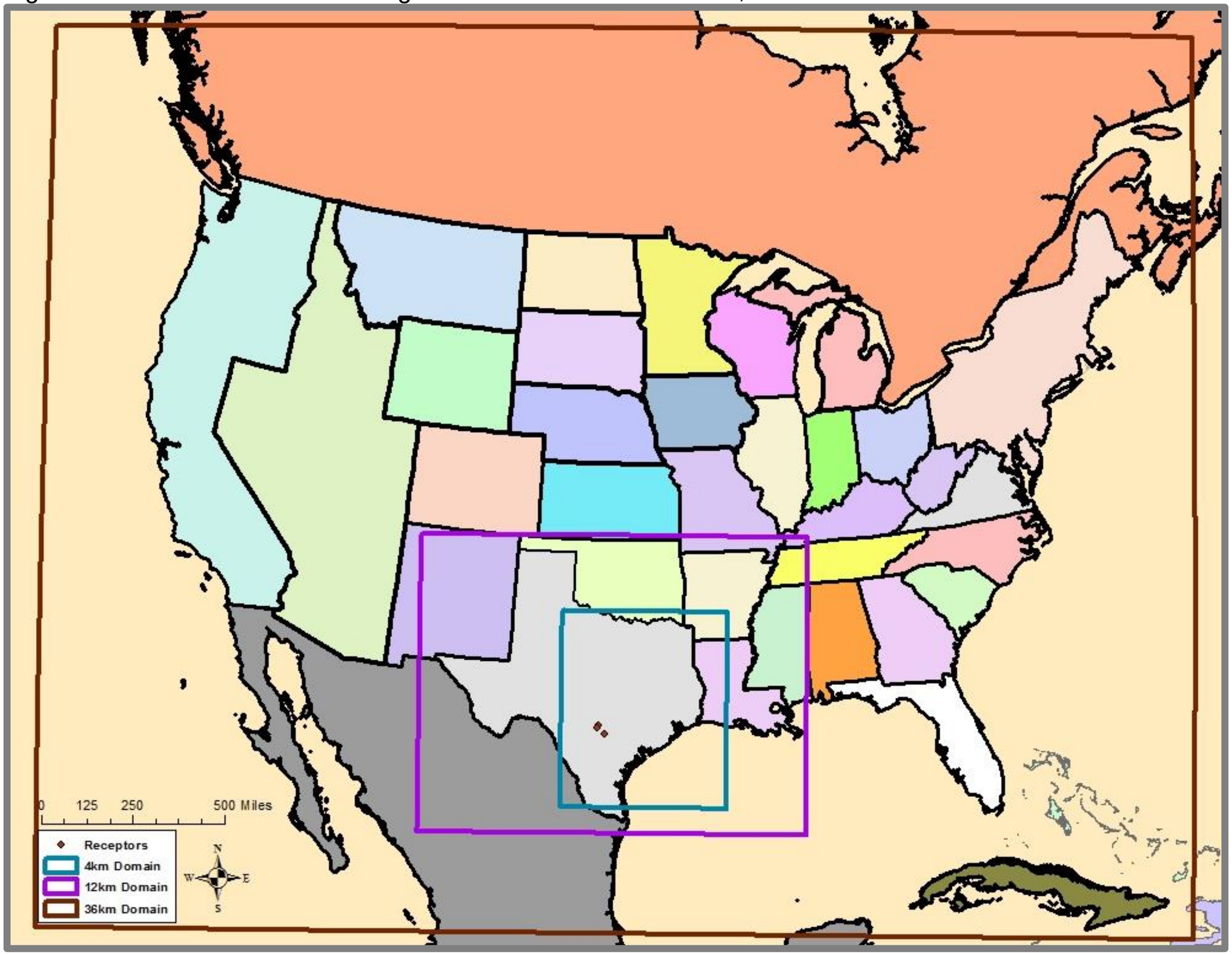
8 Other States APCA Run

8.1 APCA Run Setup

For the third APCA run, the model was used to analysis the impact of other states on ozone recorded at regulatory monitors in the San Antonio-New Braunfels MSA. The APCA run was divided into 26 geographical areas, initial conditions, and boundary conditions (Figure 8-1). The geographic source apportionment areas are:

- Texas
- Arkansas
- Kansas
- Tennessee
- Colorado
- Florida
- Virginia
- Indiana
- Minnesota
- Michigan
- DE/DC/MD
- Mountain
- Caribbean
- Initial Conditions
- Oklahoma
- Nebraska
- Missouri
- Mississippi
- Alabama
- South Carolina
- West Virginia
- Illinois
- South Dakota
- Wisconsin
- Northeast
- Offshore
- Canada
- Louisiana
- Kentucky
- New Mexico
- Georgia
- North Carolina
- Ohio
- Iowa
- North Dakota
- Wyoming
- Pacific States
- Mexico
- Boundary Conditions

Figure 8-1: APCA Other States/Regions at the 36-Km Grid Level, 2023



Plot Date: June 15, 2017
Map Compilation: June 15, 2017
Source: APCA run Setup for States

8.2 Contribution by Source Region

In the APCA run, Texas emission sources were the largest contribution of peak 8-hour ozone on days > 60 ppb C58 (34.5 percent Table 8-1). International was the second largest contributor (32.5 percent). Emission reduction controls in Texas can be effective in reducing ozone levels at the regulatory monitors in San Antonio-New Braunfels MSA. There was also a significant contribution from Offshore (9.9 percent) in 2023. From other regions, Louisiana at 4.4 percent had the highest contribution followed by Alabama at 1.5 percent and Oklahoma at 1.4 percent. Other states that had a significant contribution to peak 8-hour ozone were Georgia (1.1 percent), Mississippi (1.1 percent), and Kentucky (0.8 percent).

The results for C23 are very similar to C58 except there was a slightly less contribution from International sources (31.2 percent) and from Texas (30.1 percent). There was also a greater impact from North Carolina (1.8 percent). At C59, International contribution to average peak 8-hour ozone (23.1 percent) was less than at the other two monitors. Louisiana (5.4 percent), Tennessee (4.4 percent), North Carolina (2.6 percent) have a greater impact on local ozone at this monitor. Pie charts of the largest contributors on days > 60 ppb are provided in Figure 8-2, Figure 8-3, and Figure 8-4.

Interquartile range (ICQ) plots in Figure 8-5 shows some states can contribute a wide range of values at C58. Texas can contribute up to 30.4 ppb of hourly ozone at the C58 monitor. Both of the Gulf of Mexico, Atlantic, and Pacific Ocean regions can contribute up to 14.3 ppb and Louisiana can contribute up to 6.8 ppb. Oklahoma (4.9 ppb), Georgia. (2.7 ppb), and Arkansas (2.6 ppb) can also have a significant maximum impact on local hourly ozone. Maps in Figure 8-7 to Figure 8-10 show the spatial distribution of contributions to ozone from other states to peak 8-hour ozone at C58 on days > 60 ppb. The maps shows how South Eastern US has a great impact on ozone levels at C58 ozone monitor

Table 8-1: APCA results for C58, C23, and C59 by Source Region for Other States/Regions, 2023

Monitor	Region	All Hours		Daily Maximum (all Days)		Daily Maximum (Days > 60 ppb)	
		ppb	%	ppb	%	ppb	%
C23	Initial Conditions	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Boundary	17.66	48.7%	23.77	48.2%	17.46	31.2%
	Offshore	4.41	12.2%	4.06	8.2%	4.88	8.7%
	Texas	7.02	19.4%	12.13	24.6%	16.88	30.1%
	Louisiana	0.80	2.2%	0.95	1.9%	2.15	3.8%
	Arkansas	0.27	0.7%	0.32	0.7%	0.69	1.2%
	Oklahoma	0.39	1.1%	0.54	1.1%	1.01	1.8%
	Mexico	0.94	2.6%	1.60	3.2%	0.83	1.5%
	Kansas	0.16	0.5%	0.24	0.5%	0.37	0.7%
	Missouri	0.17	0.5%	0.21	0.4%	0.42	0.7%
	Kentucky	0.29	0.8%	0.33	0.7%	0.72	1.3%
	Tennessee	0.54	1.5%	0.66	1.3%	1.49	2.7%
	Mississippi	0.26	0.7%	0.33	0.7%	0.76	1.4%
	New Mexico	0.14	0.4%	0.20	0.4%	0.25	0.4%
	Colorado	0.10	0.3%	0.14	0.3%	0.21	0.4%
	Alabama	0.31	0.9%	0.36	0.7%	0.82	1.5%
	Georgia	0.22	0.6%	0.30	0.6%	0.76	1.4%
	Florida	0.40	1.1%	0.37	0.8%	0.35	0.6%
	South Carolina	0.11	0.3%	0.13	0.3%	0.38	0.7%
	North Carolina	0.38	1.0%	0.52	1.1%	1.00	1.8%
	Virginia	0.13	0.4%	0.16	0.3%	0.38	0.7%
	West Virginia	0.05	0.1%	0.08	0.2%	0.19	0.3%
	Ohio	0.06	0.2%	0.07	0.1%	0.19	0.3%
	Indiana	0.11	0.3%	0.13	0.3%	0.30	0.5%
	Illinois	0.16	0.4%	0.19	0.4%	0.41	0.7%
	Northeast	0.10	0.3%	0.14	0.3%	0.39	0.7%
	Minnesota	0.07	0.2%	0.09	0.2%	0.17	0.3%
	Mountain	0.13	0.4%	0.20	0.4%	0.29	0.5%
	DE/DC/MD	0.02	0.1%	0.02	0.0%	0.06	0.1%
	Michigan	0.13	0.3%	0.14	0.3%	0.32	0.6%
	Wisconsin	0.07	0.2%	0.13	0.3%	0.25	0.4%
	Iowa	0.07	0.2%	0.09	0.2%	0.15	0.3%
	Nebraska	0.09	0.2%	0.12	0.2%	0.19	0.3%
	South Dakota	0.03	0.1%	0.04	0.1%	0.07	0.1%
	North Dakota	0.07	0.2%	0.12	0.2%	0.31	0.6%
	Wyoming	0.04	0.1%	0.07	0.1%	0.07	0.1%
	Pacific	0.10	0.3%	0.13	0.3%	0.25	0.4%
	Caribbean	0.02	0.1%	0.03	0.1%	0.05	0.1%
	Canada	0.22	0.6%	0.26	0.5%	0.55	1.0%
	Total	36.23	100.0%	49.35	100.0%	56.01	100.0%

Monitor	Region	All Hours		Daily Maximum (all Days)		Daily Maximum (Days > 60 ppb)	
		ppb	%	ppb	%	ppb	%
C58	Initial Conditions	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Boundary	18.18	48.4%	23.81	47.4%	18.69	32.5%
	Offshore	4.58	12.2%	4.07	8.1%	5.70	9.9%
	Texas	7.43	19.8%	12.97	25.8%	19.84	34.5%
	Louisiana	0.82	2.2%	0.96	1.9%	2.54	4.4%
	Arkansas	0.28	0.7%	0.33	0.7%	0.58	1.0%
	Oklahoma	0.41	1.1%	0.56	1.1%	0.83	1.4%
	Mexico	0.96	2.6%	1.61	3.2%	0.93	1.6%
	Kansas	0.18	0.5%	0.25	0.5%	0.33	0.6%
	Missouri	0.17	0.5%	0.22	0.4%	0.34	0.6%
	Kentucky	0.30	0.8%	0.33	0.7%	0.47	0.81%
	Tennessee	0.55	1.5%	0.65	1.3%	0.44	0.8%
	Mississippi	0.27	0.7%	0.33	0.7%	0.61	1.061%
	New Mexico	0.14	0.4%	0.21	0.4%	0.24	0.4%
	Colorado	0.10	0.3%	0.14	0.3%	0.18	0.3%
	Alabama	0.32	0.9%	0.36	0.7%	0.85	1.5%
	Georgia	0.22	0.6%	0.28	0.6%	0.63	1.09%
	Florida	0.42	1.1%	0.39	0.8%	0.39	0.7%
	South Carolina	0.12	0.3%	0.14	0.3%	0.29	0.5%
	North Carolina	0.37	1.0%	0.49	1.0%	0.40	0.7%
	Virginia	0.14	0.4%	0.15	0.3%	0.19	0.3%
	West Virginia	0.05	0.1%	0.06	0.1%	0.12	0.2%
	Ohio	0.07	0.2%	0.07	0.1%	0.19	0.3%
	Indiana	0.12	0.3%	0.13	0.3%	0.33	0.6%
	Illinois	0.16	0.4%	0.19	0.4%	0.42	0.7%
	Northeast	0.10	0.3%	0.11	0.2%	0.27	0.5%
	Minnesota	0.07	0.2%	0.09	0.2%	0.10	0.2%
	Mountain	0.14	0.4%	0.20	0.4%	0.26	0.5%
	DE/DC/MD	0.02	0.1%	0.02	0.0%	0.07	0.1%
	Michigan	0.13	0.4%	0.14	0.3%	0.11	0.2%
	Wisconsin	0.06	0.2%	0.10	0.2%	0.07	0.1%
	Iowa	0.07	0.2%	0.10	0.2%	0.13	0.2%
	Nebraska	0.09	0.2%	0.12	0.2%	0.19	0.3%
	South Dakota	0.03	0.1%	0.05	0.1%	0.06	0.1%
	North Dakota	0.06	0.2%	0.10	0.2%	0.07	0.1%
	Wyoming	0.05	0.1%	0.07	0.1%	0.08	0.1%
	Pacific	0.10	0.3%	0.14	0.3%	0.17	0.3%
	Caribbean	0.02	0.1%	0.03	0.1%	0.06	0.1%
	Canada	0.23	0.6%	0.26	0.5%	0.36	0.6%
	Total	37.53	100.0%	50.25	100.0%	57.57	100.0%

Monitor	Region	All Hours		Daily Maximum (all Days)		Daily Maximum (Days > 60 ppb)	
		ppb	%	ppb	%	ppb	%
C59	Initial Conditions	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Boundary	16.47	43.9%	23.75	47.3%	13.33	23.1%
	Offshore	4.38	11.7%	4.47	8.9%	4.40	7.6%
	Texas	5.91	15.7%	10.45	20.8%	16.81	29.2%
	Louisiana	0.78	2.1%	1.05	2.1%	3.11	5.4%
	Arkansas	0.26	0.7%	0.35	0.7%	1.32	2.3%
	Oklahoma	0.29	0.8%	0.39	0.8%	1.07	1.9%
	Mexico	0.75	2.0%	1.38	2.8%	0.51	0.9%
	Kansas	0.13	0.3%	0.20	0.4%	0.51	0.9%
	Missouri	0.15	0.4%	0.22	0.4%	0.79	1.4%
	Kentucky	0.29	0.8%	0.35	0.7%	1.00	1.7%
	Tennessee	0.55	1.5%	0.70	1.4%	2.51	4.4%
	Mississippi	0.27	0.7%	0.41	0.8%	1.50	2.6%
	New Mexico	0.13	0.3%	0.21	0.4%	0.29	0.5%
	Colorado	0.09	0.2%	0.14	0.3%	0.26	0.5%
	Alabama	0.32	0.8%	0.41	0.8%	1.15	2.0%
	Georgia	0.23	0.6%	0.35	0.7%	0.98	1.7%
	Florida	0.40	1.1%	0.42	0.8%	0.29	0.5%
	South Carolina	0.10	0.3%	0.14	0.3%	0.40	0.7%
	North Carolina	0.39	1.0%	0.56	1.1%	1.47	2.6%
	Virginia	0.14	0.4%	0.17	0.3%	0.54	0.9%
	West Virginia	0.04	0.1%	0.06	0.1%	0.18	0.3%
	Ohio	0.06	0.2%	0.08	0.1%	0.21	0.4%
	Indiana	0.11	0.3%	0.14	0.3%	0.34	0.6%
	Illinois	0.16	0.4%	0.21	0.4%	0.64	1.1%
	Northeast	0.09	0.2%	0.12	0.2%	0.26	0.5%
	Minnesota	0.06	0.2%	0.08	0.2%	0.29	0.5%
	Mountain	0.12	0.3%	0.20	0.4%	0.33	0.6%
	DE/DC/MD	0.02	0.0%	0.02	0.0%	0.04	0.1%
	Michigan	0.11	0.3%	0.13	0.3%	0.47	0.8%
	Wisconsin	0.05	0.1%	0.08	0.2%	0.34	0.6%
	Iowa	0.06	0.2%	0.08	0.2%	0.25	0.4%
	Nebraska	0.07	0.2%	0.11	0.2%	0.27	0.5%
	South Dakota	0.03	0.1%	0.04	0.1%	0.09	0.2%
	North Dakota	0.05	0.1%	0.09	0.2%	0.38	0.7%
	Wyoming	0.04	0.1%	0.06	0.1%	0.07	0.1%
	Pacific	0.09	0.2%	0.14	0.3%	0.34	0.6%
	Caribbean	0.02	0.1%	0.03	0.1%	0.07	0.1%
	Canada	0.20	0.5%	0.25	0.5%	0.84	1.4%
	Total	33.39	89.0%	48.04	95.6%	57.64	100.0%

Figure 8-2: Pie Chart for C58 by Regions for Average 8-hour Ozone on Days > 60 ppb, 2023

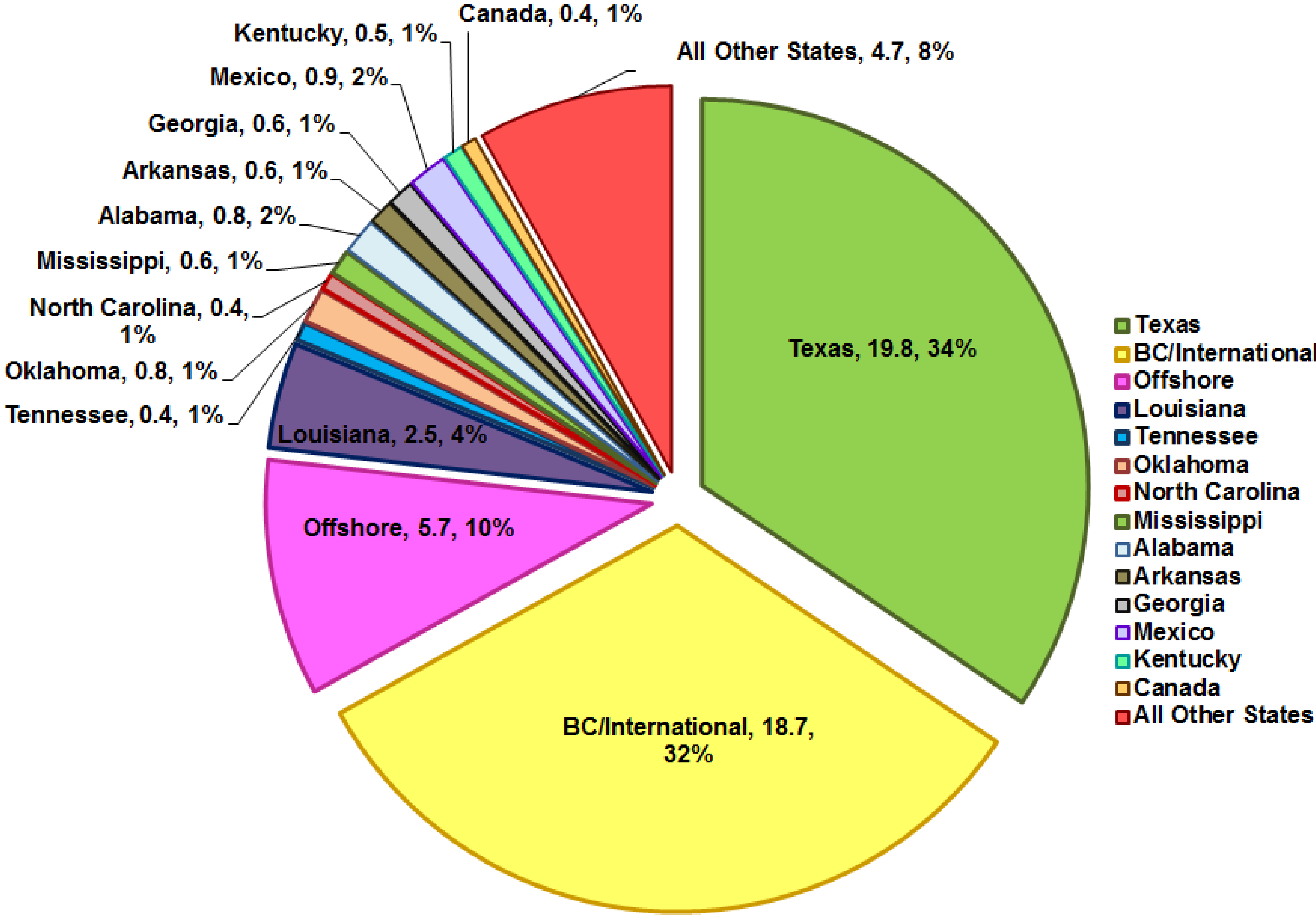


Figure 8-3: Pie Chart for C23 by Regions for Average 8-hour Ozone on Days > 60 ppb, 2023

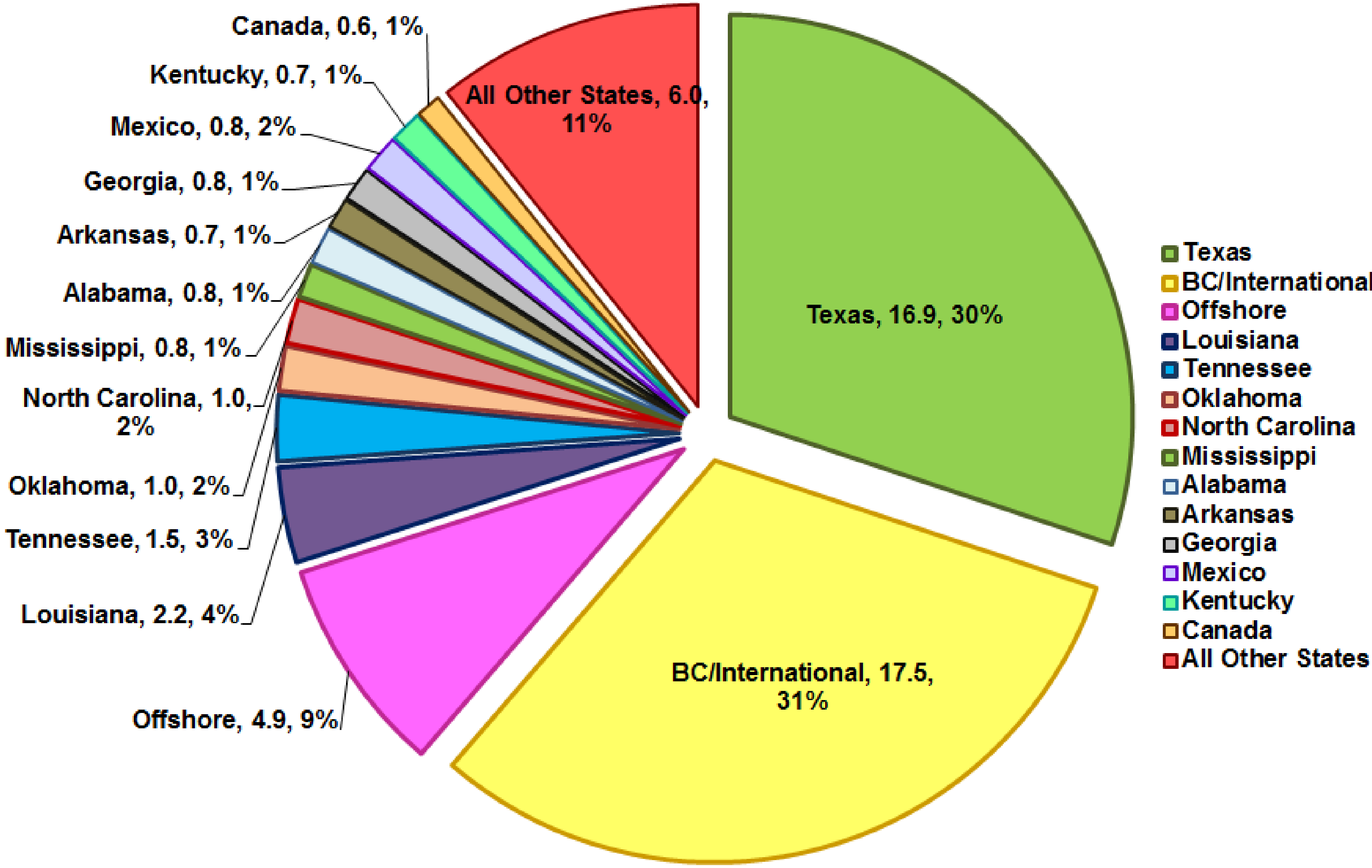


Figure 8-4: Pie Chart for C59 by Regions for Average 8-hour Ozone on Days > 60 ppb, 2023

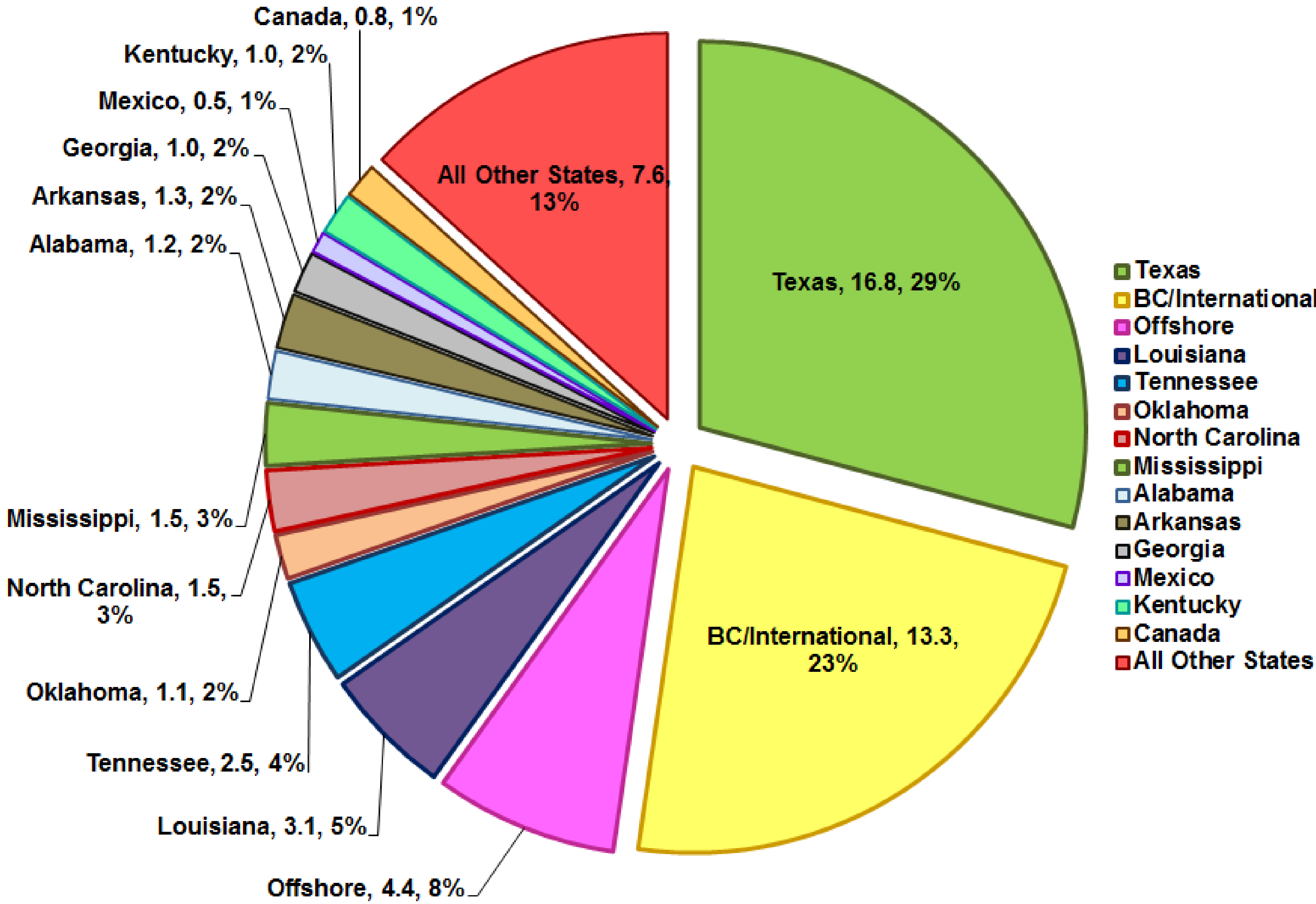
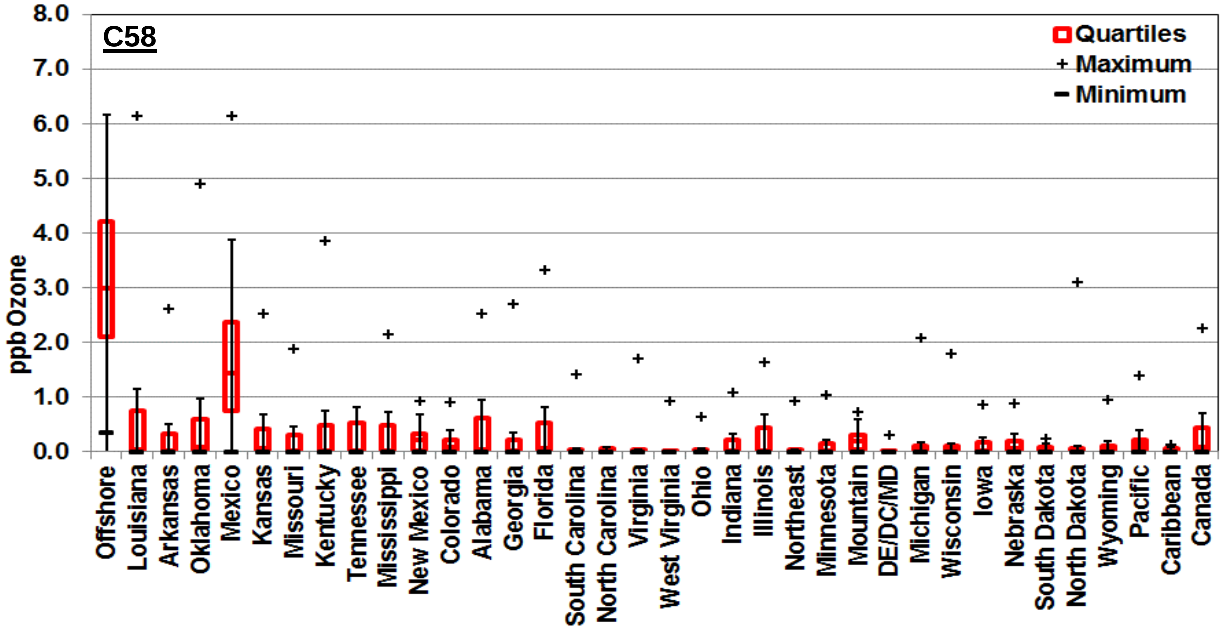
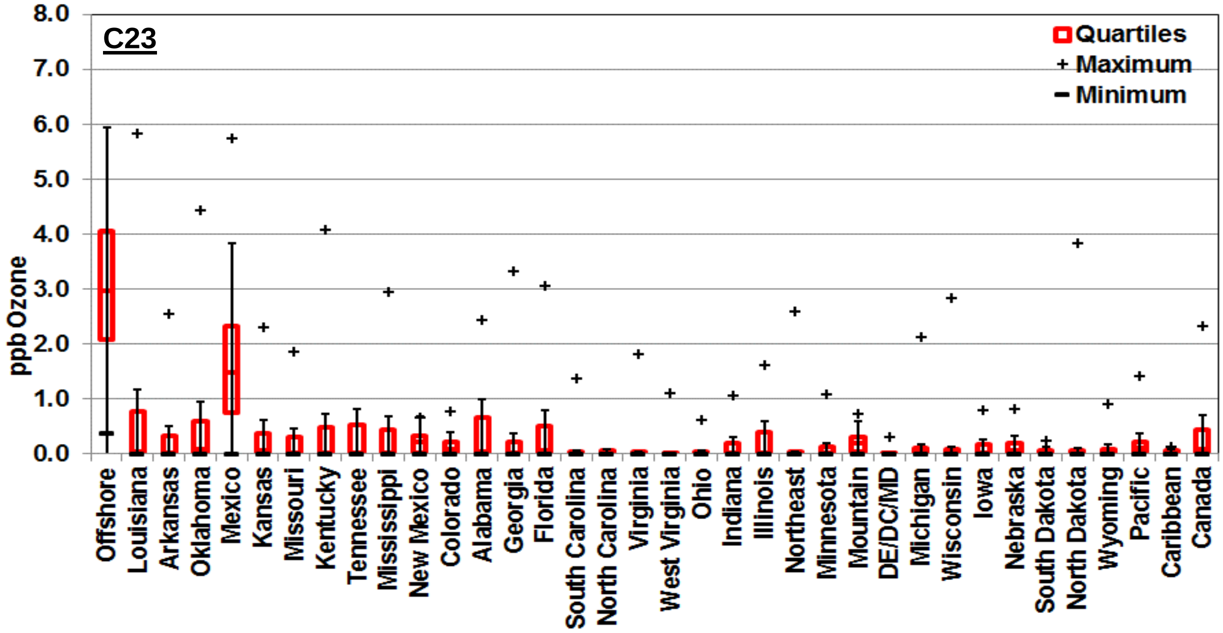
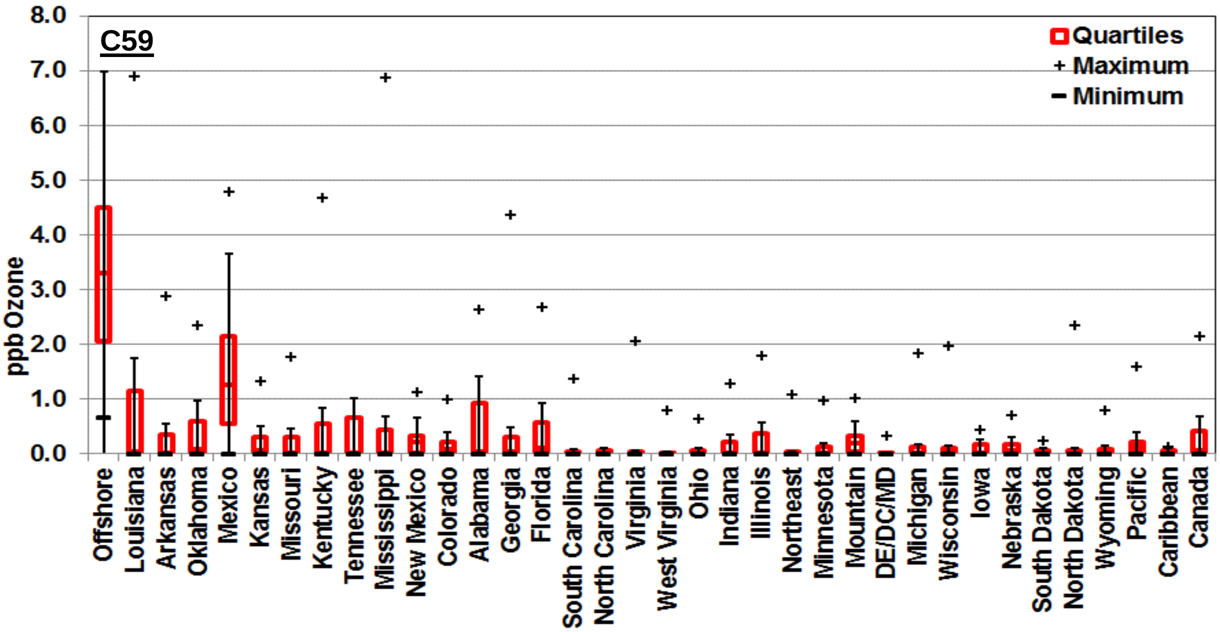


Figure 8-5: ICQ plots for C23, C58, and C59 for Hourly Ozone by Other States/Regions besides Texas on All Days, 2023

