Executive Summary
Request for Determination Regarding Termination of the One-Hour Ozone Section 185 Fee Obligation

Background

The Federal Clean Air Act (FCAA), Section 182(d)(3) and (e) and Section 185, require each state to impose a requirement for the assessment and collection of a fee for major stationary sources of volatile organic compounds (VOC) and nitrogen oxides (NO_X) located in a severe or extreme nonattainment area if the area fails to attain the ozone National Ambient Air Quality Standard (NAAQS) by the applicable attainment date. The eight-county (Brazoria, Chamber, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller) Houston-Galveston-Brazoria (HGB) area is classified as severe for both the one-hour ozone NAAQS and the 1997 eight-hour ozone NAAQS.

The United States Environmental Protection Agency (EPA) memorandum issued on January 5, 2010, entitled "Guidance on Developing Fee Programs Required by Clean Air Act Section 185 for the 1-hour Ozone NAAQS" states that if EPA determines that an area is attaining either the one-hour or the 1997 eight-hour ozone NAAQS, based on permanent and enforceable emissions reductions, the area would no longer be obligated to submit a fee program state implementation plan (SIP) revision to satisfy the anti-backsliding requirements associated with the transition from the one-hour standard to the 1997 eight-hour standard. Attachments A through E document that data for 2007 through 2009 show that the HGB area is monitoring attainment of the 1997 eight-hour ozone standard, and attainment is due to permanent and enforceable emission reductions.

Summary of Attachments

<u>Attachment A: Data Demonstrating Compliance</u>

Attachment A contains a table that displays the eight-hour ozone design values for the HGB area since 1991 and a copy of the data certification letter dated March 22, 2010. With a design value of 84 parts per billion (ppb) in 2009, the HGB area monitored attainment of the 1997 eight-hour ozone NAAQS of 0.08 parts per million (ppm)[1]. The HGB area's 2009 eight-hour ozone design value of 84 ppb was a 7.7 percent decrease from 2008 (91 ppb) and a 29.4 percent drop since 1991 (119 ppb).

<u>Attachment B: Economic Analysis</u>

The national economic recession that began in late 2007 was not detectible in data for Texas or the HGB area until late 2008. Therefore, attainment of the 1997 eight-hour ozone NAAQS in 2009, which includes ozone measurements from 2007 and 2008, could not have been due to a reduction in economic activity in those years. In fact, the HGB area exhibited the highest economic activity of any three-year period on record during the 2007 through 2009 time period. Over the previous two decades, ozone concentrations and economic growth have rarely been correlated in the HGB area: many of the years that saw robust economic growth coincided with declines in the eight-hour and one-hour ozone design values. Attachment B demonstrates two results regarding ozone and the economy using published economic and ozone data. First, because the HGB area did not experience a reduction in economic activity until late 2008, ozone reductions observed in 2007 through 2008 could not have been influenced by economic contraction and were observed during a period of robust economic expansion in the region. Second, the HGB area has consistently reduced ozone concentrations during two consecutive

1 Due to rounding conventions, a measured value of 84 ppb demonstrates attainment and 85 ppb does not demonstrate attainment.

decades of economic growth. This attachment presents evidence ozone concentrations have declined during the past two decades during increasing economic activity in the region.

Attachment C: Meteorological Analysis
Meteorological factors have played a small role in the recently observed ozone trends, but those factors do not appear to be the primary reason for decreasing ozone. Attachment C contains analyses that show ozone trends are still decreasing in the HGB area, even when accounting for the effects of meteorology. Four extensive analyses of meteorological conditions are included that indicate meteorological factors cannot explain the recent decrease in ozone. In addition, this attachment includes an analysis of the frequency of wind speed and direction that shows higher winds observed in 2008 and 2009 occurred at a time of year when high ozone usually does not occur because of the direction of the wind flow at that time of year. This analysis also shows that the wind conditions were more suitable for high ozone formation in August and September of 2008 and 2009 than in 2000 and 2004, but the number of ozone exceedance days was far lower in 2008 and 2009. Based upon the historical analysis, the effect of Hurricane Ike upon the eight-hour ozone design value for 2008 in the HGB area was minimal.

Attachment D: Emissions Inventory Analysis
The Texas Commission on Environmental Quality (TCEQ) maintains an emissions inventory (EI) of up-to-date information on NO_X and VOC sources. The EI identifies the source types present in an area, the amount of each pollutant emitted, and the types of processes and control devices employed at each plant or source category. The inventory provides data for a variety of air quality planning tasks, including establishing baseline emission levels, calculating reduction targets, developing control strategies to achieve the emission reductions, developing emission inputs into air quality models, and tracking actual emission reductions against established emissions growth and control budgets. Attachment D contains data that indicates actual emissions inventory numbers have continually reduced for industrial point sources, area source, non-road, and on-road source categories for VOC and NO_X in the HGB area, in spite of economic activity and population growth. This trend continues between 2002 through 2008 with overall inventory reductions of NO_X of 43 percent and VOC of 14 percent.

Attachment E: Control Measures
This attachment identifies control measures that have resulted in emissions reductions of NO_X and VOC that contributed to the reduction in the emission inventory from 2002 through 2008 and the air quality improvements in the HGB area. All of the listed measures for 2002 through 2008 are approved by the EPA as part of the state implementation plan (SIP). Table E-1: *Texas Rule Control Measures Applicable to the HGB Area* lists control measures that were implemented as rules in the Texas Administrative Code (TAC) and resulted in permanent and enforceable emission reductions between 2002 and 2008 as well as additional reductions for 2009 and later. Table E-2: *Texas Non-Rule Control Measures Applicable to the HGB Area* lists non-rule control measures that were implemented as permanent and enforceable measures in the SIP that resulted in emission reductions between 2002 through 2008.

Conclusion
The evidence, analysis, and data provided in Attachments A through E show that the HGB area is monitoring attainment of the 1997 eight-hour ozone standard and that the attainment is due to permanent and enforceable emission reductions. With a design value of 84 ppb in 2009, the HGB area attained the 1997 eight-hour ozone NAAQS. The HGB area's 2009 eight-hour ozone design value of 84 ppb was a 7.7 percent decrease from 2008 and a 29.4 percent drop since 1991.

The HGB area exhibited the highest economic activity for any three-year period on record during the 2008 through 2009 time period, despite a decline in economic activity in 2009. Therefore, attainment of the 1997 eight-hour ozone NAAQS in 2009, which includes ozone measurements from 2007 through 2008, could not have been due to a reduction in economic activity in those years. Further, future attainment of the ozone standard is unlikely to be derailed by a return to economic growth.

The petrochemical industry, an important factor in air quality in the region, has exhibited long-term declining trends in inputs to refineries and capacity utilization. These trends began long before 2007 and are likely the result of larger scale factors in the industry. Increases in the value of production in the industry may be due to concomitant increases in prices of crude oil and refined products. While the impacts of these phenomena on air quality in the HGB area are unclear, there is no evidence that ozone and precursor emissions could have been impacted by economic factors as early as 2007 or 2008.

Over at least the past two decades, as the economy of the HGB area has grown, ozone concentrations have declined. Ozone concentrations in the region have fallen even during periods of robust economic expansion, including 1997, 2005, and 2006, when the region saw economic growth in excess of 6 percent per year. This finding suggests that ozone in the HGB area is, at most, only weakly related to economic activity. Therefore, it is reasonable to conclude that as the HGB area recovers from the recession that began in late 2008, and as control strategies continue to be adopted and expanded, the area is likely to continue to attain the 1997 ozone NAAQS.

Evidence provided show that favorable meteorology is not adequate to explain the decreases in ozone observed in 2007, 2008, and 2009. Two analyses that adjusted ozone trends for meteorology both show that ozone would continue to be decreasing in recent years, despite changes in meteorology. Analysis of the number of ozone-conducive days show that there has been a similar number of conducive days over the past few years, yet the number of ozone exceedance days continue to decrease. Similarly, the number of forecasted ozone exceedance days in 2008 was larger than the actual number of observed exceedance days. In addition, an analysis of the frequency of wind speed and direction showed that higher winds observed in 2008 and 2009 occurred at a time of year when high ozone usually does not occur. The wind conditions were more suitable for high ozone formation in August and September of 2008 and 2009 than in 2000 and 2004, but the number of ozone exceedance days was far lower in 2008 and 2009. Finally, based upon the historical analysis, the effect of Hurricane Ike upon the eight-hour ozone design value for 2008 in the HGB area was minimal. All of the various analyses tend to agree that meteorology alone cannot explain the decreasing trend observed in ozone concentrations. Decreases in ozone precursor emissions appear to play a significant role in the recent decreases in ozone.

Emissions have continued to decline in the HGB area since 2002. In spite of steadily increasing population and increases in economic activity in the area, as discussed in Appendix B: *Economic Analysis*, overall VOC emissions declined by 14 percent and NO_X emissions declined by 39.9 percent. The largest contributor to VOC emissions were from the area source category. The estimated area source amount of 135,789 tons per year (tpy) was 59.3 percent of the overall total emissions in 2008. The VOC emissions from this category decreased 6.6 percent in spite of the steadily increasing population in the HGB area. The area source NO_X decreased by 22.4 percent during the same period.

The point source VOC emissions decreased 32.3 percent between 2002 and 2008. The NO_X emissions from point sources decreased 67.7 percent over the same time period. These reductions are largely due to the implementation of control measures. Permanent and enforceable reductions in VOC and NO_X emissions in the HGB area occurred between 2002 and 2008 as a result of rule and non-rule control measures that are included in the SIP. A specific list of these measures is in Attachment E: *Control Measures*. In addition to the state measures, numerous federal measures have been implemented that have also resulted in NO_X and VOC reductions in the HGB area.

According to EPA guidance and based on the supporting information and documentation showing that the HGB area is monitoring attainment of the 1997 eight-hour ozone standard and that attainment is due to permanent and enforceable emission reductions, the executive director requests that the EPA make a determination that a Section 185 fee program in not needed for the HGB area.

ATTACHMENT A: DATA DEMONSTRATING COMPLIANCE

Summary

The Houston-Galveston-Brazoria ozone nonattainment area (HGB area) includes Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties. Table A-1: *Eight-Hour Ozone Design Values (DV) in the HGB Area* displays the eight-hour ozone design values for the HGB area since 1991. With a design value of 84 parts per billion (ppb) in 2009, the HGB area monitored attainment of the 1997 eight-hour ozone National Ambient Air Quality Standard of 0.08 parts per million (ppm), or 85 ppb. The HGB area's 2009 eight-hour ozone design value of 84 ppb was a 7.7 percent decrease from 2008 (91 ppb) and a 29.4 percent drop since 1991 (119 ppb).

Table A-1: Eight-Hour Ozone Design Values (DV) in the HGB Area

Year	Eight-Hour DV *ppm*
1991	119
1992	116
1993	104
1994	110
1995	114
1996	116
1997	117
1998	116
1999	118
2000	112
2001	110
2002	107
2003	102
2004	101
2005	103
2006	103
2007	96
2008	91
2009	84

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

March 22, 2010

Dr. Alfredo Armendariz, Regional Administrator
U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 78202-2733

Dear Dr. Armendariz:

In accordance with the Texas Commission on Environmental Quality's (TCEQ) Fiscal Year 2009 Performance Partnership Grant, I am submitting the attached AMP450 Quick Look Summary Report for Ozone in 2009 for the specified sites in the Houston Region. Also included is the AMP255, Data Quality Indicator Report required by the certification process for the same sites and criteria pollutant. I certify that the ambient concentration data listed in the attached reports are completely submitted to AQS and the ambient data are accurate to the best of my knowledge taking into consideration the quality assurance findings and that these data were collected in conformance with the applicable requirements as specified by Title 40 of the Code of Federal Regulations.

If you need any additional information, please contact Matthew Baker, Assistant Director for the Field Operations Support Division, at (512) 239-1091.

Sincerely,

Mark R. Vickery, P.G.
Executive Director

MRV/bv

Enclosures

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

User ID: VBD

QUICKLOOK CRITERIA PARAMETERS

Report Request ID: 729279 Report Code: AMP450 Mar. 17, 2010

GEOGRAPHIC SELECTIONS

Tribal	State	County	Site	Parameter	POC	City	AQCR	UAR	CBSA	CSA	EPA Region	Method	Duration	Begin Date	End Date
	48	201									06				
	48	339									06				
	48	471									06				
	48	291									06				
	48	473									06				
	48	071									06				
	48	157									06				
	48	039									06				
	48	167									06				
	48	321									06				

PROTOCOL SELECTIONS

Parameter Classification	Parameter	Method	Duration
	44201		

SELECTED OPTIONS

Option Type	Option Value
EVENTS PROCESSING	INCLUDE EVENTS
MERGE PDF FILES	YES

SORT ORDER

Order	Column
1	PARAMETER_CODE
2	STATE_CODE
3	COUNTY_CODE
4	SITE_ID
5	POC
6	DATES
7	EDT_ID

SCR GROUP SELECTIONS

Texas

GLOBAL DATES

Start Date	End Date
2009	2009

APPLICABLE STANDARDS

Standard Description
Ozone 1-hour Daily 2005
Ozone 8-hour 2008

Mar. 17, 2010

EXCEPTIONAL DATA TYPES

EDT	DESCRIPTION
0	NO EVENTS
1	EVENTS EXCLUDED
2	EVENTS INCLUDED
5	EVENTS WITH CONCURRENCE EXCLUDED

Note: The * indicates that the mean does not satisfy summary criteria.

Mar. 17, 2010

Ozone (44201) Texas Parts per million (007)

1-HOUR

SITE ID	POC	PQAO	CITY	COUNTY	ADDRESS	YEAR	METH	VALID DAYS MEAS	NUM DAYS REQ	1ST MAX 1-HR	2ND MAX 1-HR	3RD MAX 1-HR	4TH MAX 1-HR	DAY MAX>/= 0.125	EST DAYS>/= .125	MISS DAYS< 0.125	CERT	EDT
48-039-1004	1	1035	Not in a city	Brazoria	4503 CROIX PKWY	2009	056	348	365	.127	.124	.119	.113	1	1.0	2		0
48-039-1016	1	1035	Lake Jackson	Brazoria	109 B BRAZORIA HWY 332 WEST	2009	056	365	365	.113	.092	.090	.084	0	0.0	0		0
48-167-1034	1	1035	Galveston	Galveston	9511 AVENUE V 1/2	2009	087	349	365	.104	.101	.096	.095	0	0.0	1		0
48-201-0024	2	1035	Not in a city	Harris	4510 1/2 ALDINE MAIL RD.	2009	056	358	365	.120	.111	.108	.108	0	0.0	2		0
48-201-0026	3	1035	Channelview	Harris	1405 SHELDON ROAD	2009	056	362	365	.125	.118	.113	.109	1	1.0	1		0
48-201-0029	2	1035	Not in a city	Harris	16822 KITZMAN	2009	056	352	365	.140	.128	.118	.112	2	2.1	3		0
48-201-0046	1	1035	Houston	Harris	7330 1/2 NORTH WAYSIDE	2009	087	356	365	.110	.105	.099	.099	0	0.0	2		0
48-201-0047	2	1035	Houston	Harris	4401 1/2 LANG RD.	2009	087	355	365	.134	.119	.107	.106	1	1.0	4		0
48-201-0051	2	1035	Houston	Harris	13826 1/2 CROQUET	2009	087	365	365	.134	.112	.102	.096	1	1.0	0		0
48-201-0055	1	1035	Houston	Harris	6400 BISSONNET STREET	2009	056	358	365	.157	.109	.104	.104	1	1.0	3		0
48-201-0062	1	1035	Houston	Harris	9726 1/2 MONROE	2009	087	359	365	.140	.108	.097	.093	1	1.0	0		0
48-201-0066	1	1035	Houston	Harris	3333 1/2 HWY 6 SOUTH	2009	000	355	365	.100	.092	.088	.087	0	0.0	2		0
48-201-0070	1	1035	Houston	Harris	5425 POLK AVE., SUITE H	2009	056	362	365	.124	.114	.111	.110	0	0.0	3		0
48-201-0075	1	1035	Houston	Harris	2311 TEXAS AVE.	2009	087	351	365	.128	.109	.107	.106	1	1.0	2		0
48-201-0416	1	1035	Houston	Harris	7421 PARK PLACE BLVD	2009	087	355	365	.150	.113	.111	.098	1	1.0	1		0
48-201-1015	1	1035	Houston	Harris	1001 B LYNCHBURG ROAD	2009	087	357	365	.122	.117	.111	.103	0	0.0	2		0
48-201-1034	2	1035	Houston	Harris	1262 1/2 MAE DRIVE	2009	000	335	365	.124	.121	.113	.111	0	0.0	3		0
48-201-1035	3	1035	Houston	Harris	9525 CLINTON DR	2009	087	355	365	.125	.122	.120	.098	1	1.0	6		0

Note: The * indicates that the mean does not satisfy summary criteria.

Mar. 17, 2010

Ozone (44201) Texas Parts per million (007)

1-HOUR

SITE ID	POC	PQAO	CITY	COUNTY	ADDRESS	YEAR	METH	VALID DAYS MEAS	NUM DAYS REQ	1ST MAX 1-HR	2ND MAX 1-HR	3RD MAX 1-HR	4TH MAX 1-HR	DAY MAX>/= 0.125	EST DAYS>/= .125	MISS DAYS< 0.125	CERT	EDT
48-201-1039	1	1035	Deer Park	Harris	4514 1/2 DURANT ST.	2009	087	350	365	.139	.138	.115	.114	2	2.1	1		0
48-201-1050	1	1035	Seabrook	Harris	4522 PARK RD.	2009	056	347	365	.102	.102	.102	.100	0	0.0	1		0
48-339-0078	1	1035	Conroe	Montgomery	9472 A HWY 1484	2009	056	363	365	.078	.076	.076	.075	0	0.0	2		0

Note: The * indicates that the mean does
not satisfy summary criteria.

Mar. 17, 2010

Ozone (44201) | Texas | Parts per million (007)

8-HOUR

SITE ID	POC	PQAO	CITY	COUNTY	ADDRESS	YEAR	METH	%OBS	VALID DAYS MEAS	NUM DAYS REQ	1ST MAX 8-HR	2ND MAX 8-HR	3RD MAX 8-HR	4TH MAX 8-HR	DAY MAX > 0.075	CERT EDT
48-039-1004	1	1035	Not in a city	Brazoria	4503 CROIX PKWY	2009	056	95	347	365	.096	.093	.092	.091	8	0
48-039-1016	1	1035	Lake Jackson	Brazoria	109 B BRAZORIA HWY 332 WEST	2009	056	100	365	365	.077	.076	.076	.076	4	0
48-167-1034	1	1035	Galveston	Galveston	9511 AVENUE V 1/2	2009	087	96	350	365	.085	.080	.076	.076	4	0
48-201-0024	2	1035	Not in a city	Harris	4510 1/2 ALDINE MAIL RD.	2009	056	98	357	365	.094	.086	.081	.080	9	0
48-201-0026	3	1035	Channelview	Harris	1405 SHELDON ROAD	2009	056	99	362	365	.092	.088	.085	.080	4	0
48-201-0029	2	1035	Not in a city	Harris	16822 KITZMAN	2009	056	95	348	365	.103	.101	.089	.086	6	0
48-201-0046	1	1035	Houston	Harris	7330 1/2 NORTH WAYSIDE	2009	087	97	353	365	.092	.072	.072	.069	1	0
48-201-0047	2	1035	Houston	Harris	4401 1/2 LANG RD.	2009	087	97	354	365	.091	.090	.090	.081	4	0
48-201-0051	2	1035	Houston	Harris	13826 1/2 CROQUET	2009	087	100	364	365	.100	.090	.090	.080	6	0
48-201-0055	1	1035	Houston	Harris	6400 BISSONNET STREET	2009	056	98	356	365	.106	.098	.088	.086	7	0
48-201-0062	1	1035	Houston	Harris	9726 1/2 MONROE	2009	087	98	357	365	.088	.088	.076	.071	3	0
48-201-0066	1	1035	Houston	Harris	3333 1/2 HWY 6 SOUTH	2009	000	97	353	365	.080	.079	.074	.071	2	0
48-201-0070	1	1035	Houston	Harris	5425 POLK AVE., SUITE H	2009	056	99	361	365	.103	.082	.080	.080	5	0
48-201-0075	1	1035	Houston	Harris	2311 TEXAS AVE.	2009	087	96	349	365	.095	.081	.079	.079	5	0
48-201-0416	1	1035	Houston	Harris	7421 PARK PLACE BLVD	2009	087	97	354	365	.096	.091	.087	.073	3	0
48-201-1015	1	1035	Houston	Harris	1001 B LYNCHBURG ROAD	2009	087	97	355	365	.090	.087	.082	.073	3	0
48-201-1034	2	1035	Houston	Harris	1262 1/2 MAE DRIVE	2009	000	91	333	365	.110	.090	.083	.079	6	0
48-201-1035	3	1035	Houston	Harris	9525 CLINTON DR	2009	087	96	352	365	.101	.084	.078	.078	5	0

Note: The * indicates that the mean does not satisfy summary criteria.

Mar. 17, 2010

Ozone (44201) Texas Parts per million (007)

8-HOUR

SITE ID	POC	PQAO	CITY	COUNTY	ADDRESS	YEAR	METH	%OBS	VALID DAYS MEAS	NUM DAYS REQ	1ST MAX 8-HR	2ND MAX 8-HR	3RD MAX 8-HR	4TH MAX 8-HR	DAY MAX > 0.075	CERT	EDT
48-201-1039	1	1035	Deer Park	Harris	4514 1/2 DURANT ST.	2009	087	96	350	365	.102	.099	.094	.082	7		0
48-201-1050	1	1035	Seabrook	Harris	4522 PARK RD.	2009	056	94	344	365	.083	.081	.080	.079	5		0
48-339-0078	1	1035	Conroe	Montgomery	9472 A HWY 1484	2009	056	98	358	365	.067	.066	.065	.065	0		0

Note: The * indicates that the mean does not satisfy summary criteria.

METHODS USED IN THIS REPORT

PARAMETER	METHOD CODE	COLLECTION METHOD	ANALYSIS METHOD
44201	000	MULTIPLE METHODS	MULTIPLE METHODS
44201	056	INSTRUMENTAL	ULTRA VIOLET
44201	087	INSTRUMENTAL	ULTRA VIOLET ABSORPTION

Note: The * indicates that the mean does
not satisfy summary criteria.

Mar. 17, 2010

PQAOS USED IN THIS REPORT

PQAO	AGENCY DESCRIPTION
1035	Texas Commission On Environmental Quality

Note: The * indicates that the mean does not satisfy summary criteria.

User ID: VBD

DATA QUALITY INDICATOR REPORT

Report Request ID: 729277 Report Code: AMP255 Mar. 17, 2010

GEOGRAPHIC SELECTIONS

Tribal	State	County	Site	Parameter	POC	City	AQCR	UAR	CBSA	CSA	EPA Region	Method	Duration	Begin Date	End Date
	48	201									06				
	48	339									06				
	48	471									06				
	48	291									06				
	48	473									06				
	48	071									06				
	48	157									06				
	48	039									06				
	48	167									06				
	48	321									06				

PROTOCOL SELECTIONS

Parameter Classification	Parameter	Method	Duration
	44201		

SELECTED OPTIONS

Option Type	Option Value
INCLUDE ONLY APPENDIX A MONITORS	YES
RESTRICT TO MONITORING SEASONS	NO
MERGE PDF FILES	YES

SCR GROUP SELECTIONS

Texas

GLOBAL DATES

Start Date	End Date
2009 01 01 Q1	2009 12 31

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
AIR QUALITY SYSTEM

DATA QUALITY INDICATOR REPORT

Mar. 17, 2010

Notes About this Report

For specific information about the fields appearing within this report, please refer to the README.txt file that is included with the WORKFILE output for this report.

