BAKER BOTTS L.L.P.

ONE SHELL PLAZA
910 LOUISIANA
HOUSTON, TEXAS
77002-4995

TEL +1 713.229.1234
FAX +1 713.229.1522
www.bakerbotts.com

ABU DHABI
AUSTIN
BEIJING
DALLAS
DUBAI
HONG KONG
HOUSTON
LONDON
MOSCOW
NEW YORK
PALO ALTO
RIYADH
WASHINGTON

November 19, 2009

Kathleen E. Weir
TEL +1 713.229.2108
FAX +1 713.229.7908
kathleen.weir@bakerbotts.com

BY ELECTRONIC FILING

Environmental Protection Agency
1200 Pennsylvania Ave. NW
Washington, D.C. 20460-0001
oei.docket@epa.gov

Re: Docket ID No. EPA-R06-OAR-2006-0133, NSR Reform, Nonattainment NSR for the 1997 8-Hour Ozone Standard, and Standard Pollution Control Project, 74 *Fed. Reg.* 48,467 (Sept. 23, 2009)

The Texas Industry Project ("TIP") appreciates the opportunity to provide comments on the Environmental Protection Agency's ("EPA") proposed disapproval of Texas's State Implementation Plan ("SIP") submittals relating to New Source Review ("NSR") reform by the U.S. Environmental Protection Agency ("EPA"). TIP is a coalition of 62 companies in the chemical, refining, oil and gas, oilfield services, electronic, forest projects, terminal, electric utility and transportation industries with operations in Texas. TIP members have been strong supporters of clean air improvements, and have made unprecedented investments in emission controls that have resulted in sustained, measured improvements in Texas air quality.

TIP strongly supports full approval of the Texas NSR reform provisions and definitions, including 30 TAC Chapter 116, Subchapter C regarding plant-wide applicability limits ("PALs"). TIP further supports full approval of the minor NSR state pollution control project ("PCP") standard permit codified at 30 TAC § 116.617. Texas implements a comprehensive, integrated set of pre-construction and operating permit rules. The rule revisions pending EPA review will strengthen this program.

While EPA has identified concerns with the pending revisions, the Texas Commission on Environmental Quality ("TCEQ") has laid out an effective framework for resolving EPA's approval concerns. TIP members support TCEQ's on-going efforts to resolve EPA's remaining issues. The Texas air quality permitting program is one of the most comprehensive and protective programs in the country. The Texas NSR rules are equivalent to or more stringent than the federal rules. Thus, TIP urges EPA to work expeditiously with TCEQ to approve the revisions pending review.

Sincerely,

Kathleen E. Weir

Attachment

HOU02:1185835.2

November 23, 2009

TIP COMMENTS ON EPA PROPOSED DISAPPROVAL OF TCEQ NSR REFORM SUBMITTAL

Docket ID No. EPA–R06–OAR–2006–0133
74 *Fed. Reg.* 48,467 (Sept. 23, 2009)

The Texas Industry Project ("TIP") submits the following comments in response to the proposed disapproval of Texas's state implementation plan ("SIP") submittals relating to New Source Review ("NSR") reform by the U.S. Environmental Protection Agency ("EPA") and published in the *Federal Register* on September 23, 2009. TIP is comprised of 62 companies in the chemical, refining, oil and gas, electronics, forest products, terminal, electric utility, and transportation industries with operations in Texas.[1]

I. Introduction

TIP strongly supports full approval of the Texas NSR reform provisions and definitions, including 30 TAC Chapter 116, Subchapter C regarding plant-wide applicability limits ("PALs"). TIP further supports full approval of the minor NSR state pollution control project ("PCP") standard permit codified at 30 TAC § 116.617. The Texas air quality permitting program is stringent, comprehensive and protective of both the environment and public health.

Under Texas's integrated air permitting regime, air quality in the state is demonstrating strong, sustained improvement. Between 1999 and 2005, NO_X emissions in the Houston-Galveston area decreased from almost 1,200 tons per day, to under 600 tons per day.[2] Ozone as measured under the one-hour standard in the Houston-Galveston area has declined from 220 parts per billion ("ppb") in 1991 to 127 ppb in 2009.[3] Under the eight-hour standard,

---

[1] TIP members participating in these comments are: Albemarle Corporation, Arkema Inc., Ascend Performance Materials LLC, BASF Corporation, BP, Celanese Chemicals, Ltd., CenterPoint Energy Houston Electric, LLC, Chevron Corporation, Chevron Phillips Chemical Company LP, CITGO Petroleum Corporation, ConocoPhillips, DCP Midstream, LLC, Degussa Engineered Carbons, LP, Delek Refining Ltd., Dixie Chemical Company, Inc., Dow Chemical Company, The Dynegy Inc., Eagle Rock Energy, Eastman Chemical Company, E. I. Du Pont de Nemours & Company, Entergy Texas, Enterprise Products Operating LLC, Exelon Power Texas, ExxonMobil Chemical Company, Firestone Polymers, LLC, GB Biosciences Corporation, Halliburton Company, Huntsman Corporation, INEOS NOVA LLC, Intercontinental Terminals Company, International Paper Company, International Power, Kinder Morgan Liquids Terminals, LLC, LANXESS Corporation, LBC Houston, LP, Lyondell Chemical Company, Marathon Petroleum Company LLC, MeadWestvaco Corporation, Merisol USA, L.L.C., NRG Texas Power LLC, Occidental Chemical Corporation, Odfjell Terminals (Houston) LP, Oiltanking Holding USA, Inc., Pasadena Refining System, Inc., PL Propylene, Praxair, Inc., Rohm and Haas Texas, Incorporated, Shell Oil Company, Shintech, Inc., Sterling Chemicals, Inc., Stolthaven Houston Inc., Suez Energy North America, TARGA, Temple-Inland Inc., Texas Instruments Incorporated, Texas Petrochemicals LP, Total Petrochemicals USA, Inc., Union Pacific Railroad Company, Valero Energy Corporation, Vopak Logistics North America, Inc., Western Refining Co., L.P.

[2] Susana M. Hildebrand, TCEQ Chief Engineer, *Update of Air Quality in Texas* (presented at Oct. 29, 2009 Commission Work Session, and available at TCEQ.com), 13 (attached as Exhibit 1).

[3] *Id.* at 13.

ozone in the Houston-Galveston area has declined from 119 ppb in 1991, to 84 ppb in 2009.[4] Moreover, between 1988 and 2008, there has been an 80% reduction in VOC compound indicators in the Houston area.[5] There has been a similar improvement in toxic air emissions. Between 2003 and 2008, there has been a 50% decrease in highly reactive volatile organic compounds ("HRVOCs") in the Houston area.[6] Similarly, in the Dallas-Fort Worth area, ozone as measured under the one-hour standard declined from 140 ppb in 1991 to 115 ppb in 2009.[7] Ozone for the Dallas-Fort Worth area under the eight-hour standard has declined from 105 ppb in 1991 to 86 ppb in 2009.[8] Notably, according to recent TCEQ review, all areas of Texas are in attainment for nitrogen dioxide, sulfur dioxide, and carbon monoxide.[9]

Further, the data show that stationary sources have contributed more substantial emissions reductions than any other category during the period of most dramatic air quality improvements. In the Houston-Galveston area between 1993 and 2008, NO_X emissions from stationary sources declined from 695 tons per day ("tpd"), to 156 tpd, a decrease of 539 tpd.[10] During that same period, emissions from on-road source declined from 416 tpd to 175 tpd, a decrease of 241 tpd.[11] Similarly, stationary sources made significant decreases for VOC. Between 1993 and 2009 in the Houston-Galveston area, VOC emissions from stationary sources decreased from 411 tpd, to 170 tpd, a decrease of 241 tpd.[12] On-road sources from that same period decreased from 199 tpd, to 86 tpd, a decrease of 113 tpd.[13] As the figures indicate, stationary sources in Texas have made the most significant strides in reducing emissions.

The submitted revisions strengthen a previously SIP-approved Texas program. Under the federal Clean Air Act ("CAA" or "Act"), SIP revisions are approved when those revisions do not interfere with the attainment of the National Ambient Air Quality Standards ("NAAQS"). States have the primary responsibility for developing plans for the attainment and maintenance of the NAAQS. In fact, as the Fifth Circuit recently explained:

> Although EPA is required to approve SIPs that provide for the timely attainment and subsequent maintenance of primary and secondary ambient air standards as well as satisfy other CAA general requirements, *see* 42 U.S.C. § 7410(a)(3), the EPA has no authority to question the wisdom of a

---

[4] *Id.*

[5] Houston Regional Monitoring, *Annual Average Trends for VOC Indicator Compounds for HRM Network from 1988 through 2008* (attached as Exhibit 2).

[6] Houston Regional Monitoring, *Total HRVOC Network Average Concentrations: Houston Ship Channel PAMS-GC Monitoring Sites* (attached as Exhibit 2).

[7] *Id.* at 16.

[8] *Id.*

[9] Susana M. Hildebrand, TCEQ Chief Engineer, *Update of Air Quality in Texas* (Oct. 29, 2009), 10.

[10] *Compare* TEXAS NAT'L RES. CONSERVATION COMM'N, *Revision to the State Implementation Plan (SIP) for the Control of Ozone Air Pollution: Post-1999 Rate-of-Progress and Attainment Demonstration SIP for the Houston/Galveston Ozone Nonattainment Area*, (Dec. 2000), at 2-5 (attached as Exhibit 3); *with* TEXAS COMM'N ON ENVIRONMENTAL QUALITY, *Revision to the State Implementation Plan for the Control of Ozone Air Pollution: Houston-Galveston-Brazoria 1997 Eight-Hour Ozone Standard Nonattainment Area* (Sept. 23, 2009), at 2.3-2.5 (attached as Exhibit 4).

[11] *Id.*

[12] *Id.*

[13] *Id.*

> State's choices of emission limitations if they are part of a SIP that otherwise satisfies the standards set forth in 42 U.S.C. §7410(a)(2).[14]

Rather, the proper test for determining whether a SIP revision can be approved is whether the revision interferes with attainment of the NAAQS (*i.e.* that the plan does not make air quality worse).[15] The last ten years have seen an unprecedented improvement in Texas air quality. The submitted revisions have been fully integrated components of the Texas air quality permitting program for all that time. Because the current SIP submittals function to *strengthen* the existing SIP, such submittal does not raise interference concerns, and should be fully approved.

The Texas NSR rules track closely the federal NSR rules. In instances where the Texas provisions depart from the exact wording of the federal rules, Texas has justified those departures. The Texas NSR rules and associated rules are equivalent to the federal rules and should be approved.

II. Substance of Asserted Deficiencies NSR Reform

EPA's concerns on specific aspects of the Texas NSR reform are reproduced and addressed below. Headings are for convenience only—all comments are intended to address all aspects of EPA's proposal.

A. PAL Provisions

1. A PAL should only apply to existing sources with two years of operation.

EPA Comment:

- "*The submittal lacks a provision which limits applicability of a PAL only to an existing major stationary source, and which precludes applicability of a PAL to a new major stationary source.*"

TIP Response:

The absence of a reference to "existing" facilities is not grounds for disapproval of the Texas PAL rules. Even absent a reference to existing facilities, the Texas PAL rules are substantively similar to and closely track the federal PAL regulations, as the TCEQ explained in adopting the Texas PAL program.[16] The Texas PAL rules' applicability provisions are consistent with the federal PAL program in 40 CFR Part 51, and should be approved as part of the Texas SIP on that basis.

Moreover, the federal scheme contemplates that "new" units may be included when calculating the baseline actual emissions for a PAL. In the 2002 preamble to the NSR

[14] *Clean Coalition v. TXU Power*, 536 F.3d 469, 472 (5th Cir. 2008).
[15] *Galveston-Houston Assoc. for Smog Prevention v. EPA*, 289 Fed. Appx. 745, 754 (5th Cir. 2008).
[16] *See* 31 Tex. Reg. 516, 527 & 528 (Jan. 27, 2006).

reform rulemaking in which the final PAL rules were introduced, EPA explained how a PAL is to be determined: "You must first identify all your existing emissions units (greater than 2 years of operating history) and new emissions units (less than 2 years of operating history since construction.)"[17] The preamble goes on to provide, "For any emission unit . . . that is constructed after the 24-month period, emissions equal to its PTE must be added to the PAL level."[18]

Additionally, EPA issued PALs before NSR reform and these PALs showed a degree of flexibility tailored to the specific sites. For example, in its flexible permit pilot study, EPA examined a hybrid PAL issued to the Saturn plant in Spring Hill, Tennessee.[19] This permit consisted of PSD permit for a major expansion with permitted emissions based on projected future actual emissions in combination with a PSD permit for existing emissions units with allowable emissions based on current actual emissions at the existing emissions units. According to EPA, that plant's hybrid PAL permit enabled Saturn to add and modify new lines "in a timely manner, while ensuring that best available pollution control technologies are installed and that air emissions remain under approved limits."[20]

Texas's PAL provisions are consistent with the federal PAL provisions, and so should be approved. EPA concerns regarding the TCEQ's implementation of the Texas rules are properly addressed through comments on individual permits, and not through a disapproval of the SIP revision.

2. PAL provisions should track the federal PAL reopening requirements.

EPA Comment:

- *"The submittal has no provisions that relate to PAL re-openings, as required by 40 CFR 51.165(f)(8)(ii), (ii)(A) through (C), and 51.166(w)(8)(ii) and (ii)(a)."*

TIP Response:

The current provisions of 30 TAC § 116.192 regarding amendments and alterations of PALs provide adequate safeguards to ensure that appropriate procedural requirements are followed, both to increase a PAL through an amendment and to decrease a PAL through a permit alteration. *See, e.g.,* 30 TAC § 116.190(b), requiring the decrease of a PAL for any emissions reductions used as offsets. The absence of rule language using the specific term "reopening" does not prevent the TCEQ from implementing and enforcing the program in a manner consistent with Part 51 and is not an appropriate basis for disapproval of the SIP revision. The Texas PAL rules should be approved as a revision to the Texas SIP.

---

[17] 67 *Fed. Reg.* 80,186, at 80,208 (Dec. 31, 2002).
[18] *Id.*
[19] EPA Office of Air Quality Planning and Standards & EPA Office of Policy, Economics and Innovation, *Evaluation of Implementation Experiences with Innovative Air Permits: Results of the U.S. EPA Flexible Permit Implementation Review*, 15 (attached as Exhibit 5).
[20] *Id.* at 45.

3. PAL provisions should track the federal monitoring requirements.

EPA Comment:

- *"Nor is there a mandate that failure to use a monitoring system that meets the requirements of this section renders the PAL invalid."*

TIP Response:

EPA's concern on this issue is not the absence of monitoring requirements in the rules. It is, rather, about the absence of an explicit statement that a PAL is invalid absent monitoring. This minor language issue does not rise to the level of requiring a disapproval.

The Texas PAL rules make clear that monitoring is mandatory for a PAL. The rules establish monitoring requirements in 30 TAC § 116.186(c) that are consistent with the federal PAL monitoring requirements. Most importantly, the monitoring requirements are cast in terms of requirements that ***shall*** be met. Examples include:

- § 116.186(c)(1): "The PAL monitoring system ***must*** accurately determine all emissions of the PAL pollutant in terms of mass per unit of time."[21]

- § 116.186(c)(2) further specifies requirements that ***shall*** be met for any permit holder using mass balance equations, continuous emissions monitoring system ("CEMS"), continuous parameter monitoring system ("CPMS") predictive emissions monitoring system ("PEMS"), or emission factors.[22]

These provisions adequately address the monitoring requirements required under the federal PAL provisions. Any additional statement that the PAL is rendered invalid unless the permit holder complies with these requirements is unnecessary in light of the clearly mandatory monitoring requirements that are equivalent to federal requirements.

4. All facilities at a major stationary source should be included in the PAL.

EPA Comment:

- *"The Texas submittal at 30 TAC 116.186 provides for an emissions cap that may not account for all of the emissions of a pollutant at the major stationary source. Texas requires the owner or operator to submit a list of all facilities to be included in the PAL see 30 TAC 116.182(1), such that not all of the facilities at the entire*

[21] 30 TAC § 116.186(c)(1).
[22] 30 TAC § 116.186(c)(2).

major stationary source may be specifically required to be included in the PAL."

TIP Response:

EPA's interpretation of the Texas PAL rules, which are consistent with the federal PAL, is not grounds for disapproval of the SIP revision. The Texas PAL rules are substantively similar to and closely track the federal PAL regulations, as the TCEQ explained in adopting the Texas PAL program. EPA concerns regarding the TCEQ's implementation of the Texas rules are properly addressed through comments on individual permits and not through a disapproval of the SIP revision.

The Texas rules require that applicants for a PAL specify the facilities and pollutants to be covered by the PAL. Specifically, an applicant must detail:

> [A] list of all facilities, including their registration or permit number to be included in the PAL; their potential to emit, and the excepted maximum capacity. In addition, the owner or operator of the source shall indicate which, if any, federal or state applicable requirements, emission limitations, or work practices apply to each unit.[23]

This requirement closely tracks the federal provisions.

Moreover, logic dictates, and the federal rules recognize, that not every facility emits every regulated pollutant. Under the federal rules "[e]ach PAL shall regulate emissions of only one pollutant."[24]

Additionally, EPA has recognized that states may implement PAL programs in a more limited manner. In its 1996 proposal for the PAL concept, EPA noted:

> States may choose . . . to adopt the PAL approach on a limited basis. For example, States may choose to adopt the PAL approach only in attainment/unclassifiable areas, or only in nonattainment areas, for ***specified source categories***, or only for certain pollutants in these areas.[25]

The Texas PAL provisions track the federal regulations, and so should be approved.

5. The federal definition of "baseline actual emissions" should be used.

[23] 30 TAC § 116.182.
[24] 40 CFR § 52.21(aa)(4)(e).
[25] 61 *Fed. Reg.* 38,250, at 38,265 (July 23, 1996) (emphasis added).

EPA Comment:

- *"The submitted definition of the term 'baseline actual emissions' found at 30 TAC 116.12(3)(A), (B), (D), and (E) differs from the Federal definition by providing that the baseline shall be calculated as 'the rate, in tons per year at which the unit actually emitted the pollutant during any consecutive 24-month period.'"*

TIP Response:

The substance of EPA's concern appears to be that the Texas rules are missing the word "average." The missing term is not grounds for disapproval of the Texas definition of "baseline actual emissions." The omission of the term "average" from this phrase in the § 116.12(3) definition does not render the definition invalid or inconsistent with the equivalent provision in 40 CFR Part 51. EPA cites a distinction without a substantive difference, as application of the two definitions will reach the same conclusion with regard to the tons per year ("tpy") emission rate over the 24-month baseline period. The Texas definition of "baseline actual emissions" in the proposed SIP revision is equivalent to the federal definition in this regard and should be approved.

6. PAL permits should be issued with 30-day public notice and comment.

EPA Comment:

- *"[T]here is no provision that PALs be established, renewed, or increased through a procedure that is consistent with 40 CFR 51.160 and 51.161, including the requirement that the reviewing authority provide the public with notice of the proposed approval of a PAL permit and at least a 30-day period for submittal of public comment, consistent with the Federal PAL rules at 40 CFR 51.165(f)(5) and (11) and 51.166(w)(5) and (11)."*

- *"For PALs for existing major stationary sources, there is no requirement that the State address all material comments before taking final action on the permit, consistent with 40 CFR 51.165(f)(5) and 51.166(w)(5). 3) The applicability provision in section 39.403 does not include PALs, despite the cross-reference to Chapter 39 in Section 116.194."*

TIP Response:

EPA appears to be concerned that there is not an explicit reference to PALs in the public participation provisions. The Texas rules make clear that PALs are subject to public notice and participation. The absence of a reference to PALs in the applicability section of 30

TAC § 39.403 is not significant. Section 116.194 of the PAL rules provides the clear cross-references to the applicable provisions of Chapter 39.[26] A reference back from Chapter 39 to the PAL rules is redundant and unnecessary, and not grounds for disapproval of the Texas PAL rules.

7. The federal PAL monitoring definitions must be included.

EPA Comment:

- *"The State also failed to include the following specific monitoring definitions: "Continuous emissions monitoring system (CEMS)" as defined in 40 CFR 51.165(a)(1)(xxxi) and 51.166(b)(43); "Continuous emissions rate monitoring system (CERMS)" as defined in 40 CFR 51.165(a)(1)(xxxiv) and 51.166(b)(46); "Continuous parameter monitoring system (CPMS)" as defined in 40 CFR 51.165(a)(1)(xxxiii) and 51.166(b)(45); and "Predictive emissions monitoring system (PEMS)" as defined in 40 CFR 51.165(a)(1)(xxxii) and 51.166(b)(44). All of these definitions concerning the monitoring systems in the revised Major NSR SIP requirements are essential for the enforceability of and providing the means for determining compliance with a PALs program."*

TIP Response:

EPA appears to be concerned that the monitoring provisions are not separately and discretely defined. The Texas PAL rules in 30 TAC § 116.194(c) contain monitoring requirements that are equivalent to the federal PAL rules. The absence of definitions of CEMS, CERMS, CPMS and PEMS does not render the rules unenforceable. The rules themselves identify and define each type of monitoring system, and identify federal-equivalent requirements that each monitoring system must satisfy. For example:

> An owner or operator using a continuous emission monitoring system (CEMS) to monitor PAL pollutant emissions shall meet the following requirements.
>
> (i) The CEMS must comply with applicable performance specifications found in 40 Code of Federal Regulations Part 60, Appendix B.
>
> (ii) The CEMS must sample, analyze, and record data at least every 15 minutes while the emissions unit is operating.[27]

Similar requirements are included for mass balance calculations, CPMS, PEMS and emissions factors used to monitor PAL pollutant emissions. The absence of separate definitions does not

[26] 30 TAC § 116.194.
[27] 30 TAC § 116.192(c)(2)(B).

impact the enforceability of Texas PALs. The Texas provisions adequately address monitoring requirements for PALs, and should therefore be approved.

B. Non-PAL NSR Reform

1. The Definition of "facility" should be limited to an emissions unit.

EPA Comment:

- *"The submitted NNSR non-PAL rules do not explicitly limit the definition of 'facility' to an 'emissions unit' as do the submitted PSD non-PAL rules."*

TIP Response

The term "facility" is defined in Chapter 116 and in the Texas Clean Air Act, and is used in a consistent manner throughout. The term has identical meaning in the NNSR non-PAL rules and the PSD non-PAL rules. Any failure to "explicitly limit the definition" in one part of Chapter 116 is not grounds for disapproval, given the well-established definition of "facility" in the context of Texas air permitting and that it is comparable to the federal definition of "emissions unit."

TCEQ regulations in 30 TAC § 116.10(6) defines a facility as:

> A discrete or identifiable structure, device, item, equipment, or enclosure that constitutes or contains a stationary source, including appurtenances other than emission control equipment. A mine, quarry, well test, or road is not a facility.

30 TAC § 116.10(6). Section 116.10 states that the definitions contained in the section apply to ***all*** uses throughout Chapter 116. 30 TAC § 116.10 ("[T]he following words and terms, when used in this chapter, shall have the following meanings, unless the context clearly indicates otherwise.")

This definition is similar to the definition of "emission unit" in Texas's Title V rules. There, "emissions unit" is defined as:

> A discrete or identifiable structure, device, item, equipment, or enclosure that constitutes or contains a stationary source, including appurtenances other than emission control equipment.

30 TAC § 122.10(8). Under the express terms of § 116.10, the definition of "facility" is clear, and is equivalent to the federal definition of "emission unit" in the nonattainment NSR non-PAL rules, as it is throughout Chapter 116.

2. **The definition of "baseline emission" and "projected annual emission" should include startups, shutdowns and malfunctions.**

EPA Comment:

- *The definition of the term "baseline actual emissions," as submitted in 30 TAC 116.12(3)(E), does not require the inclusion of emissions resulting from startups, shutdowns, and malfunctions.*

TIP Response:

The Texas rules' treatment of startups, shutdowns and malfunctions is not a proper basis for disapproval of the proposed SIP revision. The federal and Texas definitions both require that non-compliant emissions be excluded from the determination of baseline actual emissions.[28] Based on the Texas rules' integration of pending Chapter 101 revisions on MSS emissions (as requested by EPA), the proposed SIP revision's treatment of MSS emissions is a reasonable approach.

EPA has approved rules for baseline calculations that exclude some of the elements they assert should be included in the Texas's definition. For example, Georgia's PSD regulations give applicants the option of excluding malfunction emissions from the calculation of baseline emissions.[29] In approving this approach, EPA noted "The intent behind this optional calculation methodology is that it may result in a more accurate estimate of emission increases. The federal rules allow for some flexibility, and EPA supports EPD's analysis that the Georgia rule is at least as stringent as the federal rule."[30] Similarly, Texas's approach to the baseline calculation attempts for a more accurate estimate of emissions.

Moreover, TCEQ is underway in permitting maintenance, startup and shutdown ("MSS") emissions through Chapter 116 preconstruction permits, and a SIP revision reflecting the MSS permitting initiative has been submitted to EPA for approval. The TCEQ is distinguishing between planned and unplanned MSS emissions, and working to authorize those planned MSS emissions in Texas air permits. It is reasonable and appropriate that the MSS permitting initiative be properly integrated with the definition of "baseline actual emissions." The proposed SIP revision recognizes that such emissions may be added to the baseline in the future, based on TCEQ's ongoing process of authorizing MSS emissions. The proposed SIP revision and the TCEQ's current approach is sound and reasonable based on historical treatment of MSS emissions in Texas air permits, and is not grounds for disapproval of the proposed SIP revision.

---

[28] 30 TAC 116.12(3)(D) ("The actual rate shall be adjusted downward to exclude any non-compliant emissions that occurred during the consecutive 24-month period.")
[29] GA. COMP. R. & REGS. 391-3- 1-.02(7)(a)2.(ii)(II)II (2009).
[30] 73 *Fed. Reg.* 51,606, at 51,609 (Sept. 4, 2008).

3. **The federal definition of "baseline actual emissions should be used."**

EPA Comment:

- *"The Federal definition of the "baseline actual emissions" provides that these emissions must be calculated in terms of "the average rate, in tons per year at which the unit actually emitted the pollutant during any consecutive 24-month period." The submitted definition of the term "baseline actual emissions" found at 30 TAC 116.12 (3)(A), (B), (D), and (E) differs from the Federal definition by providing that the baseline shall be calculated as "the rate, in tons per year at which the unit actually emitted the pollutant during any consecutive 24-month period."*

TIP Response:

As stated earlier, the omission of the term "average" is not grounds for disapproval of the Texas definition of "baseline actual emissions." The omission of the term "average" from this phrase in the § 116.12(3) definition of does not render the definition invalid or inconsistent with the equivalent provision in 40 CFR Part 51. EPA cites a distinction without a substantive difference, as application of the two definitions will reach the same conclusion with regard to the tons per year ("tpy") emission rate over the 24-month baseline period. The Texas definition of "baseline actual emissions" in the proposed SIP revision is equivalent to the federal definition in this regard and should be approved.

III. Substance of Asserted Deficiencies One-Hour Nonattainment NSR

1. **The revisions do not meet the anti-backsliding Major Nonattainment NSR SIP Requirements for the 1-hour Ozone NAAQS.**

EPA Comments:

- *"The footnote 6 and the introductory paragraph add a new requirement for an affirmative regulatory action by the EPA on the reinstatement of the 1-hour ozone NAAQS major nonattainment NSR requirements before the major nonattainment NSR requirements under the 1-hour standard come will be implemented in the Texas 1-hour ozone."*

- *"The currently approved Texas major nonattainment NSR SIP does not require such an affirmative regulatory action by the EPA before the 1-hour ozone major nonattainment NSR requirements come into effect in the Texas 1-hour ozone nonattainment areas."*

TIP Response:

The cited provisions of the Texas rules regarding the 1-hour/8-hour transition are neither inconsistent with the CAA, nor the court's decision in *South Coast.* With its remand to EPA following vacatur of parts of the Phase 1 transition rule, the *South Coast* court did not offer specific direction concerning implementation of the backsliding requirements as they apply to NSR. However, the court in its Opinion on Petitions for Rehearing "urged" EPA "to act promptly in promulgating a revised rule that effectuates the statutory mandate by implementing the eight-hour standard . . . ." *South Coast Air Quality Mgmt. Dist. v. EPA*, 489 F.3d 1245, 1248-49 (D.C. Cir. 2007).

Consistent with the court's direction in *South Coast,* the language of CAA § 172(e) suggests that EPA must take definite action to implement anti-backsliding requirements:

> If the Administrator relaxes a national primary ambient air quality standard . . . the Administrator *shall, within 12 months after the relaxation, promulgate requirements* applicable to all areas which have not attained that standard as of the date of such relaxation. Such requirements shall provide for controls which are not less stringent than the controls applicable to areas designated nonattainment before such relaxation.

42 U.S.C. § 7502(e) (emphasis added). An October 2007 memorandum from EPA Deputy Administrator Robert Meyers stated that EPA intends to undertake rulemaking to conform the Agency's NSR regulations to the *South Coast* decision. However, EPA has not yet proposed such a rule. The footnote 6 and introductory paragraph cited in EPA's proposed disapproval are consistent with CAA § 172(e) and not a basis for disapproval of the proposed SIP revision.

2. The revision uses the incorrect applicability date under EPA's Major NSR rules.

EPA Comments:

- *"The rule, adopted and submitted in 2005, applies the date of administrative completeness of a permit application, not the date of permit issuance, where setting the date for determination of NSR applicability after June 15, 2004 (the effective date of ozone nonattainment designations). The submitted 2006 rule adds the date of permit issuance. Unfortunately, the submitted 2006 rule by introducing a bifurcated structure creates vagueness rather than clarity."*

- *"[T]o the extent that the date of application completeness is used in certain instances to establish the applicability date, such use is contrary to the Act and EPA's interpretation thereof."*

TIP Response:

The applicability cutoff established in the TCEQ rules is not inconsistent with the CAA or EPA rules. While it may be inconsistent with EPA's interpretation of that rule language, the use of application completeness as an applicability date is not inconsistent with Part 51 itself. As a result, the applicability cutoff dates established in 30 TAC § 116.150(a) are not appropriate grounds for disapproval of the proposed SIP revision. EPA concerns regarding applicability dates are properly addressed through comments on individual permits, and not through a disapproval of the SIP revision.

IV. Pollution Control Project Standard Permit

1. A standard permit cannot address site-specific determinations.

EPA Comment:

- *"A Standard Permit provides a streamlined mechanism with all permitting requirements for construction and operation of certain sources in categories that contain numerous similar sources. It is not a case-by-case minor NSR SIP permit. Therefore, each minor NSR SIP Standard Permit must contain all terms and conditions on the face of it (combined with the SIP general requirements) and it cannot be used to address site-specific determinations."*

TIP Response:

The Pollution Control Project ("PCP") standard permit does contain on its face all requirements applicable to its use.[31] The rule requires that a permittee make a submittal to TCEQ, but does not require the Executive Director to act to approve the submittal. Under the rules, if the Executive Director does not act, the authorization under the permit stands. Review by the Executive Director is not to make case-by-case determination, but rather to review for impacts on air quality and disallow use if air quality would be negatively impacted.[32] This is an important distinction. The Texas PCP permit is more stringent than a program that lacks a discretionary denial provision.

Moreover, the PCP is a minor NSR authorization. The CAA does not establish requirements for a state's minor NSR programs. The federal regulations that govern minor NSR programs at 40 CFR §§ 51.160-.164 provide states great flexibility in establishing SIP-approvable minor NSR programs. Indeed, EPA's Environmental Appeals Board ("EAB") has recognized the flexibility provided states in establishing a non-PSD, non-nonattainment NSR permitting program, noting that federal requirements do not mandate a particular minor NSR applicability methodology or test.[33]

---

[31] *See* 30 TAC § 116.617(d).
[32] 30 TAC § 116.617(a)(3)(B).
[33] *In re Tennessee Valley Authority*, 9 EAD 357, 461 (EAB Sept. 15, 2000).

In light of this flexibility, the Texas PCP standard permit is an acceptable part of the state's minor NSR SIP. Notably, EPA cites no statutory authority or provision of Part 51 in suggesting a bar on approval of general or standard permits. The manner in which the TCEQ implements the PCP standard permit is reasonable and practical, and a decision to reject the PCP standard permit is a decision to reject an important minor NSR tool used by Texas sources to authorize environmentally beneficial projects in an expedited fashion. Site-specific traditional NSR permitting for such projects is impractical, inefficient and detrimental to the environment.

2. A standard permit must be limited to a single source category.

EPA Comment:

- *"An individual Standard Permit must be limited to a single source category, which consists of numerous similar sources that can meet standardized permit conditions."*

TIP Response:

As noted above, states have great flexibility in establishing the requirements of a minor NSR SIP. In light of this flexibility, the manner in which the TCEQ has defined the PCP standard permit is an acceptable part of the Texas minor NSR SIP. Notably, EPA cites no statutory authority or provision of Part 51 in suggesting a bar on approval of general or standard permits or for limiting the PCP standard permit to a single source category. The manner in which the TCEQ has defined pollution control projects is reasonable and practical, and a decision to reject the PCP standard permit is a decision to reject an important minor NSR tool used by Texas sources to authorize environmentally beneficial projects in an expedited fashion. Narrowing the scope of projects that can qualify for the expedited standard permit approval (or requiring the TCEQ to promulgate source category-specific PCP standard permits for every source category in Texas) is impractical, inefficient and detrimental to the environment.

3. The Executive Director's discretion is not properly limited.

EPA Comment:

- *"There are no replicable conditions in the PCP Standard Permit that specify how the Director's discretion is to be implemented for the individual determinations. Of particular concern is the provision that allows for the exercise of the Executive Director's discretion in making case-specific determinations in individual cases in lieu of generic enforceable requirements. Because EPA approval will not be required in each individual case, specific replicable criteria must be set forth in the Standard Permit establishing equivalent emissions rates and ambient impact."*

TIP Response

TIP reiterates the comments from Section IV.1 above. Review by the Executive Director is not to make case-by-case determination, but rather to review for impacts on air quality and disallow use if air quality would be negatively impacted. The Texas PCP permit is more stringent than a program that lacks a discretionary denial provision. Also, as noted above, states have great flexibility in establishing the requirements of a minor NSR SIP. In light of this flexibility, the discretion granted the TCEQ Executive Director in making case-specific determinations regarding pollution control projects under the PCP standard permit is an acceptable part of the Texas minor NSR SIP. Notably, EPA cites no statutory authority or provision of Part 51 in suggesting a bar on approval of general or standard permits or for limiting the Executive Director's discretion in implementing the PCP standard permit.

V. The removal of the incorporation by reference of the federal PSD definition of BACT.

EPA Comments:

- *"The 2006 submittal also removed from the State rules, the PSD SIP requirement at 40 CFR 52.21(r)(4). . . [This revision provides that] if a project becomes a major stationary source or major modification solely because of a relaxation of an enforceable limitation on the source or modification's capacity to emit a pollutant, then the source or modification is subject to PSD applies as if construction had not yet commenced."*

- *"As the mechanism in Texas for ensuring that permits contain such a requirement, the State PSD SIP must both require BACT and apply the federal definition of BACT (or one that is more stringent) to be approved pursuant to part C and Section 110(l) of the Act."*

TIP Response:

Texas submitted a revision to 30 TAC 116.160(a) and a new section 116.160(c)(1) and (2) on February 1, 2006, as a SIP revision to the Texas PSD SIP. This SIP revision reorganized the earlier SIP-approved rules.

Prior to the currently-reviewed revisions, Texas had incorporated by reference certain provisions of 40 CFR 52.21. The current SIP-approved rule was adopted by the State on October 10, 2001, and EPA approved this recodified SIP rule citation on July 22, 2004.[34]

Since 1972, Texas has correctly imposed a control technology review on applications for an air quality permit.[35] Section 382.0518(b)(1) of the Texas Clean Air Act

[34] 69 *Fed. Reg.* 43,752 (July 22, 2004).
[35] *See* TACB, Regulation VI § I(B)(2) (July 5, 1972).

("TCAA") requires that "the proposed facility for which a permit, permit amendment, or a special permit is sought will use at least the best available control technology, considering the technical practicability and economic reasonableness of reducing or eliminating the emissions from the facility."[36] This requirement is echoed in Section 116.111(a)(2)(C) of TCEQ's rules, which requires that "the proposed facility utilize BACT, with consideration given to the technical practicability and economic reasonableness of reducing or eliminating the emissions from the facility." [37]

The term BACT has been defined by TCEQ in strict accordance with the statutory BACT requirement in the TCAA. Specifically, 30 TAC § 116.10(3) defines BACT as "BACT with consideration given to the technical practicability and the economic reasonableness of reducing or eliminating emissions from the facility." The TCEQ has stated that this definition shall apply to all use of the term "BACT" in Chapter 116 of its rules, unless the context clearly indicates otherwise.[38]

The Texas regulations have continuously carved out 40 CFR 52.21(j), concerning control technology review, which is the federal BACT requirement, from the Texas PSD regulations. This is true from 1992 when EPA first granted authority to Texas to administer PSD permitting. As part of the 1992 approval, EPA explained why the federal control technology review requirement of Section 52.21(j) could be properly excluded by Texas under the federal Clean Air Act. EPA explained:

> This provision of the Federal PSD regulations has been excluded from the TACB Regulation VI because the TACB claims that the Texas Clean Air Act and the existing State regulations have provisions for application of BACT as stringent as the Federal requirements in reviewing the permit applications. The EPA review of the Texas Clean Air Act and Regulation VI (Sections 116.3(a)(3) through 116.3(a)(5)) *have indeed revealed that existing TACB permit requirements meet the provisions of the Federal PSD regulations . . . .*[39]

EPA then stated in the final rule approving the Texas PSD program that the federal control technology review requirement, which requires BACT for PSD applications, was "not necessary for approval of the Texas Program."[40]

The preamble to the 2006 revisions to §116.160 in which the incorporations by reference of 40 CFR 52.21 were changed, demonstrate a consistency with the approach taken by the State in the preceding years. The preamble explains the incorporation by reference of certain

[36] TEX. HEALTH & SAFETY CODE § 382.0518(b)(1).
[37] 30 TAC § 116.111(a)(2)(C).
[38] 30 TAC § 116.10.
[39] 54 *Fed. Reg.* 52,824-25 (Dec. 22, 1989) (emphasis added).
[40] 57 *Fed. Reg.* 28,093-94 (June 24, 1992).

sections of 40 CFR 52.21 and further states, "[o]ther definitions used for the PSD program or visibility in Class I areas program are currently in [TCEQ's] rules."[41]

The appropriate BACT definition exists in Texas's rules, as demonstrated by EPA's past approval of those rules. All permits Texas has issued under the existing permitting program reflect the current TCEQ SIP-approved approach to BACT, and are valid and enforceable.

VI. Conclusion

TIP strongly supports full approval of existing Texas NSR provisions and pollution control standard permit. The Texas permitting program, including these provisions, is stringent, comprehensive and protective of both the environment and public health. Additionally, the Texas NSR rules track closely the federal NSR rules. In instances where the Texas provisions depart from the exact wording of the federal rules, Texas has justified those departures. The Texas NSR rules and associated rules are equivalent to the federal rules and should be approved.

[41] 31 *Tex. Reg.* 519 (Jan. 27, 2006).

EXHIBIT 1

Update of Air Quality in Texas

Susana M. Hildebrand, P.E.

Chief Engineer

Update of Air Quality in Texas

- Air Toxics
- National Ambient Air Quality Standards (NAAQS)
- Permitting Actions to Improve Air Quality in Texas
- Ongoing Activities
- Air Quality Challenges
- Ongoing Efforts

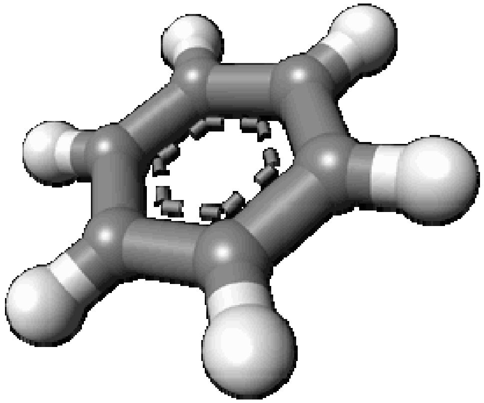
Air Toxics

- Effects Screening Levels
- Benzene
- Butadiene
- Air Pollutant Watch List

Effects Screening Levels

- New guidelines November 2006
  – External scientific peer review by panel of international experts
  – Two rounds of public comments
- Used in air permitting and for evaluating air monitoring data.
- Currently, 28 ESLs have been derived using the new process.

Benzene



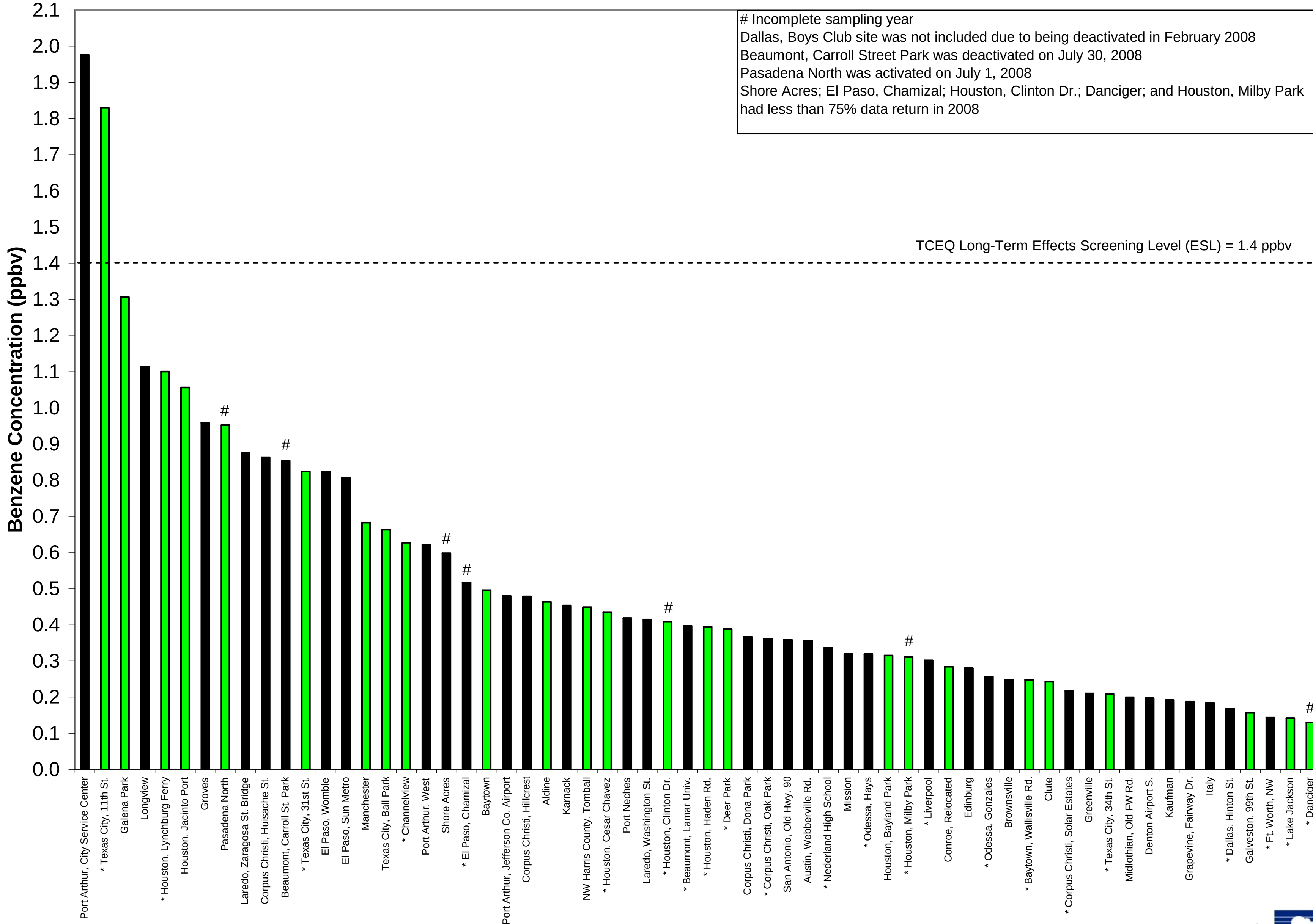
- Risk-driver for Texas and U.S.
- Wide variety of emission sources
- Representative of other chemicals

- In 2008, **no** monitors in Harris County were above the long-term ESL for benzene

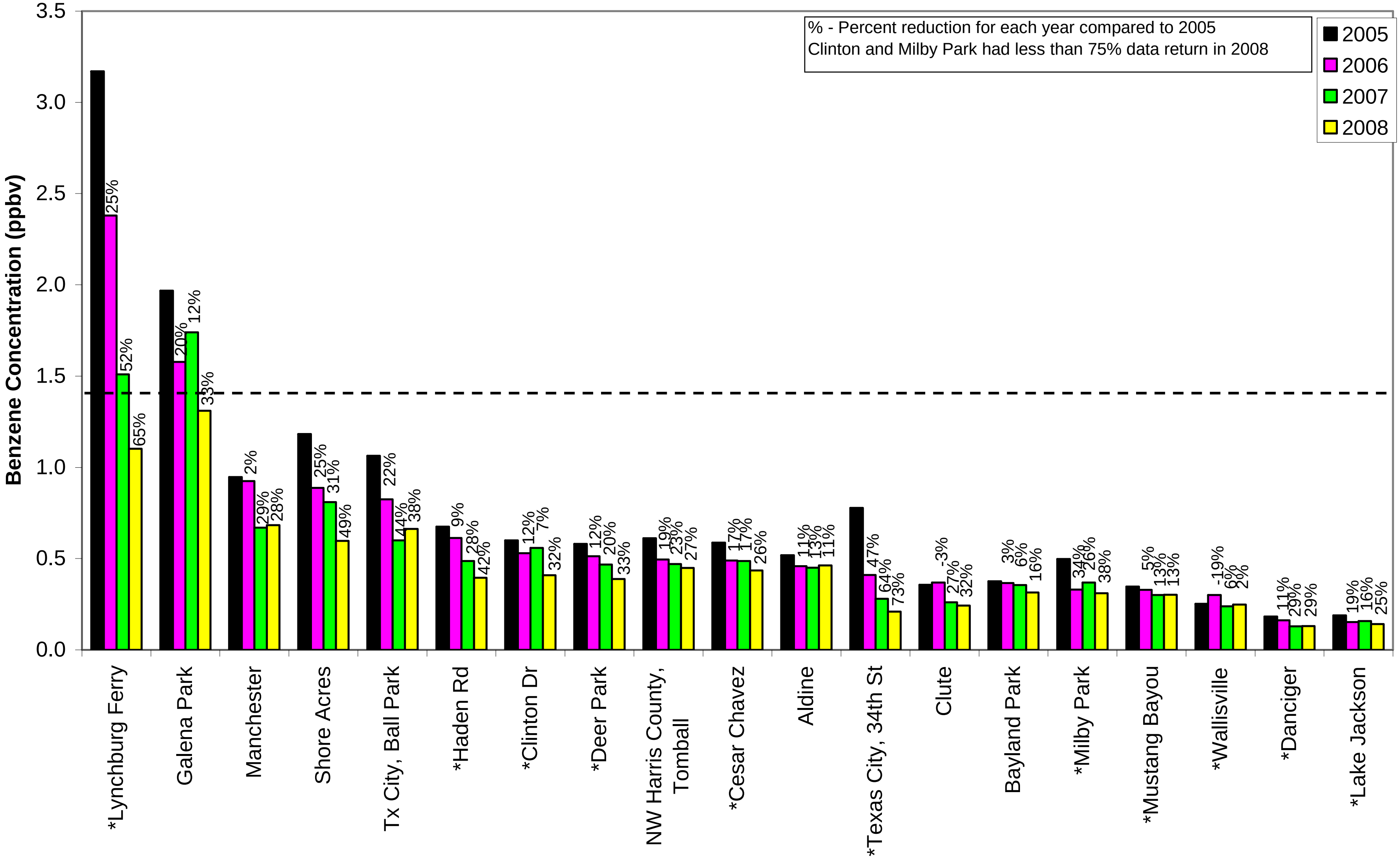
- **All monitors** in the Houston Region showed a **decrease** in average benzene concentration from 2005-2008

2008 Average Benzene Concentrations at Air Monitoring Sites in Texas

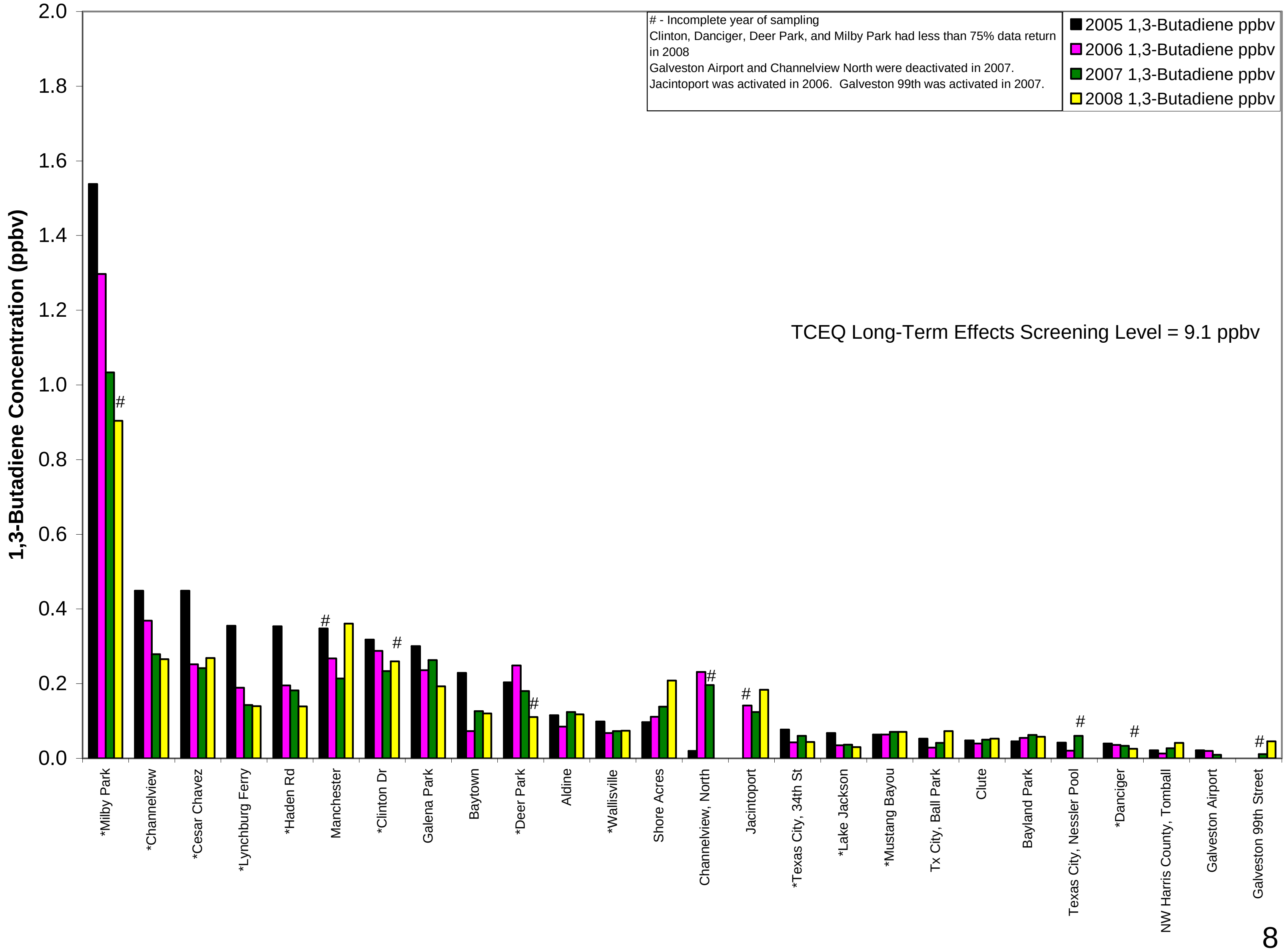
(Values shown are arithmetic means of 5329 to 7594 hourly autoGC measurements where available*; otherwise arithmetic means of 45 to 61 canister samples.)



Annual Average Benzene Levels at Selected Harris and Galveston County Sites, 2005-2008
(based on hourly autoGC data if available*; otherwise every-sixth-day 24-hour canister data)

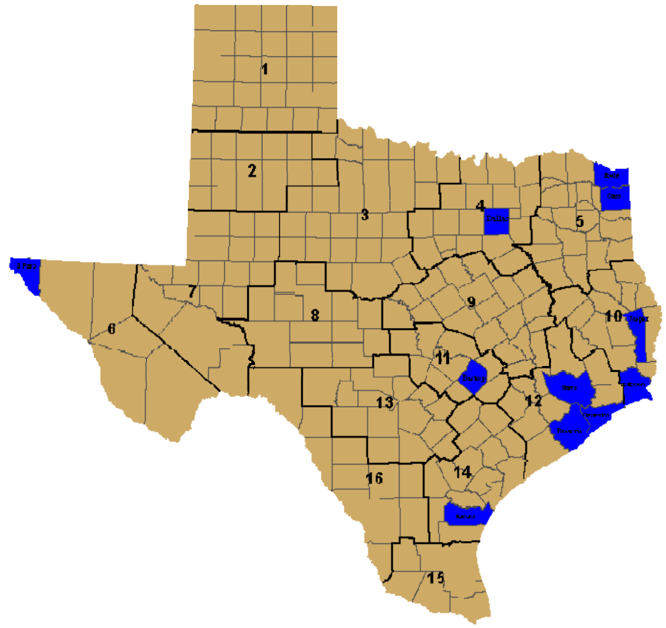


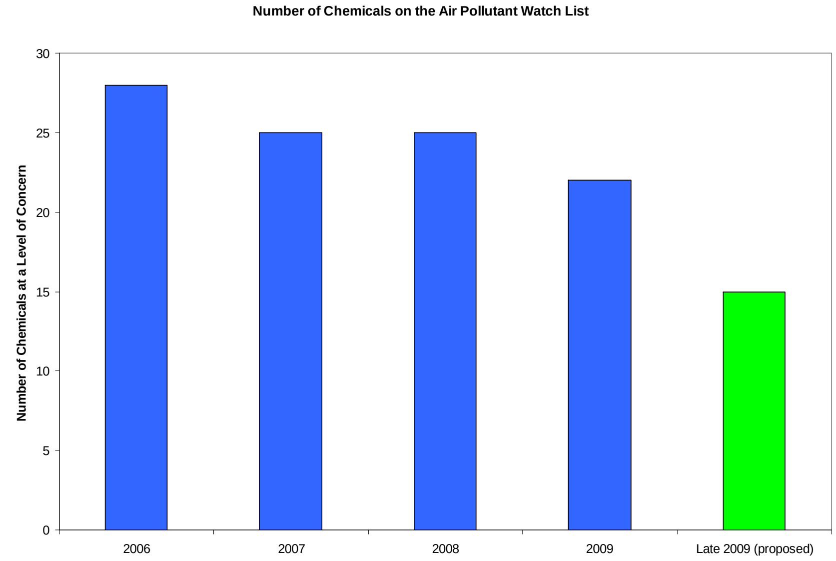
Annual Average 1,3-Butadiene Levels at Harris and Galveston County Sites, 2005-2008
(based on hourly autoGC data if available*; otherwise every-sixth-day 24-hour canister data)



Air Pollutant Watch List

- Currently, there are 12 APWL areas in 11 counties
- Over the last 2 years, 6 pollutants have been removed
- 7 more pollutants in 5 APWL areas are proposed to be removed later this year

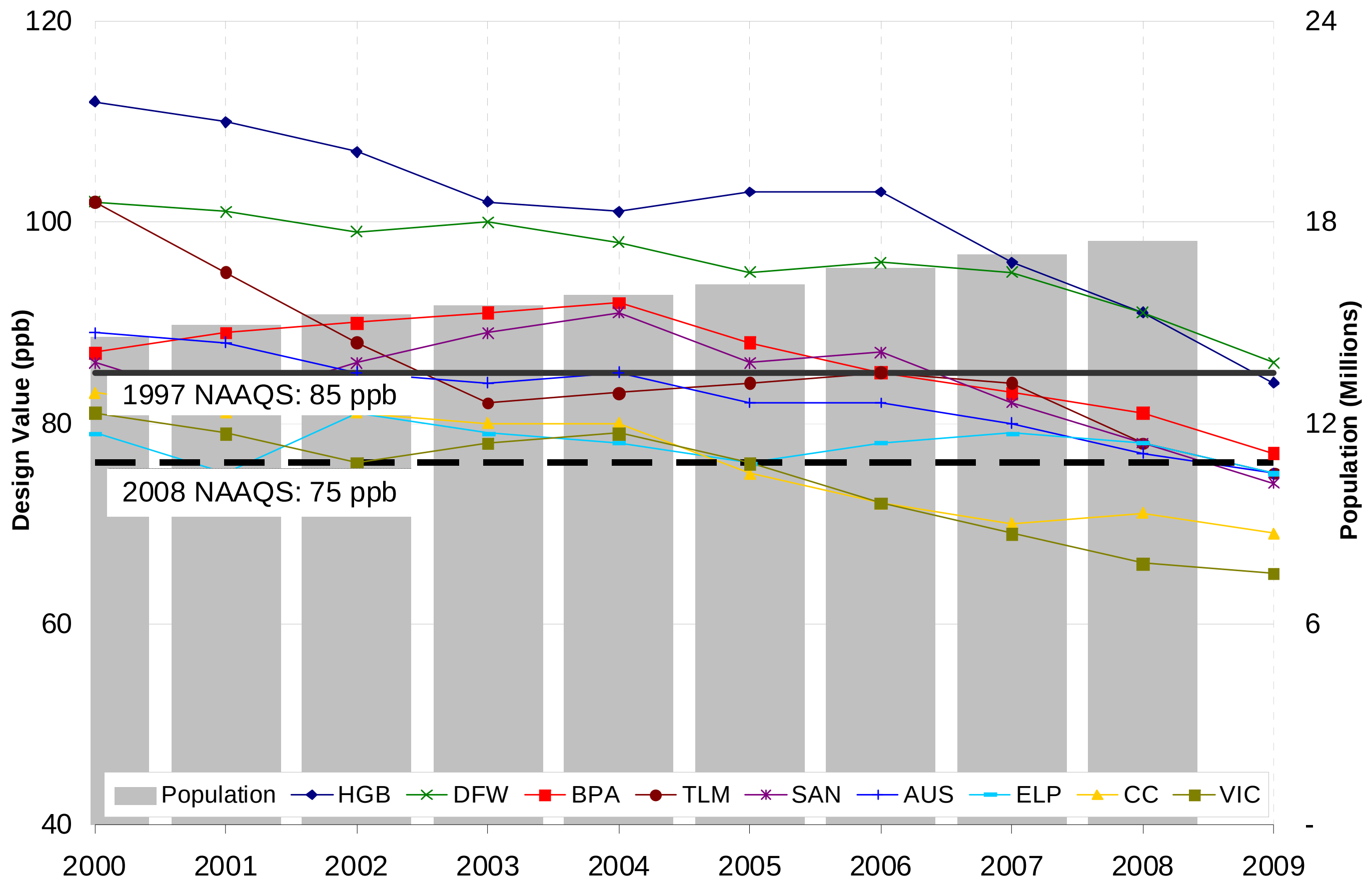




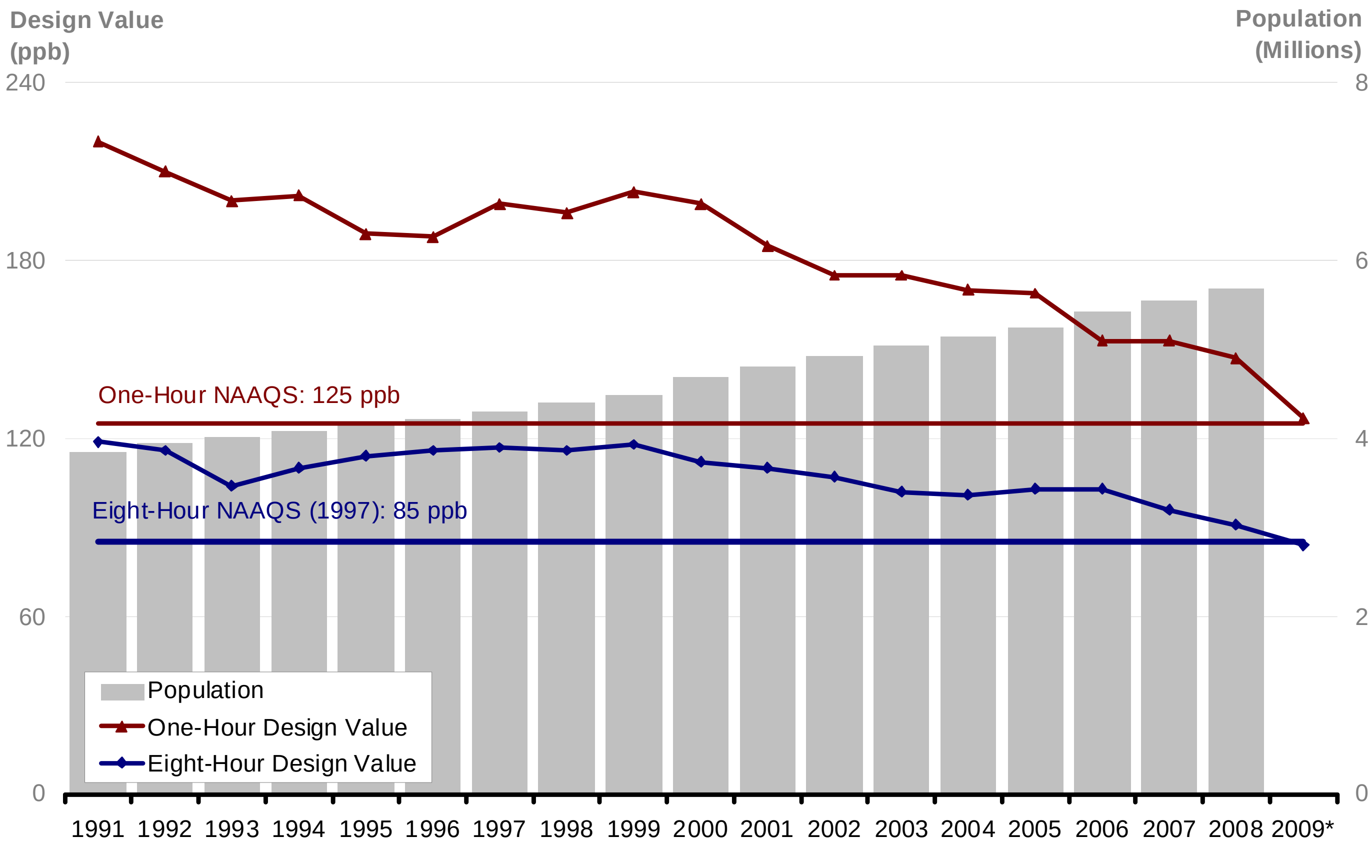
National Ambient Air Quality Standards (NAAQS)

- Ozone (1997 Standard - 0.08 parts per million)
  - Houston-Galveston-Brazoria
  - Dallas-Fort Worth
  - Beaumont-Port Arthur (redesignation request pending approval)
- Particulate Matter
  - El Paso County for PM_{10}
- Lead
  - A portion of Collin County in the Dallas-Fort Worth Area
- Nitrogen Dioxide
  - All areas attainment
- Sulfur Dioxide
  - All areas attainment
- Carbon Monoxide
  - All areas attainment

Texas Eight-Hour Ozone Design Value and Population Trends 2000-2009

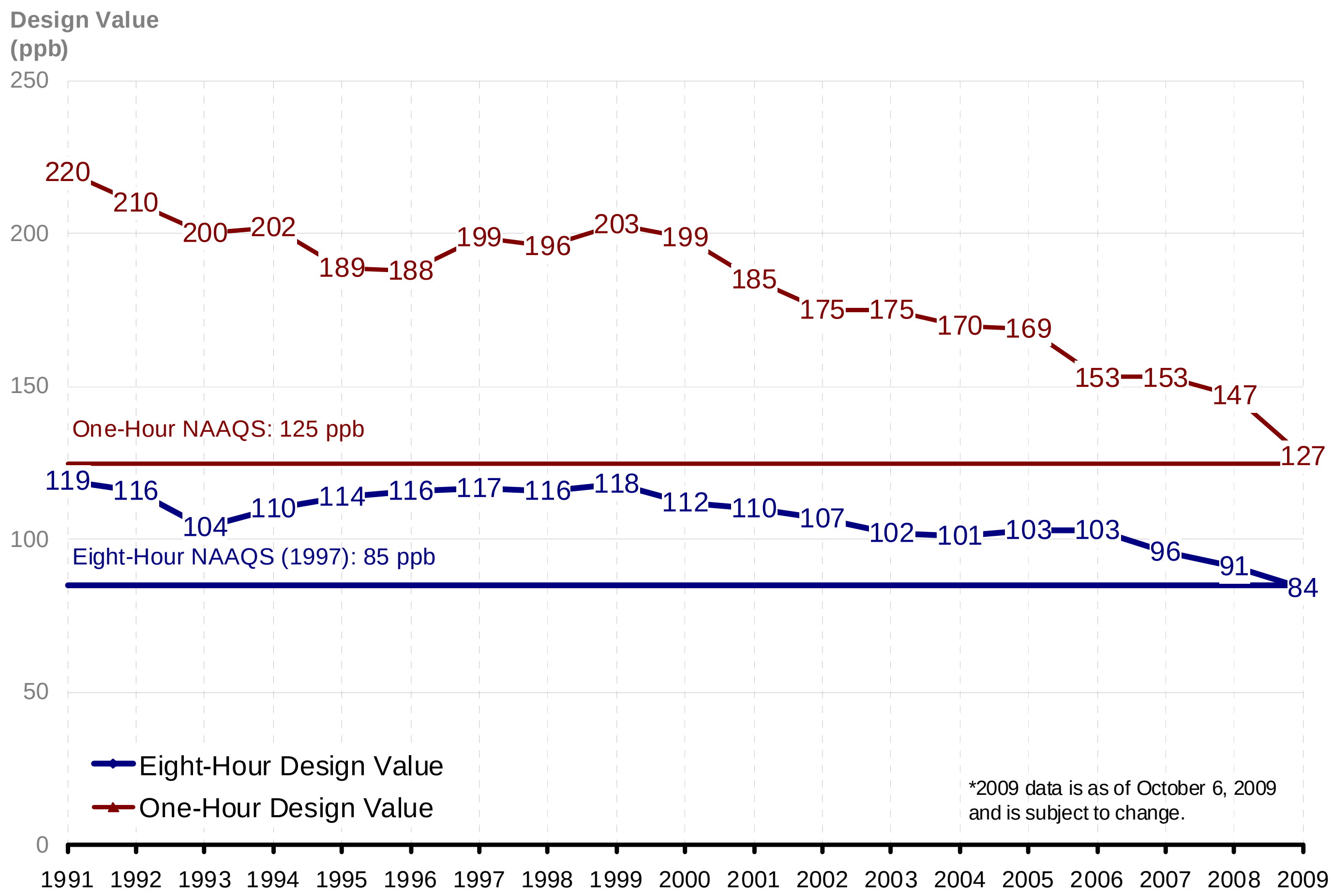


HGB Ozone Design Value and Population Trends 2000-2009

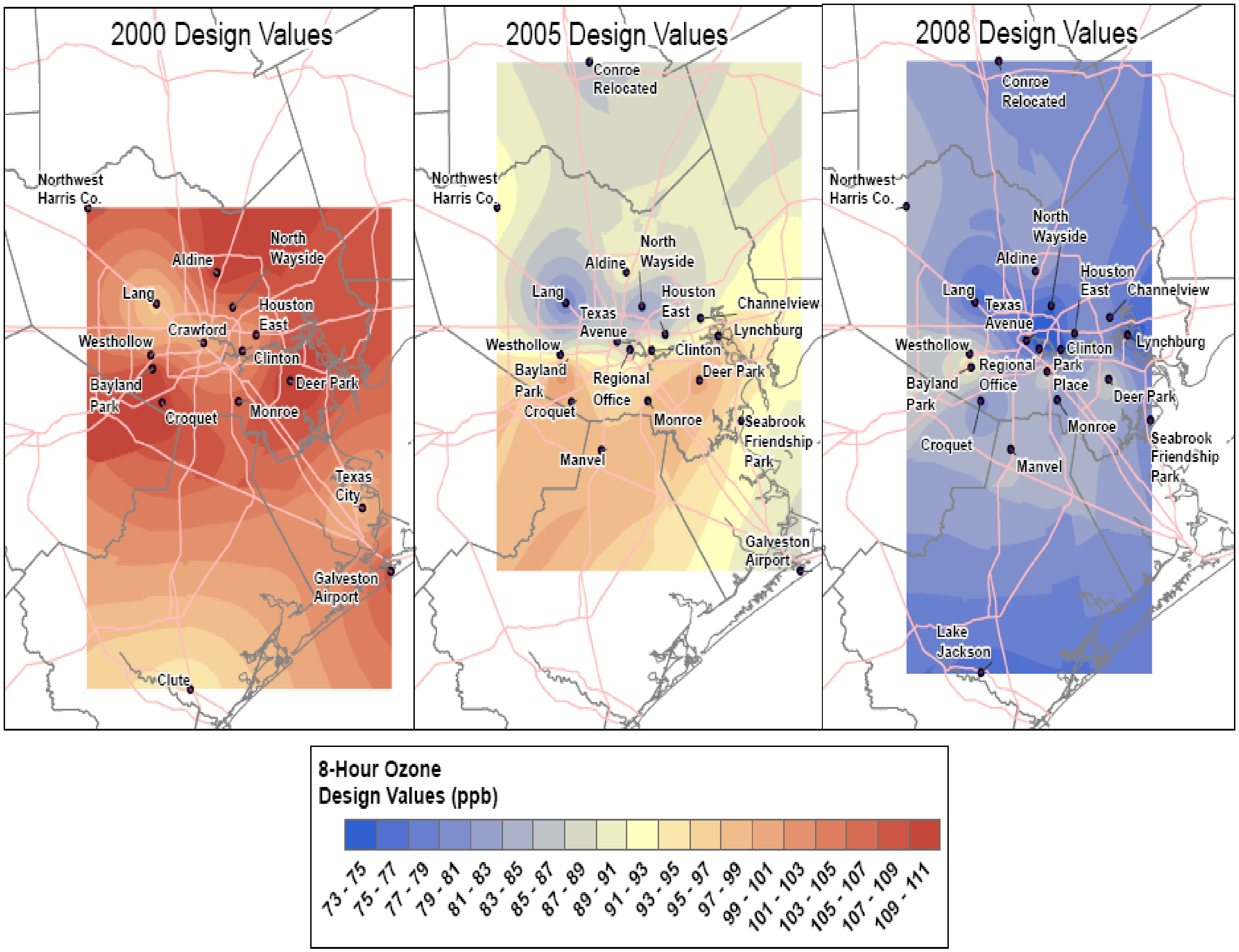


*Source: Ozone – EPA's AQS database.
1991-2008 Population --http://www.census.gov/popest/archives/1990s/MA-99-03b.txt and http://www.census.gov/popest/counties/CO-EST2008-popchg2000_2008.html
2009 Data is current as of October 6, 2009 and is subject to change. 2009 population data will not be available until June 2010.