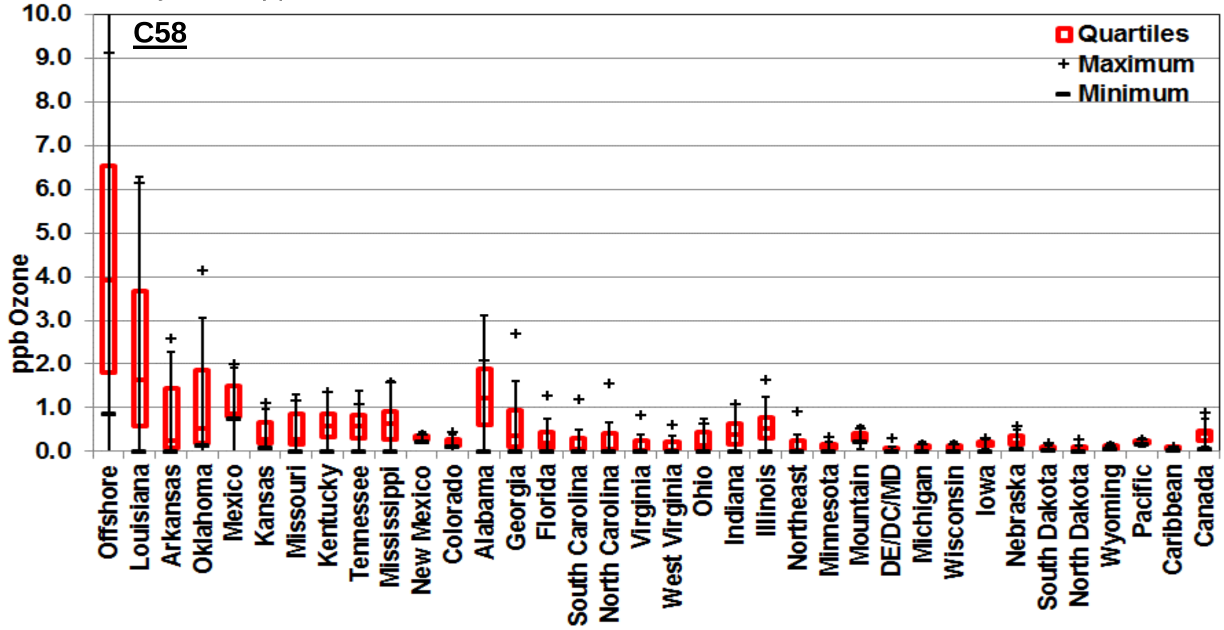


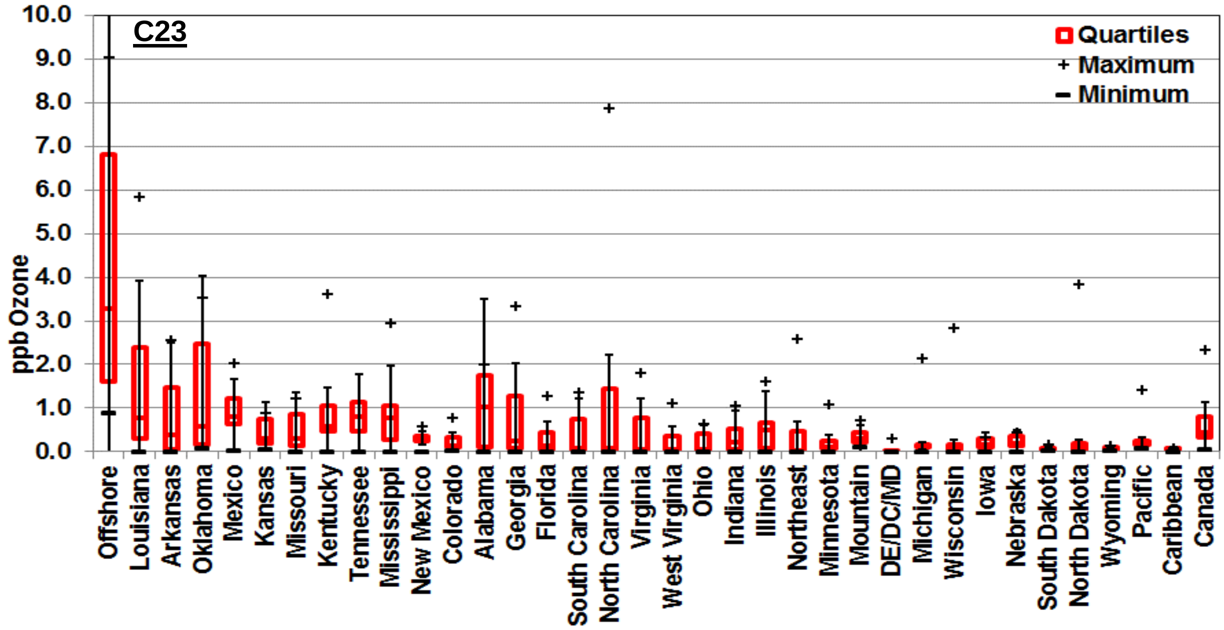


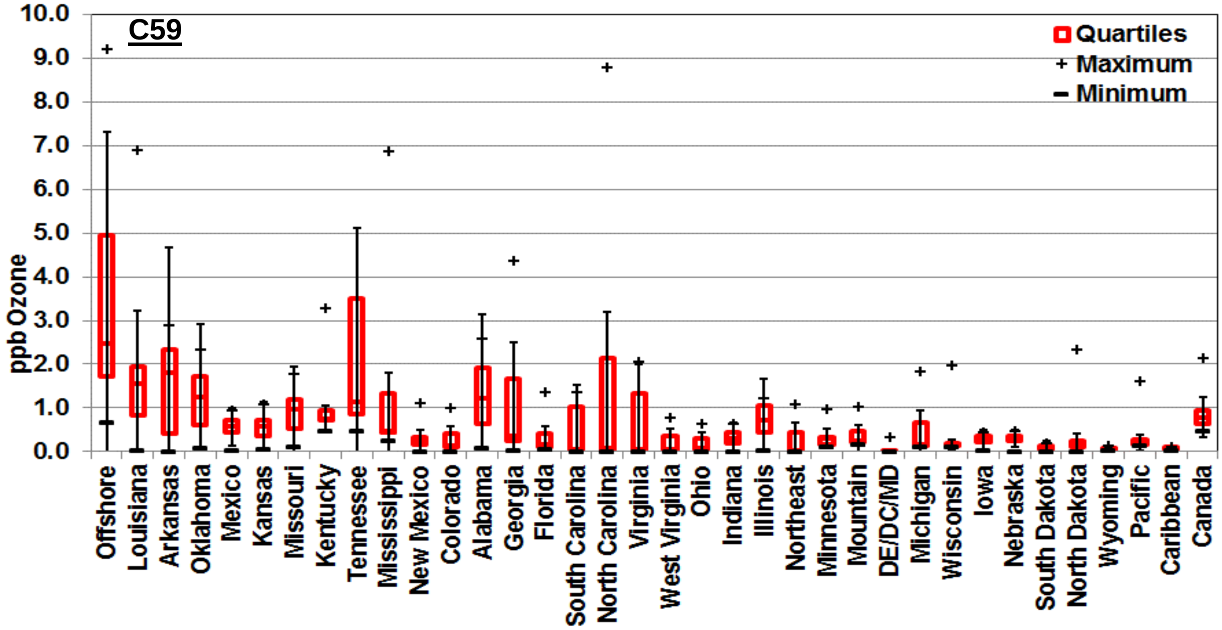


C59
Quartiles
Maximum
Minimum
ppb Ozone
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Offshore
Louisiana
Arkansas
Oklahoma
Mexico
Kansas
Missouri
Kentucky
Tennessee
Mississippi
New Mexico
Colorado
Alabama
Georgia
Florida
South Carolina
North Carolina
Virginia
West Virginia
Ohio
Indiana
Illinois
Northeast
Minnesota
Mountain
DE/DC/MD
Michigan
Wisconsin
Iowa
Nebraska
South Dakota
North Dakota
Wyoming
Pacific
Caribbean
Canada

Figure 8-6: ICQ plots for C23, C58, and C59 for Hourly Ozone by Other States/Regions besides Texas on Days > 60 ppb, 2023







C59
Quartiles
Maximum
Minimum
ppb Ozone
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Offshore
Louisiana
Arkansas
Oklahoma
Mexico
Kansas
Missouri
Kentucky
Tennessee
Mississippi
New Mexico
Colorado
Alabama
Georgia
Florida
South Carolina
North Carolina
Virginia
West Virginia
Ohio
Indiana
Illinois
Northeast
Minnesota
Mountain
DE/DC/MD
Michigan
Wisconsin
Iowa
Nebraska
South Dakota
North Dakota
Wyoming
Pacific
Caribbean
Canada

Figure 8-7: Maximum Impact of States on Peak Ozone at Regulatory Monitors in the AACOG Region, C58 on All Days 2023

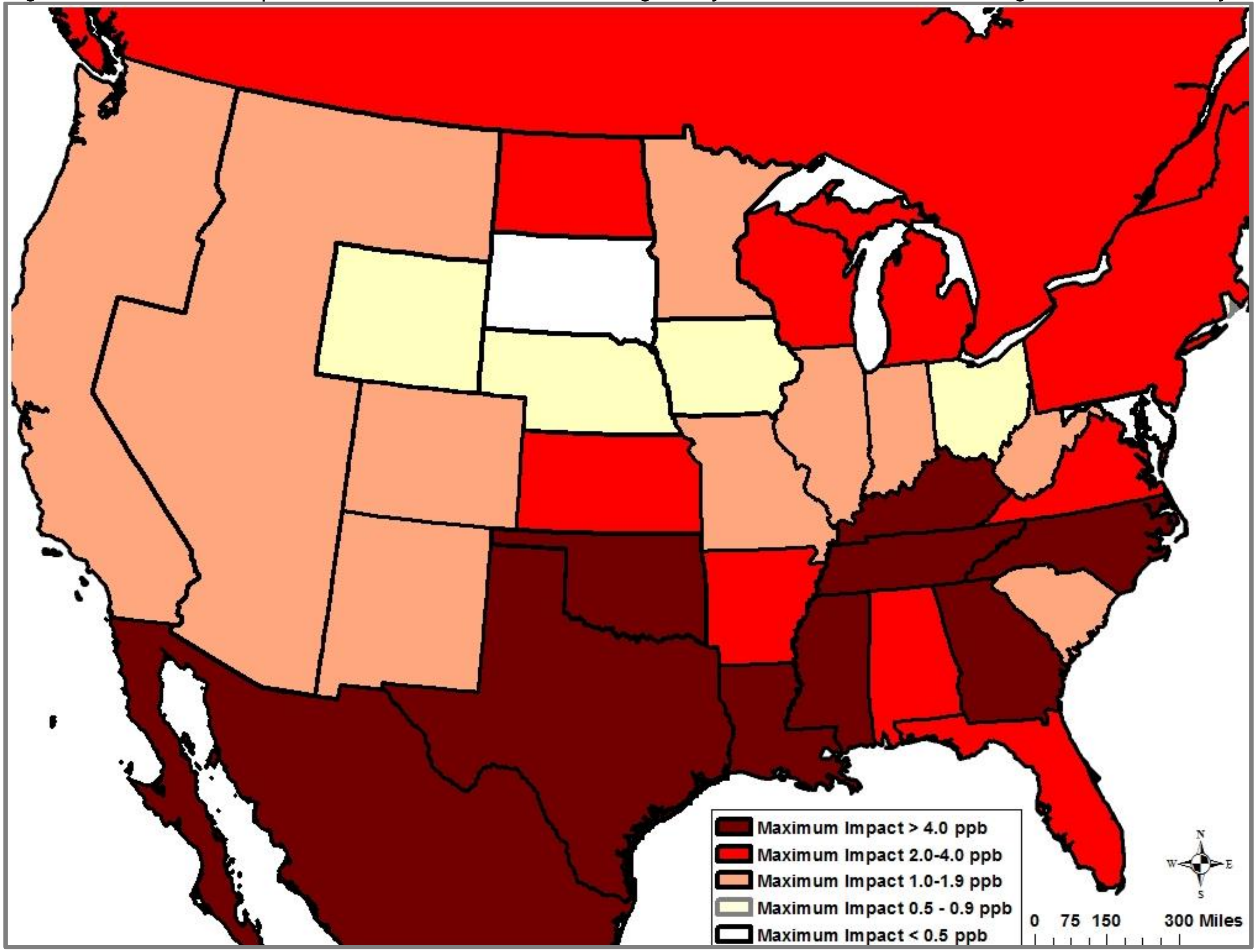


Figure 8-8: Average Impact of States on Peak Ozone at Regulatory Monitors in the AACOG Region, C58 on All Days 2023

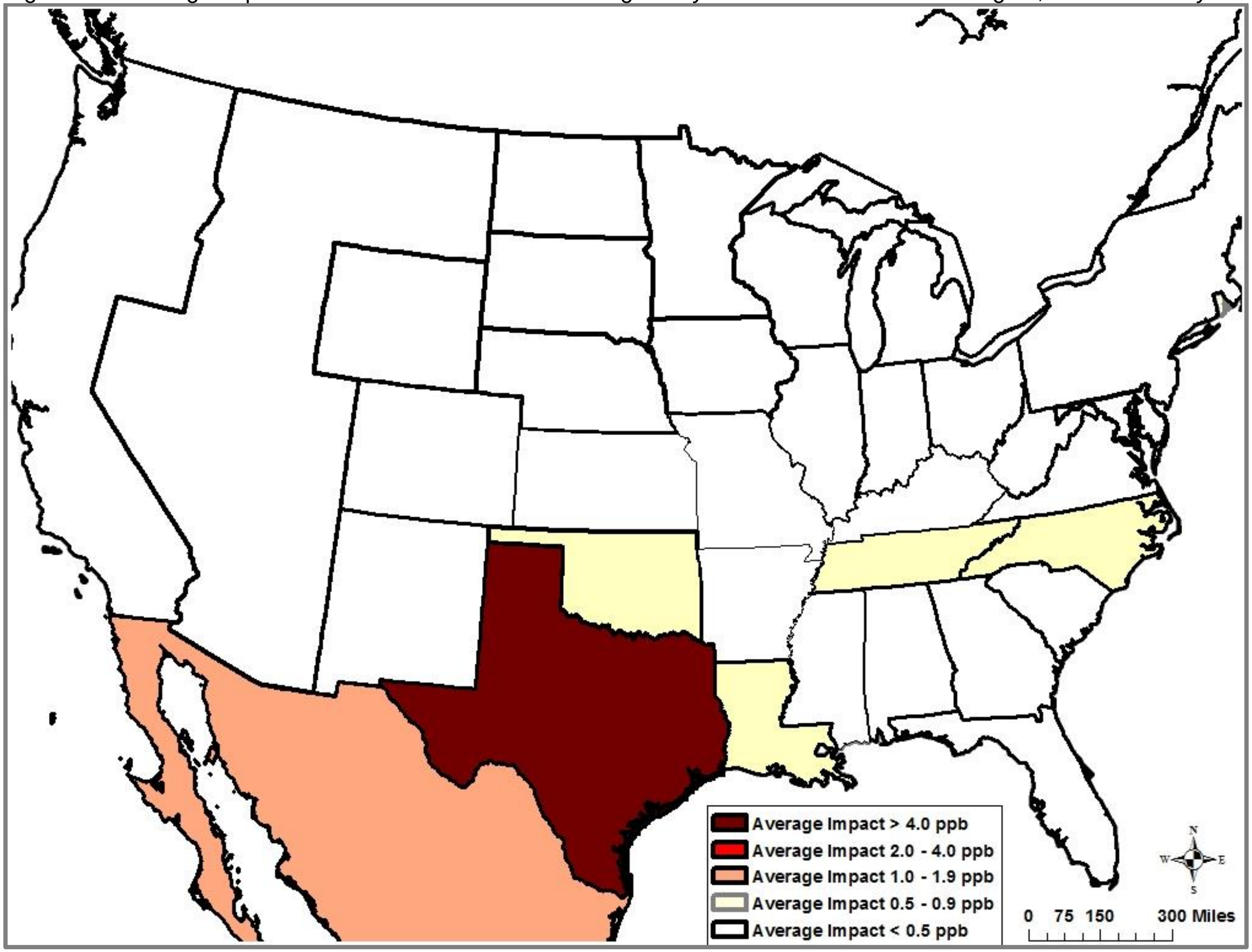


Figure 8-9: Maximum Impact of States on Peak Ozone at Regulatory Monitors in the AACOG Region, C58 on Days > 60 ppb 2023

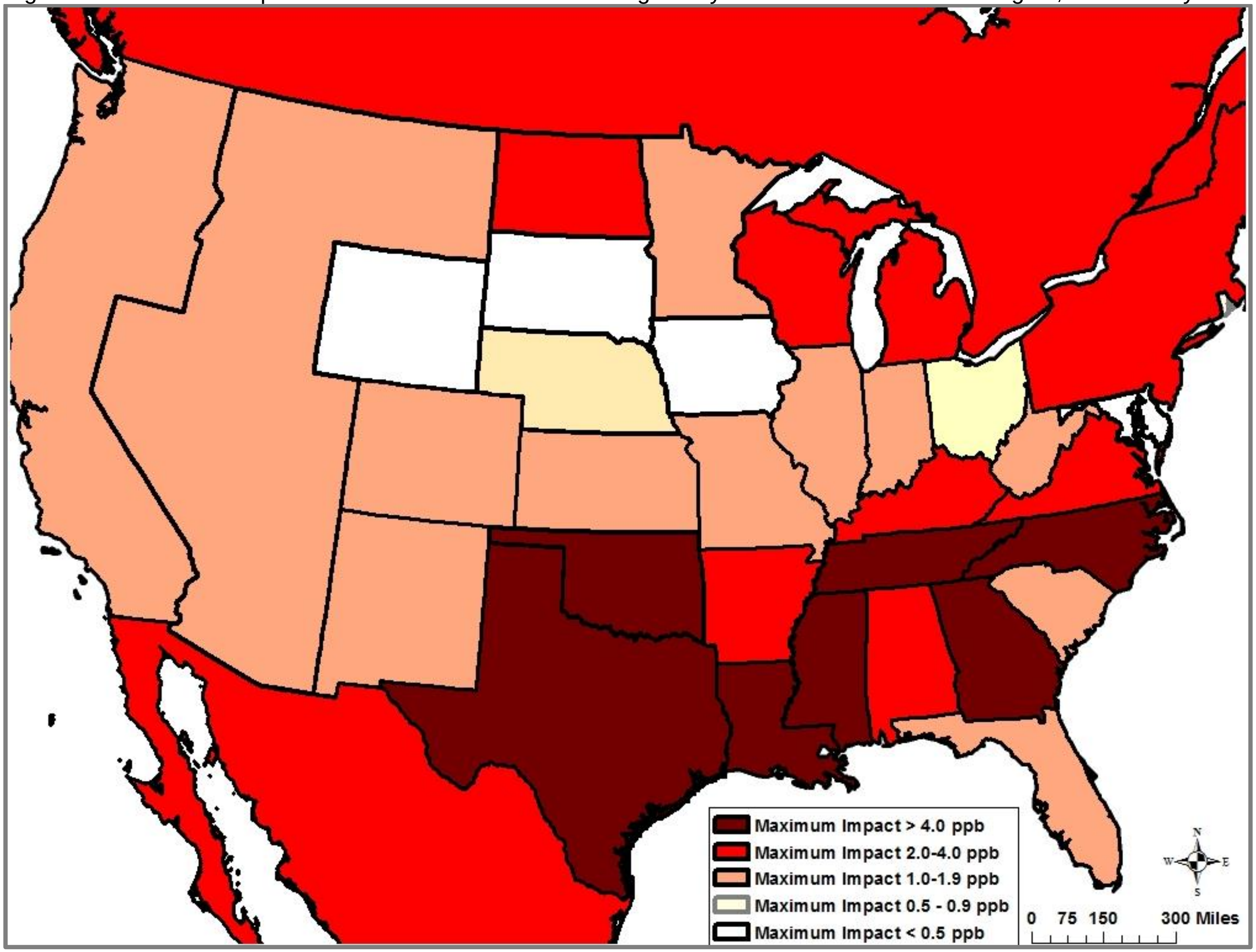
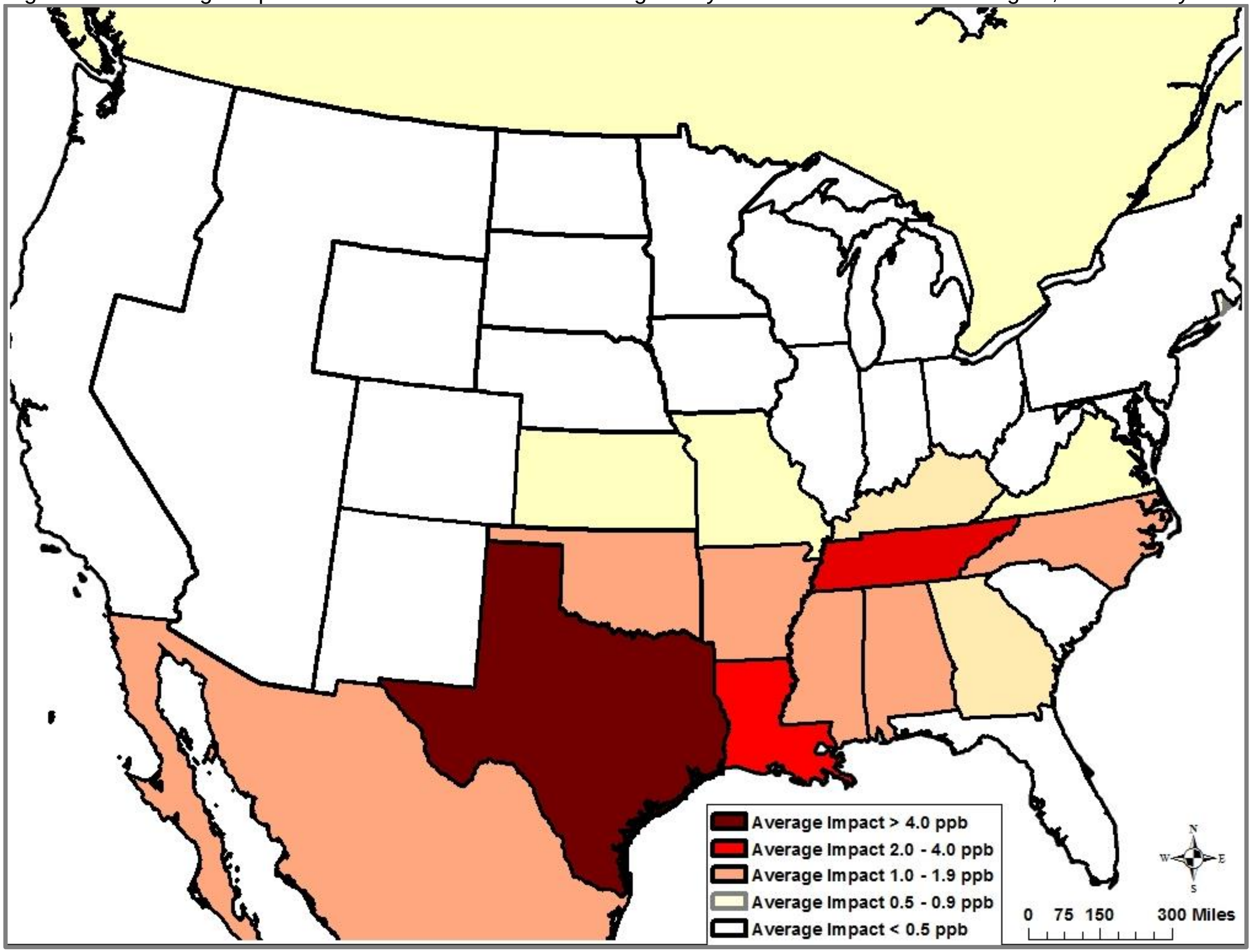


Figure 8-10: Average Impact of States on Peak Ozone at Regulatory Monitors in the AACOG Region, C58 on Days > 60 ppb 2023



Appendix A: Example of EPS3 Processing Stream for Processing the Emission Inventory

EPS3 script to run OBDII Inspection and Maintenance control strategy for 2023 summer weekday HPMS on-road emissions in east Texas

```
#!/bin/csh
set EPS3_PATH = /home/eps3_v2/src
set yy = 23
set EI_PATH = /home/eps3_v2
set OUTPUT = /home/eps3_v2
set GRID = /home/eps3_v2

foreach DAY (fri sat sun wkd)

foreach scenario (mvs14_hpms.etx_110co_2017_sum_$DAY)

# Run EPS3 PREAM module for processing texas mobile emissions
echo "########################################################################################################################"
echo  "pream :  20"$yy
echo $scenario

rm -f $OUTPUT/20$yy/msg/pream/msg.pream.$scenario.04km
rm -f $OUTPUT/20$yy/embr/embr.pream.$scenario.04km
rm -f $OUTPUT/20$yy/errors/emar.pream.$scenario.04km

$EPS3_PATH/src6/pream/pream.distrib << IEOF
Userin File        |$OUTPUT/Mobile_EI/Statewide/eps3/2017/userin.onroad.cb6p.tx_4km.etx_110co_2017_sum_$DAY
Input AMS File     |$OUTPUT/Mobile_EI/Statewide/eps3/2017/$scenario.pream_in
Output Message File|$OUTPUT/20$yy/msg/pream/msg.pream.$scenario.04km
Output EMBR File   |$OUTPUT/20$yy/embr/embr.pream.$scenario.04km
Error Message File |$OUTPUT/20$yy/errors/emar.pream.$scenario.04km
IEOF

ls -l $OUTPUT/20$yy/msg/pream/msg.pream.$scenario.04km
ls -l $OUTPUT/20$yy/embr/embr.pream.$scenario.04km
ls -l $OUTPUT/20$yy/errors/emar.pream.$scenario.04km

# Run EPS3 CNTLEM module to project Texas mobile sources from 2017 to 2023
echo "########################################################################################################################"
echo  "cntlem :  20"$yy

rm -f  $EI_PATH/20$yy/msg/cntlem/msg.cntlem.$scenario.04km
rm -f  $EI_PATH/20$yy/embr/embr.cntlem.$scenario.04km

$EPS3_PATH/src6/cntlem/cntlem.distrib << IEOF
Userin File        |$OUTPUT/Mobile_EI/Statewide/eps3/2017/userin.onroad.cb6p.tx_4km.etx_110co_2017_sum_$DAY
Input EMBR File    |$OUTPUT/20$yy/embr/embr.pream.$scenario.04km
Control Factors    |/home/eps3_v2/Nonroad_EI/AACOG/2017_2023.Texas.onroad.cntlem.prn
Output Message File|$EI_PATH/20$yy/msg/cntlem/msg.cntlem.$scenario.04km
```

```
Output EMBR File   |$OUTPUT/20$yy/embr/embr.cntlem.$scenario.04km
IEOF

ls -l  $EI_PATH/20$yy/msg/cntlem/msg.cntlem.$scenario.04km
ls -l  $EI_PATH/20$yy/embr/embr.cntlem.$scenario.04km

# Run EPS3 CNTLEM module to project Local mobile sources from 2017 to 2023
echo "#######################################################################################################################"
echo  "cntlem :  20"$yy

rm -f  $EI_PATH/20$yy/msg/cntlem/msg.cntlem.SA_MSA.$scenario.04km
rm -f  $EI_PATH/20$yy/embr/embr.cntlem.SA_MSA.$scenario.04km

$EPS3_PATH/src6/cntlem/cntlem.distrib << IEOF
Userin File        |$OUTPUT/Mobile_EI/Statewide/eps3/2017/userin.onroad.cb6p.tx_4km.etx_110co_2017_sum_$DAY
Input EMBR File    |$OUTPUT/20$yy/embr/embr.cntlem.$scenario.04km
Control Factors    |/home/eps3_v2/Mobile_EI/AACOG/cntlem.onroad.2017_2023.SA_MSA.prn
Output Message File|$EI_PATH/20$yy/msg/cntlem/msg.cntlem.SA_MSA.$scenario.04km
Output EMBR File   |$OUTPUT/20$yy/embr/embr.cntlem.SA_MSA.$scenario.04km
IEOF

ls -l  $EI_PATH/20$yy/msg/cntlem/msg.cntlem.SA_MSA.$scenario.04km
ls -l  $EI_PATH/20$yy/embr/embr.cntlem.SA_MSA.$scenario.04km

# Run EPS3 CNTLEM module to put in OBDII in 2023
echo "#######################################################################################################################"
echo  "cntlem :  20"$yy

rm -f  $EI_PATH/20$yy/msg/cntlem/msg.cntlem.obdII.$scenario.04km
rm -f  $EI_PATH/20$yy/embr/embr.cntlem.obdII.$scenario.04km

$EPS3_PATH/src6/cntlem/cntlem.distrib << IEOF
Userin File        |$OUTPUT/Mobile_EI/Statewide/eps3/2017/userin.onroad.cb6p.tx_4km.etx_110co_2017_sum_$DAY
Input EMBR File    |$OUTPUT/20$yy/embr/embr.cntlem.SA_MSA.$scenario.04km
Control Factors    |/home/eps3_v2/Mobile_EI/AACOG/2023_cntlem_obdii.prn
Output Message File|$EI_PATH/20$yy/msg/cntlem/msg.cntlem.obdII.$scenario.04km
Output EMBR File   |$OUTPUT/20$yy/embr/embr.cntlem.obdII.$scenario.04km
IEOF

ls -l  $EI_PATH/20$yy/msg/cntlem/msg.cntlem.obdII.$scenario.04km
ls -l  $EI_PATH/20$yy/embr/embr.cntlem.obdII.$scenario.04km

# Run EPS3 Chmspl module for processing texas mobile emissions
echo "#######################################################################################################################"
echo  "chmspl :  20"$yy
echo $scenario

rm -f $OUTPUT/20$yy/msg/chmspl/msg.spcems.$scenario.obdII.04km
rm -f $OUTPUT/20$yy/embr/embr.spcems.$scenario.obdII.04km
rm -f $OUTPUT/20$yy/errors/err.spcems.$scenario.obdII.04km
```

```
$EPS3_PATH/src6/spcems/spcems.distrib << IEOF
Userin File        |$OUTPUT/Mobile_EI/Statewide/eps3/2017/userin.onroad.cb6p.tx_4km.etx_110co_2017_sum_$DAY
Input EMBR File    |$OUTPUT/20$yy/embr/embr.cntlem.obdII.$scenario.04km
Split Factors File |$OUTPUT/Mobile_EI/EPS3/ei/onroad/eps3/spcems/gspro_cb6_criteria_camx_spec44_onroad90.24Apr2015
Cross Reference    |$OUTPUT/Mobile_EI/EPS3/ei/onroad/eps3/spcems/gsref_cb6_criteria_camx_spec44_onroad.2017_e10_rvp7_aro15.hpms
Conversion Factors |$OUTPUT/Mobile_EI/EPS3/ei/onroad/eps3/spcems/gscnv_cb6_criteria_camx_spec44_onroad90.24Apr2015
Output Message File|$OUTPUT/20$yy/msg/chmspl/msg.spcems.$scenario.obdII.04km
Output EMBR File   |$OUTPUT/20$yy/embr/embr.spcems.$scenario.obdII.04km
Error Message File |$OUTPUT/20$yy/errors/err.spcems.$scenario.obdII.04km
IEOF

ls -l $OUTPUT/20$yy/msg/chmspl/msg.spcems.$scenario.obdII.04km
ls -l $OUTPUT/20$yy/embr/embr.spcems.$scenario.obdII.04km
ls -l $OUTPUT/20$yy/errors/err.spcems.$scenario.obdII.04km

# Run EPS3 TMPRL module for processing texas mobile emissions
echo "##########################################################################################################################"
echo  "tmprl :  20"$yy

rm -f  $OUTPUT/20$yy/msg/tmprl/msg.tmprl.$scenario.obdII.04km
rm -f  $OUTPUT/20$yy/embr/embr.tmprl.$scenario.obdII.04km
rm -f  $OUTPUT/20$yy/errors/err.tmprl.$scenario.obdII.04km

$EPS3_PATH/src6/tmprl/tmprl.distrib << IEOF
Userin File        |$OUTPUT/Mobile_EI/Statewide/eps3/2017/userin.onroad.cb6p.tx_4km.etx_110co_2017_sum_$DAY
Input Area Emiss   |$OUTPUT/20$yy/embr/embr.spcems.$scenario.obdII.04km
Temporal XREF      |$OUTPUT/Mobile_EI/EPS3/ei/onroad/eps3/data/temporal/tmprl.onroad_mvs14.tex_only.xref.2017_sum_$DAY
Temporal profiles  |$OUTPUT/Mobile_EI/EPS3/ei/onroad/eps3/data/temporal/tmprl.onroad_mvs14.tex_only.profiles
Output message     |$OUTPUT/20$yy/msg/tmprl/msg.tmprl.$scenario.obdII.04km
Output EMBR        |$OUTPUT/20$yy/embr/embr.tmprl.$scenario.obdII.04km
Error EMAR         |$OUTPUT/20$yy/errors/err.tmprl.$scenario.obdII.04km
IEOF

ls -l  $OUTPUT/20$yy/msg/tmprl/msg.tmprl.$scenario.obdII.04km
ls -l  $OUTPUT/20$yy/embr/embr.tmprl.$scenario.obdII.04km
ls -l  $OUTPUT/20$yy/errors/err.tmprl.$scenario.obdII.04km

# Run EPS3 GRDEM module for processing texas mobile emissions
echo "##########################################################################################################################"
echo  "grdem :  20"$yy
echo $scenario

rm -f  $OUTPUT/20$yy/msg/grdem/msg.grdem.$scenario.obdII.04km
rm -f  $OUTPUT/20$yy/emiss/lo_ar.grdem.$scenario.obdII.04km
rm -f  $OUTPUT/20$yy/msg/grdem/ascfips.grdem.$scenario.obdII.04km
rm -f  $OUTPUT/20$yy/errors/emar.grdem.$scenario.obdII.04km

$EPS3_PATH/src6/grdem/grdem.distrib << IEOF
Userin File        |$OUTPUT/Mobile_EI/Statewide/eps3/2017/userin.onroad.cb6p.tx_4km.etx_110co_2017_sum_$DAY
Input EMBR File    |$OUTPUT/20$yy/embr/embr.tmprl.$scenario.obdII.04km
Surg. XREF File    |$OUTPUT/Mobile_EI/EPS3/ei/onroad/eps3/data/xref/grdem.xref.mvs.fuel_2.sut_13.hpms_12.prc_4.scc_672
```

```
Gridded Surg. File |$OUTPUT/Mobile_EI/EPS3/ei/onroad/eps3/data/surrogates/tex/onroad.surg.roadways_tex.grdem.tx_4km
Links data         |
Output Messages    |$OUTPUT/20$yy/msg/grdem/msg.grdem.$scenario.obdII.04km
Output Emissions   |$OUTPUT/20$yy/emiss/lo_ar.grdem.$scenario.obdII.04km
Output ASC/FIPS Ems|$OUTPUT/20$yy/msg/grdem/ascfips.grdem.$scenario.obdII.04km
Error Message File |$OUTPUT/20$yy/errors/emar.grdem.$scenario.obdII.04km
IEOF

ls -l  $OUTPUT/20$yy/msg/grdem/msg.grdem.$scenario.obdII.04km
ls -l  $OUTPUT/20$yy/emiss/lo_ar.grdem.$scenario.obdII.04km
ls -l  $OUTPUT/20$yy/msg/grdem/ascfips.grdem.$scenario.obdII.04km
ls -l  $OUTPUT/20$yy/errors/emar.grdem.$scenario.obdII.04km


end

end

date
```

Appendix B: Example of EPS3 Output Message File for Emission Inventory

EPS3 Cntlem msg file for OBDII Inspection and Maintenance control strategy for the 8-county San Antonio-New Braunfels MSA, 2023 summer weekday HPMS on-road emissions in east Texas

```
                  EPS3 CNTLEM module v. 3.21 Jun 2014     07/31/17 15:48:18
            Input Files
        USERIN file                   :/home/eps3_v2/Mobile_EI/Statewide/eps3/2017/userin.onroad.cb6p.tx_4km.etx_110co_2017_sum_wkd
        Input EMBR file               :/home/eps3_v2/2023/embr/embr.cntlem.SA_MSA.mvs14_hpms.etx_110co_2017_sum_wkd.04km
        Control factors file          :/home/eps3_v2/Mobile_EI/AACOG/2023_cntlem_obdii.prn
            Output Files
        Output EMBR file              :/home/eps3_v2/2023/embr/embr.cntlem.obdII.mvs14_hpms.etx_110co_2017_sum_wkd.04km

                  EPS3 CNTLEM module v. 3.21 Jun 2014     07/31/17 15:48:18
        Number of counties:   110
        Total control tables only will be created.
        Best match criteria for control factors is in place.

Control factors records read from /PROJECT PTS/ packet:     0 with     0 unique controls
Control factors records read from /PROJECT AMS/ packet:     0 with     0 unique controls
Control factors records read from /SOURCE CATEGORY/ packet:  12824 with  12824 unique controls.
Control factors records read from /FIPS CODE/ packet:   0 with   0 unique controls.

                           Total Emissions Processed
                                 English Tons
                          NO         NO2         HONO        VOC          CO
---------------------------------------------------------------------------------
Input Emissions         160.2028     26.4232      1.5038     31.1097   1415.9048
Output Emissions        159.6071     26.3029      1.4980     30.8857   1392.9673
Emissions Skipped          0.           0.          0.          0.          0.
---------------------------------------------------------------------------------
```

Totals by Source Category for Entire Domain
P A F
R S I

Criteria Pollutant Emissions by County
English Tons/Day

County	Input NO	Output NO	Input NO2	Output NO2	Input HONO	Output HONO	Input VOC	Output VOC	Input CO	Output CO
48001	0.4570	0.4570	0.0719	0.0719	0.0043	0.0043	0.0959	0.0959	3.8736	3.8736
48005	1.1708	1.1708	0.1804	0.1804	0.0109	0.0109	0.1949	0.1949	6.6774	6.6774
48007	0.1498	0.1498	0.0248	0.0248	0.0014	0.0014	0.0303	0.0303	1.3446	1.3446
48013	0.8307	0.8034	0.2204	0.2149	0.0084	0.0081	0.1223	0.1123	6.3603	5.4258
48015	1.0104	1.0104	0.1536	0.1536	0.0094	0.0094	0.1212	0.1212	4.1234	4.1234
48021	0.6547	0.6547	0.1061	0.1061	0.0061	0.0061	0.1405	0.1405	6.1728	6.1728
48025	0.2694	0.2694	0.0443	0.0443	0.0025	0.0025	0.0515	0.0515	2.2447	2.2447
48027	3.9847	3.9847	0.6025	0.6025	0.0370	0.0370	0.6610	0.6610	26.6307	26.6307
48029	8.3333	7.8723	2.0578	1.9650	0.0829	0.0784	1.9134	1.7387	118.3691	100.2100
48035	0.1848	0.1848	0.0287	0.0287	0.0017	0.0017	0.0371	0.0371	1.4887	1.4887
48037	2.0914	2.0914	0.2989	0.2989	0.0193	0.0193	0.2717	0.2717	9.8590	9.8590
48039	1.2654	1.2654	0.2114	0.2114	0.0119	0.0119	0.3098	0.3098	14.1148	14.1148
48041	1.4403	1.4403	0.2341	0.2341	0.0135	0.0135	0.3168	0.3168	13.0400	13.0400
48051	0.2891	0.2891	0.0463	0.0463	0.0027	0.0027	0.0513	0.0513	1.9861	1.9861
48055	0.4110	0.4110	0.0661	0.0661	0.0038	0.0038	0.0800	0.0800	3.7526	3.7526
48057	0.2473	0.2473	0.0390	0.0390	0.0023	0.0023	0.0409	0.0409	1.3472	1.3472
48063	0.1610	0.1610	0.0238	0.0238	0.0015	0.0015	0.0270	0.0270	0.9193	0.9193
48067	0.4643	0.4643	0.0687	0.0687	0.0043	0.0043	0.0808	0.0808	2.8495	2.8495
48071	1.8831	1.8831	0.2943	0.2943	0.0176	0.0176	0.2086	0.2086	7.4449	7.4449
48073	0.4205	0.4205	0.0660	0.0660	0.0039	0.0039	0.0948	0.0948	3.9476	3.9476
48085	4.4960	4.4960	0.7245	0.7245	0.0421	0.0421	1.0214	1.0214	47.3975	47.3975
48089	1.6459	1.6459	0.2466	0.2466	0.0153	0.0153	0.1604	0.1604	5.0652	5.0652
48091	1.2307	1.1842	0.2704	0.2608	0.0120	0.0116	0.2230	0.2063	12.7181	11.0349
48097	1.2238	1.2238	0.1779	0.1779	0.0113	0.0113	0.1595	0.1595	6.0025	6.0025
48099	0.4144	0.4144	0.0637	0.0637	0.0039	0.0039	0.0881	0.0881	3.5961	3.5961
48113	14.5147	14.5147	2.3250	2.3250	0.1358	0.1358	3.1741	3.1741	153.4757	153.4757
48119	0.0876	0.0876	0.0132	0.0132	0.0008	0.0008	0.0142	0.0142	0.5163	0.5163
48121	3.7194	3.7194	0.5983	0.5983	0.0348	0.0348	0.7883	0.7883	36.2204	36.2204
48123	0.4313	0.4313	0.0682	0.0682	0.0040	0.0040	0.0733	0.0733	2.4535	2.4535
48139	1.9543	1.9543	0.3122	0.3122	0.0183	0.0183	0.2865	0.2865	13.5543	13.5543
48145	0.3480	0.3480	0.0531	0.0531	0.0032	0.0032	0.0550	0.0550	2.1324	2.1324
48147	0.3966	0.3966	0.0601	0.0601	0.0037	0.0037	0.0742	0.0742	2.6554	2.6554

