Eastern Research Group, Inc.

Sampling and Laboratory Analysis of Retail Gasoline and Diesel Fuel for Selected Texas Cities – Summer 2008

FINAL REPORT

Prepared for:

Texas Commission of Environmental Quality (TCEQ)

August 31, 2008

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ERG No. 0230.01.006.001
TCEQ Contract No. 582-7-84004
Work Order No. 06

SAMPLING AND LABORATORY ANALYSIS OF RETAIL GASOLINE AND DIESEL FUEL FOR SELECTED TEXAS CITIES – SUMMER 2008

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August 31, 2008

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Project Overview

The purpose of this Work Order was to develop physical properties and speciation profiles, and to report laboratory test results for samples of gasoline and diesel fuel collected from retail stations across Texas. Testing of various properties was completed in an approved laboratory which involved speciation of volatile organic compounds (VOC) including oxygenates, determination of Reid vapor pressure (RVP), and estimation of sulfur in gasoline, and quantification of aromatics, cetane and sulfur in diesel fuel.

In order to maintain a high confidence level in the fuel parameters used in the development of on-road emission inventories, trend analysis and control strategy analysis, TCEQ has undertaken a program to periodically collect and analyze fuel samples. The data will ensure the accuracy of local specific fuel information and also provide the best data available to be used for analysis to support Texas State Implementation Plan (SIP) and control strategy development.

Samples of regular, mid-grade, and premium gasoline, and diesel fuel were taken from 92 retail gas stations, from the twenty-five areas across the state. The 25 areas corresponded to the 25 Texas Department of Transportation (TxDOT) Districts.

The following summarizes the results of this study, including sample collection and lab analysis, the development of fuel parameter files for use in MOBILE6 based on this data. Detailed electronic files with supporting data and analysis are provided separately on CD.

Site Selection

In this task ERG developed a fuel sampling plan to be implemented by Southwest Research Institute (SwRI) during the summer of 2008. ERG obtained background information to help assess the geographic and temporal boundaries for sampling at retail stations. This information included:

1) The geographic boundaries of the twenty-five TxDOT districts throughout the state;
2) Surrogates for estimating sales volumes from readily available data, including underground storage tank numbers and sizes (obtained from TCEQ Petroleum Storage Tank Database).

ERG used this information to develop the strata for the fuel sampling task, specifying the areas within the districts and station sizes.

Fuel Sampling Plan and Site Selection

A Sampling Plan was developed to specify the minimum number of samples per district, the total number of samples (including the number of diesel and gas samples, across gas grades), and the allocation of samples across the different areas. The following sampling plan specifications were established in consultation with the TCEQ Project Representative:

- Each fuel sampling city had a minimum of three sample sites;
- Both diesel and gasoline samples were to be collected at each location;
- Regular, mid-grade, and premium gasoline grades were to be sampled;
- Gasoline and diesel samples were to be collected separately, with no compositing of samples.

This approach requires a lab test of every sample, and is therefore more costly and limits the total number of stations. However, it does provide an indication of differences *within* areas that would not be discernable using the compositing approach. Specifically, this approach enables the determination of minimum, maximum and average fuel parameter values, not just averages for each region. This characterization is more consistent with MOBILE modeling, in that it would allow TCEQ to specify maximum and average parameter values for inputs like fuel sulfur levels.

To identify specific fuel stations for sampling, petroleum storage tank (PST) data was obtained from the TCEQ[1], consisting of several large text files. The files obtained from TCEQ included :

- Facility – contains location, number of tanks, and facility type;
- Tanks – contains tank size information and status (active or inactive);
- Composition – contains tank-specific information including fuel type.

These files were merged into one master file for site selection purposes. Next, only retail establishments were selected where the status was "active" within the PST database. (Note that retail service stations are only one type of facility that can have tanks; others include bulk fuel terminals, state agency fleet tanks, municipal fleet tanks, among others.) This filter yielded 37,003 gasoline stations, and 7,614 establishments that sold diesel. To ensure that the larger service stations were sampled – used as a surrogate for high throughput since actual throughput data is only available at the wholesale level -- the list was narrowed down by extracting only those facilities that had tank capacities over 10,000 gallons. Furthermore, ERG obtained a list of stations with enforcement actions against them from the TCEQ,[2] and any stations with enforcement actions against them were eliminated. This yielded two lists from which fuel samples could be selected: 6,426 gasoline stations and 2,471 diesel stations. These lists were not mutually exclusive, in that many stations offered both fuel types.

The above data lists were then merged to only consider stations providing both gasoline and diesel (as an efficiency measure for sampling), resulting in a list of approximately 2,300 gas stations that were candidates for sampling. Each of these gas stations was assigned to a TXDOT district based on the area where they were located.

Given that each district required a minimum of three stations to sample, stations were selected for each area using a weighted random sample. Specifically, weights were applied to each station that were directly proportional to the total number of gas plus diesel tanks listed for each station in the PST database. Random numbers between 0 and 1 were then assigned to each station, and multiplied by the weighting factor. The resulting list was then sorted by weighted random number in descending order for station selection.

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[1] Annual Enforcement Report Fiscal Year 2007, Enforcement Division Office of Compliance and Enforcement Texas Commission on Environmental Quality, November 2007

[2] Texas Commission on Environmental Quality, IR / Open Records & Reporting Services.

Additional sites were also selected based on their 8-hour ozone standard designation. Please see the "selection" page in Attachment 1 for the results of this process. Note that additional stations in each area were listed as potential alternates in case any of the others couldn't be located, had closed down, etc. Name and address of these sites were provided to SwRI for execution of the field sampling task, as described below.

Table 1 summarizes the number of fuel samples designated for each region of the state.

Table 1. Sampling Plan Summary Table

City Name	Number of Stations	Area Designation
Abilene	3	Attainment area
Amarillo	3	Attainment area
Texarkana	3	Attainment area
Austin	5	EAC area
Beaumont	5	BPA Nonattainment area
Brownwood	3	Attainment area
Bryan	3	Attainment area
Childress	3	Attainment area
Corpus Christi	4	Near Nonattainment area
Dallas	4	DFW Nonattainment area
El Paso	4	Attainment area, Maintenance
Fort Worth	4	DFW Nonattainment area
Houston	7*	HGB Nonattainment area
Laredo	3	Attainment area
Lubbock	3	Attainment area
Lufkin	3	Attainment area
Paris	3	Attainment area
San Angelo	3	Attainment area
San Antonio	5	EAC area
Tyler	5	EAC area
Wichita Falls	3	Attainment area
Odessa	3	Attainment area
Waco	3	Attainment area
Victoria	4	Victoria Near Nonattainment area
McAllen	3	Attainment area
Total	**92***	

*The 7 Houston area stations received a second round of testing in August of 2008.

In addition to this initial round of sampling, a second round of testing was conducted in an attempt to obtain a better understanding of temporal variability of fuel composition <u>within</u> a region. For a subset of fueling stations (the seven located in the Houston area), SwRI conducted a second round of sampling, approximately six weeks after the first round of sampling, to ensure complete tank turnover. This second round of sampling was intended to make a preliminary assessment of the temporal variability of fuel parameters at the station level.

Sampling and Laboratory Analysis

Objective

The following describes the sampling protocol and laboratory test results for the study. Under this project, SwRI provided containers and packaging, gasoline and diesel sample acquisition services from retail station pumps, shipping, sample handling and testing for summer fuels in 2008. Service station locations were identified by ERG, as described above.

Retail Station and Sample Collection and Handling Procedures

Independent contractors (IC) working with SwRI acquired fuel samples from retail stations. Each IC received written instructions, service station sampling procedures, sample containers, and shipping instructions. All contractors were instructed on retail station sample acquisition with special emphasis on sample handling and safe disposal of flushed gasoline.

SwRI used U.S. Department of Transportation (DOT) and International Air Transport Association (IATA) approved fuel sample containers and shipping cartons. Each carton held four aluminum containers. Boxes are assembled at SwRI by trained staff, and all appropriate shipping materials are provided to IC along with DHL-approved instructions for shipment of hazardous materials.

The containers were delivered cleaned and dried to the independent contractors. IC purged three gallons of gasoline product through the pump nozzle before obtaining a sample, or purged ½ gallon of the appropriate fuel immediately after the appropriate grade was purchased by the previous customer. When possible the temperature of the flushed sample was recorded. Immediately after the fuel was flushed from the pump, IC attached a spacer, if needed, to the pump nozzle. The nozzle extension was inserted into the sample container. The pump nozzle was then inserted into the extension with slot over the air bleed hole. The sample container was slowly filled through the nozzle extension to 70 to 85% full. The nozzle extension was removed. The seal and cap were inserted in the sample container at once. Checks were performed for leaks and the sample was prepared for air shipment. Contractors also recorded the ground cover type around the pumps at each station.

When diesel samples were acquired, the independent contractors filled the sample container slowly to 70 to 85% full. The seal and cap were inserted into the sample container at once. Checks for leaks were performed and then the sample was prepared for air shipment.