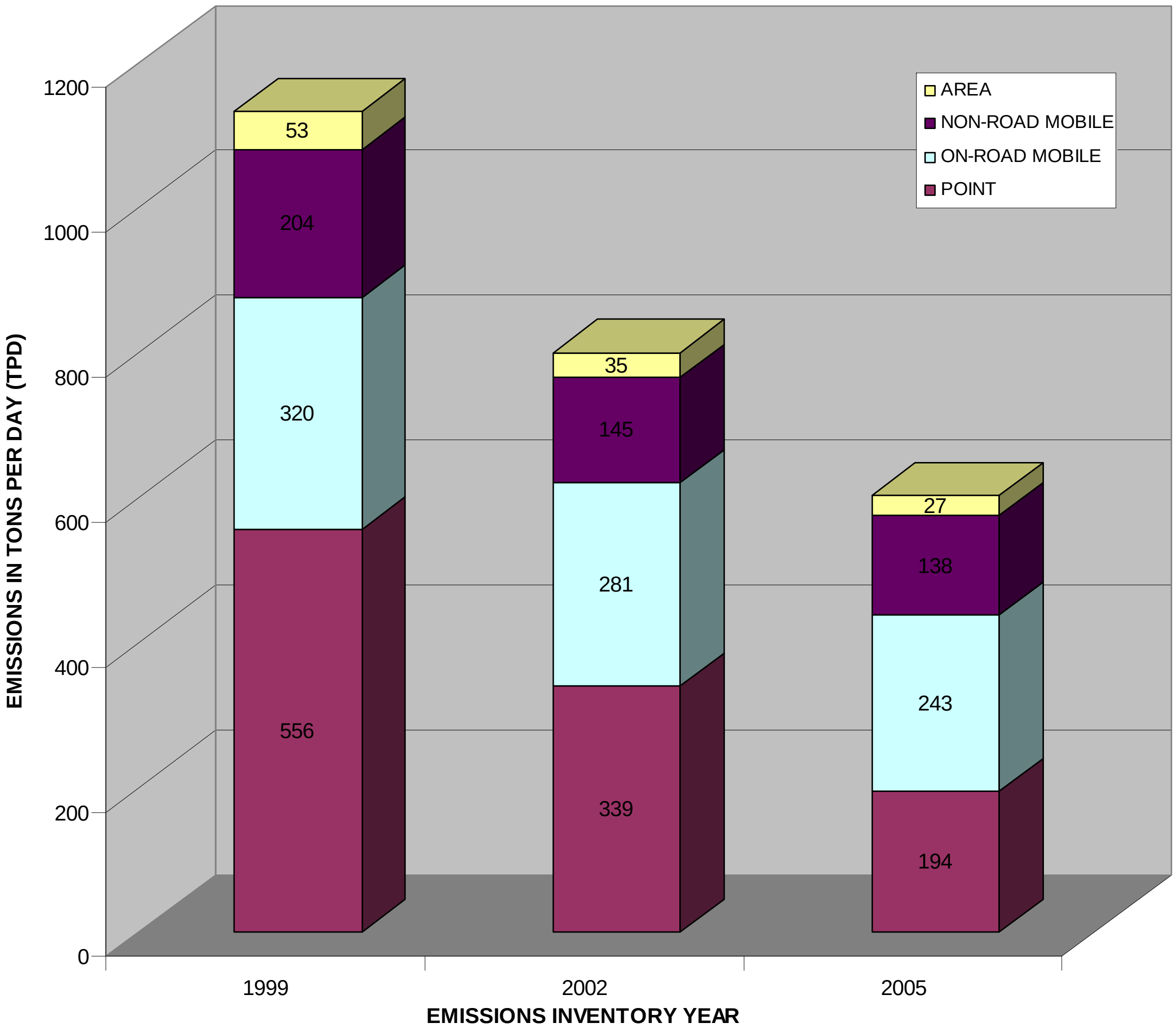
Ozone Design Values for the HGB Area



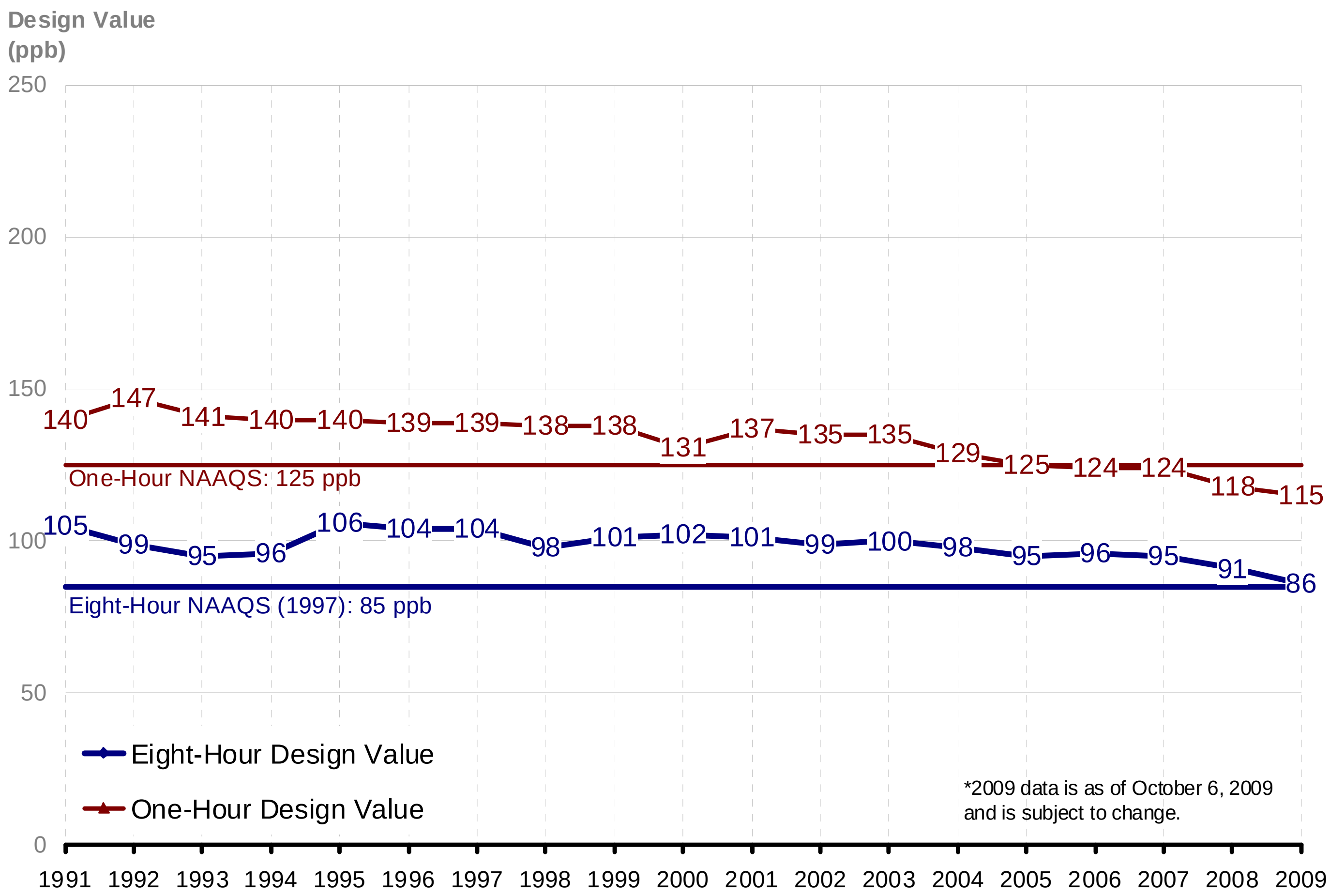
HGB 1997 Eight-Hour Design Values for 2000, 2005, and 2008



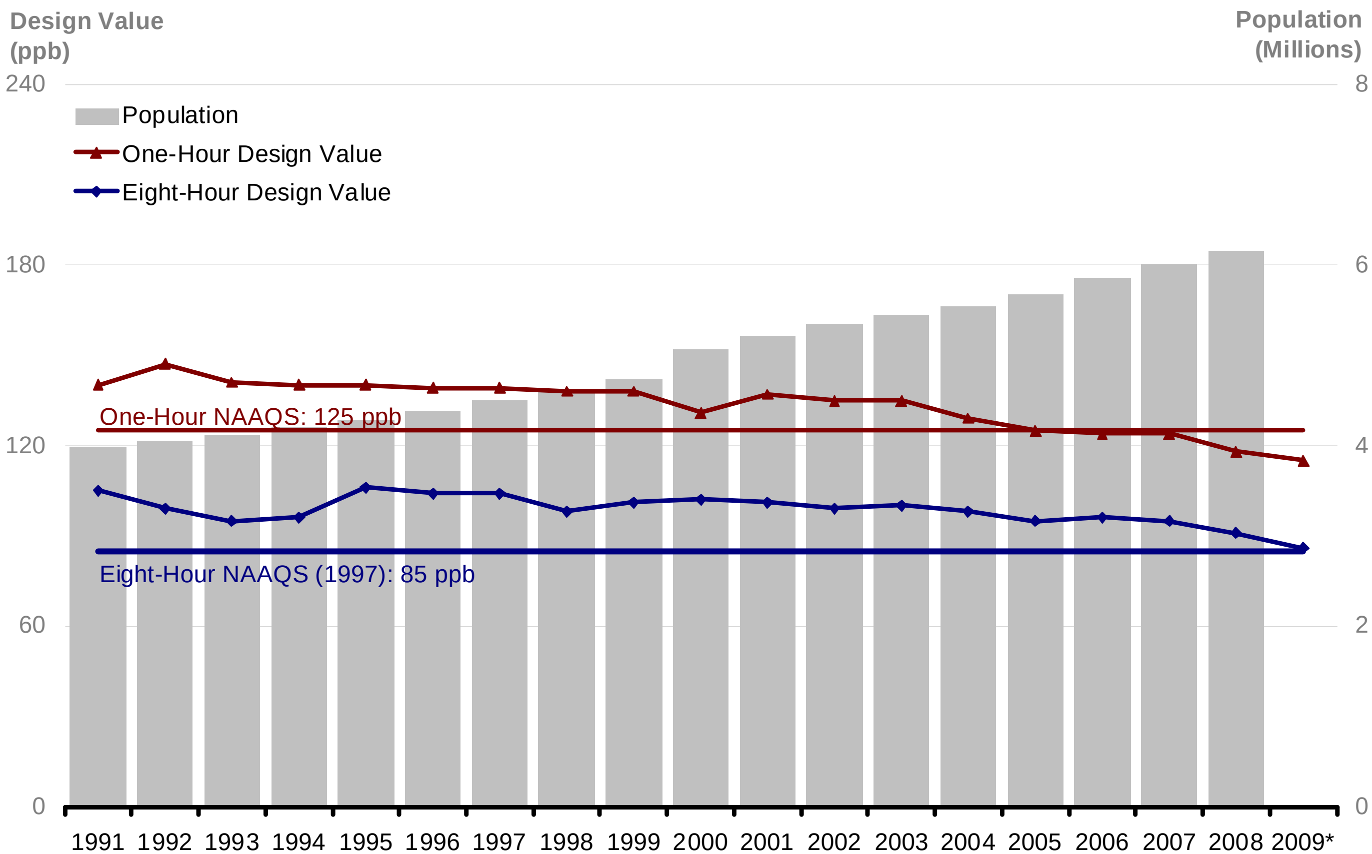
HGB Eight-County NO_X Emissions



Ozone Design Value for the DFW Area

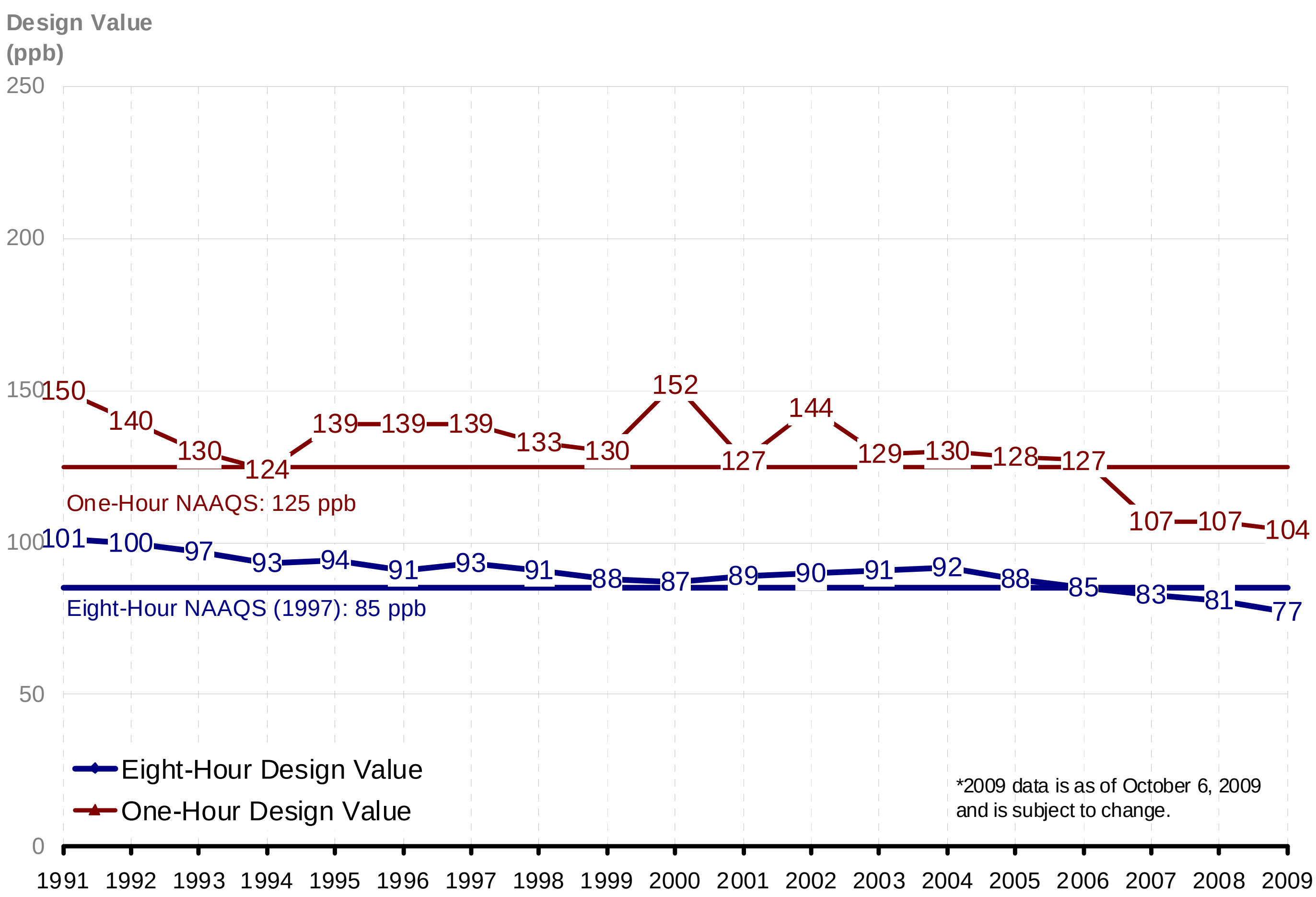


Ozone Design Values and Estimated Population in the DFW Area

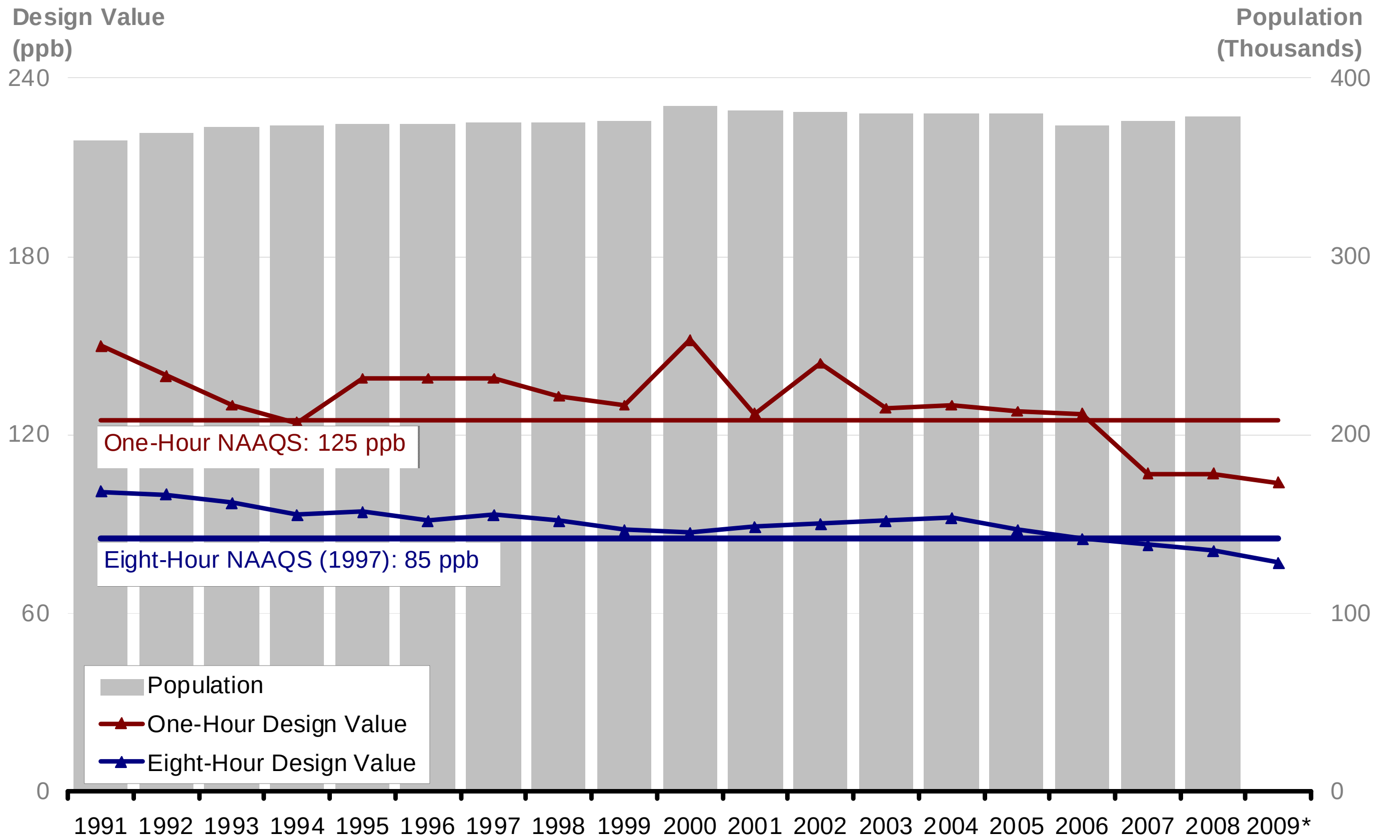


*Source: Ozone – EPA's AQS database.
1991-2008 Population --http://www.census.gov/popest/archives/1990s/MA-99-03b.txt and http://www.census.gov/popest/counties/CO-EST2008-popchg2000_2008.html
2009 Data is current as of October 6, 2009 and is subject to change. 2009 population data will not be available until June 2010.

Ozone Design Values for the BPA Area

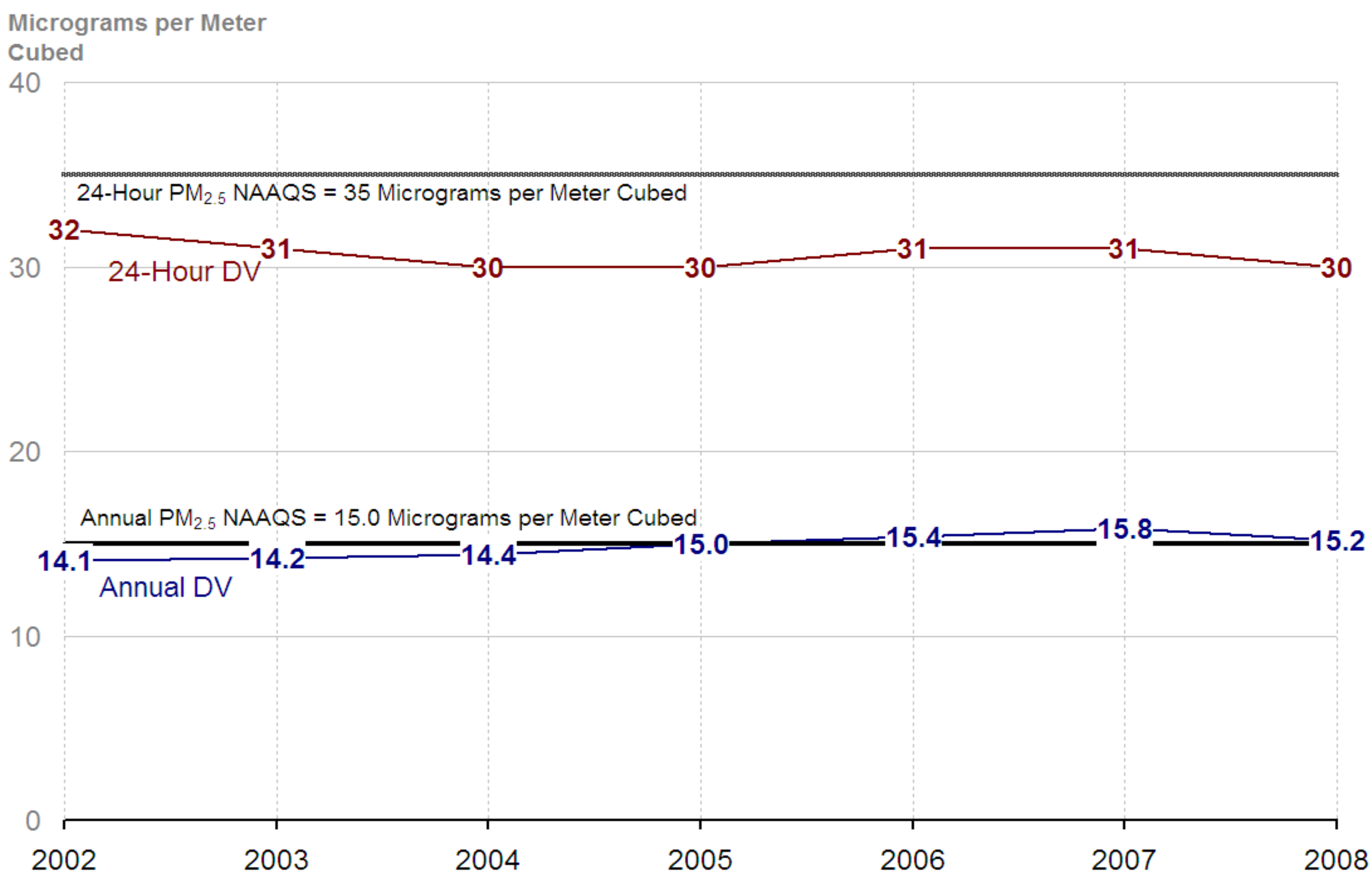


Ozone Design Values and Estimated Population in the BPA Area

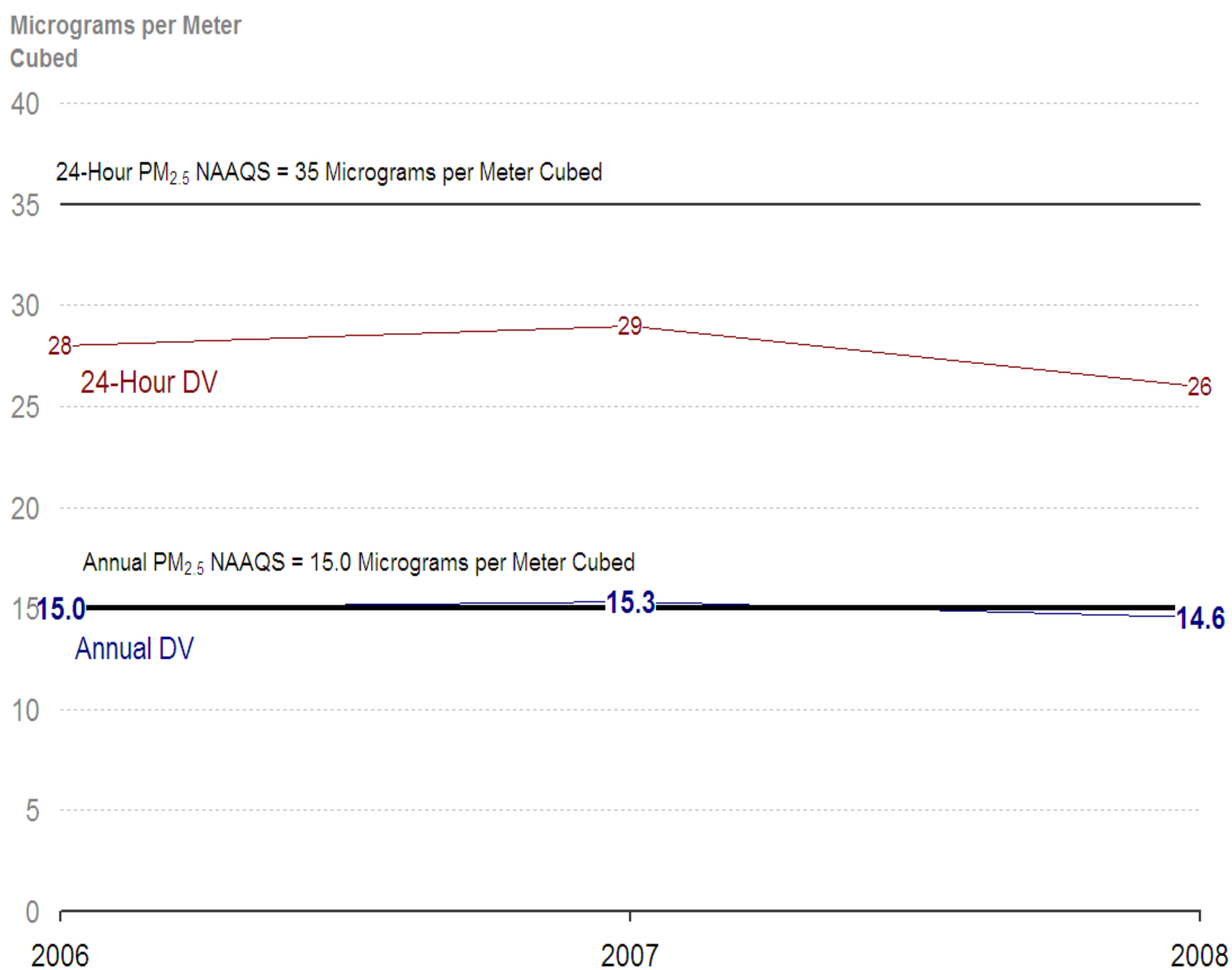


*Source: Ozone – EPA's AQS database.
1991-2008 Population --http://www.census.gov/popest/archives/1990s/MA-99-03b.txt and http://www.census.gov/popest/counties/CO-EST2008-popchg2000_2008.html
2009 Data is current as of October 6, 2009 and is subject to change. 2009 population data will not be available until June 2010.

$PM_{2.5}$ Design Values For Clinton Drive
(Includes Exceptional Events)

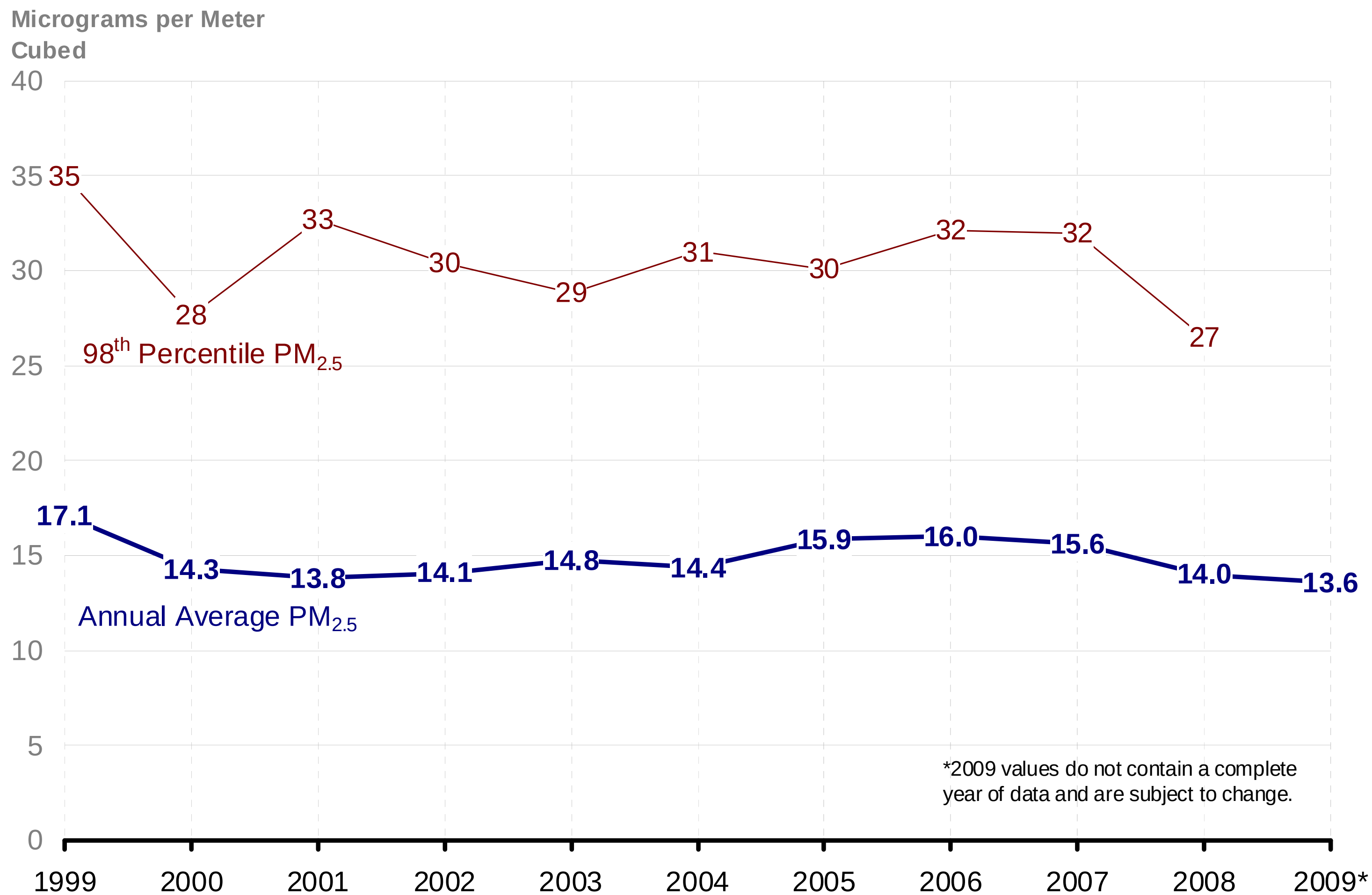


$PM_{2.5}$ Design Values For Clinton Drive
(Excludes Exceptional Events)



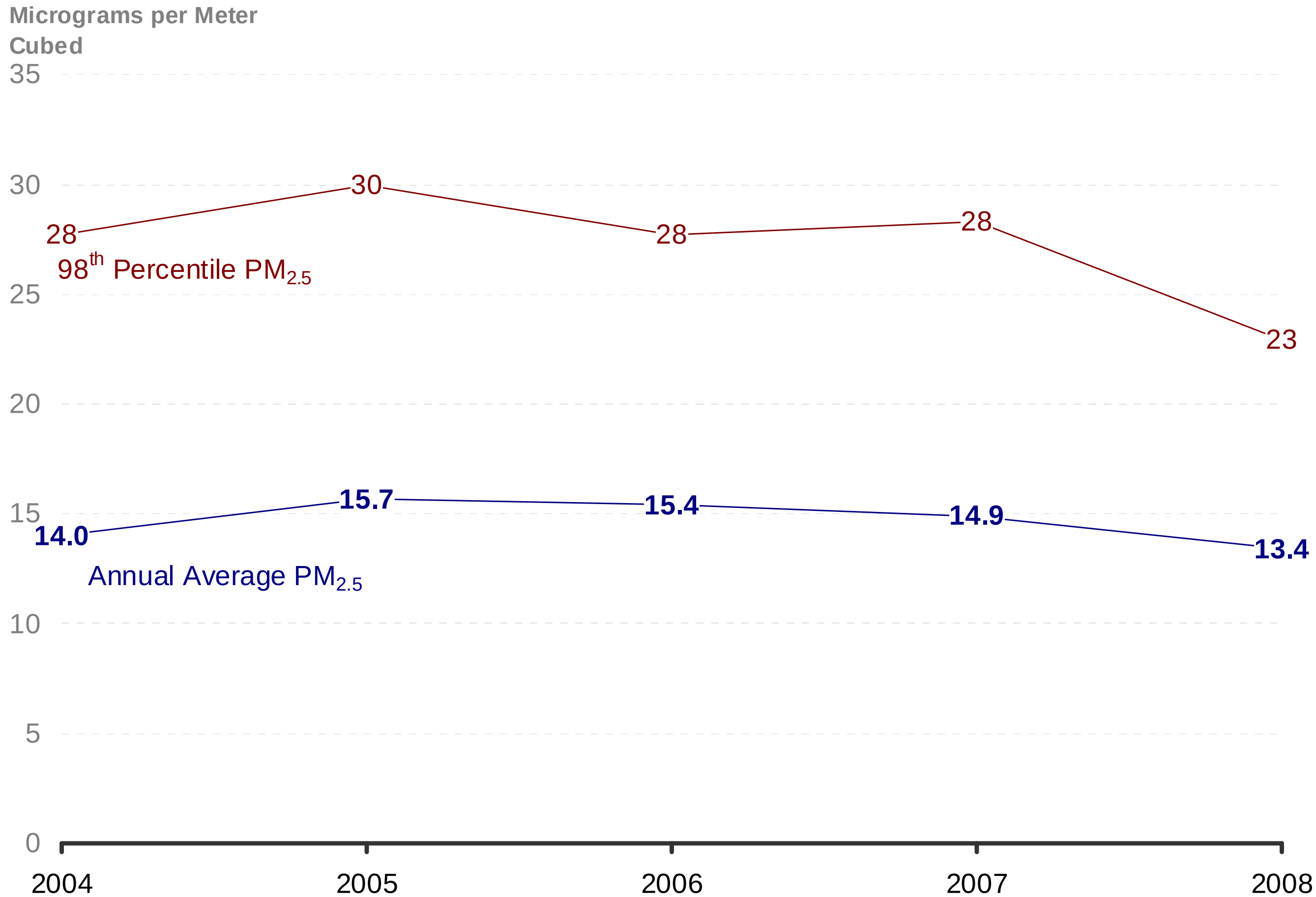
Annual Average and 98th Percentile $PM_{2.5}$ at the Clinton Drive Monitor

(Projects 2009 and Includes Exceptional Events)



Annual Average and 98th Percentile $PM_{2.5}$ at the Clinton Drive Monitor

(Excludes Exceptional Events)



Efforts to Reduce Local $PM_{2.5}$ Emissions in the Clinton Drive Area

(as of September 2009)

- Road Projects
- Railroad Projects
- Regulated Industry Projects

Road Projects

- The City of Houston installed barriers to keep trucks from driving off Clinton Drive onto the dirt shoulders of the road.
- The City of Houston installed a traffic light at Clinton Drive and the Industrial Park East gate to control traffic at the intersection and completed a landscaping project along Clinton Drive.
- The TCEQ commissioners approved an SEP to pave the parking lot directly adjacent to the monitoring station.
- The Port of Houston Authority (PHA) reports widespread use of emulsified asphalt began October 1, 2007.
- Valero Asphalt paved its large work yard located across Clinton Drive to the southeast of the monitor.

Railroad Projects

- Port Terminal Rail Association (PTRA) and Union Pacific (UP) are operating newly refurbished switcher engines on the Clinton line.
  - UP currently has 43 new gensets in the Houston area.
  - UP will be adding 9 new gensets into the Houston area.
  - UP has 13 locomotives being funded by TERP.
- 60% of UP switcher engines operating in the area have anti-idling control.
- PTRA has stopped the steel loading activities on a dirt area to the south of the monitor.

The following revised page was provided to the Commission on 10/29/2009.

Railroad Projects

- Port Terminal Rail Association (PTRA) and Union Pacific (UP) are operating newly refurbished switcher engines on the Clinton line.
  - UP currently has 52 new gensets in the Houston area.
  - UP has 13 locomotives being funded by TERP.
- 60% of UP switcher engines operating in the area have anti-idling control.
- PTRA has stopped the steel loading activities on a dirt area to the south of the monitor.

Regulated Industry Projects

- DuPont, a PHA tenant, has implemented new dust control best management practices at its fluorspar unloading and storage facility.
- Federal consent decrees are anticipated to result in an estimated 33,900 tpy of SO_2 reductions in the upper Texas Gulf Coast.
  - Valero Refining has already implemented control measures to reduce SO2 emissions by 3,500 tpy.
  - The Rhodia sulfuric acid plant will decrease its SO_2 emissions by 8,984 tpy from 2005 actual emissions by 2012.

Permitting Actions to Improve Air Quality in Texas

- Flexible Permits

Coal and petroleum coke fired power plants	Petroleum refineries
25,803 tpy SO_2	4,877 tpy SO_2
10,330 tpy NO_X	3,392 tpy NO_X
795 tpy PM/PM10	880 tpy PM
	530 tpy VOC
	4,877 tpy CO

- Senate Bill 7 - Grandfathered Electric Generating Units
  - Resulted in emissions reductions of **102,436** tpy of NO_X and SO_2 from previously grandfathered electric generating units.

The following revised page was provided to the Commission on 10/29/2009.

Permitting Actions to Improve Air Quality in Texas

- Flexible Permits

Coal and petroleum coke fired power plant	Petroleum refinery
25,803 tpy SO_2	4,877 tpy SO_2
10,330 tpy NO_X	3,392 tpy NO_X
795 tpy PM/PM10	880 tpy PM
	530 tpy VOC
	4,877 tpy CO

- Senate Bill 7 - Grandfathered Electric Generating Units
  - Resulted in emissions reductions of **102,436** tpy of NO_X and SO_2 from previously grandfathered electric generating units.

Permitting Actions to Improve Air Quality in Texas
-continued-

- The voluntary and mandatory permitting requirements for previously grandfathered facilities resulted in over **260,000** tons of reductions in actual emissions from these facilities either through the addition of controls or the shutdown of the facilities.
  - Senate Bill 766 - Voluntary Emission Reduction Permit or VERP
  - House Bill 2912 - Mandatory permitting of all grandfathered facilities.
- Planned Maintenance, Startup, and Shutdown (MSS)
- Infrared (IR) Camera

Ongoing Activities

- Texas Emission Reduction Plan (TERP)
- Drive a Clean Machine

Texas Emission Reduction Plan (TERP) Projects Awarded or Pending Award

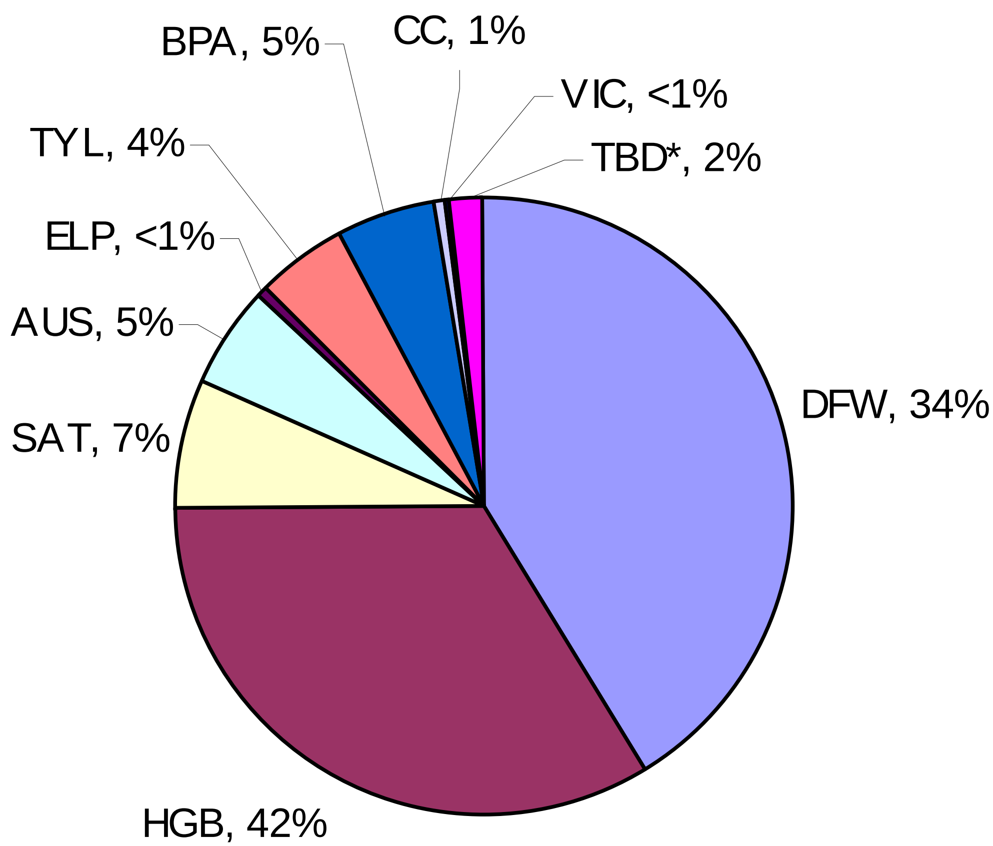
AREA	NUMBER OF PROJECTS	NUMBER OF ACTIVITES	TOTAL NO_x (TONS)	GRANT AMOUNT	COST PER TON	TONS PER DAY IN 2009	TONS PER DAY IN 2010	TONS PER DAY IN 2011	TONS PER DAY IN 2012	TONS PER DAY IN 2013
Houston/ Galveston/ Brazoria	2,213	4,840	69,822.8429	$319,444,382.79	$4,575	29.7931	30.7708	29.1571	27.3117	24.8410
Dallas/ Fort Worth	2,183	4,268	56,581.5491	$259,083,412.91	$4,579	21.9942	23.0500	23.0350	22.1917	21.6412
San Antonio	516	853	9,971.3820	$55,661,139.82	$5,582	4.1469	4.5457	4.4670	4.4036	4.1044
Austin	418	776	5,829.6737	$40,479,888.78	$6,944	2.9992	3.2717	3.0814	2.8333	2.6272
El Paso	137	172	696.6289	$3,183,977.08	$4,571	0.3273	0.3258	0.2946	0.2782	0.2194
Tyler/ Longview	113	256	6,685.3548	$37,876,742.90	$5,666	3.0795	3.4620	3.5765	3.5655	3.5023
Beaumont/ Port Arthur	106	328	8,275.3975	$40,013,009.67	$4,835	3.1543	3.4937	3.1247	2.9798	2.2243
Corpus Christi	22	84	1,086.7595	$5,304,328.28	$4,881	0.6799	0.6662	0.5746	0.3573	0.2612
Victoria	9	13	91.6944	$620,288.66	$6,765	0.0548	0.0548	0.0536	0.0519	0.0032
Unknown (TBD)*	3	3	1,820.9220	$13,656,915.00	$7,500	1.0405	1.0405	1.0405	1.0405	1.0405
	5,720	**11,593**	**160,862.2048**	**$775,324,085.89**	**$4,820**	**67.2696**	**70.6813**	**68.4050**	**65.0137**	**60.4649**

* Includes Third-Party Grants to the Railroad Commission of Texas and the Texas General Land Office for funding not yet reported as assigned to specific areas.

TERP Projects Awarded or Pending Award Summary

- Number of Projects – 5,720
- Number of Activities – 11,593
- Total NO_X Tons – 160,862.2048
- Grant Amount - $775,324,085.89
- Cost Per Ton - $4,820

TERP Grant Amount by Area



AUS	Austin Area
BPA	Beaumont-Port Arthur
CC	Corpus Christi
DFW	Dallas-Fort Worth
ELP	El Paso
HGB	Houston-Galveston-Brazoria
SAT	San Antonio Area
TBD*	To Be Determined
TYL	Tyler-Longview
VIC	Victoria

* Includes Third-Party Grants to the Railroad Commission of Texas and the Texas General Land Office for funding not yet reported as assigned to specific areas.

Drive a Clean Machine

Area	Number of Repairs	Number of Replacements	Amount Distributed for Repair/ Replacement
Central Texas	440	1,273	$4,865,105
Dallas-Fort Worth	3,427	11,645	$38,119,599
Houston-Galveston-Brazoria	3,314	9,299	$34,407,340
Total	7,181	22,217	$77,392,044

From December 2007, implementation of Senate Bill 12, to May 2009 (end of Fiscal Year 2009 third quarter)

Air Quality Challenges

- Revisions to the 2008 Ozone NAAQS
- NAAQS Review Schedule
- Effective communication of risk
- Continual improvement of APWL process focusing on consistency, transparency, and progress.

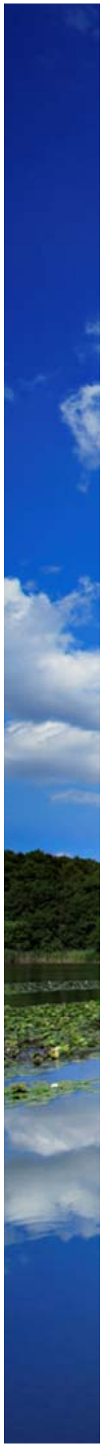
2010 Ozone Standard Key Dates

The EPA administrator announced there would be a review of the 2008 ozone National Ambient Air Quality Standard.	September 16, 2009
Proposal of the reconsideration to be published in the *Federal Register.*	December 2009
Final reconsideration published in the *Federal Register*.	August 2010
Final ozone nonattainment designations by the EPA.	August 2011
State Implementation Plan (SIP) Revisions due to the EPA.	December 2013
Attainment deadlines	2013 – 2030 (?)

The following revised page was provided to the Commission on 10/29/2009.

2010 Ozone Standard Key Dates

The EPA administrator announced there would be a review of the 2008 ozone National Ambient Air Quality Standard.	September 16, 2009
Proposal of the reconsideration to be published in the *Federal Register.*	December 21, 2009
Final reconsideration published in the *Federal Register*.	August 31, 2010
Final ozone nonattainment designations by the EPA.	August 2011
State Implementation Plan (SIP) Revisions due to the EPA.	December 2013
Attainment deadlines	August 2014 – August 2031



NAAQS Review Schedule

2009 2010 2011 2012 2013

- **Nitrogen Dioxide (NO_2)** Proposed Rule – June 26, 2009
- **Sulfur Dioxide (SO_2)** Proposed Rule – November 16, 2009
- **Ozone (O_3)** Proposed Rule – December 2009
- **Nitrogen Dioxide (NO_2)** Final Rule – January 22, 2010
- **Nitrogen Oxides (NO_X)/ Sulfur Oxides (SO_X) Secondary Level** Proposed Rule – February 12, 2010
- **Sulfur Dioxide (SO_2)** Final Rule – June 2, 2010
- **Ozone (O_3)** Final Rule – August 2010
- **Nitrogen Oxides (NO_X)/ Sulfur Oxides (SO_X) Secondary Level** Final Rule – October 19, 2010
- **Carbon Monoxide (CO)** Proposed Rule – October 28, 2010
- **Particulate Matter (PM)** Proposed Rule – January 2011
- **Carbon Monoxide (CO)** Final Rule – May 13, 2011
- **Particulate Matter (PM)** Final Rule – October 2011
- **Ozone (O_3)** Proposed Rule – June 2012
- **Ozone (O_3)** Final Rule – March 2013

The following revised page was provided to the Commission on 10/29/2009.

NAAQS Review Schedule

2009 | 2010 | 2011 | 2013 | 2014

Nitrogen Dioxide (NO_2)
Proposed Rule – June 26, 2009

Sulfur Dioxide (SO_2)
Proposed Rule – November 16, 2009

Ozone (O_3)
Proposed Rule – December 21, 2009

Nitrogen Dioxide (NO_2)
Final Rule – January 22, 2010

Nitrogen Oxides (NO_X)/ Sulfur Oxides (SO_X) Secondary Level
Proposed Rule – February 12, 2010

Sulfur Dioxide (SO_2)
Final Rule – June 2, 2010

Particulate Matter (PM)
Proposed Rule – July 2010

Ozone (O_3)
Final Rule – August 31, 2010

Nitrogen Oxides (NO_X)/ Sulfur Oxides (SO_X) Secondary Level
Final Rule – October 19, 2010

Carbon Monoxide (CO)
Proposed Rule – October 28, 2010

Particulate Matter (PM)
Final Rule – April 2011

Carbon Monoxide (CO)
Final Rule – May 13, 2011

Ozone (O_3)
Proposed Rule – May 2013

Ozone (O_3)
Final Rule – February 2014

Ongoing Efforts

- Corpus Christi Benzene Biomonitoring Project
- Barnett Shale Investigations
- Houston Exposure to Air Toxics Study (HEATS)
- Linear Dose Response Workshops
- Flare Task Force
- Flare Research Project
- Clinton Drive $PM_{2.5}$ Initiatives

Reduction of Ozone in Texas

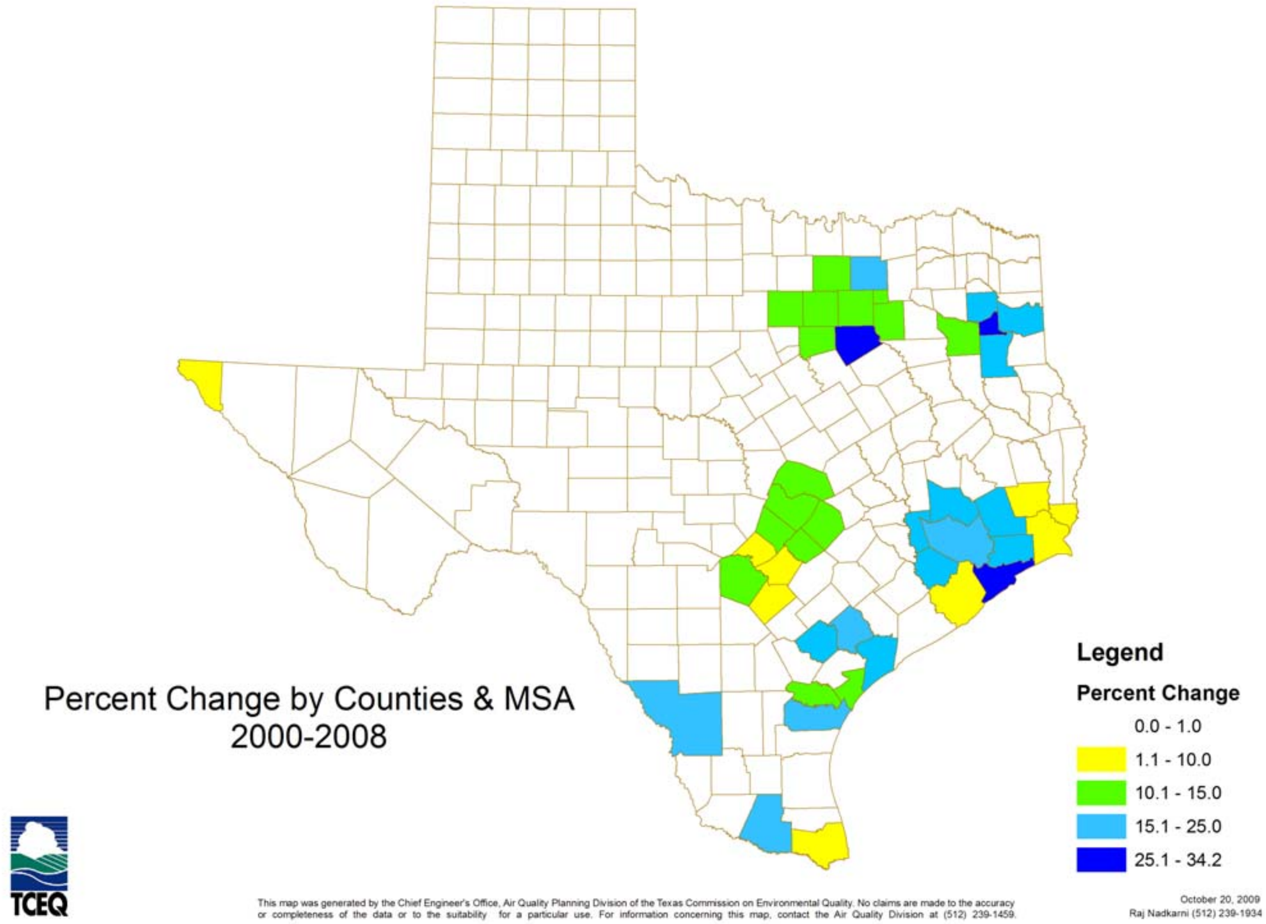
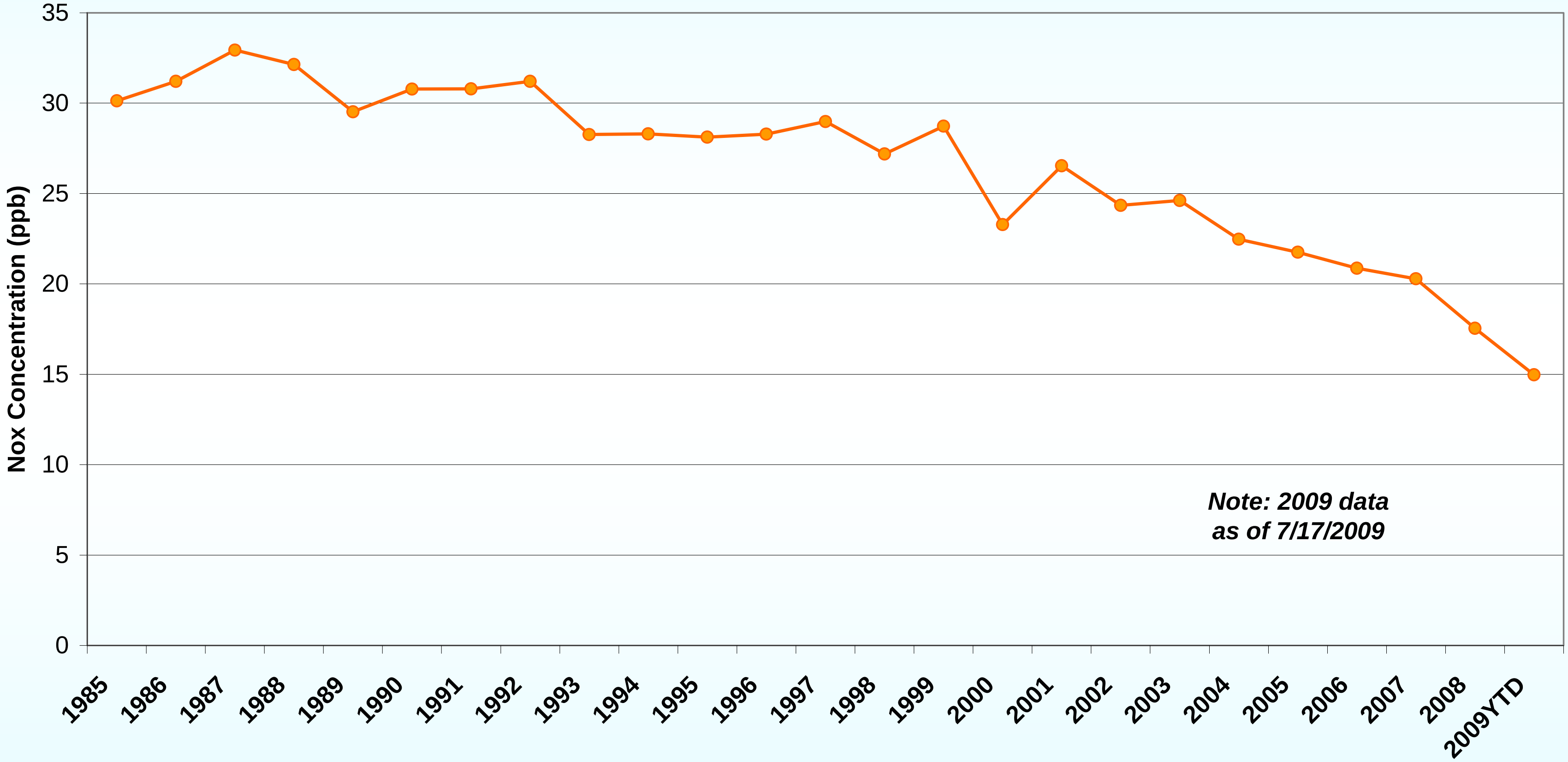


EXHIBIT 2

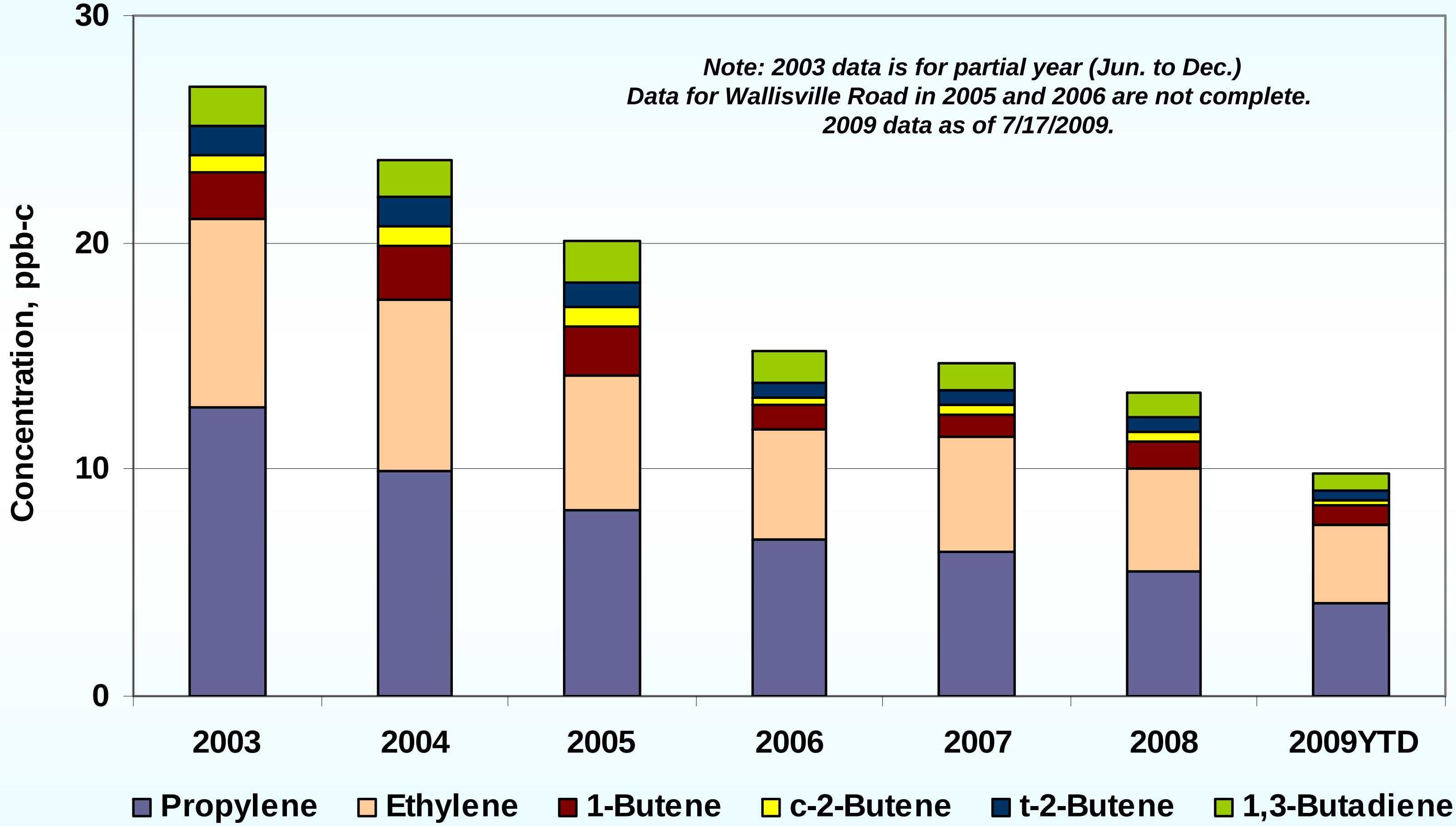
Annual Average NOx Concentration

HRM and Core Houston Area Monitors -- Crawford/Texas Ave, Clinton, Lang, Aldine



50% Reduction in Ambient NOx Concentrations Since 1985

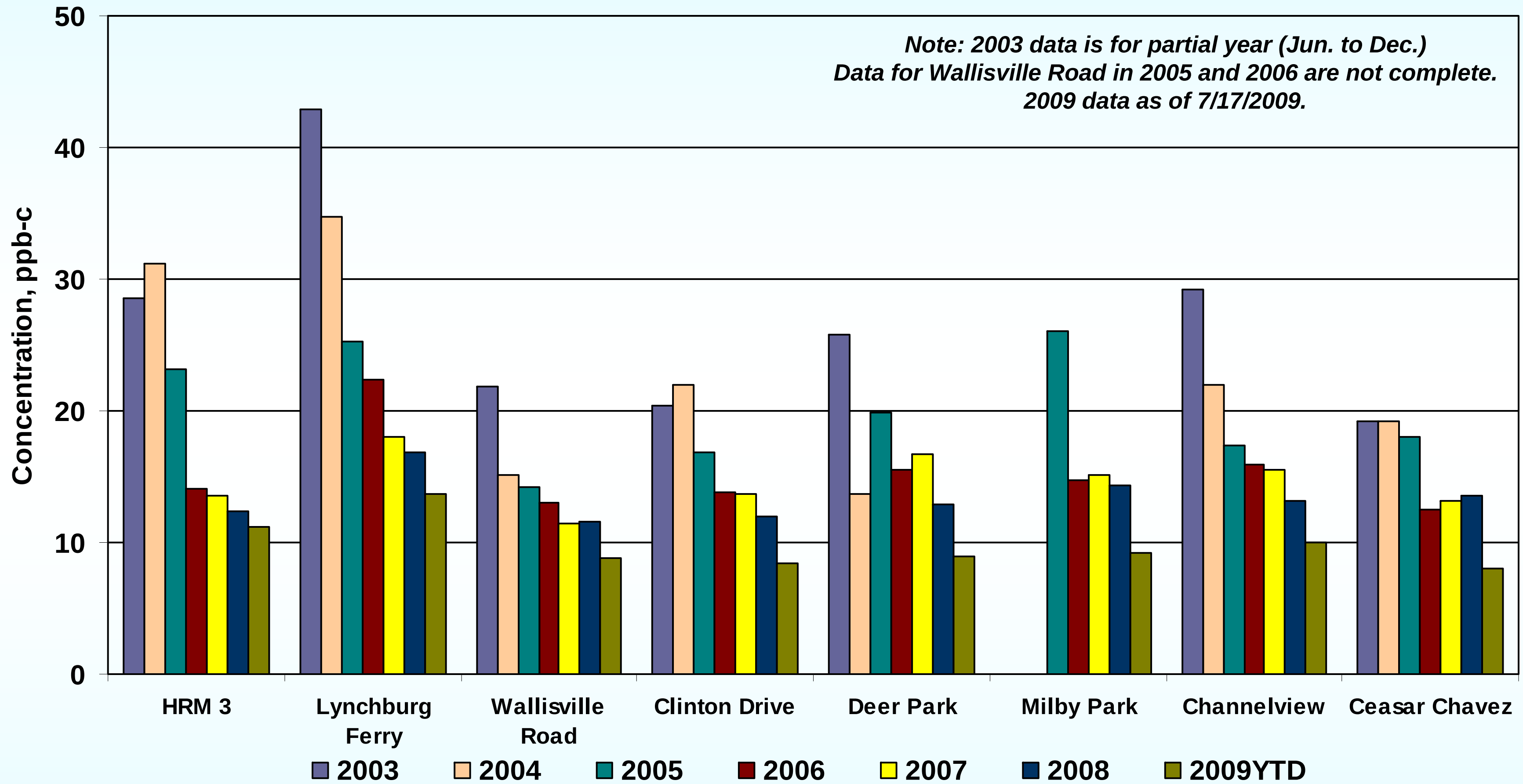
Total HRVOC Network Average Concentrations
Houston Ship Channel PAMS-GC Monitoring Sites



50% Reduction in HRVOC Concentrations From 2003 Through 2008

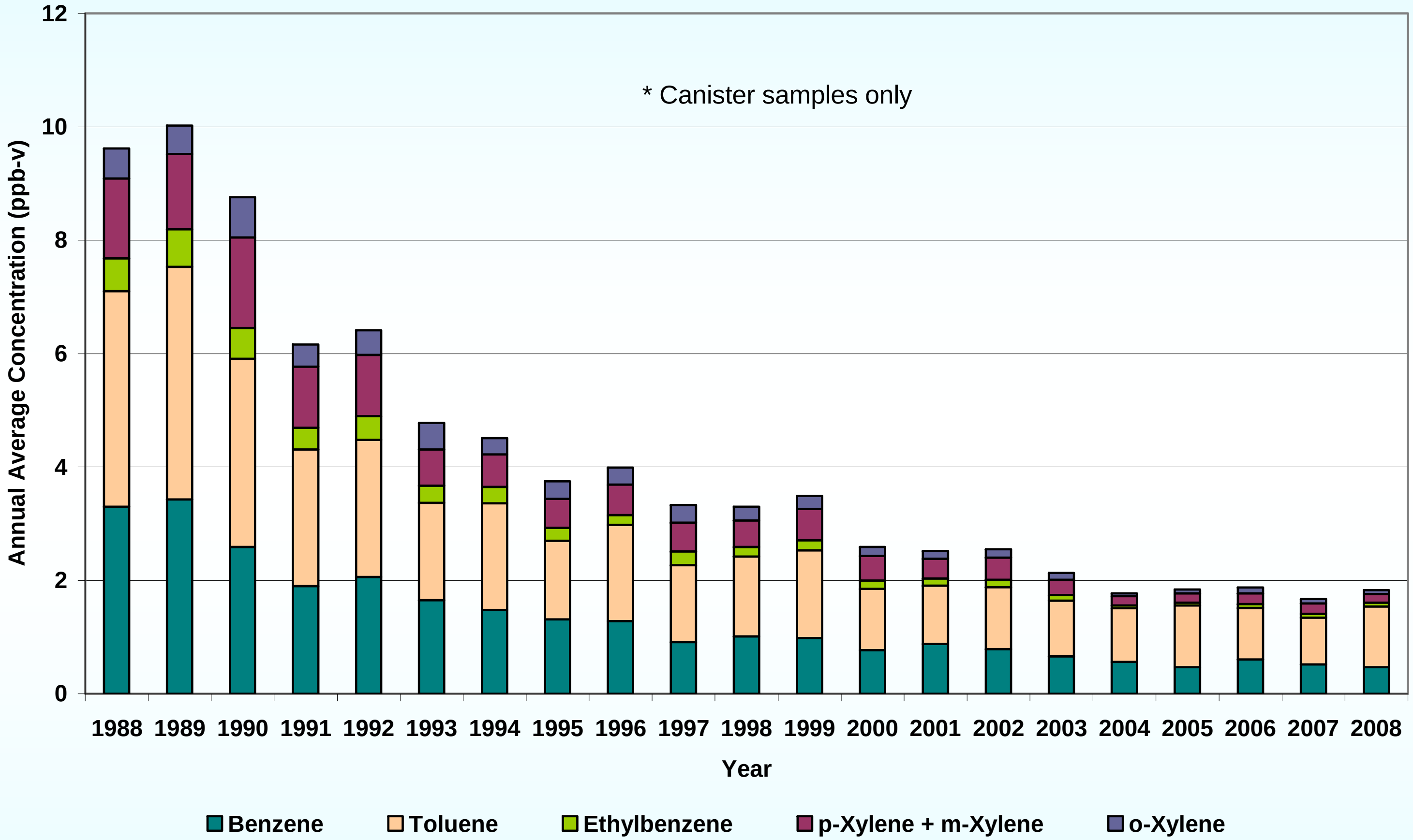
Average Annual HRVOC Concentrations

Houston Ship Channel PAMS-GC Monitoring Sites



Significant HRVOC Reductions At All Sites

Annual Average Trends for VOC Indicator Compounds for HRM Network from 1988 though 2008



80% Reduction in BTEX Concentrations Since 1988

EXHIBIT 3

REVISIONS TO THE STATE IMPLEMENTATION PLAN (SIP)
FOR THE CONTROL OF OZONE AIR POLLUTION

POST-1999 RATE-OF-PROGRESS AND ATTAINMENT DEMONSTRATION SIP
FOR THE HOUSTON/GALVESTON OZONE NONATTAINMENT AREA

INSPECTION/MAINTENANCE SIP FOR THE
HOUSTON/GALVESTON OZONE NONATTAINMENT AREA

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION
P.O. BOX 13087
AUSTIN, TEXAS 78711-3087

DECEMBER 6, 2000

RULE LOG NO. 2000-011-SIP-AI

Figure 2.7-1 1993 VOC Emissions in HGA

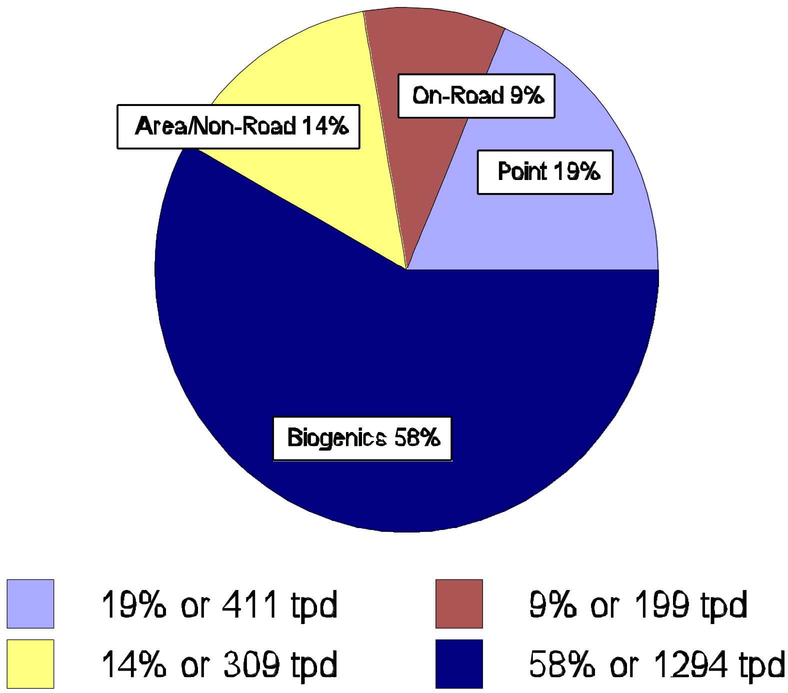


Figure 2.7-2 1993 NOx Emissions in HGA

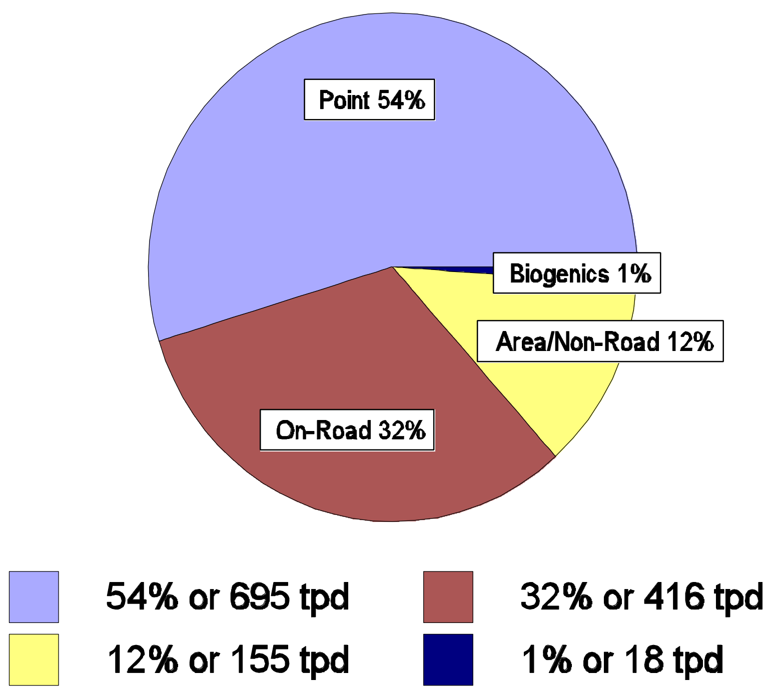


EXHIBIT 4

REVISION TO THE STATE IMPLEMENTATION PLAN
FOR THE CONTROL OF OZONE AIR POLLUTION

HOUSTON-GALVESTON-BRAZORIA 1997 EIGHT-HOUR OZONE STANDARD
NONATTAINMENT AREA

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
P.O. BOX 13087
AUSTIN, TEXAS 78711-3087

Houston-Galveston-Brazoria Attainment Demonstration
State Implementation Plan Revision for the 1997 Eight-Hour Ozone Standard

PROJECT NO. 2009-017-SIP-NR

Proposed
September 23, 2009

This page is intentionally left blank.