48149	1.3577	1.3577	0.2065	0.2065	0.0126	0.0126	0.1518	0.1518	4.9481	4.9481
48157	1.9018	1.9018	0.3168	0.3168	0.0179	0.0179	0.4976	0.4976	23.3577	23.3577
48159	0.5261	0.5261	0.0769	0.0769	0.0049	0.0049	0.0499	0.0499	1.5380	1.5380
48161	1.1233	1.1233	0.1752	0.1752	0.0105	0.0105	0.1205	0.1205	4.2207	4.2207
48167	0.9736	0.9736	0.1604	0.1604	0.0091	0.0091	0.2502	0.2502	12.6485	12.6485
48175	0.1603	0.1603	0.0264	0.0264	0.0015	0.0015	0.0275	0.0275	1.1222	1.1222
48177	1.2500	1.2500	0.1898	0.1898	0.0116	0.0116	0.1382	0.1382	4.4744	4.4744
48181	1.5802	1.5802	0.2373	0.2373	0.0147	0.0147	0.2926	0.2926	10.9316	10.9316
48183	1.1923	1.1923	0.1864	0.1864	0.0111	0.0111	0.2676	0.2676	11.3556	11.3556
48185	0.3821	0.3821	0.0615	0.0615	0.0036	0.0036	0.0711	0.0711	2.7649	2.7649
48187	1.0599	1.0148	0.2721	0.2628	0.0106	0.0102	0.1895	0.1728	10.9329	9.3057
48199	0.5493	0.5493	0.0889	0.0889	0.0051	0.0051	0.1064	0.1064	4.5530	4.5530
48201	18.6675	18.6675	3.0711	3.0711	0.1753	0.1753	4.7699	4.7699	240.1955	240.1955
48203	2.4551	2.4551	0.3494	0.3494	0.0226	0.0226	0.2678	0.2678	8.9281	8.9281
48209	1.4218	1.4218	0.2285	0.2285	0.0133	0.0133	0.2856	0.2856	13.5388	13.5388
48213	0.6233	0.6233	0.0979	0.0979	0.0058	0.0058	0.1407	0.1407	5.8171	5.8171
48217	1.5981	1.5981	0.2380	0.2380	0.0148	0.0148	0.1737	0.1737	6.5292	6.5292
48221	0.4716	0.4716	0.0796	0.0796	0.0044	0.0044	0.0911	0.0911	3.7378	3.7378
48223	1.5336	1.5336	0.2240	0.2240	0.0142	0.0142	0.1580	0.1580	5.2822	5.2822
48225	0.3497	0.3497	0.0539	0.0539	0.0033	0.0033	0.0584	0.0584	1.9872	1.9872
48231	2.1620	2.1620	0.3187	0.3187	0.0200	0.0200	0.2659	0.2659	9.0911	9.0911
48239	0.4885	0.4885	0.0768	0.0768	0.0046	0.0046	0.0812	0.0812	2.7652	2.7652
48241	0.4159	0.4159	0.0674	0.0674	0.0039	0.0039	0.0814	0.0814	3.4058	3.4058
48245	2.7483	2.7483	0.4370	0.4370	0.0257	0.0257	0.4779	0.4779	20.8981	20.8981
48251	1.4932	1.4932	0.2491	0.2491	0.0141	0.0141	0.2410	0.2410	9.8604	9.8604
48255	0.3691	0.3691	0.0612	0.0612	0.0035	0.0035	0.0642	0.0642	2.5290	2.5290
48257	1.4702	1.4702	0.2366	0.2366	0.0138	0.0138	0.2194	0.2194	9.8367	9.8367
48277	0.5096	0.5096	0.0768	0.0768	0.0047	0.0047	0.1024	0.1024	3.8688	3.8688
48285	0.3516	0.3516	0.0559	0.0559	0.0033	0.0033	0.0616	0.0616	2.0499	2.0499
48287	0.2029	0.2029	0.0329	0.0329	0.0019	0.0019	0.0433	0.0433	1.9020	1.9020
48289	1.0693	1.0693	0.1663	0.1663	0.0100	0.0100	0.1145	0.1145	4.1082	4.1082
48291	0.8125	0.8125	0.1317	0.1317	0.0076	0.0076	0.1573	0.1573	6.0641	6.0641
48293	0.2727	0.2727	0.0426	0.0426	0.0025	0.0025	0.0585	0.0585	2.2985	2.2985
48297	1.0523	1.0523	0.1678	0.1678	0.0098	0.0098	0.1159	0.1159	4.6824	4.6824
48309	3.4471	3.4471	0.5194	0.5194	0.0320	0.0320	0.5373	0.5373	21.7985	21.7985
48313	0.6955	0.6955	0.1081	0.1081	0.0065	0.0065	0.0732	0.0732	2.6235	2.6235
48315	0.1721	0.1721	0.0255	0.0255	0.0016	0.0016	0.0288	0.0288	0.9791	0.9791
48321	0.4542	0.4542	0.0719	0.0719	0.0042	0.0042	0.0764	0.0764	2.4622	2.4622
48331	0.3354	0.3354	0.0539	0.0539	0.0031	0.0031	0.0629	0.0629	2.4577	2.4577
48339	2.8685	2.8685	0.4762	0.4762	0.0270	0.0270	0.6220	0.6220	28.5078	28.5078
48343	0.4461	0.4461	0.0640	0.0640	0.0041	0.0041	0.0491	0.0491	1.5481	1.5481

48347	0.9933	0.9933	0.1531	0.1531	0.0092	0.0092	0.1659	0.1659	5.6636	5.6636
48349	1.1000	1.1000	0.1755	0.1755	0.0103	0.0103	0.1359	0.1359	6.2126	6.2126
48351	0.1589	0.1589	0.0261	0.0261	0.0015	0.0015	0.0313	0.0313	1.2248	1.2248
48355	1.7071	1.7071	0.2780	0.2780	0.0160	0.0160	0.4590	0.4590	24.5230	24.5230
48361	1.4228	1.4228	0.2245	0.2245	0.0133	0.0133	0.1988	0.1988	8.5157	8.5157
48365	0.5406	0.5406	0.0798	0.0798	0.0050	0.0050	0.0931	0.0931	3.2960	3.2960
48367	2.0670	2.0670	0.3436	0.3436	0.0194	0.0194	0.2656	0.2656	10.0515	10.0515
48373	0.8940	0.8940	0.1374	0.1374	0.0083	0.0083	0.1467	0.1467	5.0236	5.0236
48379	0.1536	0.1536	0.0232	0.0232	0.0014	0.0014	0.0272	0.0272	0.9686	0.9686
48387	0.2008	0.2008	0.0303	0.0303	0.0019	0.0019	0.0351	0.0351	1.2663	1.2663
48391	0.2932	0.2932	0.0479	0.0479	0.0028	0.0028	0.0479	0.0479	1.9844	1.9844
48395	0.3423	0.3423	0.0549	0.0549	0.0032	0.0032	0.0611	0.0611	2.3658	2.3658
48397	0.8073	0.8073	0.1298	0.1298	0.0076	0.0076	0.1168	0.1168	5.1248	5.1248
48401	0.4895	0.4895	0.0769	0.0769	0.0046	0.0046	0.1094	0.1094	4.4885	4.4885
48403	0.1517	0.1517	0.0234	0.0234	0.0014	0.0014	0.0253	0.0253	0.8654	0.8654
48405	0.1524	0.1524	0.0234	0.0234	0.0014	0.0014	0.0248	0.0248	0.8597	0.8597
48407	0.4257	0.4257	0.0656	0.0656	0.0040	0.0040	0.0705	0.0705	2.3829	2.3829
48409	0.9832	0.9832	0.1581	0.1581	0.0092	0.0092	0.1427	0.1427	6.3455	6.3455
48419	0.4625	0.4625	0.0711	0.0711	0.0043	0.0043	0.0758	0.0758	2.6060	2.6060
48423	2.3332	2.3332	0.3645	0.3645	0.0218	0.0218	0.4743	0.4743	19.6164	19.6164
48425	0.1222	0.1222	0.0206	0.0206	0.0012	0.0012	0.0206	0.0206	0.8100	0.8100
48439	9.4108	9.4108	1.5390	1.5390	0.0883	0.0883	2.3994	2.3994	113.2182	113.2182
48449	1.0231	1.0231	0.1459	0.1459	0.0094	0.0094	0.1152	0.1152	3.8887	3.8887
48453	5.5425	5.5425	0.8829	0.8829	0.0518	0.0518	1.3020	1.3020	60.6732	60.6732
48455	0.1877	0.1877	0.0290	0.0290	0.0017	0.0017	0.0312	0.0312	1.0437	1.0437
48457	0.2260	0.2260	0.0368	0.0368	0.0021	0.0021	0.0427	0.0427	1.7131	1.7131
48459	0.5616	0.5616	0.0832	0.0832	0.0052	0.0052	0.0949	0.0949	3.2249	3.2249
48467	1.1607	1.1607	0.1793	0.1793	0.0108	0.0108	0.1742	0.1742	6.8243	6.8243
48469	1.4854	1.4854	0.2331	0.2331	0.0139	0.0139	0.2364	0.2364	7.6041	7.6041
48471	1.2884	1.2884	0.2022	0.2022	0.0120	0.0120	0.1680	0.1680	6.5445	6.5445
48473	0.7495	0.7495	0.1236	0.1236	0.0070	0.0070	0.1260	0.1260	5.6113	5.6113
48477	0.4245	0.4245	0.0682	0.0682	0.0040	0.0040	0.0835	0.0835	3.3803	3.3803
48481	0.9430	0.9430	0.1481	0.1481	0.0088	0.0088	0.1525	0.1525	5.0074	5.0074
48491	2.3695	2.3695	0.3772	0.3772	0.0222	0.0222	0.5054	0.5054	23.5852	23.5852
48493	0.3266	0.3108	0.0852	0.0820	0.0033	0.0031	0.0669	0.0610	3.6061	3.0730
48497	1.1573	1.1573	0.1943	0.1943	0.0109	0.0109	0.1964	0.1964	7.8259	7.8259
48499	0.3488	0.3488	0.0551	0.0551	0.0033	0.0033	0.0769	0.0769	3.0237	3.0237
Total	160.2027	159.6070	26.4232	26.3029	1.5038	1.4980	31.1096	30.8855	1415.9038	1392.9664

Appendix C: Example of CAMx Run Script for APCA

Ozone Season 2023 Projection Case APCA run for the San Antonio-New Braunfels MSA

```
#!/bin/csh
#
# CAMx 6.3
#
setenv OMP_NUM_THREADS 12

set BASE    = "/home/camx"
set INP     = "$BASE/input"
set EXEC    = "$BASE/camx6.3/camx10/CAMx.v6.30.noMPI.pgf"
set EMISSA  = "/home/camx/input/ei/"
#
set RUN     = "APCA.MSA.23"
set ICBC    = "$INP/bcic"
set MET36   = "$INP/met"
set MET12   = "$INP/met"
set MET04   = "$INP/met"
set EMISS36 = "$INP/ei"
set EMISS12 = "$INP/ei"
set EMISS04 = "$INP/ei"
set PTSRC   = "$INP/ei"
set OUTPUT  = "$BASE/outputs/$RUN"

#
mkdir $OUTPUT
mkdir $RUN
#
#  --- set the dates and times ----
#
foreach f (120501.120430 120502.120501 120503.120502 120504.120503 120505.120504 120506.120505 120507.120506 120508.120507
120509.120508  120510.120509 120511.120510 120512.120511 120513.120512 120514.120513 120515.120514 120516.120515 120517.120516
120518.120517 120519.120518 120520.120519 120521.120520 120522.120521 120523.120522 120524.120523 120525.120524 120526.120525
120527.120526 120528.120527 120529.120528 120530.120529 120531.120530)
set TODAY = $f:r
set YESTERDAY = $f:e

set YEAR = 2012
set MM   = 05
set DD   = `echo $TODAY | cut -c5-6`

#  --- Create the input file (always called CAMx.in)

cat << ieof > CAMx.in

 &CAMx_Control

 Run_Message      = 'camx630',
```

```
!--- Model clock control ---

 Time_Zone        = 6,                  ! (0=UTC,5=EST,6=CST,7=MST,8=PST)
 Restart          = .true.,
 Start_Date_Hour  = $YEAR,$MM,$DD,0000.0,  ! (YYYY,MM,DD,HHHH)
 End_Date_Hour    = $YEAR,$MM,$DD,2400.0,  ! (YYYY,MM,DD,HHHH)

 Maximum_Timestep    = 15.0,            ! minutes
 Met_Input_Frequency = 60.,             ! minutes
 Ems_Input_Frequency = 60.,             ! minutes
 Output_Frequency    = 60.,             ! minutes

!--- Map projection parameters ---

 Map_Projection           = 'LAMBERT', ! (LAMBERT,POLAR,UTM,LATLON)
 Longitude_Pole           = -97.0,     ! deg (west<0,south<0)
 Latitude_Pole            = 40.0,      ! deg (west<0,south<0)
 True_Latitude1           = 45.0,      ! deg (west<0,south<0)
 True_Latitude2           = 33.0,      ! deg (west<0,south<0)

!--- Parameters for the master (first) grid ---

 Number_of_Grids      = 3,
 Master_SW_XCoord     = -2736.0,        ! km or deg, SW corner of cell(1,1)
 Master_SW_YCoord     = -2088.0,        ! km or deg, SW corner of cell(1,1)
 Master_Cell_XSize    = 36.0,           ! km or deg
 Master_Cell_YSize    = 36.0,           ! km or deg
 Master_Grid_Columns  = 148,
 Master_Grid_Rows     = 112,
 Number_of_Layers     = 29,

!--- Parameters for the second grid ---

 Nest_Meshing_Factor(2) = 3,            ! Relative to master grid
 Nest_Beg_I_Index(2)    = 50,           ! Relative to master grid
 Nest_End_I_Index(2)    = 98,           ! Relative to master grid
 Nest_Beg_J_Index(2)    = 14,           ! Relative to master grid
 Nest_End_J_Index(2)    = 49,           ! Relative to master grid

!--- Parameters for the third grid ---

 Nest_Meshing_Factor(3) = 9,            ! Relative to master grid
 Nest_Beg_I_Index(3)    = 68,           ! Relative to master grid
 Nest_End_I_Index(3)    = 88,           ! Relative to master grid
 Nest_Beg_J_Index(3)    = 17,           ! Relative to master grid
 Nest_End_J_Index(3)    = 40,           ! Relative to master grid

!--- Model options ---

 Diagnostic_Error_Check = false,        ! True = will stop after 1st timestep
 Flexi_Nest             = true,         ! allow flexi-nest of input files including restart
```

```
 Advection_Solver       = 'PPM',       ! (PPM,BOTT)
 Chemistry_Solver       = 'EBI',       ! (EBI,IEH,LSODE)
 PiG_Submodel           = 'GREASD',    ! (None,GREASD,IRON)
 Probing_Tool           = 'SA',        ! (None,OSAT,GOAT,APCA,PSAT,DDM,HDDM,PA,IPR,IRR,RTRAC,RTCMC)
 Chemistry              = .true.,
 Drydep_Model           = 'WESELY89',   ! (NONE,WESELY89,ZHANG03)  (new in CAMx 5.30)
 Wet_Deposition         = .true.,
 ACM2_Diffusion         = .false.,
 Super_Stepping         = .true.,
 Gridded_Emissions      = .true.,
 Point_Emissions        = .true.,
 Ignore_Emission_Dates  = .true.,

!--- Output specifications ---

 Root_Output_Name         = '/home/camx/outputs/$RUN/camx.$RUN.20$TODAY'
 Average_Output_3D        = .false.,
 Output_3D_Grid(1)        = .false.,   ! Set Average_Output_3D = .false.
 Output_3D_Grid(2)        = .false.,   ! if you set any of these to .true.
 Output_3D_Grid(3)        = .false.,
 HDF_Format_Output        = .false.,
 Output_Species_Names(1)  = 'O3',

!--- Input files ---

 Chemistry_Parameters = '/home/camx/input/other/chemparam/CAMx6.3.chemparam.2_NONE',
 Photolyis_Rates      = '/home/camx/input/other/tuv/camx620_cb6_tuv.20$TODAY.rpo_36km.2015APR28.tuv48',
 Ozone_Column         = '/home/camx/input/other/o3map/camx6_o3c.20$TODAY.rpo_36km.2013MAY24',
 Initial_Conditions   = '/home/camx/input/bcic/camx_cb6r2h_ic.20$TODAY.geoschem2015hi16B_45_29lyr.rpo_36km.2012',
 Boundary_Conditions  = '/home/camx/input/bcic/camx_cb6r2h_bc.20$TODAY.geoschem2015hi16B_45_29lyr.rpo_36km.2012',
 Top_Concentrations   = '/home/camx/input/bcic/camx_cb6r2h_tc.20$TODAY.geoschem2015hi16B_45_29lyr.rpo_36km.2012',
 Point_Sources        = '/home/eps3_v2/2023/point/emiss/ptsrce.PIG.cb6.AACOG.MAY.osd_2023',
 Master_Grid_Restart  = '/home/camx/outputs/$RUN/camx.$RUN.20$YESTERDAY.inst'
 Nested_Grid_Restart  = '/home/camx/outputs/$RUN/camx.$RUN.20$YESTERDAY.finst'
 PiG_Restart          = '/home/camx/outputs/$RUN/camx.$RUN.20$YESTERDAY.pig'

 Surface_Grid(1) = '/home/camx/input/other/landuse/camx6_landuse.rpo_36km.tceq2zhang26a.lai201206qc108ufun',
 Met3D_Grid(1)   = '/home/camx/input/met/camx6_met3d.20$TODAY.2012_wrf371_p2ma_45_29lyr.rpo_36km.v43',
 Met2D_Grid(1)   = '/home/camx/input/met/camx6_met2d.20$TODAY.2012_wrf371_p2ma_45_29lyr.rpo_36km.v43',
 Vdiff_Grid(1)   = '/home/camx/input/met/camx6_kv.20$TODAY.2012_wrf371_p2ma_45_29lyr.rpo_36km.v43.CMAQ.kv100',
 Cloud_Grid(1)   = '/home/camx/input/met/camx6_cr.20$TODAY.2012_wrf371_p2ma_45_29lyr.rpo_36km.v43',
 Emiss_Grid(1)   = '/home/eps3_v2/2023/merge/lo_emiss.bio.rpo_36km.cb6.20$TODAY.june.2012.AACOG.fy17.APCA.reg1.rpo_36km',

 Surface_Grid(2) = '/home/camx/input/other/landuse/camx6_landuse.tx_12km.tceq2zhang26a.lai201206qc108ufun',
 Met3D_Grid(2)   = '/home/camx/input/met/camx6_met3d.20$TODAY.2012_wrf371_p2ma_45_29lyr.tx_12km.v43',
 Met2D_Grid(2)   = '/home/camx/input/met/camx6_met2d.20$TODAY.2012_wrf371_p2ma_45_29lyr.tx_12km.v43',
 Vdiff_Grid(2)   = '/home/camx/input/met/camx6_kv.20$TODAY.2012_wrf371_p2ma_45_29lyr.tx_12km.v43.CMAQ.kv100',
 Cloud_Grid(2)   = '/home/camx/input/met/camx6_cr.20$TODAY.2012_wrf371_p2ma_45_29lyr.tx_12km.v43',
 Emiss_Grid(2)   = '/home/eps3_v2/2023/merge/lo_emiss.bio.tx_12km.cb6.20$TODAY.june.2012.AACOG.fy17.APCA.reg1.tx_12km',

 Surface_Grid(3) = '/home/camx/input/other/landuse/camx6_landuse.tx_4km.tceq2zhang26a.lai201206qc108ufun',
```

```
Met3D_Grid(3)   = '/home/camx/input/met/camx6_met3d.20$TODAY.2012_wrf371_i2mSNgqsfc0_45_29lyr.tx_4km.v43',
Met2D_Grid(3)   = '/home/camx/input/met/camx6_met2d.20$TODAY.2012_wrf371_i2mSNgqsfc0_45_29lyr.tx_4km.v43',
Vdiff_Grid(3)   = '/home/camx/input/met/camx6_kv.20$TODAY.2012_wrf371_i2mSNgqsfc0_45_29lyr.tx_4km.v43.CMAQ.kv100',
Cloud_Grid(3)   = '/home/camx/input/met/camx6_cr.20$TODAY.2012_wrf371_i2mSNgqsfc0_45_29lyr.tx_4km.v43',
Emiss_Grid(3)   = '/home/eps3_v2/2023/merge/lo_emiss.bio.tx_4km.cb6.20$TODAY.june.2012.AACOG.fy17.APCA.reg1.tx_4km',

&END
!-------------------------------------------------------------------------------
&SA_Control

SA_File_Root                = '$OUTPUT/camx.$RUN.20$TODAY',

SA_Master_Sfc_Output        = .true.,
SA_Nested_Sfc_Output        = .true.,
SA_Summary_Output           = .true.,
SA_Stratify_Boundary        = .false.,
SA_Deposition_Output        = .false.,
SA_Number_of_Source_Regions = 9,
SA_Number_of_Source_Groups  = 7,

Use_Leftover_Group          = .false.,

SA_Treat_SULFATE_Class      = .false.,
SA_Treat_NITRATE_Class      = .false.,
SA_Treat_SOA_Class          = .false.,
SA_Treat_PRIMARY_Class      = .false.,
SA_Treat_MERCURY_Class      = .false.,
SA_Treat_OZONE_Class        = .true.,
SA_Use_APCA                 = .true.,

Number_of_Timing_Releases   = 0,

SA_Receptor_Definitions     = '/home/camx/APCA/receptor.AACOG.CAMS'
SA_Source_Area_Map(1)       = '/home/camx/APCA/APCA.source.36km.map.SA_MSA',
SA_Source_Area_Map(2)       = '/home/camx/APCA/APCA.source.12km.map.SA_MSA',
SA_Source_Area_Map(3)       = '/home/camx/APCA/APCA.source.4km.map.SA_MSA',

SA_Use_Partial_SourceMap = .false.,
Partial_Source_Area_Map(1,1) = ' ',   ! Map for SA group 1, grid 1
Partial_Source_Area_Map(1,2) = ' ',   ! Map for SA group 1, grid 2
SA_PT_Override           = .false.,

SA_Master_Restart           = '/home/camx/outputs/$RUN/camx.$RUN.20$YESTERDAY.sa.inst '
SA_Nested_Restart           = '/home/camx/outputs/$RUN/camx.$RUN.20$YESTERDAY.sa.finst  '

SA_Points_Group(1)          = ' '
SA_Points_Group(2)          = '/home/eps3_v2/2023/point/emiss/ptsrce.PIG.cb6.AACOG.MAY.osd_2023.APCA',
SA_Points_Group(3)          = ' '
SA_Points_Group(4)          = ' '
SA_Points_Group(5)          = ' '
SA_Points_Group(6)          = ' '
```

```
 SA_Points_Group(7)          = ' '

 SA_Emiss_Group_Grid(1,1)    = '/home/eps3_v2/Bio_EI/2012may.rpo_36km.CB5.20$TODAY.camx' ,
 SA_Emiss_Group_Grid(2,1)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.point.MAY.reg1.rpo_36km' ,
 SA_Emiss_Group_Grid(3,1)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.area.reg1.rpo_36km' ,
 SA_Emiss_Group_Grid(4,1)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.mobile.APR.reg1.rpo_36km' ,
 SA_Emiss_Group_Grid(5,1)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.non_road.reg1.rpo_36km' ,
 SA_Emiss_Group_Grid(6,1)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.off_road.reg1.rpo_36km' ,
 SA_Emiss_Group_Grid(7,1)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.oil_gas.reg1.rpo_36km' ,

 SA_Emiss_Group_Grid(1,2)    = '/home/eps3_v2/Bio_EI/2012may.tx_12km.CB5.20$TODAY.camx' ,
 SA_Emiss_Group_Grid(2,2)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.point.MAY.reg1.tx_12km' ,
 SA_Emiss_Group_Grid(3,2)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.area.reg1.tx_12km' ,
 SA_Emiss_Group_Grid(4,2)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.mobile.APR.reg1.tx_12km' ,
 SA_Emiss_Group_Grid(5,2)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.non_road.reg1.tx_12km' ,
 SA_Emiss_Group_Grid(6,2)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.off_road.reg1.tx_12km' ,
 SA_Emiss_Group_Grid(7,2)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.oil_gas.reg1.tx_12km' ,

 SA_Emiss_Group_Grid(1,3)    = '/home/eps3_v2/Bio_EI/SN_12may.tx_4km.CB5.20$TODAY.camx' ,
 SA_Emiss_Group_Grid(2,3)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.point.MAY.reg1.tx_4km' ,
 SA_Emiss_Group_Grid(3,3)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.area.reg1.tx_4km' ,
 SA_Emiss_Group_Grid(4,3)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.mobile.APR.reg1.tx_4km' ,
 SA_Emiss_Group_Grid(5,3)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.non_road.reg1.tx_4km' ,
 SA_Emiss_Group_Grid(6,3)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.off_road.reg1.tx_4km' ,
 SA_Emiss_Group_Grid(7,3)    = '/home/eps3_v2/2023/merge/camx_cb6_ei_lo.20$TODAY.june.2012.AACOG.fy17.oil_gas.reg1.tx_4km' ,


 &END

ieof
#
#  --- Execute the model ---
#

cp -p CAMx.in $RUN/CAMx.$RUN.$TODAY.in
#/usr/bin/time $EXEC | & tee $RUN/camx.$RUN.$TODAY.out
/usr/bin/time $EXEC | & tee $RUN/camx.$RUN.$TODAY.out

@ JDATE ++
end
```

Appendix D: Run Log

Run Number	Run ID	Projection Year	Date	Remarks
1	TCEQ 2012 Base line Run 1	2012	02/24/2017	RPO 36-km grid system, 12-km grid, and 4-km grid Camx6.30 Existing 2012 TCEQ Emission Inventory Advection_Solver = PPM Chemistry_Solver = EBI PiG_Submodel = GREASD Probing_Tool = None Drydep_Model = WESELY89 Wet_Deposition = true ACM2_Diffusion = false Chemistry_Parameters = CAMx6.3.chemparam.3_NONE Photolyis_Rates = camx620_cb6_tuv.rpo_36km.2015APR28.tuv48 Ozone_Column = camx6_o3c.rpo_36km.2013MAY24 Initial_Conditions = camx_cb6r2h_ic.geoschem2015hi16B_45_29lyr.rpo_36km.2012 Boundary_Conditions = camx_cb6r2h_bc.geoschem2015hi16B_45_29lyr.rpo_36km.2012 Top_Concentrations = camx_cb6r2h_tc.geoschem2015hi16B_45_29lyr.rpo_36km.2012 Surface_Grid(1) = camx6_landuse.rpo_36km.tceq2zhang26a.lai201206qc108ufun Met3D_Grid(1) = camx6_met3d. 2012_wrf371_p2ma_45_29lyr.rpo_36km.v43 Met2D_Grid(1) = camx6_met2d. 2012_wrf371_p2ma_45_29lyr.rpo_36km.v43 Vdiff_Grid(1) = camx6_kv. 2012_wrf371_p2ma_45_29lyr.rpo_36km.v43.CMAQ.kv100 Cloud_Grid(1) = camx6_cr. 2012_wrf371_p2ma_45_29lyr.rpo_36km.v43 Emiss_Grid(1) = camx_cb6p_ei_lo.tx.bl12.r4a.rpo_36km Surface_Grid(2) = camx6_landuse.tx_12km.tceq2zhang26a.lai201206qc108ufun Met3D_Grid(2) = camx6_met3d. 2012_wrf371_p2ma_45_29lyr.tx_12km.v43 Met2D_Grid(2) = camx6_met2d. 2012_wrf371_p2ma_45_29lyr.tx_12km.v43 Vdiff_Grid(2) = camx6_kv. 2012_wrf371_p2ma_45_29lyr.tx_12km.v43.CMAQ.kv100 Cloud_Grid(2) = camx6_cr. 2012_wrf371_p2ma_45_29lyr.tx_12km.v43 Emiss_Grid(2) = camx_cb6p_ei_lo.tx.bl12.r4a.tx_12km Surface_Grid(3) = camx6_landuse.tx_4km.tceq2zhang26a.lai201206qc108ufun Met3D_Grid(3) = camx6_met3d. 2012_wrf371_i2mSNgqsfc0_45_29lyr.tx_4km.v43 Met2D_Grid(3) = camx6_met2d. 2012_wrf371_i2mSNgqsfc0_45_29lyr.tx_4km.v43 Vdiff_Grid(3) = camx6_kv. 2012_wrf371_i2mSNgqsfc0_45_29lyr.tx_4km.v43.CMAQ.kv100 Cloud_Grid(3) = camx6_cr. 2012_wrf371_i2mSNgqsfc0_45_29lyr.tx_4km.v43 Emiss_Grid(3) = camx_cb6p_ei_lo.tx.bl12.r4a.tx_4km

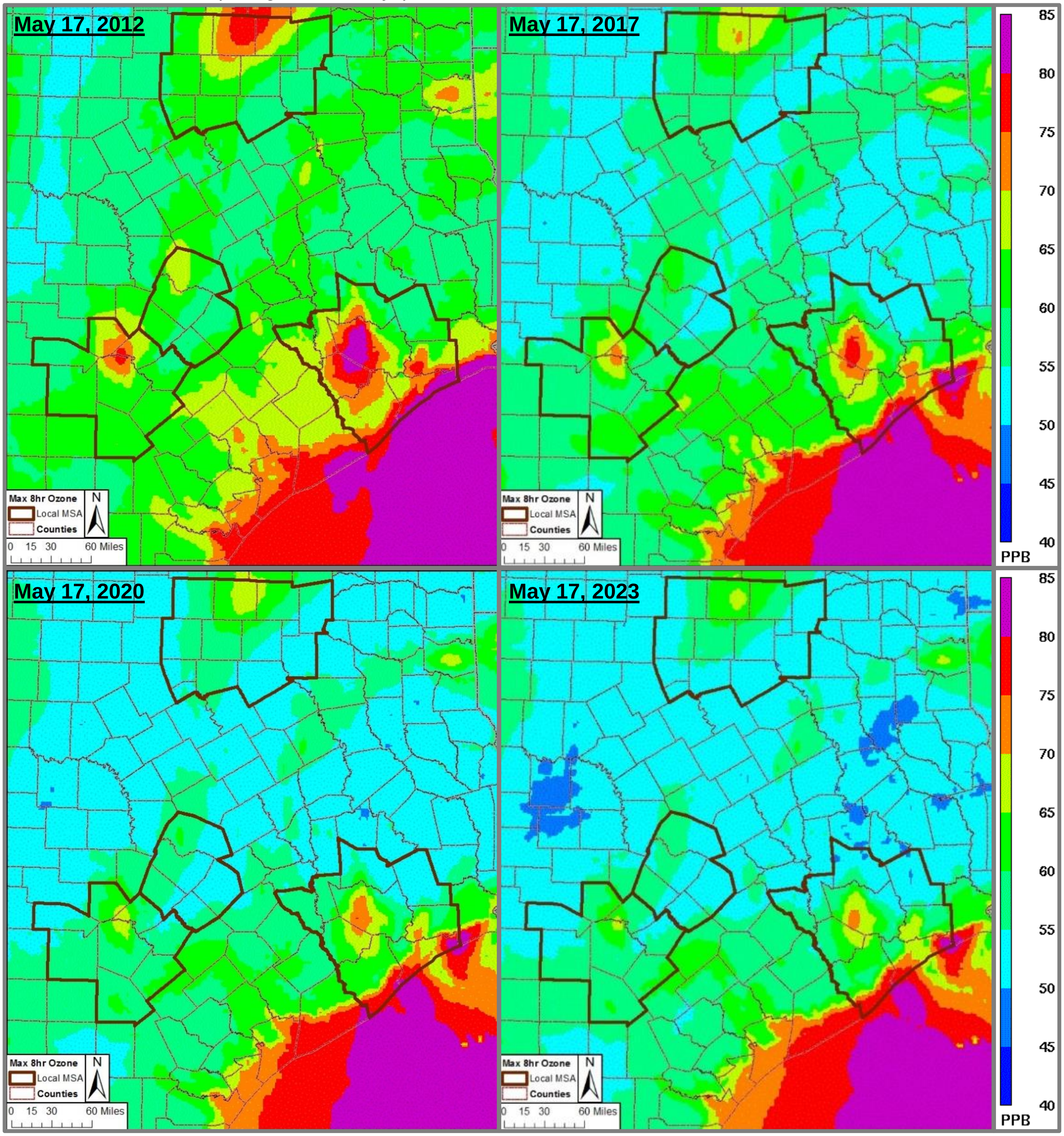
2	TCEQ 2017 Projection Case Run 2	2017	02/27/2017	Same as Run 1 Existing 2017 TCEQ Emission Inventory Emiss_Grid(1) = camx_cb6p_ei_lo. tx.fy17.c0m.rpo_36km Emiss_Grid(2) = camx_cb6p_ei_lo. tx.fy17.c0m.tx_12km Emiss_Grid(3) = camx_cb6p_ei_lo. tx.fy17.c0m.tx_4km
3	AACOG 2017 Projection Case Run 3	2017	03/24/2017	Same as Run 1 Local 2017 San Antonio-New Braunfels MSA emission data including construction equipment, lawn and garden, quarry equipment, industrial fuel usage, commercial fuel usage, landfill equipment, quarry equipment, agricultural tractors, combines, commercial airports, point sources, and heavy duty truck idling Emiss_Grid(1) = lo_emiss.bio.rpo_36km.cb6. june.2012.AACOG.fy17.reg1.rpo_36km Emiss_Grid(2) = lo_emiss.bio.tx_12km.cb6. june.2012.AACOG.fy17.reg1.tx_12km Emiss_Grid(3) = lo_emiss.bio.tx_4km.cb6. june.2012.AACOG.fy17.reg1.tx_4km
4	AACOG 2020 Projection Case Run 4	2020	03/24/2017	Same as Run 3 2020 Emission Inventory Emiss_Grid(1) = lo_emiss.bio.rpo_36km.cb6. june.2012.AACOG.fy17.reg1.rpo_36km Emiss_Grid(2) = lo_emiss.bio.tx_12km.cb6. june.2012.AACOG.fy17.reg1.tx_12km Emiss_Grid(3) = lo_emiss.bio.tx_4km.cb6. june.2012.AACOG.fy17.reg1.tx_4km
5	AACOG 2023 Projection Case Run 5	2023	03/24/2017	Same as Run 3 2017 Emission Inventory Emiss_Grid(1) = lo_emiss.bio.rpo_36km.cb6. june.2012.AACOG.fy17.reg1.rpo_36km Emiss_Grid(2) = lo_emiss.bio.tx_12km.cb6. june.2012.AACOG.fy17.reg1.tx_12km Emiss_Grid(3) = lo_emiss.bio.tx_4km.cb6. june.2012.AACOG.fy17.reg1.tx_4km
6	25% reduction in NO_X	2023	04/29/2017	Same as Run 5 25% reduction in NO_X from the San Antonio-New Braunfels MSA
7	50% reduction in NO_X	2023	04/30/2017	Same as Run 5 50% reduction in NO_X from the San Antonio-New Braunfels MSA
8	75% reduction in NOX	2023	05/01/2017	Same as Run 5 75% reduction in NO_X from the San Antonio-New Braunfels MSA
9	100% reduction in NO_X	2023	05/01/2017	Same as Run 5 100% reduction in NO_X from the San Antonio-New Braunfels MSA
10	25% reduction in VOC	2023	05/03/2017	Same as Run 5 25% reduction in VOC from the San Antonio-New Braunfels MSA

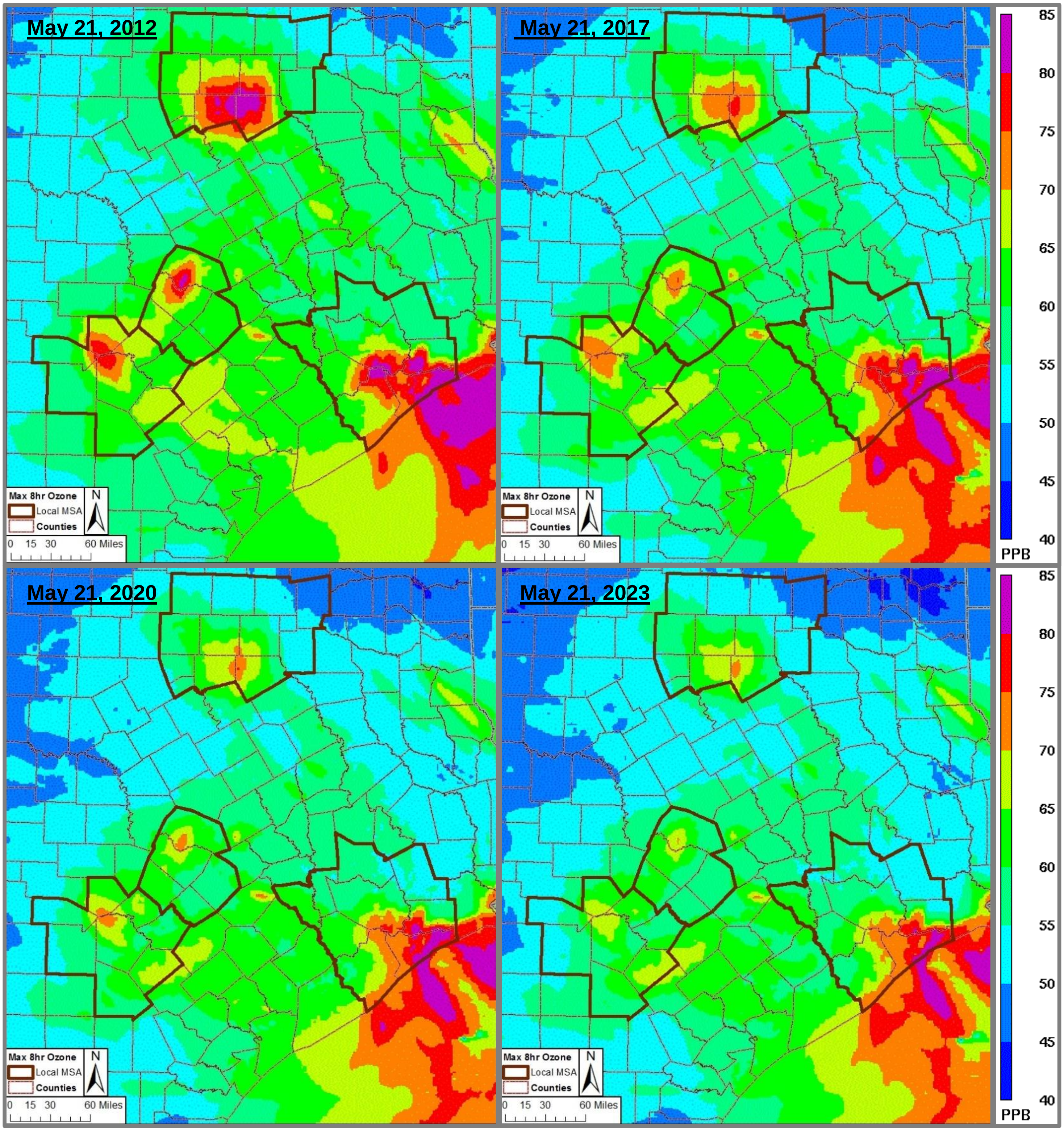
11	50% reduction in VOC	2023	05/04/2017	Same as Run 5 50% reduction in VOC from the San Antonio-New Braunfels MSA
12	75% reduction in VOC	2023	05/05/2017	Same as Run 5 75% reduction in VOC from the San Antonio-New Braunfels MSA
13	100% reduction in VOC	2023	05/09/2017	Same as Run 5 100% reduction in VOC from the San Antonio-New Braunfels MSA
14	25% reduction in NO_X and VOC	2023	05/15/2017	Same as Run 5 25% reduction in NO_X and VOC from the San Antonio-New Braunfels MSA
15	50% reduction in NO_X and VOC	2023	05/15/2017	Same as Run 5 50% reduction in NO_X and VOC from the San Antonio-New Braunfels MSA
16	75% reduction in NO_X and VOC	2023	05/15/2017	Same as Run 5 75% reduction in NO_X and VOC from the San Antonio-New Braunfels MSA
17	100% reduction in NO_X and VOC	2023	05/15/2017	Same as Run 5 100% reduction in NO_X and VOC from the San Antonio-New Braunfels MSA
18	Control Strategy Run for Anti-Idling	2023	07/26/2017	Same as Run 5 Emission reductions from an anti-idling program for vehicles weighing 14,000 pounds or more within the 8-county San Antonio-New Braunfels MSA
19	Control Strategy Run 2 with OBDII inspection and Maintenance Program	2023	08/03/2017	Same as Run 5 Emissions reduction from an On-Board Diagnostic system (OBDII) inspection and maintenance program