SwRI used DHL for sample shipment return to SwRI. Members of the SwRI shipping and receiving team meet regularly with DHL and attend IATA and International Civil Aviation Association (ICAO) hazardous materials shipping and handling training sessions to keep abreast of current regulations. All samples were chilled.

Sample Locations and Grades of Fuel

Four fuel samples were acquired at each station visited, including three grades of gasoline and one diesel sample. Sampling took place at a minimum of three retail stations for each of the 25 districts of the state, as discussed above. Attachment 2 contains the listing of all samples acquired, date of sampling, location name, brand of fuel, address, gasoline grades acquired, posted octane, temperature of flushed sample and pad cover of sampling location.

Laboratory Testing

All testing was accomplished in the PPRD laboratories of the Automotive Products and Emissions Research Division at Southwest Research Institute. The facilities are located at 6220 Culebra Road, San Antonio, Texas.

Gasoline Testing

Gasoline testing was performed on individual regular, mid-grade, and premium gasoline samples. There was no compositing of samples, as discussed above. Testing included:

- Reid vapor pressure (ASTM D5191-07)
- Sulfur (ASTM D2622-07)
- Distillation (ASTM D86-07b)
- Benzene (ASTM D3606-06e1)
- Total aromatics and olefins (ASTM D1319-03e1)
- Oxygenates (ASTM D5599-00)
- Detailed Hydrocarbon Analysis (ASTM D6729-07)

Uncertainty values are listed in Table 2. Test results are provided in Attachment 2.

Table 2. Uncertainty Estimates on Composite Data Results

Property	Test Method	Level Measured	Uncertainty
Flash point	D93	118.4 F	2.6
Distillation	D86	Initial Boiling Point	2.54

Distillation	D86	10%	2.36
Distillation	D86	50%	1.96
Distillation	D86	90%	1.57
Distillation	D86	Final Boiling Point	5.11
Cetane number	D 613	38.51-55.69	2.7
API	D 287	23.71-65.6	0.2
Aromatics	D 1319	30%	0.54
Saturates	D 1319	60%	0.59
Olefins	D 1319	10%	0.64
Relative Density	D 1298	0.71876 - 0.96492	0.001308
Sulfur	D 2622	450 ppm	11.3
Sulfur	D 2622	50 ppm	4.2
Poly Aromatics	D 5186	7.49 mass %	1.55
Mono Aromatics	D 5186	26.33 mass %	0.84
Total Aromatics	D 5186	34.51 mass%	1.38
Nitrogen	D 4629	50 mg/kg	3.67
Nitrogen	D 4629	150 mg/kg	6.9
Relative Density	D 4052	1.00000	0.00003
Relative Density	D 4052	0.6884	0.00004
Benzene	D 3606	0.800 vol%	0.036
RVP	D 5191	6.400 psi	0.048
RVP	D 5191	9.960 psi	0.07
TAME	D 5599	5.790 wt%	0.062
Ethanol	D 5599	10.100 wt%	0.235
Sulfur	D 5453	250 mg/kg	15.598
Sulfur	D 5453	25 mg/kg	1.665

Diesel Testing

Diesel samples were acquired and tested at all retail fuel sites. Sample testing performed on each sample included:

- Cetane Number (ASTM D613-05)
- Calculated cetane index (ASTM D976-06)
- API Gravity (ASTM D287-92(2006))
- Specific gravity (ASTM D1298-99(2005))
- Sulfur (ASTM D5453-06)
- Nitrogen (ASTM D4629-02(2007))
- Aromaticity (ASTM D1319-03e1)
- Total aromatic content (ASTM D5186-03)
- Polycyclic aromatic content (ASTM D5186-03)
- Distillation (ASTM D86-07b)
- Flash point (ASTM D93-07)

Sample identification and test results for diesel fuel are listed in Attachment 3. Uncertainty results for diesel analyses are not available.[3]

[3] See the applicable ASTM test procedures for repeatability and reproducibility precision estimates.

Updated MOBILE6.2 Fuel Parameter Input Files for Texas Counties

Overview

ERG used gasoline fuel sample data collected by SwRI to develop updated fuel parameter input data for MOBILE6.2. Fuel parameter files were developed for each county in Texas using fuel sample data obtained from the 92 gasoline and diesel retail locations across the State in the summer of 2008.

Methodology

The SwRI gasoline data required significant formatting prior to development of the average MOBILE6.2 parameter values. The source data was compiled in a spreadsheet with each station and gasoline grade results presented on separate worksheets. The header section of the data contained service station information, RVP, and fuel sulfur content. The body of the workbook contained chemical name, Chemical Abstracts Service (CAS) number, and percent weight by volume (mol weight was also included). ERG proceeded to extract the required parameters into one large flat file, rather than 276 individual files.

SwRI was first consulted as to how to interpret the results, which contained multiple entries for certain contaminants and combinations of contaminants. SwRI processed their data and the following parameters were sent to ERG:

- RVP (EPA Method)
- Sulfur (ppm)
- Aromatics
- I-Paraffins
- Naphthalenes
- Olefins
- Paraffins
- Benzene
- Ethanol
- MTBE
- ETBE
- TAME

MS Excel macro programs were developed to extract the specific contaminants from each sample and their associated CAS number, percent weight, percent volume, and percent MOL. ERG used a separate summary sheet to gather all of the extracted data from each tab, and then wrote the summary to a comma separated variable (.CSV) file for export. The summary contained sample identification number (ID), sample date, survey area, location name, city, zip code, fuel grade, RVP, and sulfur content (ppm).

To extract component data, ERG set up a filter to display compounds of interest (e.g., benzene, ETBE, MTBE, TAME, and EtOH) on each tab. ERG then copied the filtered data into a separate summary sheet (titled "Contams"), and exported the data to a .CSV file. This summary included sample ID, group code, compound name, CAS #, weight percent, volume percent, and MOL percent.

These files were then processed for further evaluation using SAS™. A query was written to extract station information along with fuel parameters, resulting in several dependent tables. Six dependent tables were then merged by the station sample ID number assigned by SwRI. Attachment 4 provides the SAS program used for this task.

Since three grades of gasoline were sampled, regular, mid-grade, and premium blend data were extracted from the master file separately for each grade. Parameters for RVP, fuel sulfur, benzene, ethanol, MTBE, ETBE, and TAME were then averaged by geographic area. For example, benzene for gasoline was averaged for each of the 25 districts, for regular, mid-grade, and premium blends.

ERG then used the SwRI results to calculate the required MOBILE6.2 fuel parameter inputs, weighting across fuel grades using the latest available sales data from the Energy Information Administration (EIA).[4] According to EIA data for Texas in 2007, regular gasoline comprised 86% of the market, mid-grade gasoline comprised 8%, and premium gasoline comprised 6%. These weighting factors were applied to each of the geographic areas for each parameter. Such a weighting process can be applied to any of the over 50 chemical compounds evaluated in the SwRI analysis.

The resulting weighted MOBILE6.2 fuel parameter inputs for gasoline included:

- RVP
- Sulfur (ppm)
- Olefins (% vol)
- Aromtaics (% vol)
- Benzene (% vol)
- Oxygentates (% vol)

[4] Table 39: Refiner Motor Gasoline Volumes by Grade, Sales Type, PAD District, and State from the Preliminary Petroleum Marketing Annual 2007, Energy Information Administration. http://www.eia.doe.gov/pub/oil_gas/petroleum/data_publications/petroleum_marketing_annual/current/pdf/pmaall.pdf

Additional MOBILE6.2 fuel input requirements include E200, E300, and oxygenate market share. SwRI performed distillate analysis, providing the temperatures corresponding to specific sample fractions (e.g., 5%, 10%, 20%, etc.), as shown in Attachment 2. In order to estimate E200 and E300 fractions as required by the MOBILE6.2 model, ERG performed a simple interpolation of the SwRI distillation data.

Oxygenate market share information was not available from the sample data, since the number of samples taken were too few to be statistically representative of overall fuel sales volumes in any given area. Therefore MOBILE6.2 default NTI oxygenate market share data were used for this parameter.

ERG then used the TxDOT mappings, assigning each county in the state to a unique TxDOT district. The county assignments were identical to those developed for the 2005 and 2007 sampling studies. Figure 1 indicates the TxDOT District boundaries and major city locations.