EXECUTIVE SUMMARY

The United States Environmental Protection Agency (EPA) reclassified the eight-county Houston-Galveston-Brazoria (HGB) area from a moderate to a severe nonattainment area for the 1997 eight-hour ozone National Ambient Air Quality Standard (NAAQS) effective on October 31, 2008. The HGB eight-county area includes Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties. The EPA set April 15, 2010, as the date for the state to submit a state implementation plan (SIP) revision addressing the severe ozone nonattainment area requirements of the 1990 Federal Clean Air Act Amendments (FCAA). The HGB area must attain the 1997 eight-hour ozone standard of 0.08 parts per million (ppm) as expeditiously as practicable but no later than the attainment date of June 15, 2019. Since emission reductions needed for attainment must be implemented by the beginning of the ozone season immediately preceding the HGB area's attainment date, implementation of controls need to be made by 2018, which is the attainment year for modeling.

This SIP revision addresses ozone formation in the HGB area, the precursor emissions of nitrogen oxides (NO_X) and volatile organic compounds (VOC), the control strategies that are to be implemented, the quantity of emission reductions associated with each strategy, and when these reductions will occur. Based on photochemical modeling and an evaluation of corroborative evidence, ozone measurements in the HGB area are predicted to be compliant with the 1997 eight-hour ozone NAAQS by June 15, 2019.

The existing measures to control ozone formation in the HGB area that have been adopted in previous SIP revisions center on:

- approximately 80 percent NO_X emission reductions from point sources through the Mass Emission Cap and Trade (MECT) program;
- NO_X emission reductions from on-road and non-road sources through the vehicle inspection and maintenance (I/M) program, the Texas Emission Reduction Plan (TERP), and the Texas Low Emission Diesel (TxLED) program;
- highly reactive volatile organic compounds (HRVOC) controls through the associated HRVOC Emission Cap and Trade (HECT) program; and
- VOC controls.

See Chapter 4, *Control Strategies and Required Elements*, Section 4.2, *Existing Control Measures* for a complete list of control measures.

Despite the significant decreases in one-hour and eight-hour ozone design values and in NO_X and VOC emissions in the HGB area, further reductions are needed to bring the area into attainment of the 1997 eight-hour ozone NAAQS. Even as key ozone-targeting regulatory programs have reduced the number and magnitude of ozone exceedances, the area of exceedance, and the population exposed to exceedances, economic and population growth continue to create air quality challenges for the HGB area.

This submittal contains proposed new state and local control measures. The Houston-Galveston Area Council (H-GAC), as the regional metropolitan transportation planning agency for the HGB area, has identified three voluntary programs that will aid in the improvement of the HGB area's air quality. The H-GAC's commitment for NO_X emissions reductions from the Voluntary Mobile Emission Reduction Program (VMEP) is 2.25 tons per day (tpd). The H-GAC has also identified transportations control measures (TCMs) that have been or will be implemented in the nonattainment area. By the start of the 2018 ozone season, these TCMs will reduce NO_X emissions in the HGB area by 0.015 tpd.

Photochemical modeling analysis demonstrates that a 25 percent reduction of the HECT cap on the total Harris County HRVOC allocation would contribute to attainment of the 1997 eight-hour ozone NAAQS by reducing the future 2018 ozone design values at all HGB monitors. Accordingly, this SIP revision contains a proposed 25 percent reduction in the total HRVOC allowance cap and revision to the HRVOC allocation methodology. The HECT program will continue to be applicable only in Harris County.

This plan demonstrates attainment using photochemical modeling that includes the existing and proposed control strategies previously listed. The demonstration also relies on weight of evidence (WoE) corroborative analysis and additional control measures not explicitly accounted for in the photochemical modeling (see Chapter 5, *Weight of Evidence*).

This SIP revision includes base case modeling of representative ozone exceedance episodes that occurred during 2005 and 2006. In general, the model performance evaluation of the base cases for 2005 and 2006 indicates the modeling is suitable for use in conducting the modeling attainment test. The modeling attainment test was applied by modeling a 2006 baseline year and 2018 future year to project 2018 eight-hour ozone design values. Only two regulatory monitors, Deer Park (DRPK) and Bayland Park (BAYP), and one non-regulatory monitor, Wallisville (WALV), are projected to have modeled 2018 eight-hour ozone design values greater than the 1997 eight-hour ozone NAAQS.

Modeling analyses of the sensitivity of the 2018 projected eight-hour ozone design values to emission reductions of NO_X and VOC generally indicate that the ozone design values are more sensitive to NO_X reductions than VOC. However, the sensitivity of ozone design values to reductions in HRVOC is much greater than for other VOC.

Table ES-1: *Summary of 2006 Baseline, 2018 Future Year, and 2018 Control Strategy Anthropogenic Modeling Emissions for HGB* lists the anthropogenic modeling emissions in tons per day (tpd) by source category for the 2006 baseline, 2018 future year, and the 2018 control strategies for NO_X and VOC. The differences in modeling emissions between the 2006 baseline and the 2018 future year reflect the net of growth and existing controls. The existing controls include both state and federal measures that have already been promulgated. The differences in modeling emissions between the 2018 future year and the 2018 control strategy reflect the proposed controls. These proposed controls include NO_X reductions from both the VMEP measures and TCMs, and the 25 percent reduction in the Harris County total HRVOC cap for the HECT program.

Table ES-1: Summary of 2006 Baseline, 2018 Future Year, and 2018 Control Strategy Anthropogenic Modeling Emissions for HGB

Source Type	2006 Baseline			2018 Future Year			2018 Control Strategy		
	NO_X	VOC	CO	NO_X	VOC	CO	NO_X	VOC	CO
	(tpd)			(tpd)			(tpd)		
Point	172.16	208.34	126.22	162.75	309.46	182.10	162.75	306.77	182.10
On-road	197.28	99.39	1115.23	50.76	50.39	733.17	49.21	50.39	733.17
Non-road	78.85	75.97	772.94	35.65	59.56	893.84	34.95	59.56	893.84
Off-road	73.55	6.05	53.25	85.72	6.93	44.71	85.72	6.93	44.71
Area	36.35	528.99	134.59	42.04	650.09	158.99	42.04	650.09	158.99
Totals	558.19	918.74	2202.23	376.92	1076.43	2012.81	374.67	1073.74	2012.81

Note: VOC is reported as sum of CB05 species

Table ES-2: *Summary of 2006 Baseline, 2018 Future Year, and 2018 Control Strategy Eight-Hour Ozone Design Values for BAYP and DRPK Monitors* lists the eight-hour ozone design values in parts per billion (ppb) for the 2006 baseline (DV_B), 2018 baseline future year (DV_F), and 2018 control strategy for the two regulatory monitors with model-projected 2018 eight-hour ozone design values greater than the 1997 eight-hour ozone NAAQS. However, 18 regulatory monitors have model-projected 2018 eight-hour ozone design values less than the 1997 eight-hour ozone NAAQS. Since the modeling cannot provide an absolute prediction of future year ozone design values, additional information from corroborative analyses are used in assessing whether the area will attain the standard in the future year.

Table ES-2: Summary of Modeled 2006 Baseline, 2018 Future Year, and 2018 Control Strategy Eight-Hour Ozone Design Values for BAYP and DRPK Monitors

Monitor Site Code	Monitor Designation	2006 DV_B (ppb)	2018 Baseline DV_F (ppb)	2018 Control Strategy DV (ppb)
DRPK	Deer Park (CAMS 35)	92.0	88.2	87.9
BAYP	Bayland Park (CAMS 53)	96.7	87.0	86.9

Note: The 2006 DV_B is different from the 2006 regulatory design value (DV_R). Figure 3-1: *Baseline Design Value Calculation Illustration* in Chapter 3, *Photochemical Modeling,* illustrates how DV_Bs are calculated using the three DV_Rs containing 2006 data. The 2006 DV_R is the average of the fourth high ozone values from 2004, 2005, and 2006.

This SIP revision provides ozone reduction trends analyses and supplementary data to demonstrate that the HGB eight-county nonattainment area will attain the 1997 eight-hour ozone standard of 0.08 ppm (84 parts per billion (ppb)). The EPA's April 2007 "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze" states that a weight of evidence demonstration is allowed when the future design value is at or below 87.9 ppb. The quantitative and qualitative corroborative analyses in Chapter 5, *Weight of Evidence*, support a conclusion that this SIP revision demonstrates attainment of the 1997 eight-hour ozone NAAQS.

This revision also includes FCAA-required SIP elements, including a reasonably available control measures (RACM) analysis, a reasonably available control technology (RACT) analysis, a motor vehicle emissions budget (MVEB), and a contingency plan. For the MVEB, see Table ES-3:

2018 Attainment Demonstration Motor Vehicle Emissions Budget for the Eight-County HGB Area.

Table ES-3: 2018 Attainment Demonstration Motor Vehicle Emissions Budget for the Eight-County HGB Area

Eight-County HGB Area	Summer Weekday Emissions (tpd)	
2018 MVEB	NO_X	VOC
	49.22	45.97

The Texas Commission on Environmental Quality (TCEQ) is committed to developing and applying the best science and technology towards addressing and reducing ozone formation in HGB and other nonattainment areas in Texas. This SIP revision also includes a description of how the TCEQ continues to use new technology, such as infrared VOC imaging to identify and control unaddressed or under-addressed pollution sources, to investigate possible emission reduction strategies, and other practical methods to continue making progress in air quality improvement. For more information, see Chapter 6, *Ongoing and Future Initiatives*.

SECTION V: LEGAL AUTHORITY

A. General

The Texas Commission on Environmental Quality (TCEQ) has the legal authority to implement, maintain, and enforce the National Ambient Air Quality Standards (NAAQS) and to control the quality of the state's air, including maintaining adequate visibility.

The first air pollution control act, known as the Clean Air Act of Texas, was passed by the Texas Legislature in 1965. In 1967, the Clean Air Act of Texas was superseded by a more comprehensive statute, the Texas Clean Air Act (TCAA), found in Article 4477-5, Vernon's Texas Civil Statutes. The legislature amended the TCAA in 1969, 1971, 1973, 1979, 1985, 1987, 1989, 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005, 2007, and 2009. In 1989, the TCAA was codified as Chapter 382 of the Texas Health & Safety Code.

Originally, the TCAA stated that the Texas Air Control Board (TACB) is the state air pollution control agency and is principal authority in the state on matters relating to the quality of air resources. In 1991, the legislature abolished the TACB effective September 1, 1993, and its powers, duties, responsibilities, and functions were transferred to the Texas Natural Resource Conservation Commission (TNRCC). With the creation of the TNRCC, the authority over air quality is found in both the Texas Water Code and the TCAA. Specifically, the authority of the TNRCC is found in Chapters 5 and 7. Chapter 5, Subchapters A - F, H - J, and L, include the general provisions, organization, and general powers and duties of the TNRCC, and the responsibilities and authority of the executive director. This chapter also authorizes the TNRCC to implement action when emergency conditions arise, and to conduct hearings. Chapter 7 gives the TNRCC enforcement authority. In 2001, the 77th Texas Legislature continued the existence of the TNRCC until September 1, 2013, and changed the name of the TNRCC to the Texas Commission on Environmental Quality (TCEQ). In 2009, the 81st Texas Legislature, during a special session, amended § 5.014 of the Texas Water Code, changing the expiration date of the TCEQ to September 1, 2011, unless continued in existence by the Texas Sunset Act.

The TCAA specifically authorizes the TCEQ to establish the level of quality to be maintained in the state's air and to control the quality of the state's air by preparing and developing a general, comprehensive plan. The TCAA, Subchapters A - D, also authorize the TCEQ to collect information to enable the commission to develop an inventory of emissions; to conduct research and investigations; to enter property and examine records; to prescribe monitoring requirements; to institute enforcement proceedings; to enter into contracts and execute instruments; to formulate rules; to issue orders taking into consideration factors bearing upon health, welfare, social and economic factors, and practicability and reasonableness; to conduct hearings; to establish air quality control regions; to encourage cooperation with citizens' groups and other agencies and political subdivisions of the state as well as with industries and the federal government; and to establish and operate a system of permits for construction or modification of facilities.

Local government authority is found in Subchapter E of the TCAA. Local governments have the same power as the TCEQ to enter property and make inspections. They also may make recommendations to the Commission concerning any action of the TCEQ that affects their territorial jurisdiction, may bring enforcement actions, and may execute cooperative agreements with the TCEQ or other local governments. In addition, a city or town may enact and enforce ordinances for the control and abatement of air pollution not inconsistent with the provisions of the TCAA and the rules or orders of the Commission.

Subchapters G and H of the TCAA authorize the TCEQ to establish vehicle inspection and maintenance programs in certain areas of the state, consistent with the requirements of the federal Clean Air Act; coordinate with federal, state, and local transportation planning agencies to develop and implement transportation programs and measures necessary to attain and maintain the NAAQS; establish gasoline volatility and low emission diesel standards; and fund and authorize participating counties to implement vehicle repair assistance, retrofit, and accelerated vehicle retirement programs.

B. Applicable Law

The following statutes and rules provide necessary authority to adopt and implement the State Implementation Plan (SIP). The rules listed below have previously been submitted as part of the SIP.

Statutes

All sections of each subchapter are included, unless otherwise noted.

TEXAS HEALTH & SAFETY CODE, Chapter 382 September 1, 2009

TEXAS WATER CODE September 1, 2009

Chapter 5: Texas Natural Resource Conservation Commission
Subchapter A: General Provisions
Subchapter B: Organization of the Texas Natural Resource Conservation Commission
Subchapter C: Texas Natural Resource Conservation Commission
Subchapter D: General Powers and Duties of the Commission
Subchapter E: Administrative Provisions for Commission
Subchapter F: Executive Director (except §§ 5.225, 5.226, 5.227, 5.2275, 5.231, 5.232, and 5.236)
Subchapter H: Delegation of Hearings
Subchapter I: Judicial Review
Subchapter J: Consolidated Permit Processing
Subchapter L: Emergency and Temporary Orders (§§ 5.514, 5.5145, and 5.515 only)
Subchapter M: Environmental Permitting Procedures (§ 5.558 only)

Chapter 7: Enforcement
Subchapter A: General Provisions (§§ 7.001, 7.002, 7.00251, 7.0025, 7.004, and 7.005 only)
Subchapter B: Corrective Action and Injunctive Relief (§ 7.032 only)
Subchapter C: Administrative Penalties
Subchapter D: Civil Penalties (except §7.109)
Subchapter E: Criminal Offenses and Penalties: §§ 7.177, 7.179-7.183

Rules

All of the following rules are found in 30, Texas Administrative Code, as of the following effective dates:

Chapter 7: Memoranda of Understanding, § 7.110 and § 7.119 May 2, 2002

Chapter 19: Electronic Reporting March 1, 2007

Chapter 35, Subchapters A-C, K: Emergency and Temporary Orders and Permits; Temporary Suspension or Amendment of Permit Conditions July 20, 2006

Chapter 39: Public Notice, §§ 39.201; 39.401; 39.403(a) and (b)(8)-(10); 39.405(f)(1) and (g); 39.409; 39.411 (a), (b)(1)-(6) and (8)-(10), (c)(1)-(6), and (d); 39.413(9), (11), (12), and (14); 39.418(a) and (b)(3) and (4); 39.419(a), (b), (d), and (e); 39.420(a), (b) and (c)(3) and (4); 39.423 (a) and (b); 39.601-39.605	March 29, 2006
Chapter 55: Requests for Reconsideration and Contested Case Hearings; Public Comment, §§ 55.1; 55.21(a)-(d), (e)(2), (3), and (12), (f), and (g); 55.101(a), (b), and (c)(6)-(8); 55.103; 55.150; 55.152(a)(1), (2), and (6) and (b); 55.154; 55.156; 55.200; 55.201(a)-(h); 55.203; 55.205; 55.209, and 55.211	March 29, 2006
Chapter 101: General Air Quality Rules	January 1, 2009
Chapter 106: Permits by Rule, Subchapter A	June 30, 2004
Chapter 111: Control of Air Pollution from Visible Emissions and Particulate Matter	July 19, 2006
Chapter 112: Control of Air Pollution from Sulfur Compounds	July 16, 1997
Chapter 113: Standards of Performance for Hazardous Air Pollutants and for Designated Facilities and Pollutants	May 14, 2009
Chapter 114: Control of Air Pollution from Motor Vehicles	June 26, 2008
Chapter 115: Control of Air Pollution from Volatile Organic Compounds	July 19, 2007
Chapter 116: Permits for New Construction or Modification	May 29, 2008
Chapter 117: Control of Air Pollution from Nitrogen Compounds	March 4, 2009
Chapter 118: Control of Air Pollution Episodes	March 5, 2000
Chapter 122: § 122.122: Potential to Emit	December 11, 2002
Chapter 122: § 122.215: Minor Permit Revisions	June 3, 2001
Chapter 122: § 122. 216: Applications for Minor Permit Revisions	June 3, 2001
Chapter 122: § 122.217: Procedures for Minor Permit Revisions	December 11, 2002
Chapter 122: § 122.218 Minor Permit Revision Procedures for Permit Revisions Involving the Use of Economic Incentives, Marketable Permits, and Emissions Trading	June 3, 2001

SECTION VI. CONTROL STRATEGY

A. Introduction (No change)

B. Ozone (Revised)

1. *Dallas-Fort Worth* (No change)
2. *Houston-Galveston-Brazoria* **(Revised)**
   Chapter 1: General
   Chapter 2: Anthropogenic Emissions Inventory (EI) Description
   Chapter 3: Photochemical Modeling
   Chapter 4: Control Strategies and Required Elements
   Chapter 5: Weight of Evidence
   Chapter 6: Ongoing and Future Initiatives
3. *Beaumont-Port Arthur* (No change)
4. *El Paso* (No change)
5. *Regional Strategies* (No change)
6. *Northeast Texas* (No change)
7. *Austin Area* (No change)
8. *San Antonio Area* (No change)

C. Particulate Matter (No change)

D. Carbon Monoxide (No change)

E. Lead (No change)

F. Oxides of Nitrogen (No change)

G. Sulfur Dioxide (No change)

H. Conformity with the National Ambient Air Quality Standards (No change)

I. Site Specific (No change)

J. Mobile Sources Strategies (No change)

K. Clean Air Interstate Rule (No change)

L. Transport (No change)

M. Regional Haze (No change)

LIST OF ACRONYMS

ACT	Alternative Control Techniques
AERR	Air Emissions Reporting Requirements
AGL	Above Ground Level
AIRS	Aerometric Information Retrieval System
APCA	Anthropogenic Precursor Culpability Assessment
APU	Auxiliary Power Unit
ARD	Acid Rain Database
auto-GC	Automated Gas Chromatograph
AWO	American Waterways Operators
BACT	Best Available Control Technology
BAYP	Houston Bayland Park Monitor (CAMS 53)
BCCA-AG	Business Coalition for Clean Air-Appeal Group
BELD	Biogenic Emissions Landuse Data
BMP	Best Management Practices
BPA	Beaumont-Port Arthur
C35C	Clinton Monitor (CAMS 403/CAMS 113/CAMS 304)
CAIR	Clean Air Interstate Rule
CAMS	Continuous Air Monitoring Station
CAMx	Comprehensive Air Model with Extension
CARB	California Air Resources Board
CEMS	Continuous Emission Monitoring Systems
CENRAP/RPO	Central Regional Air Planning Association/Regional Planning Organization
CFFP	Clean Fuel Fleet Program
CFR	Code of Federal Regulations
CFV	Clean Fuel Vehicles
$ClNO_2$	Nitryl Chloride
CLU	Common Land Unit
CNR2	Conroe Relocated (CAMS 78)
CO	Carbon Monoxide
CTAC	Chemical Transportation Advisory Committee
CTG	Control Technique Guidelines
DACM	AirCheckTexas Drive a Clean Machine
DERC	Discrete Emissions Reduction Credit
DFW	Dallas-Fort Worth
DIAL	Differential Absorption Lidar
DMA	Marine Distillate Fuel A
DMX	Marine Distillate Fuel X
DOAS	Differential Optical Absorption Spectroscopy
DRE	Destruction and Removal Efficiency
DRPK	Deer Park Monitor (CAMS 35/139)
DV	Design Value
DV_{18}	2018 Ozone Design Value

DV_B	Baseline Year Ozone Design Value
DV_F	Future Design Value
EBI	Euler Backward Iterative
ECA	Emissions Control Area
EDAS	Ecosystem Dynamics and the Atmosphere Section
EE/RE	Energy Efficiency and Renewable Energy
EGAS	Economic Growth Analysis System
EGU	Electric Generating Unit
EI	Emissions Inventory
EIQ	Emissions Inventory Questionnaires
EPA	United States Environmental Protection Agency
EPS3	Emissions Processing System version 3
ERC	Emissions Reduction Credit
ESL	Energy Systems Laboratory
ETH	Ethylene
FCAA	Federal Clean Air Act
FDDA	Four-Dimensional Data Assimilation
FIP	Federal Implementation Plan
FMVCP	Federal Motor Vehicle Control Program
FORM	Formaldehyde
GALV	Galveston Airport Monitor (CAMS 34/CAMS 109/CAMS 154)
GAPP	GEWEX Americas Prediction Project
GCIP	GEWEX Continental International Project
GEWEX	Global Energy and Water Cycle Experiment
GloBEIS	Global Biosphere Emissions and Interactions System
GOES	Geostationary Operational Environmental Satellite
g/kW–hr	Grams per Kilowatt Hour
GREASD	Greatly Reduced Execution and Simplified Dynamics
GWEI	Gulf-wide Emissions Inventory
HALC	Aldine Monitor (CAMS 8)
HB	House Bill
HCHV	Channelview Monitor (CAMS 15/CAMS 115)
HCQA	Croquet Monitor (CAMS 409)
HDDV	Heavy-Duty Diesel Vehicle
HECT	Highly Reactive Volatile Organic Compound Emissions Cap and Trade
H-GAC	Houston-Galveston Area Council
HGB	Houston-Galveston-Brazoria
HNWA	Northwest Harris County Monitor (CAMS 26)
HO_2	Hydroperoxy Radical
HOEA	Houston East Monitor (CAMS 1)
HONO	Nitrous Acid
hp	Horsepower
HPMS	Highway Performance Monitoring System
HRM	Haden Road Monitor (CAMS 603)

HROC	TCEQ Houston Regional Office Monitor (CAMS 81)
HRVOC	Highly Reactive Volatile Organic Compounds
HSMA	Houston Monroe Monitor (CAMS 406)
HTCA	Houston Texas Avenue Monitor (CAMS 411)
HYSPLIT	Hybrid Single Particle Lagrangian Integrated Trajectory
I/M	Inspection and Maintenance
IAF	Ike Adjustment Factor
I-DOAS	Imaging Differential Optical Absorption Spectroscopy
IMO	International Maritime Organization
IOLE	Internal Olefins
ISOP	Isoprene
JPL	Jet Propulsion Laboratory
km	Kilometer
K_V	Vertical Diffusivity Coefficient
kW	Kilowatts
LDAR	Leak Detection and Repair
LDEQ	Louisiana Department of Environmental Quality
LEADS	Leading Environmental Analysis and Display System
LIRAP	Low Income Vehicle Repair Assistance, Retrofit, and Accelerated Vehicle Retirement Program
LULC	Land-Use/Land-Cover
LYNF	Lynchburg Ferry Monitor (CAMS 1015)
m/s	Meters per Second
MACP	Manvel Croix Park Monitor (CAMS 84)
MACT	Maximum Achievable Control Technology
MARPOL	Annex VI of the International Convention for the Prevention of Pollution from Ships
MCR	Mid-Course Review
MECT	Mass Emissions Cap and Trade
METDAT	Omnibus Meteorological Database
MGO	Marine Gas Oil
MM5	Fifth Generation Meteorological Model
MMS	Minerals Management Services
MNB	Mean Normalized Bias
MNGE	Mean Normalized Gross Error
MOZART	Model for Ozone and Related Chemical Tracers
mph	Miles per Hour
MVEB	Motor Vehicle Emissions Budget
MW	Megawatt
NAAQS	National Ambient Air Quality Standard
NAM	North American Model
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCEP	National Center for Environmental Prediction
NEI	National Emissions Inventory

ng/J	Nanogram per Joule
NMIM	National Mobile Inventory Model
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
NO_X	Nitrogen Oxides
NO_Y	Total Reactive Nitrogen
NPL	National Physical Laboratory
NSR	New Source Review
NTIG	New Technology Implementation Grants
O_3	Ozone
OGV	Oceangoing Vessel
OH	Hydroxyl Radical
OLE	Olefins
OSAT	Ozone Source Apportionment Technology
OSD	Ozone Season Day
P3	The NOAA WP-3D Orion
PAMS	Photochemical Assessment Monitoring Station
PAR	Photosynthetically-Active Solar Radiation
PBL	Planetary Boundary Layer
PEI	Periodic Emissions Inventory
PFC	Portable Fuel Container
PiG	Plume-in-Grid
$PM_{2.5}$	Particulate Matter of 2.5 Microns and Less
ppb	Parts per Billion
ppbC	Parts per Billion, Carbon
ppm	Parts per Million
PPM	Piecewise Parabolic Method
psi	Pounds per Square Inch
PUCT	Public Utility Commission of Texas
QQ	Quantile-Quantile
R^2	Correlation Coefficient
RACM	Reasonably Available Control Measures
RACT	Reasonably Available Control Technology
REMI	Regional Economic Models, Inc.
rpm	Revolutions per Minute
RFP	Reasonable Further Progress
ROP	Rate-of-Progress
RRF	Relative Response Factor
RRF_D	Relative Response Factor Denominator
RRF_N	Relative Response Factor Numerator
RV	Research Vessel
RVP	Reid Vapor Pressure

SB	Senate Bill
SBFP	Seabrook Friendship Park Monitor (CAMS 45)
SCR	Selective Catalytic Reduction
SECO	State Energy Conservation Office
SEER	Seasonal Energy Efficiency Ratio
SEP	Supplemental Environmental Project
SETPMTC	Southeast Texas Photochemical Modeling Technical Committee
SGIA	Smart Growth Implementation Assistance
SHARP	Study of Houston Atmospheric Radical Precursors
SHWH	Shell Westhollow Monitor (CAMS 410)
SI	Special Inventory
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
SOF	Solar Occultation Flux
SST	Sea Surface Temperature
STARS	State of Texas Air Reporting System
TAC	Texas Administrative Code
TACB	Texas Air Control Board
TAMU	Texas A&M University
TCAA	Texas Clean Air Act
TCEQ	Texas Commission on Environmental Quality
TCM	Transportation Control Measure
TDM	Travel Demand Model
TERP	Texas Emission Reduction Plan
TexAER	Texas Air Emissions Repository
TexAQS 2000	Texas Air Quality Study 2000
TexAQS II	Texas Air Quality Study 2006
TexN	Texas NONROAD
THSC	Texas Health and Safety Code
TKE	Mellor-Yamada Turbulent Kinetic Energy
TNMHC	Total Nonmethane Hydrocarbons
TNRCC	Texas Natural Resource Conservation Commission
TOMS	Total Ozone Mapping Spectrometer
TOPAZ	Tunable Optical Profiler for Aerosol and oZone
tpd	Tons per Day
tpy	Tons per Year
TSE	Truck Stop Electrification
TTI	Texas Transportation Institute
TXCT	Texas City Monitor (CAMS 620)
TxLED	Texas Low Emission Diesel
UH	University of Houston
UPA	Unpaired Peak Accuracy
USGS	United States Geological Survey
UTC	Coordinated Universal Time

UT-CSR	University of Texas Center for Space Research
VMEP	Voluntary Mobile Emission Reduction Program
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compounds
WALV	Wallisville Monitor (CAMS 617)
WDIR	Wind Direction
WoE	Weight of Evidence
WSPD	Wind Speed

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: GENERAL

1.1 BACKGROUND

The "History of the Texas State Implementation Plan (SIP)," a comprehensive overview of the SIP revisions submitted to the United States Environmental Protection Agency (EPA) by the State of Texas, is available at the following Web site:
http://www.tceq.state.tx.us/implementation/air/sip/sipintro.html#History.

1.2 INTRODUCTION

The Houston-Galveston-Brazoria (HGB) area's hot, sunny climate, large urban population activities, and extensive, highly concentrated industrial complex provide the ingredients for ozone formation: sunlight, nitrogen oxides (NO_X), and volatile organic compounds (VOC). The Houston area's significant biogenic VOC emissions and complex meteorology, which includes land/sea breeze air parcel recirculation, complicate air quality modeling. Economic and population growth continue to create air quality challenges for the HGB area. However, key ozone-targeting regulatory programs have reduced the number and magnitude of ozone exceedances, the area of exceedance, and the population exposed to exceedances.

1.2.1 One-Hour Ozone National Ambient Air Quality Standard (NAAQS) History

The EPA established the one-hour ozone NAAQS of 0.08 parts per million (ppm) in the April 30, 1971, issue of the *Federal Register* (36 FR 8186). The EPA revised the one-hour ozone standard to 0.12 ppm in the February 8, 1979, issue of the *Federal Register* (44 FR 4202). The eight-county HGB area, defined as Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties, was first designated as a nonattainment area for the one-hour ozone NAAQS established by the Federal Clean Air Act (FCAA) in the November 6, 1991, issue of the *Federal Register* (56 FR 56694). The HGB area was classified as a Severe-17 nonattainment area, which required it to attain the one-hour ozone NAAQS by November 15, 2007. The one-hour ozone NAAQS was revoked in the June 15, 2005, issue of the *Federal Register* (69 FR 23951).

The following summaries of HGB area one-hour ozone SIP revisions are provided to give context and greater understanding of the complex issues involved in HGB's ozone challenge. For a summary of ozone SIP revisions in the HGB area prior to December 2000, please refer to the "History of the Texas State Implementation Plan (SIP)," mentioned in Section 1.1 of this chapter.

1.2.1.1 December 2000

The Post-1999 Rate-of-Progress (ROP) and Attainment Demonstration SIP for the Houston/Galveston Ozone Nonattainment Area revision contained rules and photochemical modeling analyses in support of the HGB one-hour ozone attainment demonstration. The majority of the emission reductions identified in this revision resulted from an overall 90 percent reduction in point source NO_X implemented through 30 Texas Administrative Code (TAC) Chapter 117 and the Mass Emissions Cap and Trade (MECT) program in 30 TAC Chapter 101. A modeling analysis, which showed a 141 parts per billion (ppb) peak ozone level, indicated a shortfall of 91 tons per day (tpd) in NO_X emissions reductions that were necessary, but not readily available, for an approvable attainment demonstration. In addition, the revision contained a post-1999 ROP plan for the milestone years 2002 and 2005, as well as the attainment year 2007, and transportation conformity motor vehicle emissions budgets (MVEBs) for NO_X and VOC. The SIP revision also contained enforceable commitments to implement further measures (in support of the HGB area's attainment demonstration and to remedy the estimated 91 tpd shortfall), Voluntary Mobile Emission Reduction Program (VMEP) measures, as well as a commitment to perform and submit a mid-course review (MCR) to the EPA.

1.2.1.2 September 2001

The Post-1999 ROP and Attainment Demonstration Follow-Up SIP for the Houston/Galveston Ozone Nonattainment Area revision included the following elements: 1) corrections to the ROP table/budget for the years 2002, 2005, and 2007 due to a mathematical error; 2) incorporation of a change to the idling restriction control strategy, which clarified that the operator of a rented or leased vehicle is responsible for compliance with the requirements in situations where the operator of a leased or rented vehicle is not employed by the owner of the vehicle; 3) incorporation of revisions to the clean diesel fuel rules to provide greater flexibility in complying with the rule requirements while preserving the emission reductions previously represented; 4) incorporation of a stationary diesel engine rule; 5) incorporation of revisions to the point source NO_X rules; 6) incorporation of revisions to the NO_X emissions cap and trade rules; 7) removal of the construction equipment operating restriction and the accelerated purchase requirement for Tier 2/Tier 3 heavy-duty equipment; 8) replacement of the Tier 2/Tier 3 rules with the Texas Emission Reduction Plan (TERP); 9) layout of the MCR process that detailed how the state would fulfill the commitment to obtain the additional emission reductions necessary to demonstrate attainment of the one-hour ozone standard in the HGB area; and 10) replacement of the 2007 ROP MVEB to be consistent with the attainment demonstration MVEB.

Despite the NO_X measures adopted in the December 2000 SIP revision and the stationary diesel engine rules included in the September 2001 SIP revision, an estimated 56 tpd NO_X reduction shortfall remained. The state committed to address the remaining shortfall through the MCR process. The EPA approved the December 2000 and September 2001 submittals in the November 14, 2001, issue of the *Federal Register* (66 FR 57160).

1.2.1.3 December 2002

In January 2001, the Business Coalition for Clean Air-Appeal Group (BCCA-AG) and several regulated companies challenged the December 2000 HGB SIP revision and the 90 percent NO_X reduction requirement from stationary sources. Among other things, BCCA-AG contended that the last 10 percent of the NO_X emissions reductions were not cost effective and that the ozone plan would fail because the Texas Commission on Environmental Quality (TCEQ) did not account for VOC emissions associated with upset conditions. In May 2001, the parties agreed to a stay in the case, and Judge Margaret Cooper, Travis County District Court, signed a Consent Order, effective June 8, 2001. The order required the commission to perform an independent and thorough analysis of the causes of rapid ozone formation events and to identify potential mitigating measures not yet included in the HGB attainment demonstration.

In compliance with the Consent Order, the commission conducted a scientific evaluation based in large part on aircraft data collected by the Texas Air Quality Study 2000 (TexAQS 2000). The TexAQS 2000 was a comprehensive research project, conducted in August and September 2000, involving more than 40 research organizations and over 200 scientists that studied ground-level ozone air pollution in the HGB and east Texas regions. These and other studies suggested that the HGB area's high ozone events can be attributed, in part, to the presence of significant reactivity in the airshed. An analysis of automated gas chromatograph data revealed that four highly reactive volatile organic compounds (HRVOC) were frequently responsible for high reactivity days: ethylene, propylene, 1,3-butadiene, and butenes. As such, these compounds were selected as the best candidates for HRVOC emission controls. Analysis showed that the ozone control strategy involving limits on emissions of ethylene, propylene, 1,3-butadiene, and butenes from industrial sources, in conjunction with an 80 percent reduction in industrial or point source NO_X, was equivalent or better in terms of air quality benefit than the previous ozone control strategy (a 90 percent point source NO_X emissions reduction requirement alone). Therefore, in December 2002, the TCEQ adopted a SIP revision that replaced 10 percent of industrial point source NO_X emissions reductions with industrial source HRVOC controls. HRVOC is defined in 30 TAC Chapter 115 as ethylene, propylene, 1,3-butadiene, and all isomers of butene for Harris County and ethylene and propylene for the other seven counties in the HGB area. The result was an industrial source ozone control strategy that relies on an 80 percent reduction in NO_X emissions through Chapter 117 and the MECT program, and HRVOC rules in Chapter 115 that better quantify and reduce emissions of HRVOC from four key industrial sources: fugitives, flares, process vents, and cooling tower heat exchange systems. The HRVOC fugitive emission controls are more stringent leak detection and repair requirements for components in HRVOC service such as valves and flanges. The HRVOC rules for flares, process vents, and cooling tower heat exchange systems are performance-based and emphasize monitoring, recordkeeping, reporting, and enforcement, rather than establishing individual unit emission rates. Site-wide HRVOC emission caps were established and adopted in the SIP for sites subject to the HRVOC rules for flares, process vents, and cooling tower heat exchange systems. The December 2002 SIP revision exchanging the two strategies for the one strategy met the FCAA, §110(l) requirement, which allows a revision of the SIP where that revision would not interfere with reasonable further progress toward attainment of the NAAQS.

1.2.1.4 December 2004

As previously noted in Section 1.2.1.1 of this chapter, in December 2000, the TCEQ committed to perform an MCR to ensure attainment of the one-hour ozone standard. The MCR process provided the opportunity to update emissions inventory data, use current modeling tools, and enhance the photochemical grid modeling. The data gathered from the TexAQS 2000 was used to improve the photochemical modeling of the HGB area. These technical improvements provided a more comprehensive understanding of the ozone challenge in the HGB area that is necessary to develop an attainment plan. In early 2003, as the TCEQ was preparing to move forward with the MCR, the EPA announced its plans to begin implementation of the 1997 eight-hour ozone standard. The EPA published its proposed implementation rule for the 1997 eight-hour ozone standard in the June 2, 2003, issue of the *Federal Register* (68 FR 32802). In the same timeframe, the EPA formalized its intentions to designate areas for the 1997 eight-hour ozone standard by April 15, 2004, requiring states to reassess their efforts and control strategies to address this new standard in a revised plan to be submitted to the EPA by June 2007. Recognizing that existing one-hour nonattainment areas would soon be subject to the 1997 eight-hour ozone standard and in an effort to efficiently manage the state's limited resources, the TCEQ developed an approach that addressed the outstanding obligations under the one-hour ozone standard while beginning to analyze eight-hour ozone issues.

The TCEQ's one-hour ozone SIP revision commitments that were addressed in the December 2004 HGB Ozone Nonattainment Area SIP revision include: completion of a one-hour ozone MCR; performance of modeling; adoption of measures sufficient to fill the shortfall of NO_X reductions; adoption of measures sufficient to demonstrate attainment; revision of the MVEB using the EPA's MOBILE6 model; and revision of the VMEP measures.

The December 2004 revision reflected a shift from primarily reducing industrial emissions of NO_X to reducing both industrial emissions of NO_X and industrial point source HRVOC. This revision included measures to ensure compliance with the specific strategies to control HRVOC emissions and replaced the site-wide caps adopted in the SIP with the HRVOC Emissions Cap and Trade (HECT) program in 30 TAC Chapter 101. The HECT program is an annual cap and trade program developed to provide sources compliance flexibility in meeting the control requirements for flares, process vents, and cooling tower heat exchange systems in 30 TAC Chapter 115. Sites subject to the program are required to possess an HRVOC allowance for each ton of HRVOC emissions. Sites have the option to trade excess HRVOC allowances on the open market. The December 2004 SIP revision also reflected the repeal of the motor vehicle idling rules and modified certain recordkeeping requirements of the general VOC fugitive emission rules to make them apply only to sources of HRVOC fugitive emissions.

1.2.1.5 EPA Approval of the One-Hour Ozone Attainment Demonstration

The EPA published its approval of the HGB nonattainment area one-hour ozone attainment demonstration in the September 6, 2006, issue of the *Federal Register* (71 FR 52656). Also in a separate action, the EPA concurrently approved rules for the control of HRVOC, the HECT program, the MECT program, and the emissions reduction credit banking and trading program, and conditionally approved rules for the discrete emissions reduction credit banking and trading program.

1.2.2 Eight-Hour Ozone NAAQS History

In 1997, the EPA revised the health-based NAAQS for ozone, setting it at 0.08 ppm averaged over an eight-hour time frame. The final 1997 eight-hour ozone NAAQS was published in the *Federal Register* on July 18, 1997 (62 FR 38856), and became effective on September 16, 1997. On April 30, 2004, the EPA finalized its attainment/nonattainment designations and promulgated the first phase of its implementation rule for the 1997 eight-hour ozone standard (69 FR 23951). These actions became effective on June 15, 2004. The EPA classified the HGB area as a moderate nonattainment area for the standard under the 1990 FCAA (42 United States Code, §§ 7401 *et seq*.). The TCEQ was required to submit a SIP revision for the 1997 eight-hour ozone NAAQS to the EPA by June 15, 2007, and demonstrate attainment of the standard by June 15, 2010. In the November 29, 2005, issue of the *Federal Register* (70 FR 71612) the EPA published its second phase of the implementation rule for the 1997 eight-hour ozone NAAQS, which addressed the control obligations that apply to areas designated nonattainment for the standard.

The commission adopted the 1997 eight-hour ozone nonattainment area SIP revision and the reasonable further progress SIP revision for the HGB area on May 23, 2007. These SIP revisions were the first step in addressing the 1997 eight-hour ozone standard in the HGB area. The TCEQ demonstrated reasonable further progress toward attaining the 1997 eight-hour ozone standard and committed to attaining the 1997 standard as expeditiously as practicable and developing an HGB 1997 eight-hour ozone attainment demonstration SIP revision.

On June 15, 2007, these two revisions to the Texas SIP and a letter from the governor of Texas requesting that the HGB ozone nonattainment area be reclassified from a moderate nonattainment area to a severe nonattainment area were submitted to the EPA. The EPA granted the governor’s request to voluntarily reclassify the HGB ozone nonattainment area from a moderate to a severe nonattainment area for the 1997 ozone NAAQS in the October 1, 2008, issue of the *Federal Register* (73 FR 56983). The EPA set April 15, 2010, as the date for the state to submit a revised SIP addressing the severe ozone nonattainment area requirements of the FCAA. The area’s new attainment date for the 1997 eight-hour ozone standard is as expeditiously as practicable but no later than June 15, 2019.

1.2.2.1 May 23, 2007

On May 23, 2007, the commission adopted the HGB 1997 Eight-Hour Ozone Nonattainment Area SIP revision. This SIP revision contained the reasonably available control technology (RACT) analysis, additional VMEP commitments, and the Texas 2002 Periodic Emissions Inventory for the HGB Ozone Nonattainment Area. This SIP revision also included rule revisions to 30 TAC Chapter 114 to add marine diesel fuels to the definition of diesel fuels that are subject to the Texas Low Emission Diesel Rule and to 30 TAC Chapter 115 to control underestimated, unreported, or underreported VOC emissions from tank landings, flash emissions, and degassing of storage tanks, transport vessels, and marine vessels with liquid heels. In an associated rulemaking project, 30 TAC Chapter 117 was reformatted and the 10 nanogram per Joule (ng/J) heat input NO_X standard for residential water heaters was repealed in accordance with House Bill (HB) 965, 79th Texas Legislature, 2005. The emission standard of 40 ng/J NO_X was retained.

This revision also described ongoing efforts to develop the eight-hour ozone attainment demonstration including a new modeling episode using days from 2005 and 2006, the continued implementation of increasingly lower federal on-road and non-road engine standards, and further research and consideration of additional control strategies.

The HGB 1997 Eight-Hour Ozone Nonattainment Area Reasonable Further Progress SIP revision, also adopted by the commission on May 23, 2007, demonstrates that the reasonable further progress 15 percent reduction requirement would be met for the analysis period of 2002 -

2008. Demonstration of reasonable further progress is based on the guidelines in the second phase of the EPA's 1997 eight-hour ozone implementation rule. On April 22, 2009, the EPA published a direct final approval of the reasonable further progress SIP revision, its associated MVEBs, and the 2002 base year emissions inventory (74 FR 18298).

1.2.3 Existing Ozone Control Strategies

Existing ozone control strategies and VMEP measures, discussed in Chapter 4, *Control Strategies and Required Elements*, Section 4.2, *Existing Control Measures* show key control strategies for complying with both the one-hour and eight-hour ozone NAAQS in the HGB nonattainment area. Existing control strategies targeted to the one-hour standard are expected to continue to reduce emissions of ozone precursors in the HGB area and positively impact progress toward attainment of the 1997 eight-hour ozone standard. The one-hour and 1997 eight-hour ozone design values for the HGB area from 1991 to 2008 are illustrated in Figure 1-1: *One-Hour and 1997 Eight-Hour Ozone Design Values and HGB Area Population.* Both design values have decreased over the past 18 years. The 2008 one-hour ozone design value was 147 ppb, representing a 33 percent decrease from the value for 1991 (220 ppb). The 2008 eight-hour ozone design value was 91 ppb, a 24 percent decrease from the 1991 value of 119 ppb. These decreases occurred despite a 47 percent increase in area population, as shown in the Figure 1-1: *One-Hour and 1997 Eight-Hour Ozone Design Values and HGB Area Population*.

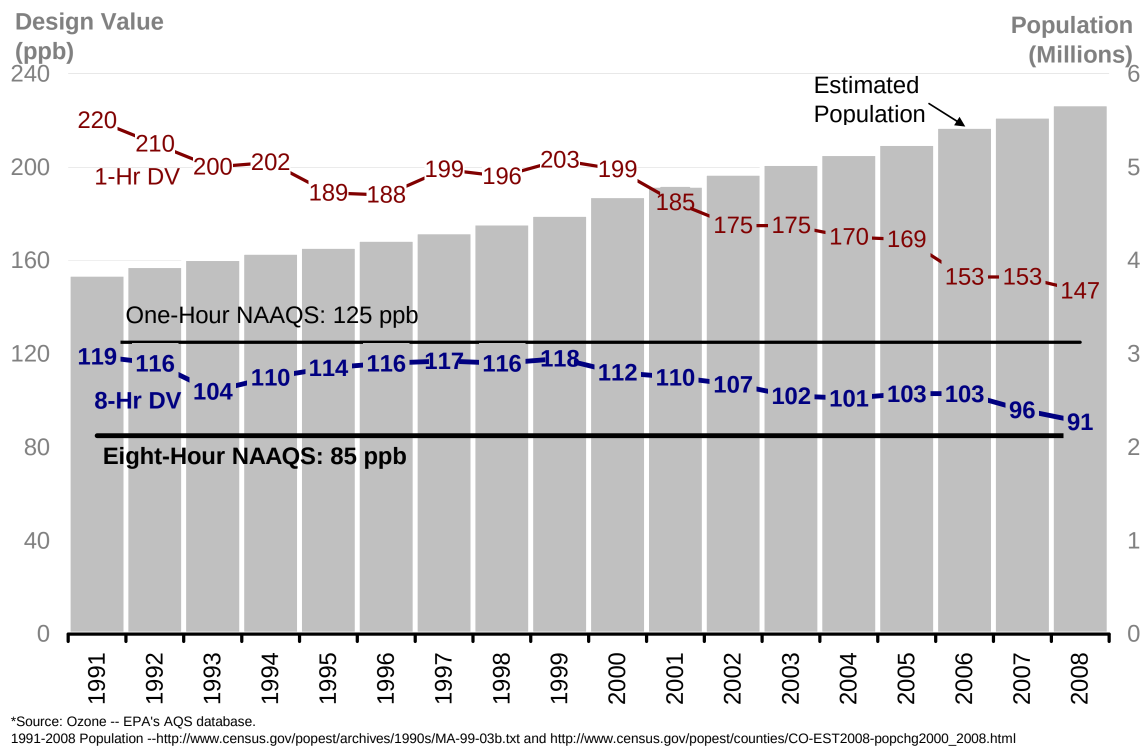


Figure 1-1: One-Hour and 1997 Eight-Hour Ozone Design Values and HGB Area Population

1.2.4 2010 Proposed Revision

The EPA reclassification of the HGB area as a severe nonattainment area for the 1997 eight-hour ozone NAAQS became effective on October 31, 2008. Severe nonattainment areas are required to attain the 1997 eight-hour ozone standard as expeditiously as practicable but no later than June 15, 2019. The state must submit a SIP revision addressing the severe ozone nonattainment area requirements of the FCAA by April 15, 2010.

This SIP revision demonstrates attainment of the 1997 eight-hour ozone NAAQS using a photochemical modeling analysis and a weight of evidence corroborative analysis. This submittal contains proposed new state and local control measures. The Houston-Galveston Area Council (H-GAC), as the regional metropolitan transportation planning agency for the HGB area, has identified VMEP measures and transportation control measures for NO_X emission reductions.

Photochemical modeling analysis demonstrates that a 25 percent reduction of the HECT cap on the total Harris County HRVOC allocation would contribute to attainment of the 1997 eight-hour ozone NAAQS by reducing the future 2018 ozone design values at all HGB monitors. Accordingly, this SIP revision contains a proposed 25 percent reduction in the total HECT allowance cap and revision of the HRVOC allocation methodology. The HECT program will continue to be applicable only in Harris County.

This SIP revision also contains the RACT analysis, the reasonably available control measures (RACM) analysis, updates to existing control measures, contingency measures, and the MVEB. The plan also describes ongoing technological research and development as well as future initiatives.

The HGB Reasonable Further Progress SIP Revision for the1997 Eight-Hour Ozone Standard (Project No. 2009-018-SIP-NR), which demonstrates the FCAA requirement of interim reductions of ozone precursors through the 2019 attainment date, is being proposed in a concurrent action.

Table 1-1: *Proposed Rule Revisions* contains the project number, title, and description of proposed rule revisions to 30 TAC Chapters 101 and 115 that are associated with this SIP revision. Additional information regarding these rule revisions is included in Chapter 4: *Control Strategies and Required Elements*.

Table 1-1: Proposed Rule Revisions

Rule Project Number	Title	Description
2009-019-101-EN	MECT Program Cap Integrity for the HGB Eight-Hour Ozone Nonattainment Area	The proposed revision to the MECT program would ensure the integrity of the modeled HGB nonattainment area cap by prohibiting the issuance of allowance allocations to major sources that did not submit the required Level of Activity Certification forms by the compliance date in 30 TAC §101.360. This proposed rule change would not reduce the current NO_X cap in the HGB nonattainment area.
2009-006-101-EN	HECT Program Cap Reduction and Allowance Reallocation	The proposed revisions to the HECT program cap rule would propose a 25 percent reduction in the total HRVOC allowance cap and revisions to the HRVOC allocation methodology. The HECT program was adopted by the commission as an ozone control measure for the HGB area on December 1, 2004. The HECT program is applicable only in Harris County.
2008-019-115-EN	VOC Control Technique Guidelines (CTG) Update	The proposed revisions to 30 TAC Chapter 115, Subchapter E, Division 4 would limit the VOC content of solvents used by offset lithographic printing facilities located in the HGB area and would implement the CTG recommendations to reduce the VOC content of the fountain solutions and cleaning materials used by such facilities. Additionally, the proposed revisions would expand the current rule applicability to include smaller sources not currently subject to the rule. The proposed revisions are to satisfy RACT for the 2006 federal CTG document for offset lithographic and letterpress printing operations.

The commission is soliciting comments on whether it is appropriate to perform a 1997 eight-hour ozone MCR analysis for the HGB area, and, if so, what elements should be contained in the analysis. The commission is also seeking input on the appropriate date to submit the MCR.

1.3 HEALTH EFFECTS

In 1997, the EPA revised the NAAQS for ozone from a one-hour to an eight-hour standard. To support the 1997 eight-hour ozone standard, the EPA provided information indicating that health effects can occur at levels lower than the previous standard and at exposure times longer than one hour. Exposure to ambient ozone can cause asthma in some people. Repeated exposures to ozone can make people more susceptible to respiratory infection and lung inflammation and can aggravate preexisting respiratory diseases, such as bronchitis and emphysema.

Children are at a relatively higher risk from exposure to ozone when compared to adults, since they breathe more air per pound of body weight than adults and because children’s respiratory systems are still developing. Children also spend a considerable amount of time outdoors during summer and during the start of the school year (August - October) when high ozone levels are typically recorded. Adults most at risk to ozone exposure are people working or exercising outdoors and individuals with preexisting respiratory diseases.

1.4 STAKEHOLDER PARTICIPATION AND PUBLIC HEARINGS

1.4.1 Local Program Control Strategy Development Meetings

The TCEQ contracted with the H-GAC to identify possible local on-road and non-road mobile source control strategies. As part of this process, stakeholder meetings were held in the HGB area. Table 1-2: *H-GAC Public and Stakeholder Meeting Dates* lists the stakeholder meetings held by H-GAC and its subcontractor, ENVIRON International Corporation from May 2008 through January 2009. These meetings gave the stakeholders and the public in the HGB area the opportunity to hear about and comment on the development of the local mobile source control strategies.

Table 1-2: H-GAC Public and Stakeholder Meeting Dates

Meetings	Dates
Airports/Airlines	5/22/08, 10/1/08, 1/6/09
Railroads	6/12/08, 12/1/08
Tug Boat Operators	12/3/08
Public Meetings	7/10/08, 12/8/08
Construction Industry	6/3/08, 12/15/08
Ports/Marine Equipment	6/12/08, 6/19/08, 12/15/08
Industrial Mobile Sources	8/13/08, 12/16/08, 1/8/09
Local Governments	1/27/09

1.4.2 TCEQ SIP and Control Strategy Development Stakeholder Meetings

The TCEQ held two identical open-participation HGB Eight-Hour Ozone SIP Stakeholder Group meetings to discuss concepts of potential control strategies for the eight-county HGB ozone nonattainment area and to hear the public's ideas on potential rulemaking concepts and provide the public an overview of the development of the HGB Attainment Demonstration SIP Revision for the 1997 Eight-Hour Ozone Standard. The meetings were held on March 25 and 26, 2008, at the Houston City Hall Annex. In these meetings, the TCEQ presented attendees with an update on the HGB Attainment Demonstration SIP Revision timeline, an update on modeling efforts, and a draft list of initial potential control strategy concepts for stationary, area, and mobile sources. The TCEQ held an additional stakeholder meeting to discuss the initial 2018 HGB modeling results, provide an update on the development status of the HGB SIP revision, and provide an update from H-GAC regarding potential local mobile source control strategies. This meeting was held on November 3, 2008, at H-GAC. Additional information on the HGB Eight-Hour Ozone SIP Stakeholder Group is available at: http://www.tceq.state.tx.us/implementation/air/sip/hgb_stakeholder.html.

A meeting was held on May 15, 2008, at H-GAC to discuss the development of the HGB Attainment Demonstration SIP Revision for the 1997 Eight-Hour Ozone Standard and potential local control measures with local governments. Letters inviting participation were sent to the 15 mayors of cities in the HGB area with populations greater than 20,000, the eight county judges, and the four Harris County commissioners. Notification was also sent to state representatives and senators representing the districts in the HGB area. Another meeting was held on July 22, 2008, at H-GAC to provide local governments information on the SIP revision, as well as discuss the process to identify potential measures that can be implemented at the local level. For this meeting, 109 letters inviting participation were sent to mayors of cities in the HGB area with populations of 20,000 or less.

1.4.3 Public Hearings and Comment Information

The commission will hold public hearings for this proposed SIP revision and associated rulemakings at the following times and locations:

CITY	DATE	TIME	LOCATION
Houston	October 28, 2009	2:00 P.M.	Houston-Galveston Area Council 3555 Timmons Lane Houston, TX 77027 Conference Room A
Houston	October 28, 2009	6:00 P.M.	Houston-Galveston Area Council 3555 Timmons Lane Houston, TX 77027 Conference Room A
Austin	October 29, 2009	3:00 P.M.	TCEQ 12100 Park 35 Circle Austin, TX 78753 Building E, Room 201S

The public comment period will open on October 9, 2009, and close on November 9, 2009. Written comments will be accepted via mail, fax, or through the eComments system. All comments should reference the "Houston-Galveston-Brazoria Attainment Demonstration State Implementation Plan Revision for the 1997 Eight-Hour Ozone Standard" and Project Number 2009-017-SIP-NR. Comments may be submitted to Lola Brown, MC 206, State Implementation Plan Team, Chief Engineer's Office, Texas Commission on Environmental Quality, P.O. Box 13087, Austin, Texas 78711-3087 or faxed to (512) 239-5687. Electronic comments may be submitted at http://www5.tceq.state.tx.us/rules/ecomments. File size restrictions may apply to comments being submitted via the eComments system. Comments must be received by November 9, 2009.

Copies of the proposed SIP revision and all appendices can be obtained from the TCEQ's Web site at http://www.tceq.state.tx.us/implementation/air/sip/hgb.html#.

1.5 SOCIAL AND ECONOMIC CONSIDERATIONS

For a detailed explanation of the social and economic issues involved with any of the measures, please refer to the preambles that precede each rule package accompanying this SIP revision.

1.6 FISCAL AND MANPOWER RESOURCES

The state has determined that its fiscal and manpower resources are adequate and will not be adversely affected through the implementation of this plan.

CHAPTER 2: ANTHROPOGENIC EMISSIONS INVENTORY (EI) DESCRIPTION

2.1 INTRODUCTION

The Air Emissions Reporting Requirements (AERR), published in the December 17, 2008, issue of the *Federal Register* (73 FR 76539), instruct states to submit EIs containing information regarding the emissions of criteria pollutants and criteria pollutant precursors (e.g., volatile organic compounds (VOC)). EIs are critical for the efforts of state, local, and federal agencies to attain and maintain the National Ambient Air Quality Standards (NAAQS).

EIs provide data for a variety of air quality planning tasks, including establishing baseline emission levels, calculating emission reduction targets, control strategy development for achieving required emission reductions, emission inputs into air quality simulation models, and tracking actual emission reductions against the established emissions growth and control budgets.

This chapter discusses general EI development for each of the AERR source categories. Chapter 3, *Photochemical Modeling* details specific emissions inventories and emissions inputs developed for the Houston-Galveston-Brazoria (HGB) ozone photochemical modeling.

2.1.1 EI Improvement

The Texas Commission on Environmental Quality (TCEQ) EI reflects years of continuous emissions data improvement, including extensive point and area source inventory reconciliation with ambient emissions monitoring data. Since the Texas Air Quality Study 2000 (TexAQS 2000), when ambient VOC concentrations were measured to be greater than EI estimates, EI improvements have targeted more accurate speciation and reporting of industrial VOC emissions. The following have significantly improved the HGB point source or area source inventory.

- Implementation of the 30 Texas Administrative Code (TAC) Chapter 115 highly reactive volatile organic compounds (HRVOC) monitoring rules improved the HGB point source VOC inventory with measurements required of vents, cooling towers, and the streams to flares in HRVOC service.

- The Houston Advanced Research Center project H51C (http://www.harc.edu/Projects/AirQuality/Projects/Projects/H051C) identified thousands of tons of VOC flash emissions from upstream oil and gas operations in the HGB area that the TCEQ has added to the area source inventory.

- A special landing loss EI was conducted that required the reporting of landing loss emissions from floating roof tanks. This special inventory also required regulated entities in the HGB area to revise their emissions inventories back to 2002, resulting in a reporting increase of approximately 7,000 to 8,000 tons of VOC per year (2002-2004). The episodic nature of these emissions is represented in the 2005 and 2006 ozone modeling based on site-specific activity data.

- A month-long hourly EI of approximately 1,200 emissions sources at 125 industrial sites was conducted during the TexAQS II intensive period. These hourly data are integrated into the 2006 modeling episode, providing highly resolved hourly VOC and nitrogen oxides (NO_X) emissions data for sources located in the HGB area. Monitored emissions data were collected for the majority of the VOC hourly emissions and all of the NO_X emissions rates. Because these sources are not included in the United States Environmental Protection Agency's (EPA) Acid Rain database, these hourly data present an opportunity to model a unique and extensive set of monitoring data that characterizes the time-dependent nature of industrial ozone precursor emissions.

- The TCEQ *Emissions Inventory Guidelines* (RG-360A), a comprehensive guidance document which explains all aspects of the point source EI process is updated and published annually. The latest version of this document is available on the TCEQ's Point Source Emissions Inventory Web site at: (http://www.tceq.state.tx.us/implementation/air/industei/psei/psei.html). Currently, six technical supplements provide detailed guidance on determining emissions from potentially underreported VOC emissions sources such as cooling towers, flares, and storage tanks.

2.2 POINT SOURCES

Stationary point source emissions data are collected annually from sites that meet the reporting requirements of 30 TAC § 101.10. These sites include, but are not limited to, refineries, chemical plants, bulk terminals, and utilities. To collect the data, the TCEQ mails EI questionnaires (EIQ) to all sites identified as meeting the reporting requirements. Companies are required to report emissions data and to provide sample calculations used to determine the emissions. Information characterizing the process equipment, the abatement units, and the emission points is also required. All data submitted in the EIQ are reviewed for quality assurance purposes and then stored in the State of Texas Air Reporting System (STARS) database. At the end of the annual reporting cycle, point source emissions data are reported each year to the EPA for inclusion in the National Emissions Inventory (NEI).

2.3 AREA SOURCES

Area sources are stationary emission sources that are not included in the point source EI. Similar area sources such as plants, facilities, equipment, and/or processes are grouped into area source categories including, but not limited to, vehicle refueling, architectural coatings, auto refinishing, dry cleaning, municipal solid waste landfills, bakeries, residential fuel combustion, structural fires, wildfires, and open burning.

Area source categories can further be characterized by the mechanism in which their emissions are released into the atmosphere: hydrocarbon evaporative emissions or fuel combustion emissions. Hydrocarbon evaporative emission sources include, but are not limited to, printing operations, industrial coatings, degreasing solvents, house painting, gasoline service station underground tank filling, and vehicle refueling operations. Fuel combustion emission sources include, but are not limited to, stationary source fossil fuel combustion at residences and businesses, outdoor burning, structural fires, and wildfires. Since area source categories represent individual emission sources that are small and numerous and that have not been inventoried as specific point or mobile sources, the EI for an area source category is developed for a specified geographic area by estimating the emissions collectively.

The emissions from these area source categories, with some exceptions, may be calculated by applying an EPA-established emission factor (emissions per unit of activity) to the appropriate activity or activity surrogate responsible for generating emissions. Population is the most commonly used activity surrogate; examples of other activity data are the amount of gasoline sold in an area, employment by industry type, and acres of crop land. Activity data for an area source category is obtained via surveys, research, and/or investigations. Air emissions data from the different area source categories are collected, reviewed for quality assurance purposes, stored in the Texas Air Emissions Repository database system, and compiled to develop the statewide area source EI. This area source Periodic Emissions Inventory (PEI) is reported every third year (triennially) to the EPA for inclusion in the NEI; the TCEQ submitted the most recent PEI for calendar year 2005.

2.4 NON-ROAD MOBILE SOURCES

Non-road mobile sources include vehicles, engines, and equipment used for construction, agriculture, transportation, recreation, and many other purposes. Non-road vehicles are also referred to as off-road or off-highway vehicles that do not normally operate on roads or highways. This broad category is comprised of a diverse collection of machines, many of which are powered by diesel engines. Examples of non-road mobile sources include, but are not limited to: agricultural equipment, commercial and industrial equipment, construction and mining equipment, lawn and garden equipment, aircraft, locomotives, and commercial marine vessels.

A Texas specific version of the EPA’s NONROAD 2005 model, called the Texas NONROAD (TexN) model, is used in calculating emissions from all non-road mobile equipment and recreational vehicles except aircraft, locomotives, and commercial marine vessels. Emissions for these three source categories are estimated using other EPA-approved methods and guidance documents. Airport emissions are calculated using the Federal Aviation Administration’s Emissions and Dispersion Modeling System, version 5.1. Locomotive emission estimates for Texas are based on specific fuel usage data derived from railway segment level gross ton mileage activity (line haul locomotives) and hours of operation (yard locomotives) provided directly by the Class I railroad companies operating in Texas. Data captured from the Automatic Identification System program is applied to the latest known emission factors to quantify emissions from commercial marine vessels.

2.5 ON-ROAD MOBILE SOURCES

On-road mobile sources consist of automobiles, trucks, motorcycles, and other motor vehicles traveling on public roadways. Combustion-related emissions are estimated for vehicle engine exhaust, and evaporative hydrocarbon emissions are estimated for the fuel tank and other evaporative leak sources on the vehicle. The information necessary to estimate on-road mobile emissions is emission factors for each vehicle type, the estimated level of vehicle activity, and estimated roadway speed.

Emission factors were developed using the newest version of the EPA's mobile emissions factor model, MOBILE6.2.03. Various inputs are provided to the model to simulate the vehicle fleet in each nonattainment area. Inputs used to develop localized emission factors include vehicle speeds, vehicle age distributions, local meteorological conditions, type of inspection and maintenance program in place, and local fuel properties. Emission factors are developed for all 28 MOBILE6.2.03 vehicle types.

The level of vehicle travel activity is developed using localized travel demand models (TDM) run by the Texas Transportation Institute, Texas Department of Transportation, or regional metropolitan planning organizations. The TDM have been validated using a large number of ground counts from traffic counters placed in various locations throughout Texas. Estimates of vehicle miles traveled (VMT) are often calibrated to outputs from the federal Highway Performance Monitor System, which is a model validated using a different set of traffic counters. VMT is allocated to the appropriate vehicle types using regional specific VMT mixes developed using ground counts and vehicle registration data.

Roadway speeds are needed to select the appropriate MOBILE6.2.03 emission factors. Roadway speeds are calculated by a post-processor to the TDM. The speed models use roadway capacity information, the estimated volumes from the TDM, and speed correlations based upon volume to capacity ratios to estimate roadway speeds.

To develop on-road mobile emissions estimates, the speed specific MOBILE6.2.03 emission factors are multiplied by the VMT for each roadway link in the TDM network.

CHAPTER 3: PHOTOCHEMICAL MODELING

3.1 INTRODUCTION

This chapter describes modeling conducted in support of the Houston-Galveston-Brazoria (HGB) Attainment Demonstration State Implementation Plan (SIP) Revision for the 1997 Eight-Hour Ozone Standard. The HGB nonattainment area consists of Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties. The 1990 Federal Clean Air Act (FCAA) amendments require that attainment demonstrations be based on photochemical grid modeling or any other analytical methods determined by the United States Environmental Protection Agency (EPA) to be at least as effective. The EPA's April 2007 "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze" (EPA, 2007; hereafter referred to as "modeling guidance") recommends new procedures for determining whether a control strategy package will lead to attainment of the 1997 eight-hour National Ambient Air Quality Standard (NAAQS) for ozone.

The current modeling guidance recommends several qualitative methods for preparing attainment demonstrations that acknowledge the limitations and uncertainties of photochemical models when used to project ozone concentrations into future years. First, the guidance recommends using model results in a relative sense and applying the model response to the observed ozone data. Second, the guidance recommends using available air quality, meteorology, and emissions data to develop a conceptual model for eight-hour ozone formation and to use that analysis in episode selection. Third, the guidance recommends using other analyses (Weight of Evidence) to supplement and corroborate the model results and support the adequacy of a proposed control strategy package.

The 1990 FCAA amendments established five classifications for ozone nonattainment areas based on the magnitude of the monitored one-hour ozone design values and established dates by which each classified area should attain the NAAQS. Based on the monitored one-hour ozone design value at that time, the HGB Consolidated Metropolitan Statistical Area (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller counties) was classified severe-17, with an attainment date of November 15, 2007. Dating back to 1990, there have been six SIP revisions with supporting photochemical modeling addressing the one-hour ozone NAAQS. The most recent one-hour ozone HGB SIP revision, submitted in December 2004, was approved by EPA on September 6, 2006.

With the change of the ozone NAAQS from a one-hour standard to an eight-hour standard, in April 2004, the EPA classified the HGB area as a moderate ozone nonattainment area with an attainment date of June 15, 2010. Ozone SIP revisions addressing the eight-hour ozone standard were due June 15, 2007. Ozone modeling and other analyses conducted by the Texas Commission on Environmental Quality (TCEQ) for the SIP revision resulted in a determination that it was not possible to attain the eight-hour NAAQS in the HGB area by the prescribed attainment date.

Therefore, the ozone SIP revision submitted to EPA on June 15, 2007, included a request to reclassify the area as severe nonattainment for the 1997 eight-hour ozone NAAQS, with an attainment date of June 15, 2019. Because the attainment date is early in the 2019 ozone season, the EPA has prescribed that the modeling attainment test be applied to the previous ozone season. Thus, 2018 is the attainment year used in the ozone modeling.

This attainment demonstration uses photochemical modeling in combination with corroborative analyses primarily associated with the 2000 and 2006 Texas Air Quality Studies (TexAQS 2000 and TexAQS II, respectively) to support a conclusion that the HGB eight-county nonattainment area will attain the 0.08 parts per million (ppm) 1997 eight-hour ozone standard by June 15, 2019. Extensive use is made of the data collected during TexAQS II to evaluate the model's performance and to improve understanding of the physical and chemical processes leading to ozone formation in the HGB area.

3.1.1 Overview of the Ozone Photochemical Modeling Process

The modeling system is composed of a meteorological model, several emissions processing models, and a photochemical air quality model. The meteorological and emissions models provide the major inputs to the air quality model.

Ozone is a secondary pollutant; it is not generally emitted directly into the atmosphere. Ozone is created in the atmosphere by a complex set of chemical reactions between sunlight and several primary (directly emitted) pollutants. The reactions are photochemical and require ultraviolet energy from sunlight. The primary pollutants fall into two groups, nitrogen oxides (NO_X) and volatile organic compounds (VOC). In addition, carbon monoxide (CO) is also an ozone precursor, but much less effective than either NO_X or VOC in forming ozone. As a result of these multiple factors, higher concentrations of ozone are most common during the summer with concentrations peaking during the day and falling during the night and early morning hours.

Ozone chemistry is complex, involving hundreds of chemical compounds and chemical reactions. As a result, ozone cannot be evaluated using simple dilution and dispersion algorithms. Due to this chemical complexity, the modeling guidance strongly recommends using photochemical computer models to simulate ozone formation and evaluate the effectiveness of future control strategies. Computer simulations are the most effective tools to address both the chemical complexity and the future case evaluation.

3.1.2 Ozone Modeling

Ozone modeling involves two major phases, the base case modeling phase and the future year modeling phase (with substeps in each phase). The purpose of the base case modeling phase is to evaluate the model's ability to adequately replicate measured ozone and ozone precursor concentrations during recent periods with high ozone concentrations (base case episodes). The purpose of the future year modeling phase is to predict attainment year ozone design values, as well as evaluate the effectiveness of controls in reaching attainment. The TCEQ developed a modeling protocol (plan) describing the process to be followed to evaluate the ozone in the urban area and submitted the plan to the EPA for approval.

3.1.3 Base Case Modeling

Base case modeling involves several steps. First, recent episodes are analyzed to determine what factors were associated with ozone formation in the area and whether those factors were consistent with the conceptual model. In consultation with the Southeast Texas Photochemical Modeling Technical Committee (SETPMTC), which serves in an advisory role for the technical aspects of applying photochemical modeling and improving the science, the TCEQ selected episodes to model.

The next step is to generate and quality-assure the emissions and meteorological data for the selected episodes. Then the meteorological and emissions (NO_X, VOC and CO) data are input to the photochemical model and the ozone photochemistry is simulated, resulting in predicted ozone and ozone precursor concentrations. Base case modeling results are evaluated by comparing them to the observed measurements of ozone and ozone precursors. Typically this step is an iterative process incorporating feedback from successive evaluations to ensure that the model is adequately replicating observations throughout the modeling episode. The adequacy of the model in replicating observations is assessed based on compliance with statistical and graphical measures as recommended in the modeling guidance. In addition to the recommended analyses, the TCEQ used the TexAQS II observations to extend its model performance evaluation to areas and chemical species not normally monitored. This extended analysis included use of monitoring data collected on aircraft and ship-based platforms. Satisfactory performance of the base case modeling provides a degree of reliability that the model can be used to predict future year ozone concentrations (future year design values), as well as to evaluate the effectiveness of possible control measures.

3.1.4 Future Year Modeling

Future year modeling involves several steps. The procedure for predicting future year ozone design values (attainment test) involves determining the ratio of the future year to the baseline year modeled ozone concentrations. This ratio is called the relative response factor (RRF). Whereas the emissions data for the base case modeling are episode-specific, the emissions data for the baseline year are based on typical ozone season emissions. Similarly, the emissions data for the future year are developed applying growth and control factors to the baseline year emissions. The growth and control factors are developed based on the projected growth in the demand for goods and services and the reduction in emissions expected from state, local, and federal control programs.