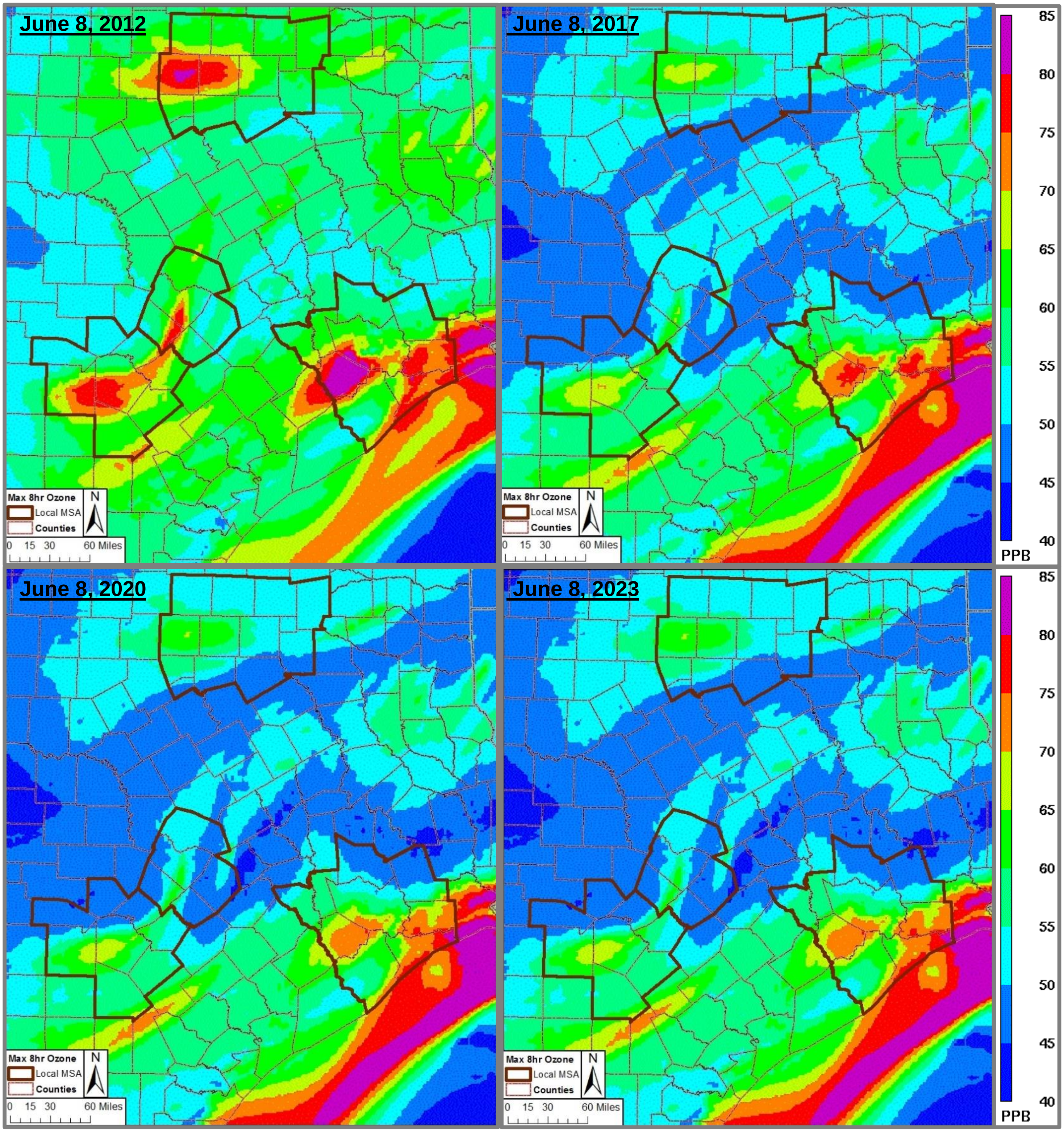
20	Control Strategy Run 3 On-road Emissions	2023	08/21/2017	Same as Run 5 Emission reductions from the following on-road control strategies: 1,000 light commercial electric vehicles, 1,000 electric vehicles passenger cars, 10,000 workers telecommuting, carpooling based on 2,000,000 VMT reduced (1,900 workers), vanpooling based on 2,000 vehicles removed, and traffic re-signalization (39 lights), and railroad grade separation.
21	San Antonio-New Braunfels MSA Counties APCA Run	2023	03/25/2017	Same as Run 5 Probing_Tool = SA SA_Master_Sfc_Output= .true. SA_Nested_Sfc_Output= .true. SA_Summary_Output = .true. SA_Stratify_Boundary= .false. SA_Deposition_Output= .false. SA_Number_of_Source_Regions = 9 SA_Number_of_Source_Groups= 7 Use_Leftover_Group= .false. SA_Treat_SULFATE_Class= .false. SA_Treat_NITRATE_Class= .false. SA_Treat_SOA_Class= .false. SA_Treat_PRIMARY_Class= .false. SA_Treat_MERCURY_Class= .false. SA_Treat_OZONE_Class= .true. SA_Use_APCA = .true. SA_Receptor_Definitions = receptor.AACOG.CAMS SA_Source_Area_Map(1) = APCA.source.36km.map.SA_MSA SA_Source_Area_Map(2) = APCA.source.12km.map.SA_MSA SA_Source_Area_Map(3) = APCA.source.4km.map.SA_MSA SA_Use_Partial_SourceMap = .false SA_PT_Override = .false
22	Texas Regions APCA Run	2023	03/30/2017	Same as Run 21 SA_Source_Area_Map(1) = APCA.source.36km.map.TEXAS SA_Source_Area_Map(2) = APCA.source.12km.map.TEXAS SA_Source_Area_Map(3) = APCA.source.4km.map.TEXAS
23	Other States APCA Run	2023	03/27/2017	Same as Run 21 SA_Number_of_Source_Regions = 37, SA_Number_of_Source_Groups = 2, SA_Source_Area_Map(1) = APCA.source.36km.map.STATES SA_Source_Area_Map(2) = APCA.source.12km.map.STATES SA_Source_Area_Map(3) = APCA.source.4km.map.STATES

Appendix E: Ozone Plots

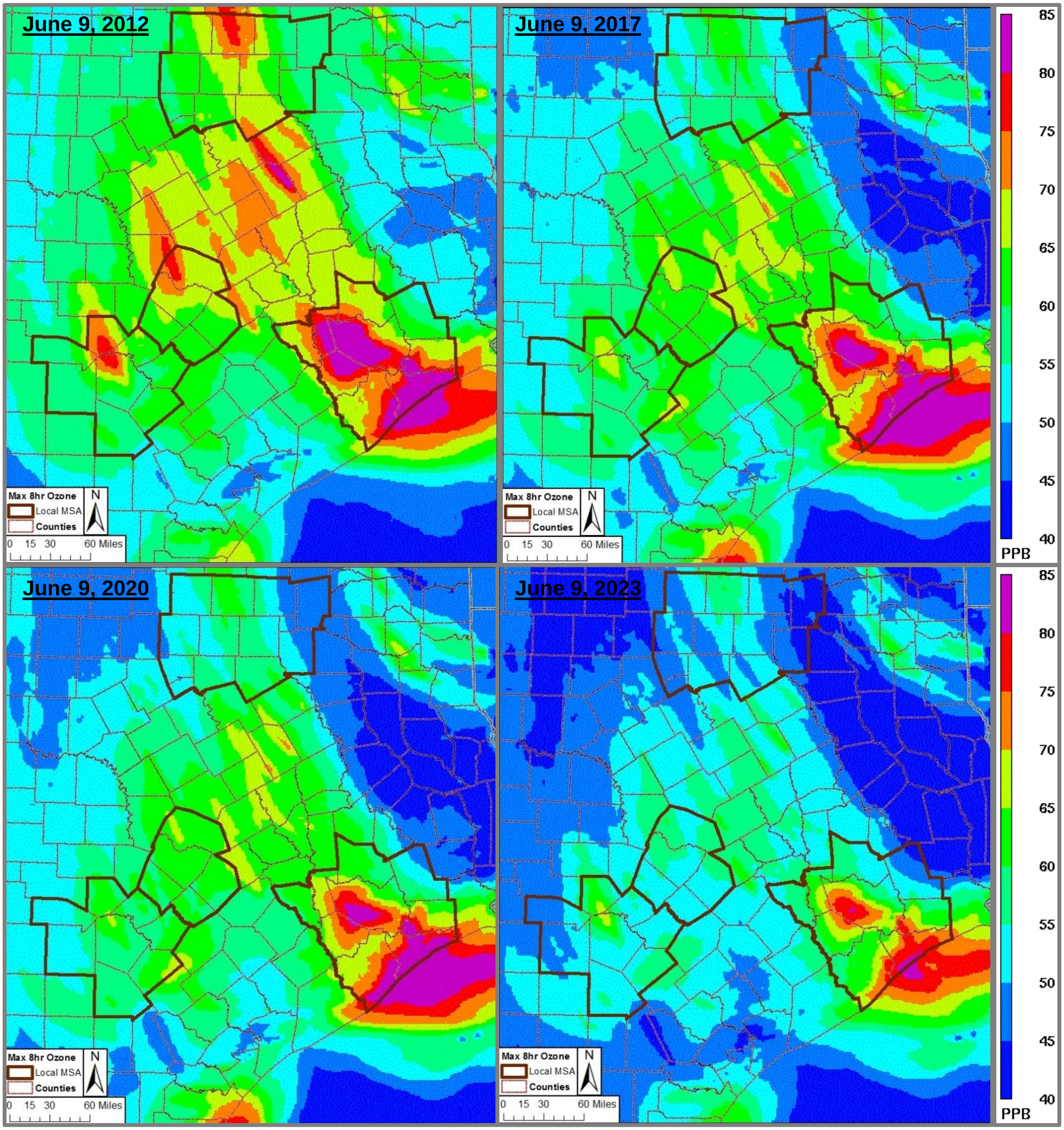
Predicted Daily Maximum 8-hour Ozone Concentrations in the 4-km Subdomain, 2012, 2017, 2023, and 2023 (Design Value Days)

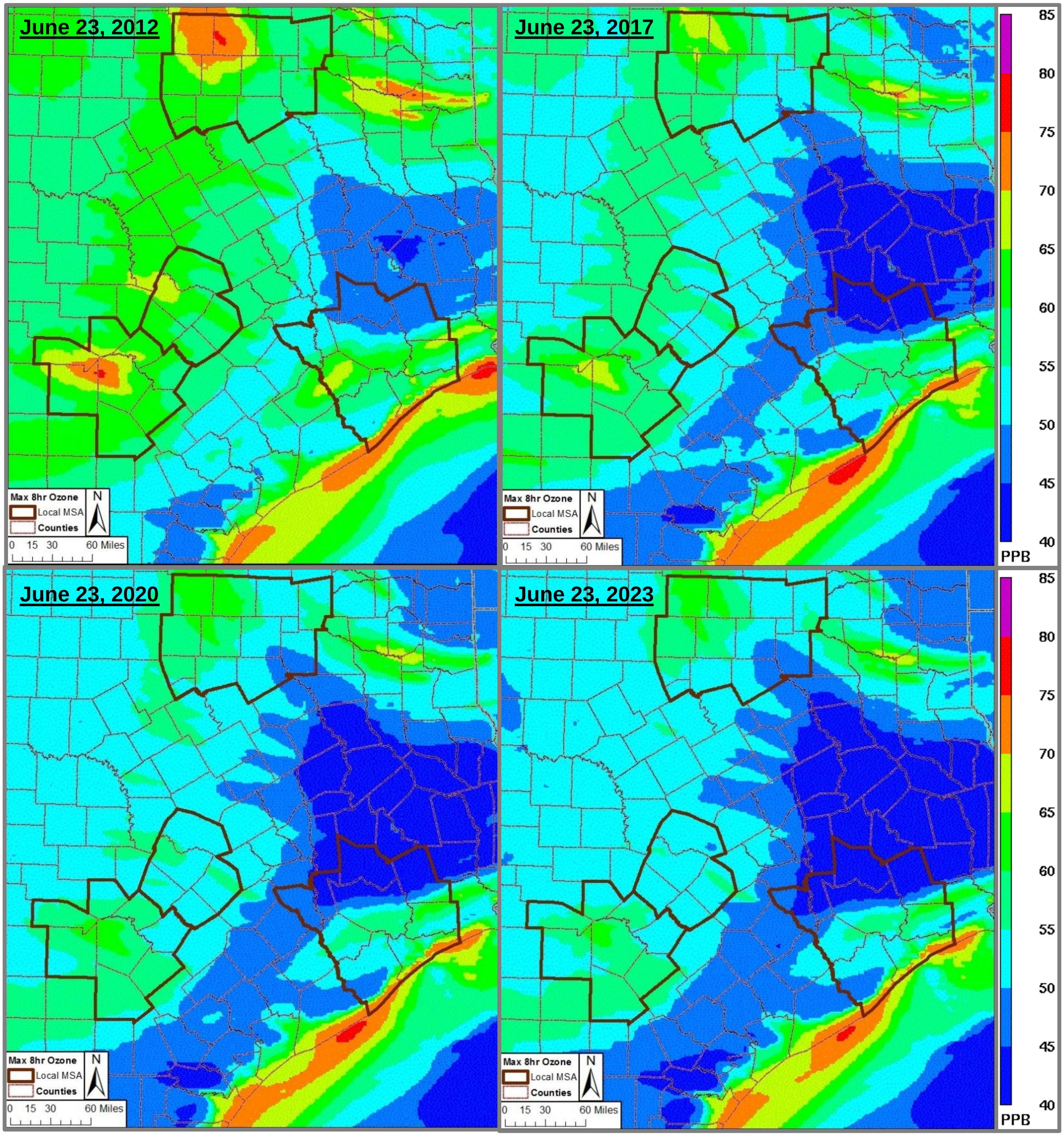


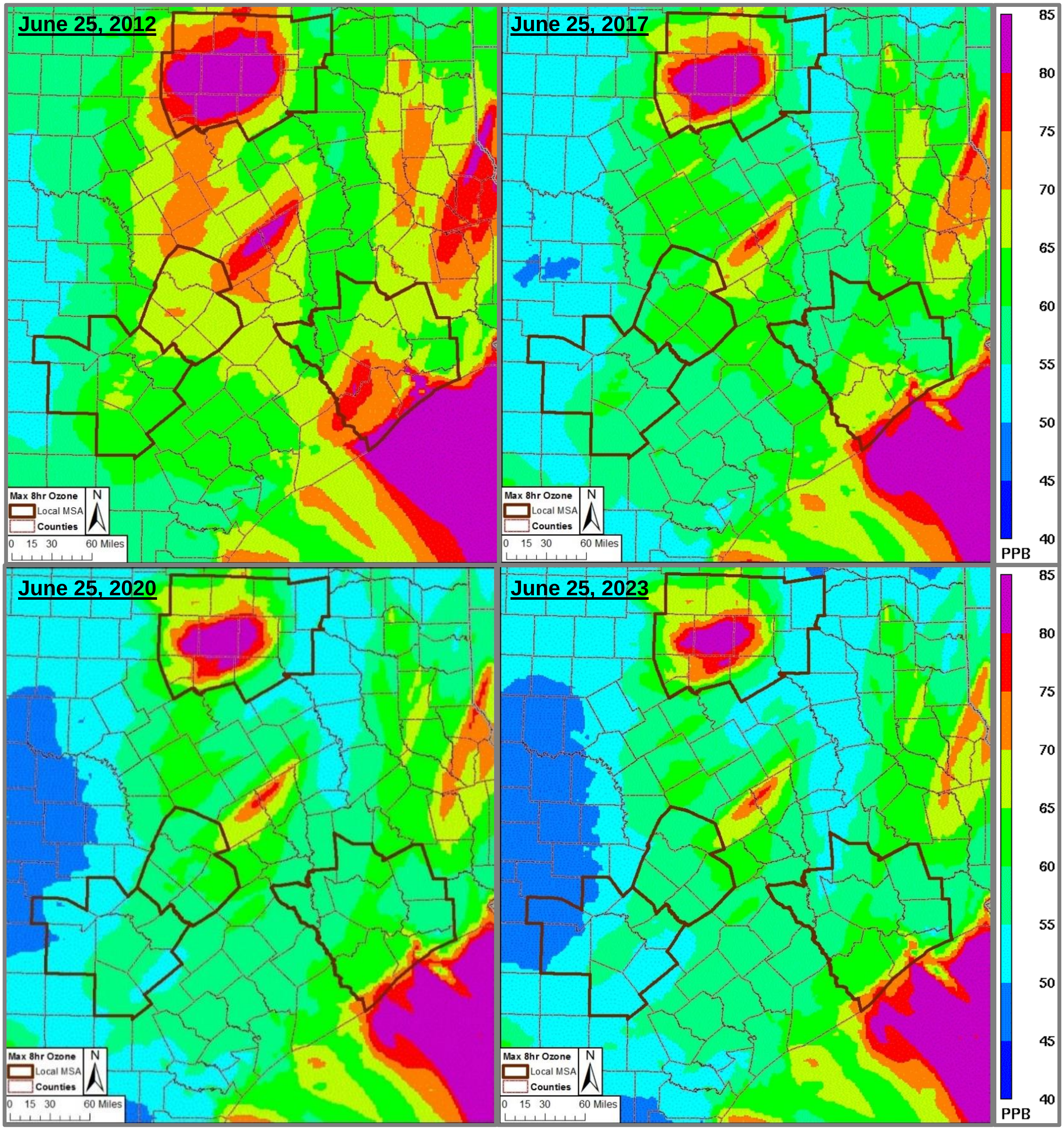

May 21, 2012
May 21, 2017
May 21, 2020
May 21, 2023
Max 8hr Ozone
Local MSA
Counties
N
0 15 30 60 Miles
85
80
75
70
65
60
55
50
45
40
PPB

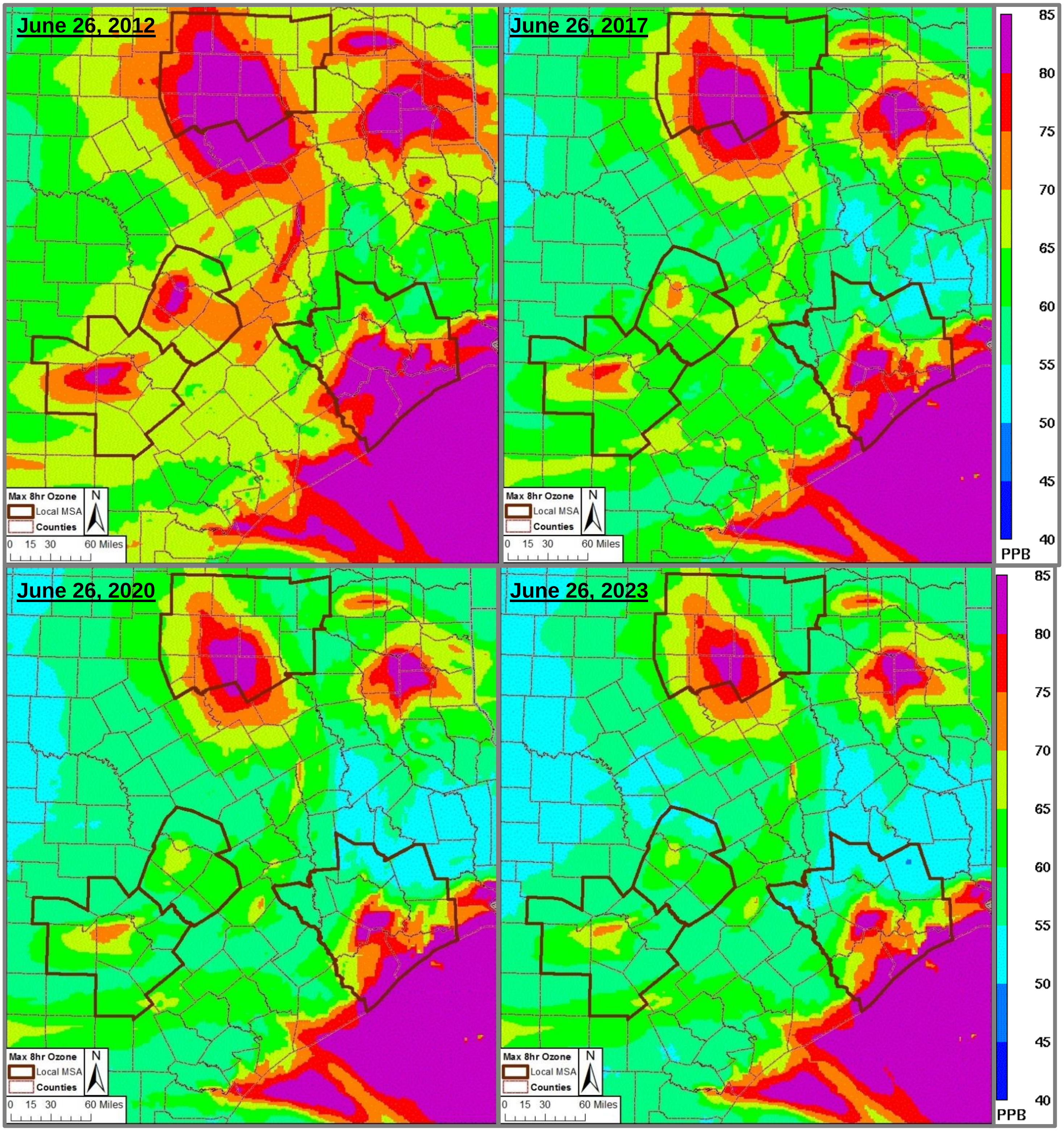


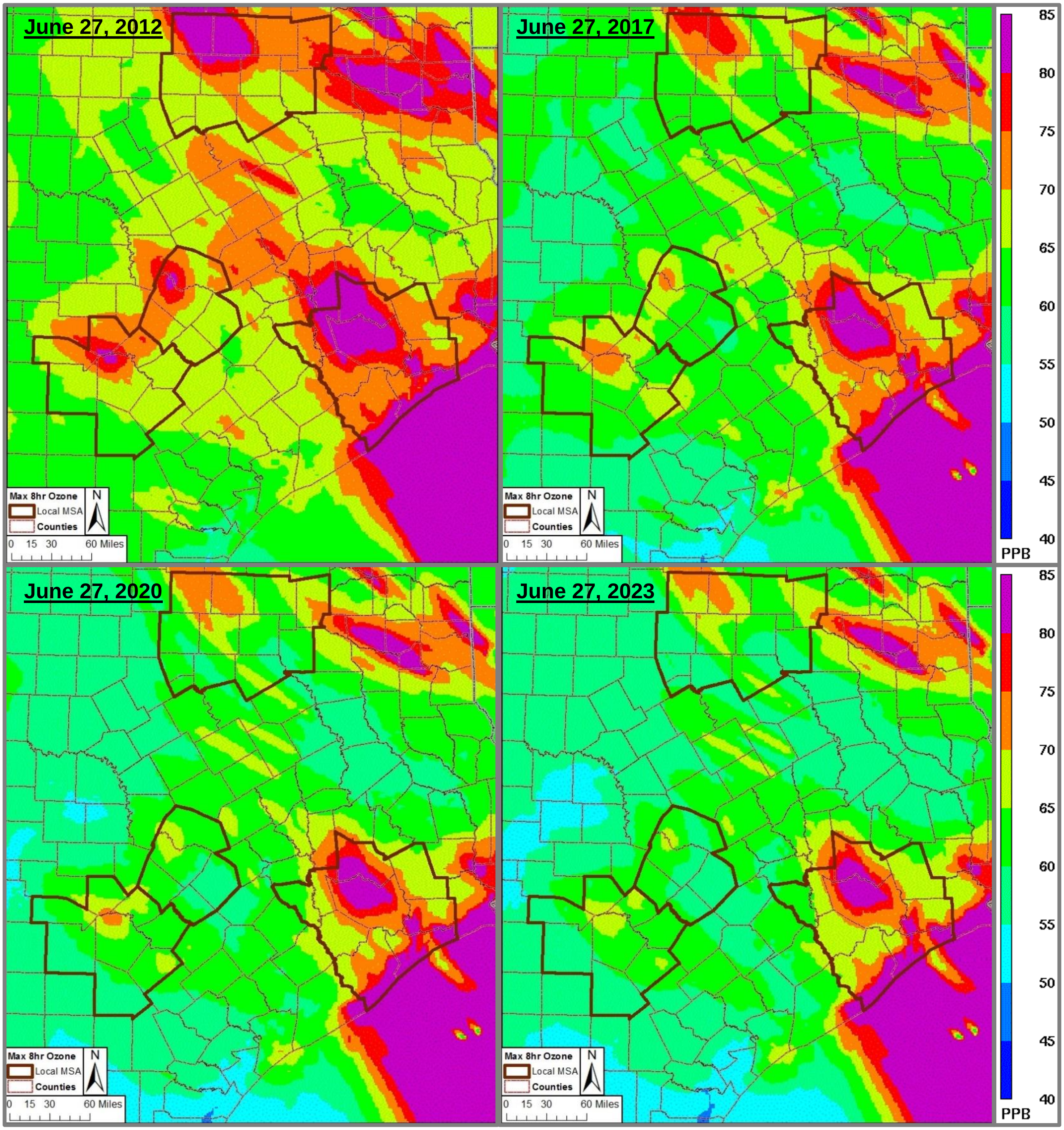
June 8, 2012
June 8, 2017
June 8, 2020
June 8, 2023
Max 8hr Ozone
Local MSA
Counties
N
0 15 30 60 Miles
85
80
75
70
65
60
55
50
45
40
PPB

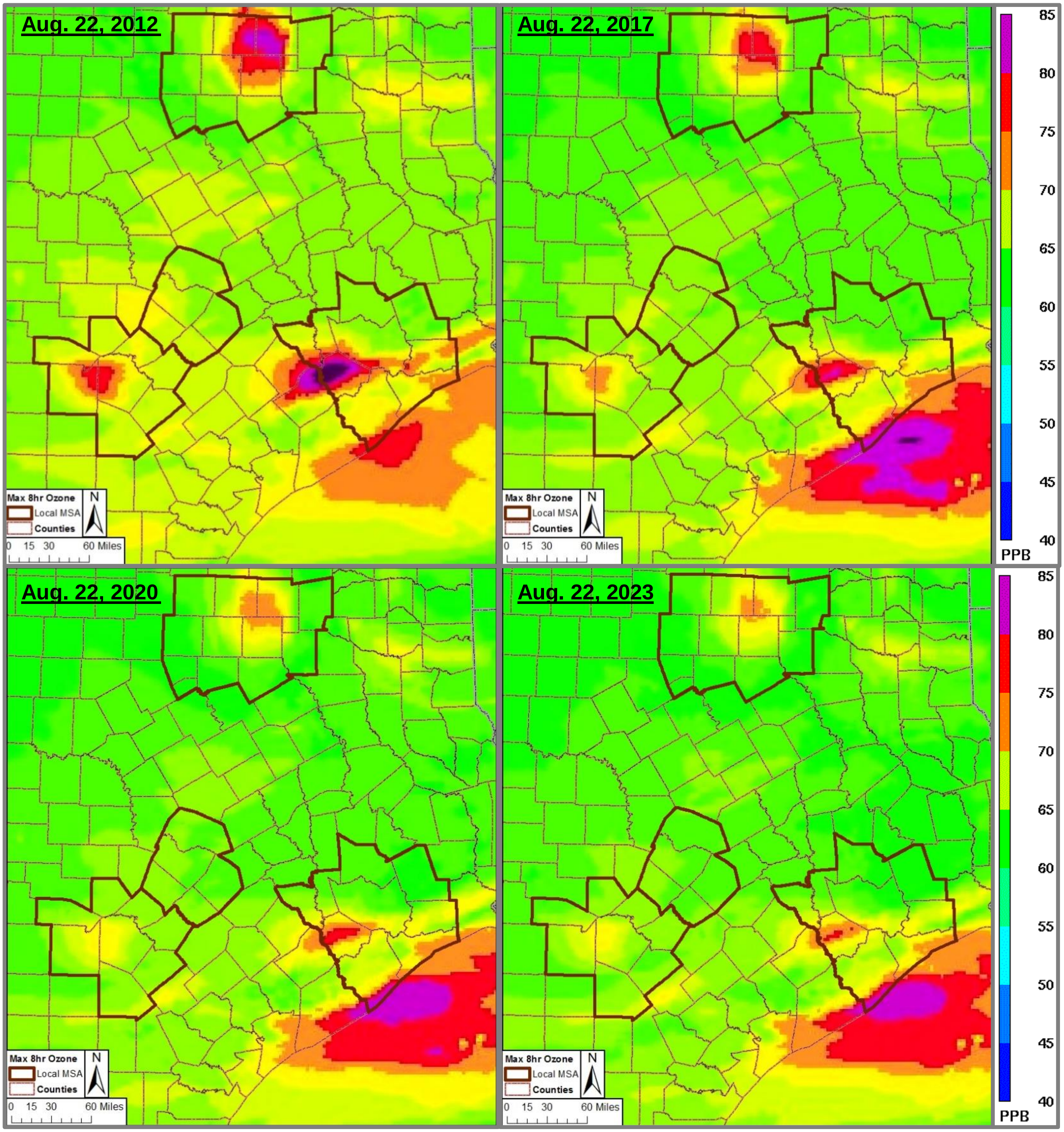

June 9, 2012
June 9, 2017
June 9, 2020
June 9, 2023
Max 8hr Ozone
Local MSA
Counties
N
0 15 30 60 Miles
85
80
75
70
65
60
55
50
45
40
PPB

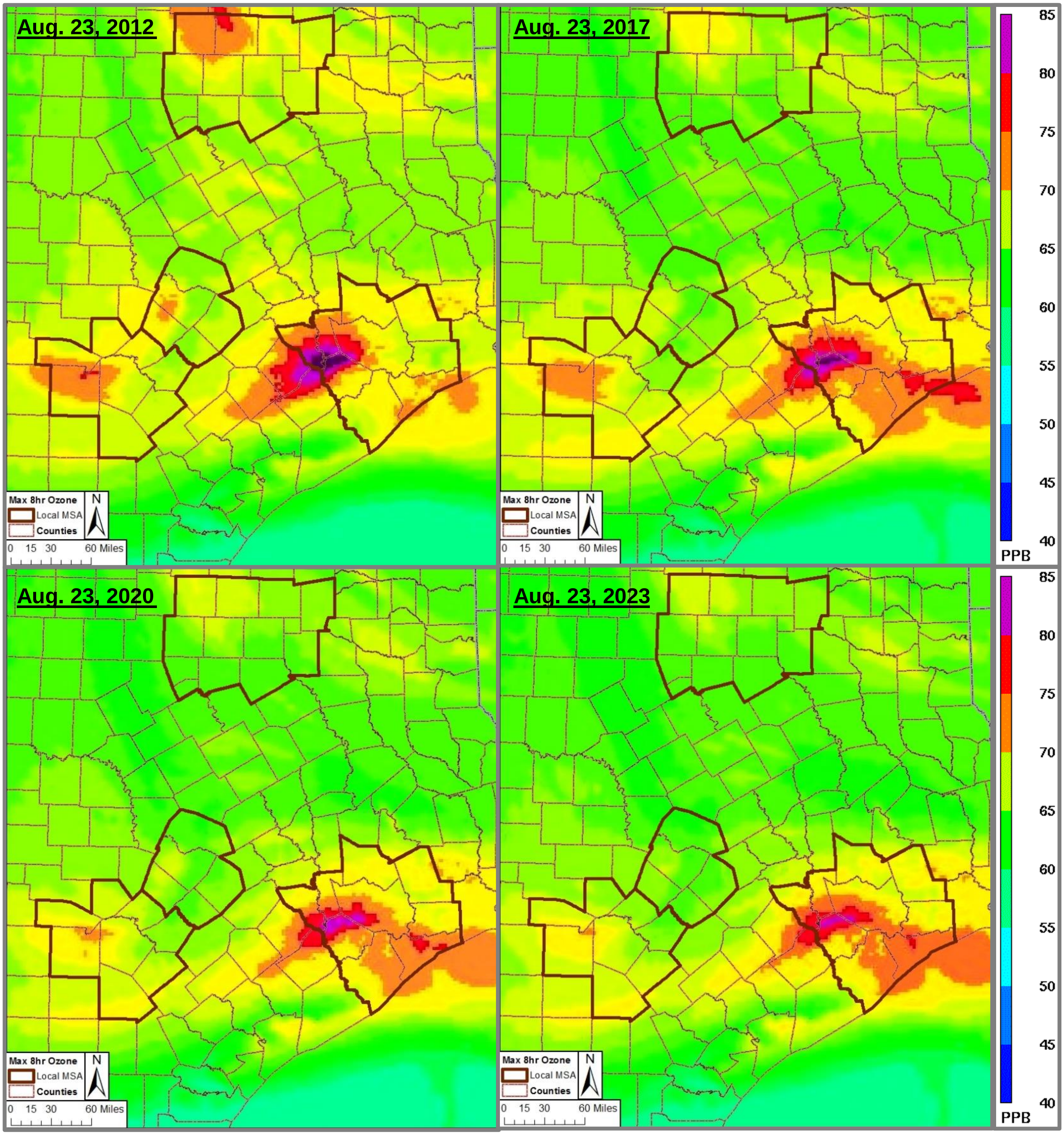

June 23, 2012
June 23, 2017
June 23, 2020
June 23, 2023
Max 8hr Ozone
Local MSA
Counties
0 15 30 60 Miles
N
85
80
75
70
65
60
55
50
45
40
PPB


June 25, 2012
June 25, 2017
June 25, 2020
June 25, 2023
Max 8hr Ozone
Local MSA
Counties
N
0 15 30 60 Miles
85
80
75
70
65
60
55
50
45
40
PPB

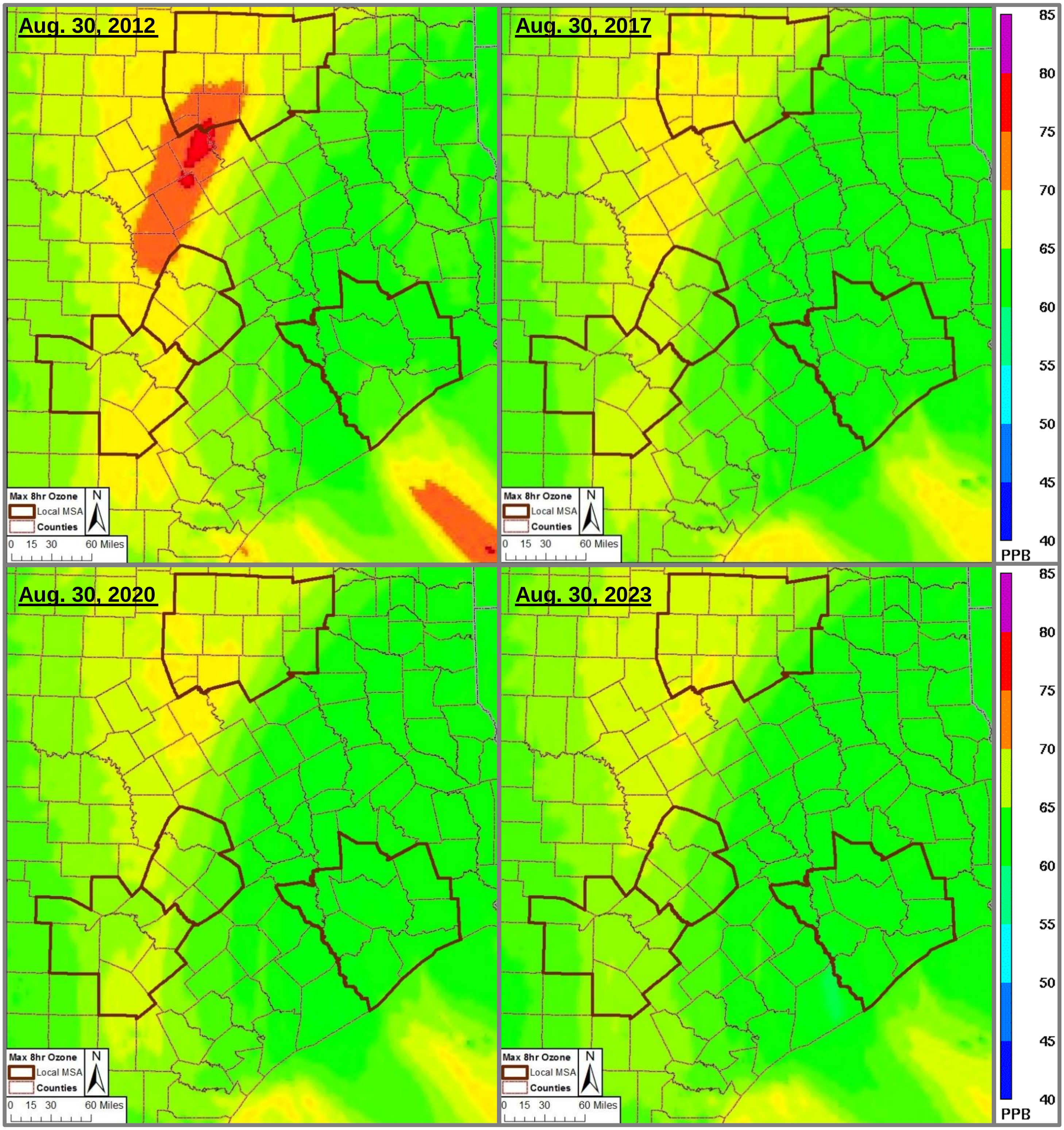

June 26, 2012
June 26, 2017
June 26, 2020
June 26, 2023
Max 8hr Ozone
Local MSA
Counties
N
0 15 30 60 Miles
85
80
75
70
65
60
55
50
45
40
PPB


June 27, 2012
June 27, 2017
June 27, 2020
June 27, 2023
Max 8hr Ozone
Local MSA
Counties
0 15 30 60 Miles
N
85
80
75
70
65
60
55
50
45
40
PPB