M

If you see this value for a column in a summarized row, this means that more than one occurence exist in the summary. For example, if you have a PQAO summary that spans multiple States, you would see this value in the States column.

Code Listing

The following codes may be seen in the "MT" column throughout this report. Please be advised that not all of the codes may appear in the report. They are provided for completeness.

Code	Description
NR	NON-REGULATORY
P	PAMS
SP	SPECIAL PURPOSE
NC	NCORE
ID	INDUSTRIAL
NA	NATTS
F	NON-EPA FEDERAL
PN	PROPOSED NCORE
VS	VOL SCHOOL AT
X	SECURED
SU	SUPLMNTL SPECIATION
TS	TRENDS SPECIATION
UP	UNOFFICIAL PAMS
M	WMO

Code	Description
S	SLAMS
T	TRIBAL MONITORS
I	IMPROVE
IX	INDEX SITE
N	NAMS
CN	CASTNET
O	OTHER
ST	SCHOOL AIR TOXICS
QA	QA COLLOCATED
SS	SLAMS SPECIATION
SU	SUPPLMNTL SPECIATION
U	UNKNOWN
W	WHO

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
AIR QUALITY SYSTEM

DATA QUALITY INDICATOR REPORT

Mar. 17, 2010

1-Point Quality Control

Pollutant: O3 **PQAO:** 1035 (Texas Commission On Environmental Quality) **App A?:** Yes

Year	Region	State	Site ID	POC	MT	Begin Date	End Date	# Req	# Obs	% Complete	CV	Bias
2009	06	TX	48-039-1004	1	S	01-JAN-09	31-DEC-09	26	37	100	0.83	+ 1.10
2009	06	TX	48-039-1016	1	S	01-JAN-09	31-DEC-09	26	39	100	0.81	+ 2.53
2009	06	TX	48-167-1034	1	UP	01-JAN-09	31-DEC-09	26	39	100	1.74	+/- 1.50
2009	06	TX	48-201-0024	2	S-P	01-JAN-09	31-DEC-09	26	38	100	1.91	+/- 1.48
2009	06	TX	48-201-0026	3	UP	01-JAN-09	31-DEC-09	26	39	100	3.12	+ 3.41
2009	06	TX	48-201-0029	2	S-P	01-JAN-09	31-DEC-09	26	38	100	1.16	- 1.16
2009	06	TX	48-201-0046	1	S	01-JAN-09	31-DEC-09	26	37	100	0.47	- 3.21
2009	06	TX	48-201-0047	2	S	01-JAN-09	31-DEC-09	26	37	100	0.90	+ 0.79
2009	06	TX	48-201-0051	2	S	01-JAN-09	31-DEC-09	26	38	100	2.05	+ 1.50
2009	06	TX	48-201-0055	1	UP	01-JAN-09	31-DEC-09	26	39	100	4.18	+ 3.41
2009	06	TX	48-201-0062	1	S	01-JAN-09	31-DEC-09	26	38	100	0.96	+ 2.24
2009	06	TX	48-201-0066	1	O	01-JAN-09	31-DEC-09	26	38	100	0.66	+/- 0.48
2009	06	TX	48-201-0070	1	S	01-JAN-09	31-DEC-09	26	39	100	1.65	- 2.07
2009	06	TX	48-201-0075	1	O	01-JAN-09	31-DEC-09	26	37	100	0.63	- 4.30
2009	06	TX	48-201-0416	1	SP	01-JAN-09	31-DEC-09	26	39	100	1.61	+/- 1.17
2009	06	TX	48-201-1015	1	S	01-JAN-09	31-DEC-09	26	38	100	1.78	- 5.41
2009	06	TX	48-201-1034	2	S	01-JAN-09	31-DEC-09	26	45	100	6.00	+/- 5.64
2009	06	TX	48-201-1035	3	S-P	01-JAN-09	31-DEC-09	26	40	100	3.60	- 4.47
2009	06	TX	48-201-1039	1	S-P	01-JAN-09	31-DEC-09	26	36	100	0.95	+ 1.29
2009	06	TX	48-201-1050	1	S	01-JAN-09	31-DEC-09	26	37	100	3.14	+ 3.84
2009	06	TX	48-339-0078	1	S	01-JAN-09	31-DEC-09	26	39	100	1.29	+/- 1.30
2009	06	TX	**SUMMARY**					546	807	100	3.11	+/- 2.29
SUMMARY	06	TX						546	807	100	3.11	+/- 2.29

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
AIR QUALITY SYSTEM

DATA QUALITY INDICATOR REPORT

Mar. 17, 2010

Annual Performance Evaluations

Pollutant: O3 **PQAO:** 1035 (Texas Commission On Environmental Quality) **App A?:** Yes

Year	Region	State	Site ID	POC	MT	Begin Date	End Date	L1	Avg %D / Level L2	L3	L4	L5	Obs / Q Q1	Q2	Q3	Q4	Criteria Met?	1-Point Conf. Limits Lower	Upper	% Btwn Conf.
2009	06	TX	48-039-1004	1	S	01-JAN-09	31-DEC-09		-2.25	-1.59	-2.00		0	0	0	3	Y			
2009	06	TX	48-039-1016	1	S	01-JAN-09	31-DEC-09		0.00	1.05	0.40		0	0	0	3	Y			
2009	06	TX	48-167-1034	1	UP	01-JAN-09	31-DEC-09		-1.11	-1.05	-0.80		0	0	0	3	Y			
2009	06	TX	48-201-0024	2	S-P	01-JAN-09	31-DEC-09		1.12	1.59	0.80		3	0	0	0	Y			
2009	06	TX	48-201-0026	3	UP	01-JAN-09	31-DEC-09		10.84	5.43	4.51		3	0	0	0	Y			
2009	06	TX	48-201-0029	2	S-P	01-JAN-09	31-DEC-09		1.14	1.06	0.80		3	0	0	0	Y			
2009	06	TX	48-201-0046	1	S	01-JAN-09	31-DEC-09		-5.40	-5.37	-5.88		0	0	3	3	Y			
2009	06	TX	48-201-0047	2	S	01-JAN-09	31-DEC-09		0.00	-2.78	-2.95		3	0	0	0	Y			
2009	06	TX	48-201-0051	2	S	01-JAN-09	31-DEC-09		-3.45	-4.53	-4.25		0	0	0	6	Y			
2009	06	TX	48-201-0055	1	UP	01-JAN-09	31-DEC-09		-1.15	-2.13	-2.83		0	0	3	0	Y			
2009	06	TX	48-201-0062	1	S	01-JAN-09	31-DEC-09		-5.45	-6.45	-6.94		3	0	0	3	Y			
2009	06	TX	48-201-0066	1	O	01-JAN-09	31-DEC-09		-1.01	-1.30	-1.41		0	0	0	6	Y			
2009	06	TX	48-201-0070	1	S	01-JAN-09	31-DEC-09		-6.67	-5.79	-5.20		0	0	3	0	Y			
2009	06	TX	48-201-0075	1	O	01-JAN-09	31-DEC-09		0.00	-0.56	-1.69		0	3	0	0	Y			
2009	06	TX	48-201-0416	1	SP	01-JAN-09	31-DEC-09		2.78	-2.22	-3.77		0	0	3	0	Y			
2009	06	TX	48-201-1015	1	S	01-JAN-09	31-DEC-09		-2.30	-3.72	-4.03		0	0	0	3	Y			
2009	06	TX	48-201-1034	2	S	01-JAN-09	31-DEC-09		-3.33	-1.58	-1.20		3	0	0	0	Y			
2009	06	TX	48-201-1035	3	S-P	01-JAN-09	31-DEC-09		-3.29	-3.51	-4.10		0	3	0	3	Y			
2009	06	TX	48-201-1039	1	S-P	01-JAN-09	31-DEC-09		-14.61	-8.95	0.80		0	3	0	0	Y			
2009	06	TX	48-201-1050	1	S	01-JAN-09	31-DEC-09		-7.78	-5.79	-5.98		0	0	3	0	Y			
2009	06	TX	48-339-0078	1	S	01-JAN-09	31-DEC-09		-2.25	-3.68	-2.80		0	0	0	3	Y			
2009	06	TX	**SUMMARY**						-2.10	-2.47	-2.31		18	9	15	36	100	-6.17	5.63	83
SUMMARY	06	TX							-2.10	-2.47	-2.31		18	9	15	36	100	-6.17	5.63	83

ATTACHMENT B: ECONOMIC ANALYSIS

Summary

The national economic recession that began in late 2007 was not detectible in data for Texas or the Houston-Galveston-Brazoria ozone nonattainment area (HGB area) until late 2008. Therefore, attainment of the 1997 eight-hour ozone National Ambient Air Quality Standard (NAAQS) in 2009, which includes ozone measurements from 2007 through 2008, could not have been due to a reduction in economic activity in those years. In fact, the HGB area exhibited the highest economic activity of any three-year period on record during the 2007 through 2009 time period. Further, future attainment of the ozone standard is unlikely to be derailed by a return to economic growth. Over the previous two decades, ozone concentrations and economic growth have rarely been correlated in the HGB area: many of the years that saw robust economic growth coincided with declines in the eight-hour and one-hour ozone design values. This finding suggests that ozone in the HGB area is, at most, only weakly related to economic activity and that other causes, such as adoption of a comprehensive array of control strategies and mobile fleet turnover, among others, are likely more important factors in the continuing decline in ozone.

Background

Observers of air quality in the HGB eight-county (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller) ozone nonattainment area, referred to as the HGB area, have noted that the recent United States recession, which began in late 2007, could have contributed to lower ozone concentrations in the HGB area by reducing economic activity and, therefore, emissions. Following this reasoning, attainment of the 1997 eight-hour ozone NAAQS over the 2007 through 2009 period in the HGB area could have been a result of the recession, and, therefore, may be unlikely to persist as the regional economy rebounds.

The TCEQ has investigated these claims and finds that this viewpoint is not supported by empirical evidence, as discussed below. The TCEQ maintains that it is possible, even likely, that the HGB area will continue to attain the 1997 ozone NAAQS as the economy in the region recovers from the 2009 slowdown. Using published economic and ozone data, this attachment demonstrates two results regarding ozone and the economy. First, because the HGB area did not experience a reduction in economic activity until late 2008, ozone reductions observed in 2007 through 2008 could not have been influenced by economic contraction and were observed during a period of robust economic expansion in the region. Second, the HGB area has consistently reduced ozone concentrations during two consecutive decades of economic growth. This attachment presents evidence ozone concentrations have declined during the past two decades during increasing economic activity in the region. This result suggests that other factors, such as increasingly stringent emissions standards, programs directed at reducing mobile source emissions, turnover in mobile fleets, and changes in industrial processes, among other factors, may all have played larger roles than the economy in ozone formation.

Certainly, economic activity can have an impact on ozone concentrations. For this reason, metropolitan areas generally generate elevated ozone events rather than sparsely populated rural areas. Further, larger metropolitan areas tend to observe higher ozone design values than smaller metropolitan areas. However, reducing ozone concentrations in the presence of continuing economic growth through the development of state implementation plans and implementing control strategies for emission reduction is possible. Expansion of emitting activities during phases of economic growth certainly makes the task of attaining clean air standards more challenging, but it should not prevent, and has not prevented, the HGB area, among many others, from making substantial progress in improving air quality.

Economic Trends in Texas and the HGB Area

Though the national economy entered a recession beginning in the fourth quarter of 2007, both Texas and the HGB area continued to experience robust economic expansion during 2007 and 2008. Figure B-1: *Real (Inflation-Adjusted) Gross Domestic Product of Texas* shows the trend since 1997 in Gross Domestic Product (GDP) in Texas. Figure B-2: *Real (Inflation-Adjusted) Gross Domestic Product of HSB* MSA* shows the trend since 2001 in GDP in the Houston-Sugarland-Baytown (HSB) Metropolitan Statistical Area (MSA), which is the definition of Houston used by the Bureau of Economic Analysis (BEA) of the United States Department of Commerce, the source of this data. The data is available on the BEA Web site at: http://www.bea.gov/regional/gsp/ (for Texas) and http://www.bea.gov/regional/gdpmetro/ (for the HSB MSA). The HSB MSA includes the eight HGB nonattainment counties plus Austin County and San Jacinto County.

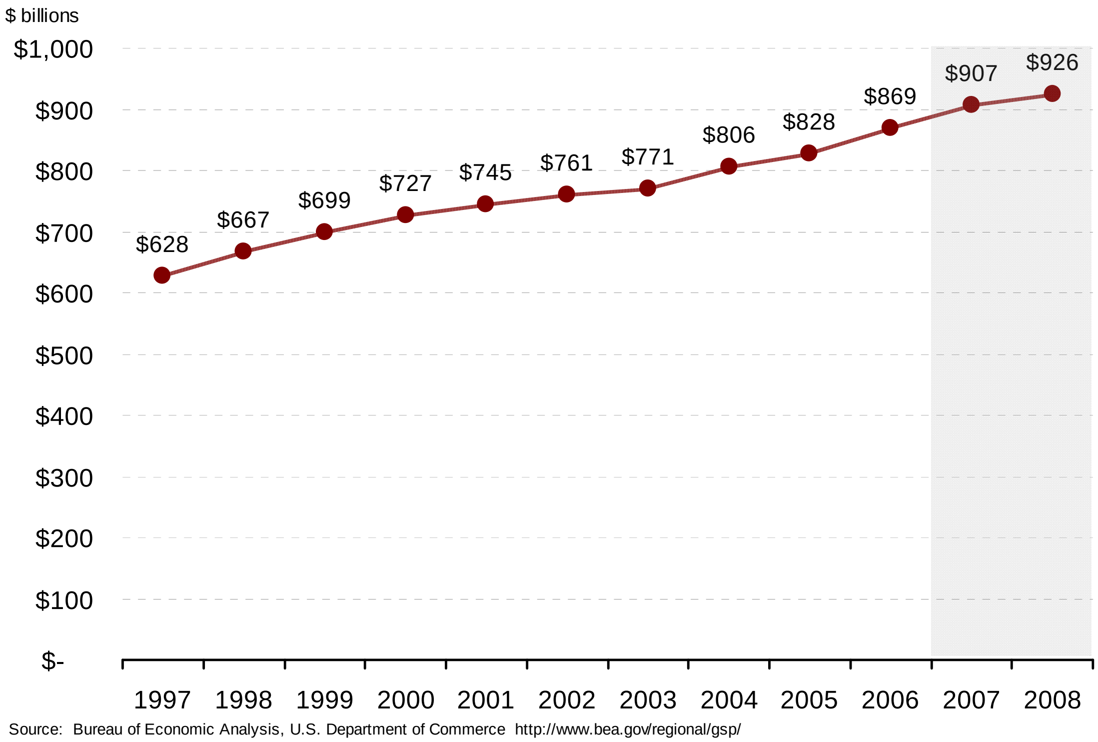


Figure B-1: Real (Inflation-Adjusted) Gross Domestic Product of Texas

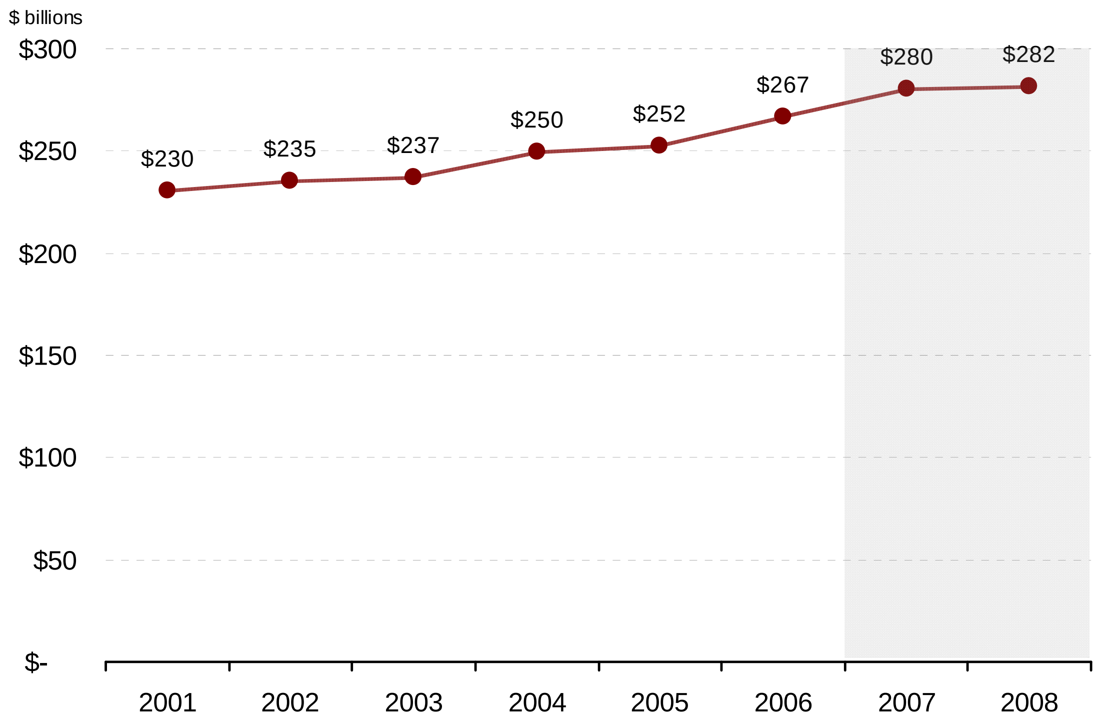


Figure B-2: Real (Inflation-Adjusted) Gross Domestic Product of HSB* MSA

*The United States Department of Commerce defines Houston as the "Houston-Sugarland-Baytown" Metropolitan Statistical Area, which includes the eight-county nonattainment area plus Austin County and San Jacinto County.

Real (inflation-adjusted) GDPs for Texas and the HSB MSA both increased robustly from 2000 through 2009. Texas GDP growth ranged from an annual low of 1.4 percent (2003) to an annual high of 6.2 percent (1998) over the decade (see Table B-1: *Real (Inflation-Adjusted) Gross Domestic Product of Texas and the HSB MSA*), whereas GDP of the HGB area grew even faster in four of the seven years with data for both series. Real GDP growth in both Texas and the HSB MSA, though still positive, began slowing in 2008. BEA GDP data for 2009 is not yet available, but is expected to show a flattening or declining trend, as the effects of the national recession began reaching the state and region.

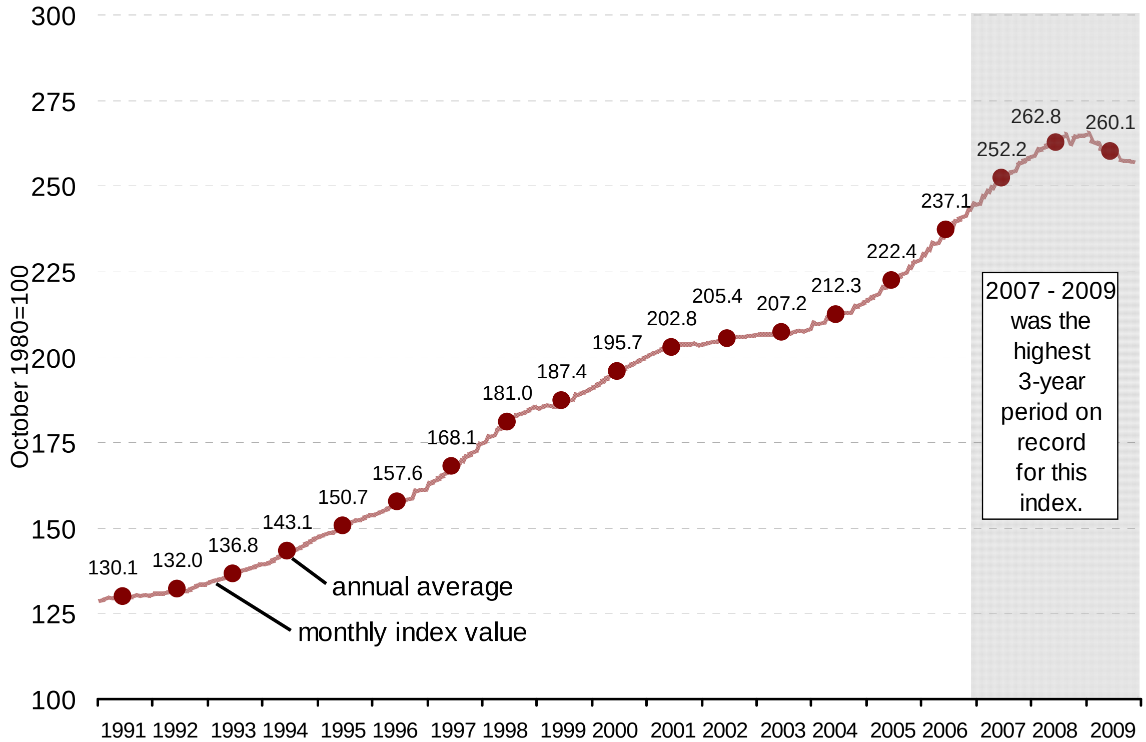
Table B-1: Real (Inflation-Adjusted) Gross Domestic Product of Texas and the HSB* MSA

year	Texas		HSB* MSA	
	*$ million (chained** 2000)*	*year-over year % change*	*$ million (chained** 2000)*	*year-over year % change*
1997	627.5		na	
1998	666.6	6.2	na	
1999	699.1	4.9	na	
2000	727.2	4.0	na	
2001	745.3	2.5	230.4	
2002	760.6	2.0	235.3	2.1
2003	771.0	1.4	237.2	0.8
2004	806.0	4.5	249.8	5.3
2005	828.4	2.8	252.5	1.1
2006	869.4	4.9	266.8	5.7
2007	907.4	4.4	280.2	5.0
2008	925.5	2.0	281.7	0.5

Source: Bureau of Economic Analysis, United States Department of Commerce, http://www.bea.gov/regional/gsp/.
na = not available.
*The United States Department of Commerce defines Houston as the "Houston-Sugarland-Baytown" Metropolitan Statistical Area (MSA), which includes the eight-county ozone nonattainment area plus Austin County and San Jacinto County.
**The "chained-dollar" method is used by the United States Department of Commerce to express inflation-adjusted (real) prices using prices of a basket of goods in each year as the base for computing changes for each successive year, thus minimizing distortions over time. See "Chained-dollar estimate" here: http://www.bea.gov/glossary/glossary.cfm?letter=C.

The Federal Reserve Bank of Dallas provides other indicators of economic activity in the HSB MSA: the monthly and annual Business Cycle Indexes (BCIs) derived from multiple data sources. These indices, available on the Federal Reserve Bank of Dallas Web site at: http://www.dallasfed.org/data/data/metro9.tab.htm, incorporate measures of nonagricultural employment, the unemployment rate, inflation-adjusted wages, and inflation-adjusted retail sales. Figure B-3: *Federal Reserve Bank of Dallas Monthly and Annual Business Cycle Indexes, HSB MSA* shows the nearly two-decade history of these BCIs since 1991. The BCI of the HSB MSA increased steadily throughout the 1990s and 2000s, with a slight slowdown during the recession of 2001 through 2002, and a leveling off in late 2008. By 2009, a downturn is evident in both the monthly and annual BCIs as the national recession began affecting the HSB MSA.