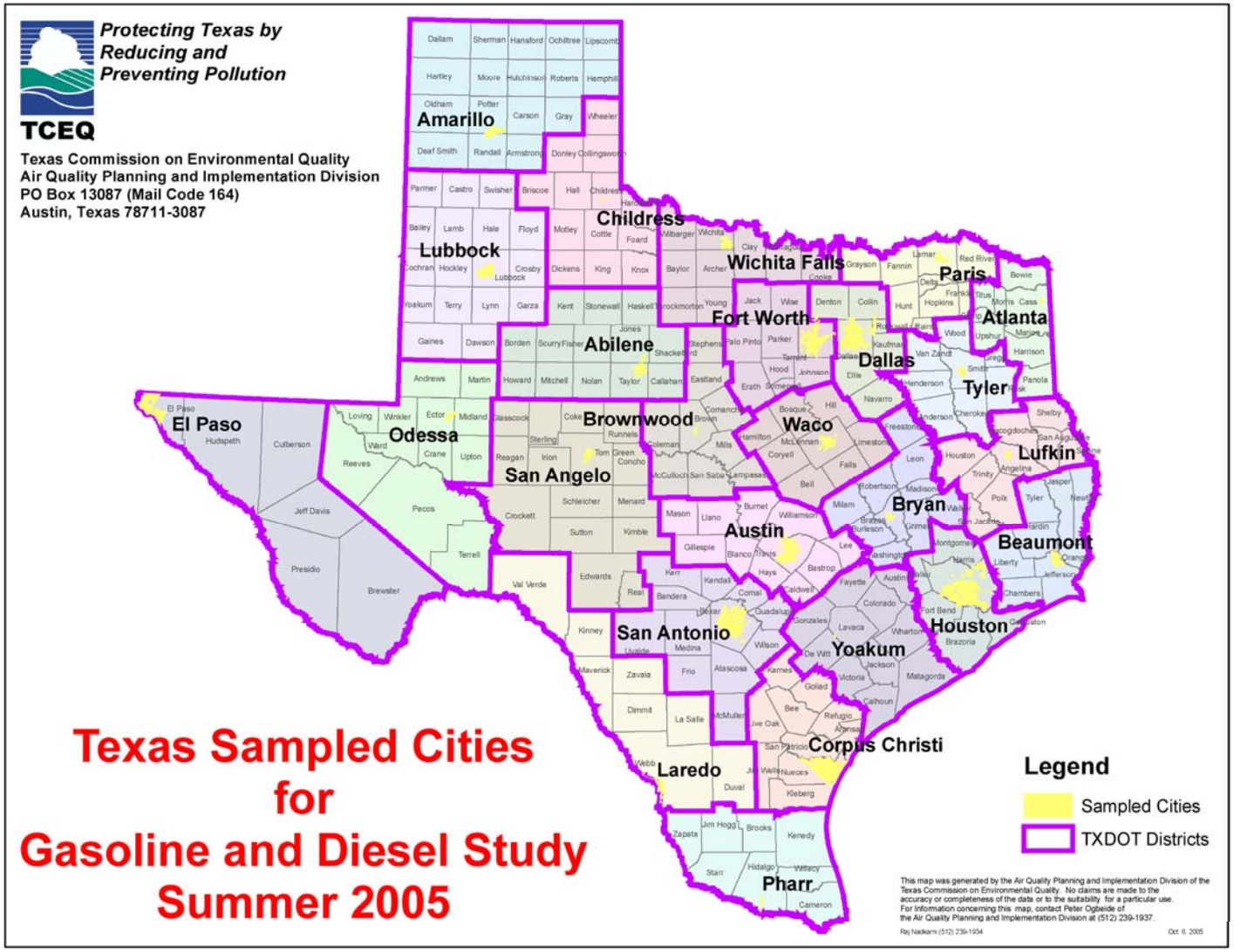


Figure 1. TxDOT Districts and Sampling Areas

Findings - Gasoline

The resulting MOBILE6.2 fuel parameter input values are presented in Table 3 for each of the 25 sampling regions, along with selected descriptive statistics. Note that statewide average values are not weighted by fuel consumption or other activity metrics, and are used only for identifying directional trends in fuel quality.

Table 3. Gasoline Properties by Region (Summer 2008)

Region	RVP	Sulfur (ppm)	Aromatics (% vol)	Olefins (% vol)	Benzene (% vol)	EtOH (% vol)	MTBE (% vol)	ETBE (% vol)	TAME (% vol)	E200 (%)	E300 (%)
ABILENE	8.06	35.3	41.36	5.64	1.92	0.006	0.055	0	0	42.62	81.53
AMARILLO	8.73	12.6	36.05	8.42	2.14	1.166	0.067	0	0.001	52.59	87.64
ATLANTA	7.33	66	36.15	7.88	1.96	0.000	0.084	0	0	42.37	83.26
AUSTIN	7.39	42.6	30.71	12.60	0.72	0.024	0.147	0	0	44.10	80.10
BEAUMONT	7.24	23.7	28.10	9.89	1.08	2.007	0.054	0	0.001	45.98	84.84
BROWNWOOD	7.56	35.8	27.61	12.58	0.68	0.000	0.150	0	0	44.42	80.16
BRYAN	7.44	8.4	39.14	3.40	1.88	0.001	0.051	0	0	43.11	81.79
CHILDRESS	9.06	9.8	33.32	8.46	2.07	3.329	0.101	0	0	58.20	88.32
CORPUS CHRISTI	7.48	28	23.20	15.86	0.73	0.032	0.114	0	0	47.39	83.74
DALLAS	6.85	26.7	18.46	7.05	0.53	5.904	0.048	0	0	49.00	86.00
EL PASO	7.44	160.7	34.89	12.10	2.24	0.738	0.000	0	0	44.31	85.48
FORT WORTH	6.97	23.8	18.28	6.12	0.47	6.815	0.062	0	0	48.81	85.40
HOUSTON	7.04	29.7	17.50	12.58	0.53	5.295	0.061	0.32	0.001	51.44	87.42
LAREDO	7.38	26.3	28.68	11.64	0.76	0.000	0.117	0	0.002	44.05	82.75
LUBBOCK	8.59	10.6	36.95	5.84	2.02	0.000	0.069	0	0	48.77	84.69
LUFKIN	7.68	51	35.35	9.16	1.68	2.177	0.095	0	0.003	44.83	83.73
ODESSA	8.39	30.4	34.45	10.07	1.08	0.000	0.106	0	0.003	44.53	81.47
PARIS	7.25	62.5	25.07	8.25	1.07	5.539	0.041	0	0	48.36	85.33
PHARR	8.44	24.9	27.80	16.31	0.87	0.000	0.000	0	0	51.81	82.54
SAN ANGELO	7.87	35.4	31.29	12.09	0.76	0.000	0.136	0	0.002	44.06	80.65
SAN ANTONIO	7.48	31	32.94	10.05	0.83	0.000	0.048	0	0	45.05	80.29
TYLER	7.69	116.5	34.69	9.09	2.25	3.830	0.042	0	0	46.80	84.73
WACO	7.44	79.3	32.29	11.47	1.35	0.593	0.000	0	0	43.71	80.27
WICHITA FALLS	8.71	35	33.45	10.59	2.72	0.000	0.102	0	0	46.05	88.36
YOAKUM	7.21	38.2	28.54	13.15	0.65	0.000	0.129	0	0	43.06	81.90
average	**7.71**	**41.77**	**30.65**	**10.01**	**1.32**	**1.50**	**0.075**	**0.01**	**0.00**	**46.62**	**83.69**
min	**6.85**	**8.4**	**17.50**	**3.40**	**0.47**	**0**	**0.000**	**0**	**0**	**42.37**	**80.10**
max	**9.06**	**160.7**	**41.36**	**16.31**	**2.72**	**6.815**	**0.150**	**0.32**	**0.003**	**58.20**	**88.36**

range	**2.21**	**152.3**	**23.86**	**12.91**	**2.25**	**6.815**	**0.150**	**0.32**	**0.003**	**15.83**	**8.27**
std deviation	**0.61**	**34.37**	**6.37**	**3.13**	**0.69**	**2.24**	**0.044**	**0.06**	**0.00**	**3.80**	**2.64**

By-county fuel parameter inputs for the summers of 2003 through 2008 (excluding 2006) can be found in Attachment 5, on the "NTI Inputs" worksheet. Fuel parameters for each sampling location, weighted across fuel grades and the specific sampling location/county assignments can be found on the "Master_output from SAS program" worksheet.

Figures 2 through 9 illustrate the trends in gasoline parameters for selected areas from 2003 through 2007. (Note that no testing was conducted in the summer of 2006.)