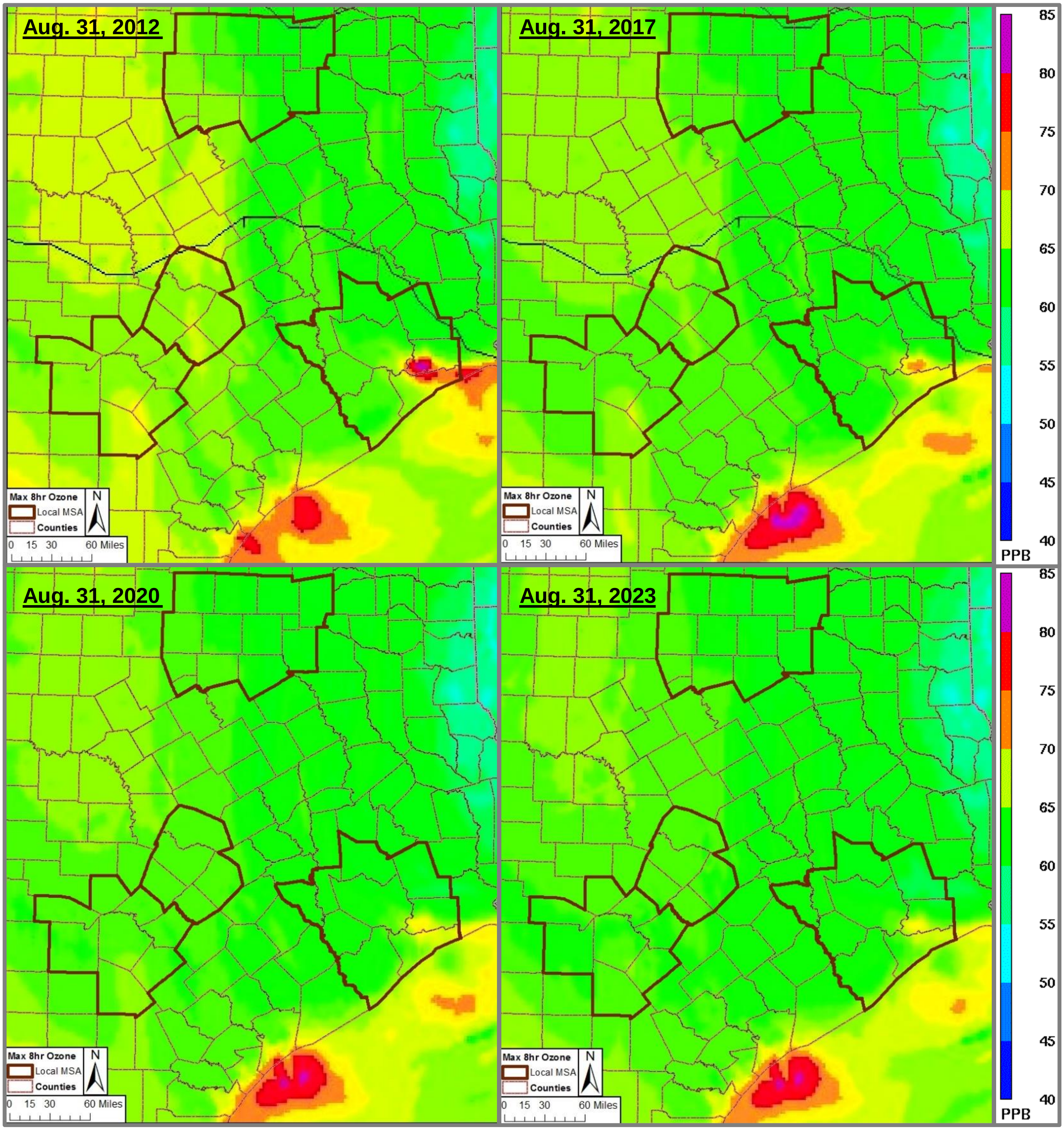

Aug. 22, 2012
Aug. 22, 2017
Aug. 22, 2020
Aug. 22, 2023
Max 8hr Ozone
Local MSA
Counties
N
0 15 30 60 Miles
85
80
75
70
65
60
55
50
45
40
PPB



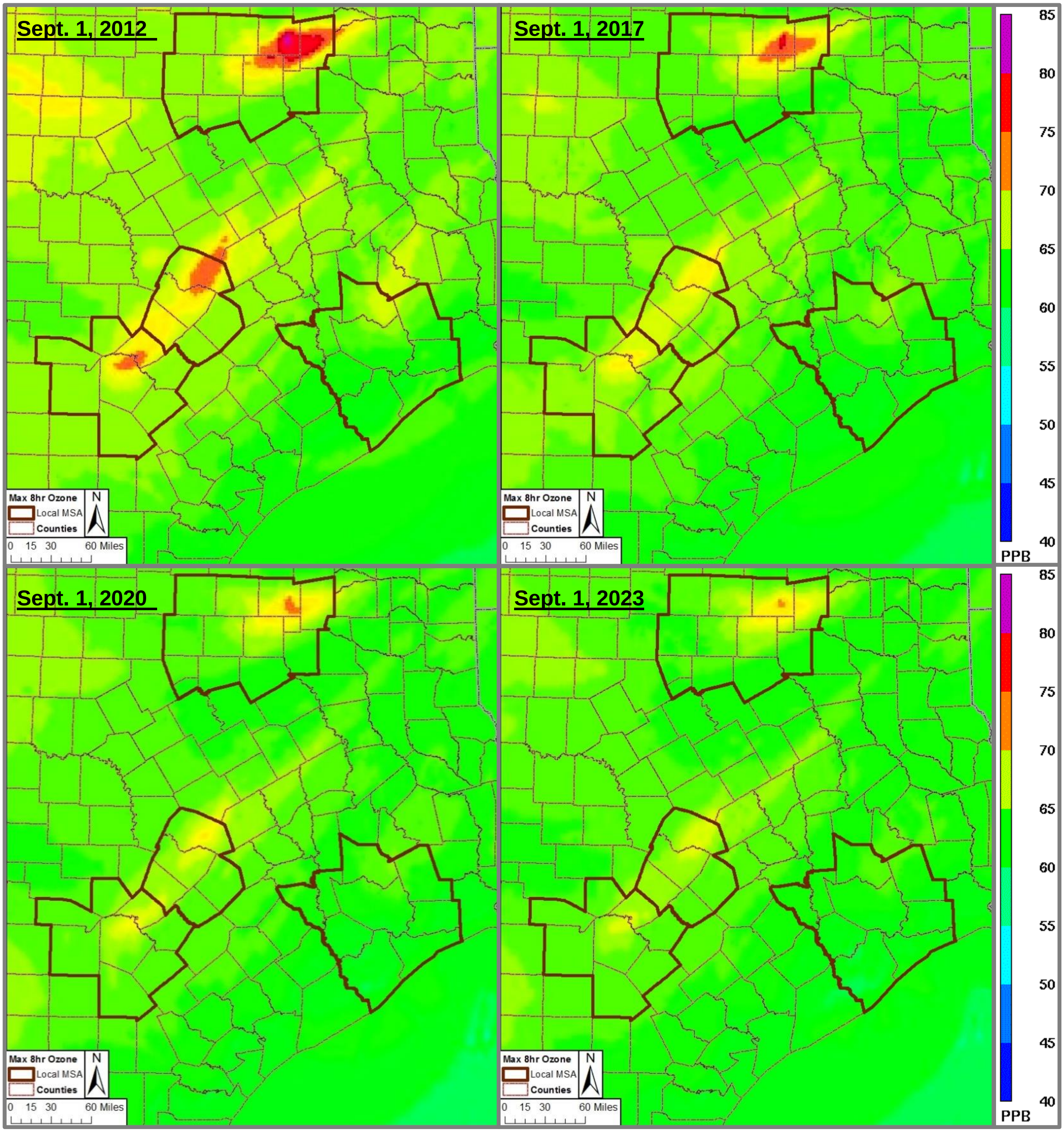
Aug. 23, 2012
Aug. 23, 2017
Aug. 23, 2020
Aug. 23, 2023
Max 8hr Ozone
Local MSA
Counties
N
0 15 30 60 Miles
85
80
75
70
65
60
55
50
45
40
PPB

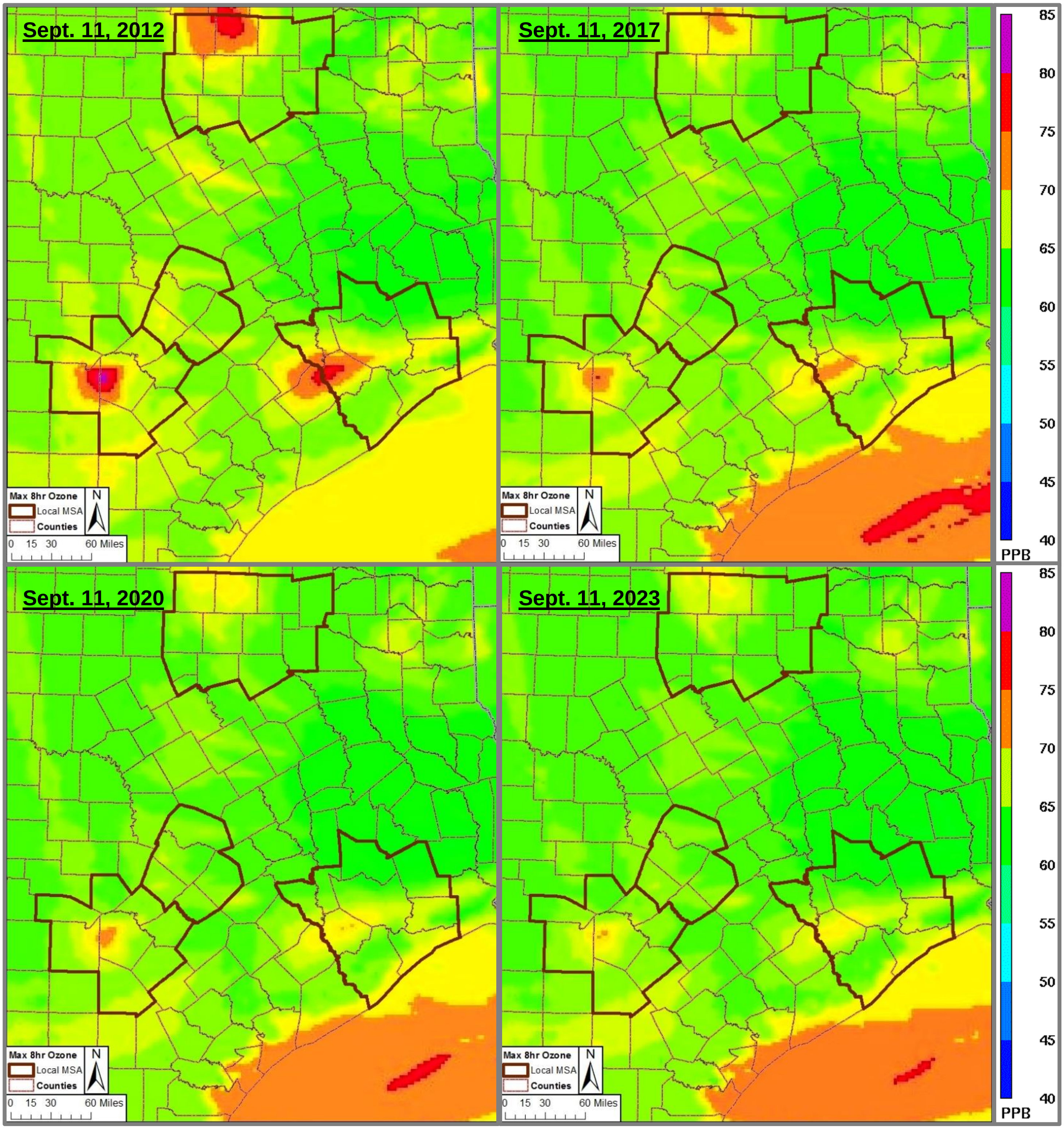


Aug. 30, 2012
Aug. 30, 2017
Aug. 30, 2020
Aug. 30, 2023
Max 8hr Ozone
Local MSA
Counties
N
0 15 30 60 Miles
85
80
75
70
65
60
55
50
45
40
PPB

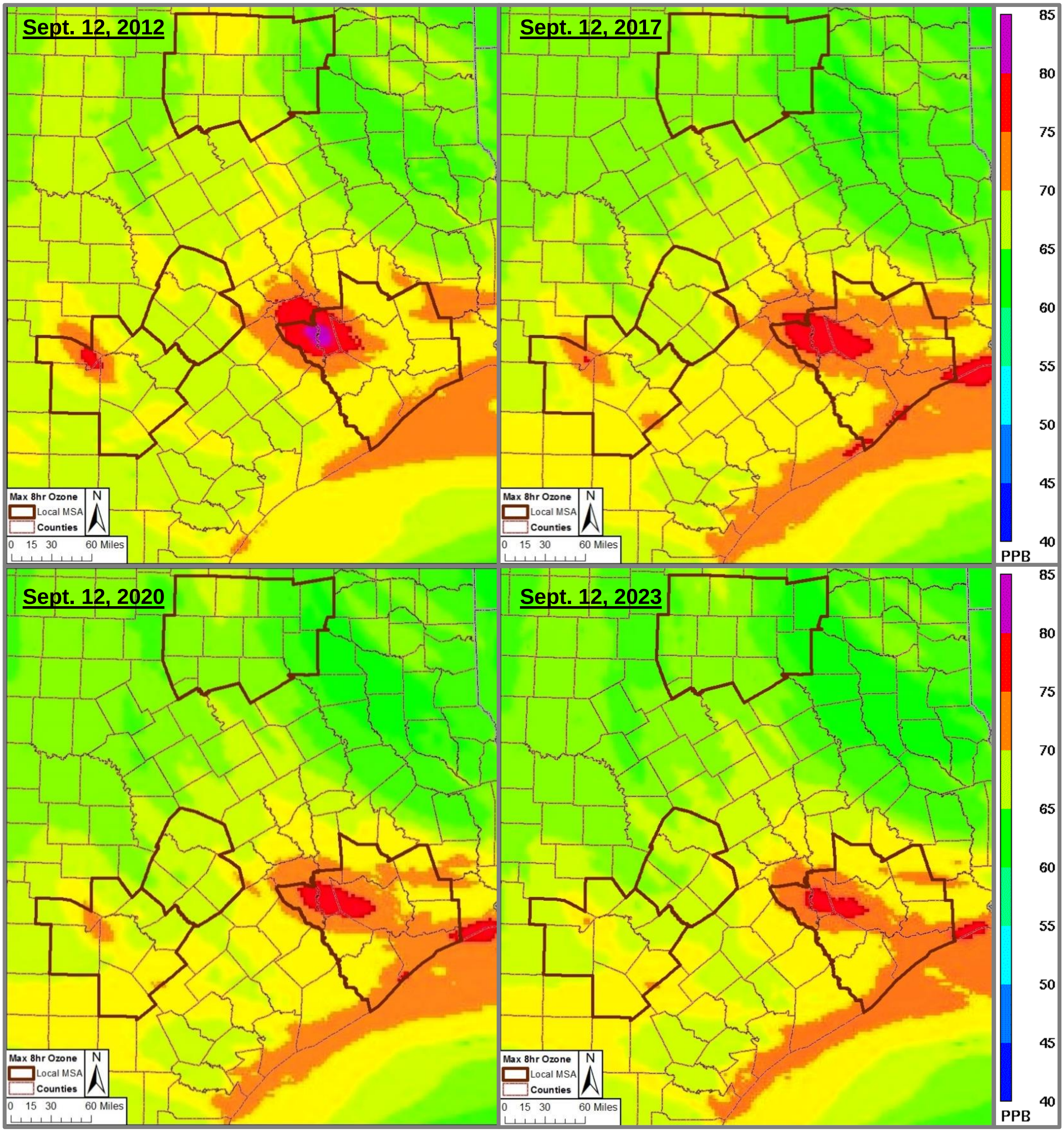


Aug. 31, 2012
Aug. 31, 2017
Aug. 31, 2020
Aug. 31, 2023
Max 8hr Ozone
Local MSA
Counties
N
0 15 30 60 Miles
85
80
75
70
65
60
55
50
45
40
PPB

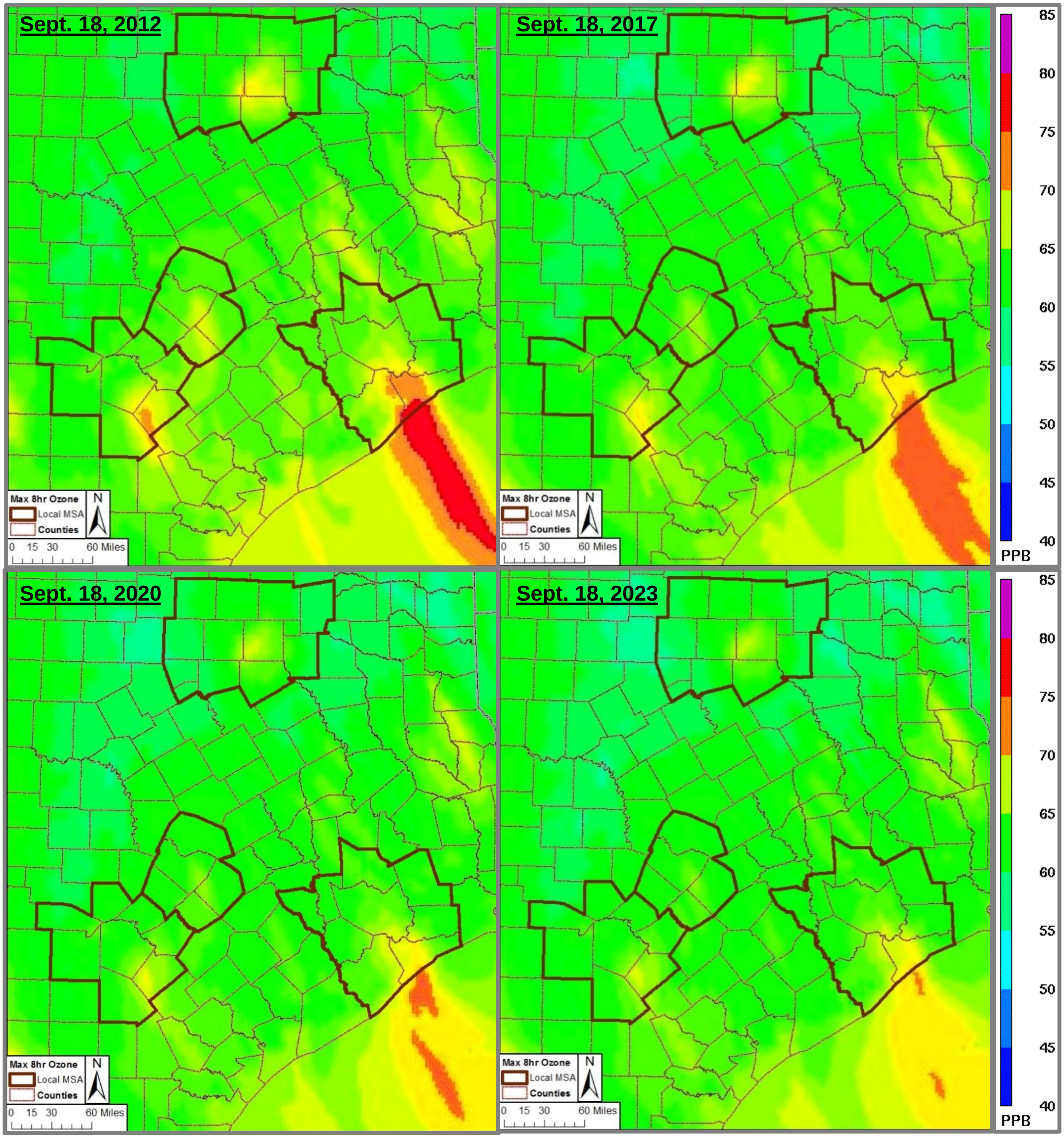

Sept. 1, 2012
Sept. 1, 2017
Sept. 1, 2020
Sept. 1, 2023
Max 8hr Ozone
Local MSA
Counties
N
0 15 30 60 Miles
85
80
75
70
65
60
55
50
45
40
PPB



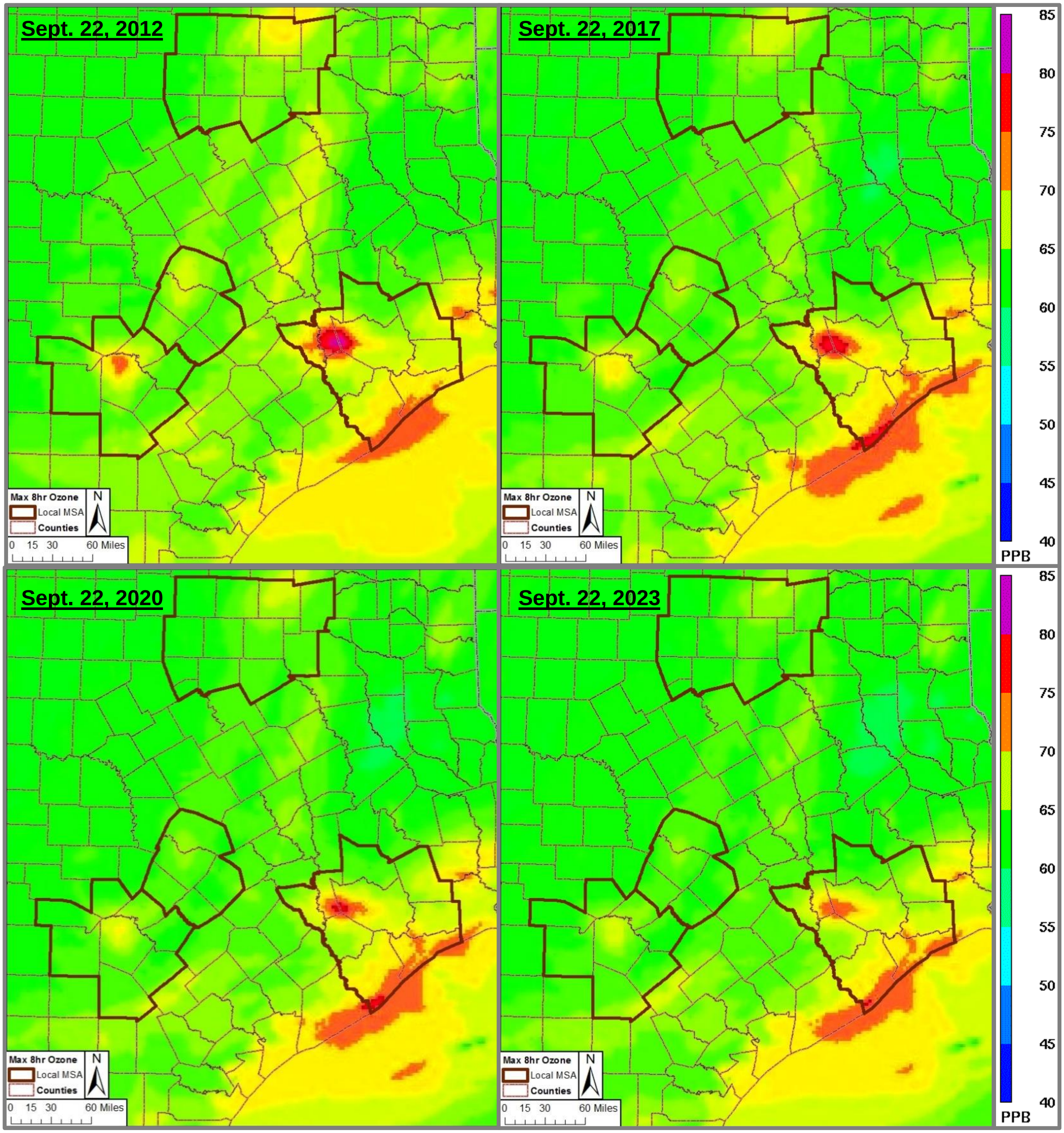
Sept. 11, 2012
Sept. 11, 2017
Sept. 11, 2020
Sept. 11, 2023
Max 8hr Ozone
Local MSA
Counties
0 15 30 60 Miles
N
85
80
75
70
65
60
55
50
45
40
PPB



Sept. 12, 2012
Sept. 12, 2017
Sept. 12, 2020
Sept. 12, 2023
Max 8hr Ozone
Local MSA
Counties
N
0 15 30 60 Miles
85
80
75
70
65
60
55
50
45
40
PPB



Sept. 18, 2012
Sept. 18, 2017
Sept. 18, 2020
Sept. 18, 2023
Max 8hr Ozone
Local MSA
Counties
N
0 15 30 60 Miles
85
80
75
70
65
60
55
50
45
40
PPB


Sept. 22, 2012
Sept. 22, 2017
Sept. 22, 2020
Sept. 22, 2023
Max 8hr Ozone
Local MSA
Counties
N
0 15 30 60 Miles
85
80
75
70
65
60
55
50
45
40
PPB

Appendix B

Contract (Grant) # 582-16-60180
PGA 582-16-60849-01
Task 5.2

Potential Cost of Nonattainment in the San Antonio Metropolitan Area

Revision 1

Study Conducted For:
Alamo Area Council of Governments

Study Conducted By:
Steve Nivin, Ph.D.
Belinda Román, Ph.D.
David Turner, Ph.D.

Steven R. Nivin, Ph.D., LLC

March 29, 2017

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The content, finding, opinions and conclusions are the work of the authors and do not necessarily represent findings, opinions or conclusions of the TCEQ.

REVISIONS

1) In Table 1, the permitting cost estimates were changed to match the total figures provided in Table 4.1.
2) In Table 2, the hard cost estimates for Bexar County under moderate nonattainment were changed from annual figures to cumulative figures.

TABLE OF CONTENTS

EXECUTIVE SUMMARY AND KEY FINDINGS

In 2015, the United States Environmental Protection Agency (EPA) issued a final rule to revise the primary 8-hour national ambient air quality standard (NAAQS) for ground-level ozone from 0.075 parts per million (ppm) (2008 standard) to 0.070 ppm, or 70 parts per billion (ppb). The EPA also revised the secondary NAAQS for ozone to be the same as the primary standard (*80 Fed. Reg. 65,291*). The final rule became effective on December 28, 2015, although the 2008 ozone standard remains in effect in some areas.

Under newly promulgated ozone NAAQS, the governor of each state must recommend designations of attainment, nonattainment, or unclassifiable under the 2015 8-hour standard for all areas of the state within one year (i.e., by October 1, 2016). The Texas Commission on Environmental Quality (TCEQ) issued its recommendations to the governor on August 3, 2016 (TCEQ, 2016a), which included that Bexar County would be designated as nonattainment with respect to ozone. The EPA makes the final decision on nonattainment area boundaries and could include counties or parts of counties within a Metropolitan Statistical Area (MSA) or other areas they feel that significantly contribute to the nonattainment status. Even though it may be the case that only Bexar County is determined to be in nonattainment, it is assumed that all counties in the San Antonio metropolitan area may be deemed to be in nonattainment.

The purpose of this study is to project the potential costs to the metropolitan economy by county that could arise under receiving either a marginal or moderate nonattainment classification. The health costs and any benefits (e.g., increased construction activity) are outside the scope of this analysis. It is not anticipated that the region would receive one of the more serious impairment classifications. Many of the costs are determined according to the lost gross regional product (GRP) that might occur due to the nonattainment designations. Input-output models are used to measure the effects on GRP, as well as the impacts on employment, incomes, and output within some relevant industries.

Table 1 provides a summary of the projected costs across the San Antonio metropolitan area. The costs will range from $3.2 billion to $27.5 billion under marginal nonattainment and will increase from $7.1 billion to $36.2 billion if the regional is given a moderate nonattainment classification. There are a couple of points to keep in mind with respect to these figures. The low projection for a lost manufacturing company expansion/relocation is the estimate of a potential lost manufacturing company expansion from which the additional costs of nonattainment may affect the decision of the company to expand. The high projection assumes the cumulative impacts of losing a manufacturing firm of a size equivalent to the five largest manufacturing firms in the region. However, indications are that large businesses are prepared for the nonattainment designation and are able to absorb the additional costs, so the risk of losing such a large firm is relatively small.

Table 1. Summary of Potential Total Costs of Nonattainment in the San Antonio MSA (2016 $)

	Marginal	
	Low Estimate	High Estimate
Lost Manufacturing Company Expansion/Relocation	$699,765,642	$24,987,024,423
Cost of Permitting	$24,200,000	$60,500,000
Cost of Project Delays	$1,426,065,502	$1,426,065,502
TERP	$8,598,424	$8,598,424
Costs Associated with Commute Solutions	$14,735,398	$14,735,398
Reductions in GRP due to Inspection Fees	-	-
Lost GRP due to Road Construction Delays	$570,598,370	$570,598,370
Costs of Point Source NOx Reduction	$423,200,000	$447,200,000
Total	**$3,167,163,336**	**$27,514,722,117**

	Moderate	
	Low Estimate	High Estimate
Lost Manufacturing Company Expansion/Relocation	$777,517,380	$27,763,360,470
Cost of Permitting	$26,900,000	$67,250,000
Cost of Project Delays	$1,584,517,224	$1,584,517,224
TERP	$9,553,804	$9,553,804
Costs Associated with Commute Solutions	$33,266,979	$33,266,979
Reductions in GRP due to Inspection Fees	$3,375,993,367	$5,430,945,289
Lost GRP due to Road Construction Delays	$855,897,555	$855,897,555
Costs of Point Source NOx Reduction	$464,000,000	$488,000,000
Total	**$7,127,646,309**	**$36,232,791,321**

Given the difficulty, and thus high level of uncertainty, in projecting the potential lost economic activity from a business that decides not to locate or expand in the area, another way to view the potential costs of nonattainment is to only consider the hard costs of nonattainment. Most of these costs would occur in Bexar County, so to be as conservative as possible, only these costs in Bexar County are presented in the following table.

Table 2. Summary of Potential Hard Costs of Nonattainment for Bexar County (Millions 2016 $)

	Marginal	
	Low Estimate	*High Estimate*
Cost of Permitting	$12,700,000	$31,750,000
Cost of Project Delays	$897,056,940	$897,056,940
Reductions in GRP due to Inspection Fees	$0	$0
Lost GRP due to Road Construction Delays	$458,580,755	$458,580,755
Total	**$1,368,337,695**	**$1,387,387,695**

	Moderate	
	Low Estimate	*High Estimate*
Cost of Permitting	$14,100,000	$35,250,000
Cost of Project Delays	$996,729,934	$996,729,934
Reductions in GRP due to Inspection Fees	$2,690,438,316	$4,328,095,972
Lost GRP due to Road Construction Delays	$687,871,132	$687,871,132
Total	**$4,389,139,382**	**$6,047,947,038**

The total costs (including both hard and soft costs) by county are provided in Table 3. As expected, the vast majority of the costs will be absorbed in Bexar County. It is estimated that costs in Bexar County could range from $2.1 billion to $21.5 billion under a marginal nonattainment designation. The costs could increase under a moderate nonattainment designation from $5.3 billion to $28.4 billion. Bandera County is projected to experience the smallest costs from nonattainment.

Table 3. Total Costs of Nonattainment by County (2016 $)

	Marginal	
County	*Low Estimate*	*High Estimate*
Atascosa	$81,537,249	$595,736,926
Bandera	$8,191,896	$231,014,588
Bexar	$2,149,252,580	$21,535,604,708
Comal	$395,760,052	$1,672,317,077
Guadalupe	$405,542,142	$1,956,297,566
Kendall	$22,797,284	$404,369,934
Medina	$67,600,054	$588,635,953
Wilson	$36,482,079	$530,745,363
Total	**$3,167,163,336**	**$27,514,722,115**

	Moderate	
County	*Low Estimate*	*High Estimate*
Atascosa	$162,154,623	$776,853,806
Bandera	$40,148,365	$306,523,509
Bexar	$5,267,047,267	$28,443,746,177
Comal	$646,910,566	$2,170,684,505
Guadalupe	$670,037,008	$2,523,907,063
Kendall	$80,943,901	$537,139,769
Medina	$147,334,056	$770,067,083
Wilson	$113,070,522	$703,869,409
Total	**$7,127,646,308**	**$36,232,791,321**

NOTE: Differences in the totals compared to Table 1 are due to rounding.

For comparison purposes, we include data from a September 2015 report on the Potential Costs of an Ozone Nonattainment Designation to Central Texas – primarily the Austin-Round Rock metropolitan area (See Table 4). As a regular touchstone for assessing the San Antonio-New Braunfels MSA performance, the Austin report highlights the differences between the two economies. The loss of Samsung investment in the Austin-Round Rock area represents a large portion of the overall costs. On the lower end, abandoning its plans all together represents 78% of the nearly $24.3 billion estimate while at the higher end of the Austin report's estimates, this same project could come to represent 81% of the $41.5 billion estimate. Without diminishing the importance that such a decision would have for the Austin-Round Rock area, we find that in the case of the San Antonio area, no single company has the same leverage over economic activity, at least for the short-term. Not one of our interviews revealed that a company was considering leaving the area. In fact, our research shows that many larger-scale local companies have taken a proactive approach toward nonattainment and have already equipped existing and planned facilities with more environmentally sound technology. However, we find that on-road mobile sources present a more significant challenge to the area.

Table 4. Overall Economic Impact of Nonattainment Designation from Central Texas Report 2015 (CAPCOG 2015, 3)

Scenario	Low	High
Loss of Samsung Expansion	($21,340,142,448)	($33,893,167,418)
Loss of Texas Lehigh Expansion	($1,811,586,399)	($3,700,575,961)
Decker and Sim Gideon Boiler Replacements	$0	$0
Transportation Conformity-Routine Analysis	($2,300,000)	($7,000,000)
Transportation Conformity-Routine Project Delays	($27,407,176)	($41,471,216)
Transportation Conformity-Lapse-Project Delays	($18,298,801)	($93,012,795)
Transportation Conformity-Loss of Federal Funds	($23,746,747)	($74,646,101)
General Conformity-Rail Expansion Delays	($7,182,369)	($14,364,738)
General Conformity-Aviation Expansion Delays	($22,449,120)	($44,898,240)
NO_x Point Source Emission Reductions	($141,494,537)	($2,047,800,546)
VOC Reductions	($904,917,445)	($1,630,209,506)
TOTAL ECONOMIC IMPACT	**($24,299,525,042)**	**($41,547,146,520)**

ACRONYMS AND ABBREVIATIONS

ACRONYM OR ABBREVIATION	DEFINITION
CAA	Clean Air Act
CBSA	Core-Based Statistical Area
CSA	Combined Statistical Area
CTG	Control technique guideline
EPA	U.S Environmental Protection Agency
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
HAP	Hazardous air pollutant
I/M	Inspection and monitoring
LAER	Lowest achievable emission rate
NA	Nonattainment
NAAQS	National Ambient Air Quality Standards
NNSR	Nonattainment New Source Review
NO_x	Nitrogen oxide (NO and NO_2)
NSR	New Source Review
PAL	Plant-wide applicability limit
PSD	Prevention of significant deterioration
RACM	Reasonably achievable control measures
RACT	Reasonably achievable control technology
RFG	Reformulated gasoline
RFP	Reasonable further progress
SIP	State Implementation Plan
SOCMI	Synthetic Organic Chemical Manufacturing Industry
TCEQ	Texas Commission on Environmental Quality
TCM	Transportation control measures
TXDOT	Texas department of Transportation
TXLED	Texas Low-Emission Diesel
VOC	Volatile organic compounds

1. Introduction to EPA's New Ozone Standard (October 1, 2015)

To meet its obligations under the Clean Air Act (CAA) as amended in 1990, the EPA has established air quality standards in 40 CFR Part 50. In these regulations, the EPA establishes the National Ambient Air Quality Standards (NAAQS) to promote and sustain healthy living conditions. Primary NAAQS are established to protect public health, and secondary NAAQS are established to protect public welfare by safeguarding against environmental and property damage (Table 1.1). These standards define acceptable ambient air concentrations for six criteria air pollutants: nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), carbon monoxide (CO), lead (Pb), and particulate matter (including PM_{10} and $PM_{2.5}$).

Table 1.1 National Ambient Air Quality Standards (NAAQS) (from EPA, 2016a)

Pollutant		Primary/Secondary	Averaging Time	Level	Form
Carbon Monoxide		Primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead		Primary/Secondary	Rolling 3 mo. avg	0.15 µg/m³	Not to be exceeded
Nitrogen Dioxide		Primary	1-hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Primary/Secondary	Annual	53 ppb	Annual Mean
Ozone		Primary/Secondary	8-hour	70 ppb (2015)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
		Primary/Secondary	8-hour	75 ppb (2008)	Remains in effect in some areas.
Particulate Matter	$PM_{2.5}$	Primary	Annual	12.0 µg/m³	annual mean, averaged over 3 years
		Secondary	Annual	15.0 µg/m³	annual mean, averaged over 3 years
		Primary/Secondary	24-hour	35 µg/m³	98th percentile, averaged over 3 years
	PM_{10}	Primary/Secondary	24-hour	150 µg/m³	Not to be exceeded more than once per year on average over 3 years

Sulfur Dioxide	Primary	1-hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

EPA requires states to monitor ambient air quality and evaluate compliance with respect to the NAAQS. Based on these evaluations, EPA characterizes the air quality within a defined area with respect to each of the six criteria air pollutants using a compliance-based classification system. Defined areas range in size from portions of cities, to metropolitan statistical area (MSA as defined by the U.S. Bureau of the Census), to large regions composed of many counties. For areas that are in *attainment*, levels for a given criteria air pollutant are below the NAAQS, while areas that are in *nonattainment* have air quality that exceeds the NAAQS. For those areas where there is insufficient available information for classification purposes, a status of *unclassifiable/attainment* is assigned. An ozone nonattainment classification can be further defined as

- Marginal,
- Moderate,
- Serious,
- Severe, or
- Extreme

based on the degree to which the NAAQS is exceeded (Table 1.2).

The ozone nonattainment classification for a given area determines the planning and control requirements that will be imposed to improve the regional air quality and move the area towards attainment status. If an area is designated as nonattainment, then the state must develop (a process that involves public review and comment) revisions to the State Implementation Plan (SIP) that demonstrate how the state plans to bring the area back into attainment status. The SIP revision will require different elements depending on the nonattainment classification.

Table 1.2. 8-Hour Design Values for the 2015 Ozone NAAQS of 70 ppb (from EPA, 2016a,b)

Area Class	8 hour design value (ppb)
Marginal	≥70 to < 81
Moderate	≥ 81 to < 93
Serious	≥ 93 to < 105
Severe-15	≥ 105 to < 111
Severe-17	≥ 111 to < 163
Extreme	≥ 163

On October 26, 2015, EPA issued a final rule to revise the primary eight-hour NAAQS for ground-level ozone from 0.075 parts per million (ppm) (2008 standard) to 0.070 ppm, or 70 parts per billion (ppb). The EPA also revised the secondary NAAQS for ozone to 70 ppb, equivalent to the primary standard (EPA, 2015a; *80 Fed. Reg. 65,291*). The final rule became effective on December 28, 2015, although the 2008 ozone standard remains in effect in some areas; for permitting purposes, the most stringent classification will control when two separate standards apply. Transitioning of these areas to the 2015 ozone standard will be addressed in the implementation rule for the current standard.