Both the baseline and future years are modeled using their respective ozone season emissions and the base case episode meteorological data as inputs. The same meteorological data are used for modeling both the baseline and future years, and thus, the ratio of future year modeled ozone concentrations to the baseline year concentrations provides a measure of the response of ozone concentrations to the change in emissions.

The future year ozone design value is calculated by multiplying the RRF by a baseline year ozone design value (DV_B). The DV_B is the average of the regulatory design values for the three consecutive years containing the baseline year (see Figure 3-1: *Baseline Design Value Calculation Illustration*). When the calculated future year ozone design value is less than or equal to 0.08 ppm (84 parts per billion (ppb)), this signifies modeled attainment. When the calculated future year ozone design value is greater than 84 ppb, then additional controls may be needed and the model can be used to test the effectiveness of various control measures in developing a control strategy.

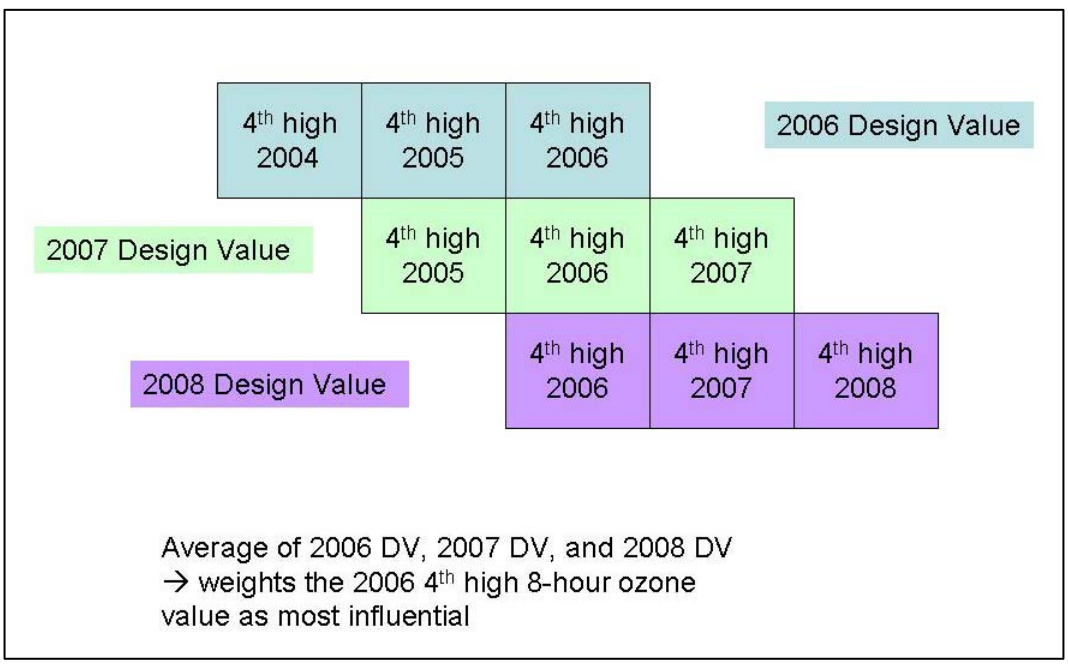


Figure 3-1: Baseline Design Value Calculation Illustration

3.2 EPISODE SELECTION

3.2.1 EPA Guidance for Episode Selection

The modeling guidance sets forth the primary criteria for selecting ozone episodes for eight-hour ozone attainment demonstration modeling:

- Select a mix of episodes reflecting a variety of meteorological conditions that frequently correspond with observed eight-hour daily maximum ozone concentrations greater than 84 ppb at different monitoring sites;
- Select periods during which observed eight-hour ozone concentrations are close to the eight-hour ozone design value at each key monitor;
- Select periods for which extensive air quality/meteorological databases exist; and
- Model a sufficient number of days so that the modeled attainment test can be applied at all of the ozone monitoring sites that are in violation of the NAAQS.

3.2.2 HGB Ozone Episode Selection Process

An episode selection analysis was performed to identify time periods with eight-hour ozone exceedance days that complied with the primary selection criteria. The analysis identified several episodes from 2005 and 2006.

Figure 3-2: *Eight-Hour Ozone Exceedance Days in HGB and Other Areas of Texas* shows the frequency distribution of days with measured daily maximum eight-hour ozone concentrations greater than 84 ppb for the period 1991 through 2008. The distribution for the HGB area is somewhat bi-modal with a notable high frequency in the late May to early June period and the more prominent period of high frequency occurring from late August through September.

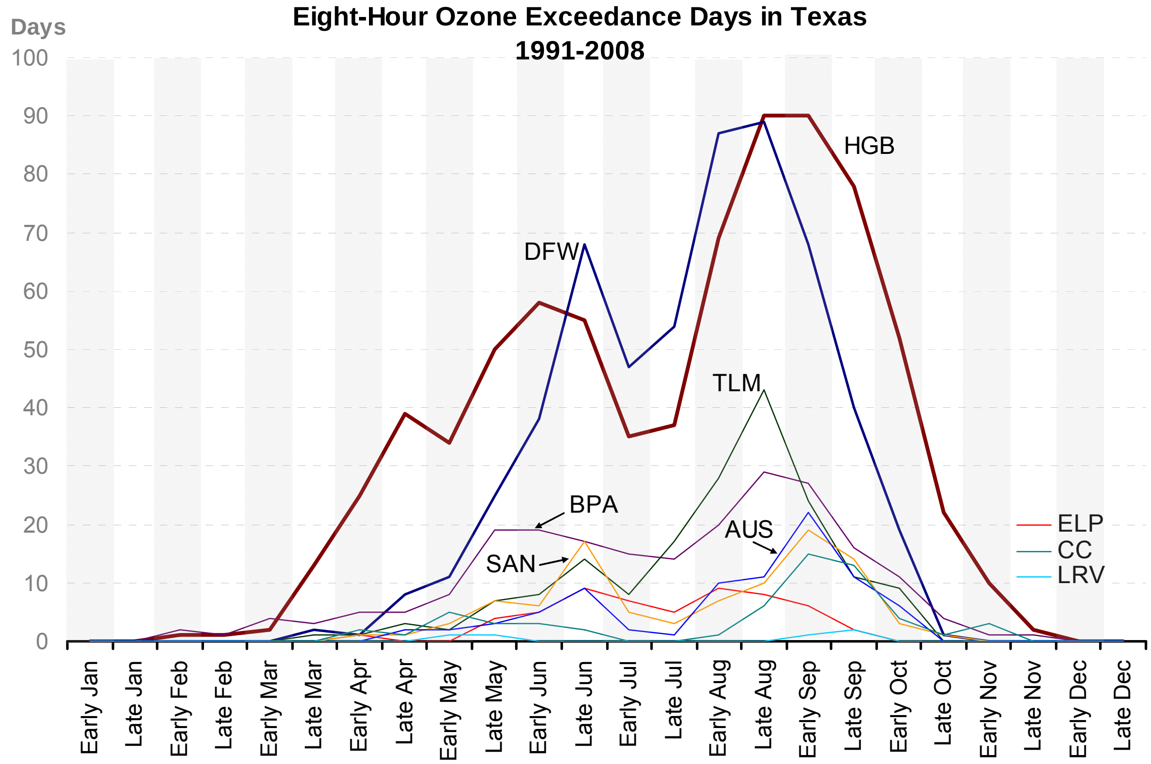


Figure 3-2: Eight-Hour Ozone Exceedance Days in HGB and Other Areas of Texas

Notes: AUS = Austin
BPA = Beaumont-Port Arthur
CC = Corpus Christi
DFW = Dallas-Fort Worth
ELP = El Paso
LRV = Lower Rio Grande Valley
SAN = San Antonio
TLM = Tyler-Longview-Marshall

In consultation with the SETPMTC, the TCEQ selected three episodes from 2005 and three episodes from 2006. Two of these occurred during the TexAQS II field intensive period. Table 3-1: *Selected Episodes* summarizes the dates of the selected episodes.

Table 3-1: Selected Episodes

Period of Episode	Number of Exceedance days
5/19/05 through 6/3/05	8
6/15/05 through 6/30/05	9
7/26/05 through 8/8/05	8
5/31/06 through 6/15/06	12
8/15/06 through 9/14/06*	10
9/19/06 through 11/11/06*	5

*TexAQS II field study intensive period

These episodes contain 52 exceedance days with occurrences from late May to early October, the primary window during which high ozone concentrations have been historically observed, and cover the periods depicted in Figure 3-2: *Eight-Hour Ozone Exceedance Days in HGB and Other*

Areas of Texas. In addition, these episodes take advantage of the TexAQS II data and findings, including the August 1 through October 15, 2006, intensive field campaign.

Selecting a large number of days also increases the likelihood that the distribution of days associated with various ozone-conducive wind patterns will be consistent with the conceptual model. The conceptual model of ozone formation in the HGB area (see Appendix C: *CAMx Modeling for the HGB Attainment Demonstration SIP)* suggests that the wind pattern characterized by a diurnal clockwise rotational veering as depicted in Figure 3-3: *Hourly Average Resultant Winds; Eight-Hour Exceedance Days, August through September 1998 through 2006* is most often associated with eight-hour ozone exceedance days.

Hourly average resultant winds are plotted in the figure. The x-axis represents the east-west component of the wind while the y-axis represents the north-south component. Each point on the loop represents an hour of the day. The red data point corresponds to midnight and the aqua point corresponds to noon. Wind vectors have two attributes, wind speed and direction, and these components were averaged across monitors for each hour of the day and then plotted. Each point represents the tail of that hour's averaged resultant wind vector, and although not plotted, all the resultant wind vectors terminate at the origin. In other words, the direction from the point to the origin represents the direction the wind blew. The distance of a point from the origin represents the average wind speed in meters per second. The pink arrow indicates the daily average of all 24 one-hour vectors, and the green halo around each point gives an indication of the variability of the data across monitors.

Of the 52 exceedance days in the selected episodes, 25 days exhibit this wind pattern. A second wind pattern also frequently associated with eight-hour ozone exceedance days is characterized by a northerly morning to southerly afternoon flow reversal. Twenty-three of the 52 exceedance days exhibit this wind pattern. The selected episodes are consistent with the conceptual model.

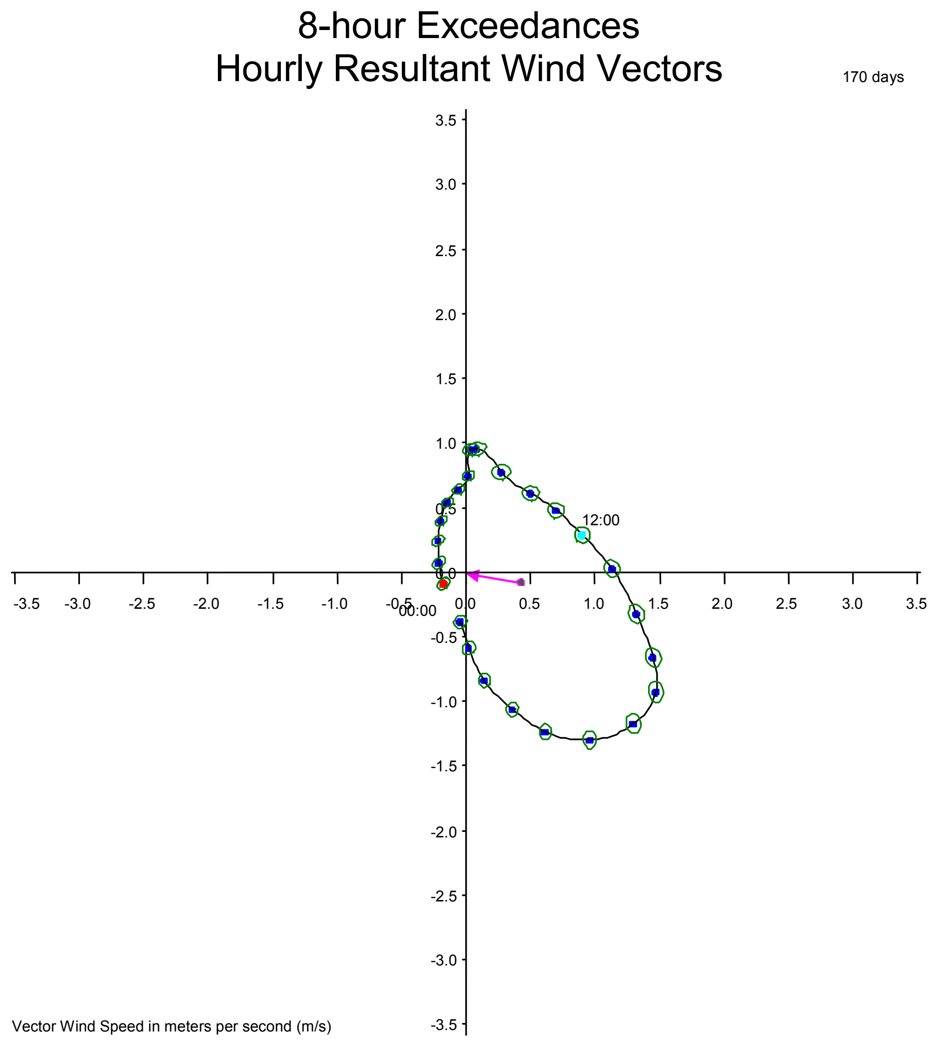


Figure 3-3: Hourly Average Resultant Winds; Eight-Hour Exceedance Days, August through September 1998 through 2006

Figure 3-4: *2005 and 2006 Non-TexAQS II Modeling Episodes* and Figure 3-5: *2006 TexAQS II Modeling Episodes* show the daily maximum eight-hour ozone concentrations observed and the number of monitors exceeding 84 ppb.

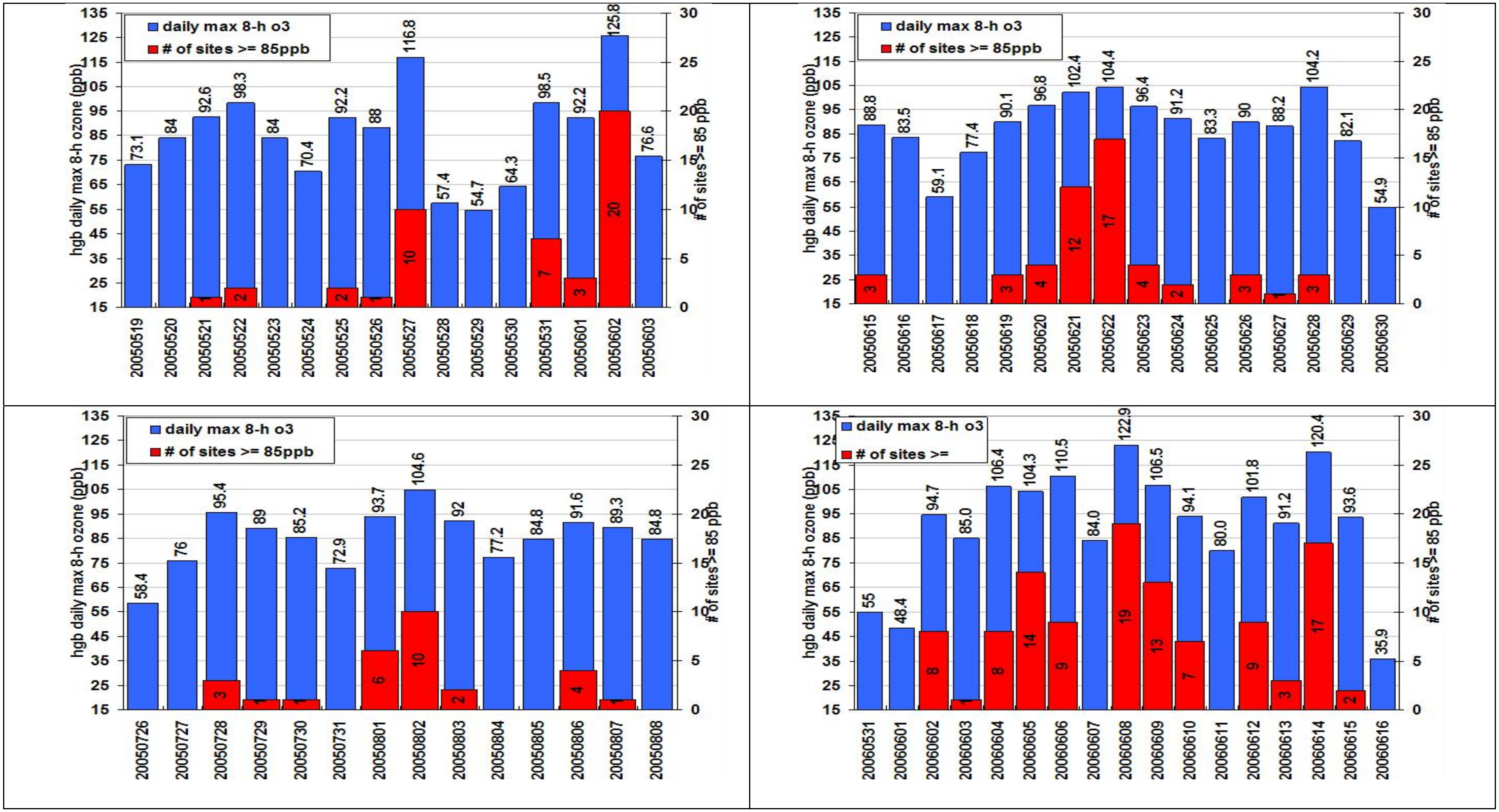


Figure 3-4: 2005 and 2006 Non-TexAQS II Modeling Episodes

Note: 8-h o3= eight-hour ozone

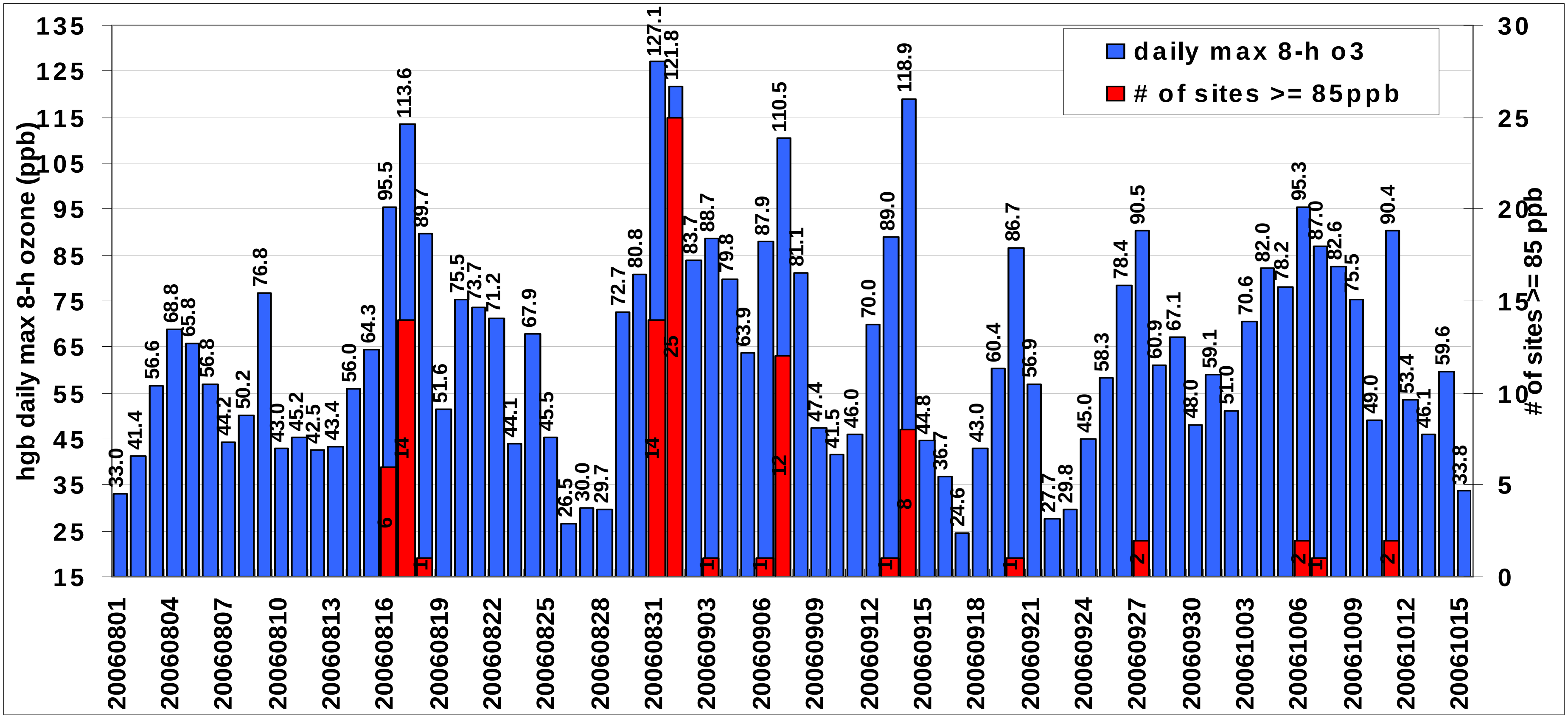


Figure 3-5: 2006 TexAQS II Modeling Episodes

Table 3-2: *Eight-Hour Ozone Design Values and Number of Exceedance Days During Selected Episodes* lists the regulatory nonattainment monitors in the eight-county HGB area along with their 2005 and 2006 eight-hour ozone design values and the number of days during the selected episodes for which the daily maximum eight-hour ozone was greater than 84 ppb.

Table 3-2: Eight-Hour Ozone Design Values and Number of Exceedance Days During Selected Episodes

Monitor Designation	Site Code	2005 Design Value (ppb)	2006 Design Value (ppb)	Number Days > 84ppb
Houston East (CAMS 1)	HOEA	87	83	7
Aldine (CAMS 8)	HALC	92	88	5
Channelview (CAMS 15)	HCHV	89	85	5
Northwest Harris County (CAMS 26)	HNWA	93	91	13
Galveston Airport (CAMS 34)	GALV	87	83	3
Deer Park (CAMS 35)	DRPK	100	96	10
Seabrook Friendship Park (CAMS 45)	SBFP	92	90	8
Houston Bayland Park (CAMS 53)	BAYP	103	103	14
Conroe Relocated (CAMS 78)	CNR2	86	85	5
TCEQ Houston Regional Office (CAMS 81)	HROC	88	84	9
Manvel Croix Park (CAMS 84)	MACP	97	96	16
Clinton (CAMS 403)	C35C	95	85	1
Houston Monroe (CAMS 406)	HSMA	97	99	10
Croquet (CAMS 409)	HCQA	98	94	8
Shell Westhollow (CAMS 410)	SHWH	89	96	12
Houston Texas Avenue (CAMS 411)	HTCA	88	84	1
Lynchburg Ferry (CAMS 1015)	LYNF	96	89	8

Note: CAMS = Continuous Ambient Monitoring Station

Figure 3-6: *Map Depicting Regulatory Monitors in the HGB Area* shows the location of the regulatory monitors in the eight-county HGB area.

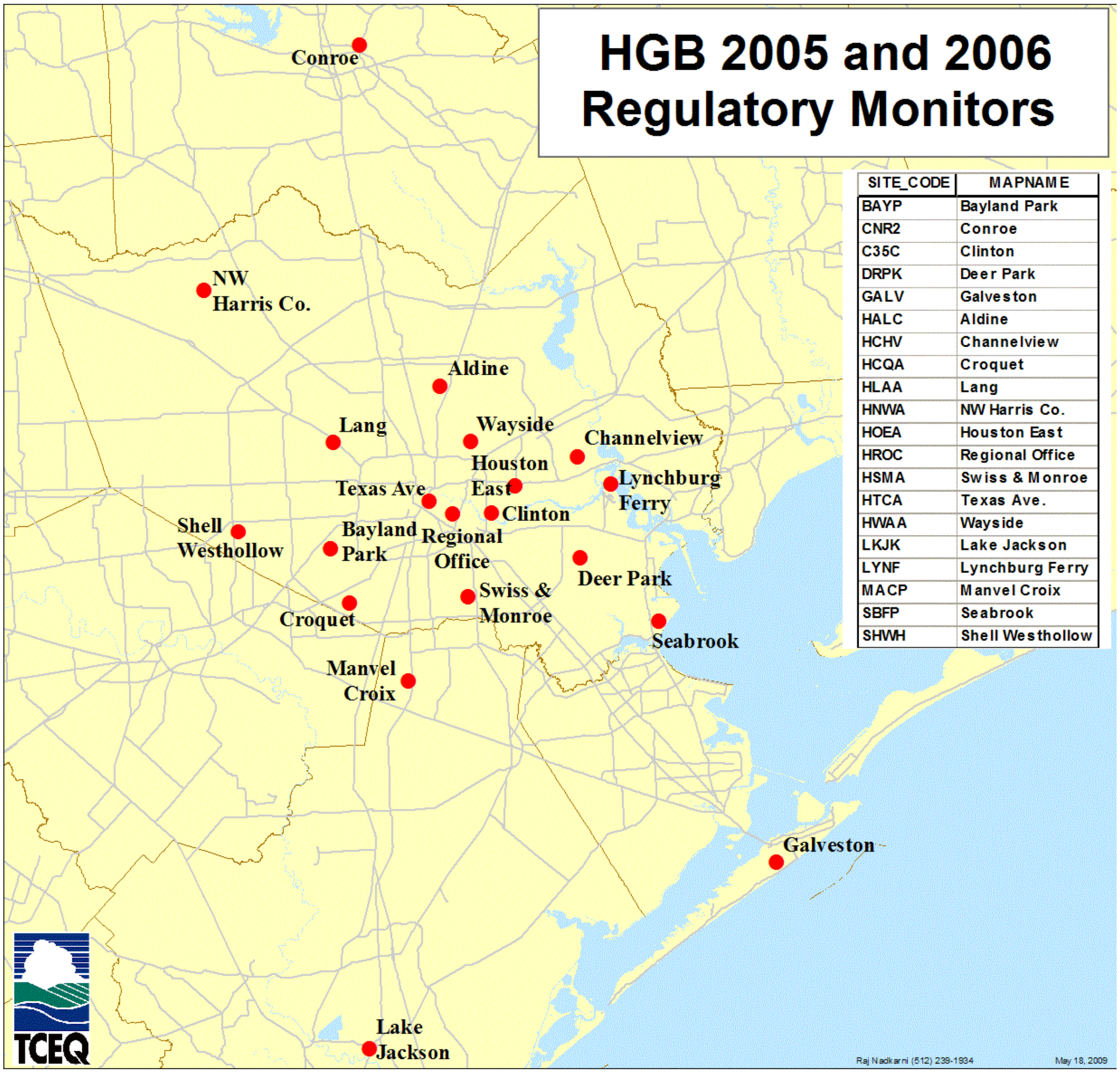


Figure 3-6: Map Depicting Regulatory Monitors in the HGB Area

Even though there are 52 exceedance days in the 2005 and 2006 episodes, only a few of the regulatory monitors measured daily maximum eight-hour ozone concentrations of greater than 84 ppb on 10 or more days. This reflects the complexity of ozone formation and distribution in the HGB area. For example, the Houston Texas Avenue (HTCA, CAMS 411) and TCEQ Houston Regional Office (HROC, CAMS 81) monitors are in fairly close proximity to one another, but the Houston Texas Avenue (CAMS 411) monitor measured a daily maximum eight-hour ozone concentration of greater than 84 ppb on only one day, while the TCEQ Houston Regional Office (CAMS 81) monitor measured it on nine days. The attainment test considers the modeled daily maximum eight-hour ozone concentration from an array of grid cells around the cell containing a monitor. By considering an array of grid cells around the monitor, rather than the single grid cell where the monitor is located, the likelihood of modeled concentrations exceeding 84 ppb is increased. This increases the number of days used in the attainment test (i.e., the RRF calculation).

There were a few other ozone episodes during the 2005 and 2006 ozone season that were not developed due to unusual meteorological conditions. For example, exceedance days that occurred in late August and September of 2005 may have been influenced by hurricanes Katrina and Rita.

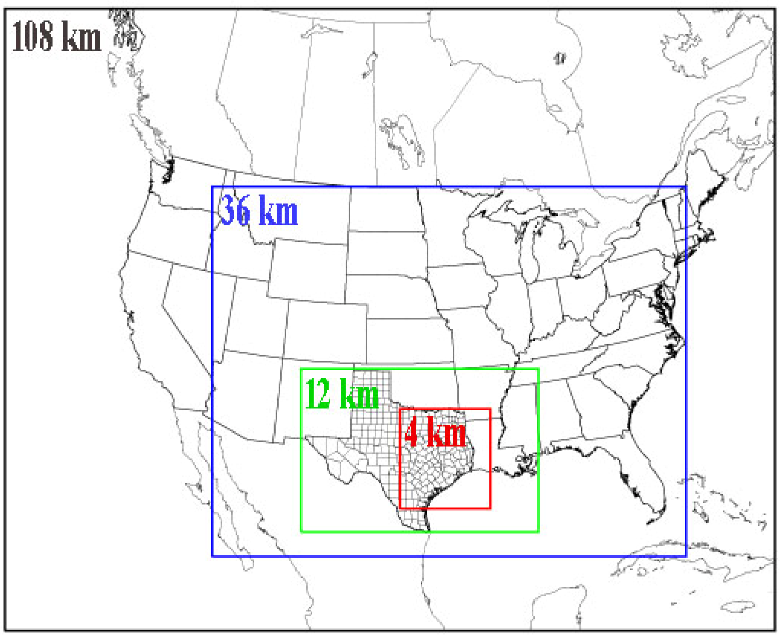
3.3 METEOROLOGICAL MODEL

The TCEQ is using the Fifth Generation Meteorological Model (MM5, version 3.7.3) developed jointly by the National Center for Atmospheric Research (NCAR) and Pennsylvania State University (Grell *et al.*, 1994). This model, supported by a broad user community including the Air Force Weather Agency, national laboratories, and academia, is being used extensively for regulatory air quality modeling analyses throughout the United States.

3.3.1 Modeling Domains

MM5 was configured with three two-way nested outer grids (108 kilometer (km), 36 km, and 12 km horizontal resolution) to cover the United States and regional areas of interest. A one-way nested 4 km fine grid covering the eastern half of Texas was used to focus on metropolitan areas with air quality degradation, as shown in Figure 3-7: *MM5 Modeling Domains*. The extent of each of the MM5 modeling domains was selected to accommodate the embedding of the commensurate air quality modeling domains (see Section 3.5: *PHOTOCHEMICAL MODELING*).

Vertically, MM5 is structured with 43 layers from the surface to approximately 20 km. Twenty layers are within the first 3,000 meters in order to resolve boundary layer phenomena. The same MM5 vertical layering structure is used for all of the domains.



	Range		Grid Points	
Domain	Easting (km)	Northing (km)	Easting	Northing
108 km	(-2808, 2808)	(-2268, 2268)	53	43
36 km	(-1296, 2160)	(-1728, 972)	97	76
12 km	(-648, 1080)	(-1548, -360)	145	100
4 km	(72, 372)	(-1380, -648)	166	184

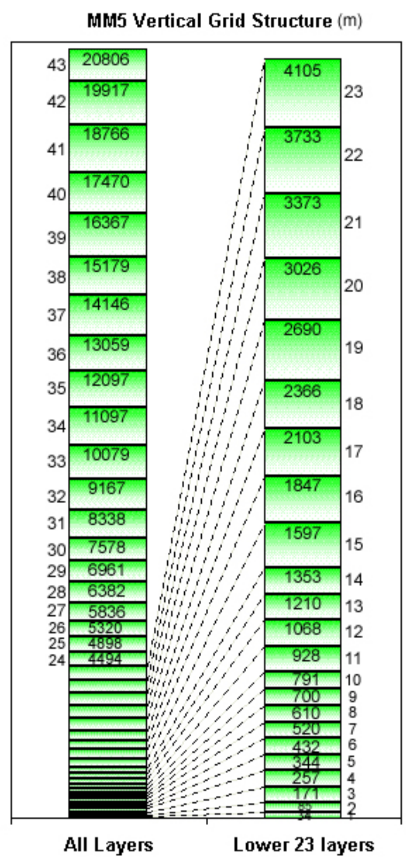


Figure 3-7: MM5 Modeling Domains

3.3.2 Model (MM5) Configuration

Based on past TCEQ modeling efforts, the EPA's modeling guidance (EPA, 2007), contractor experience, and other demonstrations including sensitivity tests and model performance evaluation, the MM5 was configured with parameterizations and improved input data to optimize the performance of the wind field (i.e., wind speed and direction). Wind speed and direction are the most important parameters predicted by the meteorological model for air quality modeling purposes because the wind field determines the transport and dispersion of pollutants. The pre-processing of the MM5 input data followed the standard progression using the TERRAIN, REGRID, and INTERPF (NCAR, 2005) programs. The NESTDOWN program was used to interpolate from the 12 km domain output to the 4 km domain input.

To improve the MM5 simulation of the meteorological parameters, in particular the wind field, the land use characteristics and sea surface temperatures on all domains were updated with high resolution satellite measurements. In addition, observed parameters are assimilated in MM5 during the model run through a process called Four-Dimensional Data Assimilation (FDDA), or nudging (Stauffer and Seaman, 1990; Stauffer *et al.*, 1991; Stauffer and Seaman, 1994). The outer domains (108 km, 36 km, and 12 km) were nudged to the National Center for Environmental Prediction (NCEP) North American Model (NAM) gridded output for winds, temperature, and water vapor. The fine scale 4 km domain was observationally nudged using quality-assured upper air wind profiler data. MM5 default nudging strength parameters were used for both the NAM and profiler nudging. The NCEP NAM gridded output was also used for model initialization (NCEP, 2009).

MM5 schemes and options typically selected for air quality applications are shown in Table 3-3: *Selected MM5 Modeling Schemes*. The selection of these schemes and options was based on previous modeling experiences, MM5 community use, and features of the ozone exceedance episodes being modeled.

Table 3-3: Selected MM5 Modeling Schemes

Domain	Nudging Type	PBL	Cumulus	Radiation	Land-Surface Model	Microphysics
108, 36, 12 km	Analysis 3-D	Eta	Grell	RRTM	Noah	Simple Ice
4 km	Observational	Eta	Grell	RRTM	Noah	Simple Ice

Notes: PBL = Planetary Boundary Layer
RRTM = Rapid Radiative Transfer Model

MM5 output was post-processed using the MM5CAMX utility to convert the MM5 meteorological fields to the Comprehensive Air Quality Model with Extensions (CAMx) grid and input format (Environ, 2008). The output was also processed with the Mellor-Yamada turbulent kinetic energy (TKE) vertical diffusivity methodology, with a minimum vertical diffusivity coefficient (K_V) of 1.0.

Appendix A: *Meteorological Modeling for the HGB Attainment Demonstration SIP* provides details on the development of the MM5 configuration, including the satellite-based Land-Use/Land-Cover (LULC) and Sea Surface Temperature (SST) data, the nudging methodology, the TKE methodology and the Grell cumulus scheme.

3.3.3 MM5 Application and Performance

The final MM5 modeling configuration was applied to periods spanning the eight-hour ozone exceedance episodes, as listed in Table 3-4: *2005 and 2006 Meteorological Modeling Episodes*.

Table 3-4: 2005 and 2006 Meteorological Modeling Episodes

Episode	All Grids Begin Date/Time (UTC)	Outer Grids End Date/Time (UTC)	Fine Grid End Date/Time (UTC)
2005ep0	May 18, 2005 06:00	June 4, 2005 06:00	June 4, 2005 06:00
2005ep1	June 15, 2005 06:00	July 1, 2005 06:00	July 1, 2005 06:00
2005ep2	July 25, 2005 06:00	August 9, 2005 09:00	August 9, 2005 07:00
2006ep0	May 29, 2006 06:00	June 17, 2006 06:00	June 17, 2006 06:00
2006ep1a	August 13, 2006 06:00	October 13, 2006 09:00	August 23, 2006 07:00
2006ep1b			September 16, 2006 07:00
2006ep1c			October 1, 2006 07:00
2006ep1d			October 13, 2006 07:00

Note: UTC = Universal Time, Coordinated.

A detailed performance evaluation for each of the 2005 and 2006 meteorological modeling episodes is included in Appendix A: *Meteorological Modeling for the HGB Attainment Demonstration SIP*. In addition, all performance evaluation products are available on the TCEQ file transfer protocol (FTP) site (TCEQ, 2009).

As mentioned, the wind speed and direction are deemed to be the most important meteorological parameters input to the air quality model. The MM5 modeled wind field was evaluated by comparing the hourly modeled and measured wind speed and direction for all monitors in the HGB area. Figure 3-8: *Meteorological Modeling Performance* exhibits the percent of hours for which the average absolute difference between the modeled and measured wind speed and direction, for all monitors in the HGB area, was within the specified accuracy benchmarks (e.g., wind speed less than or equal to two meters per second: WSPD ≤ 2 m/s).

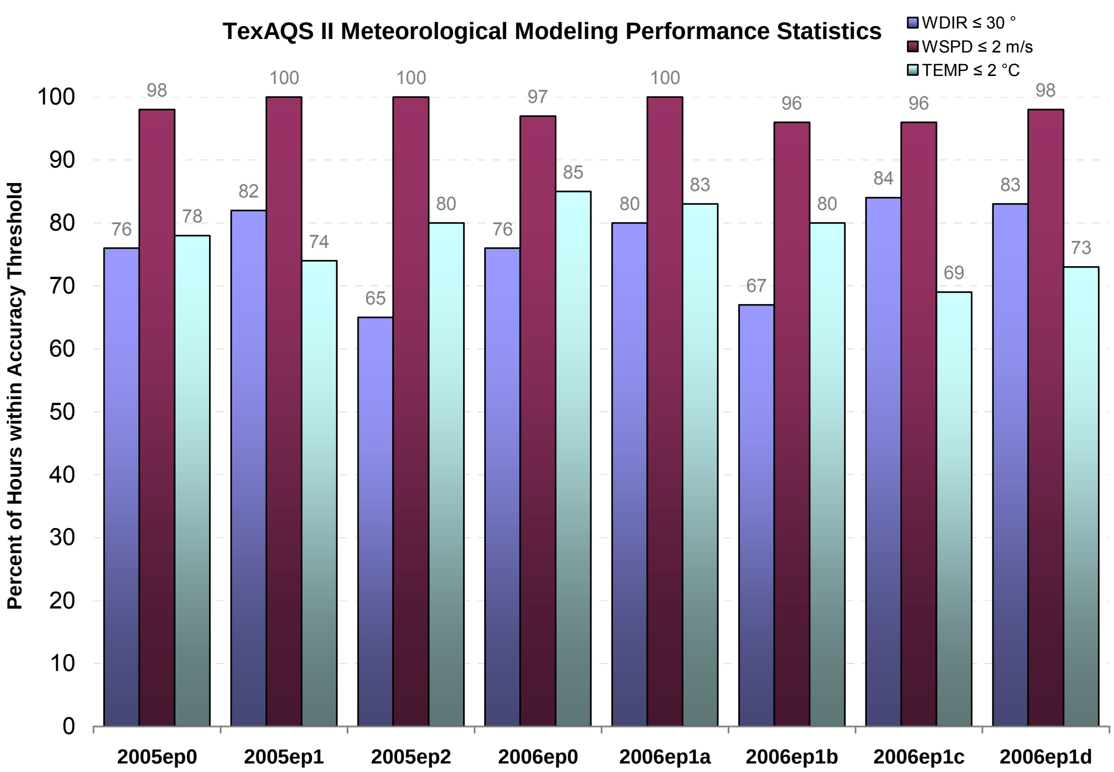


Figure 3-8: Meteorological Modeling Performance

Notes: WDIR = Wind Direction
WSPD = Wind Speed
TEMP = Temperature

Table 3-5: *Average HGB Percent Accuracy for all Meteorological Modeling Episodes* provides an additional evaluation of MM5 predictions to stricter benchmarks (Emery et al., 2001).

Table 3-5: Average HGB Percent Accuracy for all Meteorological Modeling Episodes

Episode	Wind Direction (°) Error ≤ 30 / 20 / 10	Wind Speed (m/s) Error ≤ 2 / 1 / 0.5	Temperature (°C) Error ≤ 2 / 1 / 0.5
2005ep0	76 / 67 / 49	98 / 73 / 40	78 / 49 / 30
2005ep1	82 / 71 / 40	100 / 93 / 60	74 / 50 / 28
2005ep2	65 / 54 / 33	100 / 75 / 43	80 / 57 / 31
2006ep0	76 / 63 / 45	97 / 72 / 38	85 / 57 / 33
2006ep1a	80 / 67 / 43	100 / 83 / 43	83 / 61 / 39
2006ep1b	67 / 54 / 33	96 / 63 / 26	80 / 52 / 25
2006ep1c	84 / 76 / 57	96 / 57 / 29	69 / 33 / 16
2006ep1d	83 / 66 / 33	98 / 75 / 42	73 / 51 / 32

3.4 MODELING EMISSIONS

For the stationary emission source types, which consist of point and area sources, routine emission inventories provided the major inputs for the emissions modeling processing. Emissions from mobile and biogenic sources were derived from relevant emission models. Specifically, link-based on-road mobile source emissions were derived from a travel demand model coupled with the EPA MOBILE6.2 emission factor model, and non-road mobile source emissions were derived from the EPA's National Mobile Inventory Model (NMIM), or the Texas NONROAD (TexN) mobile source models. The on- and non-road emissions were processed to air quality model-ready using version three of the Emissions Processing System (EPS3; Environ, 2007). Biogenic emissions were derived from the Global Biosphere Emissions and Interactions System (GloBEIS) model, which outputs air quality model-ready emissions.

Appendix B: *Emissions Modeling for the HGB Attainment Demonstration SIP* provides details on the development and processing of the emissions using the various EPS3 modules. The modules, listed in Table 3-6: *EPS3 Emissions Processing Modules* are used to create the chemically speciated, temporally (hourly) allocated, and spatially distributed emission files needed for the air quality model.

Table 3-6: EPS3 Emissions Processing Modules

EPS3 Module	Description
PREAM	Prepare area and non-link based mobile sources emissions for further processing
LBASE	Spatially allocate link-based mobile source emissions among grid cells
PREPNT	Group point source emissions into elevated and low-level for further processing
CNTLEM	Apply controls to model strategies, apply adjustments, etc.
TMPRL	Apply temporal profiles to hourly allocate emissions
CHMSPL	Chemically speciate emissions into nitrogen oxide (NO), nitrogen dioxide (NO_2), CB05-VOC
GRDEM	Spatially distribute emissions by grid cell using source category surrogates
MRGUAM	Merge and adjust multiple gridded files for model-ready input
PIGEMS	Assigns PiGs and merges elevated point source files

Notes: CB05 = the 2005 version of the Carbon Bond chemical mechanism
PiG = Plume-in-Grid

Model-ready emissions were developed for the episode days listed in Table 3-7: *2005 and 2006 Episode Days for Emissions Modeling*.

Table 3-7: 2005 and 2006 Episode Days for Emissions Modeling

2005 and 2006 Base Case Episodes		
Episode Code	Episode Designation	Episode Days
bc05ep0	May/June 2005	May 19 through June 3, 2005
bc05ep1	June 2005	June 17 through 30, 2005
bc05ep2	July/August 2005	July 26 through August 8, 2005
bc06ep0	June 2006	May 31 through June 15, 2006
bc06aqs1	August/September 2006	August 13 through September 15, 2006
bc06aqs2	September/October 2006	September 16 through October 11, 2006

The following sections give a brief description of the development of each type of emissions.

3.4.1 Biogenic Emissions

The TCEQ used Version 3.1 of the GloBEIS model to develop the biogenic emissions. It incorporates detailed locality-specific land-use data to generate the mix and density of vegetative species. In addition, solar radiation data from Geostationary Operational Environmental Satellite (GOES) imagery, which is used to generate the photosynthetically active solar radiation (PAR), can be input to the GloBEIS model. Further, the GloBEIS model can accept hourly temperature data generated from weather station data.

Biogenic Emissions Landuse Data,Version 3 (BELD3; Kinnee et al., 1997), a vegetation database for the entire North American continent prepared specifically for creating biogenic emissions inventories, was used for the 36 km domain and the portion of the 12 km domain outside Texas. For the land-use data in the 12 km domain within Texas, the TCEQ used the Texas vegetation database (Wiedinmyer et al., 2001), which was derived from Texas Parks and Wildlife vegetation data and agricultural statistics from the National Agricultural Statistics Survey, and field surveys carried out in 1999. Within the 4 km nested domain, a new land-cover database from the University of Texas Center for Space Research (UT-CSR) was used (Feldman et al., 2007). This database was developed from classification of recent Landsat 7 data, Shuttle Radar Topography Mission and National Elevation datasets to identify wetlands, and United States Department of Agriculture, Common Land Unit CLU data to identify agricultural land.

The episode-specific PAR data input to GloBEIS were obtained from the website operated by the Global Energy and Water Cycle Experiment (GEWEX) Continental-Scale International Project (GCIP) and GEWEX Americas Prediction Project (GAPP) located at http://metosrv2.umd.edu/~srb/gcip/cgi-bin/historic.cgi?auth=no. The episode-specific temperature data were obtained from weather stations throughout the United States, including data from the National Weather Service, the EPA Aerometric Information Retrieval System (AIRS) air quality database, the National Buoy Data Center, the Texas A&M Crop Weather Program, the Louisiana Agricultural Information Service, and the Texas Coastal Oceanographic Observation Network.

GloBEIS3.1 was run for each of the modeling episode days listed in Table 3-7: *2005 and 2006 Episode Days for Emissions Modeling*. Figure 3-9: *An Example of Day-Specific Biogenic Emissions* shows the typical magnitude and distribution of biogenic VOC and NO_X emissions in the 4 km modeling domain.

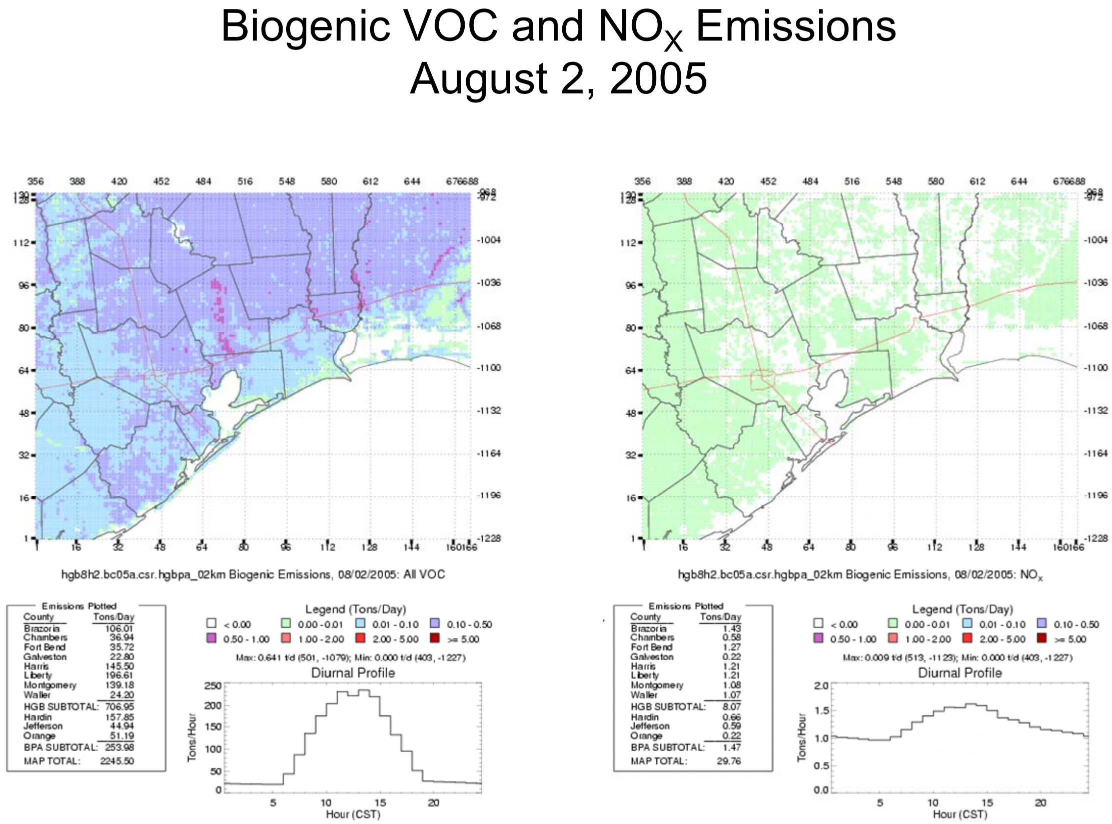


Figure 3-9: An Example of Day-Specific Biogenic Emissions

Since biogenic emissions are associated with meteorological features, the same episode day-specific emissions were used as input for the 2006 baseline and 2018 future air quality modeling.

3.4.2 Base Cases

3.4.2.1 Point Sources

Point source modeling emissions were developed using data from regional inventories such as the Central Regional Air Planning Association/Regional Planning Organization (CENRAP/RPO) emissions database and EPA's Acid Rain Database (ARD), state inventories including the State of Texas Air Reporting System (STARS), and local inventories including the TexAQS II Hourly Special Inventory (SI). Data were processed with EPS3 to generate model-ready emissions, and similar procedures were used to develop each base case episode.

Outside Texas

Point source emissions data for the regions of the modeling domains outside Texas were obtained from a number of different sources. Emissions from point sources in the Gulf of Mexico (e.g., oil and gas production platforms) were obtained from the 2005 Gulf-wide Emissions Inventory (GWEI) provided by the Minerals Management Services (MMS) as monthly totals. The Canadian emissions were obtained from EPA modeling emission files developed for the 2001 Clean Air Interstate Rule (CAIR) base case analysis (EPA, 2005) and the Mexican emissions inventory data were obtained from Phase III of the Mexican National Emissions Inventory (NEI; http://www.epa.gov/ttn/chief/net/mexico.html).

For all states beyond Texas, hourly NO_X emissions for major electric generating units (EGUs) were obtained from the ARD for each episode day. Emissions for non-ARD sources in states beyond Texas were obtained from the 2002 CENRAP/RPO emissions database, with the exception of

Arkansas, Louisiana, and Oklahoma. State-specific 2005 point source annual emissions for non-ARD sources were provided by Arkansas and Oklahoma. Louisiana provided their 2004 point source emissions, since the 2005 emissions were incomplete due to hurricane Katrina. The EPA's Economic Growth Analysis System Version 5.0 (EGAS5) was used to grow these emissions to 2005 and 2006 as appropriate for the various episodes.

Within Texas

Hourly NO_X emissions from EGUs within Texas were obtained from the ARD for each episode day. Emissions from non-ARD sources were obtained from the TCEQ 2005 and 2006 STARS emissions inventories. The 2006 TexAQS II hourly special inventory (SI) collected August 15 through September 15, 2006, was used for the August/September 2006 episode (bc06aqs1). In addition, agricultural and forest fire emissions for the 2005 and 2006 episodes were obtained from a TCEQ-funded study (Environ, 2008b), which treated fires as point sources. For the HGB area, 2005 and 2006 event-specific tank landing loss emissions were obtained from an SI revision requested by the TCEQ. Highly Reactive Volatile Organic Compounds (HRVOC) (ethylene (ETH), propylene, butenes and 1,3-butadiene) emissions were reconciled with ambient measurements by comparing concentrations observed at automated gas chromatographs (auto-GCs) in the area with concentrations expected at those locations based on the reported inventory. See Appendix B: *Emissions Modeling for the HGB Attainment Demonstration SIP* for more details.

Table 3-8: *2005 and 2006 Base Case Episode Point Source Modeling Emissions for HGB* summarizes the typical weekday point source emissions for the eight-county HGB area by episode.

Table 3-8: 2005 and 2006 Base Case Episode Point Source Modeling Emissions for HGB

Point Source Type	Bc05ep0			Bc05ep1			Bc05ep2		
	NO_X	VOC	CO	NO_X	VOC	CO	NO_X	VOC	CO
	(tpd)			(tpd)			(tpd)		
ARD[1]	43.89	3.28	29.59	43.03	3.08	38.56	55.26	4.04	48.24
N-ARD[2]	147.52	224.87	95.51	147.52	224.87	95.51	147.52	224.87	95.51
Tank L[3]	NA	49.50	NA	NA	17.80	NA	NA	33.10	NA
Fires[4]	0.04	0.29	3.61	0.10	0.81	10.37	0.92	7.19	92.70
HRVOC[5]	NA	29.92	NA	NA	29.92	NA	NA	29.92	NA
Totals	191.45	307.86	128.71	190.65	276.48	144.44	203.70	299.12	236.45

Point Source Type	Bc06ep0			Bc06aqs1			Bc06aqs2		
	NO_X	VOC	CO	NO_X	VOC	CO	NO_X	VOC	CO
	(tpd)			(tpd)			(tpd)		
ARD[1]	46.65	2.87	39.66	40.41	2.45	29.45	48.42	2.72	36.47
N-ARD[2]	124.13	180.62	89.52	121.95	165.39	88.34	124.13	180.62	89.52
Tank L[3]	NA	17.40	NA	NA	10.40	NA	NA	0.30	NA
Fires[4]	0.04	0.27	3.46	0.13	1.05	13.47	0.04	0.30	3.72
HRVOC[5]	NA	21.17	NA	NA	21.17	NA	NA	21.17	NA
Totals	170.82	222.33	132.64	162.49	200.46	131.26	172.59	205.11	129.71

Notes:
1. ARD emissions listed are for a Wednesday in a specific episode.
2. Non-ARD emissions listed are for OSD weekday, OSD weekend days are slightly less.
3. Tank landing emissions listed are episode-specific average for days with non-zero emissions.
4. Agriculture and forest fire emissions listed are episode-specific average for days with non-zero emissions.
5. HRVOC reconciled emissions listed are the amounts added through the emissions reconciliation procedure to those reported.

3.4.2.2 On-Road Mobile Sources

On-road mobile source modeling emissions were developed using the EPA's NMIM, and Highway Performance Monitoring System (HPMS) data and travel demand modeling (TDM) output coupled with the EPA MOBILE6.2 emissions model. The output from these emission modeling applications were processed through EPS3 to generate the air quality model-ready on-road mobile source emission files.

Outside Texas

For all of the states beyond Texas, the TCEQ used NMIM to generate average summer weekday mobile source emissions by county for 2005 and 2006. Average summer Friday, Saturday, and Sunday mobile source emissions were estimated using the weekday to Friday, Saturday, and Sunday ratios developed for the on-road mobile source emissions within Texas.

Within Texas

For the Texas counties outside of HGB and Beaumont-Port Arthur (BPA) areas, on-road emissions were developed by the Texas Transportation Institute (TTI) using HPMS data for 2005 and 2006, and the EPA's MOBILE6.2 on-road mobile source emissions model to generate average summer emissions for the four day types of weekday (Monday through Thursday average), Friday, Saturday, and Sunday.

For the eight-county HGB and three-county BPA areas, link-based on-road emission were developed by TTI using the TDM output for 2005 and 2006, and the EPA MOBILE6.2 on-road mobile source emissions model to generate average summer and school season on-road emission for the four day types. For the 2005 and 2006 base case episodes, both the school and summer season day type emissions were used as appropriate.

Table 3-9: *Summary of the Development of On-Road Mobile Sources Emissions* summarizes features of the on-road mobile emissions in the different regions of the modeling domain.

Table 3-9: Summary of the Development of On-Road Mobile Sources Emissions

On-Road Inventory Development Parameter	HGB and BPA	Non- HGB and BPA	Non-Texas States/Counties
VMT Source and Resolution	TDM Roadway Links	HPMS Data Sets -19 Roadways	NMIM Database - 12 Roadways
Season Types	School and Summer	Summer Only	Summer Only
Day Types	Weekday, Friday, Saturday, and Sunday	Weekday, Friday, Saturday, and Sunday	Weekday, Friday, Saturday, and Sunday
Hourly VMT Mix By Day Type	Yes	Yes	No
Roadway Speed Distribution	Varies by Hour and Link	Varies by Hour and Roadway Type	MOBILE6.2 Default
MOBILE6.2 Classes	28	28	12
Temperature/Humidity Diesel NO_X Correction	Yes	Yes	No
"18-Wheeler" Idling Emissions Separation	Yes	No	No

Note: VMT= Vehicle Miles Traveled

Table 3-10: *2005 and 2006 Base Case Episode On-Road Modeling Emissions for HGB* summarizes the on-road mobile source emissions for each of the 2005 and 2006 base case episodes for the eight-county HGB area.

Table 3-10: 2005 and 2006 Base Case Episode On-Road Modeling Emissions for HGB

On-Road Day Type	Bc05ep0			Bc05ep1			Bc05ep2		
	NO_X	VOC	CO	NO_X	VOC	CO	NO_X	VOC	CO
	(tpd)			(tpd)			(tpd)		
Weekday	233.35	110.29	1307.35	221.67	104.27	1244.93	221.67	104.27	1244.93
Friday	241.06	123.43	1457.80	223.68	113.73	1359.36	223.68	113.73	1359.36
Saturday	192.67	85.51	1099.39	180.72	80.09	1032.63	180.72	80.09	1032.63
Sunday	148.68	70.51	906.86	143.17	67.81	873.70	143.17	67.81	873.70

On-Road Day Type	Bc06ep0			Bc06aqs1			Bc06aqs2		
	NO_X	VOC	CO	NO_X	VOC	CO	NO_X	VOC	CO
	(tpd)			(tpd)			(tpd)		
Weekday	197.28	99.39	1115.23	207.64	105.15	1171.27	207.64	105.15	1171.27
Friday	199.92	108.40	1217.36	215.43	117.70	1305.77	215.43	117.70	1305.77
Saturday	160.76	76.06	920.59	171.37	81.21	980.17	171.37	81.21	980.17
Sunday	127.68	64.42	778.75	132.59	66.99	808.41	132.59	66.99	808.41

Notes: 1. Episodes bc05ep0, bc06aqs1 and bc06aqs2 use school season emissions; episodes bc05ep1, bc05ep2 and bc06ep0 use summer season emissions.
2. VOC is reported as sum of CB05 species.

3.4.2.3 Non- and Off-Road Mobile Sources

Non/Off-road mobile source modeling emissions were developed using the EPA NMIM, the EPA NEI, TexN, and data from the TCEQ's Texas Air Emissions Repository (TexAER). The output from these emission modeling applications and databases were processed through EPS3 to generate the air quality model-ready non- and off-road mobile source emission files.

Outside Texas

For all the states beyond Texas, the TCEQ used the EPA's NMIM. NMIM generates average summer weekday non-road mobile source category emissions by county and was run for 2005 and 2006. For the off-road mobile source categories (aircraft, locomotive, and marine) in the non-Texas states, the TCEQ used the EPA's 2002 NEI with EGAS5 growth factors and national controls for locomotives and marine vessels to generate 2005 and 2006 average summer weekday off-road mobile source category emissions. Summer weekend day emissions for the non- and off-road mobile source categories were developed as part of the EPS3 processing using category specific weekly activity profiles.

Within Texas

The TCEQ used the TexN model to generate average summer weekday non-road mobile source category emissions by county for 2005 and 2006. County-level off-road emissions for 2005 were obtained from the TCEQ's 2005 TexAER, and the 2006 county-level off-road emissions were estimated by adjusting the 2005 TexAER emissions with the Texas-specific Regional Economic Models, Inc. (REMI)-EGAS growth factors, except for the aircraft/airport emissions in the HGB and DFW areas. The 2005 and 2006 aircraft/airport emissions in the HGB and DFW areas were provided through a stakeholder process and these emissions are airport-specific rather than county-level. Summer weekend day emissions for the non- and off-road mobile source categories were developed as part of the EPS3 processing using category specific weekly activity profiles.

Table 3-11: *2005 and 2006 Base Case Episode Non- and Off-Road Modeling Emissions for HGB* summarizes the non- and off-road mobile source weekday emissions for each of the 2005 and 2006 base case episodes for the eight-county HGB area. Since these are average summer weekday, the 2005 emissions are used for each of the 2005 base case episodes and the 2006 emissions are used for each of the 2006 base case episodes.

Table 3-11: 2005 and 2006 Base Case Episode Non- and Off-Road Modeling Emissions for HGB

Non-Road Type	Bc05ep0			Bc05ep1			Bc05ep2		
	NO_X	VOC	CO	NO_X	VOC	CO	NO_X	VOC	CO
	(tpd)			(tpd)			(tpd)		
Non-Road	84.97	81.01	805.50	84.97	81.01	805.50	84.97	81.01	805.50
Airports	9.53	2.72	38.22	9.53	2.72	38.22	9.53	2.72	38.22
Locomotive	30.34	2.48	8.52	30.34	2.48	8.52	30.34	2.48	8.52
Marine	34.47	0.79	6.30	34.47	0.79	6.30	34.47	0.79	6.30
Totals	159.31	87.00	858.54	159.31	87.00	858.54	159.31	87.00	858.54

Non-Road Type	Bc06ep0			Bc06aqs1			Bc06aqs2		
	NO_X	VOC	CO	NO_X	VOC	CO	NO_X	VOC	CO
	(tpd)			(tpd)			(tpd)		
Non-Road	78.85	75.97	772.94	78.85	75.97	772.94	78.85	75.97	772.94
Airports	9.89	2.80	38.07	9.89	2.80	38.07	9.89	2.80	38.07
Locomotive	28.56	2.45	8.77	28.56	2.45	8.77	28.56	2.45	8.77
Marine	35.10	0.80	6.41	35.10	0.80	6.41	35.10	0.80	6.41
Totals	152.40	82.02	826.19	152.40	82.02	826.19	152.40	82.02	826.19

Note: VOC is reported as sum of CB05 species

3.4.2.4 Area Sources

Area source modeling emissions were developed using the EPA NEI and the TCEQ TexAER. The emissions information in these databases was processed through EPS3 to generate the air quality model-ready area source emission files.

Outside Texas

For all the states beyond Texas, the TCEQ used the EPA's 2002 NEI with EGAS5 growth factors to generate 2005 and 2006 daily area source emissions.

Within Texas

The TCEQ used 2005 TexAER to generate 2005 daily area source emissions and for the 2006 daily area source emissions, applied the Texas-specific REMI-EGAS growth factors.

Since these are daily emissions, the 2005 emissions are used for each of the 2005 base case episodes and the 2006 emissions are used for each of the 2006 base case episodes.

3.4.2.5 Base Case Summary

Table 3-12: *2005 and 2006 Base Case Episode Anthropogenic Modeling Emissions for HGB* summarizes the typical weekday emissions in the eight-county HGB area by source type for each base case episode.

Table 3-12: 2005 and 2006 Base Case Episode Anthropogenic Modeling Emissions for HGB

Source Type	Bc05ep0			Bc05ep1			Bc05ep2		
	NO_X	VOC	CO	NO_X	VOC	CO	NO_X	VOC	CO
	(tpd)			(tpd)			(tpd)		
Point[1]	191.45	307.86	128.71	190.65	276.48	144.44	203.70	299.12	236.45
On-Road[2]	233.35	110.29	1307.35	221.67	104.27	1244.37	221.67	104.27	1244.37
Non –Road[3]	84.97	81.01	805.50	84.97	81.01	805.50	84.97	81.01	805.50
Off-Road[3, 4]	74.35	5.99	53.04	74.35	5.99	53.04	74.35	5.99	53.04
Area[3]	36.18	524.35	131.71	36.18	524.35	131.71	36.18	524.35	131.71
Totals	620.30	1029.50	2426.31	607.82	992.10	2379.06	620.87	1014.74	2471.07

Source Type	Bc06ep0			Bc06aqs1			Bc06aqs2		
	NO_X	VOC	CO	NO_X	VOC	CO	NO_X	VOC	CO
	(tpd)			(tpd)			(tpd)		
Point[1]	170.82	222.33	132.64	162.49	200.46	131.26	172.59	205.11	129.71
On-Road[2]	197.28	99.39	1115.23	207.64	105.15	1171.27	207.64	105.15	1171.27
Non –Road[3]	78.85	75.97	772.94	78.85	75.97	772.94	78.85	75.97	772.94
Off-Road[3, 4]	73.55	6.05	53.25	73.55	6.05	53.25	73.55	6.05	53.25
Area[3]	36.35	528.99	134.59	36.35	528.99	134.59	36.35	528.99	134.59
Totals	556.85	932.73	2208.65	558.88	916.62	2263.31	568.98	921.27	2261.76

Notes:
1. Point source emissions are based on non-startup Wednesday ARD emissions and average non-zero tank landing emissions
2. On-road emissions are season- (school or summer) and year-specific emissions
3. Non-road, off-road and area emissions are year-specific OSD emissions
4. Off-road emissions consist of airport, locomotive, and marine emissions
5. VOC is reported as sum of CB05 species

3.4.3 2006 Baseline

In general, the baseline modeling emissions are based on typical ozone season emissions, whereas the base case modeling emissions are episode day-specific. The biogenic emissions are an exception in that the same episode day-specific emissions are used in the 2006 baseline and base cases. In addition, the 2006 baseline non- and off-road and area source modeling emissions are the same as used for the 2006 base case episodes, since they are based on typical ozone season emissions. No fire emissions were included in the 2006 baseline.

3.4.3.1 Point Sources

For the non-ARD point sources, the 2006 baseline emissions are the same as the modeling emissions used for the June 2006 (bc06ep0) and the bc06aqs2 episodes. The 2006 baseline ARD sources EGUs emissions were estimated using the average of the 2006 third quarter hourly ARD emissions. The 2006 baseline tank landing emissions were estimated as the average of the tank landing emissions for those 2006 episode days with non-zero emissions. The HRVOC emissions reconciliation developed for the 2006 base cases was used for the 2006 baseline. For the Gulf of Mexico, Canada, and Mexico, the 2006 baseline uses the same emissions as the base cases.

3.4.3.2 On-Road Mobile Sources

The 2006 baseline on-road mobile source emissions are the same as used for the June 2006 (bc06ep0) base case episode. These are the summer season modeling emissions for each of the day types, weekday, Friday, Saturday, and Sunday.

3.4.4 2018 Future Base and Control Strategy

The biogenic emissions used for the 2018 future base and control strategy modeling are the same episode day-specific emissions used in the base cases. In addition, similar to the 2006 baseline, no fire emissions were included in the 2018 future base and control strategy modeling.

3.4.4.1 Point Sources

Outside Texas

The non-ARD point source emissions data in the regions outside Texas were obtained from the 2018 CENRAP/RPO regional haze SIP. For the Gulf, Canada, and Mexico, the 2018 emissions are the same as used in the 2006 baseline. The CAIR Phase 2 emission levels were used for the EGU 2018 emissions, with an adjustment for the ozone season. The ozone season adjustment was developed using the ratio of the average of the 2006 third quarter hourly ARD emissions to the annual average ARD emissions.

Within Texas

Emissions for the non-ARD point sources were projected to 2018 using the larger of the Texas Industrial Production Index (TIPI) or Texas-specific REMI EGAS growth factors (or banked Emissions Reduction Credits and Discrete Emissions Reduction Credits in nonattainment areas). Controls pertinent to existing HGB, DFW, and BPA SIP revisions were applied to appropriate point source categories (e.g., Mass Emissions Cap and Trade program (MECT), HRVOC Emissions Cap and Trade program (HECT), and East Texas Combustion Rule). The 2018 future base emissions for HECT-applicable point sources in Harris County used their HECT allocations. The 2018 control strategy includes a 25 percent reduction (2.69 tpd) to the HECT cap for applicable point sources in Harris County.

Similar to the 2018 emissions for ARD sources outside Texas, the ARD sources within Texas used the CAIR Phase 2 emissions adjusted to the ozone season, with the exception of ARD sources in the eight-county HGB area, which are subject to the MECT rule. The 2018 emissions for ARD sources within the HGB area used the MECT allocations adjusted to the ozone season, similar to the adjustment for the ARD sources in the non-HGB area. Newly-permitted ARD sources were limited to the CAIR 9.5 percent set-aside for growth. The 2018 tank landing emissions were the same as the 2006 baseline, but the HRVOC reconciliation was reduced by the amount in Harris County associated with HECT applicable source categories.

For the eight-county HGB area, the point source NO_X emissions are reduced by about 5 percent from the 2006 baseline (172.16 tpd) to the 2018 future base (162.75 tpd) and the VOC emissions are increased about 48 percent from the 2006 baseline (208.34 tpd) to the 2018 future base (309.46 tpd). The 25 percent HECT control strategy reduces the 2018 control strategy VOC emissions to 306.75 tpd.

3.4.4.2 On-Road Mobile Sources

Outside Texas

The TCEQ used the EPA's NMIM to generate average summer weekday mobile source emissions by county for 2018 for all of the states beyond Texas. Average summer Friday, Saturday, and Sunday mobile source emissions were estimated using the weekday to Friday, Saturday, and Sunday ratios developed for the on-road mobile source emissions within Texas.

Within Texas

For the Texas counties outside of the HGB and BPA areas, summer season, day type, non-link on-road emissions were developed by TTI using 2018 projected traffic data and the EPA's MOBILE6.2. For the eight-county HGB and three-county BPA (Jefferson, Hardin, and Orange) areas, link-based on-road emissions were developed by TTI using the TDM output projected for 2018, and the EPA's MOBILE6.2 on-road mobile source emissions model to generate average summer season on-road emissions for the four day types. The 2018 control strategy includes a 1.55 tpd Voluntary Mobile Emission Reduction Program (VMEP) NO_X reduction to the on-road mobile sources for alternative commuting, vehicle retrofit and replacement, and traffic flow improvement measures.

For the eight-county HGB area, the on-road mobile source NO_X emissions are reduced by about 74 percent from the 2006 baseline (197.28 tpd) to the 2018 future base (50.76 tpd) and the VOC emissions are decreased about 49 percent from the 2006 baseline (99.39 tpd) to the 2018 future base (50.39 tpd). The VMEP control strategies reduce the 2018 control strategy NO_X emissions to 49.21 tpd.

3.4.4.3 Non- and Off-Road Mobile Sources

Outside Texas

For the states outside of Texas, the TCEQ used the EPA's NMIM to generate average summer weekday non-road mobile source category emissions by county for 2018. For the off-road mobile source categories, aircraft, locomotive, and marine, in the states beyond Texas, the TCEQ used the EPA's 2002 NEI with EGAS5 growth factors and national controls for locomotives and marine vessels to generate 2018 average summer weekday off-road mobile source category emissions. Summer weekend day emissions for the non- and off-road mobile source categories were developed as part of the EPS3 processing using category specific weekly activity profiles.

Within Texas

The TCEQ used the TexN model to generate average summer weekday non-road mobile source category emissions by county for 2018. 2018 county-level off-road emissions were estimated by adjusting the 2005 TexAER emissions with the Texas-specific REMI-EGAS growth factors, except for the aircraft/airport emissions in the HGB and DFW areas and marine vessels in HGB and BPA. The 2018 aircraft/airport emissions in the HGB and DFW areas were provided through a stakeholder process and these emissions are airport-specific rather than county-level. The 2018 emissions for marine vessels in HGB and BPA were developed using emission trends provided by the HGB and BPA Port Authorities (Starcrest, 2000). Summer weekend day emissions for the non- and off-road mobile source categories were developed as part of the EPS3 processing using category specific weekly activity profiles.

For the eight-county HGB area, the non- and off-road mobile source NO_X emissions are reduced by about 20 percent from the 2006 baseline (152.40 tpd) to the 2018 future base (121.37 tpd) and the VOC emissions are decreased about 19 percent from the 2006 baseline (82.02 tpd) to the 2018 future base (66.49 tpd). The 2018 control strategy includes 0.70 tpd NO_X reduction to non-road VMEP measures.

3.4.4.4 Area Sources

Outside Texas

The TCEQ obtained emissions data used in the 2018 regional haze SIP revision that was created by the CENRAP/RPO for all the states beyond Texas.