Even though the BCIs began to decline in 2009, it is noteworthy that during the three-year period of 2007, 2008, and 2009 (through November), the HSB MSA generated greater economic activity than in any previous three-year period on record. That is, even though the 2009 index value is less than 2008, it is still higher than 2007, 2006, or any previous year, indicating greater economic activity in the HSB MSA occurred during 2009 than those earlier years. Similarly, both 2007 and 2008 are higher than any previous year. Despite this high level of economic activity, the HGB area continued to exhibit reductions in both precursor emissions and resultant ozone over the 2007 through 2009 period.



Source: Federal Reserve Bank of Dallas, http://dallasfed.org/data/data/metro9.tab.htm

Figure B-3: Federal Reserve Bank of Dallas Monthly and Annual Business Cycle Indexes, HSB* MSA

*The United States Department of Commerce defines Houston as the "Houston-Sugarland-Baytown" Metropolitan Statistical Area (MSA), which includes the eight-county ozone nonattainment area plus Austin County and San Jacinto County.

Table B-2: *Maximum Annual One-Hour and Eight-Hour Ozone Design Values in the HGB Area and the Annual Average Federal Reserve Bank of Dallas Annual Business Cycle Index for the HSB MSA* presents the annual Federal Reserve Bank of Dallas BCI for the HSB MSA alongside the eight-hour ozone design values for the HGB area. While the annual BCI increased consistently over the past two decades through 2008, ozone concentrations, as measured by the eight-hour design value, mostly dropped.

Table B-2: Maximum Annual One-Hour and Eight-Hour Ozone Design Values in the HGB Area and the Annual Average Federal Reserve Bank of Dallas Annual Business Cycle Index[*] for the HSB[**] MSA

	Maximum HGB Ozone Design Value		HSB[**] Federal Reserve Bank of Dallas Business Cycle Index[*]	
	8-hour Design Value	Change	annual average	year-over-year change
	ppm	*%*	*index*	*%*
1991	119		130.1	
1992	116	-2.5	132.0	1.5
1993	104	-10.3	136.8	3.6
1994	110	5.8	143.1	4.6
1995	114	3.6	150.7	5.3
1996	116	1.8	157.6	4.6
1997	117	0.9	168.1	6.7
1998	116	-0.9	181.0	7.6
1999	118	1.7	187.4	3.5
2000	112	-5.1	195.7	4.5
2001	110	-1.8	202.8	3.6
2002	107	-2.7	205.4	1.3
2003	102	-4.7	207.2	0.9
2004	101	-1.0	212.3	2.5
2005	103	2.0	222.4	4.7
2006	103	0.0	237.1	6.6
2007	96	-6.8	252.2	6.4
2008	91	-5.2	262.8	4.2
2009[***]	84	-7.7	260.1	-1.0

Sources: Texas Commission on Environmental Quality (www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/pd/020/10-02/hgb-alt-text) and Federal Reserve Bank of Dallas (dallasfed.org/data/data/metro9.tab.htm).
[*]October 1980 = 100.
[**]The United States Department of Commerce defines the HGB area as the "Houston-Sugarland-Baytown" Metropolitan Statistical Area (MSA), which includes the eight-county ozone non-attainment area plus Austin County and San Jacinto County.
[***]Through November 2009.

Figure B-4: *Total Employment in the HSB MSA* displays annual average employment in the HSB MSA published by the Bureau of Labor Statistics of the United States Department of Labor. This series, available on the BEA Web site at: www.bea.gov/regional/REMDchart/default.cfm?account=REMD, traces roughly the same trend as the previous charts, with a peak in late 2008 followed by a downward trend into 2009. Employment tends to increase and decrease roughly in tandem with the economy, as firms acquire labor during expansionary phases and shed labor during recessionary ones.

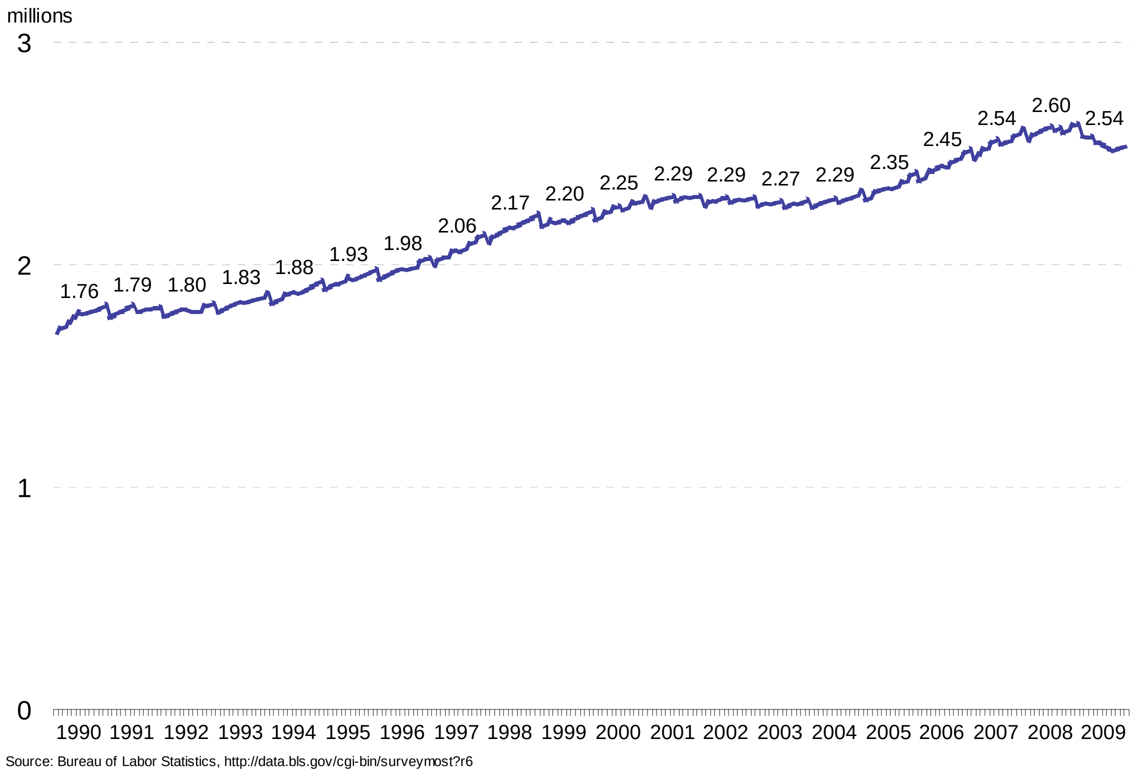


Figure B-4: Total Employment in the HSB* MSA

*The United States Department of Commerce defines Houston as the "Houston-Sugarland-Baytown" Metropolitan Statistical Area (MSA), which includes the eight-county ozone nonattainment area plus Austin County and San Jacinto County.

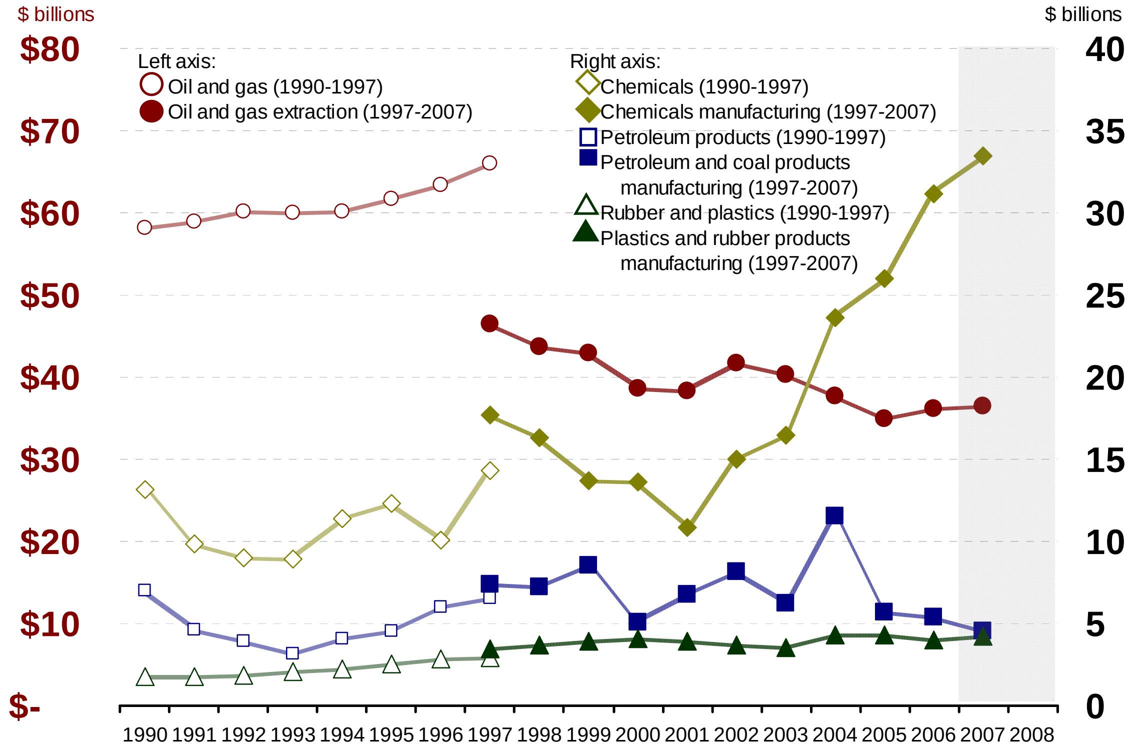
Economic Trends in the Petrochemical Industry

While the overall economies of Texas and the HGB area were not impacted by the economic downturn until late 2008, industries linked to petrochemicals and refining, which together compose one large contributor to HGB area air quality, also failed to exhibit a downward trend. BEA sub-industry production data for 2008 and 2009 are not yet available. However, it is possible to glean trends from data available through 2007, as well as weekly petroleum usage and capacity utilization figures reported by the Energy Information Administration (EIA) of the United States Department of Energy. Table B-3: *Real (Inflation-Adjusted) Gross Domestic Product of Texas Petrochemical Related Sub-Industries* shows the real (inflation-adjusted) gross domestic product of several oil- and gas-related manufacturing sub-industries. Three of the four sub-industries increased from 2006 to 2007, with only one, petroleum and coal products manufacturing, decreasing in real terms. This one sub-industry, however, represents only 5.7 percent of the total value of output of these four sub-industries. Figure B-5: *Real (Inflation-Adjusted) Gross Domestic Product of Key Petroleum-Related Industries in Texas* displays the data in the table graphically.

Table B-3: Real (Inflation-Adjusted) Gross Domestic Product of Texas Petrochemical-Related Sub-Industries

	Chemicals	Chemicals manufacturing	year-over-year change	Oil and gas	Oil and gas extraction	year-over-year change	Petroleum products	Petroleum and coal products manufacturing	year-over-year change	Rubber and plastics	Plastics and rubber products manufacturing	year-over-year change
SIC Code	52280			30130			52290			52300		
NAICS Code		32			7			31			33	
	$ mill.	*$ mill.*	*%*	*$ mill.*	*$ mill.*	*%*	*$ mill.*	*$ mill.*	*%*	*$ mill.*	*$ mill.*	*%*
1990	13.1			58.1			7.0			1.8		
1991	9.9		-24.9	58.9		1.5	4.6		-33.4	1.8		0.1
1992	9.0		-8.8	60.1		2.0	4.0		-14.8	1.8		1.1
1993	9.0		-0.3	60.0		-0.1	3.1		-21.3	2.1		16.0
1994	11.4		27.4	60.2		0.2	4.1		31.0	2.3		6.5
1995	12.3		7.5	61.7		2.5	4.6		11.7	2.5		13.1
1996	10.0		-18.2	63.4		2.8	6.0		31.7	2.8		11.3
1997	14.3	17.7	42.6	66.0	46.4	4.1	6.5	7.4	8.3	2.9	3.5	1.9
1998		16.3	-7.8		43.8	-5.7		7.2	-2.6		3.7	6.6
1999		13.7	-16.1		43.0	-1.8		8.5	18.3		3.9	6.4
2000		13.6	-0.9		38.7	-10.0		5.0	-40.9		4.1	3.8
2001		10.9	-20.0		38.3	-1.0		6.8	34.3		3.9	-3.4
2002		15.0	38.2		41.7	9.0		8.2	20.7		3.7	-6.5
2003		16.5	9.6		40.4	-3.3		6.3	-23.6		3.6	-2.7
2004		23.6	43.2		37.7	-6.6		11.6	84.9		4.3	20.1
2005		26.0	10.2		34.9	-7.4		5.7	-50.9		4.3	0.2
2006		31.2	19.9		36.1	3.3		5.4	-5.3		4.0	-6.9
2007		33.5	7.5		36.5	1.1		4.5	-15.4		4.2	5.1

Source: Bureau of Economic Analysis, United States Department of Commerce, http://www.bea.gov/regional/index.htm#gsp.
Note: Discontinuities in these series occurred in 1997 when the Bureau of Economic Analysis, United States Department of Commerce, revised industry definitions from SIC codes to NAICS codes. "Chemicals" (SIC code 52280) became "Chemicals manufacturing" (NAICS code 32); "Oil and gas" (SIC code 30130) became "Oil and gas extraction" (NAICS code 7); "Petroleum products" (SIC code 52290) became "Petroleum and coal products manufacturing" (NAICS code 31); and "Rubber and plastics" (SIC code 52300) became "Plastics and rubber products manufacturing" (NAICS code 33). Data for the year 1997 was computed using both methods to provide an overlap in the two series for continuity.
SIC = Standard Industrial Classification.
NAICS = North American Industrial Classification System.



Source: Bureau of Economic Analysis, U.S. Department of Commerce http://www.bea.gov/regional/gsp/

Figure B-5: Real (Inflation-Adjusted) Gross Domestic Product of Key Petroleum-Related Industries in Texas

Note: Discontinuities in these series occurred in 1997 when the Bureau of Economic Analysis, United States Department of Commerce, revised industry definitions from SIC codes to NAICS codes. "Chemicals" (SIC code 52280) became "Chemicals manufacturing" (NAICS code 32); "Oil and gas" (SIC code 30130) became "Oil and gas extraction" (NAICS code 7); "Petroleum products" (SIC code 52290) became "Petroleum and coal products manufacturing" (NAICS code 31); and "Rubber and plastics" (SIC code 52300) became "Plastics and rubber products manufacturing" (NAICS code 33). Data for the year 1997 was computed using both methods to provide an overlap in the two series for continuity.
SIC = Standard Industrial Classification.
NAICS = North American Industrial Classification System.

Inputs to refineries presented in Table B-4: *Annual Average of Weekly Average Crude Oil Inputs to Refineries (PADD 3)* corroborate these findings from the petroleum refining industry. According to data from the EIA, crude oil inputs to refineries in Petroleum Administration for Defense District (PADD) 3, which includes Texas, have been declining, on average, since peaking the week of July 1, 2005, at just over eight million barrels. PADD 3 consists of Alabama, Arkansas, Louisiana, Mississippi, New Mexico, and Texas. Since 2005, PADD 3 inputs to refineries have generally dropped, at a rate of about -0.8 percent per year, even when hurricane-affected periods in 2005 (Katrina and Rita—11 weeks) and 2008 (Ike—six weeks) are excluded.

Table B-4: Annual Average of Weekly Average Crude Oil Inputs to Refineries (PADD 3)

	All weeks		Excluding hurricanes*	
	thous. bbl./day	*% change*	*thous. bbl./day*	*% change*
2000	7,154		7,154	
2001	7,307	2.1	7,307	2.1
2002	7,095	-2.9	7,095	-2.9
2003	7,284	2.7	7,284	2.7
2004	7,371	1.2	7,371	1.2
2005	7,044	-4.4	7,407	0.5
2006	7,250	2.9	7,250	-2.1
2007	7,352	1.4	7,352	1.4
2008	6,910	-6.0	7,131	-3.0
2009	7,090	2.6	7,090	-0.6

Source: Energy Information Administration, United States Department of Energy.
*Excluded weeks include weeks from the date of landfall of Hurricanes Katrina, Rita, and Ike through the week inputs resumed the minimum level observed in previous years.

Weekly averages of daily inputs to refineries (grey points) are highly variable, as evident from Figure B-6: *Weekly Crude Oil Inputs to Refineries (PADD 3)*. A 13-week (quarterly) moving average (dark blue points) smooths some of this variability. A quadratic fit (medium blue line) reveals a very slight long-term downward trend beginning around 2004. The moving average reveals seasonal cycles as refineries ramp up production for periods of high-product demand. Although inputs to refineries appear to be on a slight downward trend since 2007, they have actually been increasing since early 2009, though this is likely a cyclical phenomenon. Neither high nor low values of the quarterly average since 2007 have strayed beyond the highest or lowest values observed over the previous decade, suggesting the industry as a whole has neither grown nor shrunk markedly.

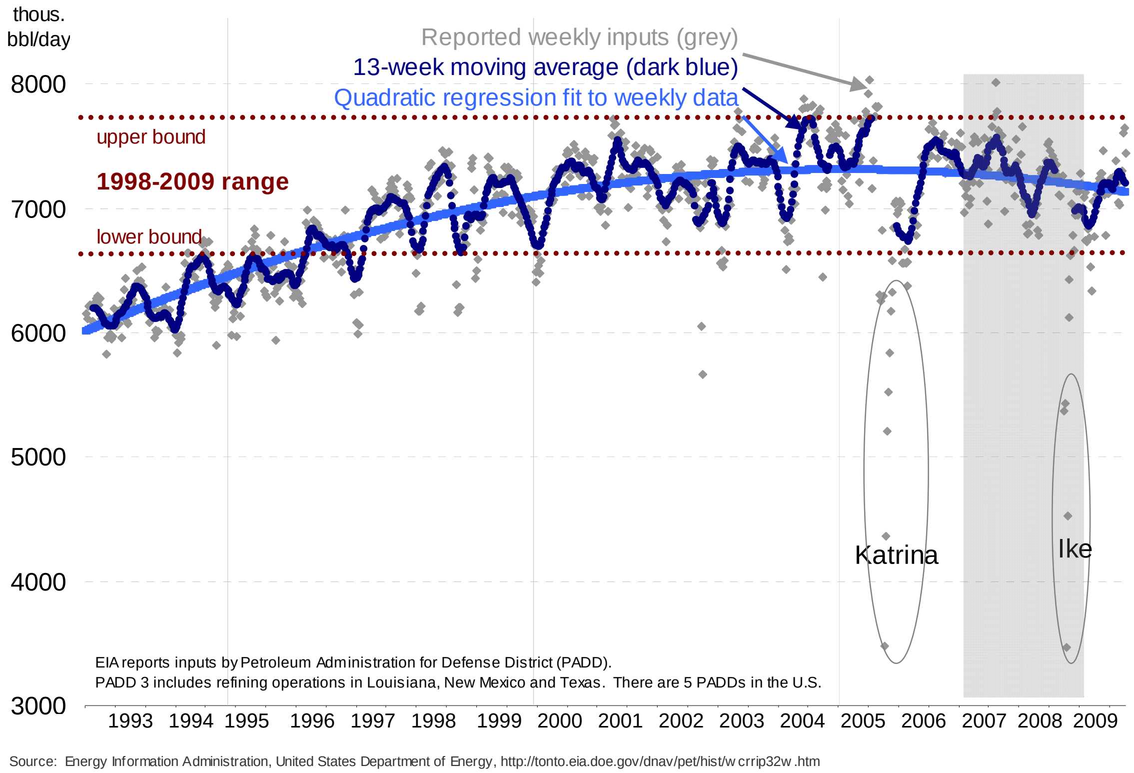


Figure B-6: Weekly Crude Oil Inputs to Refineries (PADD 3)

Table B-5: *Annual Average of Weekly United States Percent Utilization of Refinery Operable Capacity* reports the annual average of weekly United States percent utilization of refinery operable capacity, also from the EIA, which corroborates findings for inputs to refineries in PADD 3. Annual average capacity utilization has decreased each year since 2004. Since 1991, peak capacity utilization occurred in 1995 at 95.3 percent. Since that peak, it has declined 11.3 percentage points, to 84.0 percent in 2009. This is a drop of 11.9 percent or about 1.2 percent per year.

Table B-5: Annual Average of Weekly United States Percent Utilization of Refinery Operable Capacity

	capacity utilization rate	year-over year change
	%	*%*
1991	85.6	
1992	86.9	1.5
1993	91.2	4.9
1994	92.7	1.7
1995	92.4	-0.3
1996	93.5	1.2
1997	95.1	1.7
1998	95.3	0.2
1999	92.9	-2.4
2000	92.3	-0.6
2001	92.2	-0.2
2002	89.9	-2.5
2003	91.8	2.1
2004	92.3	0.5
2005	90.4	-2.1
2006	89.4	-1.1
2007	88.7	-0.7
2008	84.9	-4.3
2009	84.0	-1.1

Source: Energy Information Administration, United States Department of Energy.

Weekly capacity utilization rates, plotted in Figure B-7: *Weekly United States Percent Utilization of Refinery Operable Capacity*, are also highly variable. A quadratic fit reveals a clear long-term downward trend, beginning in 1998, when it peaked at 100.5 percent the week of August 28. Since then, despite considerable seasonal variation, it has fallen to about 84 percent, on average. A quadratic regression fit shows a downward trend since about 1999. The decade-long duration of this downward trend corroborates the earlier conclusion that the refining industry may be experiencing phenomena unrelated to the national recession that began in 2007. The recession, though severe in many areas of the country, is not apparent in the refining industry data and is likely not the primary determinant of PADD 3 activity.