With the issuance of the new ozone standard, the EPA also required that the governor of each state must recommend designations of attainment, nonattainment, or unclassifiable under the 2015 8-hour standard for all areas of the state within one year (i.e., by October 1, 2016). The Texas Commission on Environmental Quality (TCEQ) issued its recommendations to the governor on August 3, 2016 (TCEQ, 2016a). Under these recommendations, Bexar County would be designated as nonattainment with respect to ozone, but the degree of nonattainment (e.g., Marginal to Extreme) is not identified. The EPA's final decision on nonattainment area boundaries could include counties or parts of counties within an MSA, Combined Statistical

Area (CSA), or Core-Based Statistical Area (CBSA) or other counties that EPA determines contribute significantly to the nonattainment.

For the purposes of this summary report, it is assumed that the 8-county region that comprises the San Antonio MSA would be classified as either marginal or moderate nonattainment with respect to the 2015 ozone NAAQS. It is not anticipated that the region would receive one of the more serious nonattainment classifications.

2. Background on Nonattainment Area Requirements

Ground-level ozone is not produced through direct emissions. Instead, this ozone is created indirectly by photochemical reactions involving precursor emissions of NO_x and volatile organic compounds (VOC) in the presence of sunlight. Along with natural sources, these precursor chemicals are produced by a wide variety of human activities such as vehicle exhaust, power plants, industrial boilers, refineries, chemical plants, and other industrial operations, making it challenging to identify a single source of emissions. In addition, the complex photochemical reactions that produce ozone vary with local atmospheric conditions such as temperature, and seasonal and daily weather patterns. For example, ozone tends to be highest on hot, sunny days, although certain cold weather air conditions such as temperature inversions can lead to higher ozone levels. Ozone can also be transported by wind, leading to the impairment of air quality in rural areas that are downwind from urban centers that have higher levels of NO_x and VOC that result from human activity (EPA, 2014).

2.1. Overview of Nonattainment Area Requirements

As discussed previously, TCEQ issued its recommendations for area designations with respect to the 2015 eight-hour ozone rule on August 3, 2016 (TCEQ, 2016). TCEQ's recommended designation status for the eight-county study area is identified in Table 2.1.

The recommended designation of Bexar County as nonattainment is based on design values calculated using certified 2013 through 2015 eight-hour ozone data for Texas counties with regulatory monitors (TCEQ, 2016a, Attachment B). The 2015 certified design value for Bexar County was 78 ppb, slightly less than Harris (79 ppb) and Tarrant (80 ppb) in the Houston and Dallas areas. The final EPA designation is anticipated to be based on 2014 – 2016 8-hour ozone data (TCEQ, 2016j), which yields a design value of 73 ppb for Bexar County.

Table 2.1 TCEQ 2015 Eight-Hour Ozone NAAQS Designation Recommendations (from TCEQ, 2016a)

County	TCEQ Recommended Designation (8/3/2016)
Atascosa	Unclassifiable/Attainment
Bandera	Unclassifiable/Attainment
Bexar	Nonattainment
Comal	Unclassifiable/Attainment
Guadalupe	Unclassifiable/Attainment
Kendall	Unclassifiable/Attainment
Medina	Unclassifiable/Attainment
Wilson	Unclassifiable/Attainment

Depending on the nonattainment designation, a number of different requirements are imposed with the goal of improving the affected air quality and returning to attainment status. Each increased level of nonattainment (i.e., as air quality impairment becomes more severe, or the area is unable to meet the NAAQS by the attainment date associated with a lower nonattainment classification), incorporates all of the requirements for the lower levels of nonattainment, and adds additional requirements. The result is that the number of requirements for air quality improvement and the associated costs of implementation can increase markedly as regional air quality is degraded. These requirements are established through revisions to the SIP, and for ozone nonattainment, the required SIP elements by nonattainment classification include (EPA, 2016h):

Marginal (3 years to attain):

- Baseline emission inventory, followed by periodic updates
- New source review (NSR) program
    - NSR offset ratio 1.1:1
- Major source emission statements
    - Major source threshold 100 tons per year (tpy), and

- Transportation conformity demonstration

Moderate (6 years to attain):

- All requirements for Marginal classification, with
  - Major source threshold 100 tpy
  - NSR offset ratio 1.15:1
- Major source (VOC/NO_x) reasonably available control technology (RACT)
- Attainment demonstration
- 15% reasonable further progress (RFP) over 6 years
- Basic vehicle inspection and maintenance (I/M) program
- Contingency measures for failure to attain
- Stage II gasoline vapor recovery (Note: With the development of on-board vapor recovery technology, EPA determined that Stage II vapory recovery was no longer required and could be removed from state SIPs. EPA approved the revisions to the Texas SIP removing Stage II vapor recovery in April 2014, and gasoline stations were allowed to begin decommissioning Stage II equipment in May 2014 (TCEQ, 2016l).

The following is a brief listing of the controls and requirements that are imposed as a function of nonattainment status (EPA, 2016c,d,e). Examples of controls applied in Texas nonattainment areas are provided in Appendix A for the initial (July 20, 2012) Marginal designation of the Houston-Galveston-Brazoria MSA (designated as Moderate relative to the 2008 ozone standard on December 14, 2016) and the Dallas-Fort Worth MSA (Moderate):

- Nonattainment (Marginal, 3 years to attain):
  - Marginal area nonattainment new source review (NNSR) permitting rules;
  - Transportation Conformity;
  - General Conformity;
  - Emissions Inventory; and
  - Emission Statements;
- Nonattainment (Moderate, 6 years to attain):
  - All Marginal area requirements;
  - Moderate area NNSR permitting rules;

- NSR offset of 1.15:1
    - Attainment demonstration;
    - Reasonable further progress (RFP) demonstration (15% reduction in VOC emissions);
    - Reasonably available control technology (RACT) for major sources of NO_x;
    - RACT for major sources of VOC;
    - RACT for VOC sources covered by an EPA control technique guideline (CTG) document;
    - Contingency measures for attainment and RFP; and
    - A basic vehicle inspection and maintenance (I/M) program;
- Nonattainment (Serious, 9 years to attain):
    - All Marginal and Moderate area requirements;
    - Serious area NNSR permitting rules;
    - Enhanced I/M program;
    - Enhanced monitoring;
    - Clean Fleet program;
    - Transportation control measures (TCMs) to offset growth in vehicle miles traveled; and
    - Additional 3% per year reduction in NO_x and VOC emissions for RFP;
- Nonattainment (Severe, 15/17 years to attain):
    - All Marginal, Moderate, and Serious area requirements;
    - Severe area NNSR permitting;
    - An emissions fee program if the area fails to attain its standard by its attainment deadline; and
    - Additional 3% per year reduction in NO_x and VOC emissions for RFP;
- Nonattainment (Extreme, 20 years to attain):
    - All Marginal, Moderate, Serious, and Severe area requirements;
    - Extreme area NNSR permitting;
    - Clean Fuel for Boilers; and
    - Additional 3% per year reduction in NO_x and VOC emissions for RFP

If the air quality in an area that has been previously designated as nonattainment improves to meet the NAAQS, the area will be identified as a maintenance area. It is important to consider that even if the regional air quality is improved and achieves a designation of maintenance, the requirements will remain in effect until continued NAAQS compliance can be demonstrated. A general timeline is presented in Figure 2.1 with estimated dates relevant to a nonattainment designation for the San Antonio region given in Table 2.2.

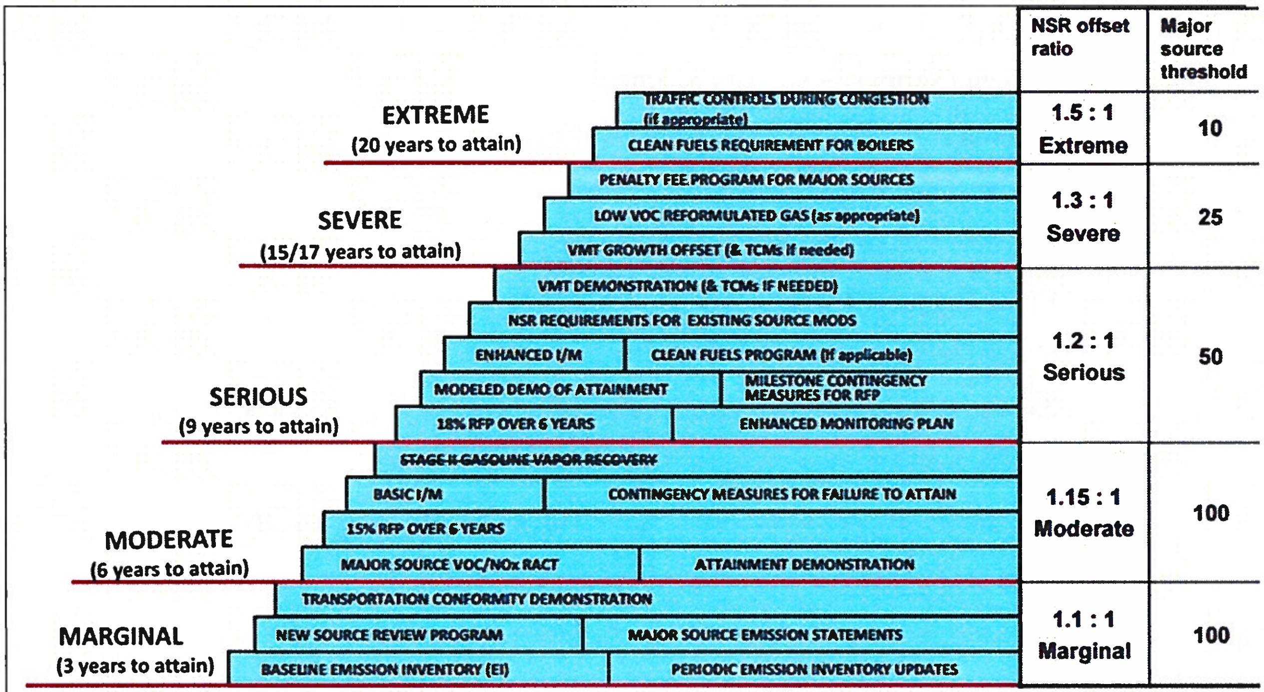

Figure 2.1. Overview of CAA Ozone Planning & Control Requirements by Classification (from EPA, 2015b)

Table 2.2. A general timeline for NAAQS compliance (Modified from TCEQ, 2016j, CAPCOG, 2015)	
October 2015	New Primary Ozone Standard: 70 ppb; Secondary standard same as primary (EPA, 2015a)
August 2016	TCEQ makes recommendations to governor for nonattainment designations (TCEQ, 2016a)
October 2016	State designation recommendations due to EPA
November 2016	EPA proposes implementation rule (EPA, 2016b)
June 2017	EPA sends letter to states with proposed nonattainment area designations
October 2017	EPA to sign (finalize) designations and classifications; EPA to finalize implementation rule
October 2019	Emissions Inventory State Implementation Plan (SIP) revisions due for all nonattainment areas
October 2020-2021	Attainment Demonstration SIP revisions due

Once the SIP revisions are proposed and approved, and the implemented programs are able to improve air quality to meet the 2015 ozone NAAQS, then nonattainment areas are eligible for redesignation. In accordance with the provisions of Section 175 of the CAA, TCEQ would propose a maintenance plan and prepare an attainment redesignation request that would be forwarded to EPA, with up to two years for EPA to consider the requests. If EPA approves the maintenance plan and the redesignation request, then there will be a 10-year maintenance period to ensure that improved air quality can be sustained. Approximately two years before the end of this period, TCEQ will prepare a second 10-year maintenance plan for EPA review and approval. In summary, the designation of an area (or areas) as nonattainment with respect to the ozone NAAQS can result in required controls, analysis, modeling, and monitoring that can cover a period of regulatory oversight that extends from years to decades.

2.2. Nonattainment New Source Review

Nonattainment New Source Review (NNSR) is required for applicants seeking permits to either construct a new major stationary source or install major modifications to an existing major source in a nonattainment area. For NNSR permitting in Marginal and Moderate ozone nonattainment areas, a major source is defined as a facility that has the potential to emit at least 100 tpy of either NO_x or VOC, while a major modification is considered to be a physical modification or change in operations that would increase emissions of NO_x or VOC by at least 40 tpy. The numerical criteria for these definitions are based on the conservative assumption that a facility is running at 100 percent capacity for 24 hours/day and 365 days/year. A permit that is under consideration as part of an NNSR cannot be approved unless the review determines that a number of location-specific requirements intended to minimize the effects on air quality from the proposed facility or modifications can be met.

TCEQ identifies the types of facilities that often require NNSR (TCEQ, 2016d) (Table 2.3):

Table 2.3. List of facilities, as defined by the Texas Clean Air Act § 382.003(6), typically found at sources that need New Source Review permits (from TCEQ, 2016d).

Abrasive Blasting Operations	Glycol Dehydrator
Absorbers	Grain Elevators
Adsorption Systems	Hot Mix Asphalt Plants
Anhydrous Ammonia Storage and Handling	Incinerators
Asphalt Processing and Asphalt Roofing Manufacturing	Internal Combustion Engines
Boilers	Iron and Steel Industry
Bulk Gasoline Terminals	Liquid Storage Terminals
Bulk Material Handling	Loading Operations
Chrome Plating and Anodizing Operations using Chromic Acid	Metallizing-Metal Spraying Operations
Coating Manufacturing Operations	Oriented Strandboard Mills
Concrete Batch Plants	Painting Operations
Cooling Towers	Petroleum Coke Storage and Transfer
Cotton Gins	Plant Fuel Gas (Under Review)
Degreasing Operations	Polyethylene and Polypropylene Manufacturing
Drum Filling	Printing Operations
Dry Bulk Fertilizer Handling	Process Furnaces and Heaters (Under Review)
Equipment Leak Fugitives	Process Vents
Ethylene Oxide Sterilization Units	Rock Crushing Plants
Fiber Reinforced Plastics and Cultured Marble	Storage Tanks
Flares and Vapor Combustors	Sulfur Recovery Units
Fluid Catalytic Cracking Units	Truck or Railcar Cleaning
Galvanizing Operations	Turbines
Glass Manufacturing	Vapor Oxidizers
	Wastewater

According to the EPA, all NNSR programs "…have to require (1) the installation of the lowest achievable emission rate (LAER), (2) emission offsets, and (3) opportunity for public involvement." (EPA, 2016f).

LAER focuses on setting the emissions limits on new or modified major sources in nonattainment areas. For the purposes of NNSR review, LAER will focus on the most stringent limitations from either of the following:

- The most stringent emissions limitation, which is contained in the SIP, for a class or source category, unless the owner or operator of the source demonstrates that such limitations are not achievable; or

- The most stringent emissions limitation that is achieved in practice by a class or source category. This limitation, when applied to a modification, means the lowest achievable emissions rate for the new or modified facilities.

The LAER requirements that are established as part of the NNSR may be achieved by a combination of methods that could include changes to raw materials, process modifications, or add-on controls. Depending on the specific technologies or processes involved, these methods may increase the cost of either building a new facility that qualifies as a major source, or expanding operations of an existing major source within a nonattainment area. In addition, a typical NNSR includes permitting fees ($75,000 maximum) as well as an extensive review process that can add to facility cost. For example, according to the voluntary TCEQ Expedited Permitting Program (TCEQ, 2016e), the NNSR permitting process can include the additional upfront costs in the form of surcharges above and beyond the costs associated with preparing the permit application:

- New Source Review (NSR) case-by-case permit - $10,000

- Federal NSR permits [Prevention of Significant Deterioration (PSD) including greenhouse gas PSD, Nonattainment (NA), Plantwide Applicability Limit (PAL), and Hazardous Air Pollutant (HAP)] - $20,000

Basic steps for the TCEQ NSR permit program (TCEQ, 2016e), include:

- <u>Pre-Application:</u> This step includes a pre-application meeting, prior to submitting the permit application package. The purpose of this meeting is to establish a general schedule for the permit application review. Prior to the meeting, the applicant submits

- An overview of the project, including a description of the processes involved and the types of emissions (contaminants and approximate quantities);
- A discussion of federal applicability including netting evaluation, if applicable;
- A discussion of best available control technology (BACT);
- A list of permitting questions to resolve in the meeting (BACT, impacts review strategies, calculation methodology, rule applicability, etc.);
- A draft application and modeling protocol, if available; and
- Anticipated submittal date and project timing (e.g., start of construction).

- Draft Application: An early draft of the application is made available to the TCEQ staff for preliminary evaluation of the application and air dispersion modeling protocols. This draft is to be submitted at least three weeks prior to the planned, formal application submittal. The TCEQ staff then has seven days to provide feedback on deficiencies, if any, that they identify in the draft. The applicant has the opportunity to resolve these deficiencies prior to submitting the formal application.

- Application Submittal: After resolving deficiencies and questions from the TCEQ staff on the draft application and the proposed modeling, the applicant submits the formal application electronically, along with the appropriate surcharge as identified previously. If deficiencies are not addressed, then the application may be voided.

- Enhanced Administrative Review: After receiving the formal application and modeling results prepared by the applicant, TCEQ staff conducts a review and identifies any deficiencies. These are communicated to the applicant who has 10 days to respond. The staff will then review the responses – if the responses are not acceptable, then the application will be voided.

- Technical Review: – If the applicant's responses to the EAR are acceptable, the TCEQ conducts a technical review. The review includes proposed control technologies (Best Available Control Technologies (BACT) or LAER in the case of NNSR), modeling calculations, federal applicability, and technical completeness. The TCEQ review will verify emission rates, and request a complete Air Quality Analysis (AQA) that follows the approved modeling protocol. As with other steps, TCEQ may void the application if the applicant does not provide complete and accurate information within the specified timeframe

- Modeling Audit: The TCEQ Air Dispersion Modeling Team (ADMT) conducts an audit of the modeling results in the context of the agreed upon modeling protocols. The air dispersion modeling must pass the modeling audit two times, or the permit application may be voided. If there are potential public health effect implications, additional impact reviews may need to be conducted by the TCEQ Toxicology Division, with additional time necessary to complete the permit application review

- Draft Permit: If the application passes these review steps, the TCEQ permit reviewer will provide a draft permit (with conditions), triggering a 30-day public comment period. Written comments are addressed by the permit reviewer, and the draft permit is updated as necessary. If a public hearing request is received within the initial 3-day period, the applicant may be required to undergo a second 30-day public notice period.

The length of time to complete the air permitting process depends on factors such as the complexity of the application, TCEQ workload, the availability of TCEQ staff to conduct the review, and the required public participation process (TCEQ, 2016f, g). The target timeframes for the NNSR permit issuance given in Table 2.4 can be as much as 365 days, but as can be seen in the previous outline, inadequate or untimely responses on the part of the applicant at several different stages in the process can void the permit application, costing additional time and resources.

Table 2.4. Air Quality Permitting Target Time Frames (from TCEQ, 2016f)

Project Type	*Permit Issuance (Days)*
New Source Review (NSR) Initial Permits	285
New Source Review Amendments	315
Major NSR New Permits - Federal Timeline	365
Major NSR Amendments - Federal Timeline	365
Federal New Source Review (Prevention of Significant Deterioration, Nonattainment, 112g) Initial & Major Modifications	365

2.3. Conformity

Conformity, established under Title I, Section 176 of the CAA, is a provision that applies to NAAQS nonattainment and maintenance areas and mandates that all federal actions conform to (i.e. meet) the requirements of an approved SIP. For conformity purposes, a *federal action* includes not just federal agency engagement in specific activities, but also federal actions that provide "...support in any way, or provide financial assistance for, license or permit, or approve, any activity that does not conform to an implementation plan..." Federal actions are evaluated as part of a conformity determination prior to proceeding with a given action. The purpose of conformity is to eliminate or reduce violations of the NAAQS and achieve attainment of these air quality standards. Specifically, conforming activities or actions should not cause or contribute to new violations, increase the frequency or severity of existing violations, or delay timely attainment of any standard or interim emission reductions.

Conformity requirements are categorized according to transportation and general conformity, under EPA regulations 40 CFR Part 93. Transportation conformity requirements apply to transportation plans, transportation improvement programs, and highway and transit projects funded or approved by the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) (40 CFR Part 93, Subpart A). General conformity requirements apply to all federal actions in nonattainment and maintenance areas not covered by the transportation conformity rule (40 CFR Part 93, Subpart B).

2.3.1. Transportation Conformity

Section 176(c)(6) of the CAA and the conformity regulation at 40 CFR § 93.102(d) provide a one-year grace period from the effective date of designation before transportation conformity applies in areas newly designated as nonattainment for any of the transportation-related NAAQS (ozone, particulate matter, nitrogen dioxide, and/or carbon monoxide) (EPA, 2012). During this grace period, a transportation conformity determination for the region must be completed and submitted to local, state, and federal consultative agencies for review, with the FHWA and FTA providing final approval. In addition, long-term metropolitan transportation plans (MTPs) and shorter-term transportation improvement programs (TIPs) that are funded in part by federal transportation agencies such as the FHWA and FTA would need to be revised to include an analysis of the potential impact of the plans on regional air quality to demonstrate that the activities "conform to" the SIP (Figure 1). The element of the SIP to which a transportation conformity demonstration must conform is the motor vehicle emission budget (MVEB), which is a representation of an area's projected regional on-road mobile source emissions in the SIP for NAAQS-related pollutants. With respect to the ozone NAAQS, a transportation conformity determination would need to demonstrate that future emissions of ozone precursors (NO_x and VOC) resulting from an area's MTP and TIP would be equal to or less than the MVEB included in the SIP and approved by EPA. The metropolitan planning organization (MPO) in a nonattainment or maintenance area is typically responsible for completing and submitting transportation conformity demonstrations.

Transportation conformity demonstrations are to be made at least every four years, but can occur more frequently if the MTP and TIPs are updated more frequently (FHWA, 2010). If, after the initial nonattainment designation, transportation conformity is not demonstrated and approved by FHWA and FTA, then after a one-year grace period, the region is considered to enter into a conformity "lapse", and federal funds for highway and transit improvements can be restricted. During a lapse, only a limited number of transportation projects can proceed, including:

- Exempt projects such as
    - Safety improvements,
    - Road maintenance,
    - Rehabilitation, or
    - Certain mass transit, bicycle/pedestrian, mass transit, carpool/vanpool projects that can be shown to not have a negative impact on the region's air quality;
- Transportation Control Measures (TCM)s in approved SIPs; and
- Projects or project phases that are already authorized.

Also, during a conformity lapse, no new non-exempt projects can be amended into the MTP or TIP.

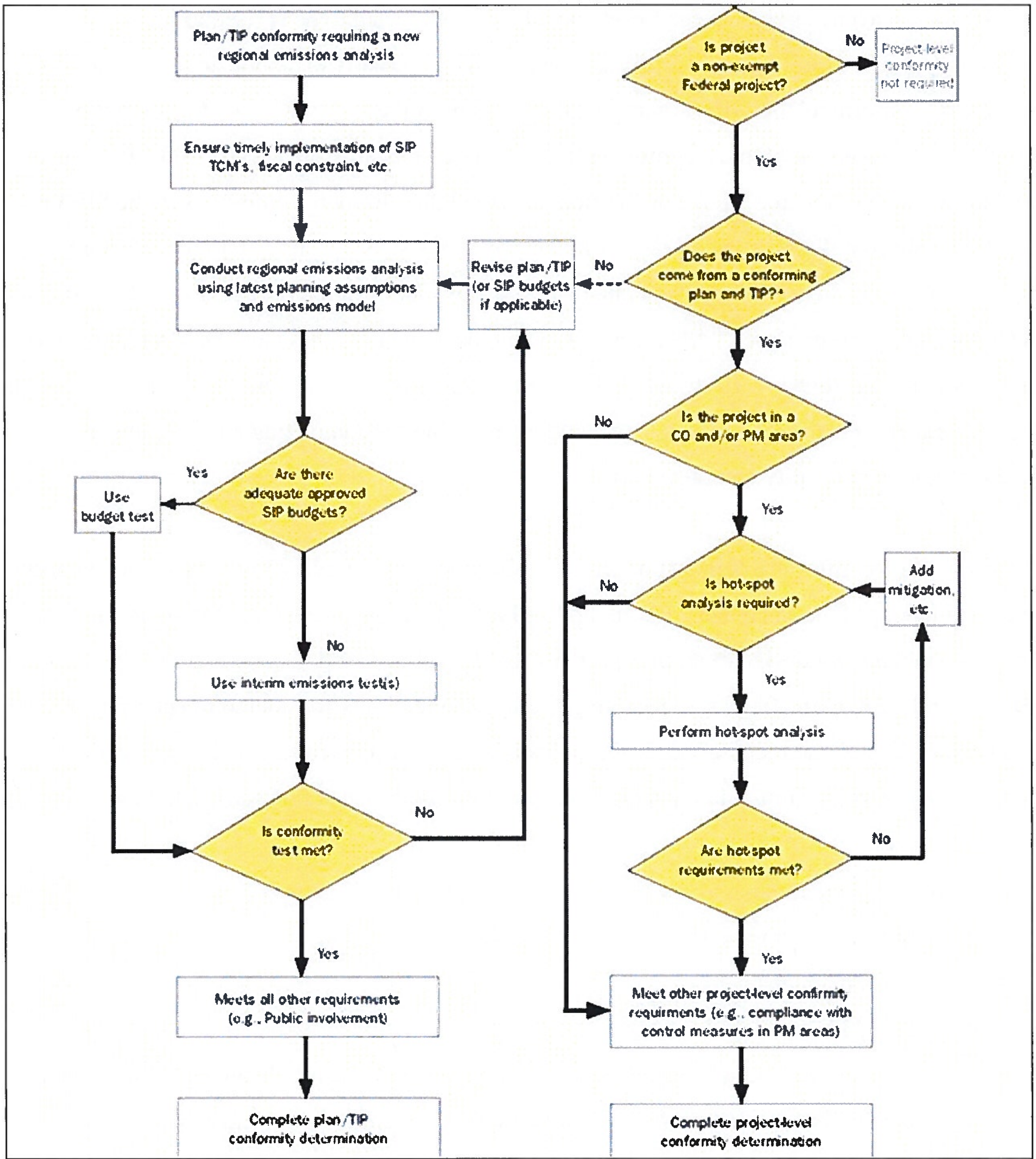

Figure 2.2. Simplified version of the transportation conformity process for metropolitan transportation plans/TIPs and projects (from FHWA, 2010).

For the San Antonio region, the Alamo Area Metropolitan Planning Organization (AAMPO) is the independent local agency that provides direction for the allocation of federal funding for urban transportation planning. In this role, the AAMPO develops and updates the MTP and TIPs for the region (AAMPO, 2015, 2016a,c). If the region is designated as nonattainment with respect to ozone, then the AAMPO would have the primary responsibility for demonstrating transportation conformity for the MTP, TIPs, and other regionally significant projects. For the purposes of the AAMPO (AAMPO, 2016b), regionally significant projects are those that include

- Roadways that are federally functionally classified as interstate freeways, other freeways, or principal arterials
- Roadways and intermodal connectors included in the federally adopted National Highway System
- Roadways designated as State Highways or US Highways
- Fixed guideway transit facilities

Since demonstrating transportation conformity would require consultation with federal, state, and local agencies, it could potentially add time and cost to transportation planning. For example, currently, the TIP is updated every two years and amended quarterly, but if the region is designated as nonattainment with respect to ozone, then the need for interagency consultation and public outreach would potentially reduce the frequency of the amendments and updates. Conformity would also be considered at the project level, where a project must be demonstrated to come from a conforming MTP and TIP, with a design and scope that has not changed significantly from the conforming plans, and addresses potential localized emissions impacts.

With respect to potential ozone nonattainment designation for the San Antonio region, the working schedule assumptions for the AAMPO (AAMPO, 2016a) are:

- Oct 2015: EPA Ozone NAAQS Final Rule – 70 ppb standard
- Oct 2016: Governors propose nonattainment areas –
    - TCEQ proposed Bexar County only
- Oct 2017: EPA designates nonattainment areas
- Dec 2017 to June 2018: AAMPO Develops Metropolitan Transportation Plan (MTP), Transportation Improvement Program (TIP), Conformity Document and conducts public involvement process

- June 2018: Consultative Partners to Receive MTP, TIP and Conformity Documents
- Oct 2018: Transportation Conformity Determination Due

If the conformity determination cannot be completed and approved to meet the October 2018 deadline, then the region would be considered to be in conformity lapse, and the requirements discussed previously would apply.

2.3.2. General Conformity

General conformity determinations are performed on a project-by-project basis in NAAQS nonattainment and maintenance areas for actions that are federally funded, licensed/permitted, or requires federal agency approval and is not covered by transportation conformity regulations. The federal agency proposing an activity would work with state and local governments to evaluate whether potential activity-related impacts to air quality would conform to the SIP based on regulations in 40 CFR Parts 6, 51, and 93 (EPA, 1993).

In the first step of the process, the federal agency evaluates a proposed project to assess the applicability of general conformity requirements. In making this evaluation, the agency assesses whether:

- The proposed activity is exempt from general conformity requirements (40 CFR § 93.153(c))
- The proposed activity is "presumed to conform" (40 CFR § 93.153(g))
- Total direct and indirect emissions are below the *de minimis* level. For the ozone NAAQS, emissions from ozone precursors determine whether general conformity must be demonstrated for an action, with *de minimis* levels of 100 tons per year of NO_x or VOC for Marginal and Moderate nonattainment areas and for maintenance areas)

If the proposed activity meets any of these criteria, then a general conformity analysis is complete and a detailed determination and analysis is not required. If these criteria are not met, then general conformity requirements are applicable, and the agency will determine whether:

- The affected facility meets an emissions budget approved by the state as part of the SIP
- The action meets all state control requirements
- The action would cause a new violation of the standard or interfere with timely attainment, maintenance, or reasonable further progress
- Total and indirect emissions are specifically identified and accounted for in the SIP
- The state/local air quality agency has provided a written statement that emissions from the project, together with other emissions in the nonattainment/maintenance area will not exceed the SIP emissions budget

As necessary, the proposing federal agency may obtain emissions offsets to ensure that there is no net increase in emissions for the nonattainment or maintenance area. Offsets would occur during the same calendar year as any emissions increase from the proposed action, unless the proposed offsets exceed a ratio to the anticipated emissions of:

- 1.15-to-1 for Moderate nonattainment areas
- 1.1-to-1 for Marginal and maintenance areas.

For the purposes of a general conformity analysis, *direct emissions* are those emissions that are caused/initiated by the proposed federal action, and occur at the same time and place within nonattainment area. As the name suggests, *indirect emissions* are those reasonably foreseeable emissions that are caused/initiated by the proposed federal action, but occur in a different time and place within the nonattainment area. Indirect emissions are further limited to those that the federal agency can "practically control" and for which the agency can maintain control through continuing program responsibility (FAA/EPA, 2002).

2.4. Reasonably Available Control Technology

Should the San Antonio region be classified as a Moderate or higher ozone nonattainment area, sources of emissions within the area will need to demonstrate that they have implemented Reasonably Available Control Technology (RACT). Existing facilities would need to be retrofitted with pollution control technology, with RACT defined under 40 CFR § 51.100(o) as "...devices, systems, process modifications, or other apparatus or techniques that are reasonably available, taking into account: (1) the necessity of imposing such controls in order to attain and maintain a national ambient air quality standard; (2) the social, environmental, and economic costs of such controls; and (3) alternative means of providing for attainment and maintenance of such standard."

For ozone nonattainment areas, there are three categories of RACT:

- VOC RACT for sources covered by an EPA Control Technique Guideline (CTG) document
- Non-CTG major source VOC RACT, including emission sources covered in an EPA Alternative Control Technology (ACT) document
- Major source NO_x RACT

The EPA defines RACT as the lowest emission limitation that a particular source is capable of meeting by the application of control technology that is reasonably available, considering technological and economic feasibility (EPA, 2016g). In Texas, RACT requirements for ozone established by TCEQ are contained in 30 TAC Chapters 115 (VOC) and 117 (NO_x), and are adopted in the Texas SIP. TCEQ applies these requirements to reduce emissions from existing sources regardless of construction authorization or date of construction for the source (TCEQ, 2011).

2.5. Reasonable Further Progress

Should all or part of the San Antonio region be classified as nonattainment-Moderate with respect to ozone, the CAA requires that the state (TCEQ in this case) submit plans that show reasonable further progress (RFP) towards achieving attainment.

TCEQ would be required to submit an RFP analysis as a revision to the SIP for the nonattainment area within three years of the effective date for the nonattainment designation.

The RFP SIP revision would not be required to demonstrate the attainment of the NAAQS ozone standard, but would instead, as specified in Section 182(c)(2) of the CAA and in 40 CFR §51.910, involve reducing ozone precursor emissions (NO_x and/or VOC) at annual increments between the baseline year and the attainment year. For example, a RFP SIP revision prepared for the moderate nonattainment classification for the Dallas-Fort Worth (DFW) 10-county area included control strategies to achieve reductions in VOC and/or NO_x, as well as annually updated MVEB inventories, transportation modeling, and quantification of control strategies, with milestones for each year of the RFP analysis to demonstrate that the proposed control strategies would result in a reduction of 15% in emissions for the ozone precursors (VOC and/or NO_x) within six years after designation (TCEQ, 2015a). Examples of the control strategies considered for the DFW RFP analysis are included in Table 2.5.

2.6. Vehicle Inspection and Maintenance (I/M) Programs

Table 2.5. Summary of DFW NO_x and VOC Cumulative Emissions Reductions from Control Strategies (from TCEQ, 2015a)
Chapter 117 NO_x point source controls
Chapter 115 storage tank rule
Coating/printing rules
Portable fuel container rule
Federal Motor Vehicle Control Program
Inspection and maintenance (I/M)
Reformulated gasoline (RFG)/ East Texas Regional Low Reid Vapor Pressure Gasoline Program
On-road Texas low emission diesel (TxLED)[a]
Tier 1 and 2 locomotive NO_x standards
Small non-road spark ignition (SI) engines (Phase 1)
Heavy duty non-road engines
Tiers 2 and 3 non-road diesel engines
Small non-road SI engines (Phase 2)
Large non-road SI and recreational marine
Non-road TxLED
Non-road RFG
Tier 4 non-road diesel engines
Diesel recreational marine
Small SI (Phase 3)
Chapter 117 NO_x area source engine controls
Drilling rig low emission diesel
2017 Low Sulfur Gasoline Standard
[a]TXLED required in 5 of the 8 counties considered in this report (Atascosa, Bexar, Comal, Guadalupe, and Wilson) (TCEQ, 2016k)

Vehicle inspection and maintenance (I/M) programs have been used for many years to improve air quality for NAAQS criteria pollutants related to vehicle emissions (CO, Ozone through its precursors NO_x and VOC). I/M programs use special equipment to measure the pollution in a vehicle's exhaust, identifying high-emitting vehicles, and causing them to be repaired.

For areas designated as Moderate nonattainment or higher with respect to ozone, the CAA establishes basic I/M programs. Specifically, under 40 CFR § 51.350(a)(4), "…any area classified as a moderate ozone nonattainment area, and not required to implement enhanced I/M under paragraph (a)(1) of this section, shall implement basic I/M in any

1990 Census-defined urbanized area with a population of 200,000 or more." Additionally, 40 CFR § 51.350(b)(2) specifies that, "outside of ozone transport regions, programs shall nominally cover at least the entire urbanized area, based on the 1990 census. Exclusion of some urban population is allowed as long as an equal number of non-urban residents of the MSA containing the subject urbanized area are included to compensate for the exclusion." Therefore, with respect to the potential nonattainment designation of the San Antonio area, not all of the counties in the eight-county area considered in this study would necessarily be required to have a vehicle I/M program. If the area were to be classified as higher than Moderate, additional I/M requirements in 40 CFR §51.350 could apply and require implementation of an I/M program in other parts of the nonattainment area.

In establishing the basic I/M program, the CAA identified EPA as the agency responsible for developing the performance standards to be met. EPA has revised the I/M performance standards several times to give greater flexibility to nonattainment regions in designing their I/M programs and to meet revisions to the NAAQS ozone standards. Although there is flexibility in designing I/M programs, common methods include visual inspection, emissions testing, and/or accessing the onboard diagnostic computer codes from 1996 and newer vehicles (EPA, 2006).

States can perform testing in a variety of ways, including centralized test-only inspection facility (State- or contractor-operated), or at privately owned and operated decentralized facilities using certified mechanics. If a vehicle does not pass the test, then it is required to be repaired before it can continue to be operated in the area. In Texas, for those nonattainment regions with I/M programs, the programs are integrated with the annual safety inspection program and operated by the Texas Department of Public Safety (DPS) in conjunction with TCEQ (TCEQ, 2016h). The components of existing Texas I/M programs include:

- Motorists must successfully pass both the emissions and safety portions of the inspection prior to receiving a vehicle inspection report, which will be used to obtain a vehicle registration sticker.
- Gasoline vehicles model-year 2 through 24 years old are inspected annually beginning with the vehicle's second anniversary.

- Remote sensing element randomly inspects vehicles emissions on highways.
- All inspections are collected at a central database.
- Recognized Emission Repair Facilities ensure quality repair of vehicles.
- Waivers and time extensions are available for eligible vehicle owners.

The SIP must be revised to include the implementation of a basic I/M program, and the revisions must be reviewed, approved, and overseen by EPA. The I/M program is required to gather test data on individual vehicle tests (including tracking Vehicle Identification Numbers or VINs) as well as quality control data on testing equipment. The I/M program is also required to report I/M program results related to test data, quality assurance, quality control and enforcement.

2.7. Attainment Demonstration

Areas that are classified as Moderate nonattainment or higher with respect to ozone require a demonstration that the area will be able to achieve attainment by the attainment date. The demonstration is accomplished by computer simulations of ozone levels during the last complete ozone season prior to the attainment date. The demonstration also must include evidence that the state has implemented reasonably available control measures (RACM) necessary to advance attainment as well as any additional measures that would be implemented if attainment was not achieved by the established date. Basic ideas of RACM include the following types of criteria for control measures:

- Technologically feasible;
- Economically feasible;
- Does not cause "substantial widespread and long-term adverse impacts;
- Is not "absurd, unenforceable, or impractical;" and
- Can advance the attainment date by at least one year

As with other measures to improve regional air quality, the SIP is revised to include the RACM used to demonstrate attainment, and submitted for review and approval by EPA. The SIP revision is due within 36 months of an initial nonattainment designation for newly designated Moderate ozone nonattainment areas.

2.8. Anti-Backsliding Requirements

When an area is designated as nonattainment with respect to NAAQS, existing rules, controls, and practices that are incorporated into the approved SIP revisions for that area cannot be relaxed, regardless of changes to the NAAQS, until the air quality improves to restore attainment status for the region. Requirements known as anti-backsliding requirements are imposed to ensure air quality in nonattainment areas will not worsen. EPA is prohibited by the Clean Air Act from approving a revision to the SIP that proposes actions that would interfere with progress towards attainment, and once an attainment designation is achieved, the state must be able to demonstrate that removal of existing controls in the SIP will not degrade or limit the ability to maintain compliance with the standards. Because the San Antonio region has not previously been designated as nonattainment with respect to previous ozone standards, the anti-backsliding requirements would not apply. If more restrictive ozone standards are to be enacted in the future, however, anti-backsliding provisions would require the region to continue to adhere to requirements established in approved SIP revisions based on the 2015 ozone standard (EPA, 2015a).