Figure 2. Gasoline RVP Trends for Selected Regions

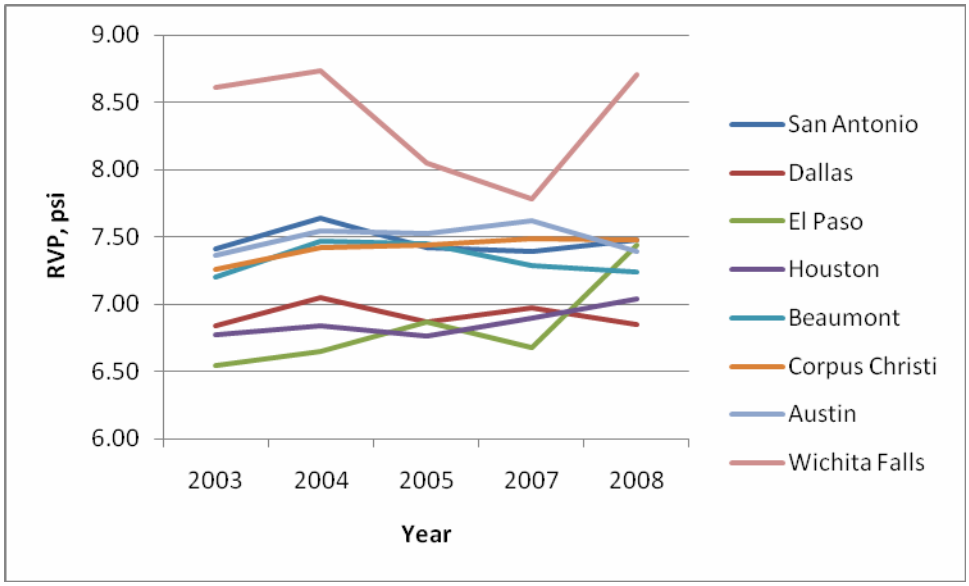


Figure 3. Gasoline Sulfur Trends for Selected Regions

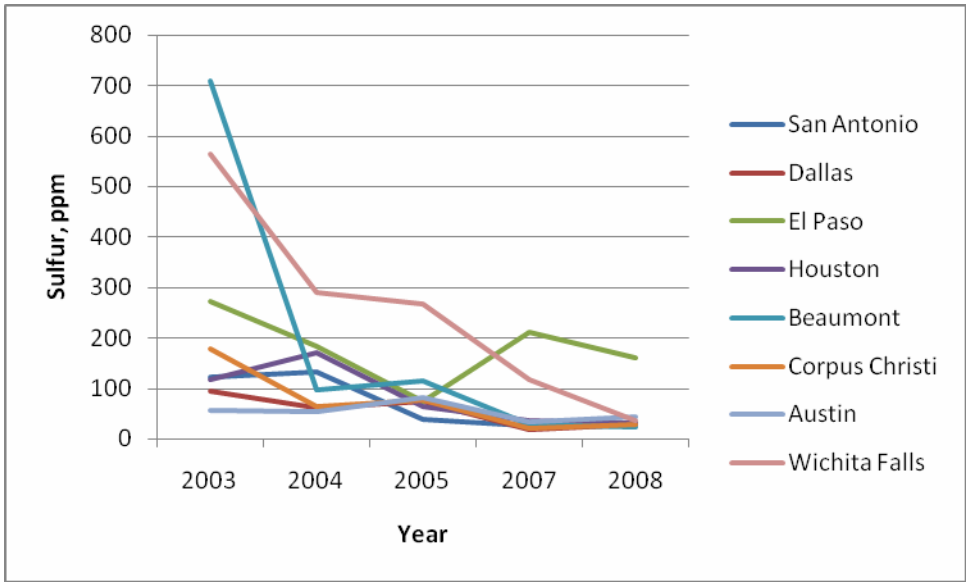


Figure 4. Gasoline Olefins Trends for Selected Regions

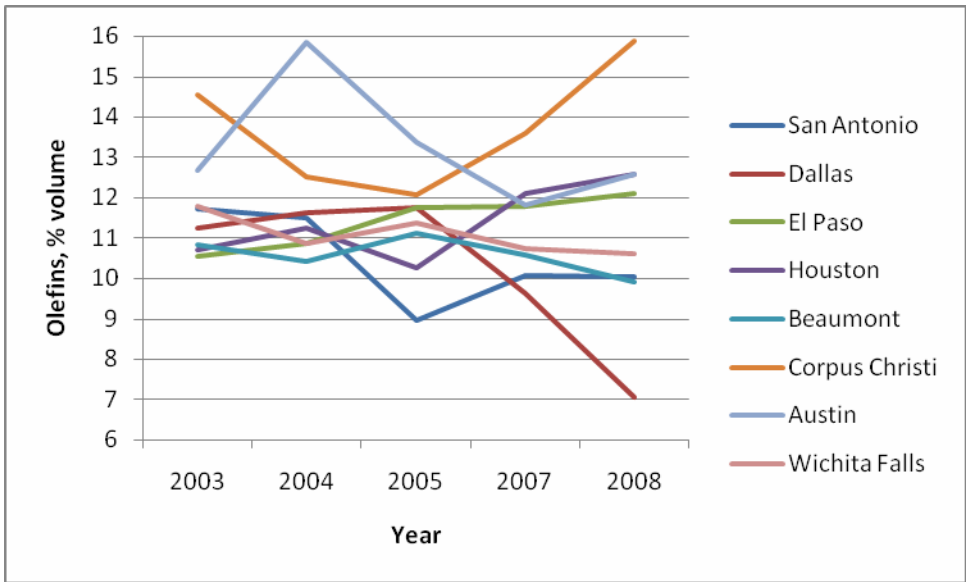


Figure 5. Gasoline Aromatics Trends for Selected Regions

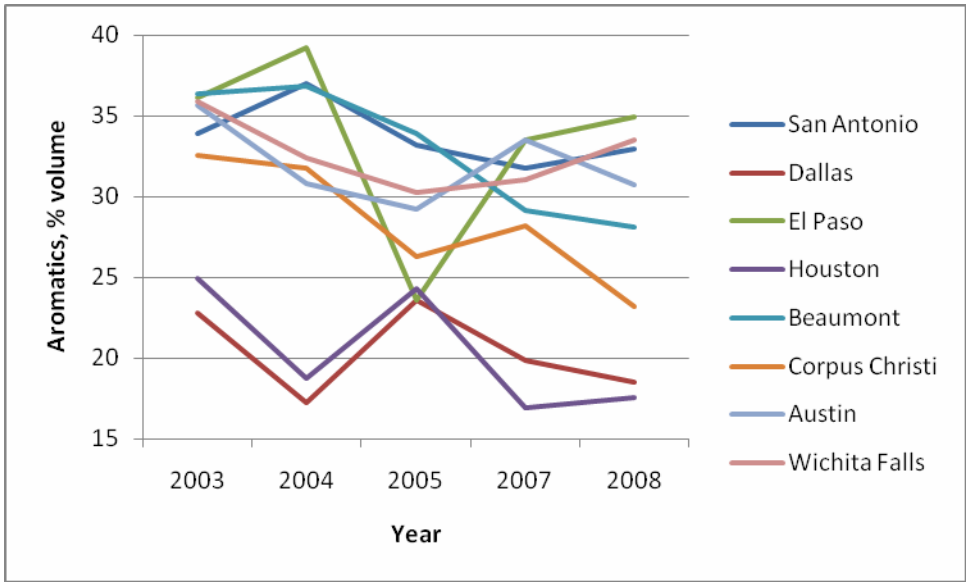


Figure 6. Gasoline Benzene Trends for Selected Regions