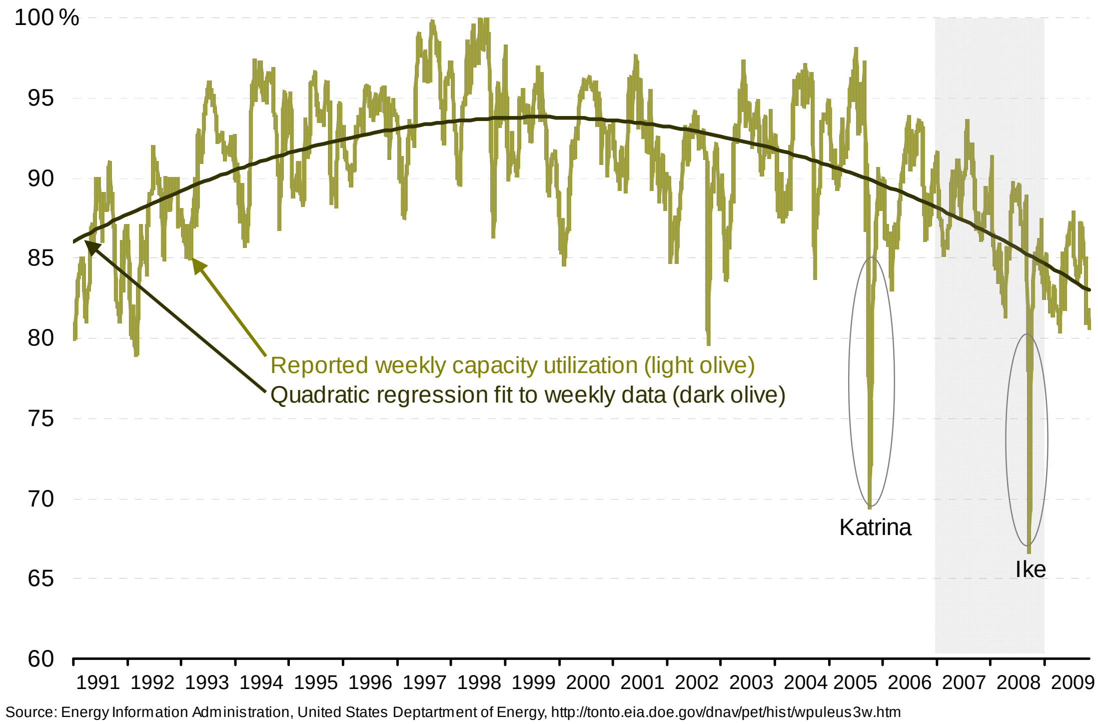
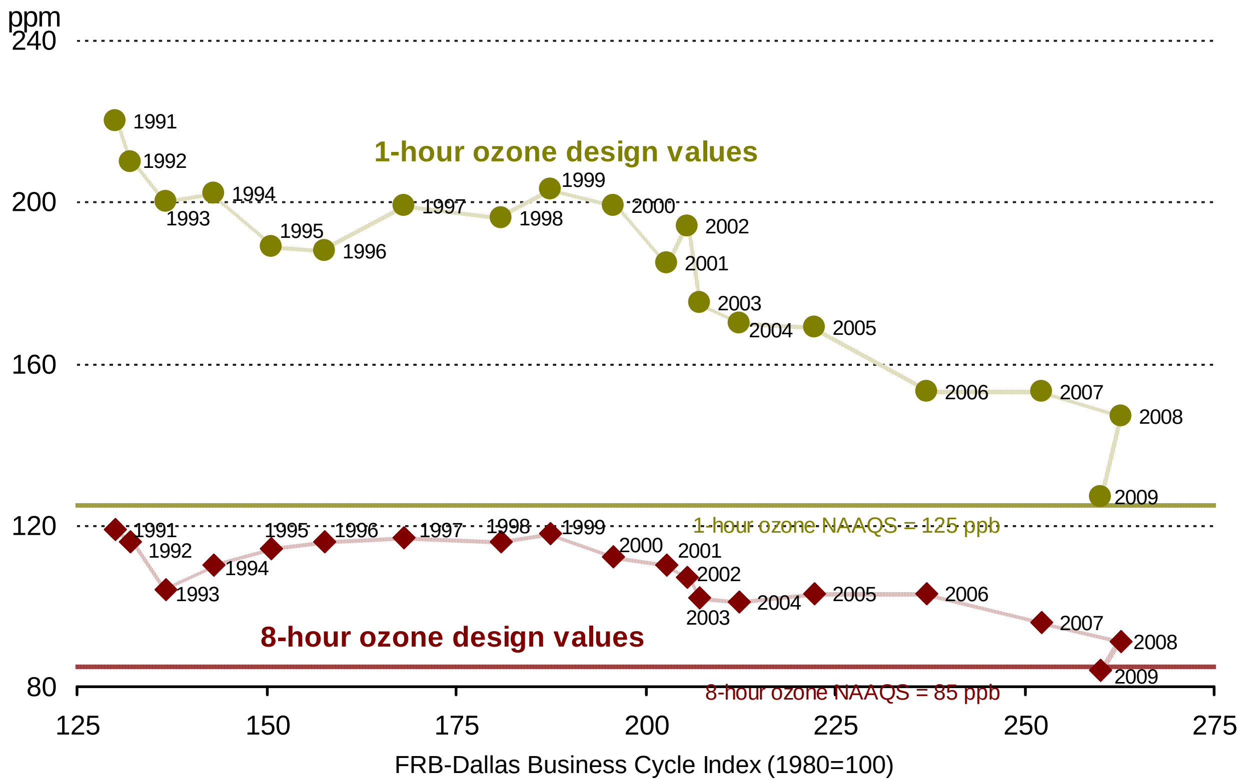


Figure B-7: Weekly United States Percent Utilization of Refinery Operable Capacity

The Missing Link Between Economic Activity and Ozone in the HGB Area
Figure B-8: *Eight-Hour and One-Hour Ozone Design Values and the Federal Reserve Bank of Dallas Business Cycle Index* explores the relationship between economic factors and the economy directly by plotting the eight-hour and one-hour ozone design values for the HGB area against the Federal Reserve Bank of Dallas annual BCI, since 1991. Downward trends in the two ozone design values correlate with increasing economic activity. This information clearly demonstrates that the decrease in ozone design values is not due to or correlated with decreased economic activity. The experience of the HGB area over the preceding two decades supports this conclusion.



Sources: Texas Commission on Environmental Quality (www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/pd/020/10-02/hgb-alt-text) and Federal Reserve Bank of Dallas (dallasfed.org/data/data/metro9.tab.htm)

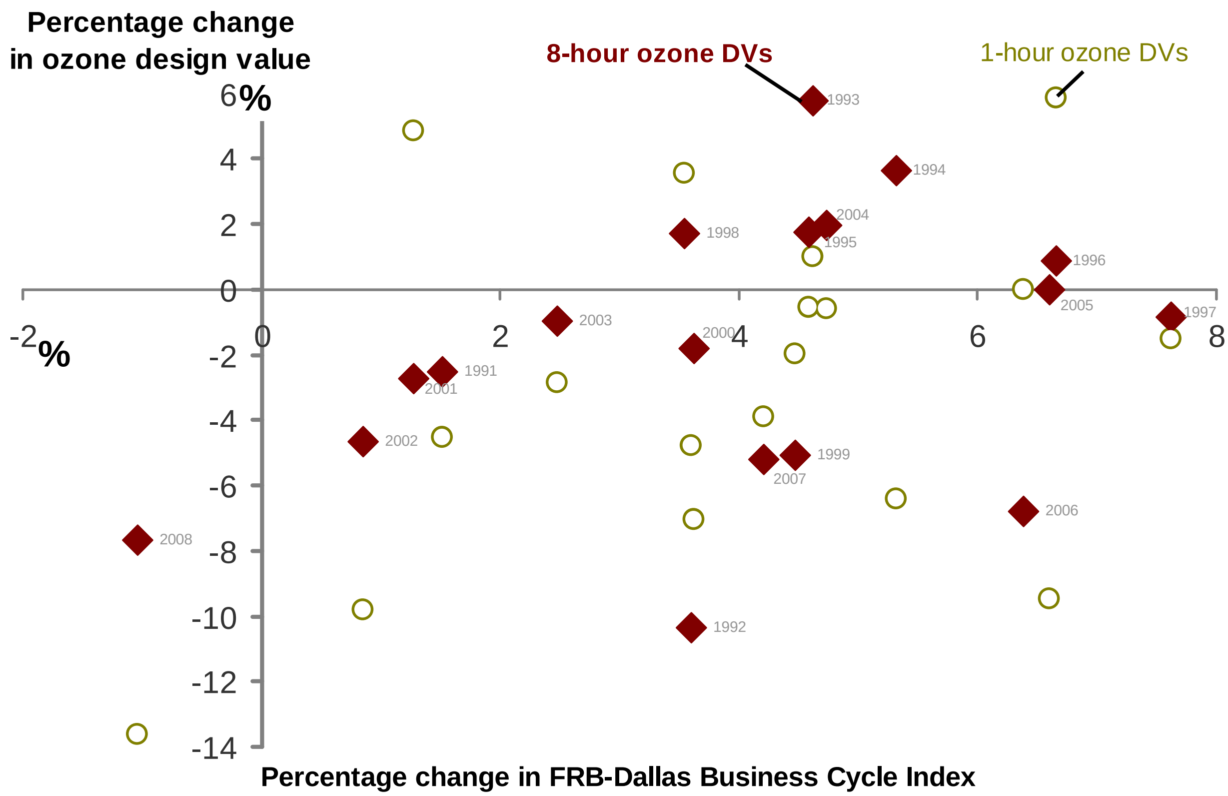
Figure B-8: Eight-Hour and One-Hour Ozone Design Values and the Federal Reserve Bank of Dallas Business Cycle Index

While the relationships plotted in Figure B-8: *Eight-Hour and One-Hour Ozone Design Values and the Federal Reserve Bank of Dallas Business Cycle Index* are generally downward sloping, they omit many important explanatory variables. Among these are additional emission controls, changing automobile fleets, and changing industrial processes, all of which contribute to reduced emissions of ozone precursors. Millions of people and thousands of businesses and organizations continually repair or replace older, more polluting vehicles and equipment with less polluting ones, and participate in programs to reconfigure and redesign their daily activities to reduce pollution. Many of these efforts are the result of local and state control strategies. Local strategies include voluntary mobile source emission reduction programs, such as alternative commuting, regional traffic flow improvements, and various non-road emission reduction measures as well as transportation control measures. State strategies for on-road and non-road sources include the AirCheck Texas Drive A Clean Machine (DACM) Program, the Texas Emissions Reduction Program (TERP), and the Clean School Bus Program. The DACM Program expended $41,728,831.55 to repair 4,527 vehicles and replace 13,083 vehicles from December 12, 2007, through November 30, 2009. To date the TERP program has awarded over $323 million for projects in the HGB area since 2001, which will help reduce more than 70,000 tons of NO_X emissions, with an estimated 30 tons per day NO_X emissions reduction during 2009.

The TCEQ has also implemented a wide range of stringent NO_X and VOC emission control measures for stationary, on-road, and non-road sources that are included in the SIP for the HGB area. For example, the Mass Emissions Cap and Trade (MECT) Program is key control measure that has resulted in substantial reductions in NO_X emissions from hundreds of sites in the HGB area. Additional information concerning SIP control measures implemented in the HGB area is contained in Attachment E: *Control Measures*.

Further, extensive photochemical modeling has established the primacy of meteorology in predicting ozone formation, accumulation, transport and fate. Excluding these factors in efforts to forecast future ozone design values is likely to generate inaccurate estimates.

Figure B-9: *Annual Percentage Changes in Eight-Hour and One-Hour Ozone Design Values Versus Annual Percentage Change in the Federal Reserve Bank of Dallas Business Cycle Index* provides a different perspective on the correlation between ozone design values and the economy. This figure plots the annual percentage changes in the eight-hour and one-hour ozone design values against annual percentage changes in the annual Federal Reserve Bank of Dallas BCI. If economic growth was correlated with increases in ozone design values, this figure would reveal a clear trend sloping from the lower left to the upper right, with positive changes in the BCI corresponding to positive changes in design values and negative to negative. While there is a detectible upward slope, the correlation is so weak that simple linear regressions, reported in Table B-6: *Selected Results from Linear Regression of Ozone Design Values on the Federal Reserve Bank of Dallas Business Cycle Index*, generate fairly poor parameter estimates: correlation coefficients (adjusted R^2) of 0.088 for the eight-hour model and 0.095 for the one-hour model, and t-statistics of 1.63 (p-value=0.12) for the eight-hour model and 1.67 (p-value=0.11) for the one-hour model. Possible values for the correlation coefficient range from zero to one and indicate the proportion of the scatter in the data that is accounted for by the linear model. These very low R^2 values indicate that there is a high degree of scatter, or variability, and these models, or estimated slopes, do a poor job of accounting for that variability. Further, t-statistics below about 1.96 generally indicate slopes that cannot be differentiated from zero with statistical confidence, i.e., no correlation is statistically detectible. That both of these models report t-statistics on the slope parameters (BCI) below 1.96 indicates an unacceptably low level of confidence in these correlations. That is, the Federal Reserve Bank of Dallas BCI alone is a poor predictor of both the eight-hour ozone design value and the one-hour ozone design value. This statistical analysis provides evidence that the performance of the economy in the HGB area and ozone design values are not well correlated.



Sources: Texas Commission on Environmental Quality (www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/pd/020/10-02/hgb-alt-text) and Federal Reserve Bank of Dallas (dallasfed.org/data/data/metro9.tab.htm)

Figure B-9: Annual Percentage Changes in Eight-Hour and One-Hour Ozone Design Values Versus Annual Percentage Change in the Federal Reserve Bank of Dallas Business Cycle Index

Table B-6: Selected Results from Linear* Regression of Ozone Design Values on the Federal Reserve Bank of Dallas Business Cycle Index

	8-hour model	1-hour model
Intercept	-0.05	-0.06
t statistic	-2.36**	-2.66**
Business Cycle Index	0.70	0.88
t statistic	1.63	1.67
F statistic	2.65	2.78
p-value	0.12	0.11
Adjusted R^2	0.088	0.095

*Ordinary least squares.

** Statistically significant at the p=0.05 level.

From Figure B-9: *Annual Percentage Changes in Eight-Hour and One-Hour Ozone Design Values Versus Annual Percentage Change in the Federal Reserve Bank of Dallas Business Cycle Index,* it is clear that both economic expansion and decreasing ozone design values were seen in the majority of the past 18 years. In only three of 17 years (1994, 1997, and 1999) when the economy grew did both design values increase, while in eight of those years, when the economy grew, both ozone design values fell. The only year that saw both decreasing economic activity and decreasing ozone design values was 2009.

Complicating this analysis is the further observation that in four years (1995, 1996, 2002, and 2005), while the economy of the HSB MSA expanded, one ozone design value decreased, while the other increased.

Conclusion

Despite a decline in economic activity in 2009, the HGB area exhibited the highest economic activity of any three-year period on record during the 2007 through 2009 time period. Therefore, attainment of the 1997 eight-hour ozone NAAQS in 2009, which includes ozone measurements from 2007 through 2008, could not have been due to a reduction in economic activity in those years. Further, future attainment of the ozone standard is unlikely to be derailed by a return to economic growth.

The petrochemical industry, an important factor in air quality in the region, has exhibited long-term declining trends in inputs to refineries and capacity utilization. These trends began long before 2007 and are likely the result of larger scale factors in the industry. Increases in the value of production in the industry may be due to concomitant increases in prices of crude oil and refined products. While the impacts of these phenomena on air quality in the HGB area are unclear, there is no evidence that ozone and precursor emissions could have been impacted by economic factors as early as 2007 or 2008.

Over at least the past two decades, as the economy of the HGB area has grown, ozone concentrations have declined. Ozone concentrations in the region have fallen even during periods of robust economic expansion, including 1997, 2005, and 2006, when the region saw economic growth in excess of 6 percent per year. This finding suggests that ozone in the HGB area is, at most, only weakly related to economic activity. Therefore, it is reasonable to conclude that as the HGB area recovers from the recession that began in late 2008, and as control strategies continue to be adopted and expanded, the area is likely to continue to attain the 1997 ozone NAAQS.

ATTACHMENT C: METEOROLOGICAL ANALYSIS

Summary
Meteorological factors have played a small role in the recently observed ozone trends, but those factors do not appear to be the primary reason for decreasing ozone. Analyses show that ozone trends are still decreasing in the Houston-Galveston-Brazoria ozone nonattainment area (HGB area), even when accounting for the effects of meteorology. The HGB area includes Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties.

Four extensive analyses of meteorological conditions indicate meteorological factors cannot explain the recent decrease in ozone. In addition, an analysis of the frequency of wind speed and direction will show that higher winds observed in 2008 and 2009 occurred at a time of year when high ozone usually does not occur because of the direction of the wind flow at that time of year. It will also show that the wind conditions were more suitable for high ozone formation in August and September of 2008 and 2009 than in 2000 and 2004, but the number of ozone exceedance days was far lower in 2008 and 2009. An additional analysis of Hurricane Ike in 2008 shows that ozone design values would only increase by 1 part per billion (ppb) if Hurricane Ike had not occurred.

Background
Meteorological Adjustment of Ozone Trends
Ozone formation is dependent not only on its precursors, nitrogen oxides (NO_X) and volatile organic compounds (VOC), but also on meteorological variables. Although trends in ozone design values have been decreasing, examining those trends will determine if the values are decreasing due to effective emission control strategies or if they are decreasing simply due to meteorological conditions in the area over the past several years. An analysis from the University of Texas at Austin (UT-Austin) uses a generalized linear model to show ozone trends adjusted for meteorology. Those trends show that ozone levels through 2007 are decreasing even with meteorological influences removed from the trends. Much of the work from UT-Austin was based upon a variation of the analysis technique developed by Camalier, Cox, and Dolwick, which is the technique recommended by the United States Environmental Protection Agency (EPA) for removing the influences of meteorology from trend data.

The first step in removing meteorological factors from ozone trends is to identify which meteorological factors are most important to ozone formation. Various correlations and factor analyses were used to identify the most important meteorological variables for ozone formation in the HGB area. Data from the Omnibus Meteorological Database (METDAT), maintained by the EPA, were compared to ozone data obtained from surface monitors in the HGB area. A consistent set of monitors in the HGB area was used to lessen the influence of the number of monitors on observed ozone levels. These monitors are listed in Table C-1: *Area Ozone Monitoring Sites with Long-Term Data*. Most contain a consistent set of data from 1990 to 2007; however, data from monitors that were moved a short distance during the period from 1990 to 2007 were combined with data from monitors in nearby locations, for example, data at Clute (CAMS 11) were combined with data from Lake Jackson (CAMS 1016).

Table C-1: Area Ozone Monitoring Sites with Long-Term Data

AQS Number	Site Name
482011039	Hous.DeerPrk2 C35/139
482011035	Clinton C403/C113/C304
482011034	Houston East C1
482010075	Houston Texas Avenue C411
482010062	Houston Monroe C406
482010051	Houston Croquet C409
482010047	Lang C408
482010046	Houston North Wayside C405
482010029	Northwest Harris Co. C26/A110/C154
482010024	Houston Aldine C8/AF108/X150
480391016	Lake Jackson C1016 (and Clute C11)

Source: Sullivan, 2009.

Figure C-1: *Actual Mean Eight-Hour Ozone Concentrations (Blue Line) and Mean Eight-Hour Predicted Concentrations with the Non-Meteorological Trend Removed (Red Line)*, which was reproduced from Sullivan (2009), displays two time series. The values in blue represent the observed mean daily maximum eight-hour ozone; values in red represent the daily peak ozone based purely on the meteorological variations, with the non-meteorological factors removed. In other words, the statistical model described above has been used to re-create the ozone time series with only the meteorology taken into account. Note that only peak ozone concentrations from May to October of each year were used.

For 2006 and 2007, the statistical model predicts that the observed mean daily peak eight-hour ozone should have been higher than observed, based upon the conduciveness of the meteorology toward ozone formation. In other words, based on the weather, ozone concentrations should have been higher in 2006 and 2007. Subtracting the meteorologically based eight-hour ozone estimates from the actual eight-hour ozone results in a mean daily peak ozone trend with the meteorological effects removed illustrated in Figure C-2: *Residual Meteorologically Adjusted Eight-Hour Ozone Concentrations Trend*, which is reproduced from Sullivan (2009). This trend represents how the sum of anthropogenic factors, model error, and undiagnosed meteorological factors has changed from 1996 to 2007. The meteorologically adjusted ozone trend is clearly downward. Since the meteorological variations have been removed, this downward trend shows the effect of emission reductions in the HGB area. Statistical results of this analysis are listed in Table C-2: *Summary Statistics for Meteorologically Adjusted Ozone Trends from 1996 to 2007*. The slope of -0.86 shows that meteorologically adjusted eight-hour ozone trends in the HGB area are decreasing and that they are significant (p-value = 0.00).

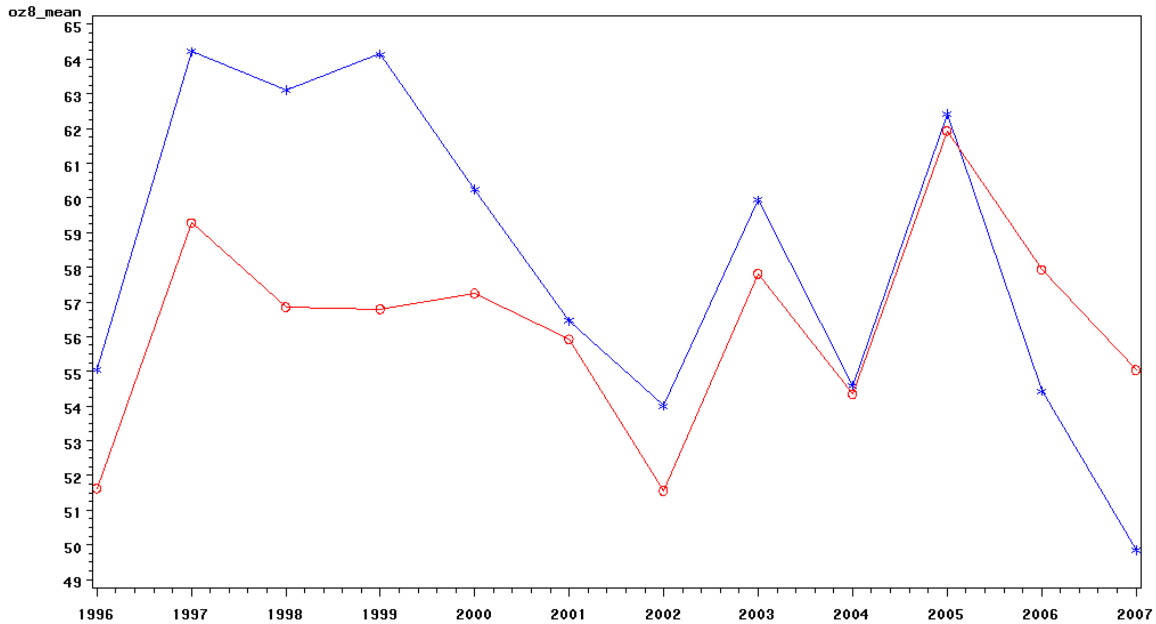


Figure C-1: Actual Mean Eight-Hour Ozone Concentrations (Blue Line) and Mean Eight-Hour Predicted Concentrations with the Non-Meteorological Trend Removed (Red Line)

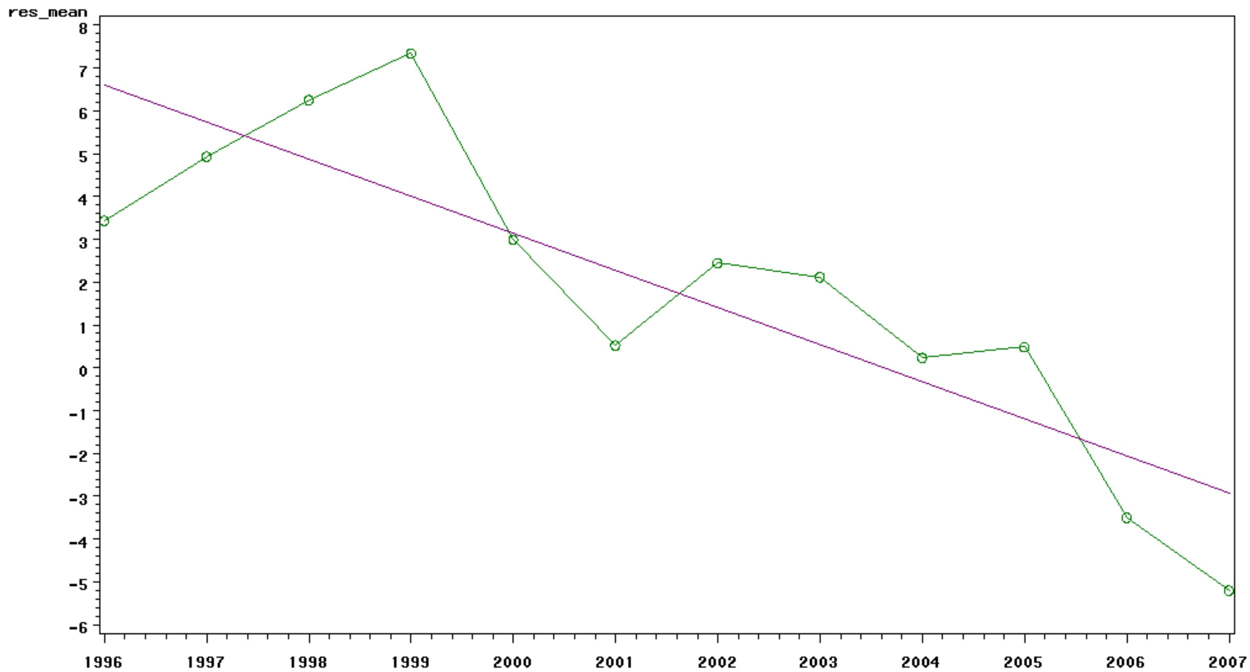


Figure C-2: Residual Meteorologically Adjusted Eight-Hour Ozone Concentrations Trend

Table C-2: Summary Statistics for Meteorologically Adjusted Ozone Trends from 1996 to 2007

Parameter	Value
Intercept	6.438
Slope	-0.86*
t-statistic	-4.20
p-value	0.00
Lag 1 Coefficient	-0.20
t-statistic	-0.63

* Value is statistically significant. (Sullivan et al., 2009)

UT-Austin's analysis shows that when the portion of the ozone variation associated with meteorological factors is removed from the observed ozone trend, the residual trend is still downward. The presence of a strong downward trend after the removal of meteorological effects strongly suggests that the overall downward trend is related to factors other than meteorology. The full analysis from UT-Austin is available on the Texas Commission on Environmental Quality's (TCEQ) Web site at: http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/da/5820586245FY0801-20090316-ut-met_effects_on_pollutant_trends.pdf.