Within Texas

The 2018 county-level area source emissions were estimated by adjusting the 2005 TexAER emissions with the Texas-specific REMI-EGAS growth factors, except for the flash emissions category. Flash emissions will be controlled in the future as a result of the Storage Vessel and Degassing rule (30 Texas Administrative Code (TAC) Chapter 115), so no growth was applied and the same emissions were used for the 2018 future base and control strategy as the 2006 baseline.

For the eight-county HGB area, the area source NO_X emissions are increased by about 16 percent from the 2006 baseline (36.35 tpd) to the 2018 future base (42.04 tpd) and the VOC emissions are increased about 23 percent from the 2006 baseline (528.99 tpd) to the 2018 future base (650.09 tpd).

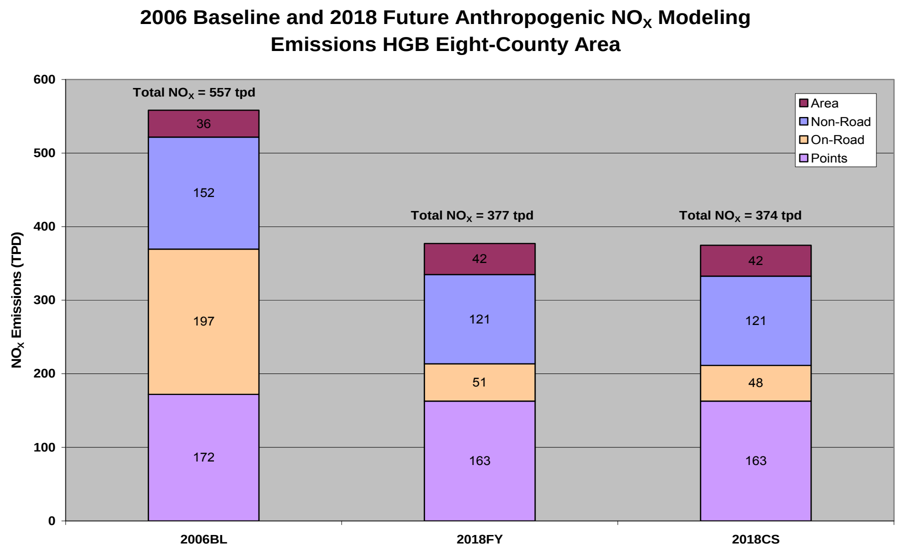
3.4.5 2006 and 2018 Modeling Emissions Summary for HGB

Table 3-13: *Summary of 2006 Baseline and 2018 Future Base, and 2018 Control Strategy Anthropogenic Modeling Emissions for HGB* summarizes the typical weekday anthropogenic emissions in the eight-county HGB area by source type for the 2006 and 2018 future base modeling emissions as well as the 2018 control strategy.

Table 3-13: Summary of 2006 Baseline and 2018 Future Base, and 2018 Control Strategy Anthropogenic Modeling Emissions for HGB

Source Type	2006 Baseline			2018 Baseline			2018 Control Strategy		
	NO_X	VOC	CO	NO_X	VOC	CO	NO_X	VOC	CO
	(tpd)			(tpd)			(tpd)		
Point	172.16	208.34	126.22	162.75	309.46	182.10	162.75	306.77	182.10
On-Road	197.28	99.39	1115.23	50.76	50.39	733.17	49.21	50.39	733.17
Non -Road	78.85	75.97	772.94	35.65	59.56	893.84	34.95	59.56	893.84
Off-Road	73.55	6.05	53.25	85.72	6.93	44.71	85.72	6.93	44.71
Area	36.35	528.99	134.59	42.04	650.09	158.99	42.04	650.09	158.99
Totals	558.19	918.74	2202.23	376.92	1076.43	2012.81	374.67	1073.74	2012.81

Figure 3-10: *2006 Baseline and 2018 Future Base, and 2018 Control Strategy Anthropogenic NO_X and VOC Modeling Emissions for HGB* graphically compares the anthropogenic NO_X and VOC modeling emissions for the eight-county HGB area.



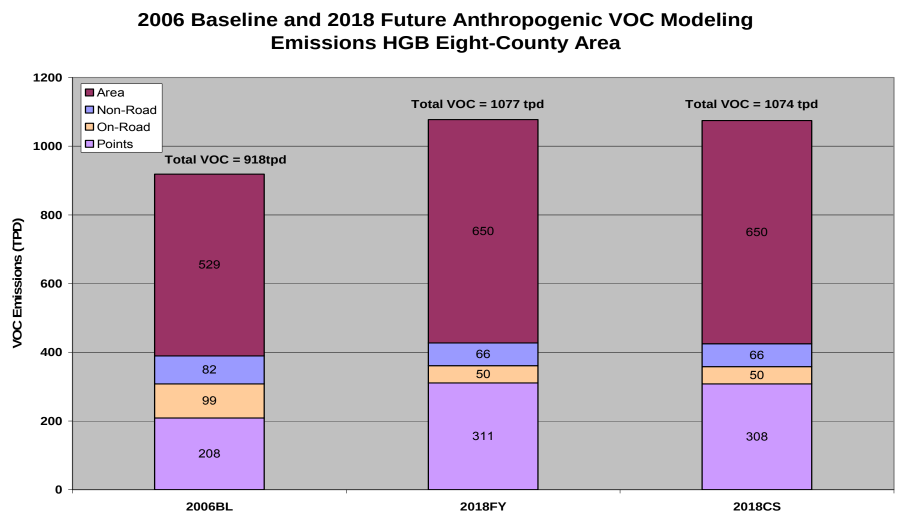


Figure 3-10: 2006 Baseline and 2018 Future Base, and 2018 Control Strategy Anthropogenic NO_X and VOC Modeling Emissions for HGB

Notes: 2006BL = 2006 Baseline
2018FY = 2018 Future Year or Future Base
2018CS = 2018 Control Strategy
In the above figures, Non-Road includes the off-road emissions

3.5 PHOTOCHEMICAL MODELING

To ensure that a modeling study can be successfully used as technical support for an attainment demonstration SIP revision, the air quality model must be scientifically sound and appropriate for the intended application and freely accessible to all stakeholders. In a regulatory environment, it is crucial that oversight groups (e.g., the EPA), the regulated community, and the interested public have access to and also be convinced of the suitability of the model. The following three prerequisites were identified for selecting the air quality model to be used in the HGB attainment demonstration:

- must have a reasonably current, peer-reviewed, scientific formulation;
- must be available at no or low cost to stakeholders; and
- must be consistent with air quality models being used for other Texas nonattainment or near nonattainment areas.

The only model to meet all three of these criteria is CAMx. The model is based on well-established treatments of advection, diffusion, deposition, and chemistry. Another important feature is that NO_X emissions from large point sources can be treated with the PiG submodel, which helps avoid the artificial diffusion that occurs when point source emissions are introduced into a grid volume. The model software and the CAMx user's guide are publicly available at http://www.camx.com (Environ, 2009). In addition, the TCEQ has many years of experience with CAMx. CAMx was used for the modeling conducted in the DFW and BPA nonattainment areas, as well as for modeling being conducted in other areas of Texas (e.g., San Antonio).

CAMx Version 4.53 was used for this modeling study. Some of the features in this version include the ability to process in parallel on multiple processors and the following probing tools for sensitivity analysis:

- Process Analysis, which provides in depth details of ozone formation, showing the various physical and chemical processes that determine the modeled ozone concentrations at specified locations and times;
- Ozone Source Apportionment Technology (OSAT), which estimates the contribution of emissions from multiple geographical areas and source categories to ozone formation (including biogenic emissions); and
- Anthropogenic Precursor Culpability Assessment (APCA), which reallocates ozone apportioned to non-controllable biogenic emissions to the controllable portion of precursors that participated in ozone formation.

3.5.1 Modeling Domains and Horizontal Grid Cell Size

Figure 3-11: *CAMx Modeling Domains* depicts the modeling domains used in CAMx. The horizontal configuration of the CAMx modeling domains consist of a 2 km x 2 km grid (2 km) encompassing a major portion of the HGB nonattainment counties (red box), nested within a 4 km x 4 km grid (4 km) encompassing both the HGB and BPA counties (blue box), nested within a 12 km x 12 km grid (12 km) covering the eastern part of Texas (green box), nested within the outer (black box) 36 km x 36 km grid (36km). The 36 km outer domain was selected to minimize the effect of boundary conditions on predicted ozone concentrations.

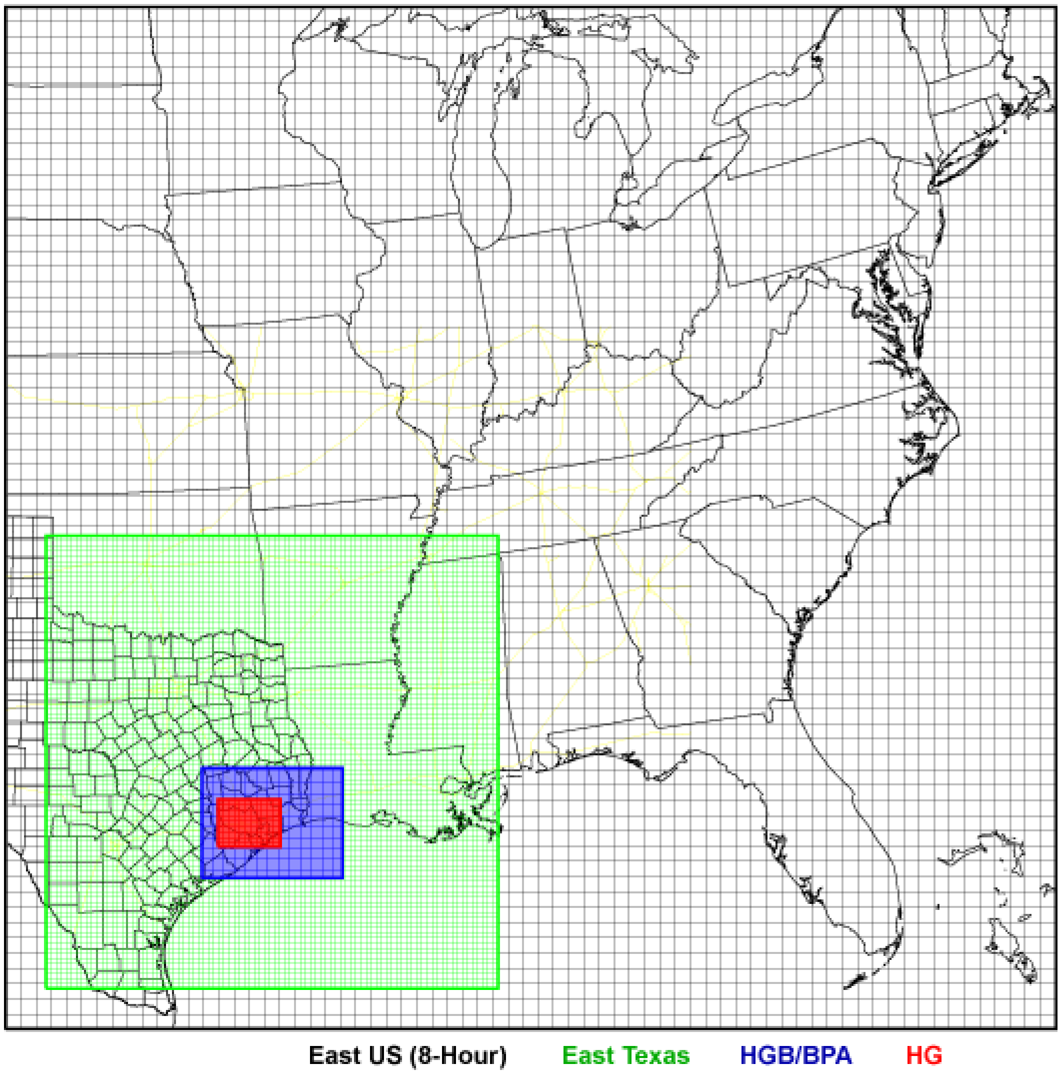


Figure 3-11: CAMx Modeling Domains

All grids align with the grid developed by the EPA for nationwide modeling for regional haze and particulate matter. Choosing a grid system compatible with an existing large-scale grid system serves several functions, including ability to use ready-made regional inventory data directly, ability to integrate the TCEQ's modeling into regional modeling projects, and promoting consistency among various regional and urban modeling applications in the central United States.

A finer resolution subdomain within the 4 km HGB-BPA domain better replicates the emission gradients in the narrow industrial plumes emanating from the Ship Channel and surrounding areas.

3.5.2 Vertical Layer Structure

The vertical configuration of the CAMx modeling domains consists of 28 layers of varying depth used with the 2 km and 4 km domains, and 17 layers of varying depth used with the 12 km and 36 km horizontal domains. The unique meteorology induced by the land/sea/bay effects and the diverse mixture of industrial source types, which release pollutants across a wide range of elevations, require more vertical layers, particularly near ground level, in the fine-grid domains. Table 3-14: *CAMx Vertical Layer Structure for 2 km and 4 km Fine Grids* and Table 3-15: *CAMx Vertical Layer Structure for Intermediate and Coarse Grids* show the vertical structuring of the 28-layered and 17-layered configurations, respectively.

Table 3-14: CAMx Vertical Layer Structure for 2 km and 4 km Fine Grids

CAMx Layer	MM5 Layer	Top (m AGL[1])	Center (m AGL[1])	Thickness (m)
28	38	15179.1	13637.9	3082.5
27	36	12096.6	10631.6	2930.0
26	32	9166.6	8063.8	2205.7
25	29	6960.9	6398.4	1125.0
24	27	5835.9	5367	937
23	25	4898	4502.2	791.6
22	23	4106.4	3739.9	733
21	21	3373.5	3199.9	347.2
20	20	3026.3	2858.3	335.9
19	19	2690.4	2528.3	324.3
18	18	2366.1	2234.7	262.8
17	17	2103.3	1975.2	256.2
16	16	1847.2	1722.2	256.3
15	15	1597.3	1475.3	249.9
14	14	1353.4	1281.6	243.9
13	13	1209.8	1139	143.6
12	12	1068.2	998.3	141.6
11	11	928.5	859.5	137.8
10	10	790.6	745.2	90.9
9	9	699.7	654.7	90.1
8	8	609.5	564.9	89.3
7	7	520.2	476.0	88.5
6	6	431.7	387.8	87.8
5	5	343.9	300.4	87.0
4	4	256.9	213.7	86.3
3	3	170.5	127.7	85.6
2	2	84.9	59.4	51.0
1	1	33.9	16.9	33.9

Note: 1. AGL - Above ground level.

Table 3-15: CAMx Vertical Layer Structure for Intermediate and Coarse Grids

CAMx Layer	MM5 Layer	Top (m AGL)	Center (m AGL)	Thickness (m)
17	38	15179.1	12172.9	6012.5
16	32	9166.6	7501.3	3330.7
15	27	5835.9	4970.9	1730
14	23	4105.9	3565.9	1080
13	20	3025.9	2564.5	922.9
12	17	2103	1728.1	749.8
11	14	1353.2	1210.6	285.2
10	12	1068.2	929.3	277.5
9	10	790.6	700.0	181.0
8	8	609.5	564.9	89.3
7	7	520.2	476.0	88.5
6	6	431.7	387.8	87.8
5	5	343.9	300.4	87.0
4	4	256.9	213.7	86.3
3	3	170.5	127.7	85.6
2	2	84.9	59.4	51.0
1	1	33.9	16.9	33.9

3.5.3 Model Configuration

The TCEQ used CAMx version 4.53, which includes a number of upgrades and features from previous versions. The following CAMx 4.53 options were employed:

- Parallel processing of the chemistry and transport algorithms;
- CB05 chemical mechanism with Euler Backward Iterative (EBI) chemistry solver;
- Piecewise Parabolic Method (PPM) advection solver;
- Flexi-nesting to interpolate the 4 km meteorological parameters to the 2 km CAMx domain; and
- PiG treatment of larger point sources of NO_X using the Greatly Reduced Execution and Simplified Dynamics (GREASD) Lagrangian module.

In addition to the CAMx inputs developed from the meteorological and emissions modeling, inputs are needed for initial and boundary conditions, spatially resolved surface characteristic parameters, spatially resolved albedo/haze/ozone (i.e., opacity) and photolysis rates, and a chemistry parameters file.

The TCEQ contracted with Environ (Environ, 2008b) who worked with National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL) to derive episode-specific boundary conditions from the Model for Ozone and Related Chemical Tracers (MOZART) global air quality model. Boundary conditions were developed for each grid cell along all four edges of the 36 km domain (number of horizontal grid cells [69 or 67 for east-west or north-south edges, respectively] times the number of vertical layers [17]) for each episode hour. This work also produced initial conditions for each of the episodes. The TCEQ used these episode-specific initial and boundary conditions for this modeling study. The top-boundary conditions were set at the clean concentration levels as previously derived by Environ and used in the recently approved DFW Ozone Attainment Demonstration SIP revision (TCEQ, 2007).

Surface characteristic parameters, including roughness, vegetative distribution, and water/land boundaries, are input to CAMx via a land-use file. The land-use file provides the fractional contribution (0 to 1) of eleven land-use categories, as defined by the United States Geological Survey (USGS) LULC database. For the 36 km and 12 km domains, the TCEQ used the land-use files developed by Environ for the DFW SIP revision approved by the EPA in 2009, which were derived from the most recent USGS LULC database. For the 2 km domain and portions of the 4 km domain, in the vicinity of HGB, the TCEQ used updated land-use files developed by Texas A&M University (Popescu et al., 2008), which were derived from more highly resolved LULC data collected by the Texas Forest Service and the UT-CSR.

The spatially-resolved opacity and photolysis rates are input to CAMx via a photolysis rates file and an opacity file, which are specific to the chemistry parameters file for the CB05 mechanism, which is also input to CAMx. The TCEQ used episode-specific satellite data from the Total Ozone Mapping Spectrometer (TOMS) to prepare the photolysis rates and opacity files.

3.5.4 Model Performance Evaluation

The CAMx model configuration was applied to the 2005 and 2006 base cases using the episode-specific meteorological parameters and emissions. The CAMx modeling results were compared to the measured ozone and ozone precursor concentrations, which resulted in a number of modeling iterations involving improvements to the meteorological and emissions modeling and subsequent CAMx modeling. A detailed performance evaluation for each of the 2005 and 2006 base case modeling episodes is included in Appendix C: *CAMx Modeling for the HGB Attainment Demonstration SIP*. In addition, all performance evaluation products are available on the TCEQ FTP site (TCEQ, 2009).

3.5.4.1 Performance Evaluations Overview

The performance evaluation of the base case modeling demonstrates the adequacy of the model to correctly replicate the relationship between levels of ozone and the emissions of NO_X and VOC. The model's ability to suitably replicate this relationship is necessary to have confidence in the model's prediction of the response of ozone to various control measures. As recommended in the EPA modeling guidance, the TCEQ conducted two types of performance evaluations, operational and diagnostic.

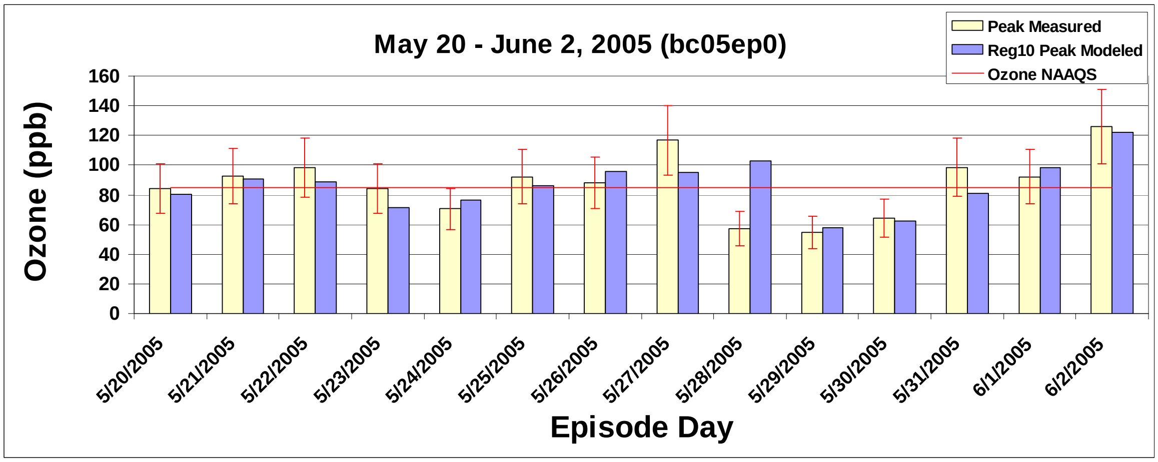
3.5.4.2 Operational Evaluations

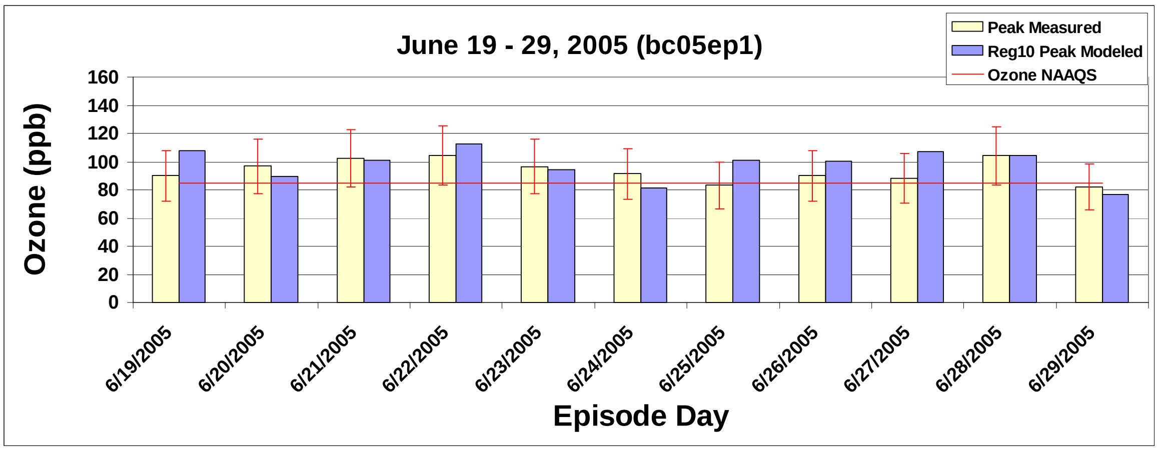
Statistical measures including the Unpaired Peak Accuracy (UPA), the Mean Normalized Bias (MNB), and the Mean Normalized Gross Error (MNGE) were calculated by comparing measured and bi-linearly interpolated modeled ozone concentrations for all episode days and regulatory monitors. Graphical measures including time series and scatter plots of hourly measured and bi-linearly interpolated modeled ozone and where applicable, some ozone precursors (e.g., nitric oxide (NO), nitrogen dioxide (NO_2), ETH, and CO) concentrations were developed for each regulatory monitor. In addition, tile plots of modeled daily maximum eight-hour ozone concentrations were developed and overlaid with the measured daily maximum eight-hour ozone concentrations. Detailed operational evaluations for each of the 2005 and 2006 base case modeling episodes are included in Appendix C: *CAMx Modeling for the HGB Attainment Demonstration SIP*.

Statistical Evaluations

The statistical evaluations presented focus on the comparison of the measured and modeled eight-hour ozone concentrations. Figure 3-12.a: *Peak Eight-Hour Ozone Concentration, Measured versus Modeled for the 2005 Episode Days* and Figure 3-12.b: *Peak Eight-Hour Ozone Concentration, Measured versus Modeled for the 2006 Episode Days* compare the measured and modeled peak eight-hour ozone concentrations for each episode day of the 2005 and 2006 base cases, respectively. Figure 3-13.a: *Mean Normalized Gross Error (MNGE) and Bias (MNB) for 2005 Episode Days* and Figure 3-13.b: *Mean Normalized Gross Error (MNGE) and Bias (MNB) for 2006 Episode Days* show the MNGE and MNB for monitored eight-hour ozone concentrations greater than 40 ppb for each episode day of the 2005 and 2006 base cases, respectively. Although there are no recommended criteria for the eight-hour UPA, MNGE, and MNB, the one-hour levels recommended by the EPA (i.e., plus or minus 20 percent, 30 percent, and plus or minus 15 percent, respectively) were used for statistical evaluations.

The error bars on the daily peak measured eight-hour ozone concentrations, in Figures 3-12.a: *Peak Eight-Hour Ozone Concentration, Measured versus Modeled for the 2005 Episode Days* and 3-12.b: *Peak Eight-Hour Ozone Concentration, Measured versus Modeled for the 2006 Episode Days* represent the plus or minus 20 percent UPA range for comparison with the daily peak modeled eight-hour ozone concentrations. For the 37 episode days in the 2005 base cases, only seven days have daily peak modeled eight-hour ozone concentrations greater than 20 percent of the daily peak measured eight-hour ozone concentrations. For the 50 episode days in the 2006 base cases only ten days have daily peak modeled eight-hour ozone concentrations outside the plus or minus 20 percent UPA range.





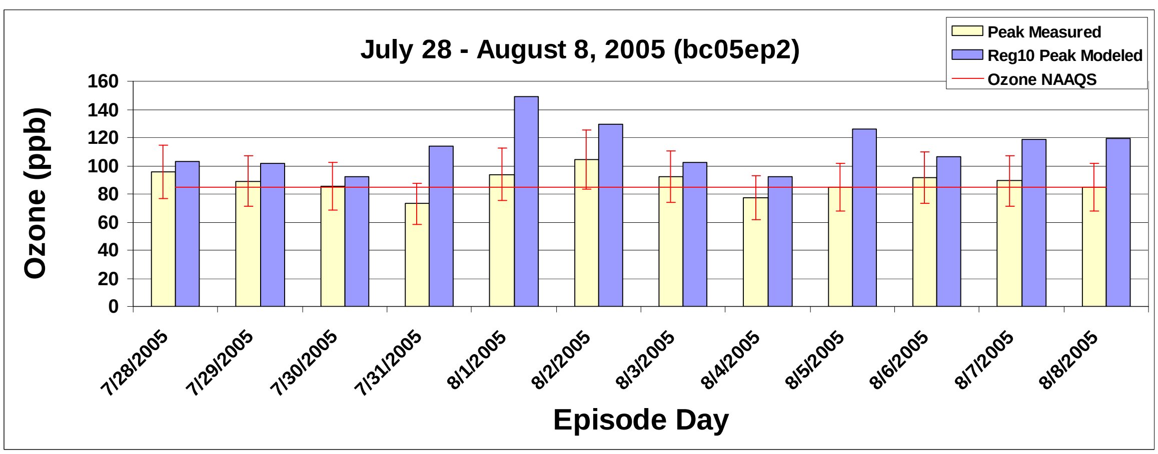
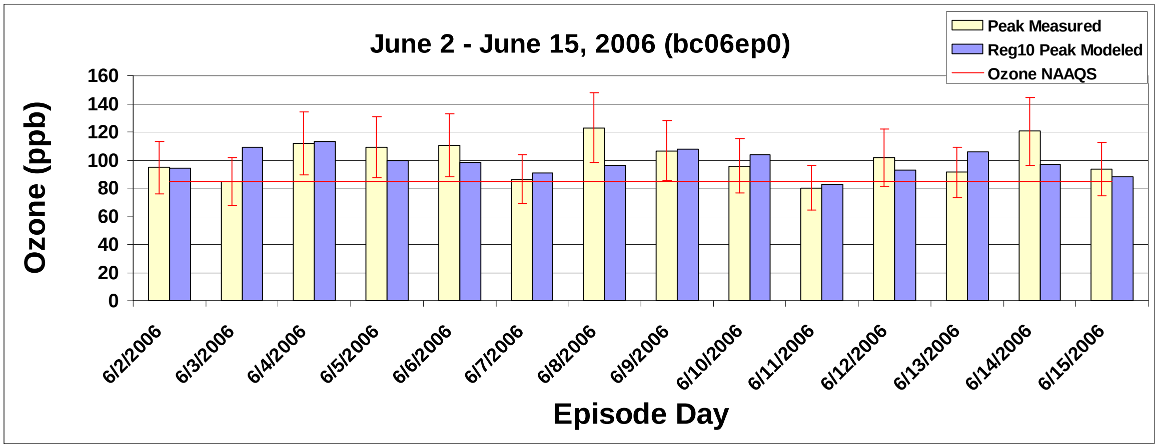
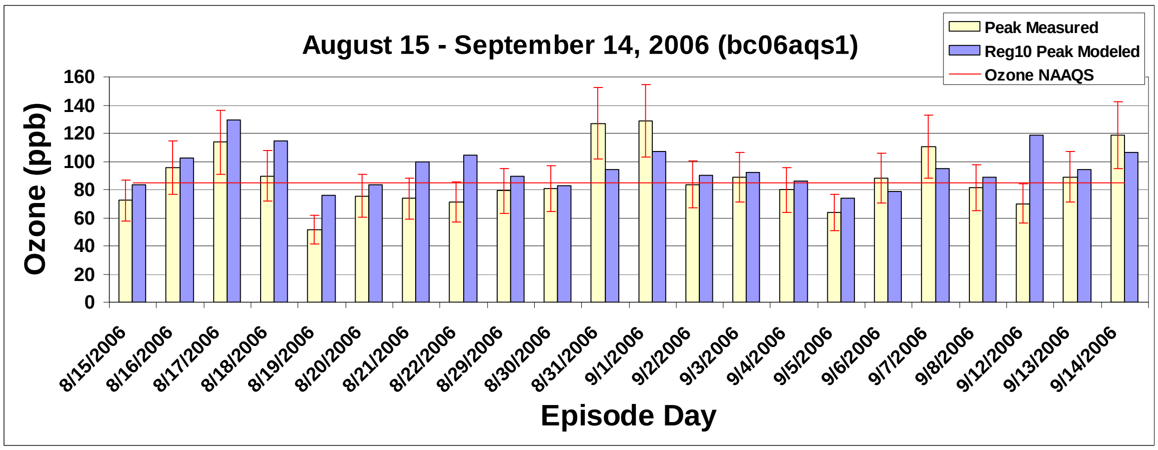


Figure 3-12.a: Peak Eight-Hour Ozone Concentration, Measured versus Modeled for the 2005 Episode Days





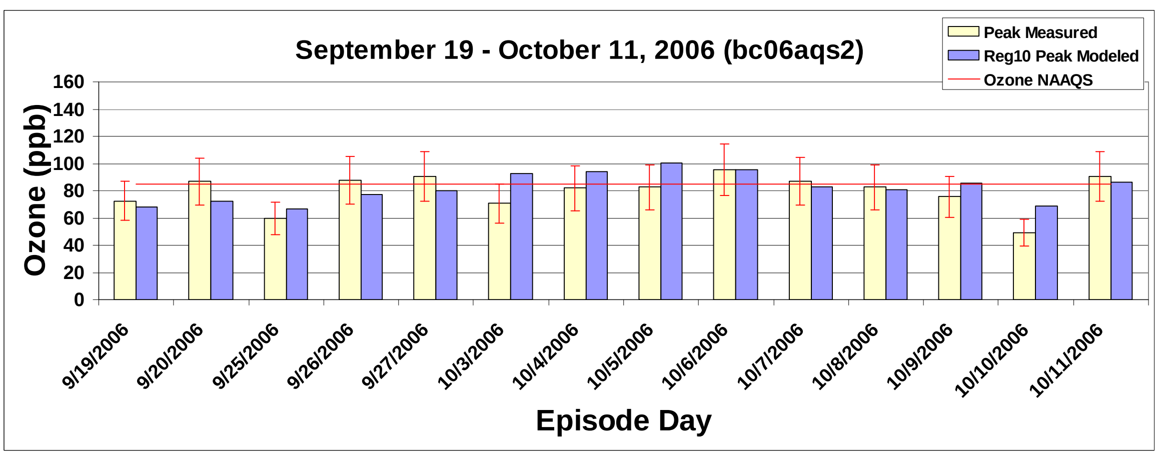


Figure 3-12.b: Peak Eight-Hour Ozone Concentration, Measured versus Modeled for the 2006 Episode Days

Taking into consideration that only 17 days out of the 87 days modeled in the 2005 and 2006 base case episodes have daily peak modeled eight-hour ozone concentrations outside the plus or minus 20 percent UPA range, the model suitably predicts the daily peak eight-hour ozone concentrations.

The area depicted in Figures 3-12.a: *Mean Normalized Gross Error (MNGE) and Bias (MNB) for 2005 Episode Days* and 3-12.b: *Mean Normalized Gross Error (MNGE) and Bias (MNB) for 2006 Episode Days* with MNGE $\leq$ 30 percent and MNB $\leq$ plus or minus 15 percent represents the joint condition for which both the MNGE and MNB are within acceptable ranges. The episode days labeled in red indicate those days for which daily peak measured eight-hour ozone concentrations were greater than or equal to 80 ppb.

For the 31 days of the 2005 base case episodes with daily peak measured eight-hour ozone concentrations greater than or equal to 80 ppb 19 days meet the joint condition of having both the MNGE $\leq$ 30 percent and MNB $\leq$ plus or minus 15 percent. The average peak monitored ozone for those 31 days was 93.9 ppb, and the corresponding average peak modeled ozone concentration was 101.1 ppb. The average mean normalized bias and mean normalized gross error were 11.4 and 19.0 percent, respectively.

For the 36 days of the 2006 base case episodes with daily peak measured eight-hour ozone concentrations greater than or equal to 80 ppb, 24 days meet the joint condition of having both the MNGE $\leq$ 30 percent and MNB $\leq$ plus or minus 15 percent. The average peak monitored ozone for those 36 days was 96.9 ppb, and the corresponding average peak modeled ozone concentration was 95.1 ppb. The average mean normalized bias and normalized gross error were 8.8 and 16.9 percent, respectively.

Taking into consideration that 43 days out of the 67 episode days in the 2005 and 2006 base cases with daily peak measured eight-hour ozone concentration greater than or equal to 80 ppb meet the joint condition of having both the MNGE $\leq$ 30 percent and MNB $\leq$ plus or minus 15 percent, the model suitably predicts the temporal pattern of daily eight-hour ozone concentrations at the various monitors.

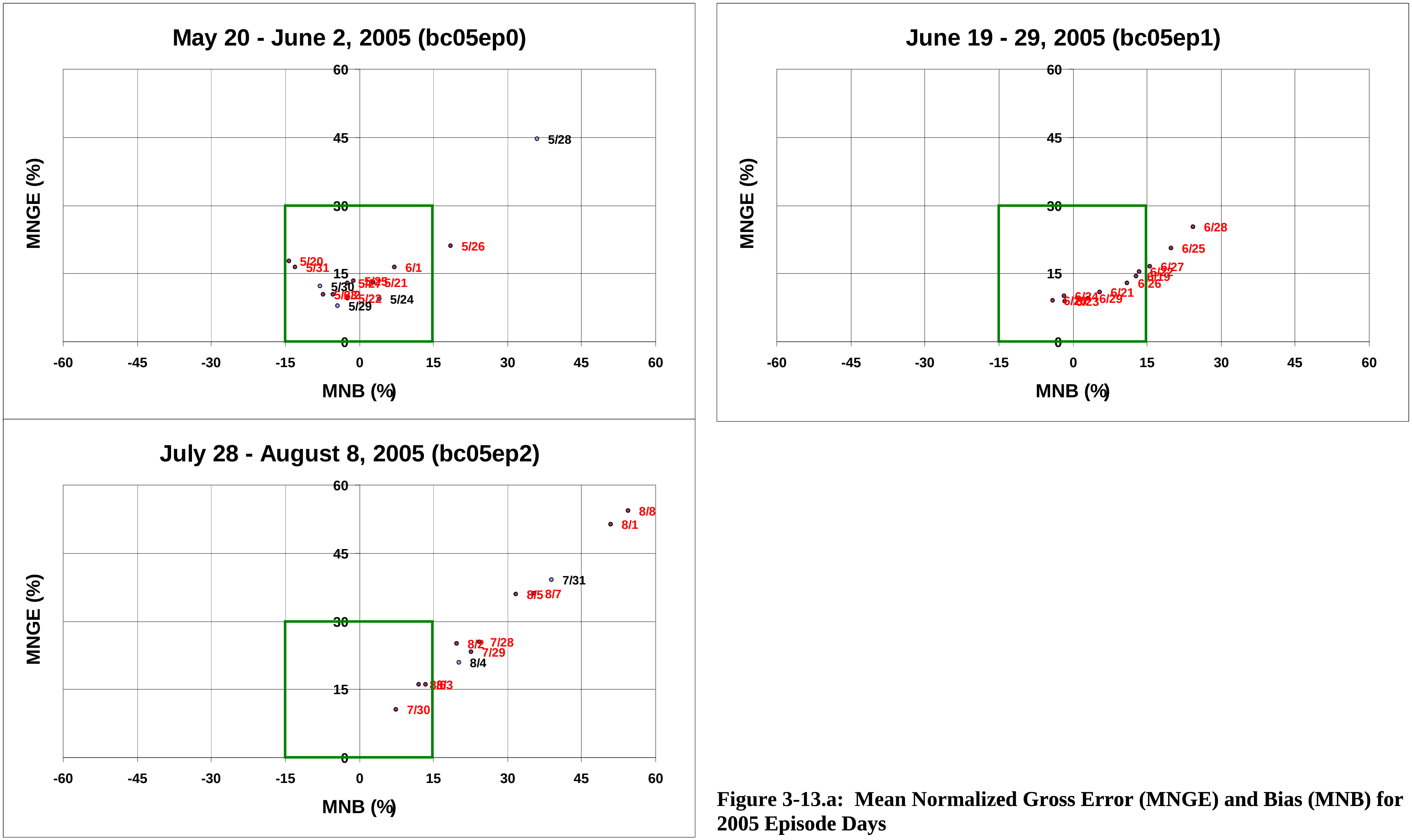
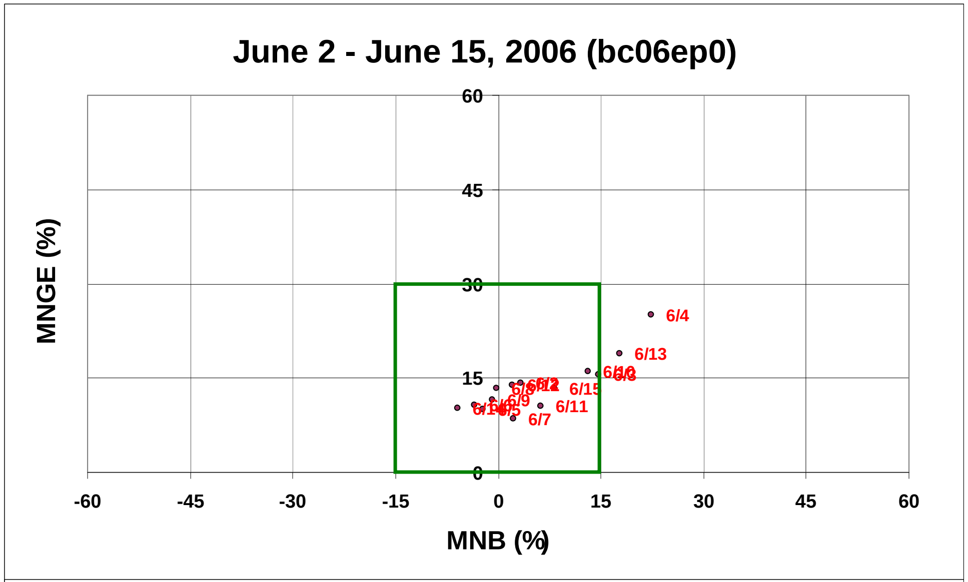
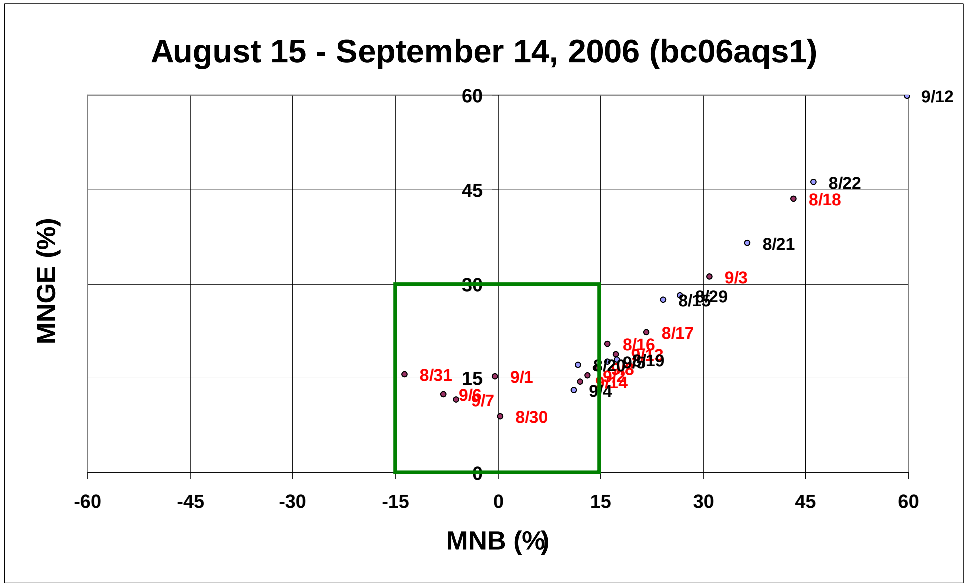


Figure 3-13.a: Mean Normalized Gross Error (MNGE) and Bias (MNB) for 2005 Episode Days





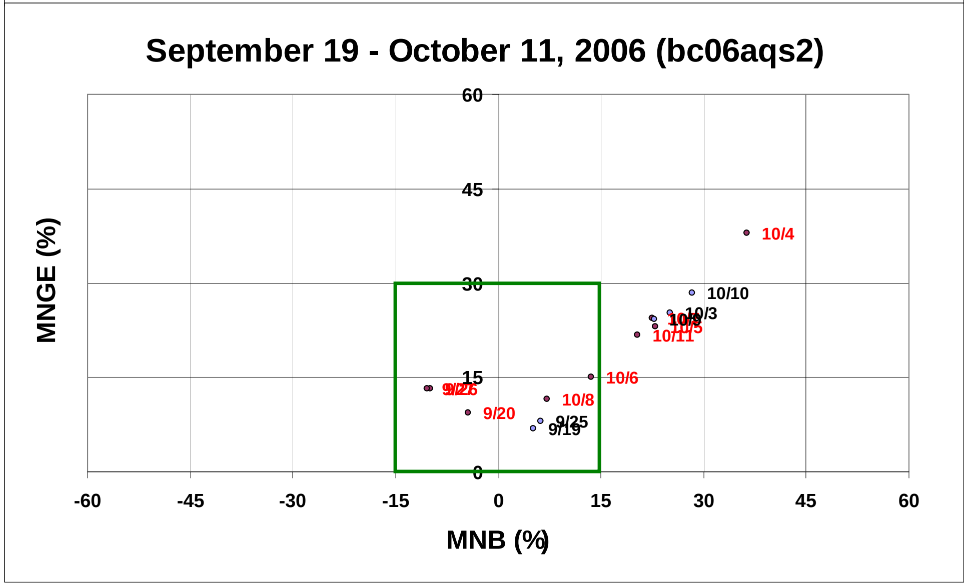
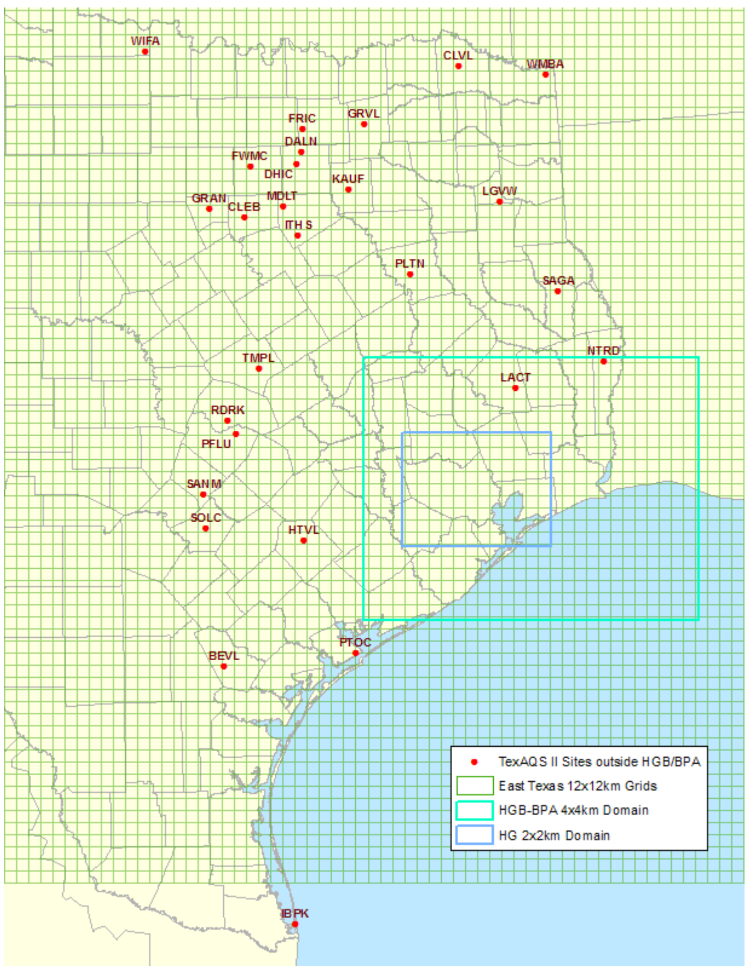


Figure 3-13.b: Mean Normalized Gross Error (MNGE) and Bias (MNB) for 2006 Episode Days

Graphical Evaluations
A detailed graphical evaluation of modeling results is presented in Appendix C: *CAMx Modeling for the HGB Attainment Demonstration SIP*. A selection of graphical evaluations, organized by episode modeled, is presented in this section.

For each of the 2005 and 2006 base case episodes, time series comparing hourly measured (red dots) and modeled (blue line) ozone concentrations are shown for three monitors in the eight-county HGB area. The monitors presented vary by episode and were selected on the basis of ozone measured. Included on the time-series graphic is the modeled maximum and minimum hourly ozone concentration within the 7 x 7 grid cell array around the monitor (green shading). Additionally, time series comparing hourly measured and modeled ozone concentrations are shown for two or three rural monitors (GRVL and LACT, and SAGA, which was not in operation during bc05ep0 and bc05ep1). Figure 3-14: *TexAQS II Monitoring Sites Outside HGB/BPA* is a map of rural monitors.



Site Code	Site Name
GRVL	Greenville, NW of Dallas
CLEB	Cleburne, SW of Fort Worth
LACT	Livingston, NW of Houston
BEVL	Beeville, NW of Corpus Christi
CLVL	Clarksville, eastern TX-OK border
NTRD	Newton, South-Central TX-LA Border
PLTN	Palestine, Central East Texas
SAGA	San Augustine, Central TX-LA Border
WMBA	Wamba, Near Texarkana
HTVL	Halletsville, N of Victoria
ITHS	Italy, S of Dallas
PTOC	Port O'Connor, Middle TX Coast
TMPL	Near Temple

Figure 3-14: TexAQS II Monitoring Sites Outside HGB/BPA

Also included for each of the episodes are logarithmically-scaled scatter plots comparing the hourly measured and modeled concentrations of ozone (O_3), NO_X, ETH, and olefins (OLE). Monitor sites included in the graphical representation were the three monitors with the highest daily maximum monitored eight-hour ozone concentrations. If one of the top three sites did not also have an auto-GC, the third highest ozone monitoring site was replaced by the auto-GC site measuring the highest ozone. OLE is a CAMx chemical surrogate representing olefinic VOC, such as propylene, but excluding ethylene and certain compounds known as internal olefins such as butenes (internal olefins are represented in CB05 by the surrogate species IOLE). Both ethylene and propylene are HRVOC and their emissions were adjusted in the base case modeling by the emissions reconciliation discussed previously in Section 3.4: *Emissions Modeling*. Included on the scatter plots is the measured versus modeled Quantile-Quantile (QQ) plot, which first sorts independently both the measured and modeled concentrations, then plots the sorted values together. QQ plot data, shown as red dots, provide a measure of how close the modeled and measured distributions of values are to each other. If the red dots lie close to the diagonal one-to-one line, the model generates the correct proportions of small, medium, and large concentration values.

Tile plots of the of the daily peak modeled eight-hour ozone concentrations are shown for selected episode days on which several monitors measured maximum daily eight-hour ozone concentrations greater than 84 ppb. Included on the tile plots are the monitor locations represented by small circles, color coded for the measured ozone concentration. The same scale is used for the measured and modeled maximum daily eight-hour ozone concentrations.

Bc05ep0: May 19 through June 3, 2005

For the bc05ep0 episode, hourly time series are presented for the Conroe Relocated (CNR2; CAMS 78), Northwest Harris County (HNWA; CAMS 26), and Wallisville Road (WALV; CAMS 617)[1] monitors in Figure 3-15: *Time Series of Hourly Ozone Concentrations for Episode bc05ep0 at the CNR2, HNWA, and WALV Monitors*. In general, the modeled ozone concentrations, including the 7 x 7 cell maximum-minimum range, replicate the diurnal pattern of the observations. The lower ozone concentrations measured during the early morning hours, especially at the Conroe Relocated monitor, and the very highest ozone concentrations, for example, Northwest Harris County, May 27, 2005, were less well replicated. The unfavorable comparison between the measured and modeled hourly ozone concentrations during the early morning hours at the Conroe Relocated monitor is likely due to local factors, such as NO_X emissions and low wind speed meteorological conditions, which reduces the areal representation of the monitor to much less than the 4 km grid cell size on which the modeled concentration is simulated. Thus, this disparity is not necessarily an indication of poor model performance since local factors may create greater ozone gradients.

[1] Note that CAMS 617 is a non-regulatory monitor.

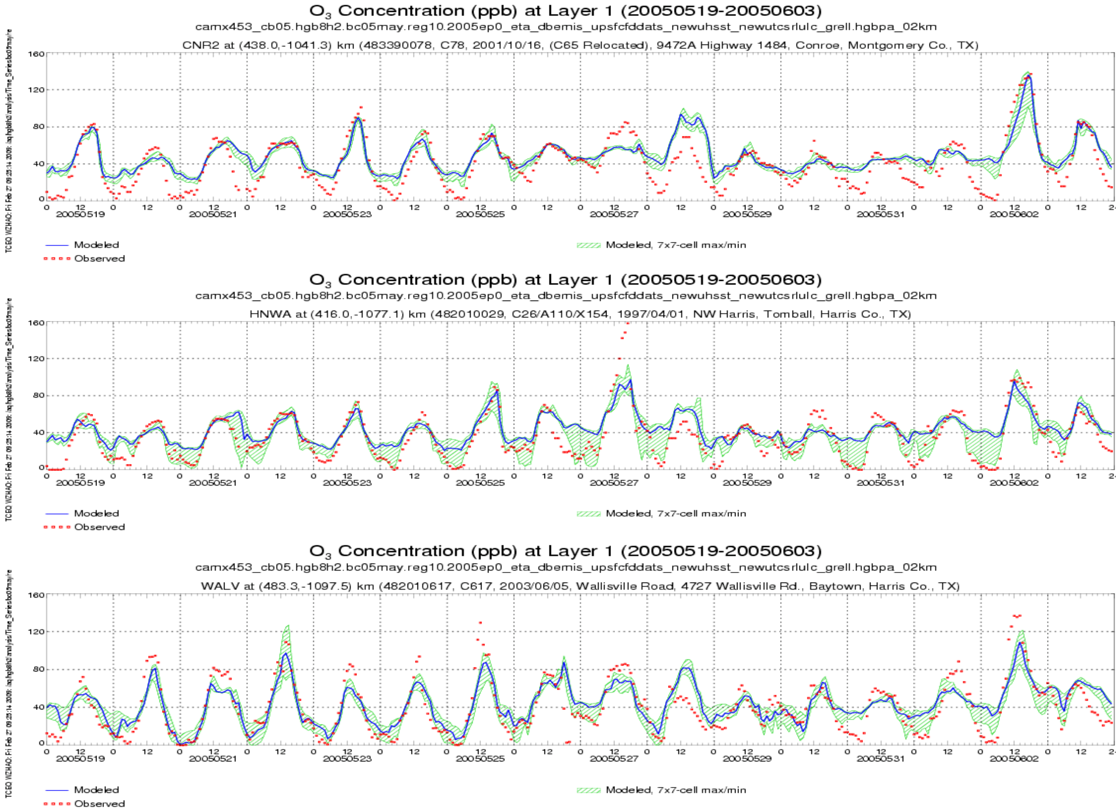


Figure 3-15: Time Series of Hourly Ozone Concentrations for Episode bc05ep0 at the CNR2, HNWA, and WALV Monitors

Note: WALV is a non-regulatory monitor.

Figure 3-16: *Time Series of Hourly Ozone Concentrations for Episode bc05ep0 at the GRVL and LACT Rural Monitors* provides a comparison of measured and modeled hourly ozone concentrations at rural monitors. Modeled concentrations generally replicate the diurnal pattern of the observations, except for the latter part of the episode in the rural region represented by the LACT monitor, for which the modeled concentrations are relatively constant throughout the day. The lower ozone concentrations measured during the early morning hours on some days and not replicated by the model are likely due to localized emissions and meteorology limiting the areal representation of the monitors as described previously. Overall, modeled and measured rural concentrations compare favorably, and modeled rural concentrations are unlikely to cause any substantial predictive bias within the HGB area during this episode.

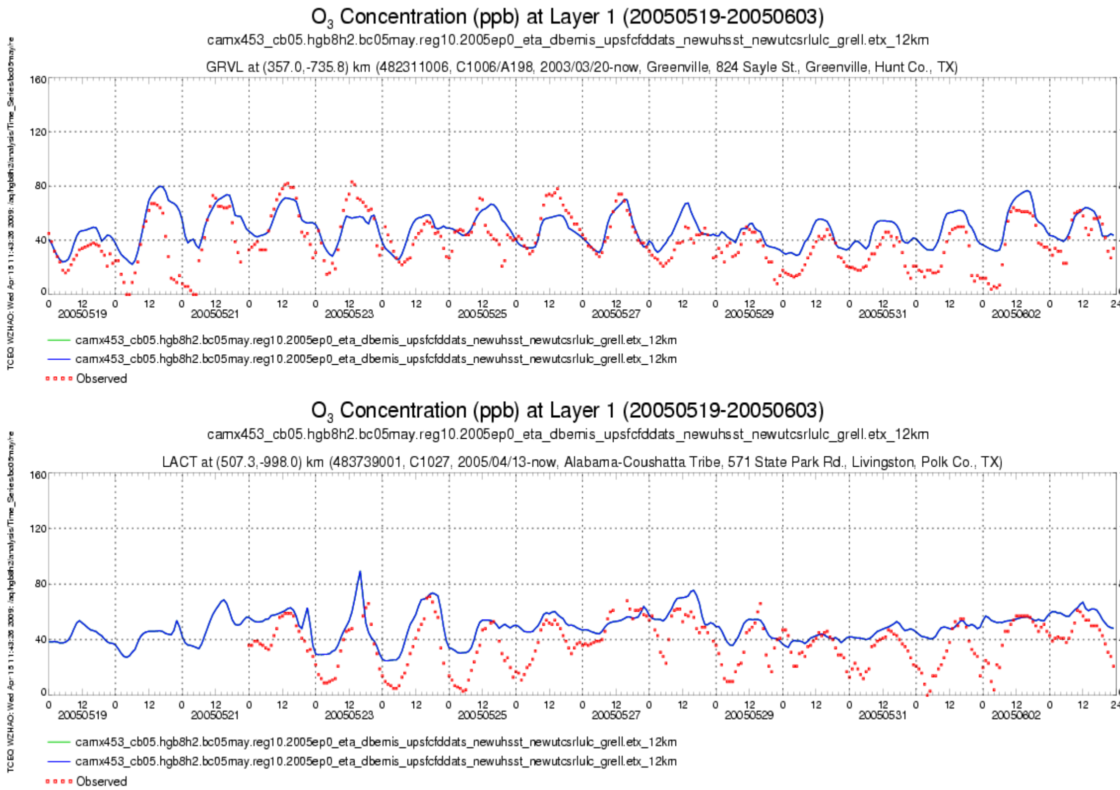


Figure 3-16: Time Series of Hourly Ozone Concentrations for Episode bc05ep0 at the GRVL and LACT Rural Monitors

Scatter plots for the bc05ep0 episode comparing the hourly measured and modeled concentrations at the Wallisville Road (CAMS 617) monitor (non-regulatory monitor) are shown in Figure 3-17: *Scatter Plots of Hourly Ozone, NO_X, ETH, and OLE at the WALV Monitor for the bc05ep0 Episode.* The model tends to over-predict ozone at the lower measured concentrations (less than 60 ppb), but compares favorably at the higher ozone concentrations. Conversely, the model tends to under-predict the NO_X at the lower measured concentrations, but compares favorably at the higher NO_X concentrations. The rank correlation QQ plot for ETH is quite favorable, although there is notable scatter in the individual hourly comparisons. The model tends to under-predict the lower and higher OLE concentrations.

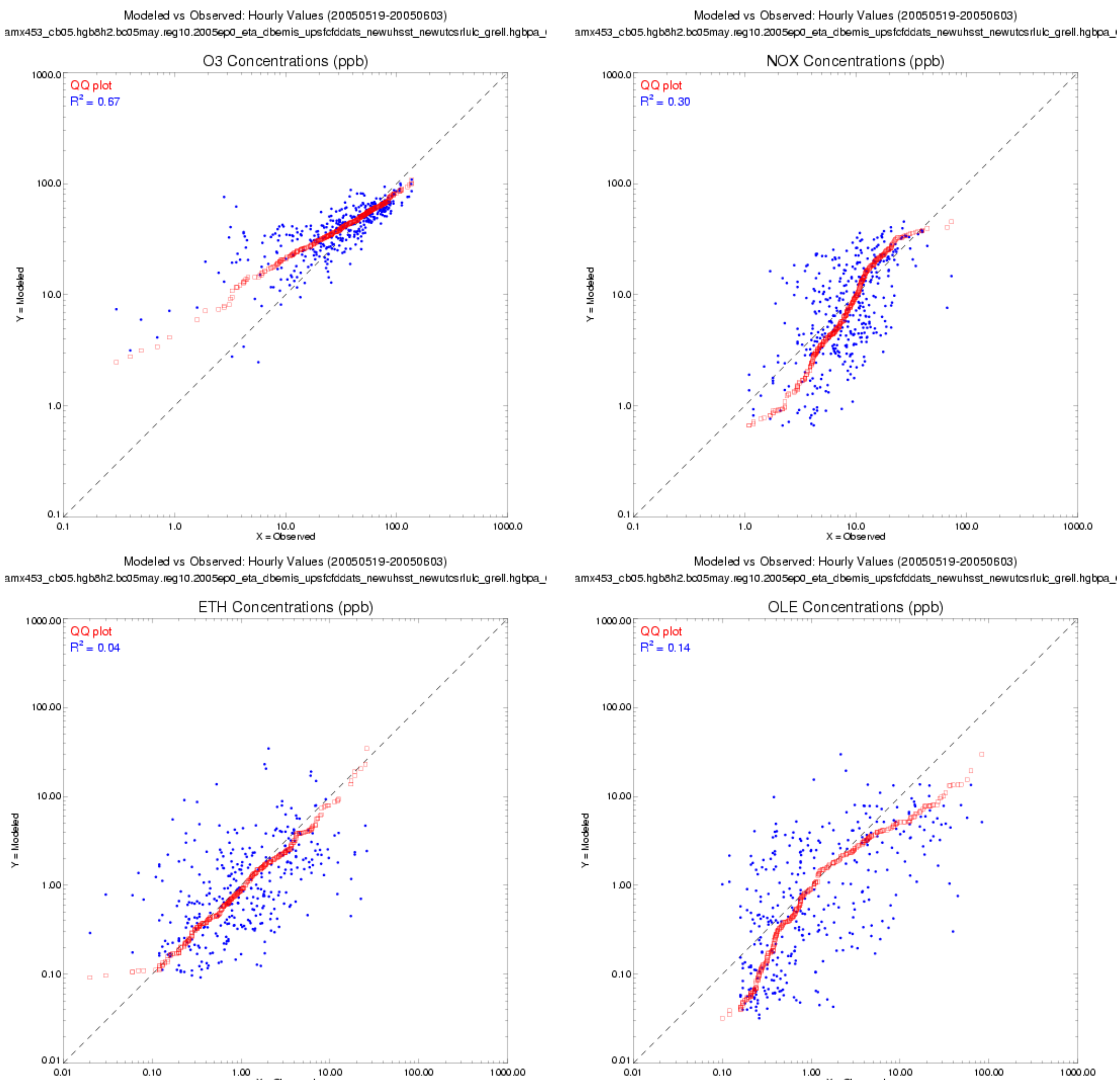


Figure 3-17: Scatter Plots of Hourly Ozone, NO_X, ETH, and OLE at the WALV Monitor for the bc05ep0 Episode

Note: WALV is a non-regulatory monitor.

Tile plots of daily maximum eight-hour ozone concentrations for May 27, May 31, June 1, and June 2, 2005, are shown in Figure 3-18: *Tile Plots of Daily Maximum Eight-Hour Ozone Concentrations for May 27 and 31 and June 1 through 2, 2005*. The dots represent the monitored value, whereas the background color represents the modeled results. Where a dot's color matches the surrounding color, the model has accurately replicated the measured ozone at that monitor. The model replicates the areas of highest eight-hour ozone for the selected days, with the exception of May 31, 2005.

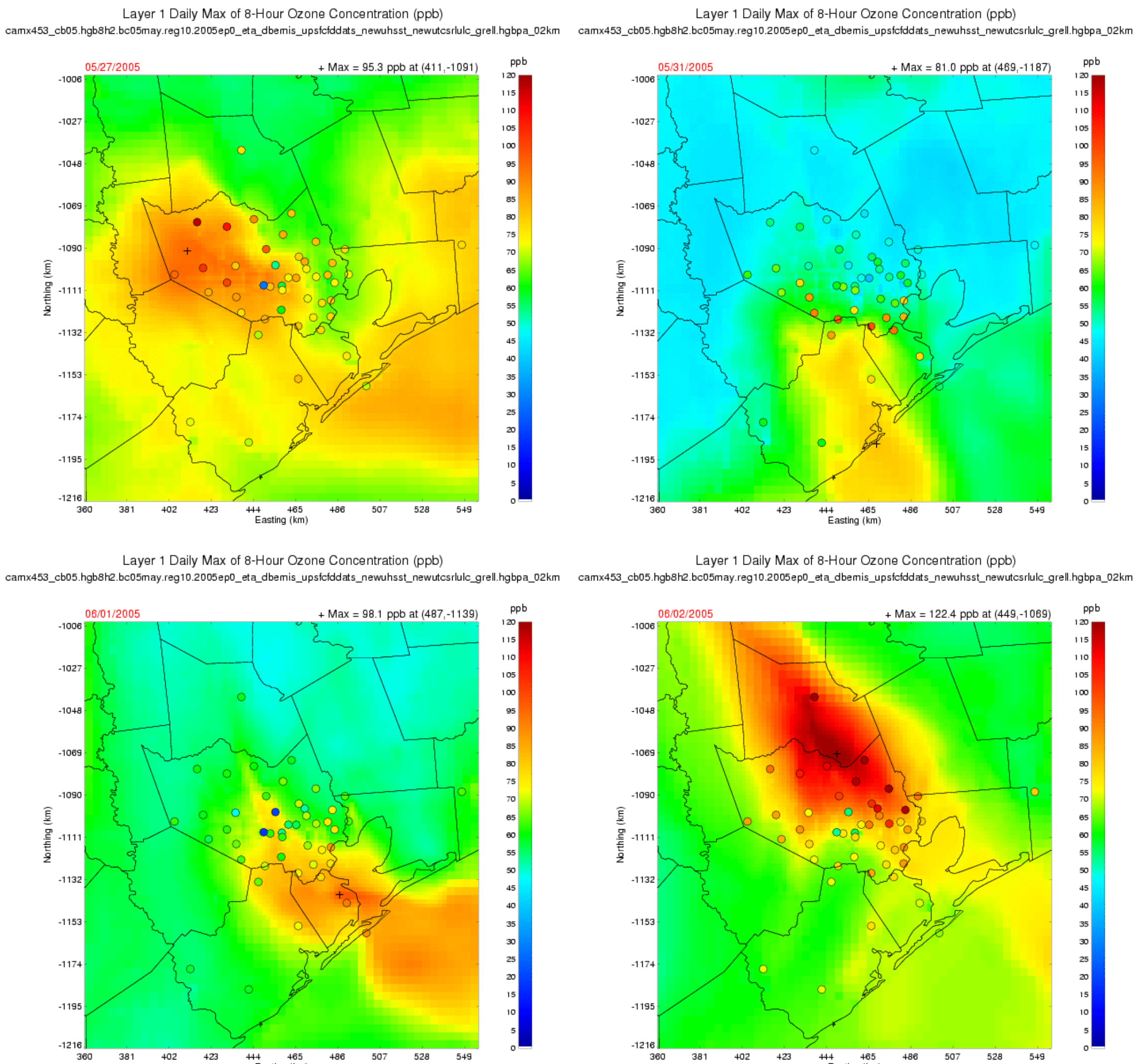


Figure 3-18: Tile Plots of Daily Maximum Eight-Hour Ozone Concentrations for May 27 and 31 and June 1 through 2, 2005

Overall, the graphical evaluation of model performance at key monitors on key episode days indicates the modeling adequately replicates the features that produced high ozone during this episode.

Bc05ep1: June 17 through 30, 2005

For the bc05ep1 episode, hourly time series are presented for the Deer Park (DRPK; CAMS 35), Houston Croquet (HCQA; CAMS 409) and Manvel Croix Park (MACP; CAMS 84) monitors in Figure 3-19: *Time Series of Hourly Ozone Concentrations for Episode bc05ep1 at the DRPK, HCQA, and MACP Monitors*. In general the modeled ozone concentrations, including the 7 x 7 cell maximum-minimum range, replicate the diurnal pattern of the observations, with the exception of the lower ozone concentrations measured during the early morning hours, especially at the Manvel Croix Park (CAMS 84) monitor.

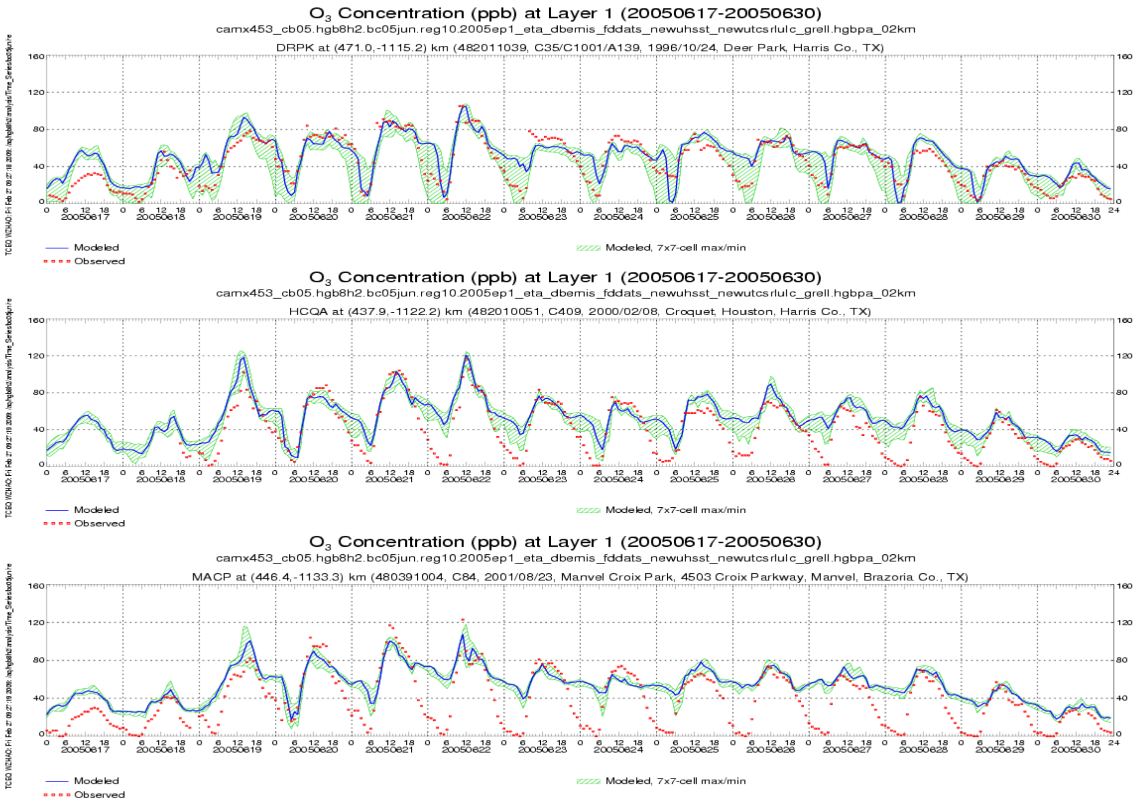


Figure 3-19: Time Series of Hourly Ozone Concentrations for Episode bc05ep1 at the DRPK, HCQA, and MACP Monitors

Figure 3-20: *Time Series of Hourly Ozone Concentrations for Episode bc05ep1 at the GRVL and LACT Rural Monitors* provides a comparison of measured and modeled hourly ozone concentrations at rural monitors. Modeled concentrations generally replicate the diurnal pattern of the observations, with generally favorable comparisons during the daytime. The model does not replicate the lower ozone concentrations measured on some days during the early morning hours, likely for reasons previously discussed. Overall, modeled and measured rural concentrations compare favorably, and modeled rural concentrations are unlikely to cause any substantial predictive bias within the HGB area during this episode.

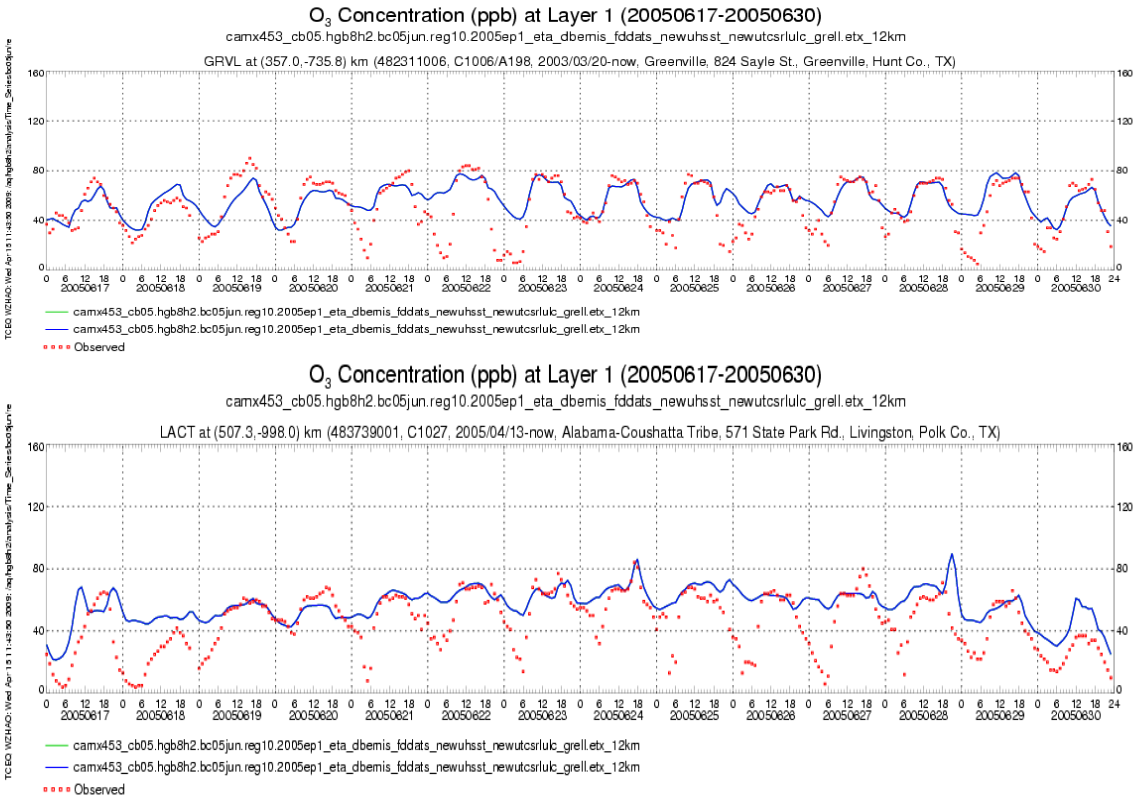


Figure 3-20: Time Series of Hourly Ozone Concentrations for Episode bc05ep1 at the GRVL and LACT Rural Monitors

Scatter plots for the bc05ep1 episode comparing the hourly measured and modeled concentrations at the Deer Park (CAMS 35) monitor are shown in Figure 3-21: *Scatter Plots of Hourly Ozone, NO_X, ETH, and OLE at the DRPK Monitor for the bc05ep1 Episode.* The model tends to over-predict ozone at the lower measured concentrations, but compares quite favorably at the higher ozone concentrations. The model tends to generally over-predict the NO_X, especially at the lower measured concentrations. The QQ plot for ETH is quite favorable, although there is some scatter in the individual hourly comparisons. The model tends to under-predict the lower OLE concentrations and while the QQ plot shows a favorable rank correlation, there is notable scatter in the individual hourly comparisons.