2.9. Sanctions

Under rare circumstances, Section 179 of the Clean Air Act provides for the EPA to impose automatic sanctions if it makes one of the following findings:

- The state failed to submit a required SIP or revision for the area;
- EPA disapproves of a required SIP or one or more elements of a SIP revision for the area
- One or more elements of the SIP is not being implemented within the area

Sanctions must be applied unless the deficiency is corrected within 18 months after the finding or disapproval. Sanctions are generally of two types (1) offset sanctions and (2) highway sanctions, and are used to induce states to comply with the requirements to develop strategies that will bring the area into attainment. The first sanction to be imposed is an offset requirement where new or expanded stationary sources must reduce emissions by 2 tons for every 1 ton of emission growth. These types of offsets can be expensive and difficult to obtain. Availability is driven by supply and demand, however, and offsets can be more easily obtained depending on the specific area and circumstances. If the deficiency is not corrected within 6 months of imposition of the offset sanction, highway sanctions may be imposed. Highway sanctions prohibit federal funding for transportation projects within the sanctioned area, including activities (FHWA, 2016) such as:

- The addition of general purpose through lanes to existing roads
- New highway facilities on new locations
- New interchanges on existing highways
- Improvements to, or reconfiguration of existing interchanges
- Additions of new access points to the existing road network
- Increasing functional capacity of the facility
- Relocating existing highway facilities
- Repaving or resurfacing except for safety purposes
- Project development activities, including NEPA documentation and preliminary engineering, right-of-way purchase, equipment purchase, and construction solely for non-exempt projects
- Transportation enhancement activities associated with the rehabilitation and operation of historic transportation buildings, structures, or facilities not categorically exempted.

Certain highway projects related to safety, air quality improvement (that do not encourage single-occupancy vehicle travel), and congressionally authorized projects are exempt from sanctions, but in general the FHWA cannot approve or award any funds in a sanctioned area, and highway sanctions can have significant impacts on transportation planning for the area.

2.10. Other Requirements

As described previously, it is assumed in this report that the San Antonio region would be designated as either Marginal or Moderate nonattainment with respect to ozone. Under the Clean Air Act, EPA has other statutory and regulatory requirements related to Serious, Severe, and Extreme nonattainment classification status, but these additional requirements are not described in this report.

3. General Overview of Economic Methodologies

3.1. Measuring Impacts on Gross Regional Product and Other Impacts

Many of the economic impacts provided in this report are presented in terms of the effects on gross regional product in the area. The impacts on potential lost businesses also include impacts on employment (measured as full-time equivalent positions), income (including benefits), and output. These economic impacts were calculated using the IMPLAN input-output model for each of the counties within the San Antonio-New Braunfels metropolitan area and the entire metropolitan area. Wassily Leontief introduced input-output analysis for which he later received the Nobel Prize in economics in 1973.[1] An input-output model describes the economic interactions or trade flows among businesses, households, and governments and shows how changes in one area of the economy impact other areas. The multipliers that result from these models are the expressions of these interactions. The input-output model provides a more complete picture of the economic impacts beyond direct spending since it also captures the multiplier effects and leakages that might occur as this economic activity reverberates through the local economy.

For instance, if being designated nonattainment creates a reduction in economic activity through a delay in a company's expansion or loss of a business in the area, the direct loss of this economic activity will then reverberate beyond this direct effect, as the firm will not be buying

[1] For an example of his seminal work, see: Leontief, Wassily et al., *Studies in the Structure of the American Economy: Theoretical and Empirical Explorations in Input-Output Analysis,* New York: Oxford University Press, 1953.

materials and other inputs from its suppliers or paying workers who then spend their incomes in the local economy.

As just alluded to, this also generates additional economic activity often referred to as the multiplier effects. The multiplier effects can be separated into two effects: the indirect effect and the induced effect. The indirect effect results from the company purchasing inputs (physical goods or services) from its local suppliers. Of course, this then sets off additional spending by the supplier in its purchases of inputs and payment of salaries and benefits to its employees. The induced effect is derived from the spending of the employees of the company resulting from the incomes they receive.

Of course, not all of this economic activity is captured within the local economy. There are leakages as businesses and individual consumers purchase goods and services outside of the local economy causing some money to leak or flow out of the local economy. This is also the case as federal and state taxes and fees are paid resulting from these activities. These leakages are accounted for in the model and are not counted as part of the economic impacts.

The IMPLAN input-output model is based off data specific to the region, much of it provided by federal government data collection agencies (IMPLAN 2015). The IMPLAN model measures the interactions across 536 industries. Input-output analysis provides snapshot of the economy at a point in time (2015 in the case of the model used for this study. It is also assumed in input-output models that demand equals supply, and as such, the multipliers that are calculated in the model to measure the indirect and induced changes that occur in a regional economy given an initial, direct change in the economy, reflect the structure of the economy at that point in time. This means that projections of future economic impacts based on input-output models assume the structure of the economy (i.e., the flows across industries) remains the same.

3.2. General Assumptions

In order to conduct the economic analysis, it is necessary to make several assumptions about future economic conditions and scenarios. This section outlines some of the general assumptions used in the analysis. Many of the assumptions will be discussed within the context of the description of the methodology used in the various components of the analysis later in the paper.

- Marginal nonattainment is assumed to be for a 27-year period, and moderate nonattainment is assumed to be for a 30-year period.
- Growth in gross domestic product was assumed to be 3.1%, which is equivalent to the average growth rate in the metropolitan area from 2001 through 2015.
- In order to allocate the costs across each of the counties, the proportion of the population in each county relative to the total population in the metropolitan area was used.
- All dollar values are in 2016 dollars.
- Transportation analysis is based on the Alamo Area Metropolitan Planning Organization definitions.
- In order to allocate the costs across the counties, in many instances this was done based on the proportion of the population in the country relative to the total metropolitan area population. These proportions are provided in the following table.

Table 3.1. County Population as Proportion of MSA Population in 2015

Atascosa	2.1%
Bandera	0.9%
Bexar	79.8%
Comal	5.1%
Guadalupe	6.3%
Kendall	1.6%
Medina	2.1%
Wilson	2.0%

4. Analysis of Potential Economic Costs of a Nonattainment Designation

4.1. Impacts on Expansion/Relocation of Companies

4.1.1. Cost of Permitting

Facilities that are seeking to expand or locate a new operation in the region may be required to conduct an environmental analysis under a new point source review. In our discussions with organizations within the region about the potential cost of conducting a conformity analysis, they project the cost to be somewhere in the range of $100,000 to $250,000. This also fits with costs in other regions (TCEQ 2016h).

In trying to calculate the total cost for these organizations across each county over the time period of the analysis, it is necessary to project the number of permits that will be filed in the future. The basis for the projections in the analysis is the historical permits filed with TCEQ. Specifically, data on the permits filed with TCEQ were downloaded from the TCEQ website. The construction permits that TCEQ received since 2000 were pulled from the database and each permit was designated by the industry of the organization filing the permit. The industries were mostly defined by two-digit NAICS codes and included manufacturing; utilities; mining, quarry, and oil and gas; and crematories (this was defined as NAICS code 812210). The average number of permits per year was calculated and the average for each county was used to project the total number of permits under marginal and moderate nonattainment, which were rounded to the nearest whole number. The total number of permits was then multiplied by the estimated cost of $100,000 and $250,000 to provide a range of the potential total costs. The total costs by county are shown in the following table. Across the metropolitan area, it is projected that total costs will range from $24.2 million to $60.5 million under marginal nonattainment and from $26.9 million to $67.3 million under moderate nonattainment (Table 4.1).

Table 4.1. Total Cost of Permitting by County

	Marginal		Moderate	
County	*Low Estimate*	*High Estimate*	*Low Estimate*	*High Estimate*
Atascosa	$1,500,000	$3,750,000	$1,700,000	$4,250,000
Bandera	$200,000	$500,000	$200,000	$500,000
Bexar	$12,700,000	$31,750,000	$14,100,000	$35,250,000
Comal	$2,500,000	$6,250,000	$2,800,000	$7,000,000
Guadalupe	$2,900,000	$7,250,000	$3,200,000	$8,000,000
Kendall	$200,000	$500,000	$200,000	$500,000
Medina	$3,000,000	$7,500,000	$3,400,000	$8,500,000
Wilson	$1,200,000	$3,000,000	$1,300,000	$3,250,000
MSA	**$24,200,000**	**$60,500,000**	**$26,900,000**	**$67,250,000**

4.1.2. Costs Associated with Construction Project Delays

A related cost to the permitting process that accompanies the nonattainment designation is the cost of a project being delayed. In other words, if a company wants to expand or locate a facility in an area designated as being in nonattainment, the permitting process through TCEQ could take up to a year if the operations at the facility will be a new source of emissions. For example, a typical standard permit without public notice or a permit by rule will typically take up to 45 days to be issued while a new source review permit could take 285 to 365 days, depending on the type of permit (TCEQ Fact Sheet – Air Permitting, 2). This delay means a lost year of economic activity. While such a delay could result in a lost expansion or location of a new firm to an area, information obtained from discussions with various organizations indicates that this is not likely to be a regular occurrence, at least with larger firms, so this analysis focuses on the cost of the delayed projects.

In order to project the number of new projects that may arise over the time period of this study, the same data on number of permits by industry were used to project the costs of project delays due to permitting. The proportion of permits by industry relative to the total number of permits was calculated and used to proportion the number of future permits by industry by multiplying the proportion for each industry in each county by the total number of permits forecast for each county. This assumes the distribution of permits by industry in each county stays the same over the entire time period. The gross regional product was calculated based on the average size of a firm in each industry in each county as described in the sections on industry impacts. This assumes that the potential delayed project is the size of the average firm in each county. Such an assumption is probably not too unreasonable because a delayed project could mean the location of a new firm. Additionally, the average numbers used to calculate these impacts on GRP are small relative to the larger firms, which may be engaged in many of these expansions, so using an average firm size may accurately represent such an expansion by a larger firm. It is also possible that the scale of the expansion or new firm could be smaller than is represented by the average, but it is also likely that such a project could be larger. The number of permits for each industry in each county was multiplied by the GRP to get an estimate of the cost of such an expansion. It is also assumed that these costs just occur for one-year, based on information obtained from local businesses. In other words, it is assumed that there is a one-year delay in the project, but the expansion then occurs or the new firm does locate into the region and begins operations after the delay.

The results of the analysis are provided in Table 4.2. Bexar and Guadalupe counties will see the largest impacts from the project delays. Across the entire metropolitan area, the project delays are projected to result in a loss of GRP of $1.4 billion under a marginal nonattainment designation and $1.6 billion under moderate nonattainment.

Table 4.2. Reductions in GRP due to Project Delays by County (2016 $)

County	*Marginal*	*Moderate*
Atascosa	$62,287,056	$69,207,840
Bandera	$267,538	$297,264
Bexar	$897,056,940	$996,729,934
Comal	$56,863,379	$63,181,532
Guadalupe	$348,509,375	$387,232,639
Kendall	$3,291,437	$3,657,152
Medina	$46,681,991	$51,868,879
Wilson	$11,107,787	$12,341,985
MSA	**$1,426,065,502**	**$1,584,517,224**

4.1.3. Potential Loss of a Company Expansion or Location

As previously discussed in the report, being designated as nonattainment will require many local firms that are a source of pollution to install new emissions control systems and engage in other activities to reduce their emissions. One example of the increase in potential costs for an industrial operation is that installing the emissions control systems required under nonattainment will cost about $1-$1.5 million plus an additional one to two staff and materials to maintain the system on an annual basis. Nonattainment will also increase the permitting costs from $30,000 under attainment to $100,000-$150,000 under nonattainment in large part to hire consultants to do additional modeling. This does not include additional staff time at the organization that will be required to work with the consultants and assemble the additional paperwork to file for the permit.[2] Additionally, the availability of offsets may also be a deterrent to firms looking to locate or expand in the region because if there are not any offsets for them to purchase, they will not be able to receive the permits necessary.

These additional costs could cause some companies to decide not to locate or expand in the region. We were able to obtain very little information about companies actually considering not expanding or locating in the region due to the potential of a nonattainment designation. In fact, based on conversations with many local economic development agencies, nonattainment does not appear to be much of an issue, especially for larger firms.

However, one local industrial firm did mention that it is a consideration in their decision to expand in the San Antonio area. The expansion under consideration would increase the productive capacity of the firm by about a third.[3] Using this information, the potential size of the expansion was run through the IMPLAN input-output model, and the annual economic impacts are provided in Table 4.3. Including multiplier effects, the annual impact on gross regional product in the region would be about $25.9 million.

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[2] These estimates come from interviews with staff from local industrial firms.

[3] This information is based on a conversation with staff of the firm. They asked that identifying information about the firm be kept confidential.

Table 4.3. Annual Economic Impacts of Potential Lost Manufacturing Company Expansion (2016 $)

Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	50	$5,327,302	$14,148,313	$33,942,127
Indirect Effect	75	$4,694,377	$7,401,584	$13,849,154
Induced Effect	57	$2,552,346	$4,367,348	$7,589,763
Total Effect	181	$12,574,025	$25,917,246	$55,381,044

While there is no other indication that a large manufacturing firm is considering not expanding or locating in the metropolitan area due to nonattainment, it is possible, and since the costs of such a loss to the economy could be quite substantial, the potential costs of losing a large manufacturing firm was estimated. A large manufacturing firm is assumed to be equivalent in size to the average of the top five largest manufacturing firms[4] in the region, as measured by employment. Such a firm would have employment of 1,070 jobs. If a firm of this size decided to leave the region or not locate in the region due to nonattainment, the annual impacts of such a decision on the regional economy are shown in Table 4.4. The overall annual impacts on gross regional product would amount to about $925.4 million.

Table 4.4. Average Annual Impacts on San Antonio MSA of Large Manufacturing Firms (2016 $)

Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	1,070	$97,385,518	$576,872,351	$1,646,514,928
Indirect Effect	2,028	$141,808,698	$227,746,573	$401,559,908
Induced Effect	1,618	$70,480,863	$120,826,425	$213,324,511
Total Effect	4,717	$309,675,079	$925,445,349	$2,261,399,347

In order to estimate the range of potential cumulative costs due to the loss of a company expansion or relocation, the potential for the loss of an expansion of a relatively small manufacturing firm, as shown in Table 4.7, was considered to be the low end of the range. This was used because it was the only indication we received that a firm's decisions might be affected by nonattainment. To get the high end of the range of costs, the potential loss of a large manufacturing firm (Table 4.8) was used. The cumulative economic costs over the 27-year and

[4] The top five firms were based on the data provided in the San Antonio Business Journal's *2016-2017 Book of Lists.*

30-year time periods for marginal and moderate nonattainment, respectively, are calculated. The IMPLAN input-output model provides the annual impacts in 2016 dollar values, so assuming similar impacts throughout the time period of the analysis, a simple multiplication by 27 and 30 was used to get the cumulative effects. These results are distributed across counties using the proportion of the population in the county relative to the total population in the MSA. It should be kept in mind that these figures are cumulative over the projected periods for marginal and moderate nonattainment. The employment is in terms of full-time employment (FTE) positions, so when multiplied by the number of years for each nonattainment designation, we have indicated it in terms of FTE person-years. These projections are provided in Tables 4.5 and 4.6.

Table 4.5. Cumulative Economic Impacts of Potential Lost Manufacturing Company Under Marginal Nonattainment by County (2016 $)

Low Estimate				
County	*Employment (FTE Person-Years)*	*Income*	*Gross Regional Product*	*Output*
Atascosa	103	$7,156,272	$14,750,318	$31,519,090
Bandera	45	$3,110,526	$6,411,334	$13,700,004
Bexar	3,903	$270,557,476	$557,665,875	$1,191,643,524
Comal	254	$17,624,151	$36,326,431	$77,623,822
Guadalupe	312	$21,616,379	$44,555,106	$95,207,194
Kendall	77	$5,329,608	$10,985,246	$23,473,727
Medina	104	$7,220,381	$14,882,457	$31,801,449
Wilson	99	$6,883,882	$14,188,875	$30,319,376
MSA	**4,898**	**$339,498,675**	**$699,765,642**	**$1,495,288,188**

High Estimate				
County	*Employment (FTE Person-Years)*	*Income*	*Gross Regional Product*	*Output*
Atascosa	2,684	$176,245,807	$526,699,995	$1,287,033,348
Bandera	1,167	$76,606,536	$228,934,026	$559,418,508
Bexar	101,489	$6,663,332,362	$19,912,968,003	$48,658,921,770
Comal	6,611	$434,050,380	$1,297,133,456	$3,169,648,812
Guadalupe	8,109	$532,371,608	$1,590,960,530	$3,887,638,647
Kendall	1,999	$131,258,421	$392,257,896	$958,513,381
Medina	2,708	$177,824,678	$531,418,356	$1,298,563,038
Wilson	2,582	$169,537,345	$506,652,159	$1,238,044,865

MSA	127,350	$8,361,227,138	$24,987,024,423	$61,057,782,369

Table 4.6. Cumulative Economic Impacts of Potential Lost Manufacturing Company Expansion Under Moderate Nonattainment by County (2016 $)

Low Estimate				
County	*Employment (FTE Person-Years)*	*Income*	*Gross Regional Product*	*Output*
Atascosa	115	$7,951,414	$16,389,242	$35,021,212
Bandera	50	$3,456,140	$7,123,705	$15,222,227
Bexar	4,337	$300,619,417	$619,628,750	$1,324,048,360
Comal	283	$19,582,390	$40,362,701	$86,248,691
Guadalupe	347	$24,018,199	$49,505,673	$105,785,771
Kendall	85	$5,921,786	$12,205,828	$26,081,919
Medina	116	$8,022,645	$16,536,063	$35,334,944
Wilson	110	$7,648,758	$15,765,417	$33,688,196
MSA	**5,442**	**$377,220,750**	**$777,517,380**	**$1,661,431,320**

High Estimate				
County	*Employment (FTE Person-Years)*	*Income*	*Gross Regional Product*	*Output*
Atascosa	2,983	$195,828,675	$585,222,217	$1,430,037,053
Bandera	1,296	$85,118,374	$254,371,140	$621,576,120
Bexar	112,766	$7,403,702,625	$22,125,520,004	$54,065,468,633
Comal	7,346	$482,278,201	$1,441,259,396	$3,521,832,014
Guadalupe	9,010	$591,524,008	$1,767,733,922	$4,319,598,496
Kendall	2,221	$145,842,690	$435,842,107	$1,065,014,868
Medina	3,009	$197,582,976	$590,464,840	$1,442,847,819
Wilson	2,869	$188,374,828	$562,946,844	$1,375,605,406
MSA	**141,500**	**$9,290,252,376**	**$27,763,360,470**	**$67,841,980,410**

The potential cumulative costs of a lost company expansion or location under marginal nonattainment are projected to be in the range of $699.8 million to $25.0 billion in lost GRP. Under moderate nonattainment, the costs are projected to range from $777.5 million to $27.8 billion.

Other industries like the utilities; transportation and warehousing; and mining and oil and gas production industries may also have to consider the costs of having operations in an area designated in nonattainment. While data are not available on the largest firms in these other industries that would allow a similar analysis as was conducted for manufacturing, the impacts of the average size of firms across these industries, as shown in Tables 4.3-4.6, is meant to provide some perspective on the potential costs of losing one of those firms due to the nonattainment designation.

The following methodology was used to calculate these estimated potential losses for each industry.

- Data was pulled on private sector average employment, number of establishments, and average annual pay for each industry by county in 2015 (the most current year available) from the Quarterly Census of Employment and Wages provided by the U.S. Bureau of Labor Statistics.
- Total wages per establishment for each industry across each county was calculated by multiplying the number of establishments by the average annual pay.
- The employment and total wages for each industry was run through the IMPLAN input-output model for each county. This provided the total economic impacts, including the indirect and induced multiplier effects for employment, income, gross regional product, and output shown in Tables 4.7–4.10.

Since the data used for this analysis only included private sector firms, the utilities industry does not include municipally owned utilities like CPS Energy and San Antonio Water System. However, public utilities are not likely to relocate due to nonattainment and are likely to make adjustments to serve the market even under a nonattainment designation. This is evidenced by the fact that these utilities have long been preparing to be able to serve the local market under a nonattainment designation.

Table 4.7. Annual Impacts of Potential Loss of Average Manufacturing Firm by County (2016 $)

Atascosa County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	16	$723,942	$735,861	$1,575,589
Indirect Effect	2	$78,286	$130,972	$272,207
Induced Effect	3	$86,123	$180,914	$339,484
Total Effect	21	$888,351	$1,047,747	$2,187,280

Bandera County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	3	$101,927	$116,405	$203,733
Indirect Effect	1	$13,470	$22,058	$68,368
Induced Effect	0	$8,338	$20,077	$42,119
Total Effect	4	$123,735	$158,541	$314,220

Bexar County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	34	$2,268,715	$3,368,672	$9,464,730
Indirect Effect	20	$1,138,576	$1,603,050	$2,821,950
Induced Effect	19	$869,596	$1,487,988	$2,585,817
Total Effect	73	$4,276,887	$6,459,710	$14,872,497

Comal County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	22	$1,139,913	$1,113,718	$2,219,362
Indirect Effect	4	$204,078	$314,800	$594,868
Induced Effect	7	$252,303	$467,171	$848,584
Total Effect	33	$1,596,295	$1,895,689	$3,662,814

Guadalupe County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	54	$13,536,515	$13,666,659	$14,777,108
Indirect Effect	5	$241,756	$366,421	$717,651
Induced Effect	36	$1,140,408	$2,720,343	$4,703,246
Total Effect	95	$14,918,679	$16,753,424	$20,198,005

Kendall County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	21	$1,585,017	$1,647,978	$2,249,540

Indirect Effect	2	$107,705	$168,338	$315,510
Induced Effect	5	$202,023	$405,434	$718,070
Total Effect	28	$1,894,744	$2,221,749	$3,283,120

Medina County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	7	$202,530	$208,104	$617,982
Indirect Effect	1	$32,075	$47,058	$98,082
Induced Effect	1	$21,704	$47,521	$90,022
Total Effect	9	$256,310	$302,683	$806,085

Wilson County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	12	$671,030	$696,492	$1,077,514
Indirect Effect	2	$30,396	$50,389	$177,018
Induced Effect	1	$45,661	$115,136	$203,913
Total Effect	15	$747,087	$862,017	$1,458,445

Table 4.8. Annual Impacts of Potential Loss of Average Transportation and Warehousing Firm (2016$)

Atascosa County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	12	$1,109,499	$1,192,037	$2,181,378
Indirect Effect	4	$155,725	$245,190	$502,864
Induced Effect	5	$135,108	$285,065	$533,986
Total Effect	21	$1,400,332	$1,722,292	$3,218,227

Bandera County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	6	$384,284	$403,820	$785,907
Indirect Effect	3	$81,089	$119,739	$283,884
Induced Effect	1	$33,878	$81,847	$171,357
Total Effect	10	$499,251	$605,406	$1,241,148

Bexar County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	24	$2,122,486	$2,344,966	$4,096,461
Indirect Effect	13	$772,398	$1,159,311	$2,013,498

Induced Effect	17	$747,411	$1,278,973	$2,222,250
Total Effect	54	$3,642,295	$4,783,251	$8,332,209

Comal County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	22	$1,364,580	$1,571,428	$3,925,650
Indirect Effect	9	$488,077	$730,270	$1,308,109
Induced Effect	9	$346,119	$641,888	$1,164,254
Total Effect	41	$2,198,776	$2,943,586	$6,398,013

Guadalupe County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	15	$666,597	$776,804	$2,241,143
Indirect Effect	4	$200,476	$294,880	$521,118
Induced Effect	2	$71,082	$167,801	$291,090
Total Effect	22	$938,156	$1,239,485	$3,053,351

Kendall County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	4	$163,162	$181,459	$500,616
Indirect Effect	1	$68,632	$99,282	$175,720
Induced Effect	1	$28,177	$56,380	$100,117
Total Effect	6	$259,971	$337,121	$776,453

Medina County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	8	$491,528	$544,770	$1,260,807
Indirect Effect	3	$121,072	$164,710	$431,973
Induced Effect	2	$56,839	$124,901	$236,267
Total Effect	13	$669,440	$834,381	$1,929,047

Wilson County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	5	$428,508	$460,300	$870,365
Indirect Effect	2	$53,371	$71,728	$157,140
Induced Effect	1	$31,550	$79,924	$141,327
Total Effect	8	$513,428	$611,952	$1,168,832

Table 4.9. Annual Impacts of Potential Loss of Average Mining, Quarrying, & Oil & Gas Production Firm (2016$)

Atascosa County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	36	$2,842,803	$3,983,055	$6,252,025
Indirect Effect	6	$166,908	$311,911	$738,273
Induced Effect	11	$322,890	$678,656	$1,273,213
Total Effect	53	$3,332,600	$4,973,622	$8,263,512

Bandera County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	1	$104,669	$127,133	$144,963
Indirect Effect	0	$5,001	$7,988	$25,492
Induced Effect	0	$7,949	$19,169	$40,178
Total Effect	2	$117,619	$154,289	$210,633

Bexar County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	19	$2,425,956	$2,866,597	$3,490,970
Indirect Effect	7	$359,896	$547,493	$1,032,332
Induced Effect	16	$710,915	$1,216,464	$2,113,967
Total Effect	42	$3,496,768	$4,630,555	$6,637,269

Comal County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	17	$1,577,809	$1,752,834	$1,756,522
Indirect Effect	4	$183,667	$284,700	$594,583
Induced Effect	9	$328,872	$610,031	$1,106,257
Total Effect	30	$2,090,349	$2,647,565	$3,457,362

Guadalupe County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	9	$821,400	$1,034,535	$1,296,432
Indirect Effect	1	$53,750	$86,982	$180,876
Induced Effect	2	$71,797	$169,624	$294,176
Total Effect	13	$946,948	$1,291,141	$1,771,485

Kendall County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	8	$1,386,475	$1,479,199	$1,083,625

Indirect Effect	2	$83,918	$117,044	$245,572
Induced Effect	5	$176,712	$354,238	$628,021
Total Effect	14	$1,647,106	$1,950,481	$1,957,219

Medina County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	18	$1,165,161	$1,676,056	$2,829,008
Indirect Effect	4	$140,098	$213,174	$557,333
Induced Effect	4	$120,818	$264,711	$501,325
Total Effect	26	$1,426,077	$2,153,942	$3,887,667

Wilson County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	11	$805,572	$1,059,271	$1,620,143
Indirect Effect	2	$42,308	$72,401	$200,050
Induced Effect	2	$55,273	$139,533	$247,025
Total Effect	14	$903,153	$1,271,205	$2,067,219

Table 4.10. Annual Impacts of Potential Loss of Average Utilities Firm (2016$)

Atascosa County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	32	$2,631,211	$13,640,975	$42,920,678
Indirect Effect	34	$2,998,793	$11,742,973	$30,833,702
Induced Effect	20	$604,538	$1,269,698	$2,382,752
Total Effect	87	$6,234,542	$26,653,646	$76,137,131

Bexar County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	18	$1,634,114	$9,529,940	$26,402,992
Indirect Effect	23	$2,487,083	$5,550,251	$11,130,142
Induced Effect	24	$1,064,424	$1,821,451	$3,164,803
Total Effect	65	$5,185,620	$16,901,641	$40,697,937

Guadalupe County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	30	$2,235,845	$12,897,944	$40,686,729
Indirect Effect	24	$2,630,552	$9,533,205	$24,004,586
Induced Effect	13	$399,049	$942,289	$1,634,469

Total Effect	66	$5,265,446	$23,373,439	$66,325,784

Kendall County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	6	$320,731	$1,959,311	$7,441,253
Indirect Effect	4	$441,443	$1,294,921	$2,511,676
Induced Effect	2	$92,891	$185,791	$330,041
Total Effect	13	$855,065	$3,440,023	$10,282,970

Wilson County				
Impact Type	*Employment*	*Income*	*Gross Regional Product*	*Output*
Direct Effect	6	$245,341	$1,892,700	$7,446,093
Indirect Effect	4	$341,457	$1,006,772	$2,103,973
Induced Effect	1	$38,047	$95,631	$169,555
Total Effect	11	$624,845	$2,995,103	$9,719,621

NOTE: Only those counties for which data were available are reported.

As previously mentioned, it should be kept in mind that based on information obtained during discussions with various business and economic development organizations, most large organizations are prepared for the nonattainment designation or will be able to absorb the additional costs.

4.1.4. Impact on Small Businesses in the Metropolitan Area

The majority of this report emphasizes the impact of nonattainment on big business but the area consists of many small businesses run by families and individuals. These will also be subject to nonattainment regulation beginning in 2018. As part of this study, a survey instrument was made available to the small business community during December 2016, with the assistance of both the Greater San Antonio Chamber of Commerce and the Hispanic Chamber of Commerce. Unfortunately, a limited number of responses meant a reliable statistical analysis was impossible. Conversations with representatives from these and other business entities suggest that area small businesses may not be wholly aware of the significance of nonattainment and will be caught off guard when these regulations go into effect. According to the U.S. Census Bureau, "small businesses with less than 100 employees represent 97% of all employer firms in Texas as well as in the metro area of San Antonio" (Halebic and Nivin 2012, 5).

The U.S. Small Business Administration (SBA), Office of Advocacy notes that under the Regulatory Flexibility Act, the EPA is required to convene an SBA Review Panel to assess the impact of regulations on small businesses. This has not happened in part due to "the tailoring rule", which the EPA has interpreted as having a limiting effect on environmental regulations, meaning the EPA assumes that this "rule" will limit the impact of regulation on small businesses. There is debate between the Office of Advocacy and the EPA on this requirement of environmental law, and the Office of Advocacy has emphasized that small businesses such as small brick manufacturers, small foundries and small pulp and paper mills will be subject to regulation. In fact, the Office of Advocacy writes in a letter to the EPA that:

> "[Research] shows how the smallest businesses bear a 45 percent greater burden than their larger competitors. The annual cost per employee for firms with fewer than 20 employees is $7,747 to comply with all regulations. ... When it comes to compliance with environmental requirements, small firms with fewer than 20 employees spend four times more, on a per-employee basis, than do businesses with more than 500 employees."
>
> (Thomas M. Sullivan, letter to EPA Administrator Stephen Johnson, Small Business Administration, July, 8, 2008, pp. 5–6.)

Without more input from area small businesses, the true economic costs of nonattainment remain incomplete. One solution would be for local officials to find additional ways to inform and educate the small business community and solicit additional information on employment and operational costs in order to better ascertain the full economic impact of nonattainment on smaller businesses.[5]

[5] A survey of small businesses was attempted, but due to the low response rate, statistically valid results were not obtained.

4.1.5. Costs of NO_x Reduction at Cement Kilns

According to a representative at Zephyr Environmental Corporation who works with several cement producers in the MSA, "… all kilns in the San Antonio and surrounding areas are dry kilns and already have (or will have in case of newly constructed kilns) selective non-catalytic reduction (SNCR) NO_x control systems. The impact of non-attainment would be that these systems would be used more frequently, increasing operating costs" (A. de la Garza, personal communication, January 25, 2017). Under nonattainment, kilns have to operate at 1.5 lbs. of NO_x per ton of clinker. There are two kilns each in Bexar and Comal County that are currently operating above that limit. To estimate the costs of getting below this standard, it was assumed that a selective catalytic reduction (SCR) control system will be installed. According to PCA, it costs $14-$20 million to install such a system on a dry kiln and $3.4 million annually to operate (PCA 2015, 5). Using the $14 million for the low estimate of potential costs and $20 million for the high estimate of costs and the same annual operating costs of $3.4 million in both the low and high estimates, the potential costs of to the kilns of reducing their NO_x was calculated with the projections shown in Table 4.11.

Table 4.11. Potential Costs of Point Source NO_x Reduction by County (2016 $)

	Marginal		**Moderate**	
County	*Low Estimate*	*High Estimate*	*Low Estimate*	*High Estimate*
Atascosa	-	-	-	-
Bandera	-	-	-	-
Bexar	$211,600,000	$223,600,000	$232,000,000	$244,000,000
Comal	$211,600,000	$223,600,000	$232,000,000	$244,000,000
Guadalupe	-	-	-	-
Kendall	-	-	-	-
Medina	-	-	-	-
Wilson	-	-	-	-
Total	**$423,200,000**	**$447,200,000**	**$464,000,000**	**$488,000,000**

4.2. Transportation Conformity Costs

4.2.1. Costs of Performing Transportation Conformity Analysis

The economic costs of nonattainment with respect to transportation conformity in the San Antonio-New Braunfels MSA (SA-NB MSA) center on issues of urban mobility. By this we mean the fluidity with which traffic moves through the MSA. Issues such as long queues of cars and trucks due to congestion contribute to ozone because of idling. The AAMPO estimates that mobile sources are the largest source of NO_x and second largest source of VOCs (see AAMPO Air Quality and Transportation, 2016). AAMPO also notes in its transportation conformity activities that the Clean Air Act of 1977 requires that areas designated in nonattainment must meet certain requirements in order to utilize Federal funds for transportation projects. Specifically, "… regional authorities must demonstrate that transportation improvement projects will improve air quality and public health." (See http://sametroplan.org/AirQuality/)." We assume that the additional cost of completing environmental assessments could range somewhere between $100,000 and $250,000 per project (CAPCOG, 71). This number is based on data contained the Capital Area Council of Government's (CAPCOG) economic impact study (2015). We do not include the construction costs of each project because they form part of the ongoing development of the San Antonio-New Braunfels MSA and would be undertaken as the area and state grow irrespective of nonattainment. Nevertheless, the technical aspects of these activities are guided by predetermined regulations. For example, regional emissions are estimated based on projected travel on existing and planned highway and public transportation facilities consistent with an area's metropolitan transportation plan and TIP. Projected emissions must be based on the latest available information and the latest EPA-approved emissions estimation models. Our economic cost estimates assume that once designated in nonattainment, the SA-NB MSA will not move to undo measures taken despite possible future improvements in the nonattainment designation. In other words, our estimates assume that public policy will hold constant.

A lapse in conformity to the federal regulations would mean a possible loss of federal funds. Although in the CAPCOG report, it was noted that TxDOT would most likely shift funds between projects in order to prevent work stoppages. Conversations with local participations of AAMPO suggest that steps to avoid such scenarios as loss of funds have already been included in planning documents. Nevertheless, using data contained in the CAPCOG report, we assume that the SA-NB MSA costs would be similar, that is, anywhere between $1.1 and $1.5 million per year of delay (73). Using a simple calculation of cost divided by 365, we find that delays might cost between $3,000 and $4,000 per day. Clearly, construction projects are not 24/7; therefore, we can assume that the daily cost would be higher when holidays and inclement weather are factored in. This figure does not include costs associated with changing the original construction plans, which according to TTI could range between $96,000 and $450,000 depending on the size of the overall construction project per month. Should the delays extend for a year, then the math is quite straight forward: $96,000 x 12 months = $1,152,000 and $450,000 x 12 = $5,400,000 in costs due to delays (See TTI https://tti.tamu.edu/conferences/tsc11/program/presentations/construction-2/ellis.pdf).

4.2.2. Congestion Mitigation

SATomorrow reports that a survey of San Antonians reveals most MSA drivers (90%) prefer to drive alone. This means that the growing pains of the city will be increasingly felt as congestion grows. If the TTI annual reports on the most congested cities are any gauge of this process, then San Antonio is moving up the ranks of most congested cities from 29th place in 2011 to 24th in 2015. As the report points out, congestion does not grow in step with population growth, meaning if population annual growth rates are 2-3%, the growth rate of congestion in the urban areas exceeds 2-3%. A simple example comparing San Antonio in 2010 versus where it might be in 2020 shows that the distance travelled in 20 minutes is much shorter than what it will be in 2020 (SA Tomorrow 6).

The options available to the MSA for addressing congestion issues under transportation conformity include: transportation control measures such as ride-sharing, bicycling programs and other programs that encourage lower vehicle use as well as programs to improve transit such as High Occupancy Vehicle (HOV) lanes and increasing the number of lanes through designated sections of the region's road network. Finally, it is important to note that we do not address the possibility of market-based solutions in this document such as peak-hour tolls or fees for traffic on a major transportation artery. These are policy alternatives not highlighted in the original request for this study.

On-road mobility. According to the *Urban Mobility Report*, the average citizen in San Antonio spends more than 38 hours in traffic each year, an increase of 58% over the past decade (Texas Transportation Institute (TTI), 2014). The *Mobility Investment Priorities* report produced by TTI contains information on the high priority roads and improvement plans that will help address congestion and in turn emissions and ozone in Bexar County. Several major road works under consideration include:

- Plans to add lanes along I-35 North of 1604 in Bexar County at a construction cost of $2 billion to add 6- or 8-lanes to a create 12- or 14-lane expressway with a toll
- Plans to expand 1604 to I-10 with a construction cost of $300 - $400 million
- Highway US 281 to I-37 in Bexar County with a construction cost of $335 million
- Highway US 281 to Comal County Line with a construction cost of $521 million

These capacity improvement projects should enhance the flow of traffic through the region. As noted above, a requirement of nonattainment would be that AAMPO (or the implementing agency) model environmental impacts to demonstrate that environmental quality will not be degraded.[6] One such example is the environmental assessment completed for work on 1604 from Potranco Road to FM 471 in western Bexar County ("Final Environmental Assessment Loop 1604 from Road to FM 471 Bexar County, Texas" CSJ# 2452-01-056, May 2016). In this study, the assessment considered a No Build versus Build scenario for the purposes of the impact study. What is important about the nonattainment status is the requirement that planning organizations include environmental analysis for those projects that will use federal funding. Comments from local planning officials indicate that impact assessments are the responsibility of the implementing agency and might not be included in the local planning organization's cost

[6] See http://sametroplan.org/AirQuality/conformity-docs/Regionally%20Significant%20Roadways%2008%2022%202016.pdf

considerations. Furthermore, these officials indicate a marginal or moderate designation might require a re-ordering of projects but no significant change to publicly available plans.[7]

Construction. An example of how a roadway construction project factors into the question of ozone is as follows: According to surveys implemented by interested parties, travel times from Bulverde Road in Bexar County to the 1604 interchange prior to a lane expansion and interchange improvement project averaged approximately 23 minutes but after construction resulted in a decrease in travel time to 18 minutes. During peak travel times – the school year and between the 8 am to 5 pm business day – this stretch of roadway might see between 60,000 and 80,000 vehicles per day. At a mean hourly wage of $19.59, as estimated in the VIA Travel Model Improvement Report, the travel time cost was approximately $7.50 per vehicle for this stretch of road and $450,000 to $600,000 for the 23 minutes each car spent on the 6.2-mile journey. When the project was completed and the travel time was reduced to 18 minutes, using the same wage assumption and same number of cars travelling, the costs fell to $5.88 per vehicle or $352,620 to $470,160 total, or a net savings of between $97,380 to $128,840 overall. For the 6.2 miles of this journey, the cost without the transit improvements would be approximately $3.16 per mile/vehicle. Stated another way, the number of dollars lost to the driver of each vehicle could be $3.16 per mile, dollars that might be spent elsewhere. In other words, the cost of not addressing the congestion in this stretch of road in northern Bexar County could be re-interpreted as a cost of nonattainment in that congestion is a contributing factor to the accumulation of criteria pollutants such as nitrogen oxide that combine with other environmental factors to create ozone. The 5-minute time savings resulting from adding capacity between Bulverde Road and the 1604 interchange resulted in additional time for other activities for the drivers involved.