A second analysis of meteorologically adjusted ozone trends can be found on the EPA's Web site at: www.epa.gov/airtrends/weather/region06.pdf. The EPA trends, shown in Figure C-3: *Meteorologically Adjusted Ozone Trends in the HGB Area from 1997 through 2008*, that illustrate the observed seasonal average ozone trend as well as the seasonal average ozone trend adjusted for weather. The ozone trend adjusted for weather represents the expected ozone levels for typical weather conditions. According to the EPA analysis, the downward trend in the HGB area's ozone is unrelated to meteorological variations, beginning in 2002 and continuing through the end of the analysis period in 2008.

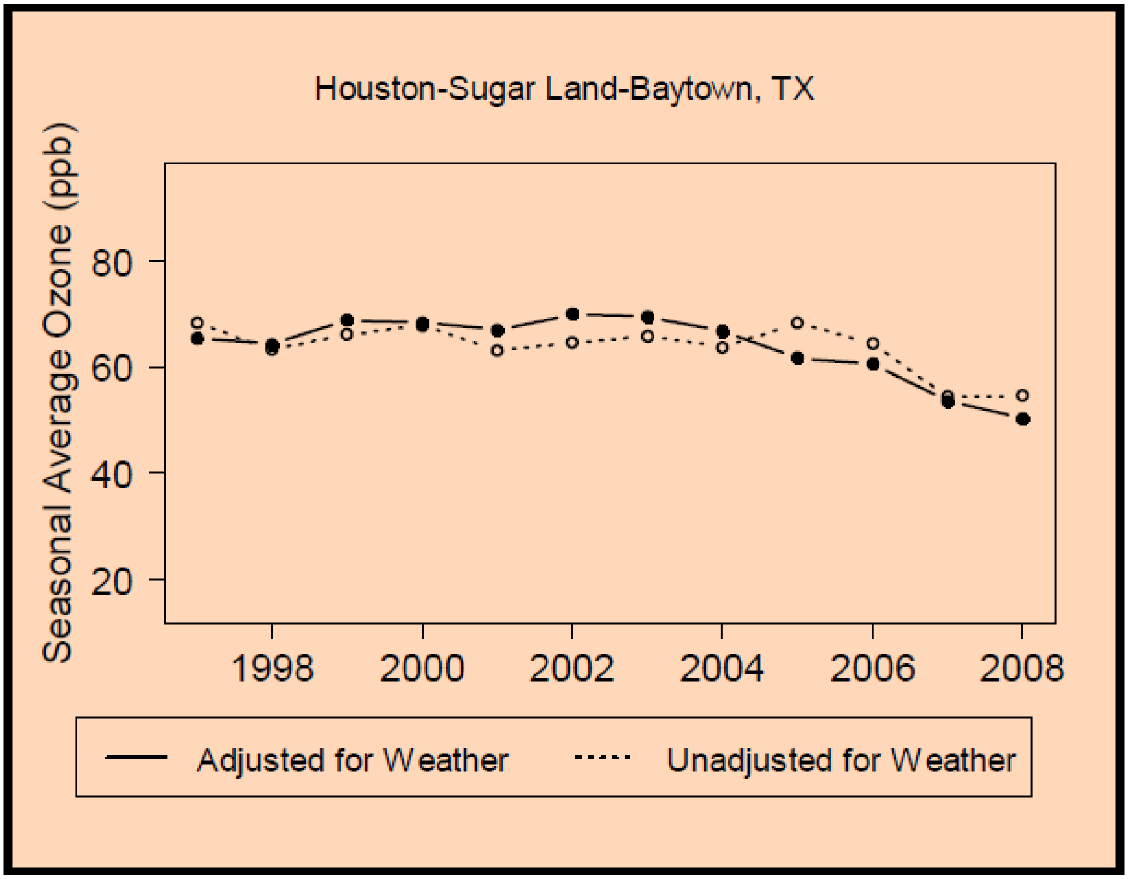


Figure C-3: Meteorologically Adjusted Ozone Trends in the HGB Area from 1997 through 2008 (Source: EPA)

Ozone-Conducive Day Analysis

URS Corporation performed a third analysis that uses the number of ozone-conducive days to examine the effects of meteorology on ozone trends. In the analysis, the author used the Classification and Regression Tree (CART) method, a multivariate statistical analysis technique, to classify ozone season days according to meteorological conditions, and determine whether those conditions are conducive to high ozone in the HGB area. URS Corporation's analysis calculated trends of the number of ozone-conducive days per year. Figure C-4: *Number of Ozone-Conducive Days and Number of Ozone-Conducive Days with Ozone Greater Than 84 ppb* shows that the number of ozone-conducive days in 2007, 2008, and 2009 is similar to or greater than previous years, indicating that the past three ozone seasons have been just as conducive to high ozone formation as previous years. Since 2005, there appear to be more ozone-conducive days than average, but fewer eight-hour ozone exceedance days. Although 2005 had the largest number of ozone-conducive days since 1990, there were fewer exceedance days in 2005 than during previous years with a lower number of ozone-conducive days, such as 1995, 2000, or 2003. A presentation that discusses URS Corporation's analysis can be found at: http://www.tceq.state.tx.us/assets/public/implementation/air/am/committees/pmt_set/20071212/20071212-setpmtc-hgb_ozone_trend.pdf.

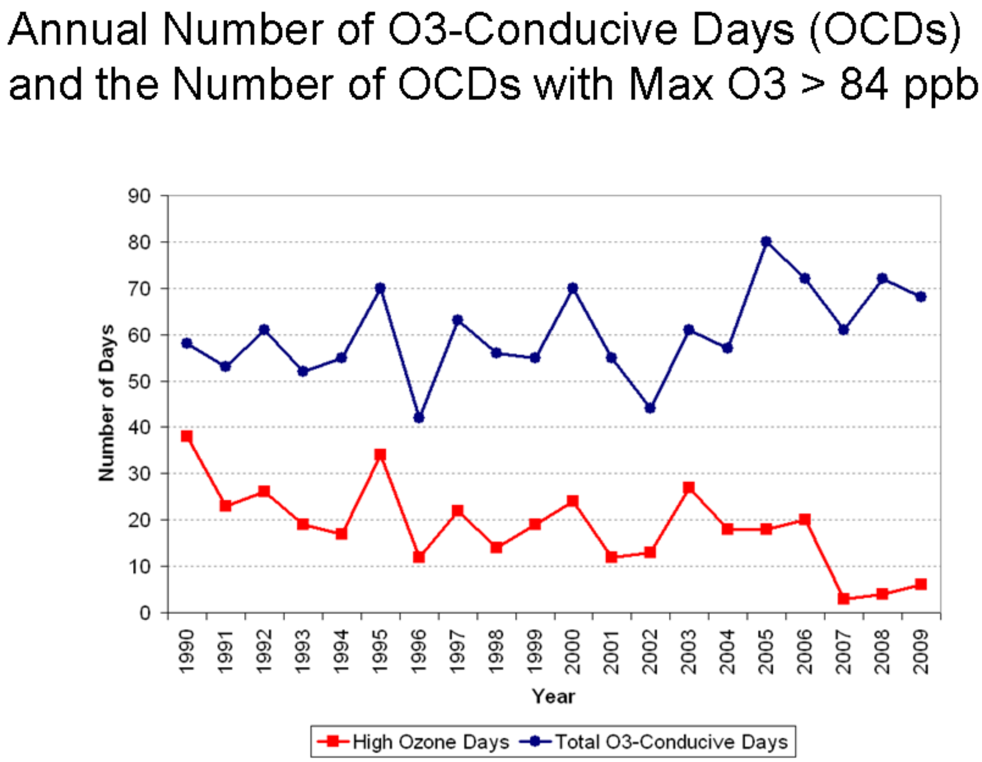


Figure C-4: Number of Ozone-Conducive Days and Number of Ozone-Conducive Days with Ozone Greater Than 84 ppb (Source: URS Corporation)

Forecasted Ozone Day Analysis

A fourth analysis evaluates trends in forecasted high ozone days. A possible surrogate for the number of ozone-conducive days during each ozone season is the number of TCEQ-forecasted eight-hour ozone exceedance days.

Figure C-5: *Forecasted and Actual Eight-Hour Ozone Exceedance Days (1997 National Ambient Air Quality Standard (NAAQS)) in the HGB Area* shows that the number of forecasted eight-hour ozone exceedance days is typically greater than the number of actual eight-hour ozone exceedances to avoid missing potentially high ozone days. To adjust the forecasted eight-hour ozone exceedances to compensate for the bias, a bias-adjusted forecast was developed by accounting for the average rates of false positives (predicted exceedances that did not occur) and false negatives (predicted non-exceedances on days with high ozone). The average percent of false negative days was added to the number of forecasted ozone exceedance days, and the average percent of false positive days was subtracted.

The bias-adjusted forecasted ozone exceedance days approximately match the actual number of eight-hour ozone exceedance days, with the exception of 2004 and 2008. In 2004, the bias-adjusted ozone exceedance forecast was much lower than the actual number of eight-hour ozone exceedance days. However, in 2008, the bias-adjusted forecast of ozone exceedance days was much higher than the actual number of eight-hour ozone exceedance days, indicating decreases due to factors other than meteorology. There are uncertainties in this analysis because meteorologists at the TCEQ adjust their forecast techniques as they learn more about which conditions are most conducive to ozone formation, accumulation, and transport in the HGB area Houston. In other words, the criteria used for developing forecasts in 2000 may have differed somewhat from the criteria used in 2008. The results, however, are consistent with the three previous analyses, in that the peak number of ozone-conducive days in recent years appears to be in 2005, with the number decreasing slightly in 2006 to 2007. The number of forecasted ozone days in 2008 approximately matched the number in 2006, but there were about half as many actual exceedance days in 2008 as in 2006.

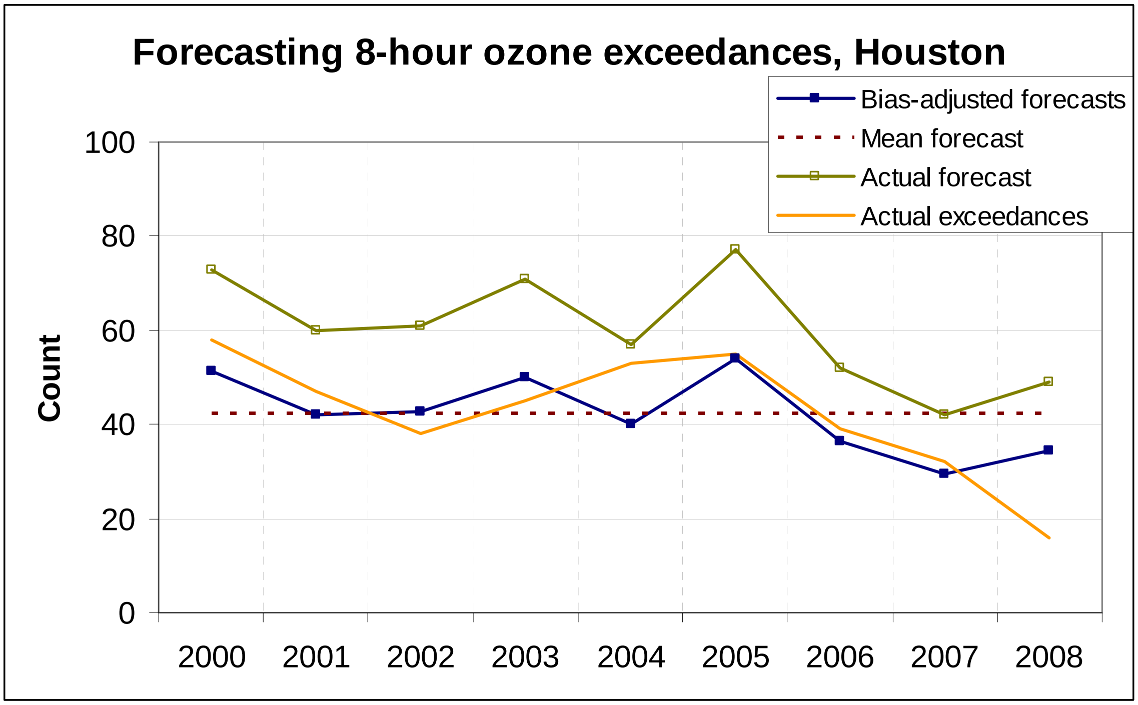


Figure C-5: Forecasted and Actual Eight-Hour Ozone Exceedance Days (1997 National Ambient Air Quality Standard (NAAQS)) in the HGB Area

Wind Speed and Direction Analysis

Analyzing the frequency of wind speeds and directions by month and by year shows recent wind data in detail. The winds in the HGB area were examined for each month of the ozone season from 2000 through 2009 to determine if higher wind speeds in 2008 and 2009 caused decreases in ozone concentrations. Daytime wind speeds were grouped into six levels, and the frequencies of those levels were examined by wind direction for each month from May to September, which represents the peak of the ozone season in the HGB area.

Figure C-6: *Frequency of Morning Wind Direction and Wind Speed by Month in the HGB Area for 2000, 2004, 2008, and 2009* compares years with similar winds and shows the number of eight-hour ozone exceedances that occurred in each month (1997 NAAQS). Winds from 0 to 90 degrees are from the north to east, a direction that typically represents higher background ozone concentrations, as well as winds that can interact with the bay breeze and Gulf breeze to create stagnant conditions (Darby, 2005; Pakalapati et al., 2008; Sullivan, 2009; Ngan and Byun, 2008; Rappenglueck et al., 2008). Winds from 90 to 225 degrees are from the east to southwest and represent cleaner air blowing in from the Gulf of Mexico (Sullivan, 2009; Rappenglueck et al., 2008). East to southwest winds accentuate the bay and Gulf breezes rather than opposing them (Darby, 2005; Banta et al., 2005). Findings from previous studies have indicated that low winds are more favorable for high ozone, whereas high winds are less favorable. Findings also show that northerly winds are more favorable for high ozone in the HGB area, and that southerly winds are less favorable.

The wind analysis found that:

- Wind speeds in May 2000 and May 2004 were higher than those observed in May 2008 and May 2009, but the number of eight-hour ozone exceedance days was higher in 2000 compared to 2008 and 2009. May 2000 and 2004 were less conducive to ozone formation based upon wind speeds but had more exceedances than May 2008 and 2009.
- May 2009 also had more winds from the north to northeast direction, which typically indicates higher background ozone, but had only three exceedance days. May 2009 was more conducive based upon wind direction yet had fewer exceedances than May 2000 or 2004.
- June 2008 and 2009 had higher wind speeds than those observed in June of 2000 and 2004; however, winds in June are mainly out of the south, which brings in clean air from the Gulf of Mexico. There were only three exceedance days in June of 2000, five in June of 2005, and two in both June 2008 and June 2009. For all years, June was dominated by southerly winds, which are not conducive to ozone formation. The low number of exceedances each year reflects how unfavorable southerly winds are to ozone exceedances; therefore, the slightly greater frequency of high winds in June 2008 was unlikely to affect the number of exceedances in that month.
- July winds were very similar in 2000 and 2009, but there were only two exceedance days in July 2009 compared to 10 exceedance days in July 2000.
- Winds in August 2008 were slower than those observed in August 2000, yet August 2008 had one exceedance day compared to 15 in 2000. August 2008 was more conducive to high ozone than August 2000, based upon wind speeds, but had far fewer exceedances.
- September 2009 had slightly lower winds in the northeast direction compared to September 2000 and 2004, but only three exceedance days compared to 10 in September 2000 and 13 in September 2004. September 2009 was more conducive to high ozone, but had far fewer exceedances than September 2000 or 2004.

In summary, Figure C-6: *Frequency of Morning Wind Direction and Wind Speed by Month in the HGB Area for 2000, 2004, 2008, and 2009* shows that the wind speed and direction were actually more conducive to ozone formation during the peak of the ozone season in August and September in 2008 and 2009 than in 2000 and 2004, but 2000 and 2004 had far more exceedances than 2008 and 2009. The greater frequency of high winds in 2008 occurred during June, when winds were southerly, and therefore not conducive to high ozone.

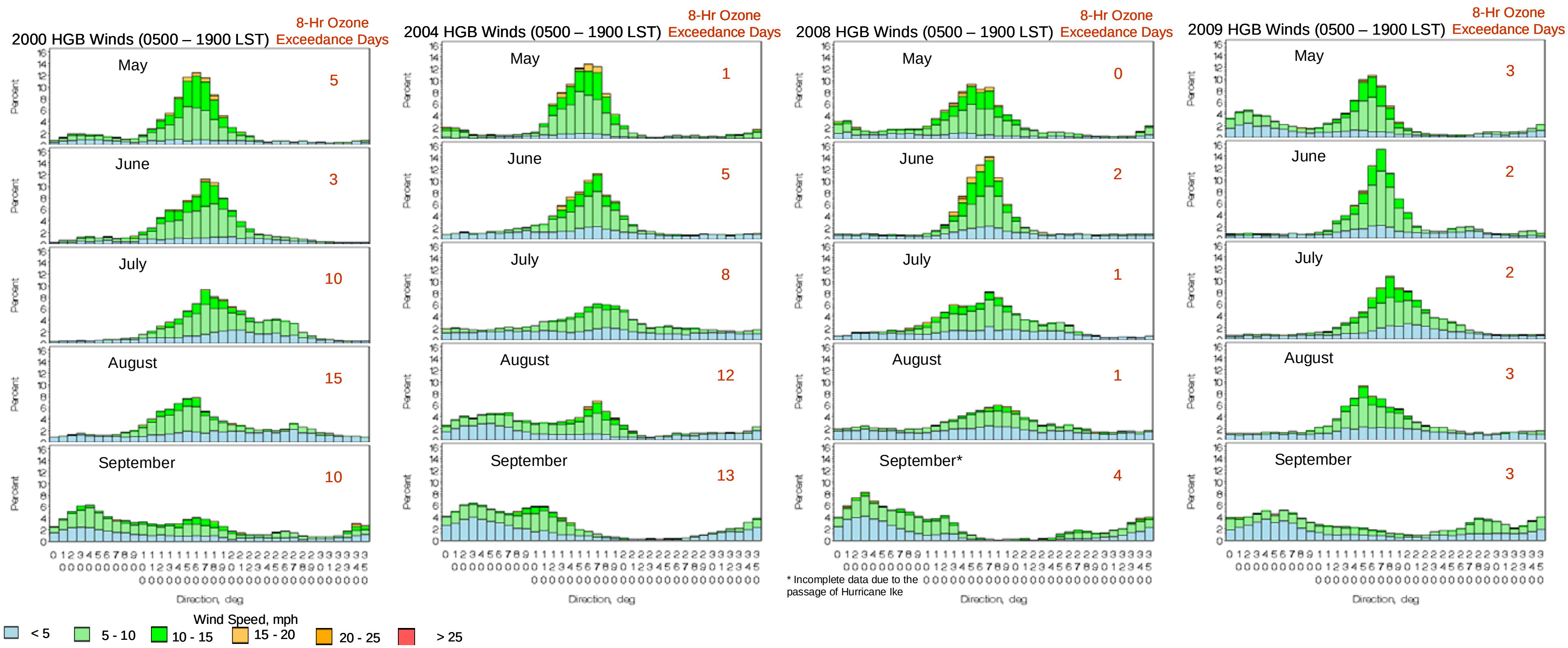


Figure C-6: Frequency of Morning Wind Direction and Wind Speed by Month in the HGB Area for 2000, 2004, 2008, and 2009

Hurricane Ike's Impact on Ozone

The HGB area typically records the highest ozone values each year in September. Sometimes, these values help determine the area-wide design value for that year. The HGB eight-hour ozone design value has been declining recently and was particularly low in 2008 (91 ppb); however, September 2008 was not typical for the HGB area. Hurricane Ike, a strong Category 2 hurricane, struck the Texas coast near Galveston Bay on September 13, 2008. The hurricane caused most monitors in the area to shut down and substantially altered emission patterns. This analysis shows the possible effect of the monitor shutdown on the ozone design value in the HGB area in 2008.

Before Hurricane Ike struck the Texas coast, the evacuation of Galveston Island and the surrounding areas created enormous traffic jams. After the storm passed, there was far less automobile traffic than normal for several weeks. In preparation for the storm, many of the local petrochemical facilities shut down their operations, and after the storm, their operations were atypical for an extended period. Rescue operations, tree cutting and burning, lack of electrical power, unusual traffic patterns, and abnormal industrial operations were among the atypical conditions that occurred before, during, and after the hurricane. The exact effect of the emission changes on ozone concentrations is unknown, due to the number of ozone monitoring sites disabled indirectly or directly by Hurricane Ike. Monitors in the HGB area ceased operations for as little as one day and as long as 69 days at a site that was severely damaged by storm surge. Key monitors that typically record the area design value were down for as much as 16 days, e.g., Houston Bayland Park (CAMS 53), as Table C-3: *List of the Number of Days HGB Ozone Regulatory and Non-Regulatory Monitors were Not Operating Before and After the Landfall of Hurricane Ike*) shows.