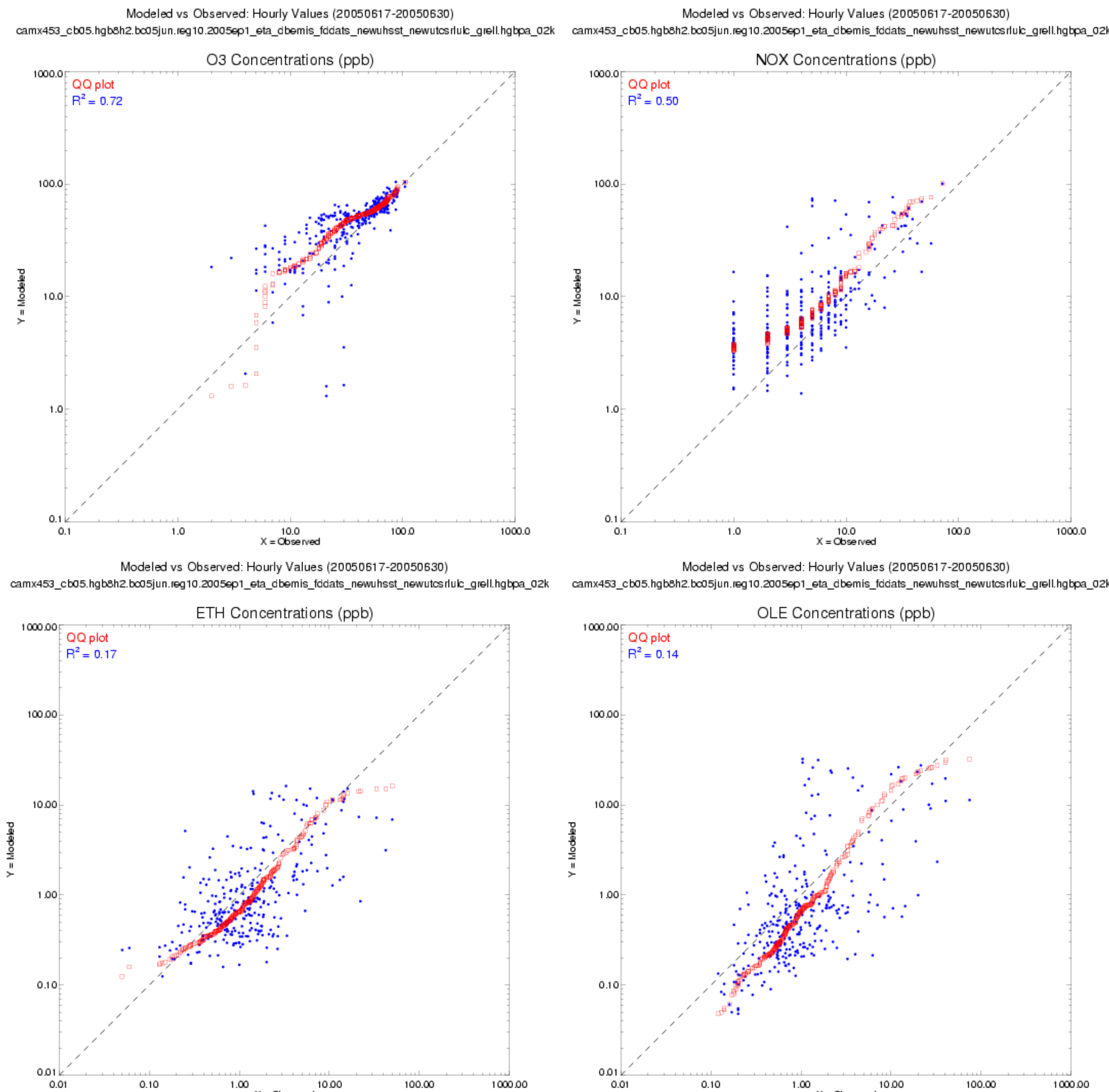


Figure 3-21: Scatter Plots of Hourly Ozone, NO_X, ETH, and OLE at the DRPK Monitor for the bc05ep1 Episode

Tile plots of daily maximum eight-hour ozone concentrations for June 20-23, 2005, are shown in Figure 3-22: *Tile Plots of Daily Maximum Eight-Hour Ozone Concentrations for June 20 through 23, 2005*. The model replicates the areas of highest eight-hour ozone for the selected days quite favorably.

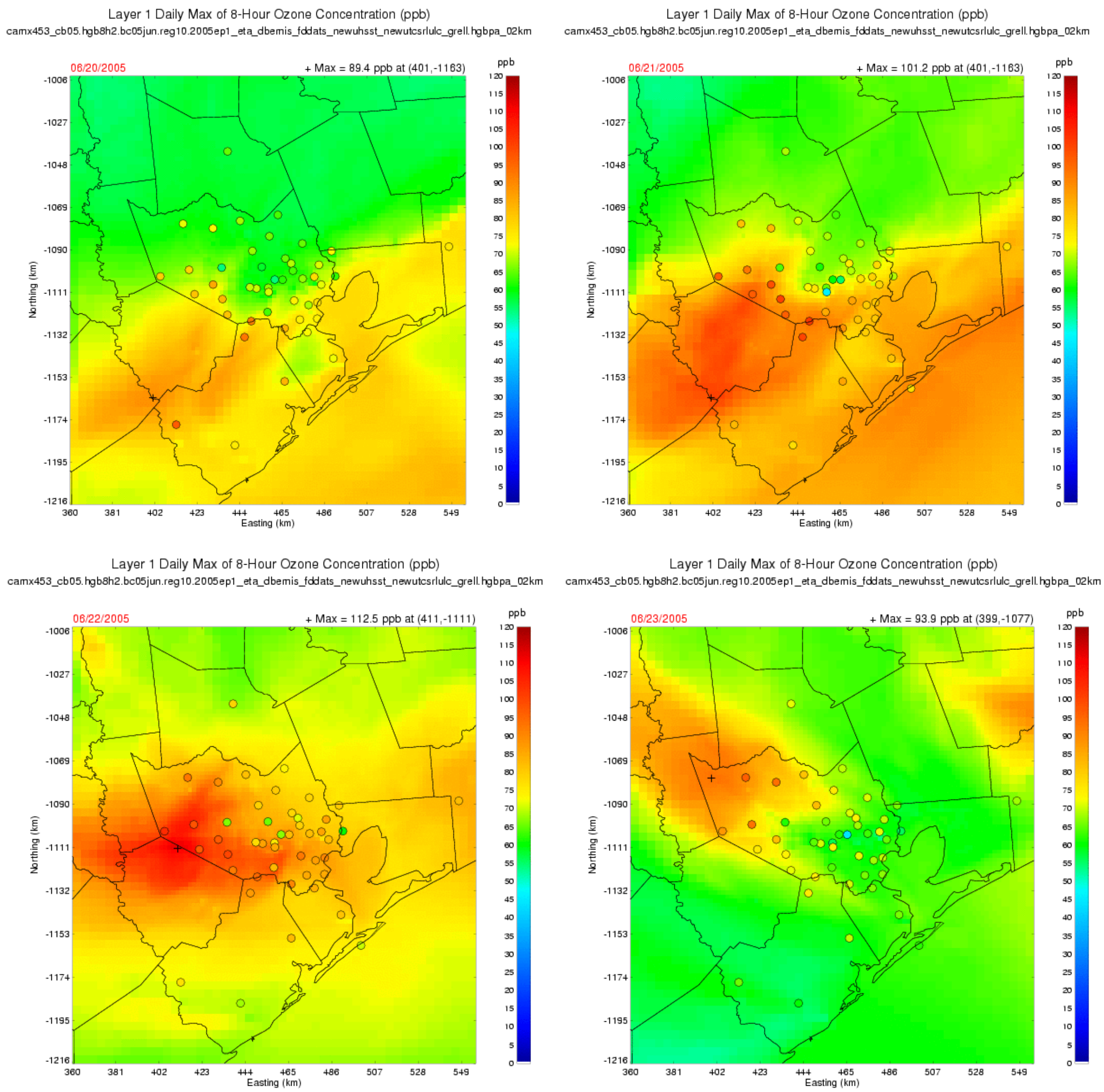


Figure 3-22: Tile Plots of Daily Maximum Eight-Hour Ozone Concentrations for June 20 through 23, 2005

Overall, the graphical evaluation of model performance at key monitors on key episode days indicates the modeling adequately replicates the features that produced high ozone during this episode.

Bc05ep2: July 26 through August 8, 2005

For the bc05ep2 episode, hourly time series are presented for the Houston Bayland Park (BAYP; CAMS 53), TCEQ Houston Regional Office (HROC; CAMS 81), and Texas City (TXCT; CAMS 620) (non-regulatory monitor) monitors in Figure 3-23: *Time Series of Hourly Ozone Concentrations for Episode bc05ep2 at the BAYP, HROC, and TXCT Monitors*. Relatively high ozone concentrations were measured at these monitors on several days during this episode. In general, the modeled ozone concentrations, including the 7 x 7 cell maximum-minimum range, replicate the diurnal pattern of the observations, with the exception of the lower ozone concentrations measured during the early morning hours, especially at the Houston Bayland Park (CAMS 53) monitor.

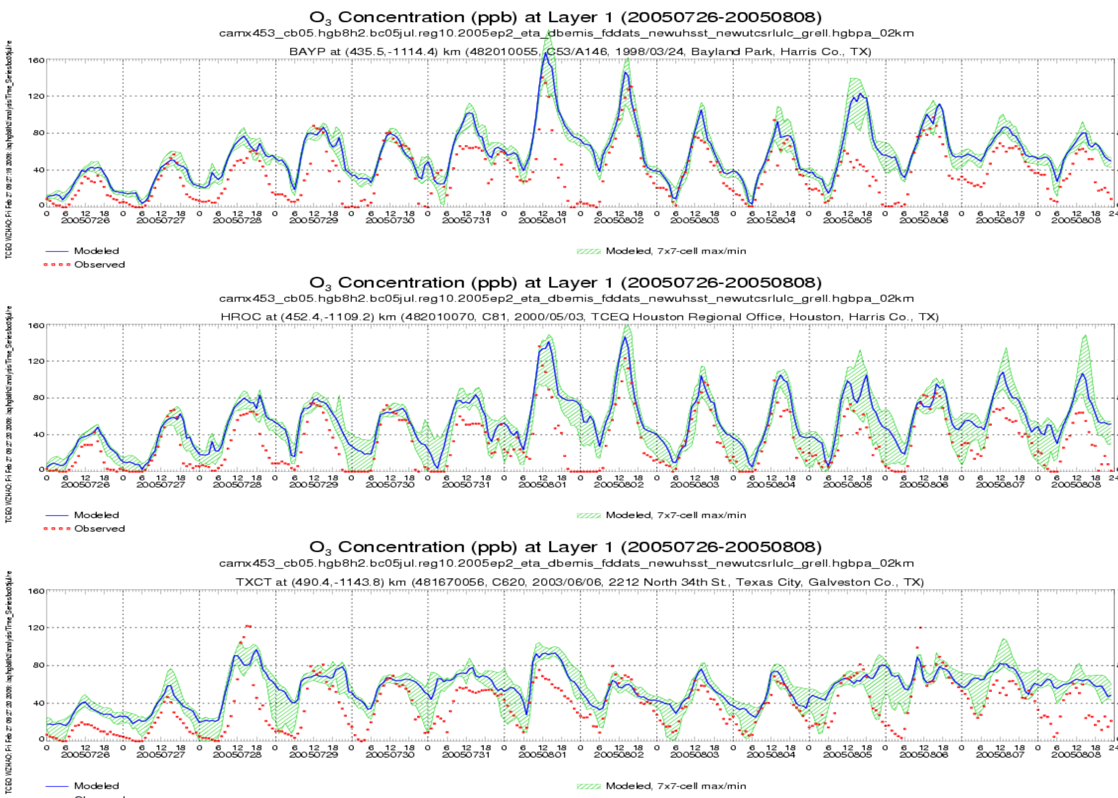


Figure 3-23: Time Series of Hourly Ozone Concentrations for Episode bc05ep2 at the BAYP, HROC, and TXCT Monitors

Note: TXCT is a non-regulatory monitor.

Figure 3-24: *Time Series of Hourly Ozone Concentrations for Episode bc05ep2 at the GRVL, LACT, and SAGA Rural Monitors* provides a comparison of measured and modeled hourly ozone concentrations at rural monitors. Modeled concentrations generally replicate the diurnal pattern of the observations, with a tendency to over-predict the peak hourly ozone concentrations during the daytime. The over-prediction at these rural monitors appears to follow the same pattern as the over-prediction of ozone concentrations in the HGB area, especially during the latter part of the episode.

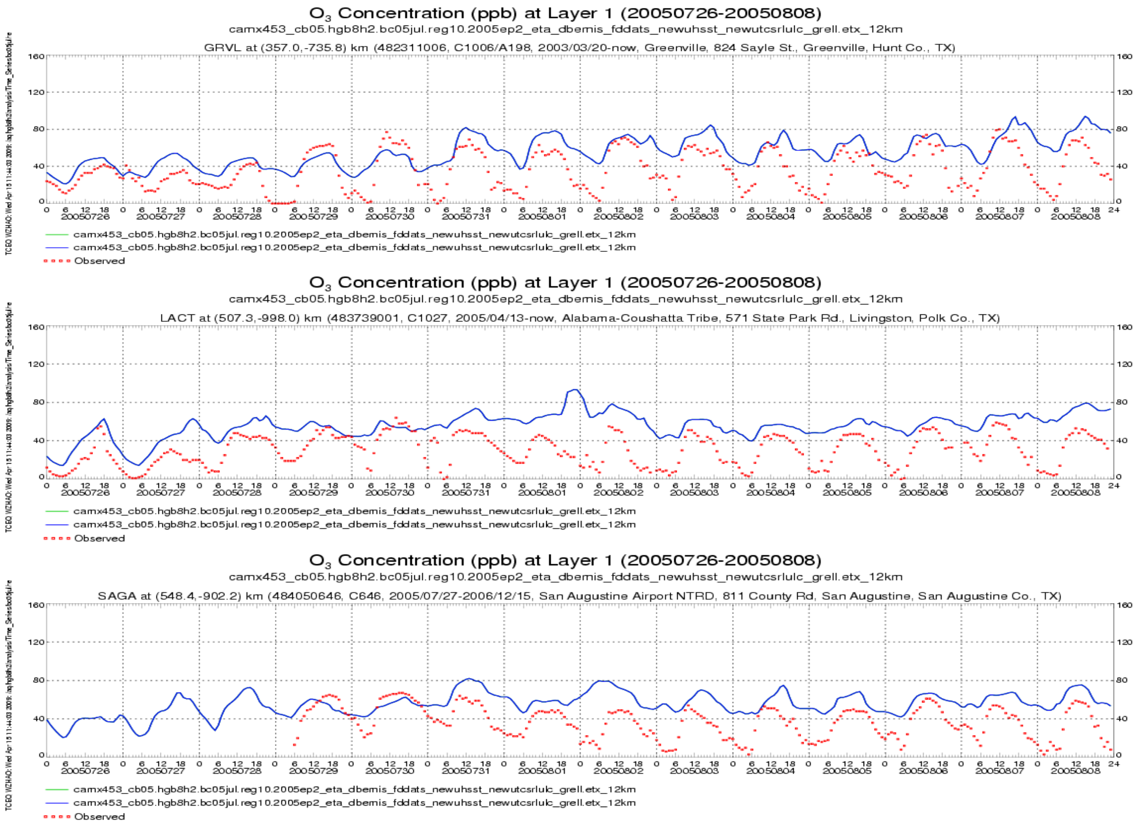


Figure 3-24: Time Series of Hourly Ozone Concentrations for Episode bc05ep2 at the GRVL, LACT, and SAGA Rural Monitors

Scatter plots for the bc05ep2 episode comparing the hourly measured and modeled concentrations at the TXCT monitor (non-regulatory monitor) are shown in Figure 3-25: *Scatter Plots of Hourly Ozone, NO_X, ETH, and OLE at the TXCT Monitor for the bc05ep2 Episode.* The model generally tends to over-predict ozone, especially at the lower measured concentrations. Although the QQ plot indicates a favorable rank correlation for the NO_X, there is notable scatter in the individual hourly comparisons. The QQ plot for ETH indicates an even more favorable rank correlation, again with notable scatter in the individual hourly comparisons. The model tends to under-predict the lower and higher OLE concentrations, also with considerable scatter in the individual hourly comparisons.

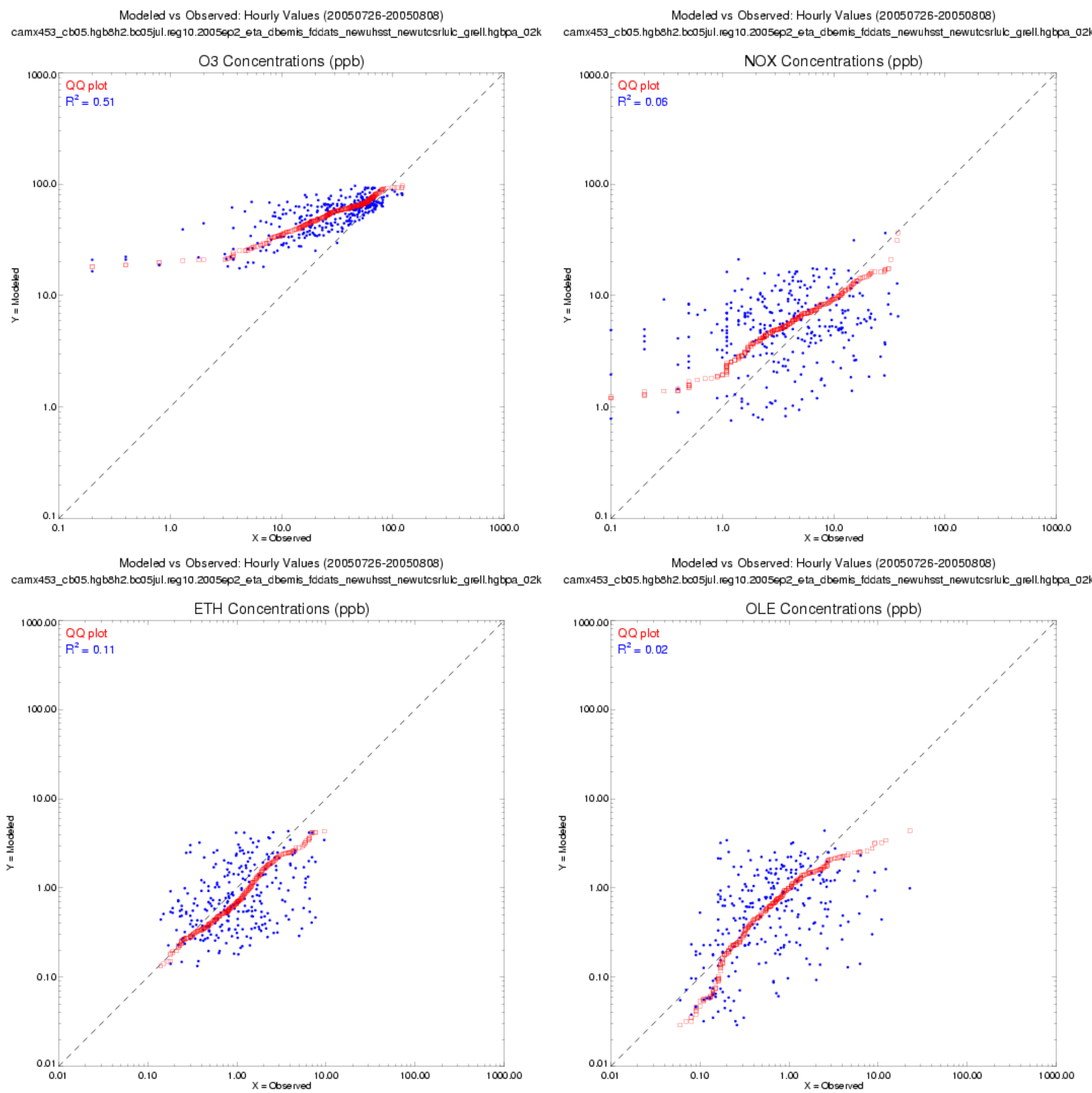


Figure 3-25: Scatter Plots of Hourly Ozone, NO_X, ETH, and OLE at the TXCT Monitor for the bc05ep2 Episode

Note: TXCT is a non-regulatory monitor.

Tile plots of daily maximum eight-hour ozone concentrations for July 28, August 1 through 2, and August 6, 2005, are shown in Figure 3-26: *Tile Plot of Daily Maximum Eight-Hour Ozone Concentrations for July 28, August 1 through 2, and August 4, 2005*. The model replicates the areas of highest eight-hour ozone for the selected days, although it over-predicts the daily maximum eight-hour ozone concentrations, especially on August 1 and 2, 2005.

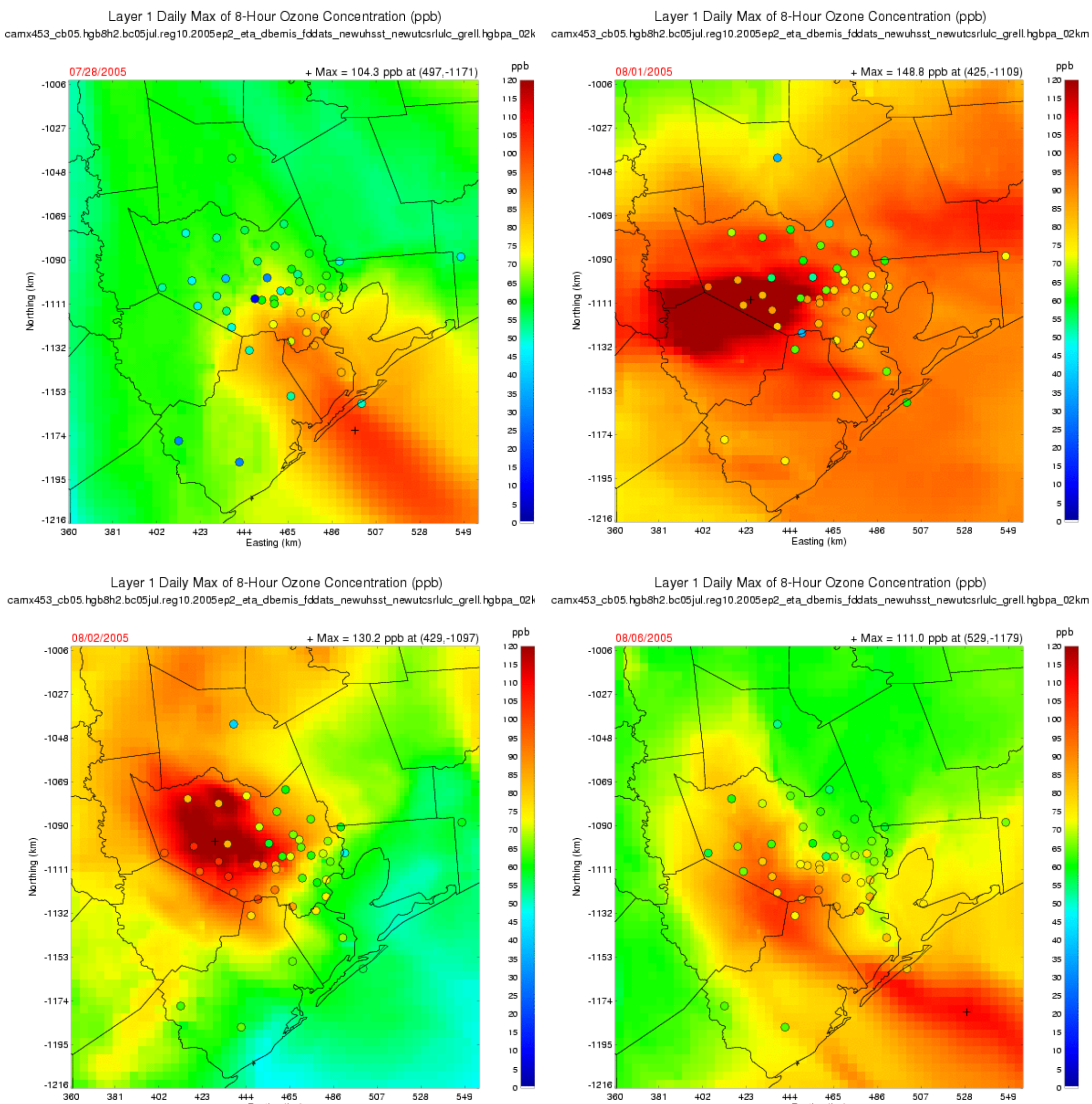


Figure 3-26: Tile Plot of Daily Maximum Eight-Hour Ozone Concentrations for July 28, August 1 through 2, and August 4, 2005

Overall, the graphical evaluation of model performance at key monitors on key episode days indicates the modeling only marginally replicates the features that produced high ozone during this episode.

Bc06ep0: May 31 through June 15, 2006

For the bc06ep0 episode, hourly time series are presented for the TCEQ Houston Regional Office (HROC; CAMS 81), Shell Westhollow (SHWH, CAMS 410), and Wallisville (WALV; CAMS 617) (non-regulatory monitor) monitors in Figure 3-27: *Time Series of Hourly Ozone Concentrations for Episode bc06ep0 at the HROC, SHWH, and WALV Monitors*. Relatively high ozone concentrations were measured at these monitors on several days during this episode. In general, the modeled ozone concentrations, including the 7 x 7 cell maximum-minimum range, replicate the diurnal pattern of the observations, with the exception of the lower ozone concentrations measured during the early morning hours, especially at the Shell Westhollow (CAMS 410) monitor.

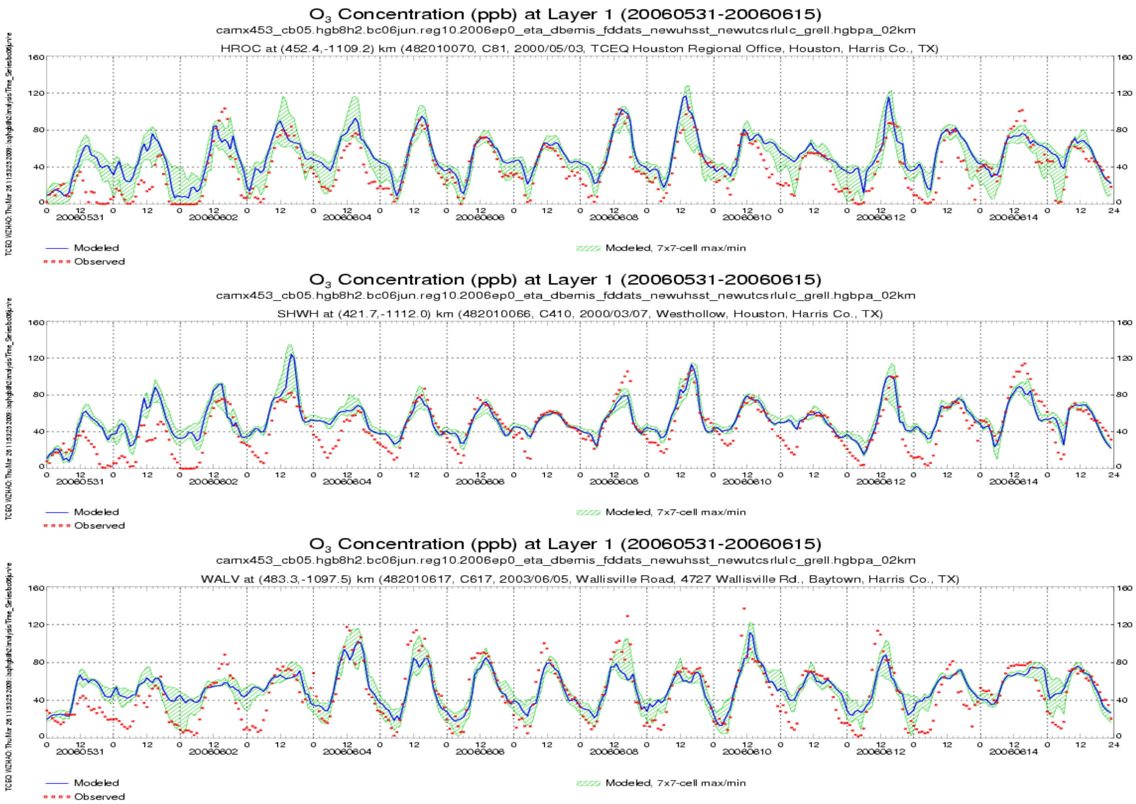


Figure 3-27: Time Series of Hourly Ozone Concentrations for Episode bc06ep0 at the HROC, SHWH, and WALV Monitors

Note: WALV is a non-regulatory monitor.

Figure 3-28: *Time Series of Hourly Ozone Concentrations for Episode bc06ep0 at the GRVL, LACT, and SAGA Rural Monitors* provides a comparison of measured and modeled hourly ozone concentrations at rural monitors. Modeled concentrations generally replicate the diurnal pattern of the observations, with generally favorable comparisons during the daytime. The model does not replicate the lower ozone concentrations measured on some days during the early morning hours. Overall, modeled and measured rural concentrations compare favorably, and modeled rural concentrations are unlikely to cause any substantial predictive bias within the HGB area during this episode.

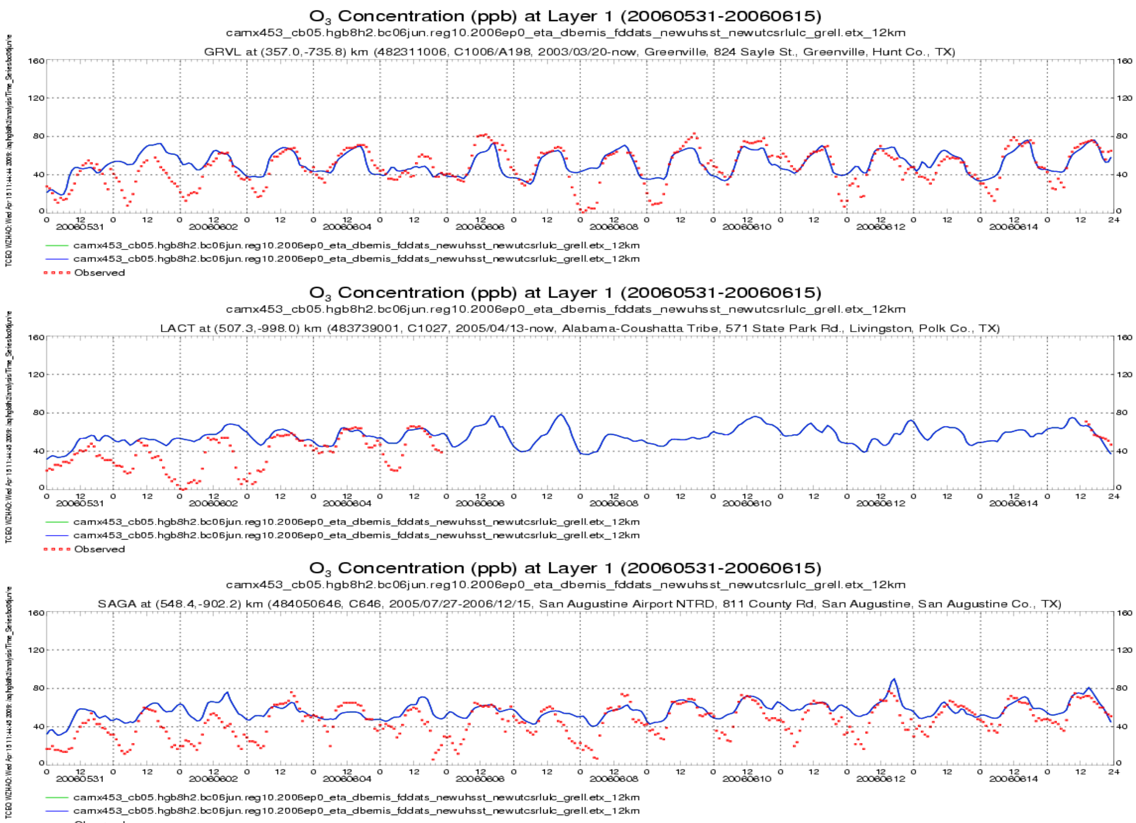


Figure 3-28: Time Series of Hourly Ozone Concentrations for Episode bc06ep0 at the GRVL, LACT, and SAGA Rural Monitors

Scatter plots for the bc06ep0 episode comparing the hourly measured and modeled concentrations at the Wallisville Road (CAMS 617) monitor (non-regulatory monitor) are shown in Figure 3-29: *Scatter Plots of Hourly Ozone, NO_X, ETH, and OLE at the WALV Monitor for the bc06ep0 Episode.* The model tends to over-predict ozone at the lower measured concentrations, but compares more favorably at the higher concentrations. Conversely, the model tends to under-predict NO_X at the lower measured concentrations, and slightly over-predict at the higher NO_X concentrations. The QQ plot for ETH indicates a somewhat favorable rank correlation, although the model generally tends to under-predict the ETH concentrations. The model also tends to under-predict the OLE concentrations.

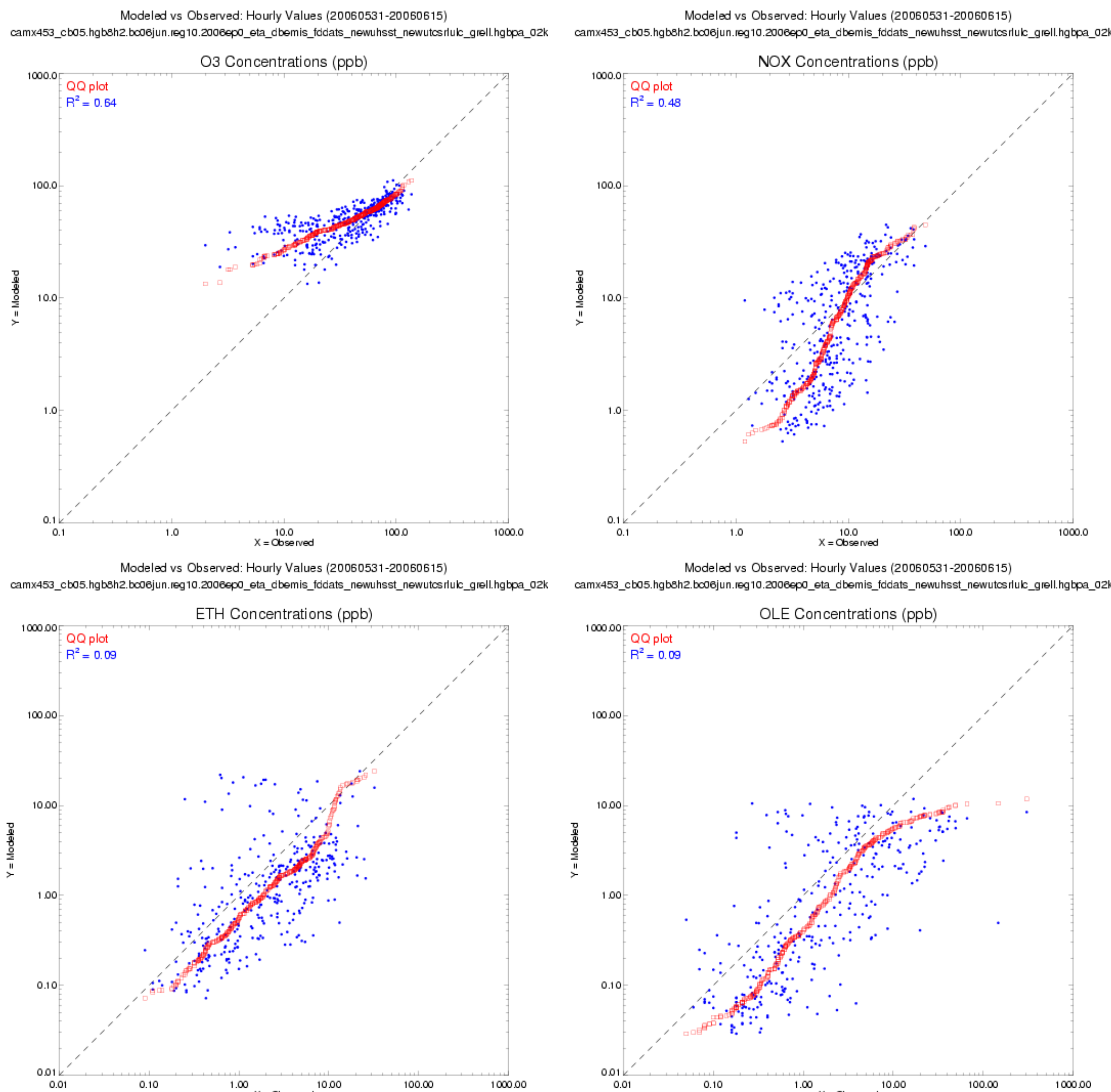


Figure 3-29: Scatter Plots of Hourly Ozone, NO_X, ETH, and OLE at the WALV Monitor for the bc06ep0 Episode

Note: WLAV is a non-regulatory monitor.

Tile plots of daily maximum eight-hour ozone concentrations for June 5, June 8 through 9, and June 14, 2006, are shown in Figure 3-30: *Tile Plot of Daily Maximum Eight-Hour Ozone Concentrations for June 5, 8 through 9, and 14, 2006*. The model replicates the areas of highest eight-hour ozone for the selected days, although it somewhat under-predicts the daily maximum eight-hour ozone concentrations.

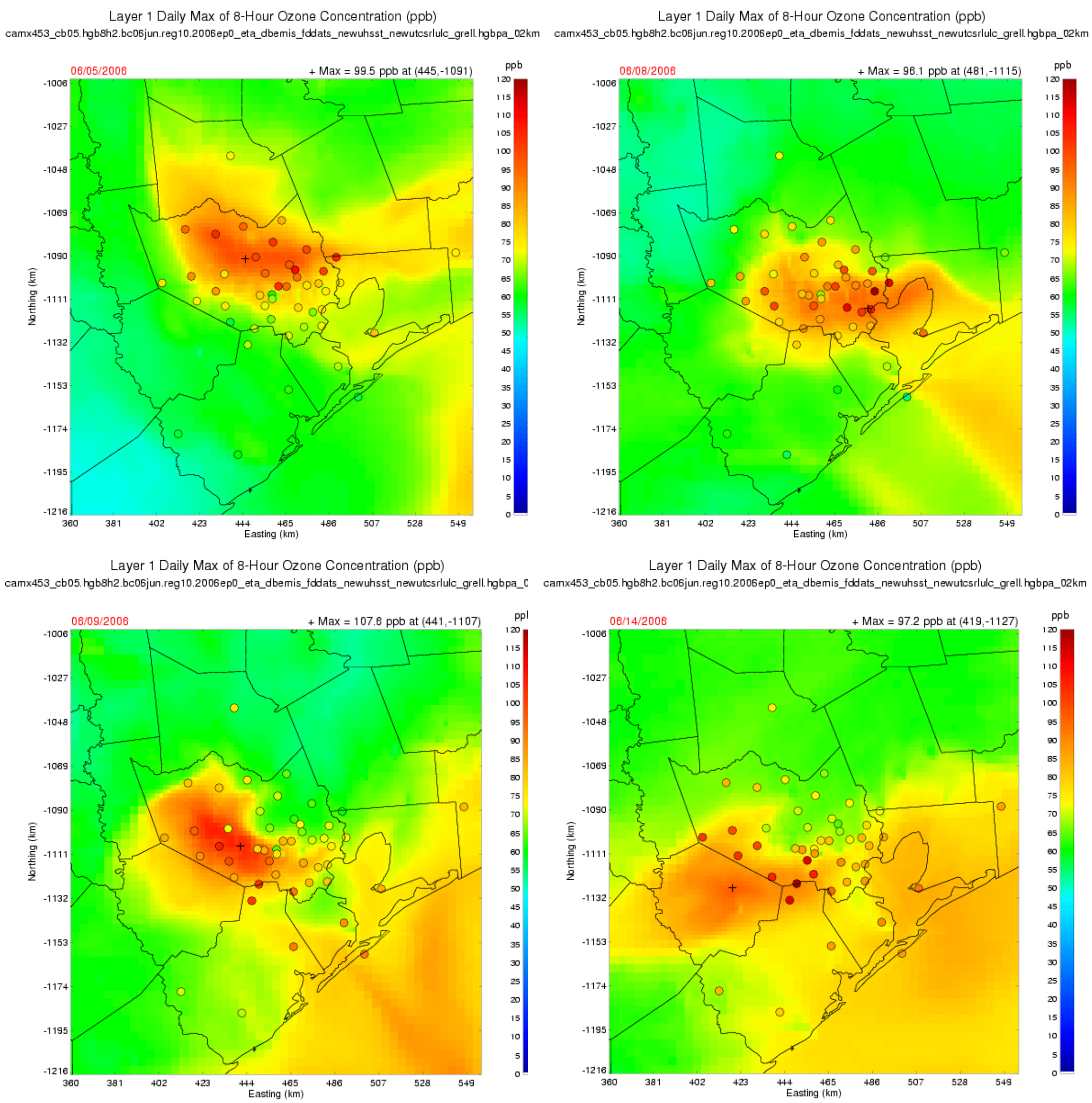


Figure 3-30: Tile Plot of Daily Maximum Eight-Hour Ozone Concentrations for June 5, 8 through 9, and 14, 2006

Overall, the graphical evaluation of model performance at key monitors on key episode days indicates the modeling adequately replicates the features that produced high ozone during this episode.

Bc06aqs1: August 13 through September 15, 2006

For the bc06aqs1 episode, hourly time series are presented for the Houston Bayland Park (BAYP; CAMS 53), Houston Monroe (HSMA; CAMS 406), and Deer Park (DRPK; CAMS 35) monitors in Figure 3-31: *Time Series of Hourly Ozone Concentrations for Episode bc06aqs1 at the BAYP, DRPK, and HSMA Monitors*. Relatively high ozone concentrations were measured at these monitors on several days during this episode. In general, the modeled ozone concentrations, including the 7 x 7 cell maximum-minimum range, replicate the diurnal pattern of the observations, with the exception of the very highest measured hourly ozone concentrations.

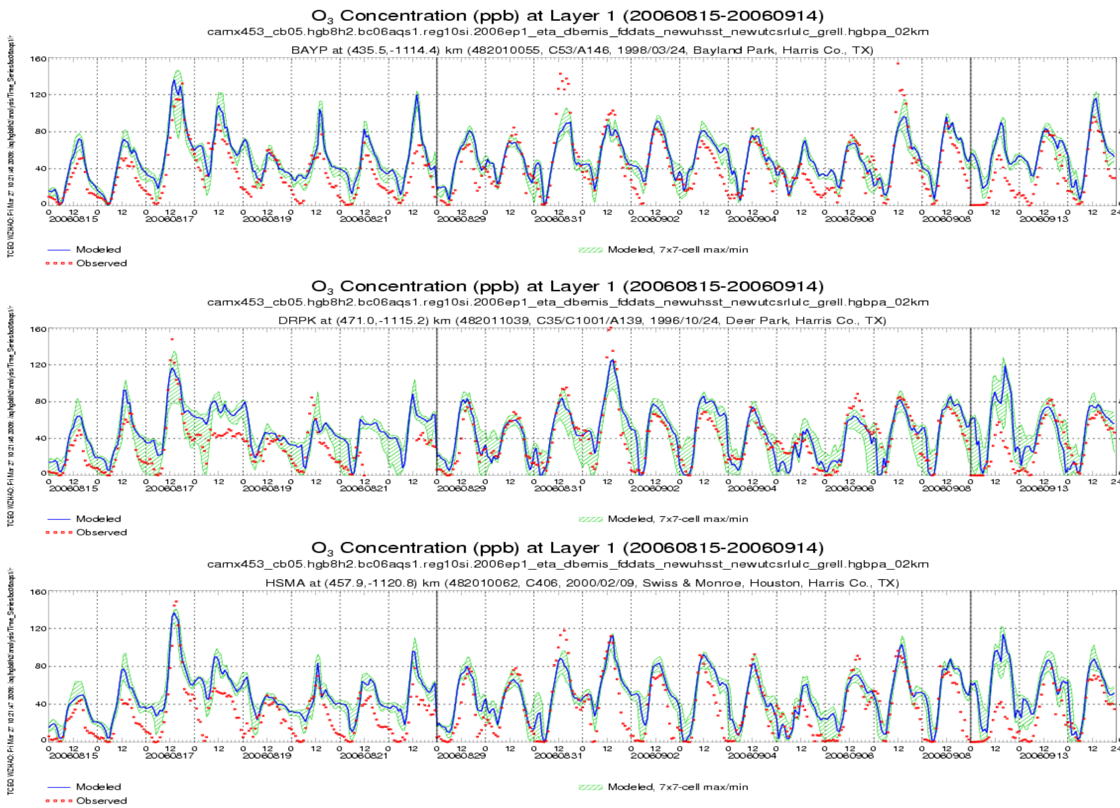


Figure 3-31: Time Series of Hourly Ozone Concentrations for Episode bc06aqs1 at the BAYP, DRPK, and HSMA Monitors

Figure 3-32: *Time Series of Hourly Ozone Concentrations for Episode bc06aqs1 at the GRVL, LACT, and SAGA Rural Monitors* provides a comparison of measured and modeled hourly ozone concentrations at rural monitors. Modeled concentrations generally replicate the diurnal pattern of the observations, with generally favorable comparisons during the daytime, with the exception of the region represented by the GRVL monitor on August 31 and September 1, 2006, when the higher measured ozone concentrations are notably under-predicted. In addition, the model tends to over-predict the ozone concentrations during the first segment of this episode, August 15 through 22, 2006, in the regions represented by LACT and SAGA monitors. Again, the model does not replicate the lower ozone concentrations measured on some days during the early morning hours. Overall, modeled and measured rural concentrations compare favorably enough that the modeled rural concentrations are unlikely to cause any substantial predictive bias within the HGB area during this episode.

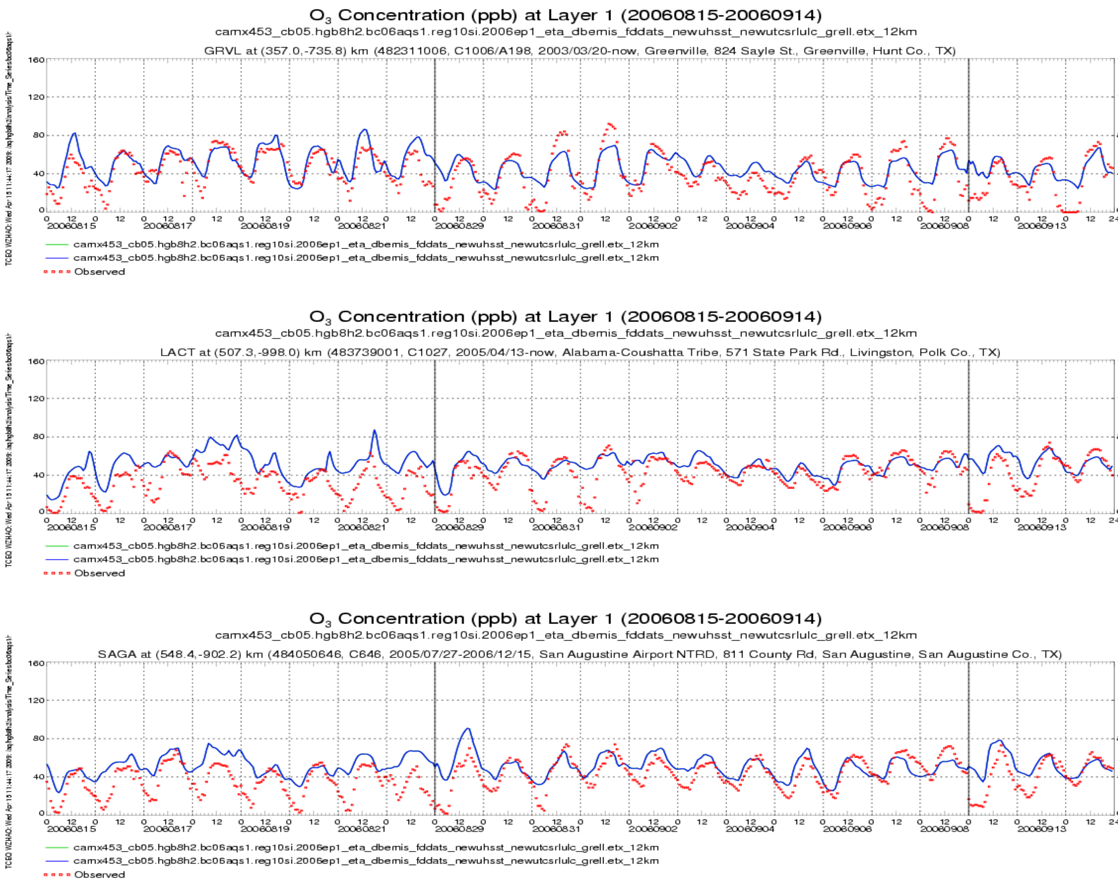


Figure 3-32: Time Series of Hourly Ozone Concentrations for Episode bc06aqs1 at the GRVL, LACT, and SAGA Rural Monitors

Scatter plots for the bc06aqs1 episode comparing the hourly measured and modeled concentrations at the Deer Park (CAMS 35) monitor are shown in Figure 3-33: *Scatter Plots of Hourly Ozone, NO_X, ETH, and OLE at the DRPK Monitor for the bc06aqs1 Episode.* The model tends to over-predict ozone at the lower measured concentrations, but compares more favorably at the higher concentrations. The model tends to generally over-predict NO_X concentrations. The QQ plot for ETH indicates a somewhat favorable rank correlation, although the model tends to under-predict the higher ETH concentrations. The model tends to under-predict the lower range of OLE concentrations and also under-predicts the very highest.

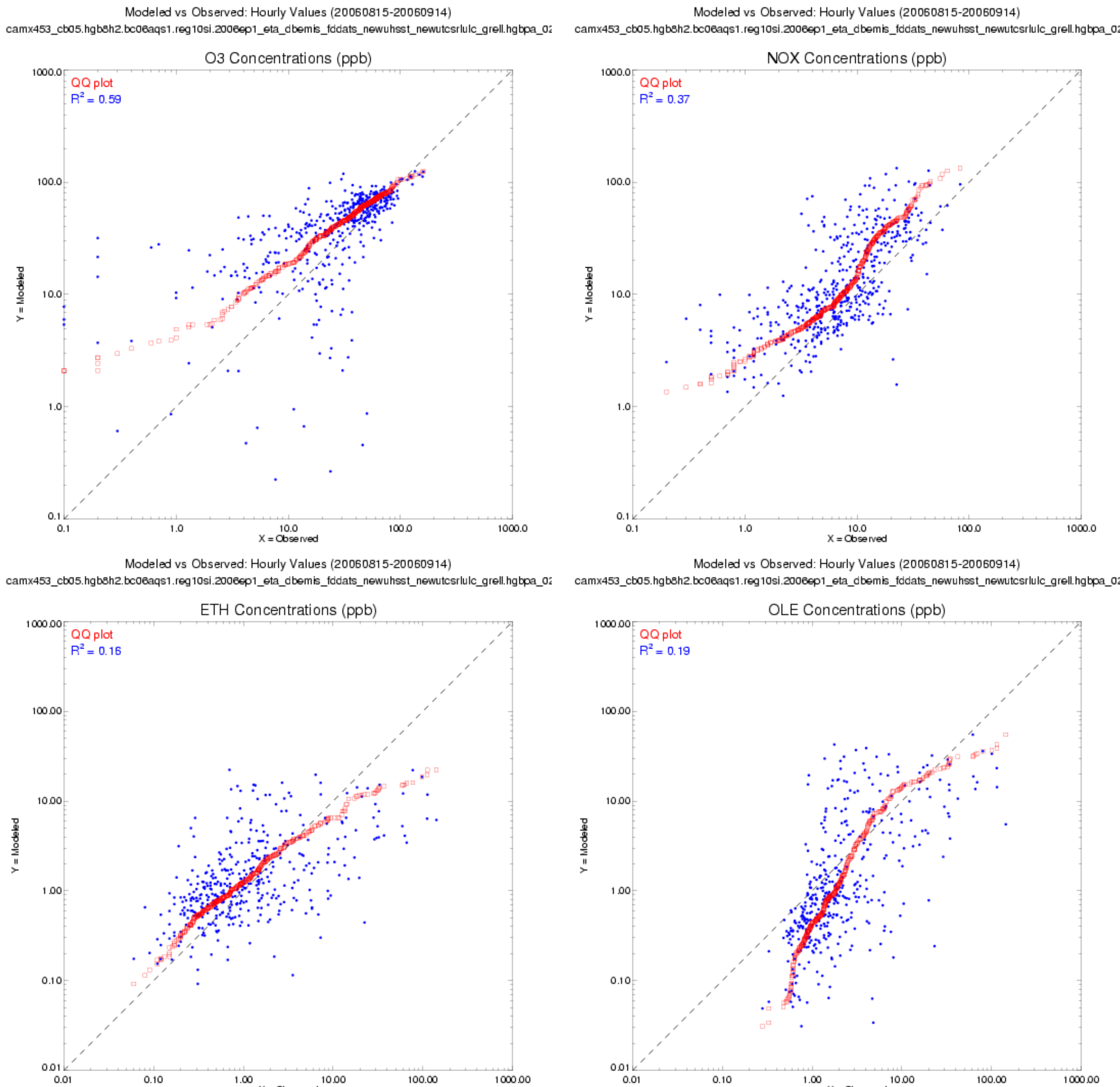


Figure 3-33: Scatter Plots of Hourly Ozone, NO_X, ETH, and OLE at the DRPK Monitor for the bc06aqs1 Episode

Tile plots of daily maximum eight-hour ozone concentrations for August 17, August 31, September 1, and September 7, 2006, are shown in Figure 3-34: *Tile Plot of Daily Maximum Eight-Hour Ozone Concentrations for August 17 and 31, and September 1 and 7, 2006*. The model replicates the areas of highest eight-hour ozone for the selected days, although it somewhat under-predicts the daily maximum eight-hour ozone concentrations, except on August 17, 2006, when the model tends to over-predict the daily maximum eight-hour ozone concentrations.

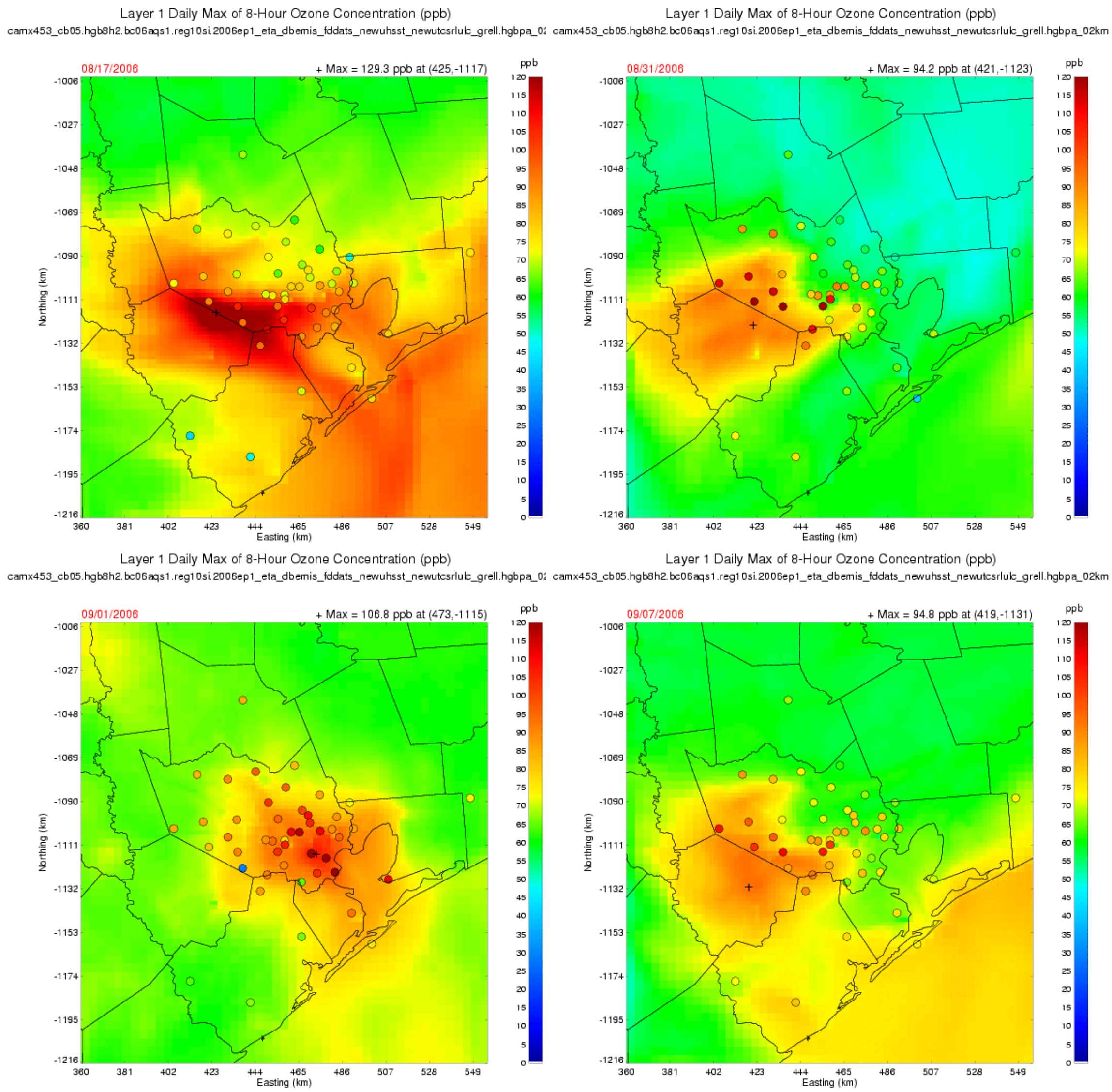


Figure 3-34: Tile Plot of Daily Maximum Eight-Hour Ozone Concentrations for August 17 and 31, and September 1 and 7, 2006

Overall, the graphical evaluation of model performance at key monitors on key episode days indicates the modeling adequately replicates the features that produced high ozone during this episode.

Bc06aqs2: September 16 through October 11, 2006

For the bc06aqs2 episode, hourly time series are presented for the Conroe Relocated (CNR2; CAMS 78), Galveston (GALV; CAMS 34), and Deer Park (DRPK; CAMS 35) monitors in Figure 3-35: *Time Series of Hourly Ozone Concentrations for Episode bc06aqs2 at the CNR2, DRPK, and GALV Monitors*. Relatively high ozone concentrations were measured at these monitors on several days during this episode. In general, the modeled ozone concentrations, including the 7 x 7 cell maximum-minimum range, replicate the diurnal pattern of the observations, with the exception of the lower ozone concentrations measured during the early morning hours, especially at the Conroe Relocated (CAMS 78) monitor.

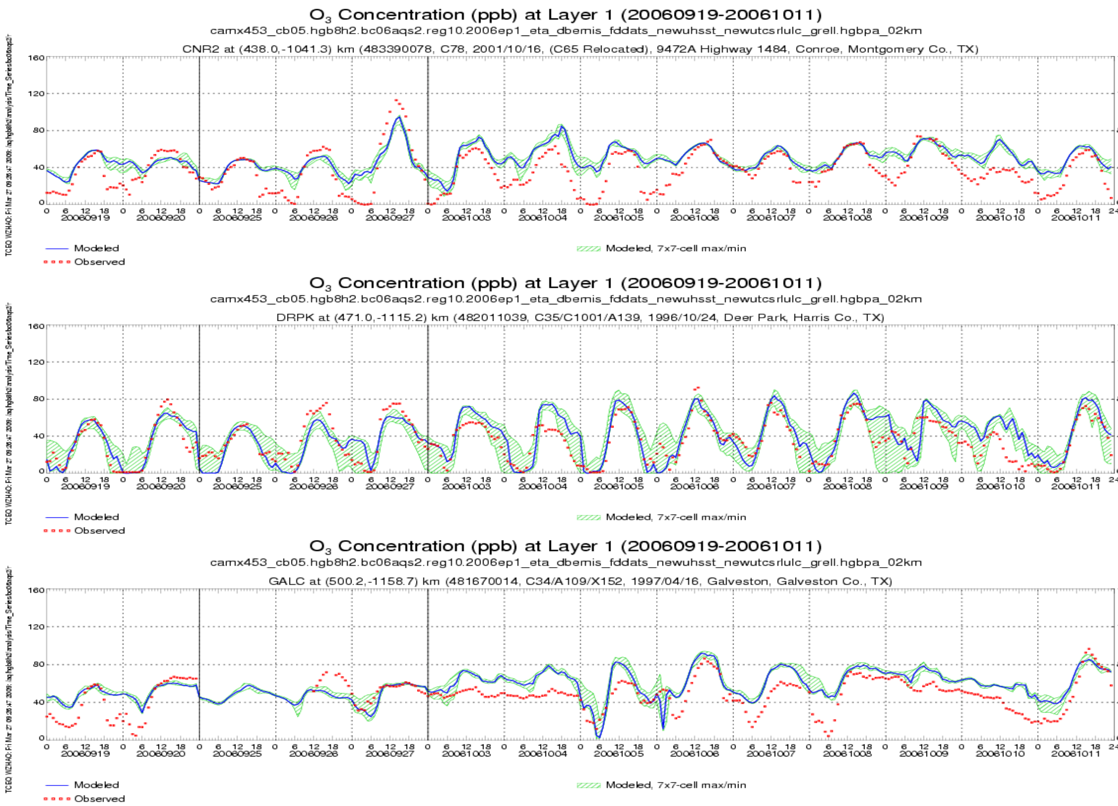


Figure 3-35: Time Series of Hourly Ozone Concentrations for Episode bc06aqs2 at the CNR2, DRPK, and GALV Monitors

Figure 3-36: *Time Series of Hourly Ozone Concentrations for Episode bc06aqs2 at the GRVL, LACT, and SAGA Rural Monitors* provides a comparison of measured and modeled hourly ozone concentrations at rural monitors. Modeled concentrations generally replicate the diurnal pattern of the observations. However, the model performance in the rural areas represented by these monitors varies for the different segments of the episode. For example, during the first segment, the model notably under-predicts the peak daytime ozone concentrations at all three monitors but compares more favorably with the peak daytime ozone concentrations measured during the middle portion of the third segment. Again, the model does not replicate the lower ozone concentrations measured on some days during the early morning hours. Overall, modeled and measured rural concentrations compare favorably enough that the modeled rural concentrations are unlikely to cause any substantial predictive bias within the HGB area during this episode.

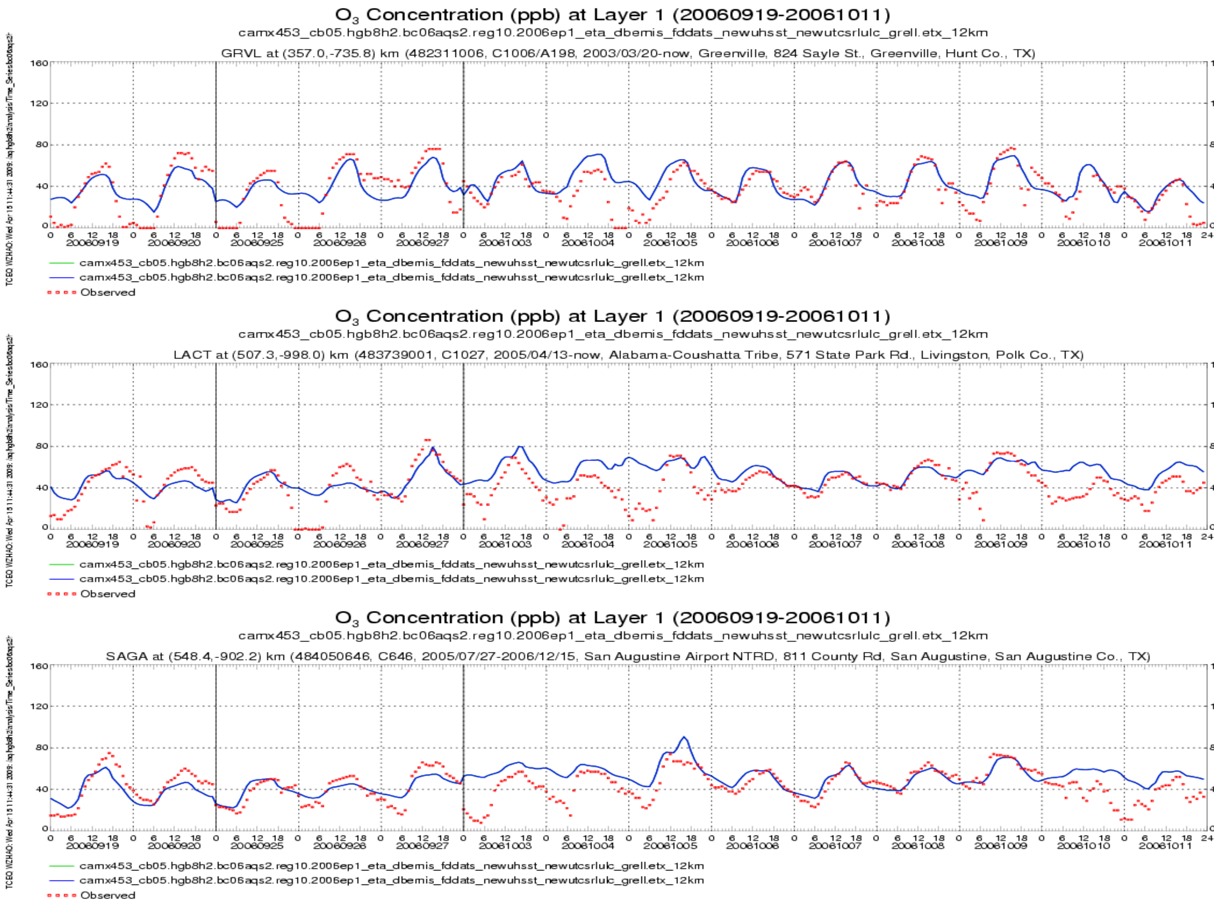


Figure 3-36: Time Series of Hourly Ozone Concentrations for Episode bc06aqs2 at the GRVL, LACT, and SAGA Rural Monitors

Scatter plots for the bc06aqs2 episode comparing the hourly measured and modeled concentrations at the Deer Park (CAMS 35) monitor are shown in Figure 3-37: *Scatter Plots of Hourly Ozone, NO_X, ETH, and OLE at the DRPK Monitor for the bc06aqs2 Episode.* As shown, there is a favorable comparison for the mid-range and higher ozone concentrations, with a slight tendency for the model to over-predict the measured concentrations. Although the QQ plot for NO_X indicates a favorable rank correlation, the model tends to generally over-predict the NO_X concentrations. The QQ plot for ETH also indicates a favorable rank correlation, although the model tends to over-predict the lower concentrations and under-predict the higher ETH concentrations. The model tends to under-predict the lower range of OLE concentrations with considerable scatter in the higher concentrations.

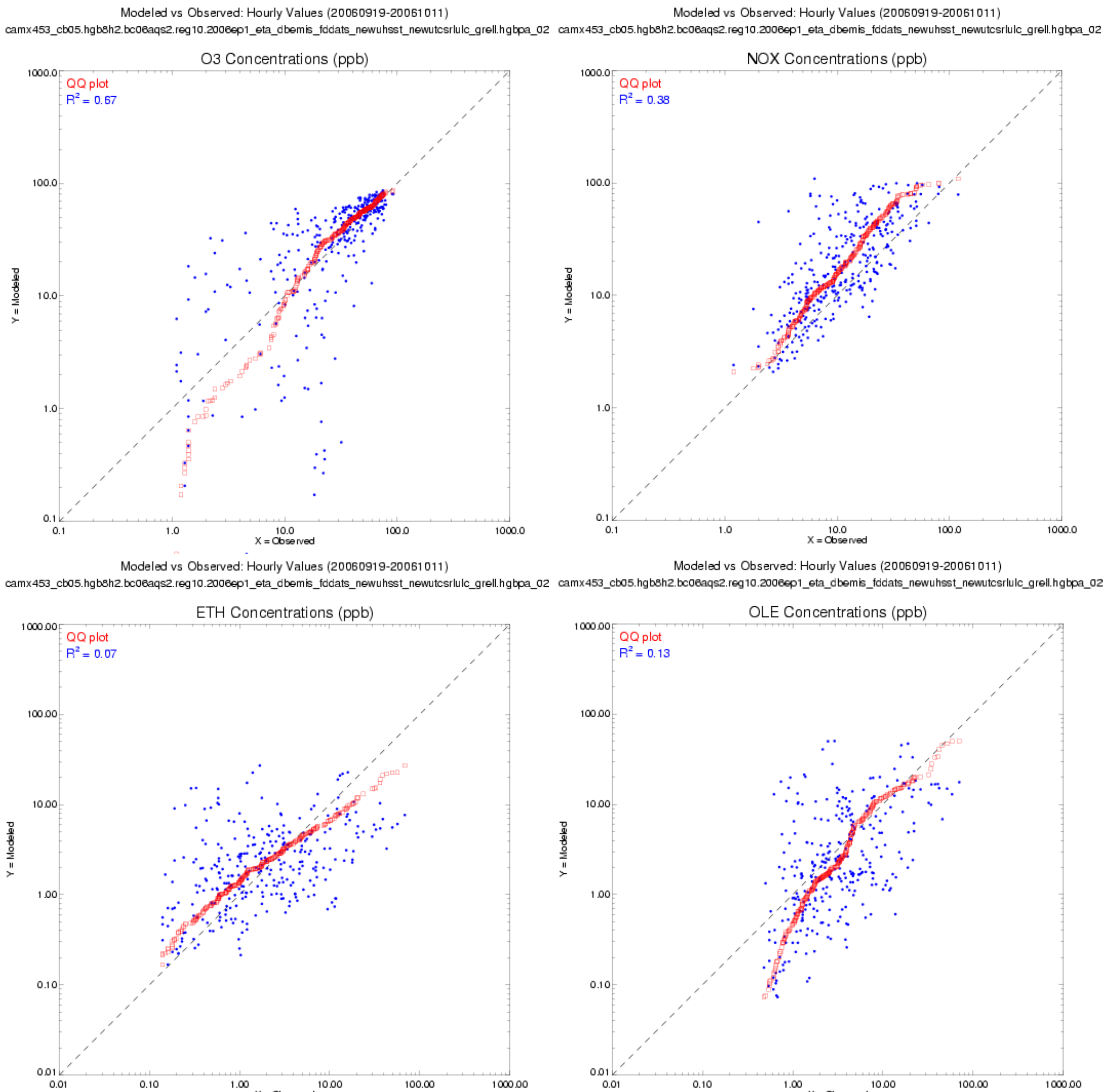


Figure 3-37: Scatter Plots of Hourly Ozone, NO_X, ETH, and OLE at the DRPK Monitor for the bc06aqs2 Episode

Tile plots of daily maximum eight-hour ozone concentrations for September 20, September 27, October 6, and October 11, 2006, are shown in Figure 3-38: *Tile Plot of Daily Maximum Eight-Hour Ozone Concentrations for September 20 and 27, and October 6 and 11, 2006.* The model replicates the areas of highest eight-hour ozone for the selected days, with the exception of September 20, 2006, when the model under-predicts higher levels of daily maximum eight-hour ozone concentrations.