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[7]In fact, Transformation Conformity rules include Air Quality See http://sametroplan.org/AirQuality/) andhttp://sametroplan.org/AirQuality/conformity-docs/AIR%20QUALITY%20AND%20TRANSPORTATION%20CONFORMITY%20April%202016.pdf

Table 4.12. Examples of Costs Associated with Road Construction Projects

Project	Miles of Road	Daily vehicles	Travel time minutes	Wage Per Minute$	Cost of Time $	90% of Vehicle's	Daily Cost All Vehicles $	Peak Cost/year $
US 281 South of Loop 1604	7.4	130,000	25	0.33	8.16	117,000	955,012.50	171,902,250.00
US 281 from Loop 1604 to Comal	7.3	130,000	25	0.33	8.16	117,000	955,012.50	171,902,250.00
Schertz to Loop 1604	2.1	235,000	25	0.33	8.16	211,500	1,726,368.75	310,746,375.00
Downtown I10-I35 Connect	4.2	167,000	25	0.33	8.16	150,300	1,226,823.75	220,828,275.00
Total	**13.6**	**662,000**	**100**	**0.33**	**32.65**	**595,800**	**19,452,870.00**	**875,379,150.00**

Source: For road length and vehicle miles see Mobility Report at TTI. Available at https://mobility.tamu.edu/mip/strategies-pdfs/added-capacity/technical-summary/adding-new-lanes-or-roads-4-pg.pdf . Travel is estimated based on example of 281. Number of single passenger vehicles is based on MPO survey as is hourly wage of $19.59. Daily cost is cost of time multiplied by 91% of vehicles. Peak Cost per year is Daily Cost x 5 days per week x 4 weeks per month x 9 months. Assumptions are based on example of 281.

Table 4.13. Costs if Vehicles travelled at normal speed 60 miles per hour

Project	*Miles of Road*	*Daily vehicles*	*Travel time minutes*	*Wage Per Minute*	*Cost of Time*	*90% of vehicles*	*Daily Cost All Vehicles*	*Peak Cost/year*
US 281 South of Loop 1604	7.4	130,000	7.4	0.33	2.42	117,000.00	282,683.70	50,883,066.00
US 281 from Loop 1604 to Comal	7.3	130,000	7.3	0.33	2.38	117,000.00	278,863.65	50,195,457.00

Schertz to Loop 1604	2.1	235,000	2.1	0.33	0.69	211,500.00	145,014.98	26,102,695.50
Downtown I10-I35 Connect	4.2	167,000	4.2	0.33	1.37	150,300.00	206,106.39	37,099,150.20
Total	**13.6**	**662,000**	**21**	**0.33**	**6.86**	595,800.00	**4,085,102.70**	**164,280,368.70**
Source: Previous table with stated adjustments								

Table 4.14. Comparison with and without congestion

Project	*Miles of Road*	*Daily vehicles*	*Travel time minutes*	*Wage Per Minute*	*Cost of Time*	*90% of Vehicles*	*Daily Cost All Vehicles $*	*Peak Cost/year $*
Total w/ congestion	13.6	662,000	100	0.33	**32.65**	595,800.00	19,669,013.00	**885,105,585.00**
Total w/o congestion	13.6	662,000	21	0.33	**6.86**	595,800.00	4,130,492.73	**166,105,706.13**
Difference (savings/cost)			**79**		**25.79**		**15,538,520.27**	**718,999,878.87**

Table 4.12 shows four specific segments of road improvement projects identified by TTI as important for the overall flow of traffic in and around the SA-NB MSA. Together, the four projects represent 13.6 miles of roadway carrying over 660,000 vehicles during peak hours. We have estimated the travel time through each segment as 25 minutes based on our previous example of Bulverde to 1604, leading to a total 100 minutes in travel time for these segments. As the table shows, we have also estimated the wage per minute of travel and further estimated that 90% of the vehicles will have one passenger (SA Tomorrow 6). Under these conditions during the peak hours – the school year week days between 8:00 am and 5:00 pm – we can begin to see that a significant economic cost emerges in the form of lost wages or rather spending opportunities. The figures can be quite staggering when one considers the number of cars and the

average value of time over the course of a school year. In short, any project that seeks to lessen travel times through either increased speeds or fewer vehicles on the roads will lead to some economic benefit.

This type of analysis could be extended to the other transportation projects listed above. With an estimated average wage of $19.59 for the greater metropolitan area, any construction project that limits access to a lane or two will result in additional time spent in congestion. The example above from Bulverde Road to 1604 Interchange, a distance of 6.3 miles, tells us that the cost per mile is approximately $3.10 (with all assumptions remaining unchanged). When construction for improvements increases, some research suggests that delays due to restricting the number of lanes, slow-downs in speed can increase up to 40%, meaning that in the case of Bulverde Road, while construction was in process, the normal travel time increased to 32 minutes and a cost of $4.34 per mile/vehicle or $10.45 in time. The cost of nonattainment in these construction scenarios are complex because, on the one hand, there are the factors of lost time, productivity, and increasing congestion along with possible public health consequences (the latter not covered in this study) if the metropolitan area elects to maintain the status quo. On the other hand, implementing construction projects will create bottlenecks and additional congestion during the construction phase of each project. But these inconveniences will lead to medium- and longer-term benefits once the construction is completed as vehicles can transit through the area at a quicker pace, with less idling time and consequently fewer opportunities for ozone build up. Therefore, great care must be taken when attempting to estimate the impact of construction projects because for every economic cost there will be an economic benefit that arises that might offset the estimated costs. As the environmental impact assessment for Potranco to FM 471 notes, increased speeds through a once congested stretch of roadway offset emissions due to congestion. In fact, according to the EPA MOVES model, emissions of all mobile source air toxic emissions (MSAT) fall when speed increases (Potranco, 12).

Emission reductions. The Potranco to FM 471 study allows for further development of the economic costs of nonattainment. As AAMPO continues down the path of implementation, the environmental assessments of key roadway projects will include estimates of emission reduction. In the Potranco case, the estimate was a 72 percent decline in MSAT (or a decline of nearly 60 tons of emissions) to 2040. (Potranco 14). In a report to the U.S. Congress, the Office of Management and Budget (OMB) (2013) estimated that for every $1 in reduced emissions from mobile sources, the public health, consumer savings, productivity and the environment received $9 in benefit - applies to the U.S. economy.[8] If we take this number and apply it to the San Antonio New Braunfels MSA, the 60-ton reduction does not lead to a direct correlation. However, the present cost of pollution is estimated at approximately $40 per ton, therefore 60 tons multiplied by 40 gives us an estimate of $2,400 worth of emission reductions. When multiplied by the OMB estimate then $2,400 x $9 gives us $21,600 benefit to the area. Here again, we see the cost of inaction, which would be a loss of $21,600 (See Technical Support Document, https://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.). In the next section, we elaborate on the issue of emissions reductions for individual vehicles since these are a significant factor in controlling ground-level ozone.

4.2.3. Costs due to Delays in Road Construction

It is possible that the four road construction projects listed in Table 4.16 could be delayed two to three years due to nonattainment as transportation conformity analyses are performed. These road expansions are expected to cost a total of $3,206,000,000 and take five to ten years complete. The delays in starting the construction will mean that the economic activity derived from the construction activity will also be delayed. The following methodology was used to calculate this delayed economic activity.

- It was assumed the projects will take ten years to complete, which will provide the most conservative estimates of annual spending activity. Under this assumption, the total cost of the projects of $3,206,000,000 was divided by ten to get the annual average amount of construction spending that will occur due to these projects.

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[8] See https://www.whitehouse.gov/sites/default/files/omb/inforeg/2013_cb/2013_cost_benefit_report-updated.pdf.

- The construction spending was run through the IMPLAN input-output model for the San Antonio metropolitan area in order to get an estimate of the total impacts on gross regional product this economic activity will have on the regional economy.
  In order to separate out the cost of this delayed economic activity across each county, data were pulled on the private sector employment in the highway, street, and bridge construction industry (NAICS 2373) in each county from the Quarterly Census of Employment and Wages database. For most counties, the employment figures from 2015 were used, as they are the most currently available. However, in Guadalupe, Kendall, and Wilson counties, disclosure rules prevented reporting of the 2015 data, so the most current data reported were used, which was 2014 data for Guadalupe and Kendall Counties and 2012 data for Wilson County. The percentage of employment in this industry in each county relative to the total employment in the metropolitan was calculated and are provided in Table 4.15.
- The average annual GRP was multiplied by two and three to account for the different scenarios under which the delays might occur.
- The GRP was then allocated across the counties according to the proportions given in Table 4.16 to give a cost of the delayed construction in each county.

Table 4.15. Proportion of Highway, Street, and Bridge Construction Employment Relative to Total Industry in MSA

County	*% of Employment*
Atascosa	0.00%
Bandera	0.00%
Bexar	80.37%
Comal	15.37%
Guadalupe	1.50%
Kendall	1.07%
Medina	0.00%
Wilson	1.70%

Table 4.16. Lost GRP due to Road Construction Delays by County (2016 $)

County	*Marginal*	*Moderate*
Atascosa	$0	$0
Bandera	$0	$0
Bexar	$458,580,755	$687,871,132
Comal	$87,677,985	$131,516,978
Guadalupe	$8,574,188	$12,861,282
Kendall	$6,084,907	$9,127,361
Medina	$0	$0
Wilson	$9,680,535	$14,520,802
MSA	**$570,598,370**	**$855,897,555**

4.3. General Conformity Costs

As is widely known, the military and various Department of Defense operations and activities are a very large part of the culture and economy of the San Antonio regional economy. It is the basis for the San Antonio being known as "Military City U.S.A." and the home of military medicine. In 2015, Joint Base San Antonio employed 87,384 military and civilian personnel throughout its various operations. Firms across a wide range of industries throughout the region also received $3.8 billion in contracts through the Department of Defense. The presence of the military bases and vast military medical facilities also attracts a large number of retirees from all branches of the military. There were 56,000 retirees located in the region in 2015 who received $2.4 billion in retirement payments. The combined impact of all of this activity amounts to an annual economic impact of $27.9 billion supporting 209 thousand jobs earning incomes of $12 billion.[9]

If the San Antonio region is deemed to be in nonattainment, the federal government operations in the region, including the military bases, will have to comply with the new regulations to reduce their emissions. These additional costs will put additional pressures on budgets already severely constrained by sequestration. While these additional budgetary pressures may not result in the loss of military missions already present within the area, it is possible that it could cause future

[9] Analysis conducted by Steve Nivin, Ph.D. for the City of San Antonio Office of Military Affairs.

military missions to locate somewhere outside the region. There is no way to know what these future missions might be, so it is impossible to reasonably forecast what the economic cost of losing one of these missions might be.[10]

4.4. Inspection and Repair Costs

Under a moderate nonattainment designation, vehicles that are two to twenty-four years old with light duty or medium duty engines will be required to get on-board diagnostics (OBD) emission inspections done each year. The inspection cost is established by the State of Texas and is currently set at a maximum of $11.50 in El Paso, Travis, and Williamson Counties and $18.50 in Dallas-Fort Worth and Houston. (TX DPS "Cost of Inspection").

These new inspection requirements will impose additional costs on vehicle owners residing within the region. In order to estimate the cost of these inspections, the following assumptions were made.

- Inspection fees will remain at $11.50 and $18.50 over the entire time period of the study (thirty years since these costs only apply under moderate nonattainment). The inspection fee will likely only be a maximum of $11.50 in the San Antonio area, but in order to provide a range of potential costs, the $18.50 fee applicable in the Dallas-Fort Worth and Houston areas was also calculated.
- It is likely that the more rural counties in the San Antonio metropolitan area will only be required to engage in the inspection program, so the costs of the inspections were only calculated for Bexar County.
- Since the eight counties of the San Antonio metropolitan area are linked economically, the overall impacts on gross regional product from the inspection fees were measured across the metropolitan area.

Data on the number of registered vehicles within each county from 2010 through 2015 was provided by the Texas Department of Transportation. An exponential smoothing model was used to project the number of vehicles in Bexar County for the thirty years covered in the analysis.

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[10] These statements are based on communications with Joint Base San Antonio officials.

The inspection fees of $11.50 and $18.50 were multiplied by the projected number of vehicles, and the average annual inspection costs was calculated. This equates to average annual inspection fees in Bexar County of $21.8 million and $35.1 million with the $11.50 and $18.50 inspection fees, respectively.

With the assessment of the additional inspection fees, household spending in the region could be affected as disposable incomes decline, similar to a tax being imposed. The impacts of this potential decline in spending on the regional economy were also estimated. The eight counties of the region are considered to be part of the metropolitan area because they are connected economically. Specifically, the U.S. Office of Management and Budget defines the metropolitan areas "as representing larger regions that reflect broader social and economic interactions, such as wholesaling, commodity distribution, and weekend recreation activities..." (OMB Bulletin No. 15-01, 2). The effects of spending on the inspections is only counted in Bexar County since that is likely the only county where they will be assessed, but because of the economic ties among the eight counties within the San Antonio metropolitan region, it makes sense to focus on the impacts throughout the region instead of only measuring it for Bexar County.

Data on household expenditures in Bexar County for 2015 from ESRI were used to estimate the allocation of spending by households. The annual average amount of spending on the two inspection fees was assumed to reduce the amount of spending across each category based on the proportion of the budget spent on each category. This amount was subtracted from the expenditures to estimate the amount of reduced spending by category. This spending activity was run through the IMPLAN input-output model for the San Antonio metropolitan area, and the difference in the impacts on GRP under the different scenarios provided a measure of the reduction in GRP annually due to the assessment of fees. The GRP was projected over thirty years assuming the same average annual growth rate of 3.1%, which is equivalent to the growth in GRP in the San Antonio metropolitan area from 2001 through 2015.[11] The GRP for each year was multiplied by the proportionate reduction in GRP because of the reduced spending. The total reduction in GRP amounts to $3.4 billion under the inspection fee of $11.50 and $5.4 billion,

[11] U.S. Bureau of Economic Analysis Regional Economic Accounts: https://bea.gov/regional/index.htm

assuming an inspection fee of $18.50. The reduction in GRP that will occur in each county was estimated by multiplying the total reduction in GRP for the metropolitan area by the proportion of population in each county relative to the overall population in the metropolitan area. Table 4.17 shows the projected costs in terms of lost GRP in each county.

Table 4.17. Reductions in GRP due to Inspection Fees (2016 $)

	Inspection Fee per Vehicle	
County	$11.50	$18.50
Atascosa	$71,162,363	$114,478,571
Bandera	$30,931,244	$49,758,953
Bexar	$2,690,438,316	$4,328,095,972
Comal	$175,255,519	$281,932,763
Guadalupe	$214,954,454	$345,796,260
Kendall	$52,997,909	$85,257,498
Medina	$71,799,860	$115,504,110
Wilson	$68,453,702	$110,121,162
MSA	**$3,375,993,367**	**$5,430,945,289**

A portion of these vehicles will not pass the inspection and will require repairs. In the Houston-Galveston-Brazoria and Dallas-Fort Worth areas, 4.0% and 3.9% of the vehicles failed their initial inspections, respectively (ERG 2016, 22). These vehicles will require repairs that typically cost in the range of $200 to $300 per vehicle (ERG 2016b, 33). Assuming a 4.0% failure rate and an average repair of $250, the total costs in repairs in Bexar County is projected to be $656,254,648. However, the spending on repairs is a redistribution of spending from one activity to another, so it will not have a direct effect on GRP, so it is not counted in the overall projected reductions in GRP as was done with the inspection.

4.5. Commute Solutions Program

Commute Solutions is a program that is run by AACOG with the purpose of "educating people about the connection between air quality and transportation, informing them of what they could do differently to use less gas, and offering them viable alternatives to driving as a single occupant in a vehicle" (AACOG 2016, 55). Commute Solutions includes the following programs:

1) *NuRide Carpool Matching and Emissions Reduction Tracking System* – "NuRide is a free, online carpool matching system, contracted to operate in Greater San Antonio by AACOG, through which members who do not have carpool partners can search for them" (AACOG 2016, 60). By recording the trips they make by alternative means of transportation at Nuride.com, members can also receive rewards for their efforts (AACOG 2016, 60).

2) *CARE Program* – CARE is the Certified Auto Ride in case of Emergency program. Through this program, people who commute by alternative means may get up to four cab rides home reimbursed up to $50 per ride if they had to get the ride home to address an emergency situation.

3) *Ozone Action Day Alert Program* – Through this program, AACOG's Air Quality staff sends an email or text message to organizations, individuals, and media who have registered to receive messages about Ozone Action Days, including steps they can take to reduce the health risks and the ozone levels. The public education efforts also include providing materials to local television meteorologists about ozone season and Ozone Action Day Alert banners hung in 353 schools in the area. A series of graphics is also being developed to help educate the public about certain air quality concepts (AACOG 2016, 59-60).

4) *Employer / School Outreach* – The bulk of Commute Solutions' outreach efforts takes place through direct contact with area employers and schools, not only to educate and

inform them of AACOG's Commute Solutions programs, but also to inform employers of the federal commuter benefits of which they could be taking advantage. Commute Solutions staff is available to provide presentations and help establish commuting programs at businesses, agencies, schools, and other organizations.

5) *Fresh Air Friday* – While Commute Solutions staff often exhibit materials at area health, transportation, and environmental events, it also hosts its own informative ozone season kickoff event during March. Fresh Air Friday, which is held during the lunch hour on San Antonio's Main Plaza and is open to the public, encourages downtown employees to bring a brown bag or buy lunch from a nearby restaurant instead of driving out to get their lunches. The ultimate goal is to reduce the number of vehicle miles traveled during the mid-day, as modeling done by AACOG indicates that this will have the greatest impact on reducing ozone concentrations relative to trips in the early morning or evenings (AACOG 2016, 55).

6) *Walk & Roll Challenge* – This is a month-long contest where employees of participating organizations are encouraged to use alternative forms of transportation, such as walking, biking, carpooling, or busing or save trips by telecommuting or using compressed work schedules. Participating employees are eligible for special drawing prizes and the organizations whose employees record the most trips by these modes win the challenge (AACOG 2016, 57).

7) *Air Quality Stewardship Awards* – These annual awards are given to those organizations in the Greater San Antonio area "that have made significant voluntary efforts to reduce air pollution through commuter assistance programs, fleet management, energy efficiency, air quality education, and other means" (AACOG 2016, 58).

8) *Media Interaction* – Press releases, requests for coverage, and public service announcements are issued to various media outlets to help inform the public about the

air quality status and suggestions for best dealing with the current air quality (AACOG 2016, 60).

For purposes of estimating costs, the focus is on the expansion of employee and school outreach to promote transportation alternatives and inform administrators and employees throughout the eight-county metropolitan area of Commute Solutions' programs as well as other existing commuter benefits. More promotion and outreach of this program is expected to help address the nonattainment designation. In order to project the costs of the Commute Solutions across each county, the following methodology was used.

- The per capita cost of the Commute Solutions in the Houston area was calculated using the TxDOT source of funds for the air quality programs of the Houston-Galveston Area Council of $3,006,421 in 2016 (HGAC 2016, 63). The population of the area used was 6,674,880 in 2016.[12] This gives a per capita cost of $0.45.
- The per capita cost was multiplied by the population projections for each year across each county.[13]
- Since the Houston area is in moderate nonattainment, it was assumed that the costs under marginal nonattainment for the San Antonio area would be fifty percent of the full projected costs calculated. The full costs were used for the cost projections under moderate nonattainment.
- The current amount spent on the Commute Solutions programs in the San Antonio region was subtracted from the cost estimate each year in order to capture just the additional cost due to nonattainment.

The costs per county are shown in Table 4.18.

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[12] Texas Demographic Center of the Texas State Demographer: http://osd.texas.gov/Data/TPEPP/Projections/
[13] ibid

Table 4.18. Total Cost of Commute Solutions by County (2016 $)

County	Marginal	Moderate
Atascosa	$315,132	$712,131
Bandera	$123,062	$273,972
Bexar	$11,649,010	$26,279,135
Comal	$792,257	$1,793,836
Guadalupe	$1,003,473	$2,282,960
Kendall	$235,893	$533,650
Medina	$311,687	$702,678
Wilson	$304,882	$688,616
MSA	**$14,735,398**	**$33,266,979**

4.6. Cost of Voluntary Control Measures

4.6.1. Cost of Texas Emissions Reduction Plan

Through the Texas Emissions Reduction Plan (TERP), communities can receive funding to pay for programs that will reduce emissions from transportation sources within the area. These programs include the Diesel Emissions Reduction Incentive Program (DERI), Texas Clean Fleet Program (TCFP), Texas Natural Gas Vehicle Grant Program (TNGVGP), and the Drayage Truck Incentive Program (DTIP).

Based on data provided by TCEQ, San Antonio received $68,061,268 in grants through the DERI program from 2001 through August 2015 and $2,703,326 from the TNGVGP program from 2012-2015. This equates to an average annual amount received of $4,537,418 and $193,095 from the DERI and TNGVGP programs, respectively (TCEQm 2016, 9 and 13). Assuming the community continues to participate in these programs and receives the same amount on average each year, the total cost under marginal nonattainment will amount to $127,723,840, and the total cost under moderate nonattainment will be $141,915,377.

In order to distribute these costs across each of the eight counties in the metropolitan area, it was assumed that the costs in each county will be proportionate to the population level in the county relative to the population in the metropolitan area. Since Bexar, Comal, Guadalupe, and Wilson Counties are already impacted by TERP, so there will not be any additional costs in those counties due to nonattainment. The costs by county are shown in Table 4.19.

Table 4.19. Total Cost of TERP by County

County	Marginal	Moderate
Atascosa	$2,684,743	$2,983,047
Bandera	$1,189,962	$1,322,180
Bexar	$0	$0
Comal	$0	$0
Guadalupe	$0	$0
Kendall	$1,999,801	$2,222,001
Medina	$2,723,919	$3,026,576
Wilson	$0	$0
MSA	**$8,598,425**	**$9,553,804**

4.6.2. Anti-Idling

The City of San Antonio passed an anti-idling ordinance effective as of January 1, 2017.[14] While there are numerous exemptions to the ordinance the basic idea for this ordinance was very clear. Limiting the idling of heavy vehicles reduces the amount of emissions. This ordinance applies to vehicles weighing over 14,000 pounds-the fine for idling is no more than $500 and is classified as a Class C Misdemeanor. The City of San Antonio also adopted an anti-idling ordinance for all city vehicles and equipment (dated August 2016).[15] Bexar County also implemented an anti-idling ordinance, which went into effect in 2016. Additionally, company policy for large-scale warehousing operations such as the Wal-Mart Distribution center in New Braunfels or Union

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[14] This ordinance was sponsored by Councilman Ron Nirenberg. See City of San Antonio Anti-Idling Ordinance at https://www.sanantonio.gov/sustainability/OrdinancesAndGovernance/AntiIdling

[15] The complete ordinance is available at ttps://www.sanantonio.gov/Portals/0/Files/EmployeeInformation/ADs/AD1-3.pdf

Pacific railroad have also adopted policies designed to limit idling.[16] For example, the Wal-Mart Warehouse in New Braunfels requires that all trucks turn off engines while loading or waiting. Additionally, Union Pacific requires that all trains turn off their engines while in the yards within the city.

[16] See Union Pacific Railroad at https://www.up.com/aboutup/environment/operations/index.htm

5. Conclusion

The San Antonio MSA will likely be designated nonattainment of the 2015 ozone NAAQS beginning October 2017. While the classification of nonattainment, such as marginal or moderate, remains to be clarified, it is clear that future economic growth in the greater San Antonio area brings with it future environmental considerations such as ground level ozone pollution. This study has attempted to estimate the economic costs associated with more stringent environmental quality regulations as specified by the EPA, the Clean Air Act, and other legal and regulatory considerations. While every effort has been made to engage with regional stakeholders, many of the economic outcomes contained in this report rely on assumptions based on research contained in public documents and standards represented in reports similar in scope and content -an example being the report prepared for Austin, Texas.

Table 4.20. Annual Potential Costs of Nonattainment by County (Millions 2016 $)

	Marginal		**Moderate**	
County	*Low Estimate*	*High Estimate*	*Low Estimate*	*High Estimate*
Atascosa	$3.0	$22.1	$5.4	$25.9
Bandera	$0.3	$8.6	$1.3	$10.2
Bexar	$79.6	$797.6	$175.6	$948.1
Comal	$14.7	$61.9	$21.6	$72.4
Guadalupe	$15.0	$72.5	$22.3	$84.1
Kendall	$0.8	$15.0	$2.7	$17.9
Medina	$2.5	$21.8	$4.9	$25.7
Wilson	$1.4	$19.7	$3.8	$23.5
Total	**$117.3**	**$1,019.1**	**$237.6**	**$1,207.8**

The implications of increased economic growth in and around San Antonio are clear. The region will see its GRP increase, implying improvement in the overall standard of living of the local population but this will also carry with it the need for greater environmental awareness as industries expand or relocate to and citizenry transits through the area. In very general terms, the costs to the region could range from $117.3 million to $1,019.1 million per year under a marginal nonattainment designation, and under a moderate designation costs are projected to range from $237.6 million to $1,207.8 million per year (Table 4.20). This means that under marginal nonattainment total costs could range from $3.2 billion to $27.5 billion over the entire time period. Under moderate nonattainment, the total costs are projected to range from $7.1 billion to $36.2 billion. Based on interviews with local representatives it is apparent that the largest economic entities have an ongoing interest in the regional air quality and include these analyses as part of their planning. In other words, larger-scale companies do not see the nonattainment designation as a significant negative factor. The same may not be said of small businesses who remain silent and perhaps uninformed on this matter.

In terms of transportation conformity, conversations with local stakeholders suggest that many have already undertaken to include air quality in future planning transportation improvement scenarios. In reviewing the impact of possible scenarios, this study finds that while on-road vehicles play a large part in the ozone issue, there are many plans in place to improve regional transit, which in turn would relieve congestion problems, contributing to the reduction in overall ozone levels. As the MSA grows and its overall economic performance improves there will be a tendency for those individuals benefiting from higher incomes to own more vehicles. This fact is contained in the MPO modeling outcomes. Nevertheless, the AAMPO has a number of transit improvement (construction) projects in its pipeline designed to offer the population alternatives to personal vehicles. For this study, the impact on the individual driver in the region appears to be important as increasingly stringent inspection and maintenance programs could lead to losses in GRP of between $3.4 and $5.4 billion dollars. Here the costs would be associated with more rigorous vehicle inspections and costs associated with remedying any mechanical issues. Regarding transportation projects, extant research suggests that there are minor increases in congestion and pollution during the life of the construction projects but these are offset by the longer-term benefits once the projects have been completed.

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Appendix A

Texas Examples of SIP Requirements for Nonattainment Designation

Table A.1. Example of SIP Requirements for Nonattainment Designation - Marginal
Texas: Ozone-(8-hr, 2008) / Houston-Galveston-Brazoria
(From EPA, 2016e)

SIP Requirement	Deadline	Submittal Date	Latest Action	Date of Latest Action	FR Citation Click to view FR notice
Emission Inventory	07/20/2014	07/18/2014	Approval	04/21/2015	80 FR 9204
Emission Statement	07/20/2014	10/27/1992	Approval	10/25/1994	59 FR 44036
Nonattainment NSR rules – Marginal	07/20/2015	11/13/1992	Approval	11/27/1995	60 FR 49781

Table A.2. Example of SIP Requirements for Nonattainment Designation - Moderate
Texas: Ozone (8-hr, 2008) / Dallas-Fort Worth
(From EPA, 2016e)

SIP Requirement	Deadline	Submittal Date	Latest Action	Date of Latest Action	FR Citation Click to view FR notice
Contingency Measures VOC and NO_x	07/20/2015	07/13/2015	Completeness	01/13/2016	
Emission Inventory	07/20/2014	07/18/2014	Approval	04/21/2015	80 FR 9204
Emission Statement	07/20/2014	10/27/1992	Approval	10/25/1994	59 FR 44036
I/M Basic	07/20/2015	07/13/2015	Completeness	01/13/2016	
Nonattainment NSR rules - Moderate	07/20/2015	11/13/1992	Approval	11/27/1995	60 FR 49781
Ozone Attainment Demonstration	07/20/2015	07/13/2015	Completeness	01/13/2016	
RACT Non-CTG VOC for Major Sources	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT NO_x for Major Sources	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Aerospace	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Auto and Light-Duty Truck Assembly Coatings (2008)	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Bulk Gasoline Plants	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Equipment Leaks from Natural Gas/Gasoline Processing Plants	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Factory Surface Coating of Flat Wood Paneling	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Fiberglass Boat Manufacturing Materials (2008)	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Flat Wood Paneling Coatings (2006)	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Flexible Packaging Printing Materials (2006)	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Fugitive Emissions from Synthetic Organic Chemical Polymer and Resin Manufacturing Equipment	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Graphic Arts - Rotogravure and Flexography	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Industrial Cleaning Solvents (2006)	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Large Appliance Coatings (2007)	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Large Petroleum Dry Cleaners	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Leaks from Gasoline Tank Trucks and Vapor Collection Systems	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Leaks from Petroleum Refinery Equipment	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Lithographic Printing Materials and Letterpress Printing Materials (2006)	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Manufacture of High-Density Polyethylene, Polypropylene, and Polystyrene Resins	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Manufacture of Pneumatic Rubber Tires	07/20/2014	07/13/2015	Completeness	01/13/2016	

RACT VOC CTG Manufacture of Synthesized Pharmaceutical Products	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Metal Furniture Coatings (2007)	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Miscellaneous Industrial Adhesives (2008)	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Miscellaneous Metal Products Coatings (2008)	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Paper, Film, and Foil Coatings (2007)	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Petroleum Liquid Storage in External Floating Roof Tanks	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Plastic Parts Coatings (2008)	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Refinery Vacuum Producing Systems, Wastewater Separators, and Process Unit Turnarounds	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG SOCMI Air Oxidation Processes	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG SOCMI Distillation and Reactor Processes	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Shipbuilding/repair	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Solvent Metal Cleaning	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Stage I Vapor Control Systems - Gasoline Service Stations	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Storage of Petroleum Liquids in Fixed Roof Tanks	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Surface Coating for Insulation of Magnet Wire	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Surface Coating of Automobiles and Light-Duty Trucks	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Surface Coating of Cans	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Surface Coating of Coils	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Surface Coating of Fabrics	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Surface Coating of Large Appliances	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Surface Coating of Metal Furniture	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Surface Coating of Miscellaneous Metal Parts and Products	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Surface Coating of Paper	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Tank Truck Gasoline Loading Terminals	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Use of Cutback Asphalt	07/20/2014	07/13/2015	Completeness	01/13/2016	
RACT VOC CTG Wood Furniture	07/20/2014	07/13/2015	Completeness	01/13/2016	
RFP VOC and NO_x - Moderate	07/20/2015	07/13/2015	Completeness	01/13/2016	

Appendix C

TCEQ Interoffice Memorandum

To: David Brymer, Division Director
Air Quality Division

From: Stephen B. Davis, Manager
Air Modeling & Data Analysis Section

Date: February 16, 2018

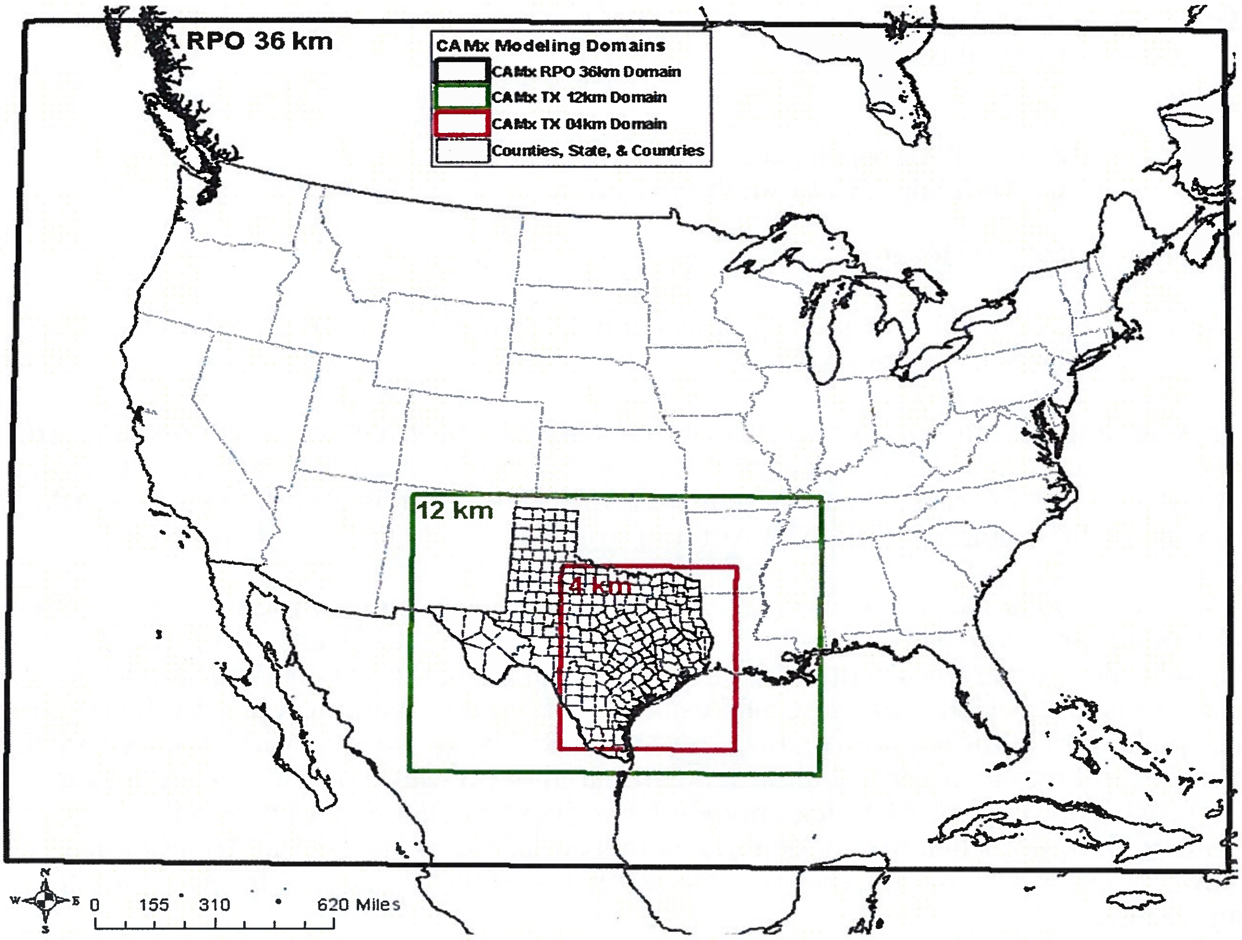
Subject: Review of Available Technical and Scientific Information on Air Quality in the San Antonio Area.

Air Modeling & Data Analysis staff reviewed available information on San Antonio Area ozone air quality to access a greater understanding of local versus transported ozone into the area. This review may help inform future discussions and decisions regarding the air quality planning in the San Antonio Area.

This review included review of several years of applicable monitoring data and ozone precursor emissions and preliminary results of the TCEQ 2017 San Antonio Air Quality Field Study. Numerous scientific papers and research on the impacts of foreign emissions and background were also examined to ascertain applicability to the region's air quality. In addition, information from the U.S. Environmental Protection Agency on background ozone in general and their estimated background ozone levels in Bexar County based on photochemical modeling results were also reviewed. Finally, preliminary photochemical modeling results conducted by the Alamo Area Council of Government were obtained that provide estimates of the impacts of foreign emissions and ozone.

The information below provides a summary of staff's current assessment of the most applicable analysis with the primary focus on the latest photochemical modeling results that provides a clear indication of the significant impact of international emissions and ozone.

Foreign Emissions Impact on San Antonio Area Air Quality
San Antonio area ozone levels are significantly impacted by foreign emissions and ozone (both from natural sources as well as anthropogenic sources). Specifically, photochemical modeling recently performed by the Alamo Area Council of Government indicates that emissions from these foreign sources contribute more than 20 ppb of ozone to San Antonio during those days with eight-hour ozone levels over 60 ppb. As shown in the table below, this estimate is based on source apportionment modeling that calculates how much ozone each region contributes to the ozone concentrations at each of the two ozone monitors (Continuous Air Monitors C23 and C58) in the San Antonio area with the highest ozone levels. In this table, the boundary and international region represents the ozone contribution from emissions originating in Mexico and Canada, as well as those emissions outside the model's geographic boundary. The figure below shows that this modeling boundary, marked as the CAMx RPO 36 km Domain, is at least 200 miles away from any continental U.S. border and it is therefore reasonable to assume that emissions and ozone outside this boundary did not originate within the continental United States.



Ozone Contribution in the San Antonio Area, Maximum 8-hour Ozone on Days > 60 ppb of Ozone, 2017

Region	C23		C58	
	ppb	Percentage	ppb	Percentage
Boundary and International	23.02	38%	24.05	38%
Texas	22.54	37%	22.93	37%
Other US States	15.66	26%	15.64	25%
Total	61.22	100%	62.61	100%

Source: International Contribution to Local Ozone in the San Antonio-New Braunfels MSA, 2017, APCA Run of Photochemical Modeling by the Alamo Area Council of Governments for first half of the modeling episode.

In addition, the U.S. Environmental Protection Agency recognizes the significant impact of non-US anthropogenic emissions on locally measured ozone levels and released a

white paper in December 2015 – *Implementation of the 2015 Primary Ozone NAAQS: Issues Associated with Background Ozone.*
https://www.epa.gov/ozone-pollution/background-ozone-workshop-and-information

This white paper includes results of EPA's own modeling that estimates background ozone in 2017.
Some notable items from the paper:

- The EPA recognizes that, periodically, in some locations in the U.S., sources other than domestic manmade emissions of ozone (O3) precursors can contribute appreciably to monitored O3 concentrations.
- The EPA considers background O3 to be any O3 formed from sources or processes other than U.S. manmade emissions of nitrogen oxides (NOx), volatile organic compounds (VOC), methane (CH4), and carbon monoxide (CO). It is referred to as U.S. Background or USB.

Because of the limitations in quantifying USB contributions solely from monitoring data, photochemical grid models have been widely used to estimate the contribution of background sources to observed surface O3 levels.

EPA source apportionment modeling concluded that across the 178 eastern U.S. counties with design values that exceeded 70 ppb for the 2012-2014 period, the average fractional contribution of U.S. manmade emissions to O3 design values was estimated to be 64%, with a low of 39% for Bell County, TX. The average contribution for background sources for Eastern states (which includes Texas) is 36%
For Bexar County, the model estimates that in 2017 49% percent of the ozone would be from manmade U.S. sources and 36% from state sources. **While the report is silent on the remaining 15%, this data suggests that background ozone contributes approximately 10 ppb of a design value of 72 ppb in 2017.**

Please let me know if you have questions or concerns.