Table C-3: List of the Number of Days HGB Ozone Regulatory and Non-Regulatory Monitors were Not Operating Before and After the Landfall of Hurricane Ike

Monitor	First Date Monitor Did Not Report Data	Restart Date	Days Down
Houston Bayland Park C53/A146	9/13/2008	9/29/2008	16
Houston Westhollow C410	9/12/2008	9/30/2008	18
Park Place C416	9/12/2008	9/15/2008	3
Houston Deer Park 2 C35/C139	9/12/2008	9/22/2008	10
Manvel Croix Park C84	9/12/2008	9/21/2008	9
Northwest Harris Co. C26/A110/X150	9/13/2008	9/14/2008	1
Houston Aldine C8/AF108/X150	9/13/2008	9/15/2008	2
Houston Monroe C406	9/12/2008	9/19/2008	7
Houston Croquet C409	9/12/2008	9/26/2008	14
Conroe Relocated C78/A321	9/13/2008	9/17/2008	4
Channelview C15/AH115	9/13/2008	9/16/2008	3
Houston East C1/G316	9/13/2008	9/29/2008	16
Seabrook Friendship Park C45	9/13/2008	9/16/2008	3
Houston Texas Avenue C411	9/12/2008	9/16/2008	4
Lake Jackson C1016	9/12/2008	9/16/2008	4
Lang C408	9/12/2008	9/18/2008	6
Houston North Wayside C405	9/12/2008	9/15/2008	3
Lynchburg Ferry C1015/A165	9/12/2008	10/16/2008	34
Houston Regional Office C81	9/13/2008	9/20/2008	7
Clinton C403/C304/AH113	9/12/2008	9/30/2008	18
West Houston C554	9/13/2008	9/14/2008	1
Tom Bass C558	9/13/2008	9/18/2008	5
Wallisville Road C617	9/12/2008	9/17/2008	5
Meyer Park C561	9/13/2008	9/15/2008	2
Atascocita C560	9/14/2008	9/23/2008	9
La Porte Sylvan Beach C556	9/12/2008	11/6/2008	55
Baytown Wetlands Center C552	9/12/2008	10/31/2008	48
Mustang Bayou C619	9/12/2008	9/26/2008	14
Clear Lake High School C572	9/13/2008	9/14/2008	1
HRM-3 Haden Road C617	9/12/2008	9/22/2008	10
Crosby Library C553	9/13/2008	9/20/2008	7
Texas City 34th St. C620	9/12/2008	9/18/2008	6
Dacinger C618	9/12/2008	9/19/2008	7
Kingwood Library C555	9/13/2008	9/14/2008	1
Mercer Arboretum C557	9/22/2008	10/8/2008	16
Sheldon C551	9/12/2008	9/22/2008	10
Clear Creek High School C571	9/13/2008	9/15/2008	2
Galveston 99th St. C1034/A320/X183	9/12/2008	11/20/2008	69
Pasadena AAMS C672	9/12/2008	9/22/2008	10

Hurricane Ike's greatest impact occurred during the second half of September and the first half of October. August and September are typically the months when the HGB area records the most number of days that exceed the ozone standard. For 2000 through 2008, 21 percent of the 266 observed 85 ppb exceedance days in the HGB area were recorded in September as illustrated in Figure C-7: *Number of Days that Exceeded the 1997 Eight-Hour Ozone NAAQS by Month from 2000 through 2008 in the HGB Area.*

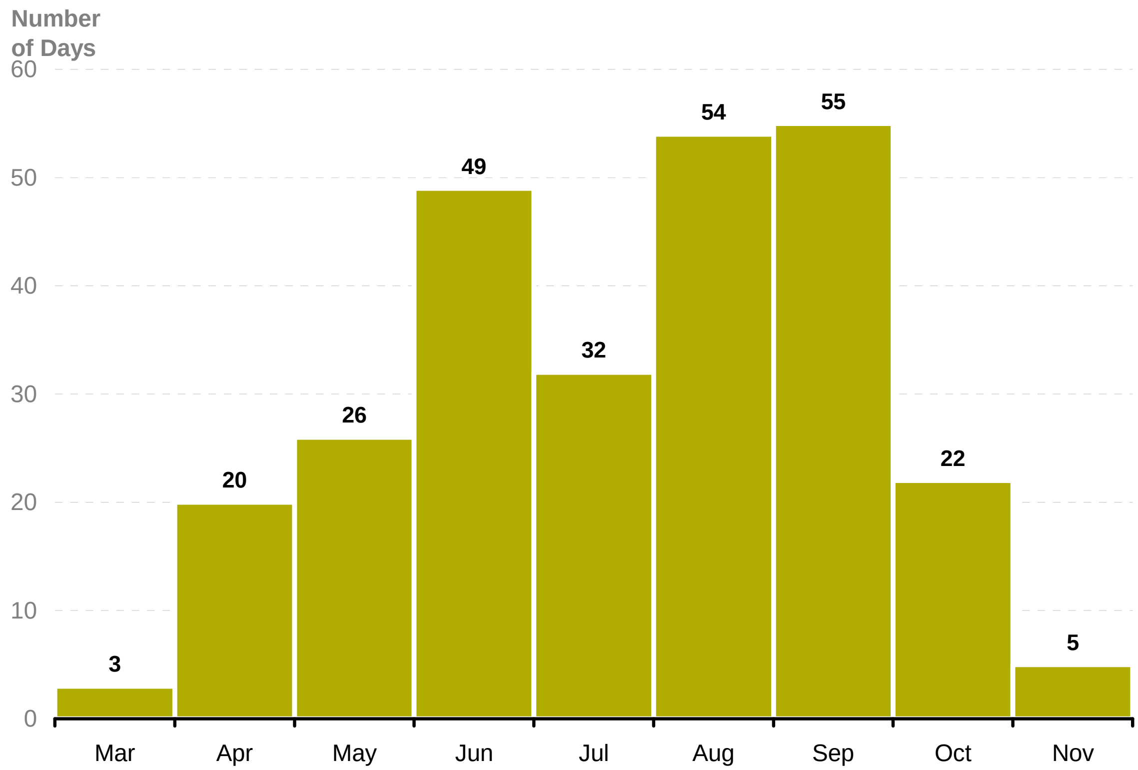


Figure C-7: Number of Days that Exceeded the 1997 Eight-Hour Ozone NAAQS by Month from 2000 through 2008 in the HGB Area

Figure C-8: *Frequency of Daily Peak Eight-Hour Ozone Values for All Ozone Monitoring Sites in Texas, September 2006* and Figure 9: *Frequency of Daily Peak Eight-Hour Ozone Values for All Ozone Monitoring Sites in Texas, September 2008* show peak eight-hour ozone at all Texas monitoring sites in September 2006, which was unaffected by tropical systems, and in September 2008, the month in which Hurricane Ike struck. In 2008, the number of monitors in operation dropped substantially just before the hurricane made landfall, as they were shut down by the TCEQ. The monitors came back on-line gradually, as electrical power was restored and storm damage was repaired. Ozone concentrations immediately before and after Ike were fairly low.

The purpose of this analysis is to examine how the ozone behavior in September and October 2008 deviated from the 2000 through 2007 average, and thus to ascertain whether the lower design value observed in 2008 was due primarily to the effects of Hurricane Ike.

One approach to estimate the influence of Hurricane Ike on the HGB area's ozone design value is to estimate what the eight-hour ozone design value might have been in 2008 if Hurricane Ike had not occurred. This estimate is derived from historical data collected during 2000 through 2007. Removing calendar days affected by Hurricane Ike and replacing them with averages derived from historical data yields a re-calculated fourth-highest eight-hour ozone concentration for each monitor. The actual fourth-high is then divided by the re-calculated fourth-high to obtain an adjustment ratio or an Ike Adjustment Factor (IAF). This ratio is expected to be greater than one, and can be used to adjust 2008 ozone data to non-hurricane conditions. The IAF can be calculated as an area-wide average IAF or as a monitor-specific IAF. An area-wide average IAF is computed as the average of all IAFs from all monitors in the region, applied to all 2008 data. The monitor-specific IAF was applied only to the monitor in question.

After the data were adjusted with IAFs, an IAF-corrected design value was calculated and compared to the current unadjusted ozone design value to determine the influence of Hurricane Ike.

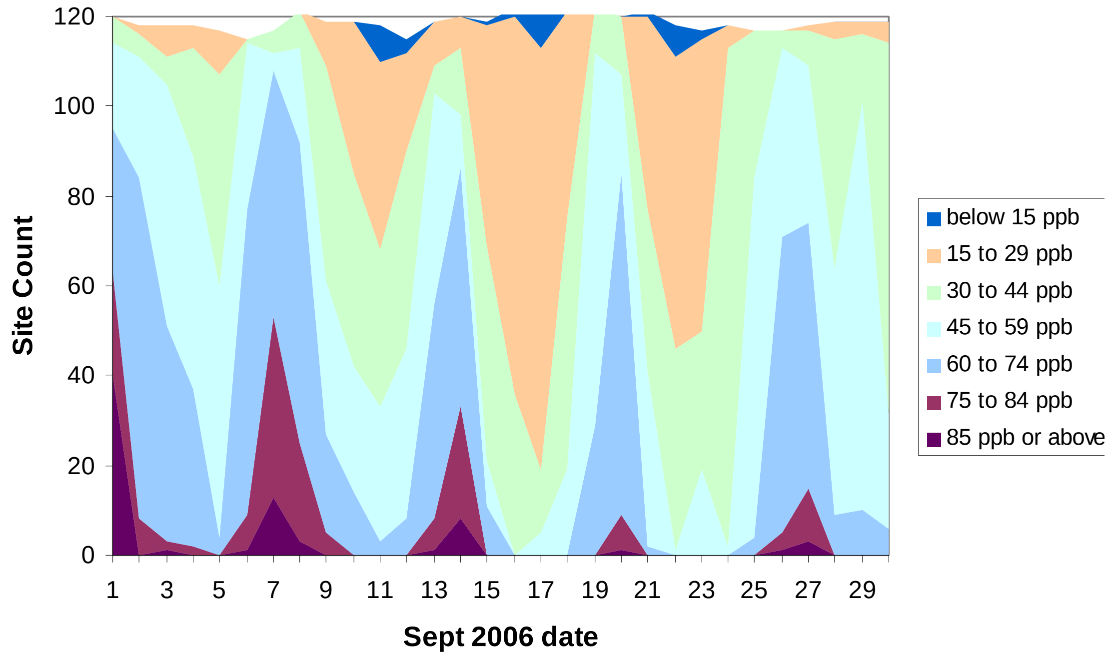


Figure C-8: Frequency of Daily Peak Eight-Hour Ozone Values for All Ozone Monitoring Sites in Texas, September 2006

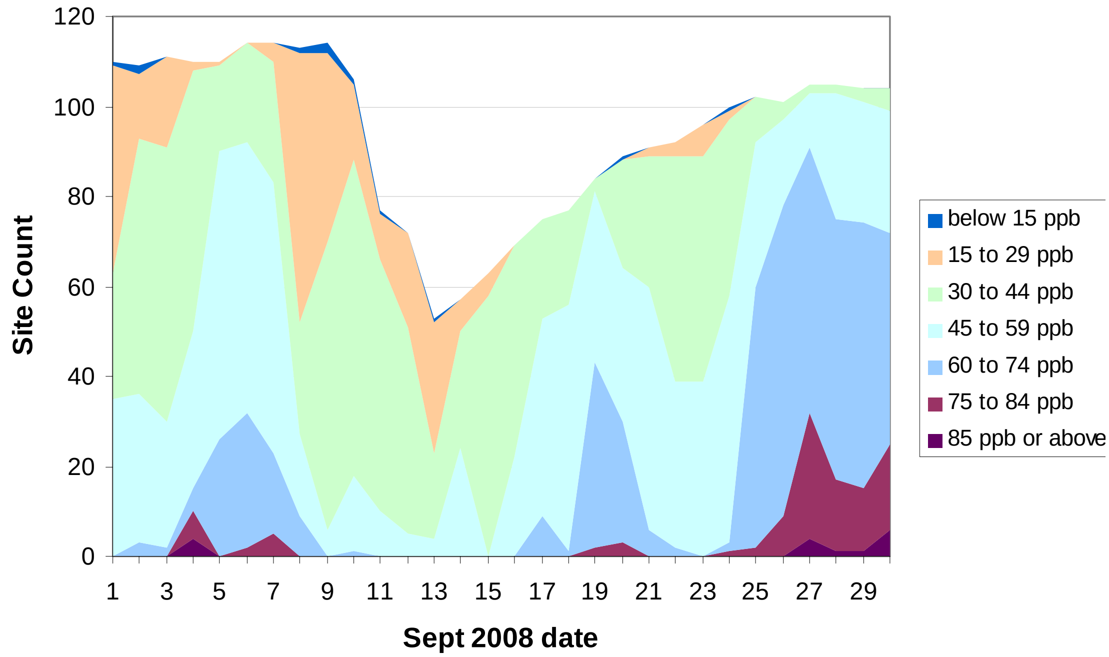


Figure C-9: Frequency of Daily Peak Eight-Hour Ozone Values for All Ozone Monitoring Sites in Texas, September 2008

The days affected by Hurricane Ike are not easy to identify. As stated before, many unusual activities occurred in the HGB area before the arrival of Hurricane Ike and many others occurred in the aftermath.

For example, many industrial facilities shut down operations before the storm arrived, releasing emissions that they would not typically release. After the hurricane, electrical power was not available in parts of the HGB area for two or more weeks. Given the difficulties in establishing the exact period of Hurricane Ike's influence, alternative IAFs were calculated by removing three different time periods from the historical ozone data. The first period considered for exclusion was a two-week period from September 11 through September 25, 2008, which includes days immediately before and after the hurricane. Two other periods considered for exclusion were a one-month period from September 6 through October 5, 2008, and a one-month period after the storm from September 13 through October 12, 2008. All data used in this analysis were obtained from the TCEQ-LEADS system, and are eight-hour ozone averages. The HGB area eight-hour ozone design value was obtained from the EPA.

Table C-4: *Alternative Fourth-High Daily Peak Eight-Hour Ozone Concentration Calculations Using Different Ike Adjustment Factors (IAFs)* shows results of the six different methods for estimating the fourth-high daily peak eight-hour ozone concentration for each monitoring site. The table shows that the expected fourth high is greater than the observed at most sites, regardless of which method is used to calculate the expected fourth high. This indicates that the atypical conditions experienced during and after Hurricane Ike during September and October in 2008 did have an effect on the monitored values, but the effect was no greater than 4 ppb on the fourth-high daily maximum ozone concentration.

Table C-4: Alternative Fourth-High Daily Peak Eight-Hour Ozone Concentration Calculations Using Different Ike Adjustment Factors (IAFs)

Monitoring site	2008 observed fourth high	9/11-9/26 average IAF	9/11-9/26 monitor-specific IAF	9/6-10/5 average IAF	9/6-10/5 monitor-specific IAF	9/13-10/12 average IAF	9/13-10/12 monitor-specific IAF
	ppb	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*	*ppb*
Houston Aldine C8 /AF108/X150	83	85	86	87	86	86	86
Houston Bayland Park C53	83	85	84	87	86	86	85
Channelview C15/C115	76	78	77	79	78	79	78
Houston Croquet C409	76	78	78	79	80	79	79
Houston Deer Park C18	76	78	78	79	79	79	78
Lake Jackson C1016	76	78	77	79	80	79	78
Northwest Harris Co. C26/A110/C154	76	78	78	79	81	79	80
Manvel Croix Park C84	75	77	77	78	81	78	78
Conroe C65	73	75	74	76	75	76	75
Houston East C1	73	75	74	76	76	76	76
Houston Monroe C406	71	73	73	74	75	74	74
Seabrook Friendship Park C45	71	73	75	74	75	74	75
Houston North Wayside C405	70	72	70	73	71	73	71
Houston Texas Avenue C411	70	72	71	73	73	73	73
Lang C408	70	72	73	73	75	73	74
Clinton C403/C113/C304	69	71	70	72	72	71	72
Houston Westhollow C410	69	71	70	72	71	71	71
Houston Regional Office C81	68	70	69	71	71	70	70
Lynchburg Ferry C1015	65	66	65	68	66	67	66

This table compares the observed 2008 fourth-high at each monitor to the expected fourth high, as calculated by six different methods.

The attainment status of an area is not based upon fourth-high ozone concentrations, but upon the design value, which is the three-year average of those fourth-highest values. Table C-5: *Observed and Expected*

Design Values, Recalculated to Account for Hurricane Ike shows the observed 2008 design value, and the expected design value, as calculated with the six different methods described above. As Table 5-12: *Observed and Expected Design Values, Recalculated to Account for Hurricane Ike* shows, the effect upon the design value for the HGB area is at most 1 ppb, and for two of the alternatives there is no effect. This analysis is robust, because six different methods of estimating the effect of the hurricane on ozone design value have given substantially the same answer: the 2008 eight-hour ozone design value was not different from the expected design value, based upon comparisons with historical data. Therefore, based upon the historical analysis, the effect of Hurricane Ike upon the eight-hour ozone design value for 2008 in the HGB area was apparently minimal.

Table C-5: Observed and Expected Design Values, Recalculated to Account for Hurricane Ike

Observed Design Value: 91 ppb	2-weeks 9/11-9/25	1-month 9/13-10/12	1-month 9/6-10/5
Estimated Design Value after applying area-wide average Ike Adjustment Factor	91 ppb	92 ppb	92 ppb
Estimated Design Value after applying monitor-specific Ike Adjustment Factor	92 ppb	91 ppb	92 ppb

Conclusion

Evidence provided show that favorable meteorology is not adequate to explain the decreases in ozone observed in 2007, 2008, and 2009. Two analyses that adjusted ozone trends for meteorology both show that ozone would continue to be decreasing in recent years, despite changes in meteorology. Analysis of the number of ozone-conducive days show that there has been a similar number of conducive days over the past few years, yet the number of ozone exceedance days continue to decrease. Similarly, the number of forecasted ozone exceedance days in 2008 was larger than the actual number of observed exceedance days. In addition, an analysis of the frequency of wind speed and direction showed that higher winds observed in 2008 and 2009 occurred at a time of year when high ozone usually does not occur. The wind conditions were more suitable for high ozone formation in August and September of 2008 and 2009 than in 2000 and 2004, but the number of ozone exceedance days was far lower in 2008 and 2009. Finally, an analysis of Hurricane Ike data shows that ozone design values would only increase by 1 ppb if Hurricane Ike had not occurred.

All of the various analyses tend to agree that meteorology alone cannot explain the decreasing trend observed in ozone concentrations. It appears that decreases in ozone precursor emissions played a significant role in the recent decreases in ozone.

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ATTACHMENT D: EMISSIONS INVENTORY ANALYSIS

Summary

Data indicate that in spite of economic activity and population growth, actual emissions inventory (EI) numbers have continually decreased for industrial point sources, area source, non-road, and on-road source categories for volatile organic compounds (VOC) and nitrogen oxides (NO_X) in the Houston-Galveston-Brazoria ozone nonattainment area (HGB area). This trend continues between 2002 through 2008 with overall inventory reductions of NO_X of 44 percent and VOC of 14 percent.

Background

The 1990 Federal Clean Air Act (FCAA) requires that emissions inventories (EIs) be prepared for ozone nonattainment areas. Ozone is photochemically produced in the atmosphere when VOC mixes with NO_X in the presence of sunlight. The Texas Commission on Environmental Quality (TCEQ) maintains an EI of up-to-date information on NO_X and VOC sources. The EI identifies the source types present in an area, the amount of each pollutant emitted, and the types of processes and control devices employed at each plant or source category. The inventory provides data for a variety of air quality planning tasks, including establishing baseline emission levels, calculating reduction targets, developing control strategies to achieve the emission reductions, developing emission inputs into air quality models, and tracking actual emission reductions against established emissions growth and control budgets.

Inventory Development

Point Sources

Emissions data has been collected from industrial point sources annually since 1990 for the nonattainment areas and since 1992 for all major industrial sources meeting or exceeding the reporting thresholds of 30 Texas Administrative Code (TAC) Section 101.10 (EI reporting rule).

To collect data, the commission mails EI questionnaires (EIQs) to all sources identified as meeting the reporting requirements in the EI reporting rule. For the eight-county HGB area (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller), all sources with actual or potential VOC emissions of 10 tons or more or NO_X emissions of 25 tons or more are required to annually report and update their emissions and emissions-related data. Companies are required to report emissions for all emissions generating unit and emissions points and to provide representative samples of calculations used to estimate the emissions. Information is also required on process equipment descriptions, operating schedule, emission control devices, abatement device control efficiencies, and emission point discharge parameters, such as location, height, and exhaust gas flow rate. All data submitted in an EIQ are quality assured by the TCEQ staff and stored in the State of Texas Air Reporting System (STARS). Table D-1: *Industrial Point Source HGB Eight-County Total Emissions* summarizes the annual and ozone seasonal rates for the HGB area since 2002. These data are further portrayed in Figure D-1: *Industrial Point Source HGB Eight-County Emissions Trends.*

Table D-1: Industrial Point Source HGB Eight-County Total Emissions

Year	VOC		NO_X	
	Annual (tons per year)	Ozone Season (pounds per day)	Annual (tons per year)	Ozone Season (pounds per day)
2002	51,208	298,862	113,404	678,970
2003	51,389	311,278	94,562	544,329
2004	48,073	279,869	81,501	465,604
2005	47,432	272,251	66,264	388,997
2006	40,467	241,171	57,227	345,125
2007	36,702	243,174	43,859	291,843
2008	34,645	199,634	36,561	222,362

(Data Source: TCEQ)

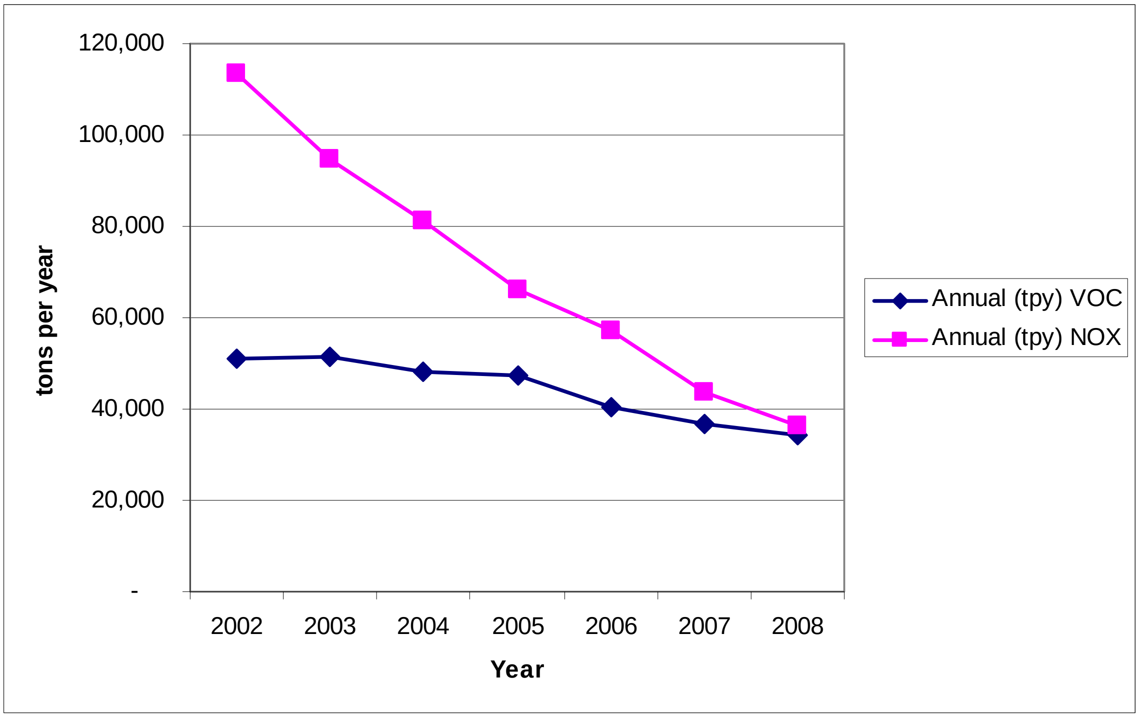

Figure D-1: Industrial Point Source HGB Eight-County Emissions Trends. (Data Source: TCEQ)

Refinery Trends

Petrochemical capacity has steadily increased in Texas since 1993. Data from the Energy Information Administration (EIA) indicates that there were 26 operating refineries in 2007 with an operating capacity of 4,747,179 barrels per calendar day (b/cd), an increase from 4,246,050 barrels per day in 2000 from 27 operating refineries as shown in Figure D-2: *Texas Oil and Gas Refinery Capacity*. Of this capacity, the HGB area hosts approximately half of the petroleum refining capacity. Refinery capacities in 2006 by refinery are listed in Table D-2: *Refinery Capacity in Texas in 2006*.