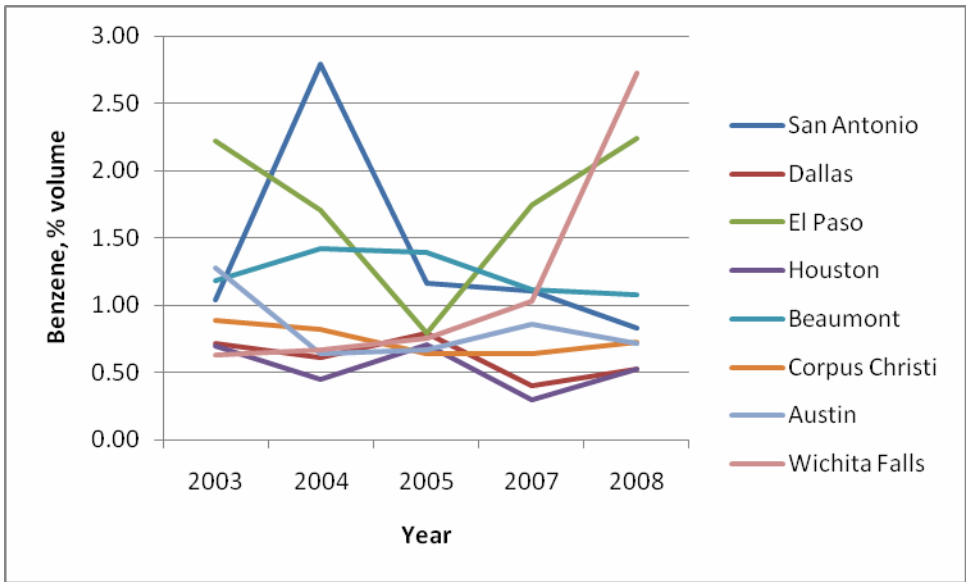


Figure 7. Gasoline MTBE Trends for Selected Regions

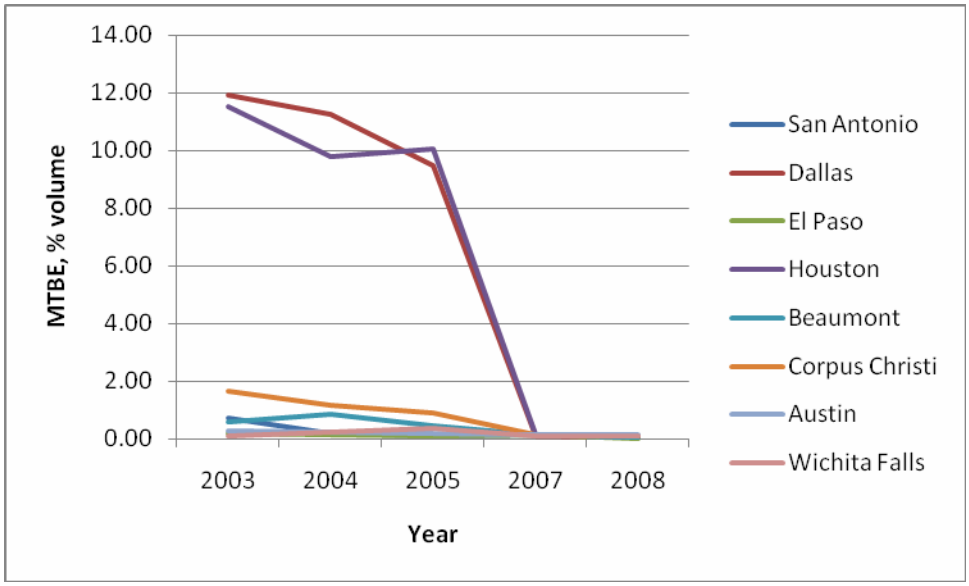


Figure 8. Gasoline ETBE Trends for Selected Regions

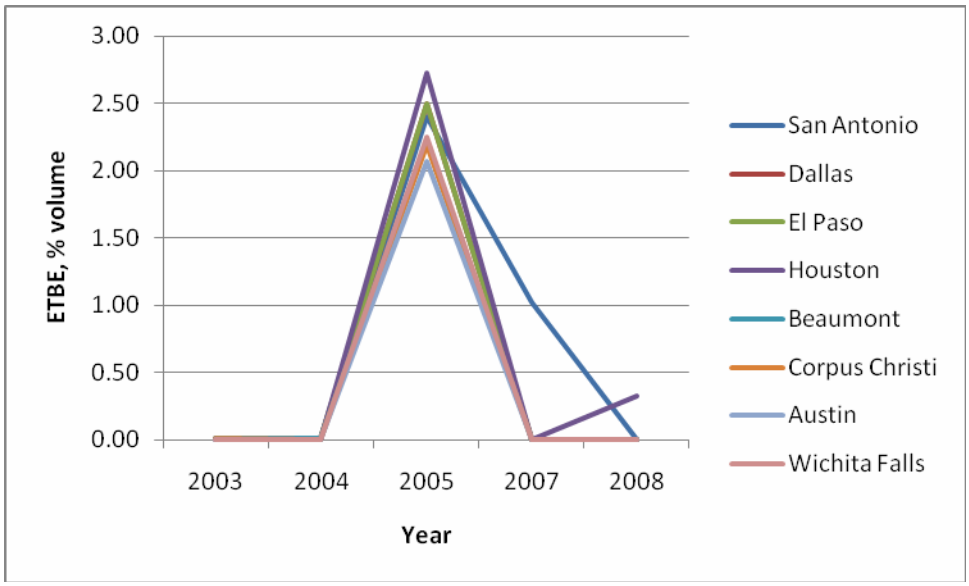
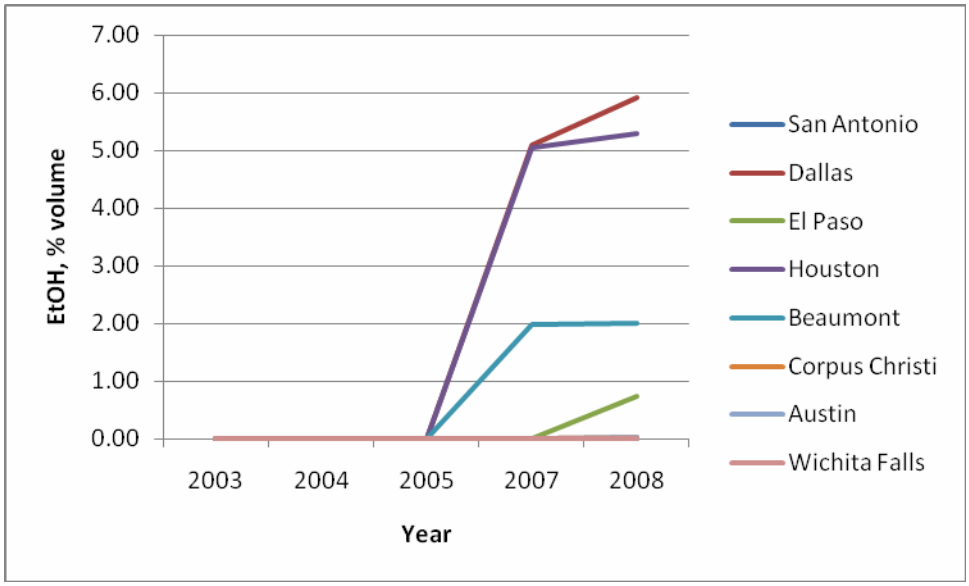


Figure 9. Gasoline Ethanol Trends for Selected Regions



Figures 10 through 12 show trends for TAME, E200, and E300 from 2007 to 2008. (Prior years are not available for comparison.)