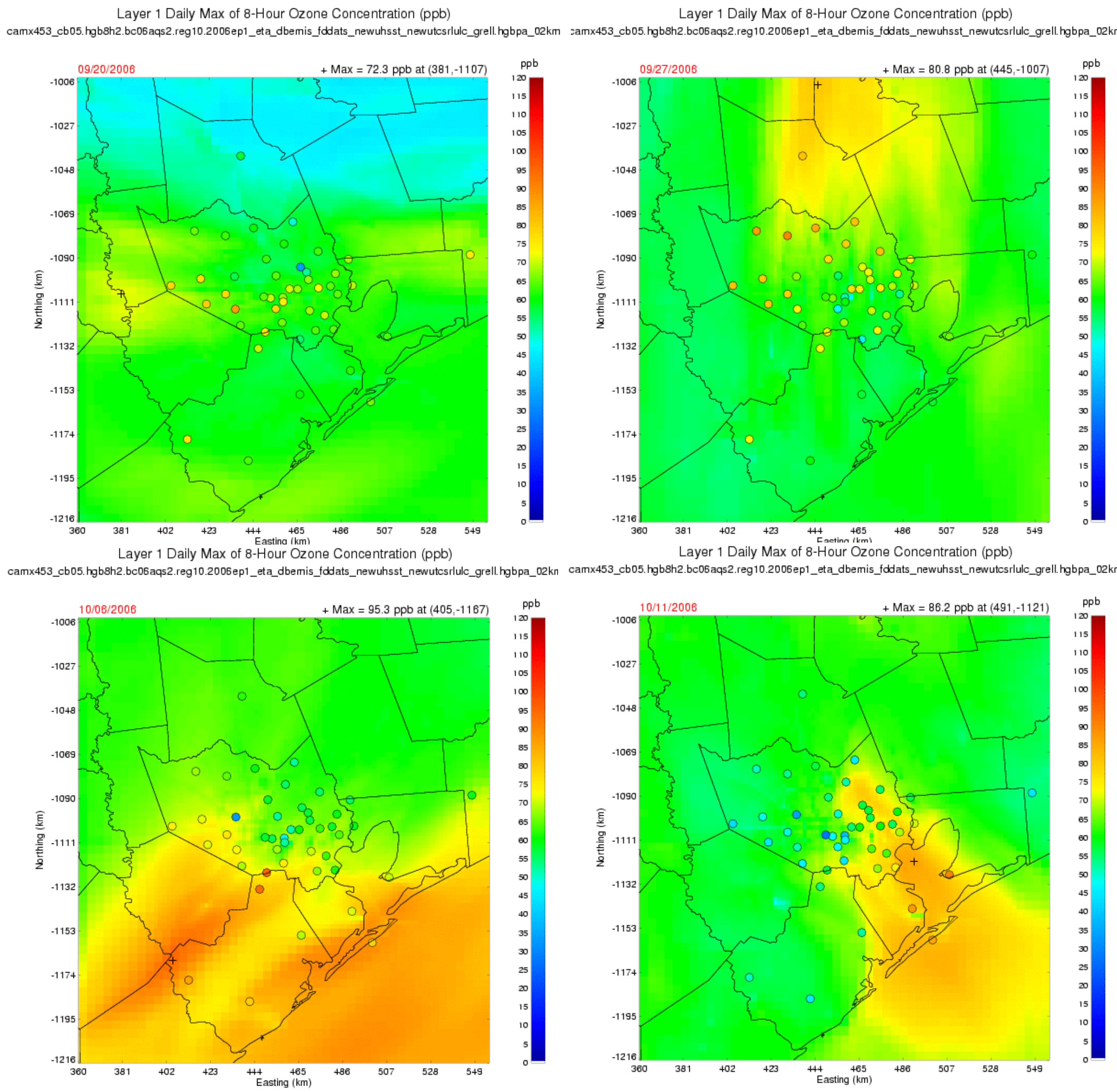


Figure 3-38: Tile Plot of Daily Maximum Eight-Hour Ozone Concentrations for September 20 and 27, and October 6 and 11, 2006

Overall, the graphical evaluation of model performance at key monitors on key episode days indicates the modeling adequately replicates the features that produced high ozone during this episode.

Evaluations Based on TexAQS II Data

Appendix C: *CAMx Modeling for the HGB Attainment Demonstration SIP* includes extensive comparisons of model predictions with observations collected by the many platforms employed during TexAQS II. This section provides general descriptions of the major sampling platforms employed and presents highlights of some of the conclusions reached based on these comparisons. In graphics comparing TexAQS II observations with modeled output, observational data are typically labeled as mixing ratios, which report moles of the pollutant per mole of ambient air. In practical terms, the term mixing ratio is synonymous with concentration.

Rural Monitoring Network

The TexAQS II study included a number of additional monitoring sites, which began collecting data in the summer of 2005 and continued until late October, 2006. During the TexAQS II intensive period, August 1 through October 15, 2006, a total of nine additional ozone monitors had been deployed in rural areas. Two of these additional monitors were the CLVL monitor near the Texas Oklahoma border, which also collected NO_X and total reactive nitrogen (NO_Y) during this period, and the SAGA monitor, which collected NO_X in addition to ozone. The SAGA monitor, discussed in the previous section, was one of those deployed for TexAQS II. A full discussion of model performance at these and other rural monitors is provided in Appendix C: *CAMx Modeling for the HGB Attainment Demonstration SIP*.

National Oceanic and Atmospheric Administration (NOAA) WP3-3D Orion

The NOAA WP-3D (P3) flew missions in the area between August 31 and October 13, 2006, and sampled many species not routinely monitored, including formaldehyde, NO_Y, nitric acid, and a suite of reactive hydrocarbons. Figure 3-39: *Comparison of Modeled and P3 Observed Ozone (O_3), August 31, 2006, 14:16 to 15:33 CST*, illustrates the flight of August 31, 2006, as the aircraft first arrived from Florida. The top two panels compare observed and modeled ozone concentrations (referred to on the plots as mixing ratio) along the flight track, while the bottom two compare the observed and modeled concentrations as a time series and a scatter plot superimposed with a QQ plot. The results are consistent with Figure 3-34: *Tile Plot of Daily Maximum Eight-Hour Ozone Concentrations for August 17 and 31, and September 1 and 7, 2006*, which showed that the model correctly placed the highest ozone concentrations geographically, but did not replicate the magnitude of the highest observations at the surface. The P3 flight shows that at the elevation of the aircraft, around 500 meters above ground level (AGL), the model also replicated the position of the highest ozone concentrations, but, as above, the model did not replicate the high concentrations seen in western Harris County.

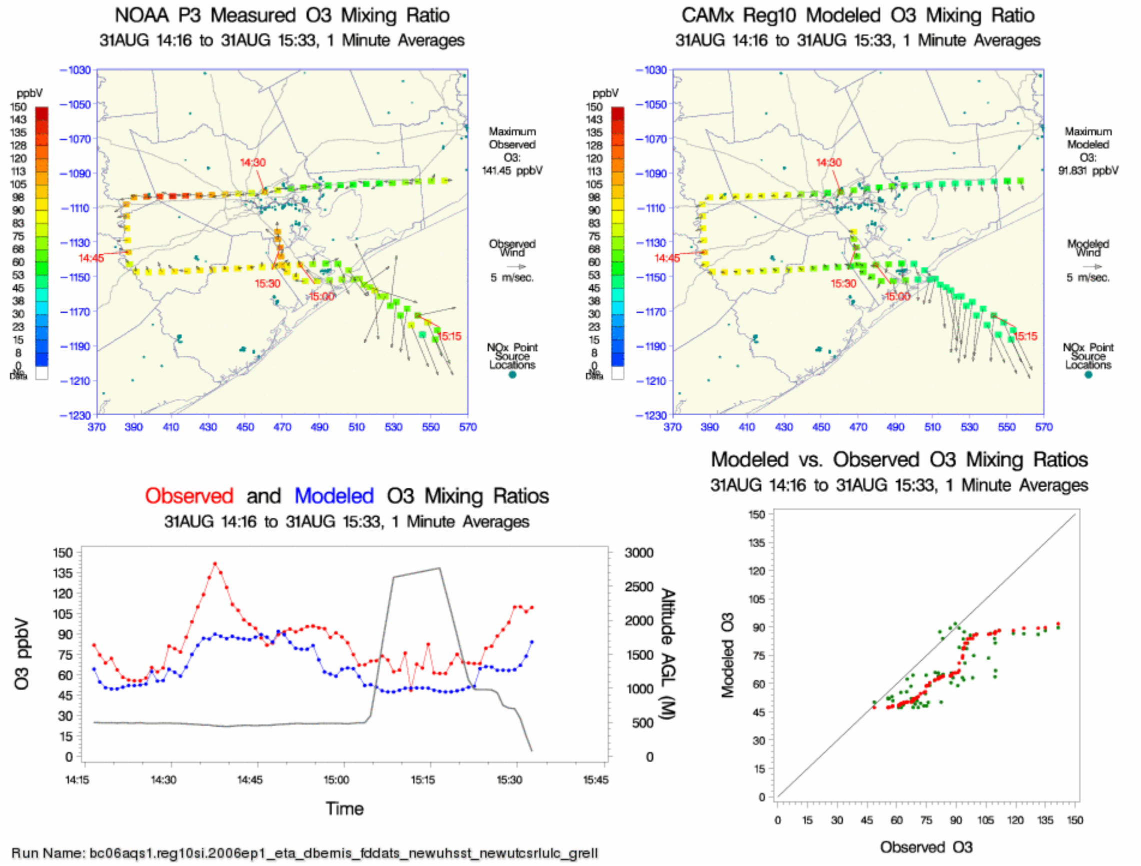


Figure 3-39: Comparison of Modeled and P3 Observed Ozone (O_3), August 31, 2006, 14:16 to 15:33 CST

The model's under-prediction of the highest observed ozone concentrations was common throughout most of the flights. A detailed discussion of model comparisons with P3 data can be found in Appendix C: *CAMx Modeling for the HGB Attainment Demonstration SIP*. Some of the conclusions reached are that the model usually replicated the winds observed by the P3 well and even in cases where it showed a directional bias, usually placed the highest ozone concentrations in about the right location. The model reproduced the observed NO_X concentrations well, but over-predicted CO. Most hydrocarbon species were under-predicted by the model, even after the HRVOC reconciliation, as was formaldehyde on most occasions. Isoprene concentrations were generally modeled well, but some high modeled isoprene concentrations did not match the observations.

<u>NOAA Twin Otter Tunable Optical Profiler for Aerosol and oZone (TOPAZ)</u>

A second NOAA aircraft, a Twin Otter, carried a downward-looking lidar tuned to ozone and aerosol loading called TOPAZ. Data from this instrument were valuable because they allowed modeled ozone to be compared with measurements vertically through up to 3,000 meters AGL. The instrument was flown on 13 missions between August 15 and September 13, 2006. The top two panels of Figure 3-40: *TOPAZ-Observed and Modeled Ozone Concentrations on August 31, 2006* compare observed and measured ozone concentrations between 255 and 377 meters AGL, which is the fifth vertical modeling layer. The lower plots are ozone curtains, showing ozone concentrations from the surface up to the aircraft elevation along the entire flight path and show that at around 15:00 the under-prediction carried upwards to over 1,500 meters. The TOPAZ concentrations near the surface are highly variable and may include contamination from surface features and thus, may not accurately reflect ozone concentrations within the first 200 meters.

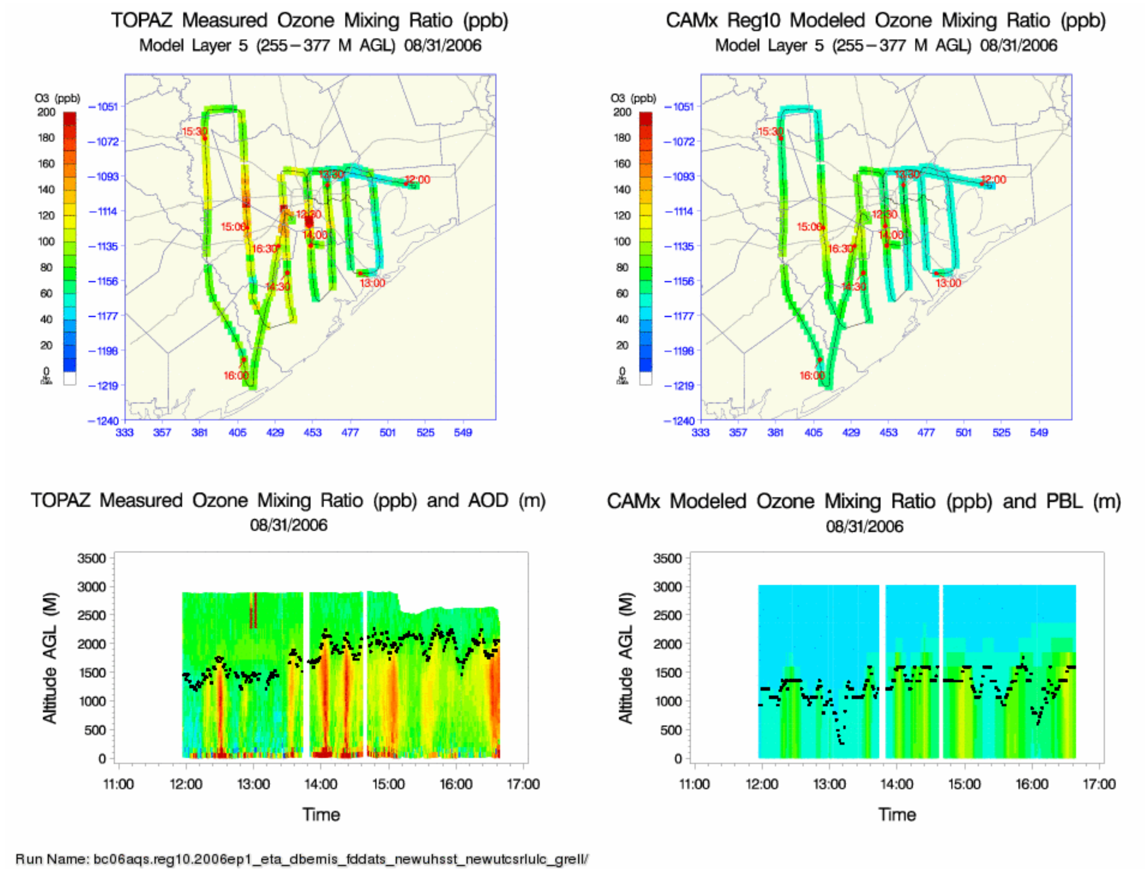


Figure 3-40: TOPAZ-Observed and Modeled Ozone Concentrations on August 31, 2006

Like the P3, the TOPAZ also showed that the model usually placed the highest ozone concentrations in the correct location, but generally under-predicted the observed peak concentrations. A comparison between the TOPAZ measurements of ozone concentration with those made by the P3 (the two flew together on only two days), showed relatively good agreement. The TOPAZ measured ozone concentrations above the mixed layer on most days that were notably higher than the model predicted.

<u>The Research Vessel (RV) Ronald H. Brown</u>

The NOAA RV Ron Brown arrived in the HGB area on August 15, 2006, and collected data until its departure on September 13. The ship carried a wide array of sampling platforms onboard and provided extensive data collected in the Gulf of Mexico, Galveston Bay, and in the Houston Ship Channel. Figure 3-41: *Comparison of Ozone Concentrations Observed by the RV Ron Brown with Modeled Concentrations, August 31, 2006, 08:00 to 16:30*, compares observed and modeled ozone for the period from 8:00 to 16:30 on August 31. The ship sailed from Barbour's Cut into the Gulf of Mexico, and then along the coast to near Freeport. This figure shows that the model predicted the observed concentrations of ozone very well from Barbour's Cut to Galveston and then showed a brief period of over-prediction as the observed concentrations dipped between 11:00 and 12:00. The decrease in measured ozone concentrations coincided with a period of very high NO_X concentrations observed in the channel between Galveston Island and Bolivar Peninsula. The observed NO_X was probably emitted by local ship traffic and likely reduced the ozone concentrations through titration. As the ship sailed into the Gulf of Mexico, it measured unusually high ozone concentrations moving onshore, which the model under-predicted. This under-prediction may be the result of long-range transport or of model boundary conditions that are too low on this day. As an alternative, the under-prediction may have resulted from air advected out into the Gulf of Mexico the previous day from the Houston or Beaumont areas.

More often, the ship encountered low ozone concentrations in the Gulf of Mexico, particularly under southerly wind conditions, which the model often over-predicted.

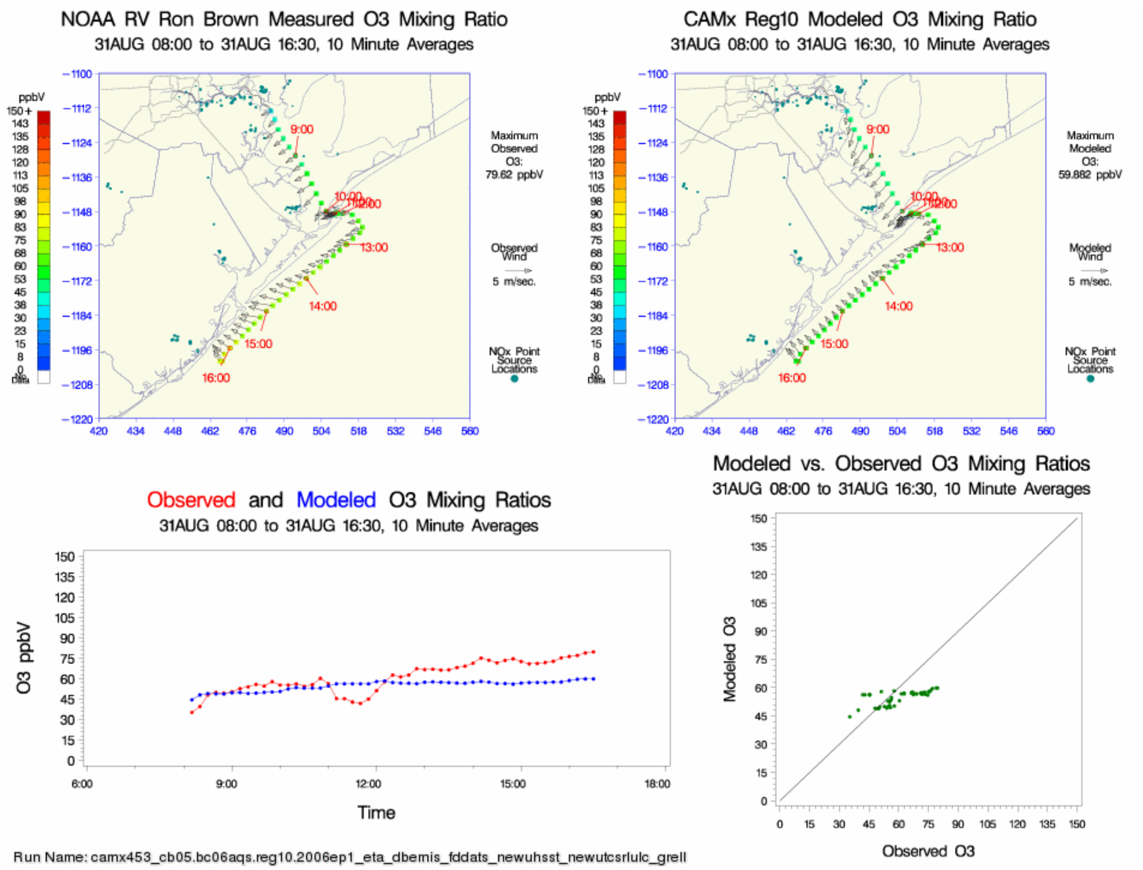


Figure 3-41: Comparison of Ozone Concentrations Observed by the RV Ron Brown with Modeled Concentrations, August 31, 2006, 08:00 to 16:30

Ozone Sondes

A number of ozone sondes, lightweight and compact balloon-borne instruments, were launched from the University of Houston (UH) campus southeast of downtown Houston and also from the deck of the RV Ron Brown in 2006. Ozone monitors attached to these balloons provide an opportunity to evaluate the model's vertical ozone distribution. Figure 3-42: *Comparison of Modeled and Observed Vertical Ozone Profiles from Two Sonde Launches at UH Campus and One Sonde Launch from the RV Ron Brown in the Gulf of Mexico, August 31, 2006,* shows three vertical ozone profiles measured by sondes launched from the UH campus on August 31, 2006, compared with modeled concentrations on that day. The left-hand panel shows that for the morning (6:00 a.m.) launch from the UH campus, ozone concentrations fluctuated with altitude within the first 1,500 meters. This effect may not represent actual variability in concentrations, however, since the measurements made by the sondes launched from UH were susceptible to interference by sulfur dioxide (SO_2); each molecule of SO_2 encountered by the instrument effectively cancels out one molecule of ozone. Because there are numerous SO_2 sources relatively close to the UH campus, it is very likely that the balloon may have encountered one of these plumes during ascent.

Aside from the fluctuations, the model replicated ozone concentrations reasonably well up to around 1,200 meters. The model under-predicted ozone concentrations up to about 5,000 meters, but predicted concentrations fairly well above that altitude. At 12:29 p.m. (center panel), the model slightly over-predicted ozone concentrations near the surface, but observed ozone concentrations increased dramatically within the first 100 meters or so to 30 ppb greater than modeled concentrations. Unlike the notches seen in the morning launch, this effect is most likely caused by ozone scavenging by nearby NO_X sources, probably vehicular traffic. More significantly, after the first few meters, the model continued to under-predict observed ozone concentrations up to 4,000 meters.

The right-hand panel of Figure 3-42: *Comparison of Modeled and Observed Vertical Ozone Profiles from Two Sonde Launches at UH Campus and one Sonde Launch from the RV Ron Brown in the Gulf of Mexico, August 31, 2006* shows ozone concentrations observed and modeled for a sonde launch from the deck of the RV Ron Brown, coincident with the 12:29 p.m. launch from the UH. In this case, the model initially over-predicted ozone concentrations near the surface by 15 ppb, but within the first 100 meters or so the sonde recorded a drop in ozone concentrations, followed by a rapid rise. This feature is probably due to the balloon encountering sulfate emissions from a ship plume, possibly from a passing ship or from the Ron Brown. The modeled and observed profiles crossed at about 1,200 meters, and then the observations exceeded the model by 10 to 20 ppb up to 4,000 meters. Farther above, the observations oscillated around the modeled values.

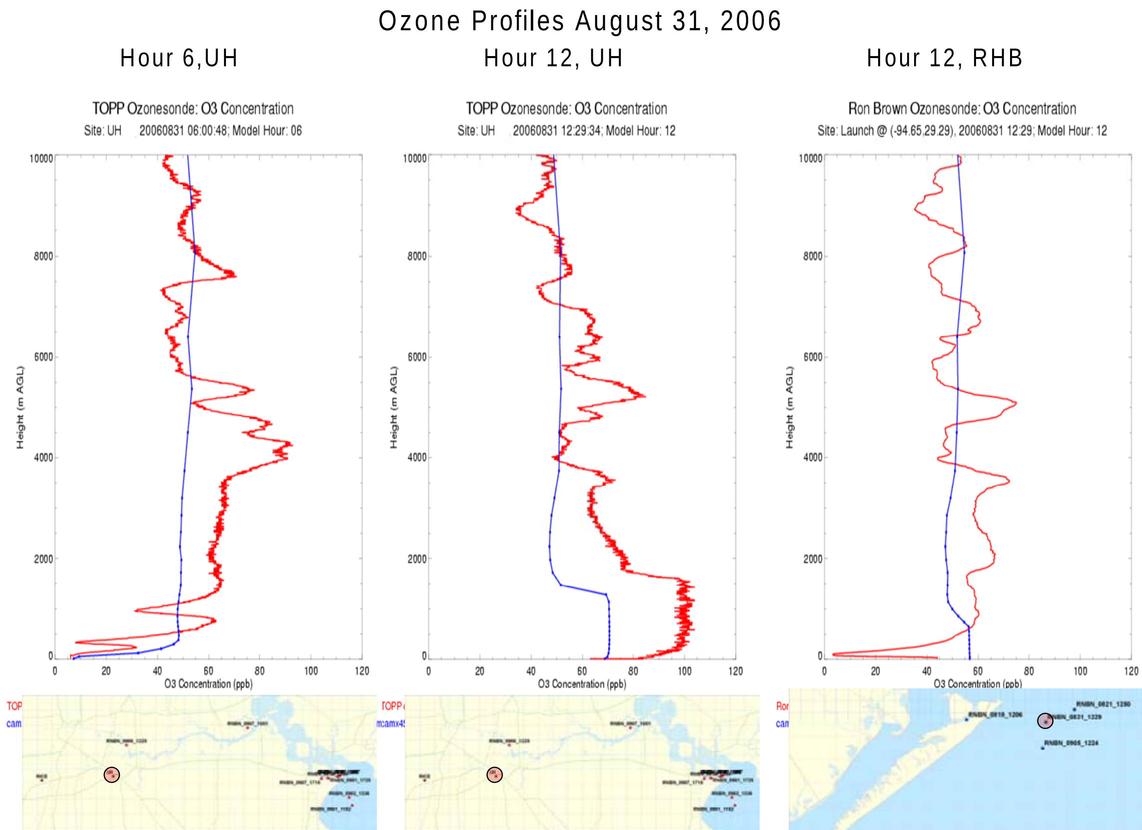


Figure 3-42: Comparison of Modeled and Observed Vertical Ozone Profiles from Two Sonde Launches at UH Campus and One Sonde Launch from the RV Ron Brown in the Gulf of Mexico, August 31, 2006

Notes: TOPP = Tropospheric Ozone Pollution Project
RHB = Ronald H. Brown

Moody Tower

The Moody Tower site is located atop a dormitory on the UH campus southeast of downtown Houston. The site is useful because it is located 60 meters AGL (in model layer 2), hence is insulated from some of the more localized emission sources. Much of the Moody Tower data has been incorporated into the standard model performance evaluation processing performed at the

TCEQ for surface sites, with special provisions to use modeled concentrations from layer 2 instead of layer 1. Within this framework, the Moody Tower data offers measurements of some atmospheric constituents explicitly tracked in the CB05 mechanism, including nitric acid, nitrous acid, and formaldehyde. In addition, researchers at this site collected a wealth of information on radicals associated with photochemical ozone production. These data are used in conjunction with CAMx Chemical Process Analysis in Section 5.1: *QUANTITATIVE CORROBORATIVE ANALYSIS* of this document.

Other TexAQS II Data

During TexAQS II, formaldehyde data were collected at two sites, Lynchburg Ferry and Houston Regional Monitor-3. These data have been incorporated into the TCEQ model performance evaluation database and are being used in routine comparisons between modeled and observed concentrations.

Some additional TexAQS II data have not yet been used for model performance evaluation because they were not yet available in a usable form, but may be useful in the future. These data sources include the Houston Triangle project, the Baylor Aztec flights, the Solar Occultation Flux (SOF) measurements, "smart" balloon data, Differential Optical Absorption Spectroscopy (DOAS) observations, and satellite observations.

3.5.4.3 Diagnostic Evaluations

Since future design values are based solely on the model's relative response and not on the magnitude of its future case ozone predictions, evaluating the model's response to emission changes becomes at least as important as evaluation of its ability to reproduce historically observed events. The EPA modeling guidance recommends several possible means of assessing model response to emission changes. However, most of these methods are either indirect (probing tools, alternative base cases, most observation-based models) or are difficult to employ in practice (retrospective analyses). In this section the TCEQ employs three tests to evaluate the model's response to emission changes. The first of these is a sensitivity analysis designed to test the model's response to a hypothetical inventory change, specifically, an increase in emissions from flares. The second test is a retrospective analysis that uses an existing 2000 baseline inventory to test the model's ability to predict ozone design values in a previous year. The third, a weekday-weekend analysis, is based on observational modeling designed to assess an area's VOC- or NO_X-sensitivity.

Flare Sensitivity Modeling

The TCEQ has been evaluating flares as a potential source of underreported VOC emissions since TexAQS 2000. Flare monitoring requirements in the HRVOC rules in 30 TAC Chapter 115, Subchapter H, Division 1, were adopted in 2002 and designed to provide more accurate information on HRVOC and total flow rate to the flares. More recently, the TCEQ has been evaluating potential issues with the destruction efficiencies used to calculate emissions from flares. Due to the open combustion nature of flares, direct measurement of flare emissions or verification of flare destruction efficiencies is problematic. Remote sensing technologies such as differential absorption lidar (DIAL) can be used to estimate flare emissions and destruction efficiency. Recent work with DIAL during TexAQS II indicated destruction efficiencies on an actual industrial flare were less than assumed for reporting purposes. However, the use of such remote sensing technology is expensive and currently limited to research activities such as TexAQS II. Therefore, companies must still use an assumed destruction efficiency to calculate VOC emissions from flares. Most companies assume a flare destruction efficiency of 98 to 99 percent, meaning the VOC emission rate is only one or two percent of the VOC mass rate sent to the flare. These assumptions are based on a small number of controlled studies conducted in the early 1980s and may not represent flare operations in real-world conditions. Furthermore, the chemistry that occurs within the flare flame is not well-understood in the majority of situations. Products of incomplete combustion may be formed and emitted from flares in addition to uncombusted VOC from the material sent to the flares. Some researchers have speculated that flares could emit formaldehyde in sufficient quantities to significantly enhance photochemical reactivity in the flare plumes (Castineira and Edgar, 2006; Robinson et al., 2008).

To study the sensitivity of the model to potential unaccounted-for flare emissions, a model run was conducted in which flare emissions were increased ten-fold (10X). This is equivalent to reducing assumed flare destruction efficiency from 99 percent to 90 percent. At the same time, the potential source contribution function (PSCF)-based HRVOC reconciliation was removed. The net effect on emissions was to replace the 23.1 tpd of ground-level HRVOC emissions with 321.6 tpd of elevated flare VOC, of which 87.9 tpd is HRVOC.

Figure 3-43: *Comparison of P3 Measurements with Base Case and Enhanced Flare Emissions; observed ethylene, formaldehyde, and ozone compared to modeled concentrations using the base case inventory, and (right) the base case inventory with 10X flare VOC emissions, minus the HRVOC reconciliation* compares (A) modeled ETH, (B) formaldehyde (FORM), and (C) Ozone concentrations with observations made on the NOAA WP-3D Orion aircraft during TexAQS II, inside the 2 km HGB modeling grid. In each row, the left-hand panel shows the comparison using the 2005-2006 base case modeling inventory, while the right-hand panel shows a similar comparison using the inventory with the ten-fold increase in flare VOC emissions (and concurrent removal of the HRVOC reconciliation discussed earlier in Section 3.4.2.1: *Point Sources*). The green dots represent actual data pairs. The red dots are plotted by matching the smallest observed value with the smallest modeled value, then the next smallest of each, and so on. The resulting QQ plot provides a means to compare the two distributions; if it lies close to the diagonal line, then the model is simulating the correct proportions of small, medium, and large concentrations of the pollutant.

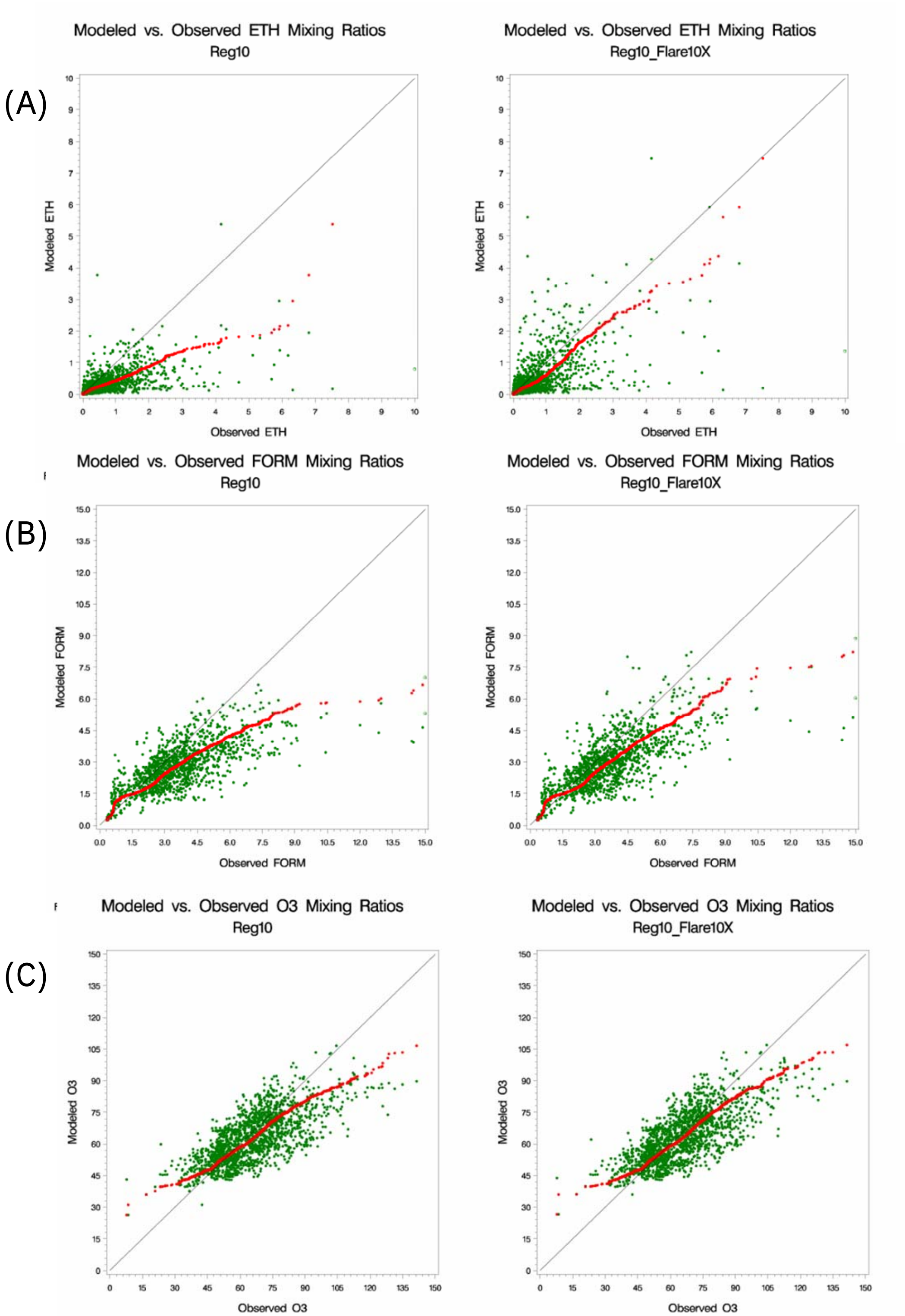


Figure 3-43: Comparison of P3 Measurements with Base Case and Enhanced Flare Emissions; observed ethylene (Panel A), formaldehyde (Panel B), and ozone (Panel C) compared to modeled concentrations using (left) the base case inventory, and (right) the base case inventory with 10X flare VOC emissions, minus the HRVOC reconciliation

The flare sensitivity markedly improves the distribution of modeled ethylene concentrations compared with observations and also improves modeled formaldehyde and ozone concentrations, although the highest modeled ozone concentration remains at about 105 ppb compared with observations ranging to near 145 ppb. This discrepancy is at least partly due to the incommensurability of the measurements: modeled values represent averages over one hour over a 2 km x 2 km region (also across a vertical depth depending on model layer), while the aircraft measurements are essentially single points in space and time. However, the 10X flare sensitivity modeling degrades performance for some pollutants at the surface, as illustrated in Figure 3-44: *Log-Log Plots of Observed vs. Modeled Ethylene at Deer Park September 19 through October 11, 2006; with base case inventory, and base case inventory with 10X flare emissions minus the HRVOC reconciliation*, which compares modeled and observed ozone concentrations at Deer Park to base case and 10X flare emissions (note that these plots use a log-log scale; blue dots represent observed-modeled pairs, and red dots indicate the QQ plot).

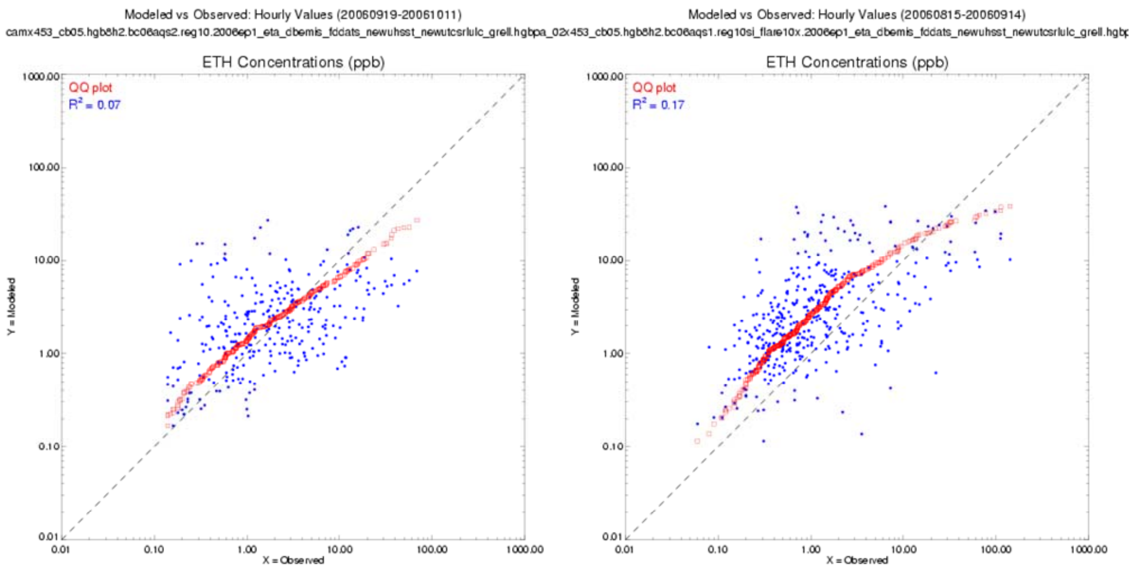


Figure 3-44: Log-Log Plots of Observed vs. Modeled Ethylene at Deer Park September 19 through October 11, 2006; with (Left) base case inventory, and (Right) base case inventory with 10X flare emissions minus the HRVOC reconciliation

Figure 3-45: *Daily Peak Modeled Eight-Hour Ozone Concentrations with Base Case Inventory and 10X Flare Inventory; the difference between the two plots (Flare 10X – Reg 10) is shown at right* shows the effect of the 10X flare VOC increase on eight-hour peak ozone concentrations on October 6, 2006. The ozone plume, while still under-estimated, clearly matches the observed surface concentrations better with the 10X flare inventory (center) than the base case inventory (left). Observed eight-hour peak ozone concentrations are shown as small circles at the monitor locations.

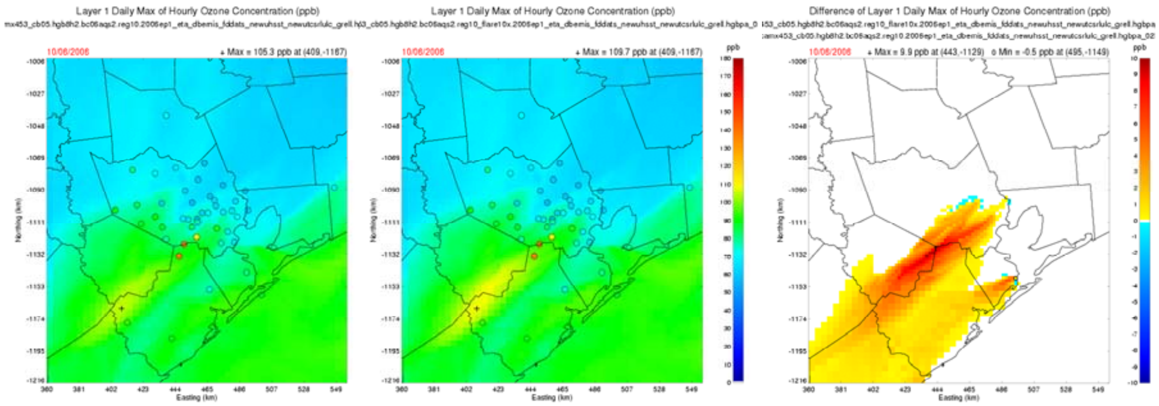


Figure 3-45: Daily Peak Modeled Eight-Hour Ozone Concentrations with Base Case Inventory (Left) and 10X Flare Inventory (Center); the difference between the two plots (Flare 10X – Reg 10) is shown at right

In addition to the 10X VOC sensitivity, the TCEQ ran a sensitivity in which only HRVOC emissions from flares were increased (also 10X). A third sensitivity further modified the 10X HRVOC sensitivity to add a formaldehyde boost equal to 10 percent of the added HRVOC emissions. Results of these sensitivities can be found in Appendix C: *CAMx Modeling for the HGB Attainment Demonstration SIP*.

More work is needed to determine whether a flare adjustment is superior to the surface-level reconciliation currently in use. The TCEQ plans to investigate using a PSCF-based technique applied to flare emissions in the near future.

Retrospective Modeling – 2000 Backcast

The purpose of this test is to test the model in a forecast (in this case, backcast) mode, where the answer is known in advance. Retrospective modeling is usually difficult to implement in practice because of the need to create an inventory, but a 2000 inventory was already available. In this test, most of the 2006 baseline inventory was replaced with a baseline inventory previously developed for the 2000 ozone episode used in prior SIP revisions. However, the episode day-specific biogenic emissions for the 2005 and 2006 episodes were not replaced, as is also the practice when modeling a future base emissions inventory. Similarly, the 2005 and 2006 meteorology was used with the 2000 baseline emissions as is the procedure when modeling with the future emissions.

Since the model predictions of the typical future design values are based on a DV_B, which is the average of three regulatory design values (EPA, 2007), the quantity forecast in this test is not a specific future year's design value but rather the average of three years. Thus, the regulatory design values for 2000, 2001, and 2002 were averaged in the same manner as the 2006 DV_B was calculated as the average of the 2006, 2007, and 2008 regulatory design values. Table 3-16: *2000 Baseline Design Value Calculation for Retrospective Analysis* shows the calculation. Only monitors that had at least one regulatory design value in the 2000-2002 window and also in the 2006-2008 window were used.

Table 3-16: 2000 Baseline Design Value Calculation for Retrospective Analysis

Modeling Site Code	CAMS Number	Eight-Hour DV			2000 Baseline DV
		2000	2001	2002	
BAYP	53	111	110	100	107.0
C35C	403	101	97	93	97.0
DRPK	35	112	108	103	107.7
GALV	34	108	98	89	98.3
HALC	8	111	108	107	108.7
HCQA	409	110	104	102	105.3
HLAA	408	96	91	83	90.0
HNWA	26	108	105	101	104.7
HOEA	1	102	103	101	102.0
HROC	95	-	-	95	95.0
HSMA	406	106	93	90	96.3
HWAA	405	105	98	89	97.3
SHWH	410	102	104	95	100.3

Once the model was run with the 2000 baseline emissions, RRFs were calculated. In a retrospective analysis, most of the RRFs are expected to be greater than 1 because ozone has decreased since the retrospective year. Table 3-17: *2000 Projected DVs Compared with Calculated DVs* shows the calculated RRFs and the respective projected 2000 design values, compared with those listed in Table 3-16: *2000 Baseline Design Value Calculation for Retrospective Analysis*.

Table 3-17: 2000 Projected DVs Compared with Calculated DVs

Modeling Site Code	CAMS Number	2006 Baseline DV	2006-to-2000 RRF	Projected 2000 DV	Baseline 2000 DV
BAYP	53	96.7	1.11	107.0	107.0
C35C	403	79.0	1.18	93.5	97.0
DRPK	35	92.0	1.18	108.1	107.7
GALV	34	83.0	1.11	92.5	98.3
HALC	8	85.0	1.15	97.9	108.7
HCQA	409	87.0	1.13	98.6	105.3
HLAA	408	77.7	1.11	86.4	90.0
HNWA	26	89.0	1.13	100.4	104.7
HOEA	1	80.3	1.17	94.0	102.0
HROC	95	79.7	1.15	91.6	95.0
HSMA	406	90.3	1.16	104.8	96.3
HWAA	405	76.3	1.14	86.9	97.3
SHWH	410	92.3	1.11	102.9	100.3

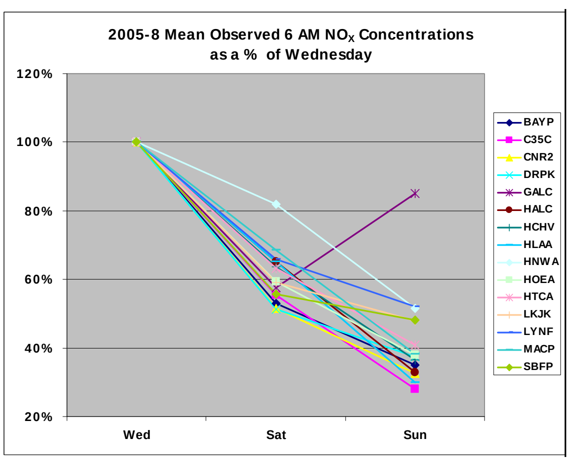
For two sites, Houston Bayland Park (CAMS 53) and Deer Park (CAMS 35), the projections were identical, or nearly identical, to the calculated baseline values. For all other sites but one, the model-projected 2000 DVs were lower than the calculated values, indicating that the model did not respond as well to emission changes as the actual airshed for these sites. In only one case did the model respond notably more strongly than the airshed, Houston Monroe (CAMS 406).

In conclusion, the modeled response generally was lower than the actual airshed's response to 2000-2006 emission changes. This conclusion gives confidence going forward that the model's predictions are conservative, and that future ozone concentrations may be even lower than predicted by the model.

Observational Modeling – Weekday/Weekend

Weekend emissions of NO_X in urban areas tend to be lower than weekday emissions because of fewer miles driven. The effect is most pronounced on weekend mornings, especially Sundays, since commuting is much lower than weekdays. In a detailed analysis presented in Appendix C: *CAMx Modeling for the HGB Attainment Demonstration SIP* an analysis using modeled Wednesdays, Saturdays, and Sundays is described, but the results were rather inconclusive because of small sample sizes (15 Wednesdays and 11 each Saturdays and Sundays). A more comprehensive analysis was undertaken to simulate more of each day type; in three separate runs each day's modeled emissions were substituted with, Wednesday, Saturday, and Sunday emissions. These runs provided a total of 88 each Wednesdays, Saturdays, and Sundays.

For comparison, 6:00 a.m. NO_X concentrations were averaged for every Wednesday, Saturday, and Sunday between May 15 and October 15 in the years 2005 through 2008, which gives over 100 of each day (less for some monitors because of missing data). Figure 3-46: *Mean Observed NO_X Concentrations at HGB Monitors as a Percentage of Wednesday Mean Values, May 15 through October 15, 2005 through 2008* shows observed and modeled 6:00 a.m. NO_X concentrations at 15 sites in the HGB area. Except for anomalous behavior at Galveston Airport (CAMS 34), all monitors show observed and modeled NO_X concentrations that decline monotonically from Wednesday through Saturday to Sunday. The observed concentrations (excluding Galveston Airport (CAMS 34)) show similar percentage declines, but the modeled values have much greater variability, with sites in eastern Harris County (near the Ship Channel) showing the slowest declines. This effect could be due to the model mixing down industrial NO_X emissions too rapidly.



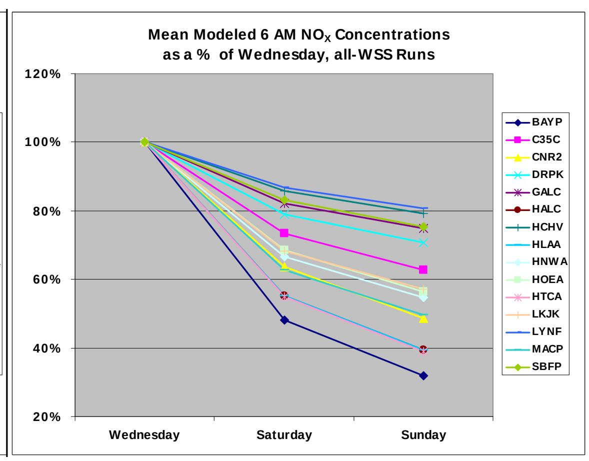
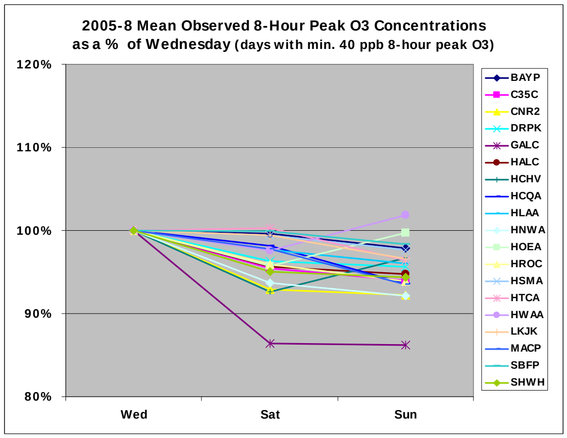


Figure 3-46: Mean Observed NO_X Concentrations at HGB Monitors as a Percentage of Wednesday Mean Values, May 15 through October 15, 2005 through 2008

Figure 3-47: *Observed and Modeled Daily Peak Eight-Hour Ozone Concentrations as a Percentage of Wednesdays* shows observed and modeled daily peak eight-hour ozone concentrations as a percentage of Wednesdays for the same sites. Because the modeled episodes represent periods of higher-than-average ozone concentrations, the observed concentrations were filtered to remove values less than 40 ppb. The left-hand panel of the figure shows observed concentrations trending downward for nearly all sites, but some seem to rebound on Sunday and exceed the respective Saturday concentrations. This effect is probably due to filtering concentrations below 40 ppb, which removes very low concentrations from the average.



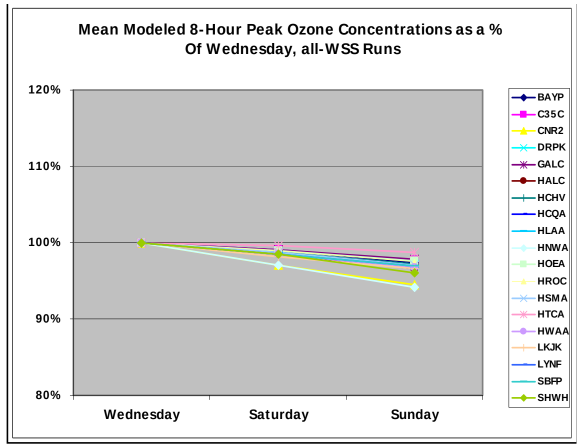


Figure 3-47: Observed and Modeled Daily Peak Eight-Hour Ozone Concentrations as a Percentage of Wednesdays

While the modeled concentrations are very tightly clustered in the figure, they universally decline from Wednesday through Saturday to Sunday, similar to the pattern shown by the observations (ignoring the anomalous rebound effect). The airshed and model both show sensitivity to NO_X reductions, at least for days with some ozone-forming potential. In fact, the airshed seems to show greater sensitivity to NO_X than the model, which suggests that anticipated reductions to motor vehicle emissions over the next several years may be more effective than suggested by the model.

3.6 BASELINE (2006) AND FUTURE CASE (2018) MODELING

3.6.1 2006 Baseline Modeling

The TCEQ selected 2006 as the baseline year for conducting the attainment modeling. Two features of the 2006 baseline year are used in the attainment modeling. First, the 2006 baseline year identifies the three consecutive years (2006, 2007, and 2008) with design values (DVs) that include the fourth high of the 2006 baseline year. These three DVs are averaged to calculate the baseline design value (DV_B), as previously illustrated in Figure 3-1: *Baseline Design Value Calculation Illustration*. Second, typical 2006 ozone season day (OSD) emissions were developed, as previously summarized in Table 3-13: *Summary of 2006 Baseline and 2018 Future Base, and 2018 Control Strategy Anthropogenic Modeling Emissions for HGB.*

The typical 2006 OSD emissions were modeled for all episode days to calculate the denominator of the RRF for each of the regulatory monitors. The denominator of the RRF is the average of the modeled maximum daily eight-hour ozone concentrations for those days with modeled concentrations greater than or equal to 85 ppb, within a grid cell array about each monitor.

Figure 3-48: *Near Monitoring Site Grid Cell Array Size* shows a map of the 2 km subdomain nested in a portion of the 4 km x 4 km fine grid domain depicting the monitors, and the extent of 7 x 7, 5 x 5, and 3 x 3 grid cell arrays based on the 2 km grid. The TCEQ has calculated RRF values for each of these array sizes, but used a 7 x 7 grid array about each monitor.

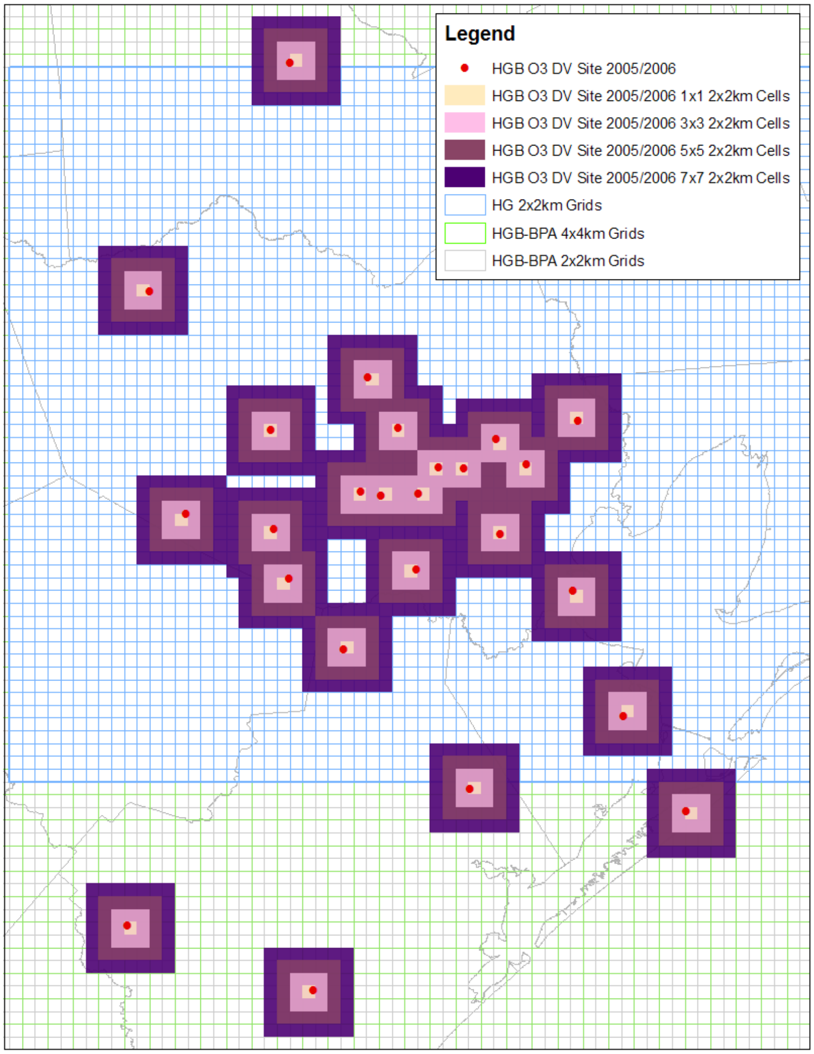


Figure 3-48: Near Monitoring Site Grid Cell Array Size

The monitor-specific denominator of the RRF is calculated as the average of the modeled daily maximum eight-hour ozone concentrations above 84 ppb at that monitor. Per the EPA's modeling guidance, if there are fewer than 10 days with 2006 baseline modeled concentrations greater than 84 ppb, then days with modeled concentrations less than or equal to 84 ppb can be used so the average is based on at least 10 days. Table 3-18: *2006 DV_B, RRF Denominator (RRF_D), and Number of 2006 Baseline Modeled Days Averaged* summarizes the DV_B and the denominator of the RRF for the HGB regulatory monitors. There is also one non-regulatory monitor, Wallisville Road (CAMS 617), which has a DV_B greater than or equal to 85 ppb. Including non-regulatory monitors that have a DV_B and a RRF denominator greater than or equal to 85 ppb mitigates the need to conduct an unmonitored area analysis for the area represented by the monitor, as required by the EPA's modeling guidance.

Table 3-18: 2006 DV_B, RRF Denominator (RRF_D), and Number of 2006 Baseline Modeled Days Averaged

Monitor Designation	Site Code	2006 DV_B (ppb)**	2006 RRF_D (ppb)	Modeled Days Averaged
Houston East (CAMS 1)	HOEA	80.3	96.662	20
Aldine (CAMS 8)	HALC	85.0	97.069	17
Channelview (CAMS 15)	HCHV	82.7	96.609	16
Northwest Harris County (CAMS 26)	HNWA	89.0	93.773	21
Galveston Airport (CAMS 34)	GALV	83.0	95.411	10
Deer Park (CAMS 35)	DRPK	92.0	95.032	20
Seabrook Friendship Park (CAMS 45)	SBFP	85.3	92.227	14
Houston Bayland Park (CAMS 53)	BAYP	96.7	96.949	28
Conroe Relocated (CAMS 78)	CNR2	83.0	91.325	10
TCEQ Houston Regional Office (CAMS 81)	HROC	79.7	96.776	22
Manvel Croix Park (CAMS 84)	MACP	90.7	94.912	23
Clinton (CAMS 403)	C35C	79.0	98.297	20
Houston Monroe (CAMS 406)	HSMA	90.3	95.494	25
Croquet (CAMS 409)	HCQA	87.0	96.338	26
Shell Westhollow (CAMS 410)	SHWH	92.3	101.532	22
Houston Texas Avenue (CAMS 411)	HTCA	79.3	97.392	23
Lynchburg Ferry (CAMS 1015)	LYNF	81.7	95.742	16
Wallisville Road (CAMS 617)*	WALV	92.0	95.091	13

* Wallisville Road (CAMS 617) is not a regulatory monitor;

** Values 85 ppb or greater are shown in red.

3.6.2 Future Baseline Modeling

Similar to the 2006 baseline modeling, the 2018 modeling was conducted for each of the episode days using the projected 2018 ozone season day emissions, as previously summarized in Table 3-13: *Summary of 2006 Baseline and 2018 Future Base, and 2018 Control Strategy Anthropogenic Modeling Emissions for HGB*. Using the same days as used in the 2006 baseline modeling to calculate the RRF_D, an RRF numerator (RRF_N) was calculated as the average of the of the 2018 modeled maximum daily eight-hour ozone concentrations within the 7 x 7 grid cell array about each monitor. The RRF at each monitor was calculated as the quotient of the RRF_N and RRF_D, and the 2018 future design value (DV_F) at each monitor was estimated as per EPA's modeling guidance, by the multiplying the 2006 DV_B by the RRF. Table 3-19: *Summary of 2006 Baseline Modeling, RRF, and Future Design Values* summarizes the 2006 DV_B, RRF and 2018 DV_F at each of the regulatory monitors as well as the Wallisville Road (CAMS 617) monitor (non-regulatory monitor).

Table 3-19: Summary of 2006 Baseline Modeling, RRF, and Future Design Values

Monitor Designation	Site Code	2006 DV_B (ppb)**	RRF	2018 DV_F (ppb)
Houston East (CAMS 1)	HOEA	80.3	0.959	77.0
Aldine (CAMS 8)	HALC	85.0	0.920	78.2
Channelview (CAMS 15)	HCHV	82.7	0.958	79.2
Northwest Harris County (CAMS 26)	HNWA	89.0	0.869	77.4
Galveston Airport (CAMS 34)	GALV	83.0	0.956	79.3
Deer Park (CAMS 35)	DRPK	92.0	0.958	88.2
Seabrook Friendship Park (CAMS 45)	SBFP	85.3	0.945	80.6
Bayland Park (CAMS 53)	BAYP	96.7	0.900	87.0
Conroe Relocated (CAMS 78)	CNR2	83.0	0.877	72.8
Houston Regional Office (CAMS 81)	HROC	79.7	0.960	76.5
Manvel Croix Park (CAMS 84)	MACP	90.7	0.900	81.6
Clinton (CAMS 403)	C35C	79.0	0.959	78.5
Houston Monroe (CAMS 406)	HSMA	90.3	0.935	84.4
Croquet (CAMS 409)	HCQA	87.0	0.900	78.3
Shell Westhollow (CAMS 410)	SHWH	92.3	0.859	79.3
Houston Texas Avenue (CAMS 411)	HTCA	79.3	0.942	74.7
Lynchburg Ferry (CAMS 1015)	LYNF	81.7	0.961	78.5
Wallisville Road (CAMS 617)*	WALV	92.0	0.960	88.3

* Wallisville Road (CAMS 617) is not a regulatory monitor;
** Values 85 ppb or greater are shown in red.

The 2018 baseline attainment modeling projects two regulatory monitors (Houston Bayland Park (CAMS 53) and Deer Park (CAMS 35)) and one non-regulatory monitor (Wallisville Road (CAMS 617)) to have DV_Fs greater than 84 ppb.

3.6.2.1 Matrix Modeling

A series of modeling sensitivities using across-the-board percentage reductions to the 2018 baseline modeling emissions from sources in the eight-county HGB area was conducted. The results of the modeling were used to estimate the amount of NO_X and/or VOC emissions reduction needed to reduce the DV_Fs for each of the three monitors to 85 ppb. Figure 3-49: *DV_F versus NO_X and/or VOC Emissions Reduction Response Curves for the BAYP, DRPK, and WALV Monitors* graphically shows the response of the DV_Fs for the Houston Bayland Park (CAMS 53), Deer Park (CAMS 35), and WALV (non-regulatory monitor) monitors to reductions in emissions of NO_X and/or VOC from sources in the eight-county HGB area.

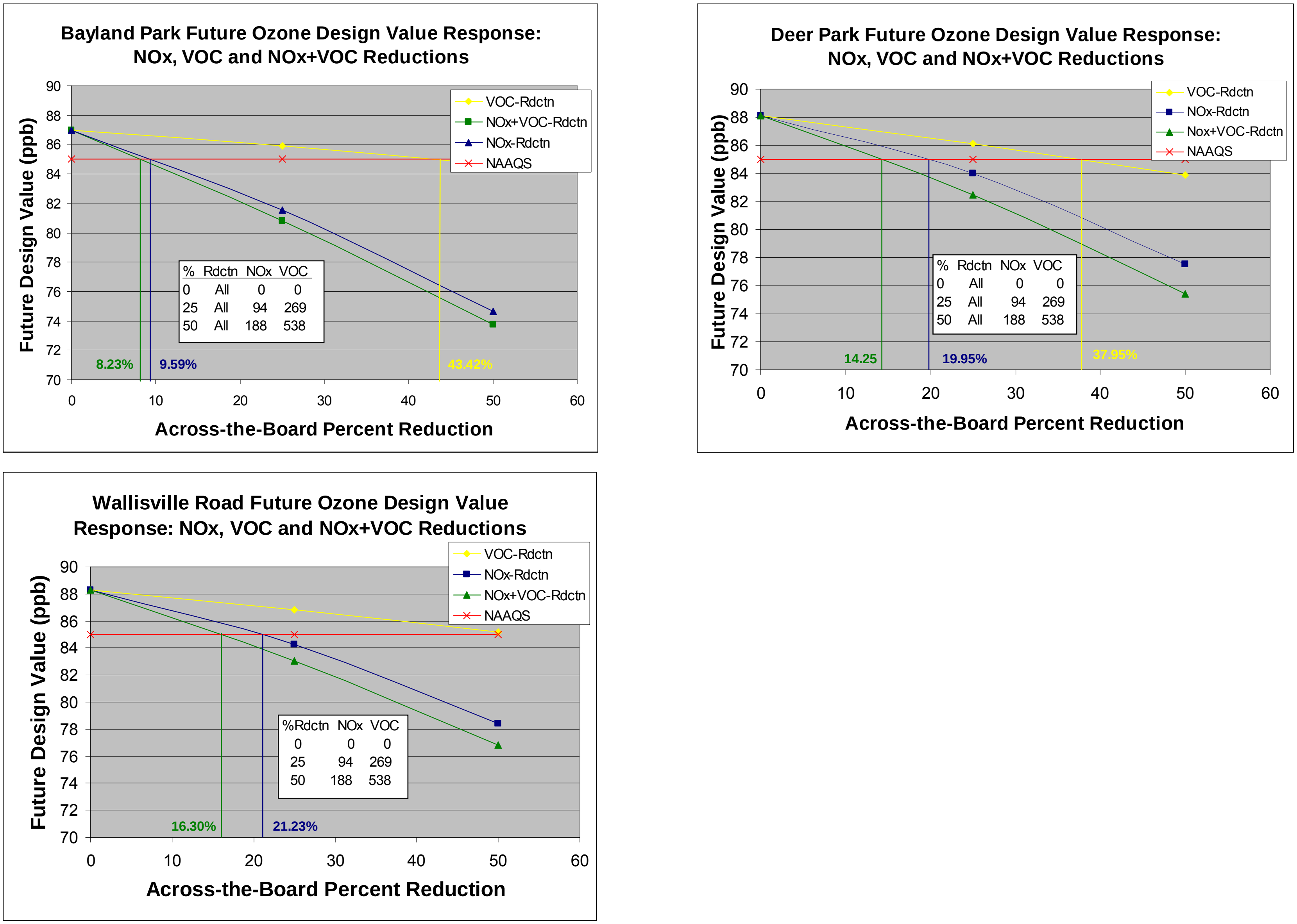


Figure 3-49: DV_F versus NO_X and/or VOC Emissions Reduction Response Curves for the BAYP, DRPK, and WALV Monitors.

Table 3-20: *VOC, NO_X, and VOC+NO_X Emissions Reductions Needed to Model Attainment* summarizes the percent and mass emissions reductions projected to be needed to model attainment for the Houston Bayland Park (CAMS 53), Deer Park (CAMS 35), and Wallisville Road (CAMS 617) (non-regulatory) monitors.

Table 3-20: VOC, NO_X, and VOC+NO_X Emissions Reductions Needed to Model Attainment

Monitor Site Code	VOC Reductions		NO_X Reductions		VOC + NO_X Reductions	
	Percent	Mass (tpd)	Percent	Mass (tpd)	Percent	Mass (tpd)
BAYP	43.4	467	9.59	36.2	8.23	120
DRPK	38.0	408	20.2	75.2	14.2	207
WALV	> 50	> 538	21.2	80.0	16.3	237

Note: WALV is a non-regulatory monitor.

3.6.2.2 Modeling Sensitivities: Emissions Reductions within 100 and 200 km of HGB

Since the EPA allows NO_X and VOC reduction credit for reasonable further progress within 200 km and 100 km of a nonattainment area, respectively, emissions reduction modeling sensitivities were conducted for selected point sources of NO_X and area sources of VOC in the 200 km adjacent to the eight-county HGB area. Figure 3-50: *Map of Counties within 100 km (Red) and 200 km (Orange) of the Eight-County HGB Area* displays a map of the counties within 100 km and 200 km of the HGB area.

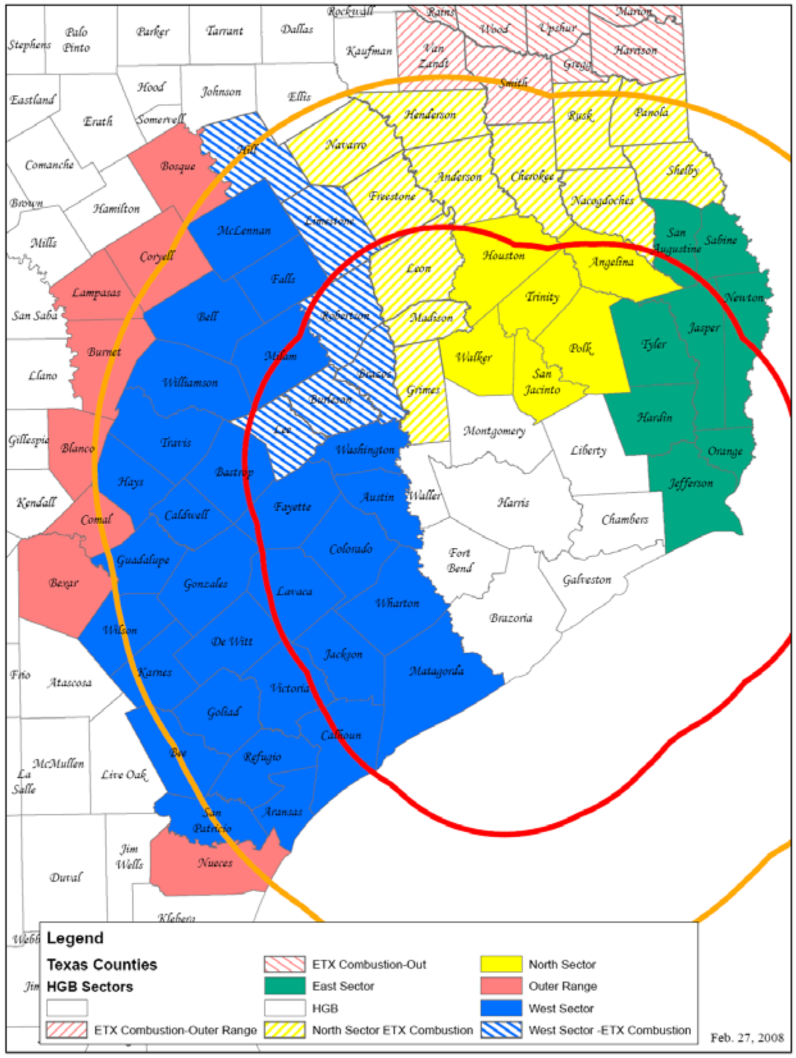


Figure 3-50: Map of Counties within 100 km (Red) and 200 km (Orange) of the Eight-County HGB Area

These modeling sensitivities were conducted on an earlier version of the 2018 modeling emissions inventory. However, the sensitivity of the HGB 2018 future design values to reductions of NO_X and VOC emissions from these outer regions is still representative for the final version of the 2018 modeling.

For the counties within 200 km of the eight-county HGB area, point source NO_X emission reductions (i.e., 25 and 50 percent) were made to selected Texas non-ARD sources including compressor engines, boilers, and process heaters. Compressor engines account for approximately 47 tpd of the estimated 124 tpd of NO_X emissions from the selected sources in the 2018 baseline modeling emissions. In addition, in a separate modeling run, a 50 percent NO_X emissions reduction was made to only those counties in the eastern segment of the 200 km region (the green sector in Figure 3-50: *Map of Counties within 100 km (Red) and 200 km (Orange) of the Eight-County HGB Area*). Compressor engines in the eastern segment account for approximately 11 tpd of the estimated 64 tpd of NO_X emissions from the selected sources in the 2018 baseline modeling emissions.