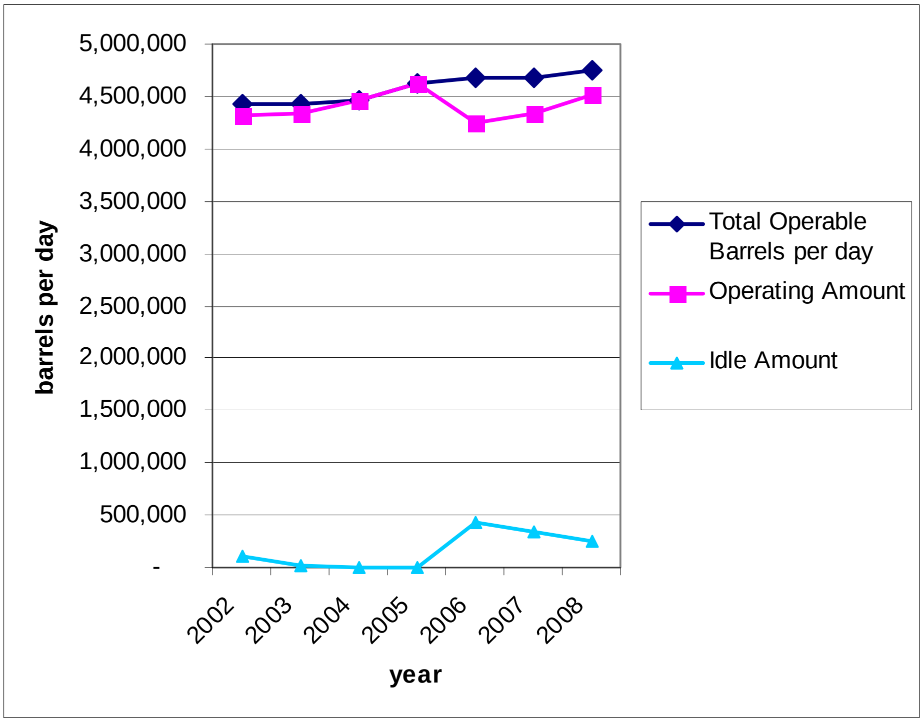

Figure D-2: Texas Oil and Gas Refinery Capacity. (Data source: EIA)

Table D-2: Refinery Capacity in Texas in 2006

***Oil and Gas Journal* 2006 Facility Name**	**County**	**City**	**Nonattainment Area**	**Crude Processing Capacity ('000 b/cd) in 2006**
AGE Refining	Bexar	San Antonio		12
Alon Isreal	Howard	Big Springs		70
BP	Galveston	Texas City	HGB	447
Citgo Petroleum Corp	Nueces	Corpus Christi		157
Conoco Philips Petroleum – Borger	Hutchinson	Borger		146
Conoco Philips Petroleum – Sweeny	Brazoria	Sweeny	HGB	247
ExxonMobil Oil - Baytown	Harris	Baytown	HGB	563
ExxonMobil Oil - Beaumont	Jefferson	Beaumont	BPA	349
Flint Hills	Nueces	Corpus Christi		279
Delek Refining	Smith	Tyler		60
Lyondell Citgo Refining LP	Harris	Houston	HGB	283
Marathon Ashland Petroleum	Galveston	Texas City	HGB	72
Motiva Enterprises LLC	Jefferson	Port Arthur	BPA	290
Pasadena Refining	Harris	Pasadena	HGB	117
Shell Deer Park Refining	Harris	Deer Park	HGB	332
Total S.A.	Jefferson	Port Arthur	BPA	231
Valero - Corpus Christi	Nueces	Corpus Christi		205
Valero – Houston	Harris	Houston	HGB	90
Valero - Port Arthur	Jefferson	Port Arthur	BPA	250
Valero – Sunray	Moore	Sunray		167
Valero - Texas City	Galveston	Texas City	HGB	225
Valero	Live Oak	Three Rivers		96
Western Refining	El Paso	El Paso		117

(Table Source: Pechan)

NO_X and VOC emissions from petrochemical refining have been declining in the HGB area since 1992 as illustrated in Figure D-3: *Refinery Emissions for the HGB Area*. Between 1992 and 2008, VOC emissions declined 72 percent and NO_X emissions declined 83 percent in the HGB area. More recently, between 2002 through 2008, VOC emissions reduced 34 percent and NO_X emissions reduced 66 percent. An important factor affecting the state refinery NO_X emissions during the mid-to-late 2000s is the series of United States Department of Justice cases and settlements. These settlements affect emissions from catalytic crackers, boilers, and process heaters. Sixteen refineries, making up more than 81 percent of Texas' refining had settlements (Pechan 2009). In 2008, the petrochemical VOC emissions level of 10,376 tons per year (tpy) from the petrochemical industry was 29 percent of the industrial point source emisisons inventory. The petrochemical NO_X emissions of 8,965 tons was 24 percent of the point source inventory.

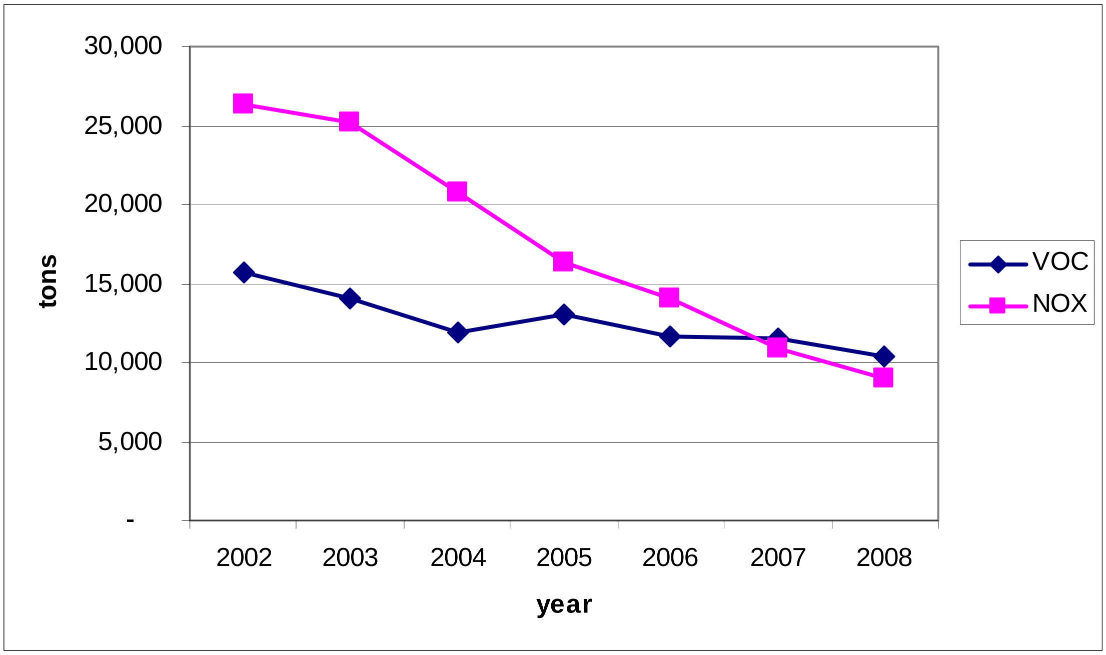

Figure D-3: Refinery Emissions for the HGB Area (Data Source: TCEQ)

Area Sources

Area sources are commercial, small-scale industrial and residential sources that use materials or operate processes that can generate emissions. Area sources are too small to meet the reporting criteria for major point sources, so emissions are calculated as county-wide totals rather than as individual facilities. Area sources can be divided into two groups characterized by the emission mechanism: hydrocarbon evaporative emissions or fuel combustion emissions. Examples of evaporative sources include printing operations, industrial coatings, degreasing solvents, house paints, leaking underground storage tanks, gasoline service station underground tank filling, and vehicle refueling operations. Fuel combustion sources include stationary source fossil fuel combustion at residences and businesses, outdoor refuse burning, structural fires, and wildfires. With some exceptions, these emissions may be calculated by multiplying an established emission factor (emissions per unit of activity) by the appropriate activity or activity surrogate responsible for generating emissions. Population is the most commonly used activity surrogate for many area sources, while another activity measures include the amount of gasoline sold in an area, employment by industry type, and acres of cropland. Unlike industrial source data, which are collected annually, area source data are only estimated for the periodic inventory years. These years are every three years and include 2002, 2005, and 2008.

Since the 2002 inventory, there have been additional improvements to the area source inventory process. Improvements resulted from "bottom-up" surveys for some categories, e.g., gasoline stations. Surveys produce data that more accurately depict facility activity levels than "top-down" methodologies that usually rely on default surrogates such as county populations and numbers of employees associated with appropriate United States Environmental Protection Agency (EPA) emission factors. Activity data for other categories were available from various sources. The Energy Information Administration maintains state-level fuel use data for the residential, industrial, and commercial sectors for fuels ranging from coal to natural gas. This data is useful in calculating emissions from home cooking, water heating, and similar use at the industrial and commercial levels. The data from the periodic inventory years since 2002 are shown in Table D-3: *Periodic Area Source Inventory* and Figure D-4: *Area Source Annual Emissions 2002 through 2008.* Actual oil and gas production data is available from the Texas Railroad Commission.

Table D-3: Periodic Area Source Inventory

	2002	2005	2008
VOC (tpy)	145,418	149,397.	135,789
NO_X (tpy)	11,236	13,455	12,515

(Data Source: TCEQ)

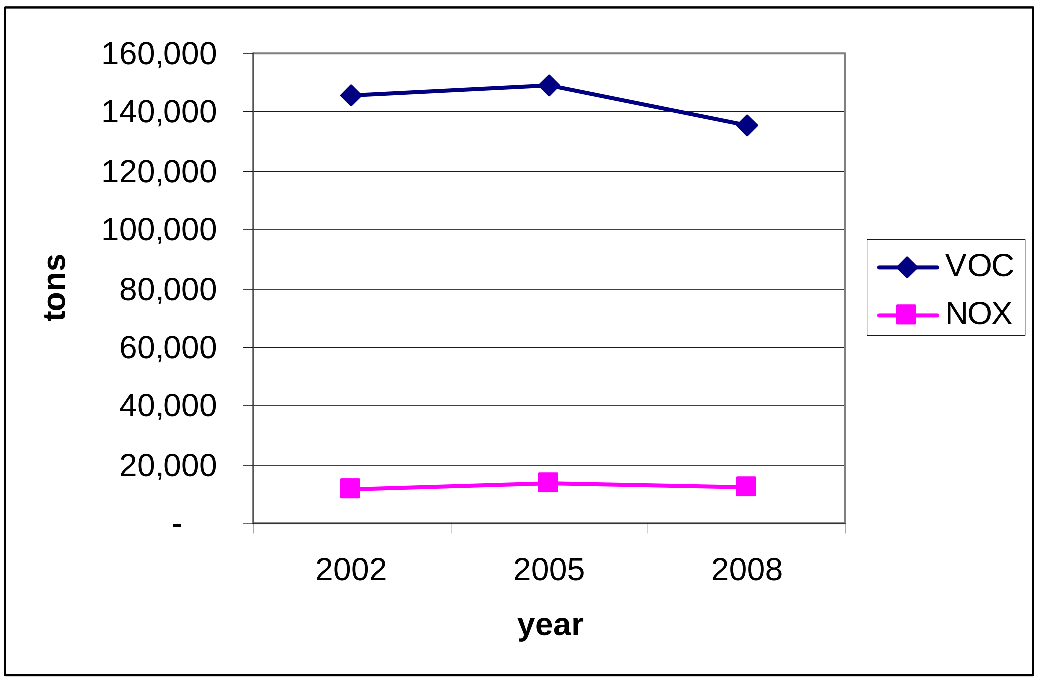

Figure D-4: Area Source Annual Emissions 2002 through 2008 (Data Source: TCEQ)

Non-Road Mobile Sources

Non-road mobile sources include a large assortment of off-highway equipment, from 600-horsepower engines mounted on construction equipment to one-horsepower string trimmers. The EPA's NONROAD model was used to calculate emissions from all non-road mobile source categories, except aircraft, commercial marine, and locomotives. Equipment classes in the model include equipment associated with the following areas: recreational, construction, industrial, lawn and garden, agricultural commercial, logging railroad maintenance, recreational boating, oil exploration, and airport ground support. Emissions from the NONROAD model sources are based on information about population, engine horsepower and load factor emission factors, and annual usage. Aircraft emissions are calculated using the Federal Aviation Administration (FAA) Emissions and Dispersion Modeling System (EDMS), which uses aircraft types and actual airport operations as calculation activities. Locomotives data, such as actual fuel use and track distances, were obtained from rail lines and used in emissions calculations. The EI for commercial marine vessels has been developed from two surveys of vessel types and activities in the Port of Houston and surrounding ports.

Several updates in non-road mobile source emissions have occurred since the development of the 2002 base year EI. Several emission inventory studies have been conducted in Texas at county level in recent years to improve upon the default data available in the EPA's NONROAD model. These data are incorporated into a Texas-specific version of EPA's NONROAD model called TexN as the data becomes available to the TCEQ. These studies have focused on various equipment categories operating in different areas of the state, including diesel construction, liquid propane gas powered forklifts, transportation refrigeration units, commercial lawn and garden, recreational marine vessels, and agricultural. Similar to the area source inventory the data are typically reported for the periodic inventory years. Data from the periodic inventory for the non-road category are summarized in Table D-4*: Non-Road HGB Eight-County Emission Totals* and Figure D-5: *Non-Road HGB Eight-County Emissions Trends.*

Table D-4: Non-Road HGB Eight-County Emission Totals

Inventory Year	**Emissions**			
	VOC		**NO_X**	
	Annual (tons per year)	**Ozone Season Day (tons per day)**	**Annual (tons per year)**	**Ozone Season Day (tons per day)**
2002	26,606.70	82.99	50,566.86	147.36
2005	23,711.93	71.90	47,724.63	139.66
2008	23,705.44	62.65	49,941.78	149.25

(Data Source: TCEQ)

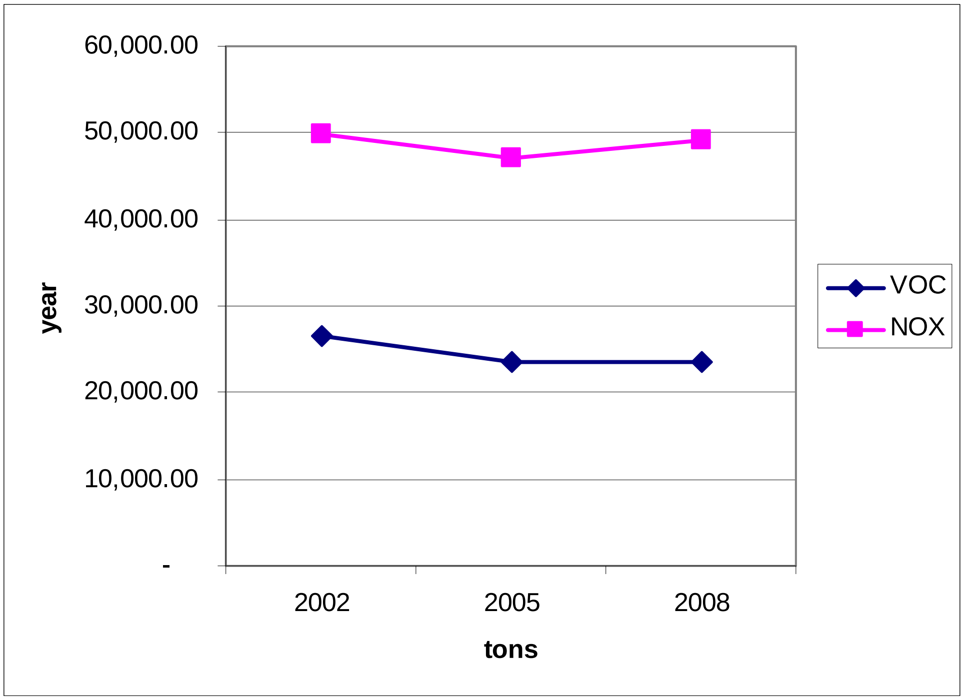

Figure D-5: Non-Road HGB Eight-County Emissions Trends (Data Source: TCEQ)

On-Road Mobile Sources

On-road mobile emissions sources consist of automobiles, trucks, motorcycles, and other motor vehicles traveling on public roadways. On-road mobile source emissions are usually categorized as either combustion-related emissions or evaporative hydrocarbon emissions. Combustion-related emissions are estimated for vehicle engine exhaust. Evaporative hydrocarbon emissions are estimated for the fuel tank and other evaporative leak sources on the vehicle. To calculate emissions, both the rate of emissions per unit of activity (emission factors) and the number of units of activity must be determined.

Emission factors are developed using the EPA's mobile emission factor model MOBILE. The model may be run using national default information or input may be provided to modify the model calculations to simulate the driving behavior, meteorological conditions, and vehicle characteristics specific to the HGB area. Localized inputs used for the HGB area on-road mobile EI development include vehicle speeds for each roadway link, temperature, humidity, vehicle age distributions for each vehicle type, percentage of miles traveled for each vehicle type, type of inspection-maintenance program, fuel control programs, and gasoline vapor pressure.

To estimate on-road mobile emissions, emissions factors calculated by the MOBILE model previously described must be multiplied by the level of vehicle activity. On-road mobile source emission factors are expressed in units of grams per mile. Therefore, the activity information required to complete the inventory calculation is vehicle miles traveled (VMT) in units of miles per day. The level of vehicle travel activity is developed using travel demand models (TDM) run by the Texas Department of Transportation or the local metropolitan planning organizations. TDMs are validated against a large number of ground counts, i.e., traffic passing over counters placed in various locations throughout a county or area. VMT estimates for the HGB area are calibrated against outputs from the Federal Highway Performance Monitoring System, a federal model built from a different set of traffic counters.

In addition to the number of miles traveled on each roadway link, the speed on each roadway type or segment is also needed to complete on-road inventory development. Roadway speeds, required inputs for the MOBILE model, are calculated by using the activity volumes from the TDM and a post-processor speed model. Periodic emissions inventory data are summarized in Table D-5: *On-Road HGB Eight-County Total Emissions* and Figure D-6: *On-Road HGB Eight-County Annual Emissions Trends.*

Table D-5: On-Road HGB Eight-County Total Emissions

Inventory Year	Emissions			
	VOC		NO_X	
	Annual (tons per year)	Ozone Season Day (tons per day)	Annual (tons per year)	Ozone Season Day (tons per day)
2002	43,194	115.3	118,080	322.7
2005	39,102	106.6	91,679	261.0
2008	35,027	96.4	68,046	190.6

(Data Source: TCEQ)

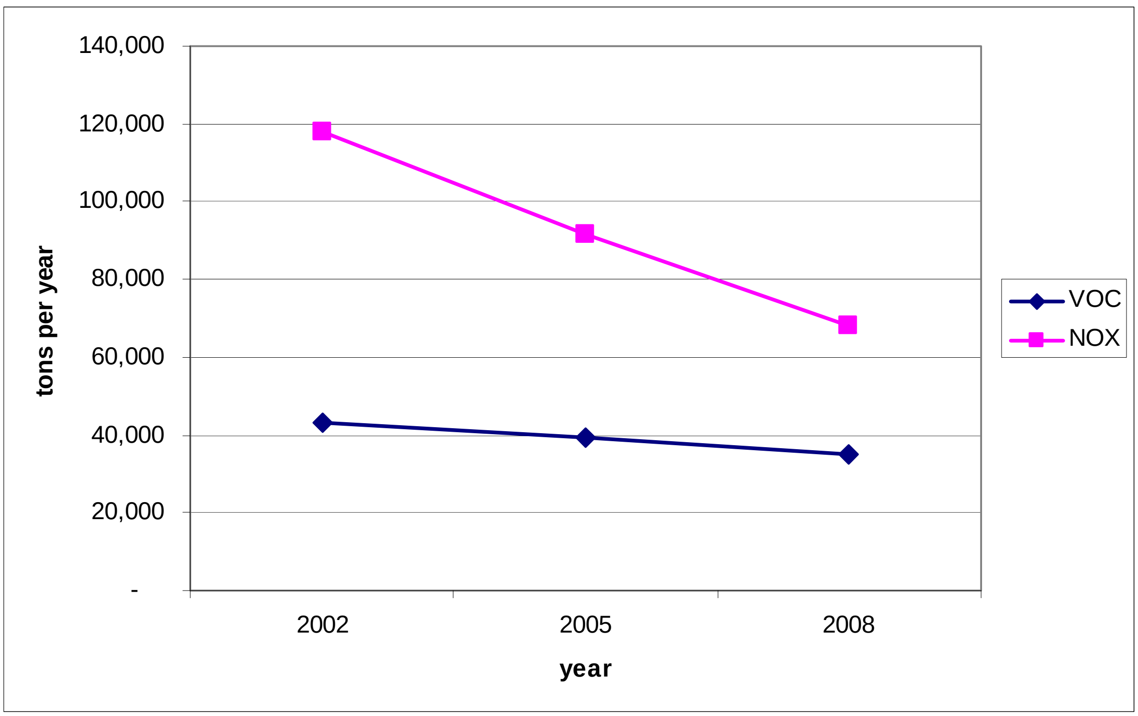

Figure D-6: On-Road HGB Eight-County Annual Emissions Trends. (Data Source: TCEQ)

The emission factors developed for the 2002 through 2008 inventories include the combined effects of progressively more stringent federal and state motor vehicle emissions control programs, use of low-volatility and low-emissions fuels, and regular checks and maintenance of vehicle emissions control systems. The programs vary by vehicle class, by year (depending on the implementation schedule), and by county. Included in the federal programs is the Federal Motor Vehicle Control Program (FMVCP), which consists of a set of rules that require implementation of progressively more stringent pollutant emissions standards for newly manufactured vehicles (for particular vehicle classes and pollutants, as defined by the rule). Seven new vehicle emissions certification rules that are in effect for the analysis years from 2002 through 2008 are: Tier 1 rule 1994, National Low-Emissions Vehicle (NLEV) rule, heavy-duty diesel vehicle 2004 rule, Tier 2 rule 2004, heavy-duty diesel vehicle 2005 rule, heavy-duty diesel vehicle 2007 rule, and highway motorcycle 2006 rule. Over time the portion of the on-road fleet consisting of cleaner emitting vehicles grows, as the older vehicles with less stringent emissions standards are phased out of the fleet (or retired from use), resulting in increasingly cleaner on-road vehicle fleets in future years.

The trend in the on-road emissions for the years from 2002 through 2008 shows a substantial decrease in both VOC and NO_X. Over the same period of time there is substantial growth in VMT as summarized in Figure D-7: *Annual Vehicle Miles Traveled for the Eight-County HGB Area*. The difference in the two trends is due to the effectiveness of the FMVCP controls in reducing emission rates. As vehicles are retired and replaced with newer technology, lower emission vehicles, the effect of the emission rate decrease is much greater than the activity growth rate.