Figure 10. Gasoline TAME Trends for Selected Regions

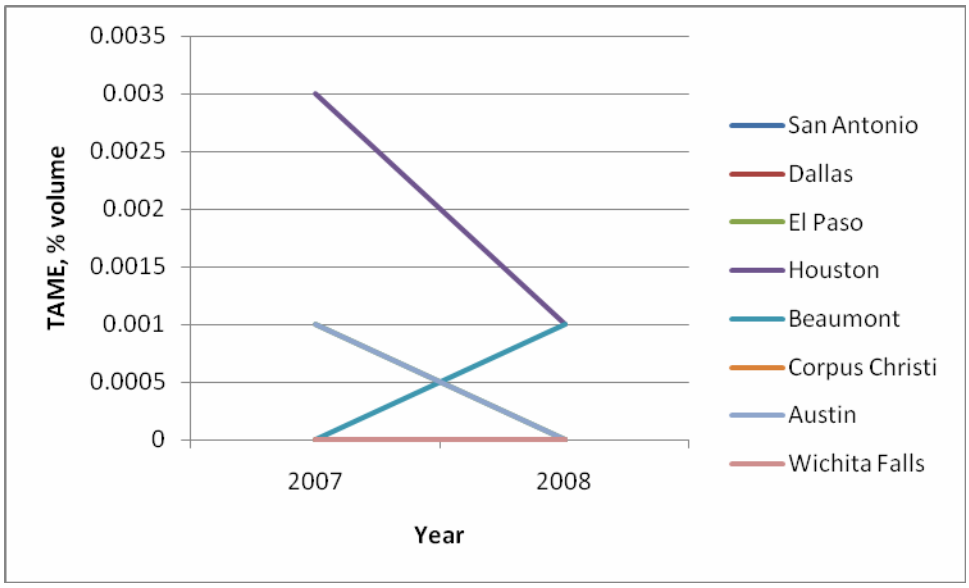


Figure 11. Gasoline E200 Trends for Selected Regions

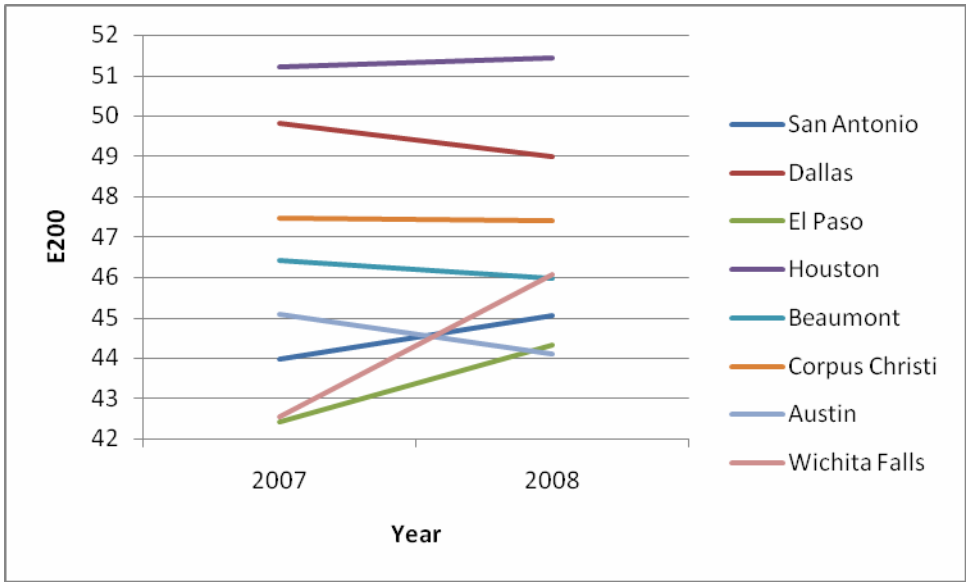
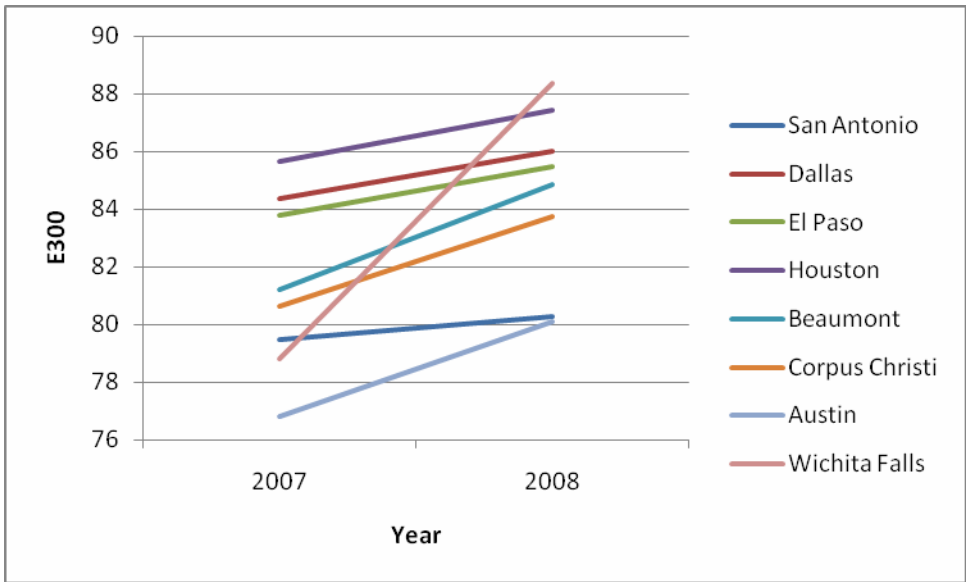


Figure 12. Gasoline E300 Trends for Selected Regions



A brief comparison of maximum differences for each fuel parameter across the selected counties is provided in Table 4. Sample sites corresponding to the maximum differentials are shown in parentheses. A table of how the regions sampled in 2007 compared to the TxDOT districts sampled in 2008 is available in Attachment 4 on the "District comp – 2008 vs. 2007" worksheet.

Table 4. Gasoline Comparison of 2008 with 2007 Findings*

Fuel Parameter	Maximum Delta
RVP	**+0.93** (Wichita Falls)
Sulfur (ppm)	**-174.80** (Abilene)
Olefins (% vol)	**-6.44** (Abilene)
Aromatics (% vol)	**+11.13** (Abilene)
Benzene (% vol)	**+1.70** (Wichita Falls)
Ethanol (% vol)	**+5.54** (Paris)
MTBE (% vol)	**-0.14** (Pharr)
ETBE (% vol)	**-1.02** (San Antonio)
TAME (% vol)	**-0.01** (Atlanta, Paris)
E200	**+10.87** (Childress)
E300	**+9.58** (Wichita Falls)

*Changes are expressed in absolute terms. Positive values indicate increases relative to 2005, negative values indicate decreases

The following provides some general observations regarding the gasoline sampling data.

- While RVP in most regions appears relatively stable over time, Wichita Falls showed a sharp increase in average RVP between 2007 and 2008.
- Sulfur averages continue to decline, as expected with the new Federal fuel standards.
- There doesn't appear to be any apparent trend in olefins, aromatics, or benzene in most regions.
- Wichita Falls and El Paso regions showed a sharp increase in benzene averages.
- MTBE averages have declined in all areas as expected.
- The Houston area showed a sharp increase in average ETBE between 2007 and 2008.
- Ethanol averages continue to rise in most regions as expected.
- While there is no clear trend for E200, E300 values increased between 2007 and 2008 for each of the key sampling regions evaluated.

Findings - Diesel

The diesel fuel the analysis focused on cetane, aromatics, specific gravity, T50 (ºF), olefins, saturates, and fuel sulfur. Summary results for 2008 are shown in Table 5, with selected descriptive statistics.

Table 5. Diesel Fuel Properties by Region (Summer 2008)

Region	Aromatics, % vol	Olefins, % vol	Saturate, % vol	Sulfur, ppm	Cetane No.	Specific Gravity	T50, deg F
ABILENE	28.5	4.2	67.2	5.3	47.5	0.84	500.00
AMARILLO	21.6	3.2	75.2	2.3	49.7	0.83	480.53
ATLANTA	20.1	3.5	76.4	8.7	53.8	0.83	507.97
AUSTIN	23.9	4.1	72.0	5.6	48.7	0.84	493.56
BEAUMONT	26.5	3.3	70.2	4.9	49.3	0.84	495.16
BROWNWOOD	25.7	4.6	69.7	5.5	45.6	0.84	489.23
BRYAN	20.5	4.0	75.5	4.7	54.6	0.82	501.73
CHILDRESS	20.1	2.9	76.9	3.5	49.5	0.83	480.47
CORPUS CHRISTI	19.3	4.3	76.5	31.1	50.8	0.83	497.75
DALLAS	30.1	4.0	65.9	6.1	46.1	0.84	499.18
EL PASO	28.3	3.2	68.5	5.7	46.8	0.84	499.98
FORT WORTH	27.1	5.1	67.8	4.6	47.9	0.84	509.55
HOUSTON	33.5	3.5	63.0	60.5	47.8	0.85	506.54
LAREDO	21.7	4.2	74.1	3.8	48.1	0.84	492.30
LUBBOCK	22.0	3.8	74.2	3.9	47.5	0.84	488.33
LUFKIN	24.7	3.5	71.9	5.8	50.2	0.83	491.63
ODESSA	26.0	3.7	70.3	5.0	47.4	0.84	503.70
PARIS	34.7	3.7	61.6	6.1	43.6	0.85	510.77
PHARR	19.6	4.6	75.8	3.2	52.5	0.83	497.73
SAN ANGELO	29.3	3.3	67.4	4.2	45.8	0.84	498.80
SAN ANTONIO	23.4	3.7	73.0	3.8	48.7	0.84	493.80
TYLER	28.4	5.2	66.4	9.7	48.2	0.84	497.50
WACO	21.3	4.0	74.7	5.6	50.2	0.83	492.13
WICHITA FALLS	25.1	4.2	70.7	5.4	51.3	0.83	485.53
YOAKUM	24.1	4.5	71.5	156.7	46.5	0.84	491.40
average	**25.02**	**3.93**	**71.05**	**14.47**	**48.72**	**0.84**	**496.21**
min	**19.28**	**2.93**	**61.63**	**2.27**	**43.57**	**0.82**	**480.47**
max	**34.67**	**5.20**	**76.93**	**156.65**	**54.60**	**0.85**	**510.77**
range	**15.39**	**2.27**	**15.30**	**154.38**	**11.03**	**0.03**	**30.30**
std deviation	**4.26**	**0.58**	**4.28**	**32.00**	**2.57**	**0.01**	**8.11**

Diesel fuel may qualify for a sulfur exemption from the Federal fuel standards, if it is labeled correctly. Examples of the different fuel labels are provided in Figures 13 and 14.

Figure 13. Low Sulfur Diesel Fuel Label

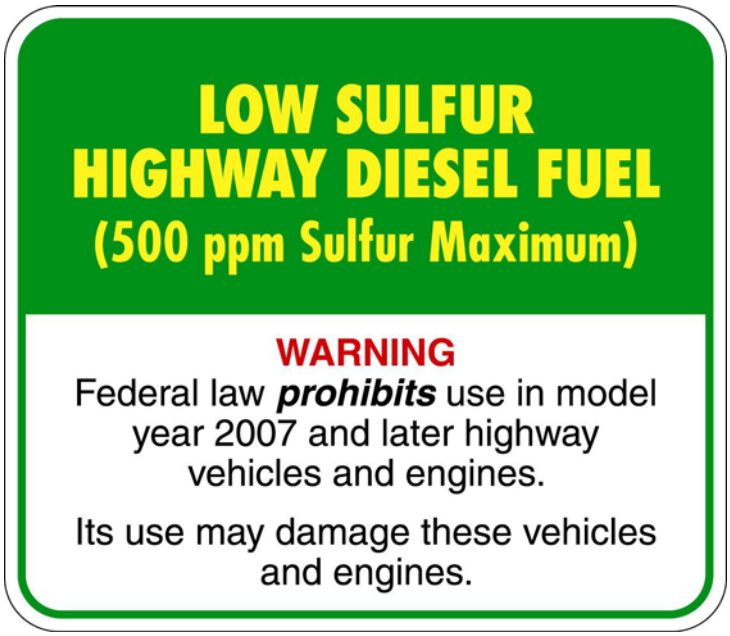


Figure 14. Ultra-Low Sulfur Diesel Fuel Label

The average values for diesel fuel, broken out by fuel type can be seen in Table 6 for low sulfur diesel. Eleven of the total diesel samples were labeled as low sulfur diesel. Table 7 shows the average values for ultra-low sulfur diesel. Eighty-five of the total diesel samples were labeled as ultra-low sulfur diesel. Three samples collected were not properly labeled at the

pump, and were generally classified as "diesel". These three samples were excluded from further analysis by type.