Table 3-21: *200 km NO_X Reduction Modeling Sensitivity* summarizes the sensitivity of the projected DV_Fs for the Deer Park (CAMS 35), Houston Bayland Park (CAMS 53), and Wallisville Road (CAMS 617) (non-regulatory) monitors to NO_X emissions reduction from the selected point sources in the 200 km region. The columns indicating change rate report the amount by which the DV_F is reduced per 1.0 tpd of NO_X emissions reduction in this region. Of the three monitors, the Deer Park (CAMS 35) monitor DV_F shows the largest sensitivity to NO_X emission reductions. However, even the 0.0134 ppb per tpd change rate for 50 percent NO_X emissions reductions from the eastern segment is rather low, indicating that the HGB monitors are not very sensitive to emission reductions from the sources analyzed.

Table 3-21: 200 km NO_X Reduction Modeling Sensitivity

Monitor Site Code	25% NO_X All (31 tpd)		50% NO_X All (62 tpd)		50% NO_X East (32 tpd)	
	DV_F Change (ppb)	Change Rate (ppb/tpd)	DV_F Change (ppb)	Change Rate (ppb/tpd)	DV_F Change (ppb)	Change Rate (ppb/tpd)
DRPK	0.23	0.0074	0.47	0.0076	0.43	0.0134
BAYP	0.14	0.0045	0.27	0.0044	0.23	0.0072
WALV	0.11	0.0035	0.30	0.0048	0.26	0.0081

Note: WALV is a non-regulatory monitor.

The TCEQ also tested the sensitivity of DV_Fs to reductions by 50 percent of VOC emissions from area sources in the counties within the 200 km region. The VOC reduction modeled was approximately 273 tpd. Table 3-22: *200 km VOC Reduction Modeling Sensitivity* summarizes the sensitivity of the projected DV_Fs for the Deer Park (CAMS 35), Houston Bayland Park (CAMS 53), and Wallisville Road (CAMS 617) monitors to VOC emission reduction from the area sources in the200 km region.

Table 3-22: 200 km VOC Reduction Modeling Sensitivity

Monitor Site Code	50% VOC (273 tpd)	
	DV_F Change (ppb)	Change Rate (ppb/tpd)
DRPK	0.09	0.0003
BAYP	0.06	0.0002
WALV	0.0	0.0

Note: WALV is a non-regulatory monitor.

3.6.2.3 Ozone Source Apportionment Tool and Anthropogenic Precursor Culpability Analysis

The TCEQ applied the OSAT and APCA CAMx tools to the 2018 baseline modeling. For both types of analyses, emission source groups, for example, on-road mobile, non- and off-road mobile, and biogenics, and source regions, HGB and non-HGB, are defined. OSAT keeps track of the origin of the NO_X and VOC precursors creating the ozone, and ozone can then be apportioned to specific sources groups and regions. APCA is similar to OSAT, but it recognizes that certain sources groups, such as biogenics, are not controllable. Where OSAT would apportion ozone production to biogenic emissions, APCA reallocates that ozone production to the controllable or anthropogenic emissions that combined with the biogenic emissions to create ozone.

Results are plotted as layered area plots for every rolling eight-hour average of every episode for the Houston Bayland Park (BAYP; CAMS 53), Deer Park (DRPK; CAMS 35) and Wallisville Road (WALV; CAMS 617) (non-regulatory) monitors. Results of one episode of the six modeled are presented here as an example. Plots for all episodes for these three monitors are included in Appendix C: *CAMx Modeling for the HGB Attainment Demonstration SIP*.

Table 3-23: *OSAT/APCA Source Groups and Regions Defined* lists all of the source groups and regions tracked in the OSAT and APCA analyses.

Table 3-23: OSAT/APCA Source Groups and Regions Defined

Figure Legend Abbreviation	Description of Source Group and Region
TOPBC	Top Boundary Condition
NTHBC	North Boundary Condition
STHBC	South Boundary Condition
ESTBC	East Boundary Condition
WSTBC	West Boundary Condition
IC	Initial Condition
Other	All emission source types outside HGB, with the exception of elevated point sources
Non-HGB El Points	Elevated point sources outside HGB
HGB Non-Road	Non-road sources in HGB
HGB Area	Area sources in HGB
HGB On-Road	On-road sources in HGB
HGB Low Points	Low-level point sources in HGB
HGB El Points	Elevated point sources in HGB
HGB Ships	Ship emissions in HGB
HGB HECT	HECT sources in HGB
HGB MECT	MECT sources in HGB
Biogenics	Biogenic emissions from the entire modeling domain

Figures 3-51: *OSAT and APCA Results for BAYP*, 3-52: *OSAT and APCA Results for DRPK*, and 3-53: *OSAT and APCA Results for WALV* show the results of these analyses for Houston Bayland Park (CAMS 53), Deer Park (CAMS 35), and Wallisville Road (CAMS 617) (non-regulatory monitor), respectively. The layer corresponding to the initial model conditions disappears after the first few days of the episode are modeled, as expected. Layers corresponding to boundary conditions give an indication of wind direction on individual episode days and concentrations of ozone attributable to that boundary.

Layers that correspond to HGB emission sources indicate HGB contribution to the total modeled ozone concentration. The other layers, Biogenics, Other, Initial and Boundary Conditions, and Non-HGB Elevated Points, indicate non-HGB contributions to ozone concentration. Differences between the depth of the biogenic layers between the OSAT and APCA plots indicate how ozone of biogenic origin is reallocated to anthropogenic sources in APCA.

Lower-level local emission sources, including non-road mobile, area, on-road mobile, and low-level points, make a greater contribution to ozone at Houston Bayland Park (CAMS 53) than Deer Park (CAMS 35), although Ship Channel sources make a noticeable contribution at Houston Bayland Park (CAMS 53). Conversely, local elevated sources, including HGB elevated points, ships, HECT, and MECT, make a greater contribution at Deer Park (CAMS 35) than Houston Bayland Park (CAMS 53). Wallisville ozone origins are more like Deer Park (CAMS 35) than Houston Bayland Park (CAMS 53).

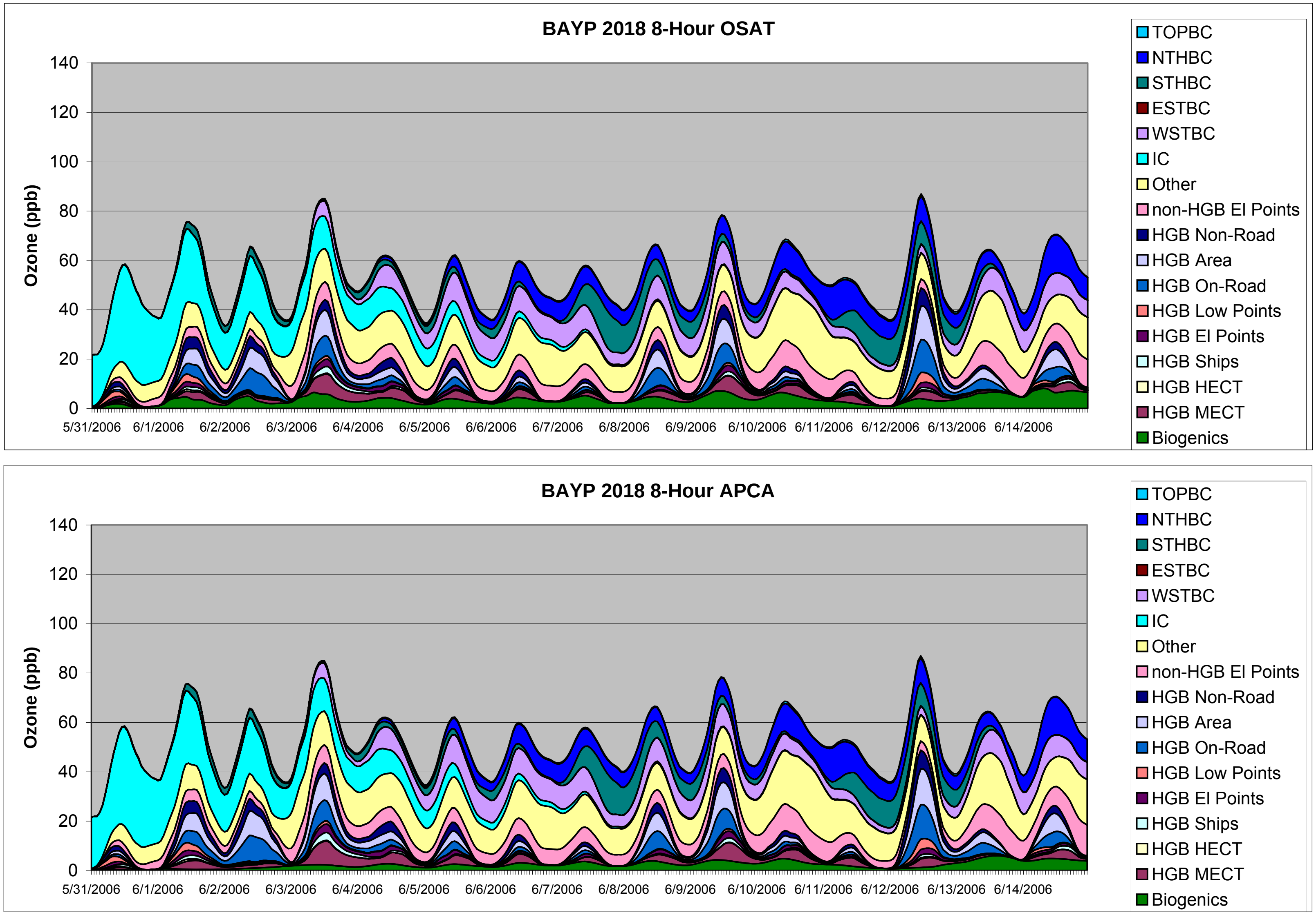


Figure 3-51: OSAT and APCA Results for BAYP

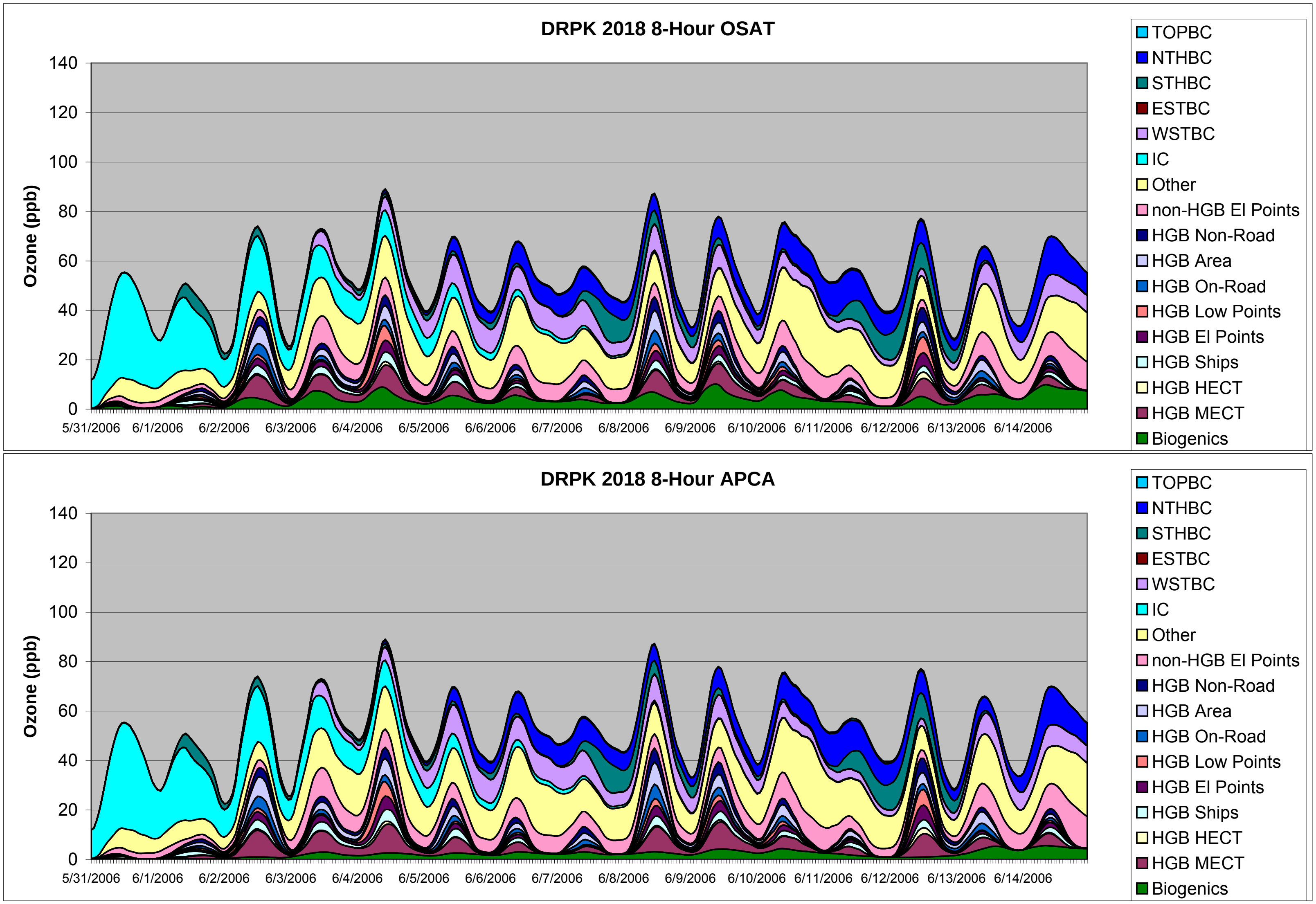
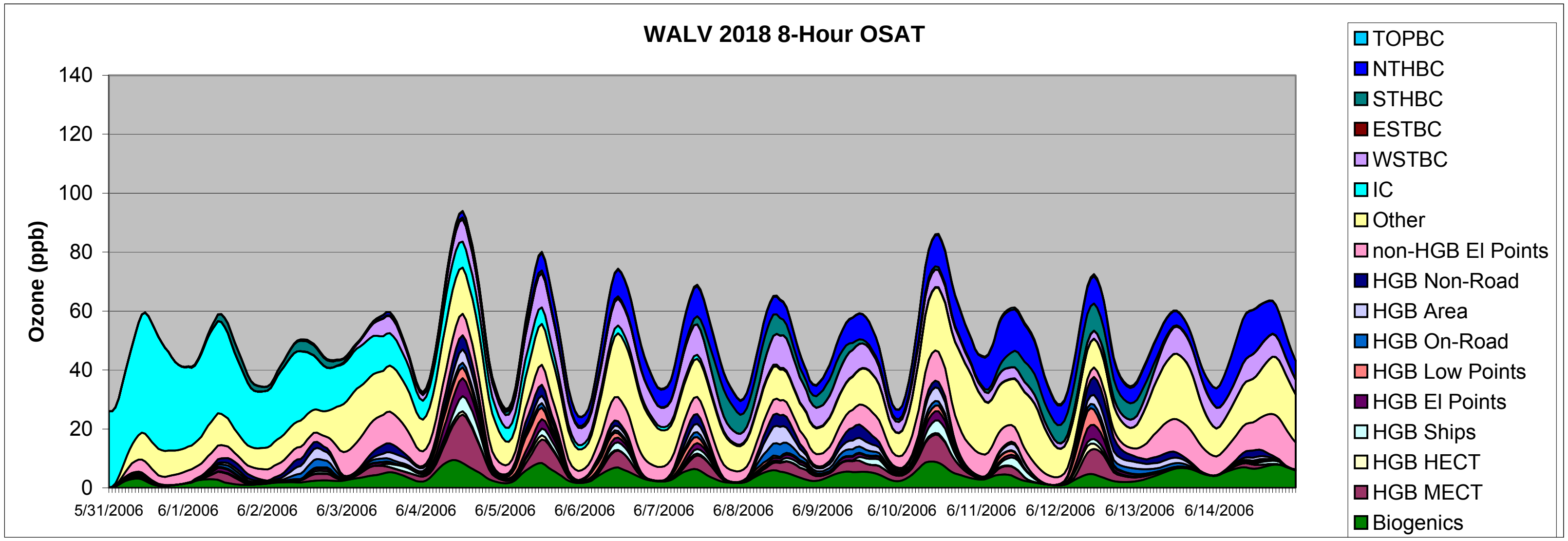


Figure 3-52: OSAT and APCA Results for DRPK



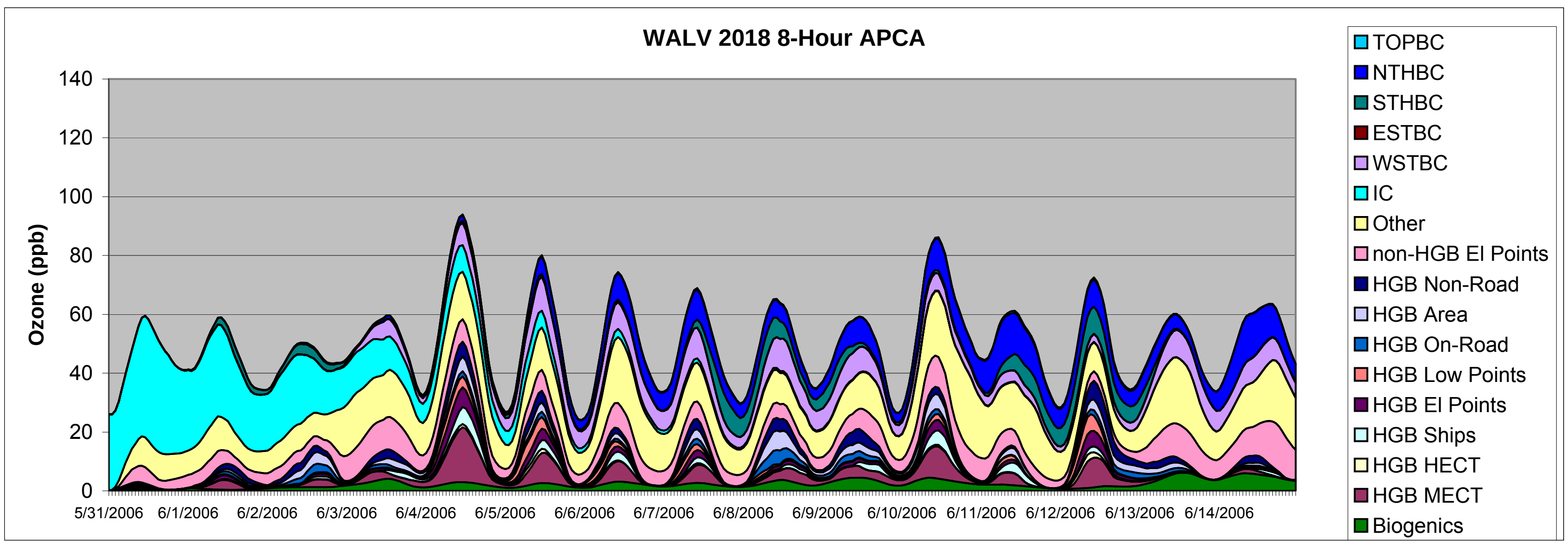


Figure 3-53: OSAT and APCA Results for WALV

3.6.3 Future Case Modeling with Controls

Proposed controls include lowering the total point source HRVOC emissions allocated by the HECT rule in Harris County and voluntary emission reductions of NO_X and VOC from on- and non-road mobile sources within the eight-county HGB area.

3.6.3.1 25 Percent HECT Cap Reduction

The modeling sensitivity for the HECT rule revision reduced current total allocated point source HRVOC emissions by 25 percent, 2.69 tpd. Table 3-24: *HECT Modeling Sensitivity Results* shows the DV_Fs at the Deer Park (CAMS 35), Houston Bayland Park (CAMS 53), and Wallisville Road (CAMS 617) (non-regulatory) monitors for the baseline as well as those resulting from a 25 percent reduction in the HRVOC from HECT applicable sources in Harris County.

Table 3-24: HECT Modeling Sensitivity Results

Monitor Site Code	Baseline DV_F (ppb)	HECT DV_F (ppb)
DRPK	88.14	87.90
BAYP	86.97	86.89
WALV	88.28	88.12

Note: WALV is a non-regulatory monitor.

3.6.3.2 VMEP Reductions

Up to 3 percent of the estimated emissions needed for attainment (i.e., 75.2 tpd NO_X at Deer Park (CAMS 35) as shown in Table 3-20: *VOC, NO_X and VOC+NO_X Emissions Reductions Needed to Model Attainment*) can be obtained from voluntary control measures. The Houston-Galveston Area Council (H-GAC; http://www.h-gac.com/taq/) has estimated that approximately 2.25 tpd of NO_X emissions reductions from on-road (1.55 tpd) and non-road (0.70 tpd) mobile sources will result from the application of VMEPs, including alternative commuting, regional traffic flow and vehicle retrofit and replacement, as well as non-road equipment measures. The modeling sensitivity for VMEP was coupled with the HECT modeling sensitivity. Table 3-25: *HECT and VMEP Modeling Sensitivity Results* shows the DV_Fs at the Deer Park (CAMS 35), Houston Bayland Park (CAMS 53), and Wallisville Road (CAMS 617) (non-regulatory) monitors for the baseline as well as those resulting from both a 25 percent reduction in the HECT cap and a 2.25 (1.55 on-road and 0.70 non-road) tpd VMEP reduction.

Table 3-25: HECT and VMEP Modeling Sensitivity Results

Monitor Site Code	Baseline DV_F (ppb)	HECT/VMEP DV_F (ppb)
DRPK	88.14	87.88
BAYP	86.97	86.75
WALV	88.28	88.09

Note: WALV is a non-regulatory monitor.

Applying the truncating convention for calculating DV_Fs, as per the EPA's modeling guidance, only the Wallisville Road (CAMS 617) (non-regulatory) monitor is projected to have a DV_F greater than 87 ppb, the recommended limit for weight-of-evidence considerations.

3.7 MODELING ARCHIVE AND REFERENCES

3.7.1 Modeling Archive

The TCEQ has archived all modeling documentation and modeling input/output files generated as part of the HGB SIP modeling analysis. Interested parties can contact the TCEQ for information regarding data access or project documentation.

3.7.2 Modeling References

Castineira and Edgar, 2006. Computational Fluid Dynamics for Simulation of Steam-Assisted and Air-Assisted Flare Combustion Systems, Energy & Fuels, 20: 1044-1056.

Emery, C., E. Tai, and G. Yarwood, 2001. Enhanced Meteorological Modeling and Performance Evaluation for Two Texas Ozone Episodes, Final Report to the Texas Natural Resource Conservation Commission under TNRCC Umbrella Contract No. 582-0-31984, Environ International Corporation, Novato, CA.

Environ, 2007. User's Guide Emissions Processor, Version 3, Environ International Corporation, Novato, CA.

Environ, 2008. Description from MM5CAMx README file contained in mm5camx.21feb08.tar.gz archive, http://www.camx.com/files/mm5camx.21feb08.tar.gz, Environ Holdings, Inc.

Environ, 2008b. Boundary Conditions and Fire Emissions Modeling, Final Report to the Texas Commission on Environmental Quality (TCEQ), Contract No. 582-7-84005-FY08-06, Environ International Corporation, Novato, CA.

Environ, 2009. User's Guide Comprehensive Air Quality Model with Extensions (CAMx), Version 4.53, Environ International Corporation, Novato, CA.

EPA, 2005. Modeling files obtained via data request from the EPA in support of the Clean Air Interstate Rule Notice of Data Availability Technical Support Document, as documented at http://www.epa.gov/cair/technical.html.

EPA, 2007. Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze, http://www.epa.gov/scram001/guidance/guide/final-03-pm-rh-guidance.pdf.

Feldman, M.S., T. Howard, E. McDonald-Buller, G. Mullins, D.T. Allen, A. Webb, Y. Kimura, 2007. Applications of Satellite Remote Sensing Data for Estimating Dry Deposition in Eastern Texas. Atmospheric Environment, 41(35): 7562-7576.

Grell, G., J. Dudhia, and D. Stauffer, 1994. A Description of the Fifth Generation Penn State/NCAR Mesoscale Model (MM5), Technical Report NCAR/TN-398+STR, National Center of Atmospheric Research (NCAR) Tech Note.

Kinnee et al., 1997. United States Land Use Inventory for Estimating Biogenic Ozone Precursor Emissions. Ecological Applications 7(1): 46-58.

NCAR, 2005. MM5 On-line Tutorial Home Pages, http://www.mmm.ucar.edu/mm5/On-Line-Tutorial/teachyourself.html, NCAR, Colorado.

NCEP, 2009. Global Energy and Water Cycle Experiment (GEWEX) Continental International Project (GCIP) National Centers for Environmental Prediction (NCEP) Eta Model Output, Computational and Information Systems Laboratory (CISL) Research Data Archive (RDA): ds609.2 Home Page, http://dss.ucar.edu/datasets/ds609.2/, NCEP.

Popescu, Sorin C., Jared Stukey, Mark Karnauch, Jeremiah Bowling, Xuesong Zhang, William Booth, and Nian-Wei Ku, 2008. The New Central Texas Land Use Land Cover Classification Project, Final Report to the TCEQ, Contract No. 582-5-64593-FY08-23, Texas A & M University, College Station, Texas.

Robinson, R., T. Gardiner, and B. Lipscombe, 2008. Measurements of VOC Emissions from Petrochemical Industry Sites in the Houston Area Using Differential Absorption Lidar (DIAL) During Summer 2007, Draft. Submitted to Russell Nettles, TCEQ, by Rod Robinson, Tom Gardiner, and Bob Lipscombe of the National Physical Laboratory, Teddington, Middlesex UK TW11 0LW, February 8, 2008, pp. 86.

Starcrest, 2000. Houston-Galveston Area Vessel Emissions Inventory, Starcrest Consulting Group, Houston, Texas.

Stauffer, D. R. and N. L. Seaman, 1990. Use of Four-Dimensional Data Assimilation in a Limited-Area Mesoscale Model. Part I: Experiments with Synoptic-Scale Data. Monthly Weather Review, 118: 1250-1277.

Stauffer, D.R. and N.L. Seaman, 1994. Multiscale four-dimensional data assimilation. Journal of Applied Meteorology, 33: 416-434.

Stauffer, D. R., N. L. Seaman, and F. S. Binkowski, 1991. Use of Four-Dimensional Data Assimilation in a Limited-Area Mesoscale Model. Part II: Effects of Data Assimilation Within the Planetary Boundary Layer. Monthly Weather Review, 119: 734-754.

TCEQ, 2007. Revisions to the State Implementation Plan (SIP) for the Control of Ozone Air Pollution, Dallas-Fort Worth Eight-Hour Ozone Nonattainment Area Attainment Demonstration, TCEQ, Austin, Texas.

TCEQ, 2009. TCEQ Air Modeling and Data Analysis (AMDA) Section file transfer protocol (FTP) site, ftp://ftp.tceq.state.tx.us/.

Wiedinmyer , C., A. Guenther, M. Estes, I.W. Strange, G. Yarwood, and D. Allen, 2001. A Land Use Database and Examples of Biogenic Isoprene Emission Estimates for the State of Texas, USA. Atmospheric Environment, 35: 6465-6477.

CHAPTER 4: CONTROL STRATEGIES AND REQUIRED ELEMENTS

4.1 INTRODUCTION

The Houston-Galveston-Brazoria (HGB) nonattainment area for the 1997 eight-hour ozone National Ambient Air Quality Standard (NAAQS), which consists of Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties, includes one of the most comprehensively controlled industrial complexes in the world. The Texas Commission on Environmental Quality (TCEQ) has developed stringent and innovative regulations that address nitrogen oxides (NO_X), volatile organic compounds (VOC), and highly reactive volatile organic compounds (HRVOC). Despite the significant decreases in ozone design values and emissions of ozone precursors in the HGB area, further reductions are necessary to bring the area into attainment of the 1997 eight-hour standard. This chapter describes existing and proposed ozone control measures for the HGB area, as well as how Texas meets the following severe ozone nonattainment area state implementation plan (SIP) requirements: reasonably available control technology (RACT), reasonably available control measures (RACM), motor vehicle emissions budgets (MVEBs), and contingency measures.

4.2 EXISTING CONTROL MEASURES

Over several years of ozone planning in the HGB area, a broad range of control measures have been implemented for each emission source category. Table 4-1: *Existing Ozone Control Measures Applicable to the HGB Eight-County Nonattainment Area* lists the existing ozone control strategies that were implemented for the one-hour and eight-hour ozone standards in the HGB area.

Table 4-1: Existing Ozone Control Measures Applicable to the HGB Eight-County Nonattainment Area

Measure	Description	Start Date(s)
POINT SOURCE MEASURES		
NO_X Mass Emissions Cap and Trade (MECT) Program	Overall 80 percent NO_X reduction from existing industrial sources and utility power plants, implemented through a cap and trade program. Affects utility boilers, gas turbines, heaters and furnaces, stationary internal combustion engines, industrial boilers, and many other industrial sources.	April 1, 2003, and phased in through April 1, 2007
HRVOC Rules and HRVOC Emissions Cap and Trade (HECT) Program	Affects cooling towers, process vents, and flares, and establishes an annual emissions cap with a cap and trade for each site in Harris County. The seven perimeter counties are subject to permit allowable limits and monitoring requirements.	Monitoring requirements are January 31, 2006, and cap and trade program is January 1, 2007
HRVOC Fugitive Rules	More stringent leak detection and repair (LDAR) requirements for components in HRVOC service. Additional components included in LDAR program are more stringent repair times, lower leak detection, and third part audit requirements.	March 31, 2004

Measure	Description	Start Date(s)
VOC Rules on Storage and Degassing Operations	Requires controls for slotted guide poles and more stringent controls for other fittings on floating roof tanks, and control requirements or operational limitations on landing floating roof tanks. Eliminates exemption for storage tanks for crude oil or natural gas condensate, and regulates flash emissions from these tanks. Requires vapors from degassing to be vented to a control device for a longer time period, and removes exemption from degassing to control for tanks with capacity of 75,000 to 1,000,000 gallons.	January 1, 2009
NO_X Emission Standards for Nitric Acid/Adipic Acid manufacturing	NO_X emission standards for nitric acid and adipic acid manufacturing facilities in the HGB area	November 15, 1999
Utility Electric Generation in East and Central Texas	NO_X control requirements (approximately 55%) on utility boilers and stationary gas turbines at utility electric generation sites in East and Central Texas.	May 1, 2003, through May 1, 2005
VOC Control Measures	Additional control technology requirements for batch processes, bakeries, and offset lithographic printers by December 31, 2002. Examples of additional VOC measures adopted earlier for RACT purposes include: storage, general vent gas, industrial wastewater, loading and unloading operations, general VOC LDAR, solvent using process, etc.(see Appendix D: *Reasonably Available Control Technology Analysis*).	December 31, 2002, and earlier
AREA/NON-ROAD MEASRUES		
Refueling - Stage I	Stage I vapor recovery captures gasoline vapors that are released when gasoline is delivered to a storage tank. The vapors are returned to the tank truck as the storage tank is being filled with fuel, rather than released into the ambient air.	1990
Refueling - Stage II	Stage II vapor recovery captures gasoline vapors when a vehicle is being fueled at the pump. The vapors are returned through the pump hose to the petroleum storage tank, rather than released into the air.	1992
Federal Area/Non-Road Measures	The United States Environmental Protection Agency (EPA) has implemented a series of emissions limits for area and non-road sources. Examples are diesel and gasoline engine standards for locomotives and leaf-blowers.	Through 2007
Texas Emission Reduction Plan (TERP) (See also on-road TERP reductions)	Provides grant funds for heavy-duty diesel engine replacement/retrofit.	January 2002
California Gasoline Engines	California standards for non-road gasoline engines 25 horsepower and larger.	May 1, 2004
Stationary Diesel Engines	Prohibition on operating stationary diesel and dual-fuel engines for testing and maintenance purposes between 6:00	April 1, 2002

Measure	Description	Start Date(s)
	A.M. and noon.	
Natural Gas-Fired Small Boilers, Process Heaters, and Water Heaters	NO_X emission limits on small-scale residential and industrial boilers, process heaters, and water heaters equal to or less than 2.0 million British thermal units per hour.	2002
Minor Source NO_X Controls for Non-MECT Sites	NO_X emission limits on boilers, process heaters, and stationary engines and turbines at minor sites not included in the MECT program (uncontrolled design capacity to emit less than 10 tons per year (tpy)).	March 31, 2005
VOC Control Measures	Additional control technology requirements for batch processes, bakeries, and offset lithographic printers by December 31, 2002. Examples of additional VOC measures adopted earlier for RACT purposes include: storage, general vent gas, industrial wastewater, loading and unloading operations, general VOC LDAR, solvent using process, cutback asphalt, etc.	December 31, 2002, and earlier
Texas Low Emission Diesel (TxLED)	Requires all diesel for both on-road and non-road use to have a lower aromatic content and a higher cetane number.	Phase in began October 31, 2005
TxLED for Marine Fuels	Adds marine distillate fuels X and A commonly known as DMX and DMA, or Marine Gas Oil (MGO), into the definition of diesel fuels, requiring them to be TxLED compliant.	June 24, 2007
Texas Low Reid Vapor Pressure (RVP) Gasoline	Requires all gasoline for both on-road and non-road use to have a RVP of 7.8 pounds per square inch (psi) or less from May 1 through October 1 each year.	April 2000
Voluntary Mobile Emissions Reduction Program(VMEP)	Voluntary measures administered by the Houston-Galveston Area Council (H-GAC) (see Appendix F7 of the 2004 HGB Mid-Course Review SIP revision)	Through 2007
ON-ROAD MEASRUES		
Federal On-Road Measures	The EPA has implemented a series of emissions limits for on-road vehicles. Some of these include Tier 1/2 vehicle standards, low sulfur diesel standards, National Low Emission Vehicle standards, and reformulated gasoline.	Phase in through 2007
TERP (See also area/non-road TERP)	Provides grant funds for heavy-duty diesel engine replacement/retrofit.	January 2002
Vehicle Inspection/ Maintenance (I/M)	Yearly treadmill-type testing for pre-1996 vehicles and computer checks for 1996 and newer vehicles. -Begin May 1, 2002, in Harris County. -Begin May 1, 2003, in Brazoria, Fort Bend, Galveston, and Montgomery Counties.	May 1, 2002 May 1, 2003
Speed Limit Reduction	On roadways where speeds were 65 mph or higher, speed limits remain at 5 miles per hour (mph) below what was posted before May 1, 2002.	September 2003
TxLED	Requires all diesel for both on-road and non-road use to have a lower aromatic content and a higher cetane number.	Phase in began October 31, 2005

Measure	Description	Start Date(s)
Texas Low RVP Gasoline (see also non-road Low RVP Gasoline)	Requires all gasoline for both on-road and non-road use to have a RVP of 7.8 psi or less from May 1 through October 1 each year.	April 2000
VMEP	Voluntary measures administered by the H-GAC (see Appendix F7 of the 2004 HGB Mid-Course Review SIP revision)	Phase in through 2007
Transportation Control Measures	Various measures in H-GAC's long-range transportation plans.	Phase in through 2007
OTHER		
Portable Fuel Containers Rule See section 4.3.2 *Repeal of State Portable Fuel Container Rule* for additional information about this measure.	Establishes new design "no spill" criteria requirements for portable fuel containers sold, offered for sale, manufactured, and/or distributed in Texas.	December 31, 2004
Voluntary Energy Efficiency/Renewable Energy	Senate Bill (SB) 5 and SB 7 from the 80th session of the Texas Legislature have encouraged energy efficiency and renewable energy projects.	December 2000
Automotive Windshield Washer Fluid	VOC content limitation on automotive windshield washer fluid sold, supplied, distributed, or manufactured for use in Texas.	January 1, 1995

4.3 UPDATES TO EXISTING MEASURES

4.3.1 Mass Emissions Cap and Trade (MECT) Program

The MECT program in 30 Texas Administrative Code (TAC) Chapter 101 is a market-based component of the SIP that provides flexibility for stationary source compliance with the emission specifications under 30 TAC Chapter 117, while establishing a mandatory cap for total NO_X emissions from affected source categories in the HGB ozone nonattainment area. The MECT program was adopted as a primary control measure of the HGB attainment demonstration for the one-hour NAAQS for ozone.

The proposed revision to the MECT program would ensure the integrity of the modeled HGB nonattainment area cap by prohibiting the issuance of allowance allocations to major sources that did not submit the required Level of Activity Certification forms by the compliance date in 30 TAC § 101.360. This proposed rule change would not reduce the current NO_X cap in the HGB nonattainment area.

The MECT program allocated NO_X emission allowances to applicable existing facilities in the HGB area based on their 1997 to 1999 levels of activity. The program also provided for a system of allocating allowances to facilities that had submitted administratively complete permit applications before January 2, 2001. After January 2, 2001, any applicable new or modified facilities in the HGB area must acquire allowances equal to their annual NO_X emissions (one NO_X ton per year equals one annual allowance) from existing facilities already participating in the program.

The current rule does not prohibit the issuance of new allowances to existing applicable facilities that failed to previously participate in the MECT program; therefore, an increase of the total NO_X cap in the HGB ozone nonattainment area may occur in certain circumstances under existing regulations. The proposed rulemaking would prohibit these potential future increases in the MECT program NO_X cap for maintenance of the HGB one-hour ozone attainment demonstration. Additionally, maintaining the integrity of the MECT program NO_X cap would prevent potential adverse impacts on the attainment and maintenance of the 1997 eight-hour ozone NAAQS.

The proposed rulemaking would maintain the NO_X cap integrity by revising the rule language to eliminate the future allocation, after the effective date of the rule, of additional allowances to applicable facilities that failed to previously participate in the MECT program and previously permitted facilities that have failed to submit the required level of activity certification by the applicable deadlines. These facilities include:

- facilities that were in operation prior to January 1, 1997;
- new and modified facilities not in operation prior to January 1, 1997, but were included in a submitted New Construction or Modification Permit determined to be administratively complete before January 2, 2001; and
- new and modified facilities not in operation prior to January 1, 1997, but qualified for a Permit by Rule and had commenced construction before January 2, 2001.

This proposed rulemaking would also revise Chapter 101, Subchapter H, Division 3, to clarify the definition of "uncontrolled design capacity" as it relates to applicability of this division. The TCEQ has received comments from stakeholders requesting clarification of the MECT program applicability, specifically relating to uncontrolled designed capacity and how it differs from a facility's potential to emit. The definition of "uncontrolled design capacity" would also be revised to allow owners or operators of emergency back-up engines at minor sources an alternative to using 8,760 hours to calculate the uncontrolled designed capacity to emit for the engines. Emergency back-up engines at minor sites are typically authorized by Permit-by-Rule and restricted to 10 percent or less of the normal annual operating schedule. Allowing companies to use this restriction to calculate the uncontrolled designed capacity would more accurately reflect the actual restriction on use of the engine while avoiding potentially making many minor sites needlessly subject to the MECT program solely because the engine is no longer exempt under Chapter 117. Because these sites would still be subject to the Chapter 117 minor source rules in Subchapter D, Division 1, this proposed change does not constitute backsliding under the Federal Clean Air Act (FCAA).

4.3.2 Repeal of State Portable Fuel Container Rule

The EPA adopted a federal portable fuel container (PFC) rule in the February 26, 2007, issue of the *Federal Register* (72 FR 8432) that set a national standard for gasoline, diesel, and kerosene PFCs. The rule requires all PFCs manufactured on or after January 1, 2009, to comply with the federal standards. The new federal PFC regulations are consistent with the revised PFC regulations adopted by the California Air Resources Board (CARB) on September 15, 2005. The current Texas PFC regulations are inconsistent with the new federal standards, because they are based on the previous PFC testing methods adopted by CARB in 2001. Therefore, the state is proposing to repeal its PFC regulations (rule project number 2008-032-115-EN) and to rely on the implementation of the federal PFC regulations to control VOC emissions from PFCs used within the state. According to an EPA analysis entitled, *Federal Register Rule vs. Texas Register Rule Portable Fuel Containers*, the Federal PFC rule is more stringent than the Texas PFC rule.

The repeal of the current Texas PFC regulations and reliance on the new federal PFC standards will not have a negative impact on the Texas SIP. The estimated emission reductions applicable to the implementation of the federal PFC rule in Texas are expected to be equivalent to the current Texas PFC rule in the early years and to provide greater reductions in the later years.

4.3.3 Clean Fuel Fleet Requirement

Participation in a Clean Fuel Fleet Program (CFFP) is required by § 246 of the FCAA for nonattainment areas with 1980 populations greater than 250,000 that are classified as serious or above for ozone. In accordance with this requirement, a CFFP was instituted by rule in the HGB area beginning on September 1, 1998. The CFFP requires that a certain percentage of fleet purchases after model year 1998 be Clean Fuel Vehicles (CFV) that meet the standards set forth in § 243 of the FCAA.

The most recent federal standards for both light-duty and heavy-duty vehicles have eclipsed the CFV standards because subsequent to September 1, 2005, any new vehicle purchase ranging from 0-26,000 pounds gross vehicle weight rating would have either equaled or, in most cases, exceeded CFV standards. In a letter to manufacturers (EPA, 2005), the EPA stated that "subsequent to publishing its CFV regulations, EPA has promulgated new emission standards that are generally more stringent than or equivalent to the CFV emission standards for light-duty vehicles, light-duty trucks, and heavy-duty engines." This EPA letter, dated July 21, 2005, applied to fleet purchases that began with the 2006 model year (September 1, 2005).

During the 79th Texas Legislature Regular Session in 2005, Senate Bill 1032 was signed into law, which repealed the Texas Clean Fleet Program in its entirety because the federal standards already in place at that time eclipsed the CFV standards referenced in the FCAA. On April 26, 2006, the TCEQ formally repealed the Texas Clean Fleet Program because no additional benefit could be achieved from new vehicle purchases under CFFP. A revision to the SIP that reflected the repeal of the Texas Clean Fleet Program was submitted to the EPA on May 15, 2006. EPA approval of measures that substitute for the initial requirement to implement CFFP is provided for in § 182(c)(4) of the FCAA as long as the EPA determines the substitute will accomplish equal long-term reductions attributable to the CFFP. However, the EPA has not provided guidance on how states are to address the Clean Fuel Fleet substitution requirement in their SIP submittals, in light of the more stringent federal standards. Since new vehicle purchases subsequent to the date of repeal would meet more stringent federal emission standards, cancellation of the Texas Clean Fleet Program does not necessitate action to substitute this program with a separate emission reduction measure containing equivalent benefits. Such a substitution would only be warranted when a net increase in emissions would occur due to repeal or cancellation of an existing program.

4.4 REASONABLY AVAILABLE CONTROL TECHNOLOGY (RACT) ANALYSIS

4.4.1 General Discussion

The HGB area is currently classified as a severe nonattainment area for the 1997 eight-hour ozone NAAQS. Under the eight-hour ozone standard, the HGB area is required to meet the mandates of the FCAA under §§ 172(c)(1), 182(b)(2), and 182(f). According to the EPA's Final Rule to Implement the 1997 eight-hour ozone NAAQS (40 Code of Federal Regulations (CFR) § 51.912), states containing areas classified as moderate nonattainment or higher must submit a SIP revision demonstrating that their current rules fulfill the RACT requirements for all Control Technique Guidelines (CTG) categories and all non-CTG major sources of NO_X and VOC. The major source threshold for severe nonattainment areas is a potential to emit 25 tons per year (tpy) or more of either NO_X or VOC.

In the September 17, 1979, issue of the *Federal Register* (44 FR 53762) RACT is defined as the lowest emissions limitation that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility. RACT requirements for nonattainment areas classified as moderate and higher are included in the FCAA to assure that significant source categories at major sources of ozone precursor emissions are controlled to a reasonable extent, but not necessarily to best available control technology (BACT) levels expected of new sources or to maximum achievable control technology (MACT) levels required for major sources of hazardous air pollutants. While RACT and RACM have similar consideration factors like technological and economic feasibility, there is a significant distinction between RACT and RACM. To be considered RACM, a control measure must advance attainment of the area towards meeting the NAAQS for that measure (see § 172(c)(1) of the FCAA). Advancing attainment of the area is not a factor of consideration when evaluating RACT because the benefit of implementing RACT is presumed under the FCAA.

Under the current state rules, the HGB area is subject to some of the most stringent NO_X and VOC emission control requirements in the country, and for many source categories, the existing rules are more stringent than recommended RACT standards for those categories. In the final approval notice for the revised HGB one-hour ozone attainment demonstration SIP published in the September 6, 2006, issue of the *Federal Register* (71 FR 52676), the EPA noted that the HGB VOC rules in 30 TAC Chapter 115 and NO_X rules in Chapter 117 were previously determined to meet the FCAA RACT requirements. Under the one-hour ozone NAAQS, the HGB area was also designated as a “severe” nonattainment area and the threshold for major stationary sources under the one-hour ozone nonattainment designation was identical to the current threshold under the eight-hour ozone designation. Therefore, controls to satisfy RACT for most major sources under the eight-hour ozone designation were implemented by the TCEQ under the one-hour ozone attainment demonstration and previously approved by the EPA.

Specified information regarding the TCEQ's NO_X and VOC RACT analysis is provided in Appendix D: *Reasonably Available Control Technology Analysis*; Table D-1: *State Rules Addressing RACT Requirements in CTG and ACT Reference Documents* provides additional details on the CTG and Alternative Control Techniques (ACT) source categories; and Table D-2: *State Rules Addressing RACT Requirements for Major Emission Sources in the HGB Area* provides additional detail on the non-CTG/ACT major emission source categories.

4.4.2 NO_X RACT Determination

The TCEQ's analysis demonstrates that the current NO_X rules and controls for the HGB area fulfill the FCAA requirements for NO_X RACT. The MECT program and accompanying Chapter 117 rules represent one of the most comprehensive NO_X control strategies in the nation and encompass both RACT and beyond-RACT levels of control. Except for the EPA's Glass Furnace ACT document, the current EPA-approved Chapter 117 rules fulfill RACT requirements for all CTG and ACT NO_X source categories. For non-CTG/ACT major NO_X emission source categories, RACT is fulfilled by the MECT program or by separate source-specific rules in Chapter 117 for sources that NO_X controls are technologically and economically feasible.

The TCEQ identified one major source glass manufacturing facility, Longhorn Glass Corporation (TCEQ Account No. HG-0028-R), in the 2006 point source emissions inventory for the HGB area. The TCEQ has determined that RACT for the Longhorn Glass Corporation glass furnace is met through the site's New Source Review (NSR) permit. TCEQ Permit Number 42623 requires Longhorn's oxy-fired glass furnace to meet a NO_X emission specification of 1.48 pounds per ton of glass produced. This control requirement is more stringent than the current Chapter 117 NO_X emissions specification of 4.0 pounds per ton of glass produced for glass furnaces that was approved by the EPA as part of the 2007 Dallas-Fort Worth eight-hour ozone attainment demonstration and is sufficient to satisfy RACT for the glass furnace category for the HGB area. Therefore, the TCEQ is not implementing any rule amendments or new rules for the glass furnaces in the HGB area.

4.4.3 VOC RACT Determination

The TCEQ's analysis demonstrates that the current VOC rules and controls for the HGB area satisfy the FCAA requirements for RACT for all CTG or ACT VOC source categories specific to any CTG or ACT documents issued prior to 2006. RACT for all non-CTG/ACT major VOC emission source categories that controls are technologically and economically feasible is fulfilled by the EPA-approved Chapter 115 rules or other federally enforceable measures.

The EPA issued 11 Consumer and Commercial Products CTG documents between 2006 and 2008 with recommendations for VOC controls on a variety of consumer and commercial products. Some of the new CTG recommendations are updates to previously issued CTG documents and some are recommendations for new categories. The TCEQ evaluated these new CTG documents in this RACT analysis to determine if additional VOC controls were necessary to fulfill RACT requirements. The following is a list of the 11 CTG documents:

- *Flat Wood Paneling Coatings, Group II Issued in 2006*
- *Flexible Packaging Printing Materials, Group II Issued in 2006*
- *Industrial Cleaning Solvents, Group II Issued in 2006*
- *Offset Lithographic and Letterpress Printing, Group II Issued in 2006*
- *Large Appliance Coatings, Group III Issued in 2007*
- *Metal Furniture Coatings, Group III Issued in 2007*
- *Paper, Film, and Foil Coatings, Group III Issued in 2007*
- *Auto and Light-Duty Truck Assembly Coatings, Group IV Issued in 2008*
- *Fiberglass Boat Manufacturing Materials, Group IV Issued in 2008*
- *Miscellaneous Industrial Adhesives, Group IV Issued in 2008*
- *Miscellaneous Metal and Plastic Parts Coatings, Group IV Issued in 2008*

The following provides a brief summary of the TCEQ's determinations regarding these 11 CTG documents. Additional details regarding the evaluation of the 11 CTG documents are provided in Appendix D: *Reasonably Available Control Technology Analysis*.

<u>4.4.3.1 CTG Documents That Are Not Applicable to the HGB Area</u>

The TCEQ provides a negative declaration for the Automobile and Light-Duty Truck Assembly Coatings and the Flat Wood Paneling Coatings CTG documents. The TCEQ determined that no sources meeting the applicability criteria recommended in these two CTG documents are located in the HGB area.

<u>4.4.3.2 CTG Documents That Do Not Represent RACT for the HGB Area</u>

For the following three CTG documents, the TCEQ determined that the CTG recommendations either do not represent RACT due to economic or technological feasibility concerns or that the current Chapter 115 rules are equivalent or superior to the CTG-recommended controls: Fiberglass Boat Manufacturing Materials; Flexible Packaging Printing Materials; and Paper, Film, and Foil Coatings. Therefore, the TCEQ is not implementing any rule amendments or new rules associated with these CTG categories.

<u>4.4.3.3 CTG Documents That a RACT Determination Cannot Be Made at This Time</u>

The TCEQ is not making a determination at this time whether the Industrial Cleaning Solvents or the Miscellaneous Industrial Adhesives CTG recommendations represent RACT for Texas. The TCEQ's initial assessment indicates that the EPA substantially underestimated the scope and potential impact of the CTG recommendations and that implementing the CTG recommendations would have widespread and potentially adverse impacts to small businesses and micro-businesses. The TCEQ will continue to evaluate these CTG documents and plans to provide small business outreach to engage stakeholders that could be potentially impacted by the EPA's suggested control measures. A RACT determination for these CTG categories will be made after adequate stakeholder input and the TCEQ has determined the impact to small businesses, economic and technological feasibility, and practical enforceability of the CTG recommendations.

By letter dated December 8, 2008, the TCEQ requested clarification from the EPA regarding several issues related to the following three CTG documents: Large Appliance Coatings; Metal Furniture Coatings; and Miscellaneous Metal and Plastic Parts Coatings. A number of the recommended VOC content limits for specific coatings categories in the CTG documents are less stringent than the more general VOC content limits specified in the EPA's original CTG recommendations. The TCEQ requested clarification to assure that implementing the CTG recommendations would not be considered as backsliding and to be certain that the TCEQ has the appropriate information to determine whether the CTG recommendations actually represent RACT for Texas. As of September 4, 2009, the EPA has not responded to the TCEQ request for clarification on the CTG recommendations. Therefore, the TCEQ is not making a determination at this time whether these CTG recommendations represent RACT for Texas until the EPA provides clarification to the issues identified by the TCEQ and staff has had sufficient time to evaluate the CTG recommendations in context with the EPA's response.

4.4.3.4 CTG Documents That Represent RACT for the HGB Area

The TCEQ has determined that portions of the Offset Lithographic and Letterpress Printing CTG recommendations represent RACT for the HGB area. Concurrent with this SIP revision, the TCEQ is proposing rulemaking to limit the VOC content of solvents used by offset lithographic printing facilities in the HGB area (Rule Project 2008-019-115-EN). The proposed rulemaking would implement the CTG recommendations to reduce the VOC content of the fountain solutions and cleaning materials. Additionally, the proposed rulemaking would expand the current rule applicability to include smaller sources not currently subject to the rule. The TCEQ is not implementing any rule amendments or new rules associated with the CTG-recommended control requirements for heatset presses or with the letterpress printing portion of this CTG document for the HGB area. Additional discussion concerning the TCEQ's determination regarding the CTG recommendations for heatset press and letterpress printing is provided in Appendix D: *Reasonably Available Control Technology Analysis*.

4.5 REASONABLY AVAILABLE CONTROL MEASURES ANALYSIS

4.5.1 General Discussion

States are required by § 172(c)(1) of the FCAA to "provide for implementation of all reasonably available control measures as expeditiously as practicable" and to include RACM analyses in the SIP. In the General Preamble for implementation of the FCAA Amendments of 1990 published in the April 16, 1992, issue of the *Federal Register* (57 FR 13498), the EPA explains that it interprets § 172(c)(1) of the FCAA as a requirement that states incorporate into their SIP all reasonably available control measures that would advance a region's attainment date. However, regions are obligated to adopt only those measures that are reasonably available for implementation in light of local circumstances.

The TCEQ used a two-step process to identify potential control strategies for the HGB area RACM analysis. The TCEQ compiled a list of potential control strategy concepts based on an initial evaluation of the existing control strategies and existing sources of VOC and NO_X in the HGB area. Stationary sources outside the HGB area within either a 100 kilometer (km) or 200 km range of the HGB area were also considered for this initial evaluation. According to the EPA's guidance, sources of VOC must be within 100 km of the nonattainment area and sources of NO_X must be within 200 km. The EPA allows states the option of considering control measures outside the ozone nonattainment area that can be shown to advance attainment; however, consideration of these sources is not a requirement of the FCAA. Draft lists of potential control strategy concepts for stationary and mobile sources were developed from this initial evaluation. The draft lists of potential control strategy concepts were presented to stakeholders for comment at stakeholder meetings held in the HGB area on March 25 and 26, 2008. The TCEQ requested comment on the potential control strategies and invited stakeholders to suggest any additional strategies that might help advance attainment of the HGB area. The final lists of potential control strategy concepts for the RACM analyses of stationary and mobile sources include both the strategies presented to stakeholders in March 2008 and the strategies suggested by stakeholders during the informal stakeholder comment process.

Each potential control measure identified through the control strategy development process was evaluated to determine if the measure would meet established criteria to be considered reasonably available. The TCEQ used the general criteria specified by the EPA in the proposed approval of the New Jersey RACM published in the January 16, 2009, issue of the *Federal Register* (74 FR 2945):

> *RACM is defined by the EPA as any potential control measure for application to point, area, on-road and non-road emission source categories that meets the following criteria:*
>
> - *The control measure is technologically feasible*
> - *The control measure is economically feasible*
> - *The control measure does not cause ''substantial widespread and long-term adverse impacts''*
> - *The control measure is not ''absurd, unenforceable, or impracticable''*
> - *The control measure can advance the attainment date by at least one year.*

The EPA did not provide guidance in the *Federal Register* on how to interpret the criteria "*advance the attainment date by at least one year."* Because modeling all possible year scenarios for potential control measures is not practical, the TCEQ evaluated whether a potential control measure would help the HGB area make progress toward attainment of the NAAQS based on potential eight-hour ozone reduction benefit in terms of parts per billion (ppb) using modeling sensitivity runs.

The TCEQ also considered whether the control measure was similar or identical to control measures already in place in the HGB area. If the suggested control measure would not provide substantive and quantifiable benefit over the existing control measure, then the suggested control measure was considered not RACM because reasonable controls were already in place.

The control measure must be able to be implemented before and reduce emissions prior to the beginning of the ozone season immediately before the attainment date. The attainment date for the 1997 eight-hour ozone NAAQS for the HGB area is June 15, 2019. Any control measures must be implemented and emissions reductions made no later than January 1, 2018. However, the HGB area must make progress toward attainment of the 1997 eight-hour ozone NAAQS as expeditiously as practicable. Therefore, if control measures can be implemented earlier than January 1, 2018, the measure should be implemented as early as feasible.

4.5.2 Results of RACM Analysis

Based on the RACM analysis, the TCEQ determined that only one potential control measure met the criteria to be considered RACM. A reduction in the HRVOC cap for Harris County under the HECT program was determined to help advance attainment of the HGB area and to meet the other RACM criteria. Reported HRVOC emissions from sources in the HECT program during the first two years of the HECT program, calendar years 2007 and 2008, averaged approximately 56 percent of the total allocated HRVOC allowances for Harris County. Because there is a demonstrated substantial surplus in the HRVOC cap, a 25 percent reduction in the cap for Harris County is technologically feasible and should have minimal economic impact. Modeling demonstrates that a 25 percent reduction in the HRVOC cap for Harris County will help the HGB area make progress toward attainment of the 1997 eight-hour ozone NAAQS. Based on 2007-2008 emissions, a 25 percent reduction would leave a buffer of approximately 600 tpy, or more, in the cap that should be sufficient to account for any significant variations in HRVOC emissions in future years due to emission events and scheduled startup, shutdown, and maintenance events as well as allow for future economic growth. Additional discussion regarding the proposed control measure to reduce the HRVOC cap for Harris County is included in Section 4.6: *New Control Measures*.

All other potential control measures evaluated for both stationary and mobile sources were determined not to be RACM due to technological or economic feasibility, enforceability, adverse impacts, or ability of the measure to advance attainment of the NAAQS. Additional information and specific details regarding the RACM analysis for the HGB area are contained in Appendix E: *Reasonably Available Control Measure Analysis*.

4.6 NEW CONTROL MEASURES

4.6.1 Stationary Sources

4.6.1.1 HECT Cap Reduction and Allowance Reallocation

The proposed revisions to the HECT Program Cap rule would result in a 25 percent reduction in the total HECT allowance cap and revise the HRVOC allocation methodology. The HECT program was adopted by the commission as an ozone control measure for the HGB area on December 1, 2004. Currently, the HECT program is applicable only in Harris County.

Photochemical modeling analysis demonstrates that a 25 percent reduction of the HECT cap on the total Harris County HRVOC allocation would advance attainment of the 1997 eight-hour ozone NAAQS by reducing the future 2018 ozone design values (DV_{18}s) at all HGB monitors. Future design value calculations were based on 2006. The largest decrease in the projected DV_{18}s (0.24 ppb) was at the Deer Park monitor. The average decrease for all sites was 0.11 ppb. The three HGB monitors projected to be exceeding the eight-hour ozone NAAQS (i.e., $DV_{18} > 84$ ppb) in the 2018 future case modeling, also exceed in the HECT sensitivity modeling. The Wallisville monitor has the highest predicted DV_{18} (88.3 ppb) in the 2018 future case modeling, and continues to be the highest in the HECT sensitivity modeling (88.1 ppb). See Chapter 3: PHOTOCHEMICAL MODELING for further discussion regarding the modeling.

HRVOC data from the first two years indicates that the total reported actual emissions from sources in the HECT program are approximately 50 percent of the total HRVOC cap. Because the HRVOC rules in Chapter 115, Subchapter H, Divisions 1 and 2, require emissions from startup, shutdown, and maintenance activities be included in the HECT program, the total surplus observed in the first two years of the program cannot be removed. Proposing a 25 percent reduction leaves a buffer in the cap that is still needed to account for the inherent variability of HRVOC emissions associated with these activities.

Following the initial allocation of allowances, companies participating in the HECT program commented that the allocation was not equitably distributed and that some sites did not receive enough allocations while other sites received allocations greater than necessary. Monitoring data supports the assertion of an inequitable distribution of allowances. Revisions to the rule are anticipated to result in a more equitable approach while contributing to the area’s attainment of the NAAQS as expeditiously as practicable.

The existing allocation methodology was based on the total amount, in pounds, of HRVOC produced as an intermediate, byproduct, or final product, or used by a process unit at each participating site. Analysis of the monitoring data from previous control periods indicate that refineries may have been over-allocated while polymer, plastics, and other chemical producers may have not received a sufficient allocation.

The rule revision proposes a new allocation methodology beginning with the 2011 calendar-year control period based on actual emissions data with the goals of fairly and equitably distributing the compliance burden for HECT program participants, applying credit for controlling and reducing HRVOC emissions, and not rewarding or encouraging emissions from emissions events. The proposed revised allocation methodology is based on calculating “uncontrolled” or “precontrolled” emissions for facilities using reported control efficiencies based on the specifications for flares in Chapter 115; creating a 250 ton emission event set aside pool to encourage market trading; and dividing the cap into four industry-type sector pools to account for different HRVOC emission rates associated with the processes of the industry sectors with HRVOC emissions in Harris County.

The proposed rulemaking would also reduce the cap in a gradual step down fashion beginning with a 10 percent cap reduction at the beginning of the 2014 calendar-year control period, and continue to reduce the cap to a total of 25 percent in annual five percent reductions from 2015 to 2017.

4.6.2 Local Programs

The H-GAC worked with HGB area local governments and business stakeholders to develop appropriate control strategies to meet the SIP requirements and to recruit stakeholders who would take legal responsibility for implementing these strategies through the establishment of memoranda of agreement. As a result, six projects were identified as Transportation Control Measures (TCMs), and numerous strategies were agreed upon with local governments as voluntary measures. For more information regarding the development of local control strategies, see Appendix F: *Evaluation of Mobile Source Control Strategies for the Houston-Galveston-Brazoria State Implementation Plan* (prepared by ENVIRON for the H-GAC).

4.6.2.1 Transportation Control Measures

TCMs are transportation projects and related activities that are designed to reduce on-road mobile source emissions and are included as control measures in the SIP. Allowable types of TCMs are listed in § 7408 (Air Quality Criteria and Control Techniques) of the FCAA, and defined in the federal transportation conformity rule found in 40 CFR, Part 93 (Determining Conformity of Federal Actions to State or Federal Implementation Plans). The federal transportation conformity rule requires that timely implementation of TCMs be demonstrated. In general, TCMs are transportation related projects that attempt to reduce vehicle use, change traffic flow, or reduce congestion conditions. Projects that add single-occupancy-vehicle roadway capacity or are based on improvements in vehicle technology or fuels are not considered to be TCMs.

The H-GAC has identified TCMs that have been or will be implemented in the nonattainment area. By the start of the 2018 ozone season, these TCMs will reduce NO_X emissions in the HGB area by .015 tons per day (tpd). Appendix G: *Transportation Control Measures for the HGB Attainment Demonstration SIP Revision for the 1997 Eight-Hour Ozone Standard* (prepared by ENVIRON for the H-GAC) summarizes the emission reductions by type of TCM. The H-GAC's Technical Advisory Committee approved and identified funding for these local commitments.

4.6.2.2 Voluntary Mobile Emission Reduction Programs

Voluntary mobile source measures have the potential to contribute, in a cost-effective manner, emission reductions needed for progress toward attainment and maintenance of the NAAQS.

Historically, federal mobile source control strategies have focused primarily on reducing emissions per mile through vehicle and fuel technology improvements. Tremendous strides have been made resulting in new light-duty vehicle emission standards that are 70 to 90 percent less than that for the 1970 model year. However, mobile sources continue to constitute a significant portion of ozone precursor emissions in the HGB area due to population and employment growth as well as an increase in daily vehicle miles traveled per person. Therefore, mobile source strategies that attempt to complement existing regulatory programs through voluntary, non-regulatory changes in local transportation sector activity levels or changes in vehicle and engine fleet composition were explored and developed.

A number of voluntary mobile source and transportation programs have already been initiated at the state and local levels in response to increasing interest by the public and business sectors in creating alternatives to traditional emission reduction strategies. Some examples include economic and market-based incentive programs, trip reduction programs, growth management strategies, ozone action programs, and targeted public outreach. These programs attempt to gain additional emissions reductions beyond mandatory FCAA programs by engaging the public to make changes in activities that will result in reducing mobile source emissions.

The H-GAC identified three voluntary measures that will aid in the improvement of the HGB region's air quality. These measures were identified through a contract between H-GAC and ENVIRON International Corporation. Nineteen meetings were held with stakeholders from the region to solicit comments and suggestions for voluntary programs. The H-GAC's commitment for NO_X from VMEP is 2.25 tpd. The H-GAC, as the regional metropolitan transportation planning agency for the HGB area, has committed to make a good faith effort to implement the projects and/or programs outlined in this document and will be responsible for monitoring and reporting the emission reductions to the TCEQ. More information on each of the VMEP commitments can be found in Appendix H: *Voluntary Mobile Emission Reduction Programs for the HGB Attainment Demonstration SIP Revision for the 1997 Eight-Hour Ozone Standard* (prepared by ENVIRON for the H-GAC).

4.7 Motor Vehicle Emissions Budget (MVEB)

The MVEB refers to the maximum allowable emissions from on-road mobile sources for each applicable criteria pollutant or precursor as defined in the SIP. The budget must be used in transportation conformity analyses. Areas must demonstrate that the estimated emissions from transportation plans, programs, and projects do not exceed the MVEB. The attainment budget represents the on-road mobile source emissions that have been modeled for the attainment demonstration. The budget reflects all of the on-road control measures reflected in that demonstration. The MVEB is shown in Table 4-2: *2018 Attainment Demonstration Motor Vehicle Emissions Budget for the Eight-County HGB Area*. For additional detail, see Appendix B*: Emissions Inventory Development*.

Table 4-2: 2018 Attainment Demonstration MVEB for the Eight-County HGB Area

Eight-County HGB Area	Summer Weekday Emissions (tpd)	
2018 MVEB	NO_X	VOC
	49.22	45.97

4.8 MONITORING NETWORK

States are required by 40 CFR, Part 58, Subpart B, to submit an annual monitoring network review to the EPA by July 1 of each year. This network review is required to provide the framework for establishment and maintenance of an air quality surveillance system. The annual monitoring network review must be made available for public inspection for at least 30 days prior to submission to the EPA. The review, and any comments received during the 30 day inspection period, are then forwarded to the EPA for final review and approval. The TCEQ posted this plan from June 1 through June 30, 2009. The document presented the current Texas network of ambient air Photochemical Assessment Monitoring Station (PAMS) monitors as well as proposed changes to the network from July 1, 2009, through December 31, 2010.

This network review includes posting of the TCEQ's EPA-approved PAMS Network Plan which focuses on ozone precursors. The reclassification of the Houston ozone nonattainment area to severe requires one major change in the HGB area PAMS plan. The TCEQ will conduct intensive carbonyl sampling at the Clinton PAMS Type 2 Site (AQS ID 48-201-1035) each year. As agreed upon with the EPA, Region 6, the TCEQ will collect a total of 240 carbonyl samples at this site at a sampling frequency of eight 3-hour samples per day every three days during July-September. Carbonyl sampling will be terminated at the Houston Channelview site to offset this increased sampling schedule at the Clinton site. The 24 hour sample every sixth day carbonyl sampling at the Deer Park monitor (AQS ID 48-201-1039) will continue January through December.

4.9 CONTINGENCY PLAN

SIP revisions for nonattainment areas are required by § 172(c)(9) of the FCAA to provide for specific measures to be implemented should a nonattainment area fail to meet reasonable further progress (RFP) requirements or attain the applicable NAAQS by the attainment date set by the EPA. These contingency measures are to be implemented without further action by the state or the EPA. In the

General Preamble for implementation of the FCAA Amendments of 1990 published in the April 16, 1992, issue of the *Federal Register* (57 FR 13498), the EPA interprets the contingency requirement to mean additional emissions reductions that are sufficient to equal up to 3 percent of the emissions in the adjusted base year inventory. These emissions reductions should be realized in the year following the year in which the failure is identified (i.e., an RFP milestone year or attainment year).

The adjusted base year emissions inventory is used in the RFP planning process to calculate required emissions reduction targets and excludes certain on-road mobile source emissions reductions from controls that were promulgated prior to the 1990 amendments to the FCAA. This 1997 eight-hour ozone attainment demonstration SIP revision also uses the adjusted base year inventory as the inventory from which to calculate the required 3 percent reduction for contingency. For further information regarding the adjusted base year inventory for the HGB area and how the area meets RFP requirements, see the HGB 1997 Eight-Hour Ozone Nonattainment Area Reasonable Further Progress SIP revision (Project No. 2009-018-SIP-NR), which is being proposed concurrently with this attainment demonstration SIP revision.

A summary of the 2019 contingency analysis is provided in Table 4-3: *2019 Contingency Demonstration for the HGB Area*. Consistent with the EPA's NO_X substitution guidance, the 3 percent attainment demonstration contingency analysis for 2019 is based on a 2 percent reduction in NO_X emissions (17.16 tpd) and a 1 percent reduction in VOC emissions (9.36 tpd) to be achieved between 2018 and 2019 (EPA, 1993). Inventory analyses were performed on the fleet turnover effects for the federal emission certification programs for on-road and non-road vehicles. The emission reductions from 2018 to 2019 were estimated for these programs. For a detailed description of the contingency reductions, see Appendix 1: *HGB Reasonable Further Progress Demonstration Calculations Spreadsheet* of the HGB 1997 Eight-Hour Ozone Nonattainment Area Reasonable Further Progress SIP revision (Project No. 2009-018-SIP-NR).

Table 4-3: 2019 Contingency Demonstration for the HGB Area

Description	**NO_X**	**VOC**
Adjusted 2018 Base Year Emissions Inventory	**858.18**	**935.57**
Percent for Contingency Calculation (total of 3 percent)	**2.00**	**1.00**
2018 to 2019 Required Contingency Reductions	**17.16**	**9.36**
Federal On-Road Mobile New Vehicle Certification Standards	3.97	2.73
Federal On-Road Reformulated Gasoline (RFG)	5.09	0.70
State I/M and Anti-Tampering Programs (Brazoria, Fort Bend, Galveston, Harris, and Montgomery Counties)	1.23	0.31
Federal Non-Road Mobile New Vehicle Certification Standards	3.56	1.78
Non-Road RFG Gasoline	0.00	0.03
Federal Tier I and II Locomotive Standards	0.68	0.01
Federal Tier 2 Marine Diesel Standard	0.55	0.02
Additional Contingency Measures to be Quantified before 2019	2.08	3.78
Total Contingency Reductions	**17.16**	**9.36**
Contingency Excess (+) or Shortfall (-)	**0.00**	**0.00**

Note: Emissions are represented in tons per day.

To meet the contingency requirement, the TCEQ will evaluate potential control measures to be implemented at the state level that require more study before emissions reductions can be quantified and federal measures that are not yet final or have not yet been implemented. Potential measures include but are not limited to the following:

Potential State Measures

- *Gas Imaging "Find and Fix" Rule*
  Contingency measure rule to require the use of gas imaging camera technology for periodic inspection of sources of VOC emissions such as storage tanks, barges, etc., that are not currently subject to leak detection monitoring programs and set reasonable time periods for companies to address possible problems found (e.g., leaking seals).

- *Enhanced LDAR for Difficult-to-Monitor Components* Contingency measure rule to require the use of gas imaging camera technology for more frequent monitoring on difficult-to-monitor and unsafe-to-monitor components that would normally have very long monitoring frequencies under traditional LDAR monitoring rules.

Potential Federal Measures

- *International Maritime Engine Emission Standards for Oceangoing Vessels*
  If implemented by the EPA, this measure would result in annual emissions reductions from fleet turnover.

- *Potential Enhanced Corporate Average Fuel Economy (CAFE) Standards for Cars and Trucks*
  The original federal measure increased the fuel economy of vehicles starting with model year 2011 to approximately 35 miles per gallon (mpg) in 2020. The CAFE rules are part of a larger federal energy bill, H.R. 6, which was signed into law on December 19, 2007. The administration is proposing to move the 35-mpg requirement to 2016. This measure would result in fleet turnover reductions that could be available in 2019.

- *EPA Proposed Rule to Reduce Air Toxics from Stationary Diesel and Gas-Fired Engines*
  If finalized, this rule would become effective in 2013.

- *EPA Proposed Rule to Reduce Air Toxics Emissions from Area Source Asphalt Refining and Asphalt Roofing Manufacturing Facilities*
  If finalized, this rule would likely go into effect before 2019.

- *EPA Final Rule for National Volatile Organic Compound (VOC) Emission Standards for Aerosol Coatings*
  Final rule amendments to add compounds and reactivity factors go into effect July 2009.

Any measure used to meet the contingency requirement will be included in the SIP for the 1997 eight-hour ozone standard in the HGB area before 2019.

4.10 REFERENCES

EPA, 1993. NO_X Substitution Guidance, http://www.epa.gov/ttncaaa1/t1/memoranda/noxsubst.pdf

EPA, 2005. Clean-Fuel Vehicle Standards, no. CCD-05-12.