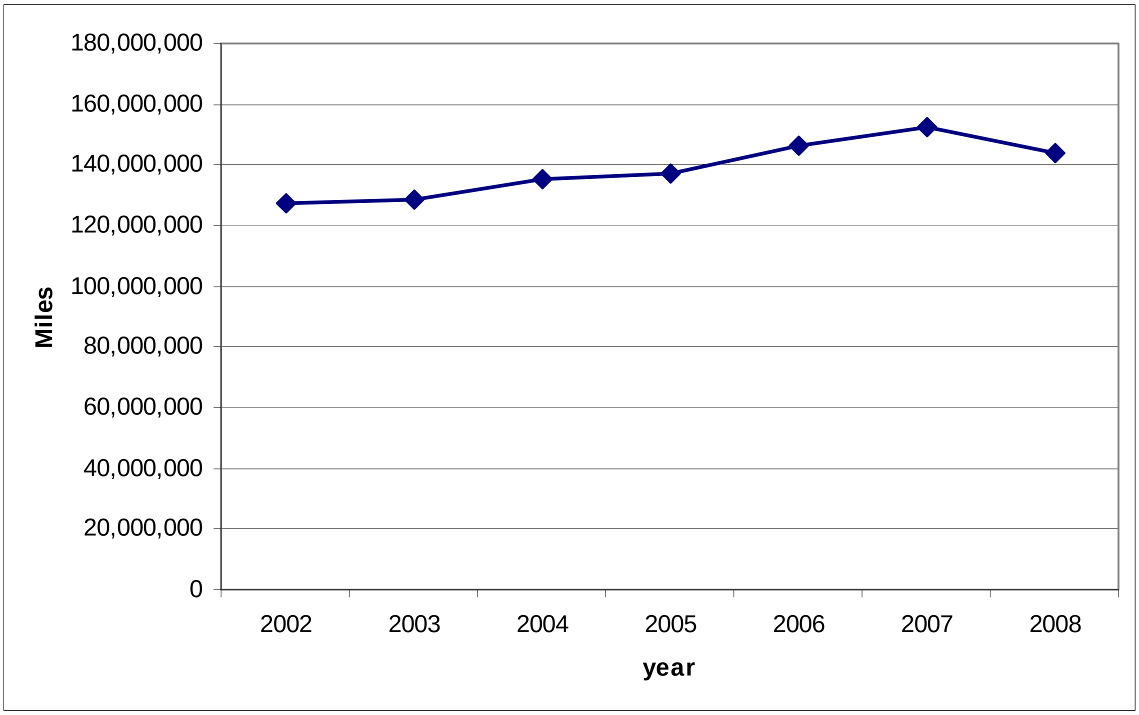

Figure D-7: Annual Vehicle Miles Traveled for the Eight-County HGB Area (Data Source: TTI)

Combined Inventory Trends

The overall emissions reductions in the HGB area between 2002 and 2008 are shown in Table D-6: *Combined Emissions Inventory Trends*. Between 2002 and 2008, both VOC and NO_X emissions were reduced in industrial point, non-road, and on-road categories. Area source emissions were fairly constant. Reductions ranged from an industrial point source NO_X emissions reduction of 76,810 tpy at 67.7 percent to a little more than 1.2 percent for non-road NO_X emissions. VOC emission reductions ranged from 32.3 percent from industrial point sources to 6.6 percent from area sources. Between 2002 and 2008, overall emission inventory reductions were 131,047 tpy or a total of 43.0 percent for $NO_{X.}$ Reductions for VOC were 37,260 tpy or a total of 14 percent between 2002 and 2008.

Table D-6: Combined Emissions Inventory Trends

Category	2002 Annual Emissions		2008 Annual Emissions		Change from 2002	
	VOC (tpy)	NO_X (tpy)	VOC (tpy)	NO_X (tpy)	VOC (percent)	NO_X (percent)
Point	51,208	113,404	34,645	36,634	-32.3%	-67.7%
Area	145,418	11,236	135,789	12,515	-6.6%	11.4%
On-road	43,194	118,080	35,027	68,046	-18.9%	-42.4%
Non-road	26,607	50,567	23,705	49,942	-10.9%	-1.2%
Total	266,427	293,287	229,166	167,137	-14.0%	-43.0%

(Data Source: TCEQ)

Emissions Limitations

In addition to the permanent and enforceable controls measures discussed in Appendix E: *Control Measures*, other constraints place restrictions on emissions growth from industrial sources in the HGB area.

Emissions Banking and Trade Programs

The amount of NO_X and highly reactive volatile organic compounds (HRVOC) reductions required for the area to attain the 1997 ozone NAAQS has been estimated by extensive use of sophisticated air quality grid modeling, which because of its scientific and statutory grounding, is the chief policy tool for designing emission reduction strategies. The attainment demonstration modeling shows that a significant amount of NO_X reductions are necessary from ozone control strategies in order for the HGB nonattainment area to achieve the 1997 ozone NAAQS, including reductions from surrounding counties included in the HGB consolidated metropolitan statistical area. Results from photochemical modeling indicate that HRVOC reductions prevent ozone production more quickly than other types of VOC. Consideration of this modeling outcome was used to develop the HRVOC Emissions Cap and Trade Program or HECT Program.

The emission credit programs have been designed to offer flexibility in generating and using emission reduction credits (ERCs), mobile emission reduction credits (MERCs), discrete emission reduction credits (DERCs), and mobile discrete emission reduction credits (MDERCs). Flexibility has been built into the rules to create incentives for the early or permanent retirement of VOC and NO_X emissions.

The cap and trade programs are applicable in the HGB-eight county area for $NO_{X.}$ and in Harris County for HRVOC. The underlying goal of the programs, in conjunction with agency limitations on applicable emission sources is to reduce the overall amount of NO_X and HRVOC emitted from applicable sources. Regional reductions of NO_X also assist in the reduction of ozone formation in the HGB area.

The cap and trade programs are designed to give owners the option of making reductions or purchasing additional allowances. For example, if allowances are for sale, the holder of those allowances did not actually emit the amount of NO_X that it had historically. Consequently, a facility using allowances in lieu of making real reductions is able to do so because another facility in the same area has lowered its emissions by the same amount. A finite number of allowances is available for the overall emissions in the HGB area. As the implementation schedule proceeds, the HGB area has fewer allowances available on the market, forcing a reduction at all facilities in the region as allowances become more expensive. Summary data for the HECT program are listed in Table D-7: *HRVOC Emissions Cap and Trade Allowances Allocated and Yearly Emissions.* Furthermore, the HECT Program allocated allowances are being reduced by 25 percent in rules adopted by the commissioners on March 10, 2010, which will be phased-in between 2014 through 2017. Data for the Mass Emissions Cap and Trade Program or MECT Program are in Table D-8: *Mass Emission Cap and Trade Data for NO_X Emissions Allowances Allocated and Yearly Emissions.*

Table D-7: HRVOC Emissions Cap and Trade Allowances Allocated and Yearly Emissions

Category	2007	2008
Emissions (tons)	2045.9	1851.2
Allowances Allocated (tons)	3446.7	3446.7

(Data Source: TCEQ)

Table D-8: Mass Emission Cap and Trade Data for NO_X Emissions Allowances Allocated and Yearly Emissions

Category	2002	2003	2004	2005	2006	2007	2008
Emissions (tons)	106,573	90,784	74,327	57,922	50,425	34,438	26,330
Allowances Allocated (tons)	291,962	209,294	139,264	86,014	63,416	49,538	44,767

(Data Source: TCEQ)

Note: MECT data is as of March 19, 2010. Numbers are subject to change due to pending projects.

The reduction trend for NO_X in both allowances allocated and actual emissions expended are shown in Figure D-8*: Mass Emission Cap and Trade Trend for NO_X Emissions Allowances Allocated and Yearly Emissions***.** This table shows the reductions made in the allocated allowances. It also shows the corresponding reductions in the emissions for applicable sources.

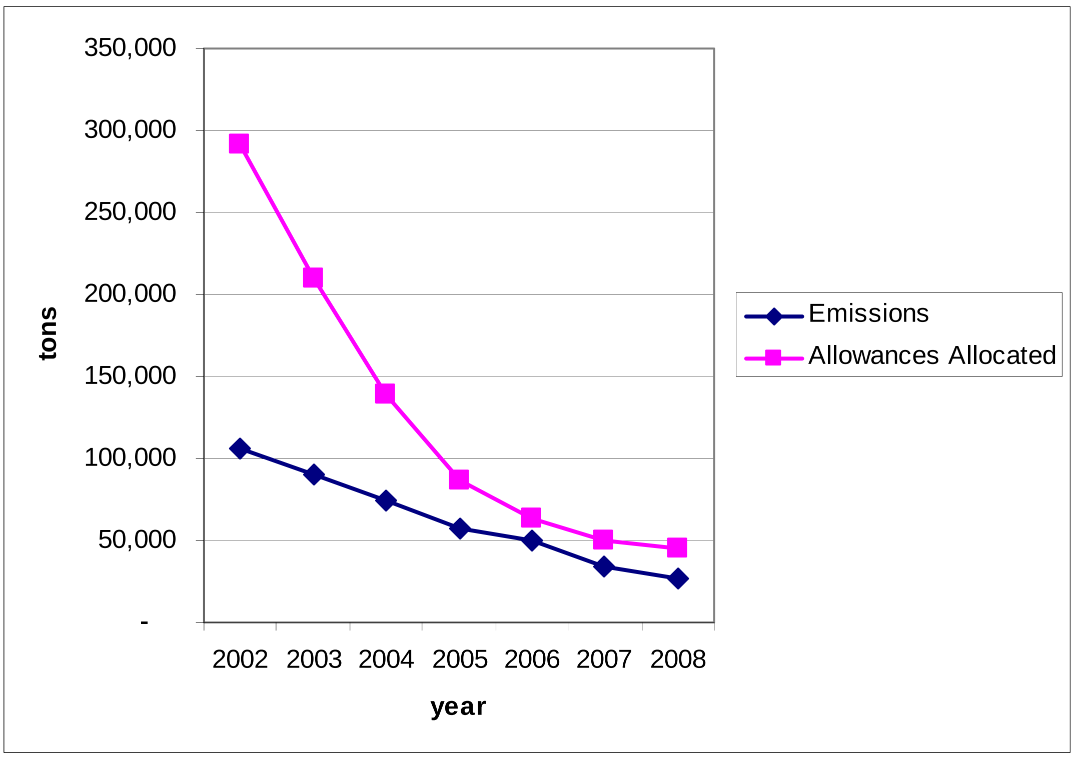

Figure D-8: Mass Emission Cap and Trade Trend for NO_X Emissions Allowances Allocated and Used. (Data Source: TCEQ)

Conclusion

Emissions declined in the HGB area between 2002 and 2008 by 44 percent for NO_X and 14 percent for VOC, in spite of steadily increasing population and increases in economic activity in the area as discussed in Appendix B: *Economic Analysis*. The estimated area source amount of 135,789 tpy was 59.3 percent of the overall total emissions in 2008. The VOC emissions from this category decreased 6.6 percent in spite of the steadily increasing population in the HGB area. The area source NO_X decreased by 22.4 percent during this same period.

The point source VOC emissions decreased 32.3 percent between 2002 and 2008. The NO_X emissions from point sources decreased 67.7 percent over the same time period. These reductions are largely due to rules and control measured implemented by the TCEQ. Additional rules implemented by the federal government and refinery consent decrees implemented by the United States Department of Justice also contributed to these reductions.

The agency's HECT and MECT programs were designed with decreases in the annual allowances allocated. These programs have successfully, in conjunction with agency limitations on applicable emissions sources, reduced the amount of NO_X and HRVOC emitted from the applicable sources. Actual NO_X emissions expended under the program have decreased from 106,573 tpy in 2002 to 26,330 tpy in 2008. The allowances allocated were reduced 84.7 percent between 2002 and 2008; the allocated amount was reduced from 291,962 tpy in 2002 to 44,767 tpy in 2008. The current, and thus, future cap levels limit emission levels to amounts lower than the actual amount prior to 2006 levels.

Over time, older higher-emitting portions of the on-road fleet are being phased out and cleaner vehicles with more stringent federal emissions standards are growing. As a result, on-road mobile source emissions are decreasing although vehicle miles traveled are increasing. The VOC emissions decreased 18.9 percent and the NO_X emissions decreased 42.4 percent between 2002 and 2008.

A specific list of control measures that resulted in permanent and enforceable reductions in VOC and NO_X emissions in the HGB area between 2002 and 2008 are listed in Attachment E: *Control Measures*.

References

EIA. United States Energy Information Administration website, www.eia.doe.gov

Pechan. Analysis of Historical Emission Changes to Inform New Emission Projection Analysis, Final Report, prepared by E.H. Pechan & Associates, March 2009

TTI. Texas Transportation Institute, TxDOT RIFCREC HPMS Data, Episode is Summer (J-J-A) Weekday (M-F), Episode adjustment to AADT based on 2000 - 2008 ATR data, prepared by Dennis Perkinson, February 13, 2010

ATTACHMENT E: CONTROL MEASURES

Summary
This attachment identifies control measures that have resulted in emissions reductions of nitrogen oxides (NO_X) and volatile organic compounds (VOC) that contributed to the reduction in the emission inventory from 2002 through 2008 and the air quality improvements in the Houston-Galveston-Brazoria ozone nonattainment area (HGB area). The HGB area includes Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties. All of the listed measures for 2002 through 2008 are approved by the United States Environmental Protection Agency (EPA) as part of the state implementation plan (SIP). Table E-1: *Texas Rule Control Measures Applicable to the HGB Area* lists control measures that were implemented as rules in the Texas Administrative Code (TAC) and resulted in permanent and enforceable emission reductions between 2002 and 2008 as well as additional reductions for 2009 and later. Table E-2: *Texas Non-Rule Control Measures Applicable to the HGB Area* lists non-rule control measures that were implemented as permanent and enforceable measures in the SIP that resulted in emission reductions between 2002 and 2008. Non-rule measures are made enforceable through the SIP and mechanisms such as agreed orders (AO), memorandums of agreement (MOA), or memorandums of understanding (MOU).

In addition to the state measures listed in this attachment, numerous federal measures have been implemented that have also resulted in NO_X and VOC reductions in the HGB area. Examples of these federal measures include: Tier 2 Emission Standards for Vehicles and Gasoline Sulfur Standards; Heavy-Duty Diesel Engine Rule; and Non-Road Diesel Engine Rule.

Table E-1: Texas Rule Control Measures Applicable to the HGB Area

Measure	TCEQ Rule Citation	EPA Approval (Most Recent)	Description
Control Measures Implemented 2002 through 2008			
NO_X Mass Emissions Cap and Trade (MECT) Program	30 TAC Chapter 101 Subchapter H, Division 3 §§101.350 - 101.363 30 TAC Chapter 117 Subchapter B, Division 3 §§117.300 - 117.356 Subchapter C, Division 3 §§117.1200 - 117.1256 Subchapter D, Division 1 §§117.2000 - 117.2045	11/14/01 - 66 FR 57252 09/06/06 - 71 FR 52664 12/03/08 - 73 FR 72562	NO_X reductions 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.
Highly Reactive Volatile Organic Compound (HRVOC) Rules and HRVOC Emissions Cap and Trade (HECT) Program	30 TAC Chapter 101 Subchapter H, Division 6 §§101.390 - 101.403 30 TAC Chapter 115 Subchapter H, Divisions 1 and 2 §§115.720 - 115.729 §§115.760 - 115.769	09/06/06 - 71 FR 52659 09/06/06 - 71 FR 52656	An annual emissions limit with a cap and trade and a short-term limit (1,200 pounds per hour) for each site in Harris County. The seven perimeter counties are subject to permit allowable limits. More stringent monitoring and testing requirements for all applicable sites in the eight nonattainment area counties.
HRVOC Fugitive Rules	30 TAC Chapter 115 Subchapter H, Division 3 §§115.780 - 115.789	09/06/06 - 71 FR 52656	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.
System Cap Requirements for Electric Generating Facilities	30 TAC Chapter 117 Subchapter B, Division 3 §117.320 Subchapter C, Division 3 §117.1220	12/03/08 - 73 FR 72562	Daily and 30-day rolling average NO_X emission system caps for applicable electric generating facilities with the owner's system in the nonattainment area. System cap requirements are in addition to the NO_X MECT program.

Table E-1: Texas Rule Control Measures Applicable to the HGB Area

Measure	TCEQ Rule Citation	EPA Approval (Most Recent)	Description
Stationary Diesel Engines	30 TAC Chapter 117 Subchapter B, Division 3 §§117.300 - 117.356 Subchapter D, Division 1 §§117.2000 - 117.2045	12/03/08 - 73 FR 72562	Diesel engine emission standards. Prohibition on operating stationary diesel and dual-fuel engines for testing and maintenance purposes between 6:00 A.M. and noon. Exemption criteria to discourage recycling of used diesel engines.
Natural Gas-Fired Small Boilers, Process Heaters, and Water Heaters	30 TAC Chapter 117 Subchapter E, Division 3 §§117.3200 - 117.3215	12/03/08 - 73 FR 72562	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. Implementation based on manufactured date.
Minor Source NO_X Controls for Non-MECT Minor Sites	30 TAC Chapter 117 Subchapter D, Division 1 §§117.2000 - 117.2045	12/03/08 - 73 FR 72562	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)).
Vehicle Inspection and Maintenance (I/M)	30 TAC Chapter 114 Subchapter C, Division 1 §§114.50 - 114.53	11/14/01 - 66 FR 57264 09/06/06 - 71 FR 52670	Yearly treadmill-type testing for pre-1996 vehicles and computer checks for 1996 and newer vehicles.
Texas Low Emission Diesel (TxLED)	30 TAC Chapter 114 Subchapter H, Division 2 §§114.312 - 114.319	10/06/05 - 70 FR 58325 10/24/08 - 73 FR 63378	Requires all diesel for both on-road and non-road use to have a lower aromatic content and a higher cetane number.
TxLED for Marine Fuels	30 TAC Chapter 114 Subchapter H, Division 2 §§114.312 - 114.319	10/24/08 - 73 FR 63378	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.
Non-Road Large Spark-Ignition Engine Standards (California Gasoline Engine Standards)	30 TAC Chapter 114 Subchapter I, Division 3 §§114.420 - 114.429	11/14/01 - 66 FR 57222	California standards for non-road spark-ignited (gasoline) engines 25 horsepower and larger.
Off-Set Lithographic Printing Operation VOC Controls	30 TAC Chapter 115 Subchapter E, Division 4 §§115.440 - 115.449	04/06/00 - 65 FR 18003 01/19/06 - 71 FR 3009 07/17/08 - 73 FR 40972	VOC control requirements for off-set lithographic printing operations with uncontrolled VOC emissions equal to or greater than 25 tpy.
Batch Process VOC Controls	30 TAC Chapter 115 Subchapter B, Division 6 §§115.160 - 115.169	12/20/00 - 65 FR 79745 07/16/01 - 66 FR 36913 02/27/08 - 73 FR 10383	VOC control requirements for vent gas streams at certain batch process operations with total VOC emissions equal to or greater than 25 tpy.

Table E-1: Texas Rule Control Measures Applicable to the HGB Area

Measure	TCEQ Rule Citation	EPA Approval (Most Recent)	Description
Portable Fuel Containers Rule	30 TAC Chapter 115 Subchapter G, Division 2 §§115.620 - 115.629 Rule repealed February 10, 2010: superseded by Federal rule 40 CFR 59, Subpart F (72 FR 8533, February 26, 2007)	02/10/05 - 70 FR 7041	Establishes new design "no spill" criteria requirements for portable fuel containers sold, offered for sale, manufactured, and/or distributed in Texas.
Control Measures Implemented 2009 and Later			
Off-Set Lithographic Printing Operation VOC Controls - Control Techniques Guideline Update	30 TAC Chapter 115 Subchapter E, Division 4 §§115.440 - 115.449	Not yet approved	More stringent requirements for off-set lithographic printing operations currently subject to rules. New requirements for minor off-set lithographic printing operations sites (between 3.0 and 25 tpy uncontrolled VOC) that were previously exempt.
HRVOC Emissions Cap and Trade (HECT) Program - 25 Percent Reduction in HRVOC Cap	30 TAC Chapter 101 Subchapter H, Division 6 §§101.390 - 101.403	Not yet approved	A phased 25 percent reduction in the allowable HRVOC cap for Harris County.
Updated VOC Storage Rules for Flash Emissions and Roof Landings	30 TAC Chapter 115 Subchapter B, Division 3 §§115.110 - 115.119	Not yet approved	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.
More stringent VOC Rules on Degassing Operations	30 TAC Chapter 115 Subchapter F, Division 3 §§115.541 - 115.549	Not yet approved	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.

Table E-2: Texas Non-Rule Control Measures Applicable to the HGB Ozone Nonattainment Area

Measure	SIP Enforceable Mechanism	EPA Approval (Most Recent)	Description
Speed Limit Reduction	State and local police enforcement 2004 HGB SIP	11/14/02 - 67 FR 68944 09/06/06 - 71 FR 72670	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.
Voluntary Mobile Emissions Reduction Program (VMEP)	Houston-Galveston Area Council (H-GAC) Commitment 2004 HGB SIP	09/06/06 - 71 FR 72670	Voluntary measures administered by H-GAC (see Appendix F7 of the 2004 HGB Mid-Course Review SIP revision) (Tug/Tow, Ferries, and Railroad MOAs listed separately)
HGB Area Tugboat and Towing Agreement (Part of VMEP)	MOA with EPA, H-GAC, and participating companies 2004 HGB SIP	09/06/06 - 71 FR 72670	Participating companies implemented measures to reduce emissions from tugboats and towing vessels. Examples include: operating practices to reduce engine idling; local fleet management programs; modifications to tug, towing vessel, and barge engine and support equipment; early integration of new marine diesel engines; retrofit of existing marine diesel engines; early use of regulated fuels; and other maintenance measures.
Emission Reductions from Texas Department of Transportation (TxDOT) Ferries (Part of VMEP)	MOA with EPA, H-GAC, and TxDOT 2004 HGB SIP	09/06/06 - 71 FR 72670	TxDOT implemented measures to reduce emissions from ferries. Examples include: operating practices to reduce engine idling; vessel engine modifications; early integration of new marine diesel engines; retrofit of existing marine diesel engines; early use of regulated fuels; and other maintenance measures.
HGB Area Railroad Program (Part of VMEP)	MOA with the EPA, H-GAC, and Participating railroad companies 2004 HGB SIP	09/06/06 - 71 FR 72670	Participating railroad companies implemented measures to reduce emissions from HGB area railroad operations. Examples include: operating practices measures, including application of methods to reduce locomotive idling time; switch and local unit fleet management measures, including assignment of specific locomotives to the HGB area; modifications to the locomotive engine and support equipment; use of regulated fuels; and other maintenance measures consistent with railroad support operations.
Houston Airport System Ground Support Equipment (GSE) Agreement	MOA with the City of Houston 2000 HGB SIP	11/14/01 - 66 FR 57222 11/14/01 - 66 FR 57195	City of Houston implemented measures to reduce emissions from GSE used at the Houston Airport System. Examples include: consolidation of rental car facilities and common bussing system; consolidated employee parking lot and busses; cleaner busses for the City economy lot; a fuel cell technology pilot program; and voluntary reductions by various operators.

Table E-2: Texas Non-Rule Control Measures Applicable to the HGB Ozone Nonattainment Area

Measure	SIP Enforceable Mechanism	EPA Approval (Most Recent)	Description
Southwest Airlines Co. (Southwest) NO_X Controls	AO and MOA with Southwest (AO No. 2000-0827-SIP) 2000 HGB SIP	11/14/01 - 66 FR 57222 11/14/01 - 66 FR 57195	Southwest implemented measures to reduce NO_X emissions from sources located at the Houston-Hobby Airport under the control of Southwest. Measures had to result in a 75 percent reduction in the NO_X emissions from Southwest's 1996 GSE fleet.
Continental Airlines Co. (Continental) NO_X Controls	AO and MOA with Continental (AO No. 2000-0826-SIP) 2000 HGB SIP	11/14/01 - 66 FR 57222 11/14/01 - 66 FR 57195	Continental implemented measures to reduce NO_X emissions from sources located at the Bush Intercontinental Airport (IAH) under the control of Continental. Measures had to result in a 75 percent reduction in the NO_X emissions from Continental's 1996 GSE fleet.
Transportation Control Measures	H-GAC Commitment 2004 HGB SIP	 09/06/06 - 71 FR 72670	Various measures in H-GAC’s long-range transportation plans.