Table 6. Diesel Fuel Property Averages for Low Sulfur Diesel (LSD)

District	Sample Type	Aromatic, % vol	Olefins, % vol	Saturates, % vol	Sulfur, ppm	Cetane Number	Specific Gravity
AUSTIN	LSD	23.80	3.00	73.20	4.80	48.70	0.84
HOUSTON	LSD	33.45	3.33	63.23	101.38	47.93	0.85
LAREDO	LSD	22.10	3.80	74.10	5.00	48.20	0.84
SAN ANTONIO	LSD	23.50	2.40	74.10	3.30	47.60	0.84
TYLER	LSD	29.90	8.40	61.70	9.50	45.90	0.85
YOAKUM	LSD	27.60	4.25	68.15	309.75	43.50	0.84
	average	**26.73**	**4.20**	**69.08**	**72.29**	**46.97**	**0.84**
	min	**22.10**	**2.40**	**61.70**	**3.30**	**43.50**	**0.84**
	max	**33.45**	**8.40**	**74.10**	**309.75**	**48.70**	**0.85**
	range	**11.35**	**6.00**	**12.40**	**306.45**	**5.20**	**0.02**
	deviation	**4.39**	**2.16**	**5.60**	**122.49**	**1.95**	**0.01**

Table 7. Diesel Fuel Property Averages for Ultra-low Sulfur Diesel (ULSD)

District	Sample Type	Aromatic, % vol	Olefins, % vol	Saturates, % vol	Sulfur, ppm	Cetane Number	Specific Gravity
ABILENE	ULSD	28.53	4.23	67.23	5.30	47.53	0.84
AMARILLO	ULSD	21.57	3.20	75.23	2.27	49.67	0.83
ATLANTA	ULSD	20.07	3.53	76.40	8.73	53.83	0.83
AUSTIN	ULSD	23.91	4.40	71.69	5.85	48.70	0.83
BEAUMONT	ULSD	26.50	3.30	70.20	4.94	49.32	0.84
BROWNWOOD	ULSD	25.35	4.85	69.80	5.50	46.45	0.84
BRYAN	ULSD	20.50	4.02	75.48	4.73	54.60	0.82
CHILDRESS	ULSD	20.70	3.15	76.15	4.00	48.85	0.83
CORPUS CHRISTI	ULSD	19.28	4.28	76.45	31.13	50.75	0.83
DALLAS	ULSD	30.13	4.03	65.85	6.05	46.10	0.84
EL PASO	ULSD	28.33	3.23	68.45	5.73	46.75	0.84
FT WORTH	ULSD	27.10	5.10	67.80	4.63	47.93	0.84
HOUSTON	ULSD	33.53	3.67	62.80	6.03	47.57	0.85
LAREDO	ULSD	21.55	4.40	74.05	3.15	48.00	0.84
LUBBOCK	ULSD	22.00	3.83	74.17	3.87	47.47	0.84
LUFKIN	ULSD	24.67	3.47	71.87	5.77	50.17	0.83
ODESSA	ULSD	25.97	3.70	70.33	5.00	47.43	0.84
PARIS	ULSD	34.67	3.70	61.63	6.13	43.57	0.85
PHARR	ULSD	19.57	4.60	75.83	3.20	52.47	0.83
SAN ANGELO	ULSD	29.33	3.27	67.40	4.23	45.80	0.84
SAN ANTONIO	ULSD	23.33	4.00	72.68	3.88	48.98	0.84
TYLER	ULSD	30.63	4.80	64.57	11.43	46.73	0.84
WACO	ULSD	21.30	3.97	74.73	5.60	50.20	0.83
WICHITA FALLS	ULSD	25.13	4.17	70.70	5.37	51.27	0.83
YOAKUM	ULSD	20.50	4.65	74.85	3.55	49.45	0.83

District	Sample Type	Aromatic, % vol	Olefins, % vol	Saturates, % vol	Sulfur, ppm	Cetane Number	Specific Gravity
	average	24.97	3.98	71.05	6.24	48.78	0.84
	min	19.28	3.15	61.63	2.27	43.57	0.82
	max	34.67	5.10	76.45	31.13	54.60	0.85
	range	15.39	1.95	14.82	28.86	11.03	0.03
	deviation	4.43	0.56	4.42	5.50	2.53	0.01

Figures 15 through 21 illustrate the diesel composition trends from 2003 through 2008. (Note that no testing was conducted during the summer of 2006.)

Figure 15. Diesel Aromatics Trends for Selected Regions

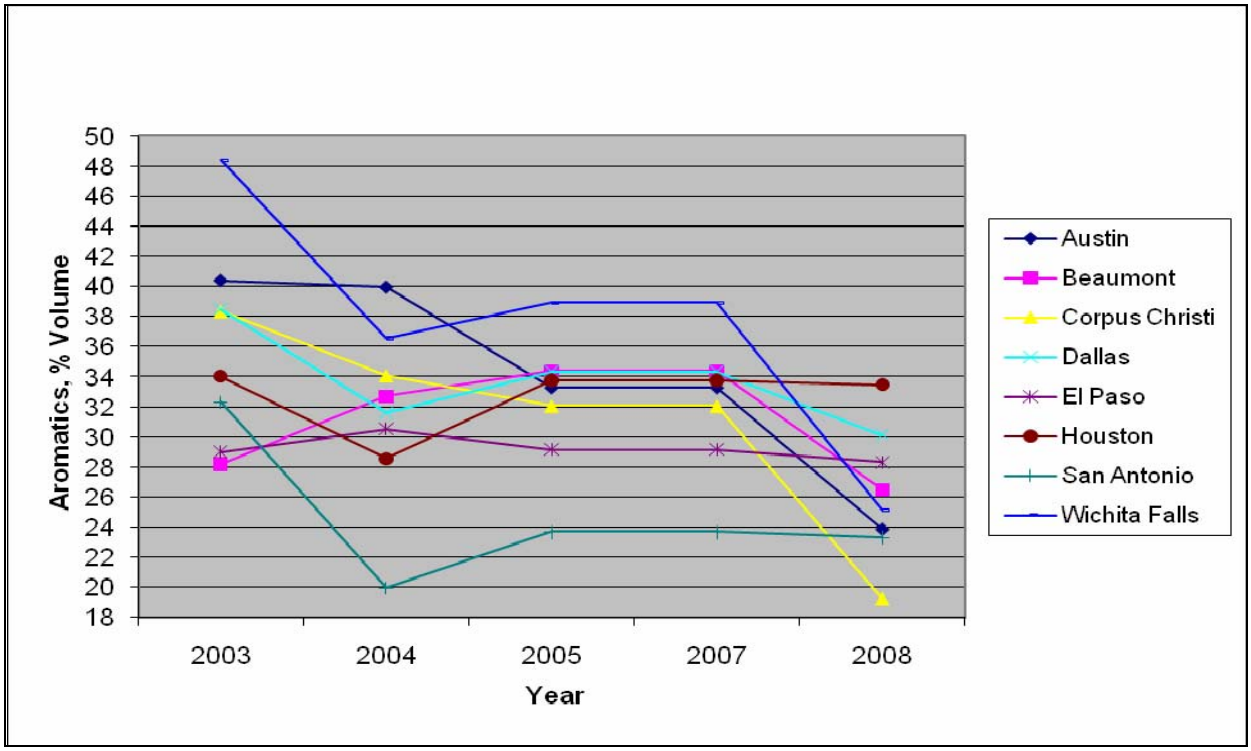


Figure 16. Diesel Olefins Trends for Selected Regions

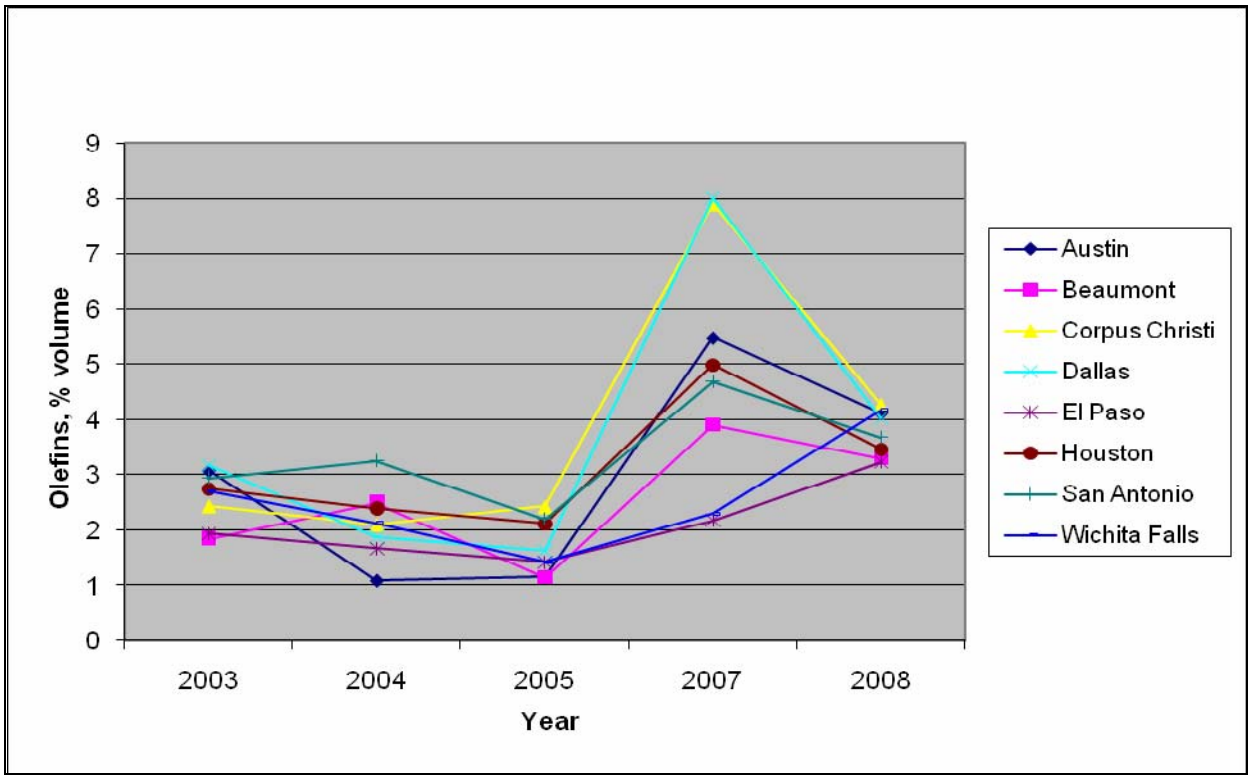


Figure 17. Diesel Saturates Trends for Selected Regions

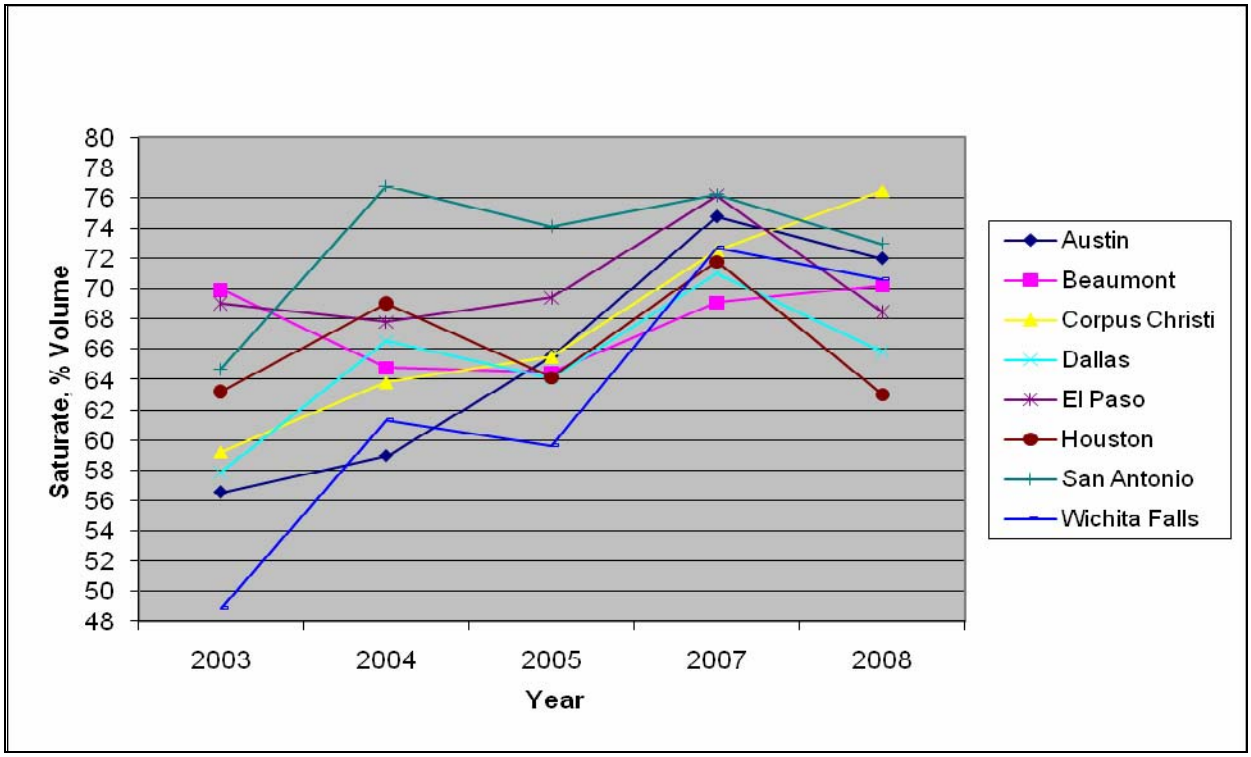


Figure 18. Diesel Sulfur Trends for Selected Regions

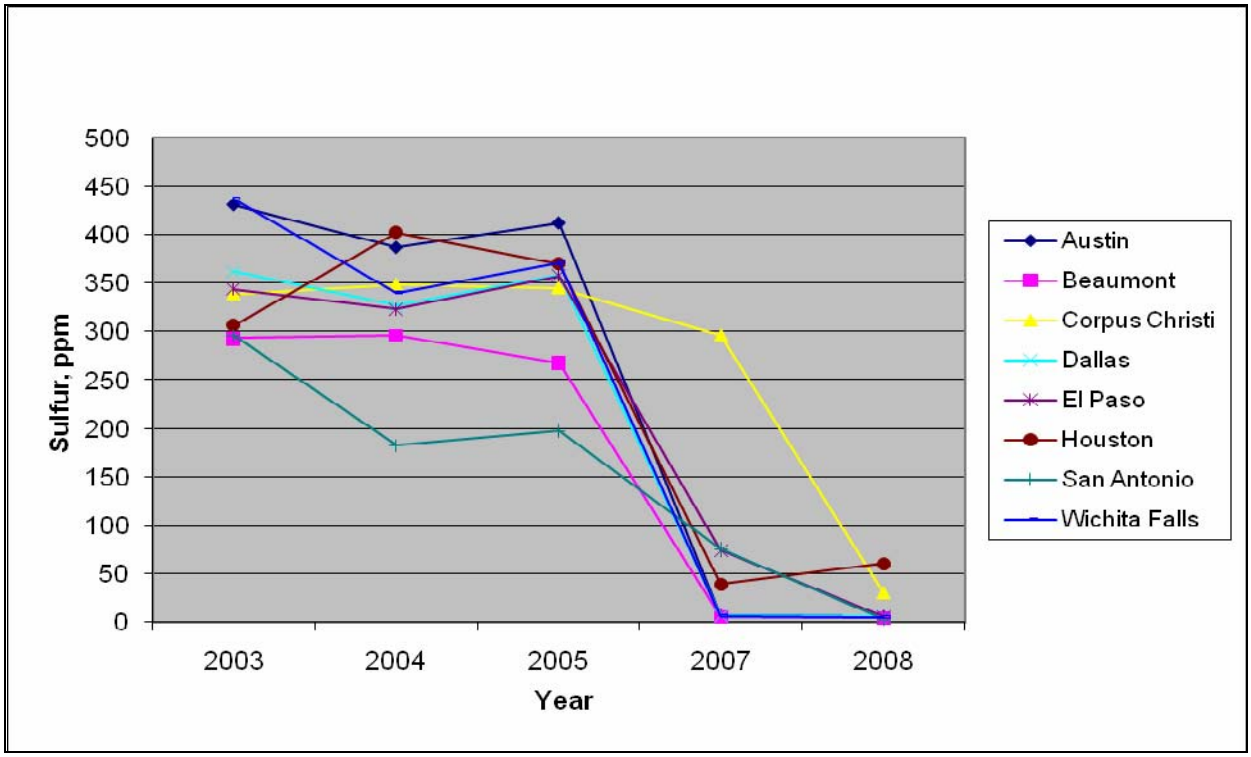


Figure 19. Diesel Cetane Trends for Selected Regions

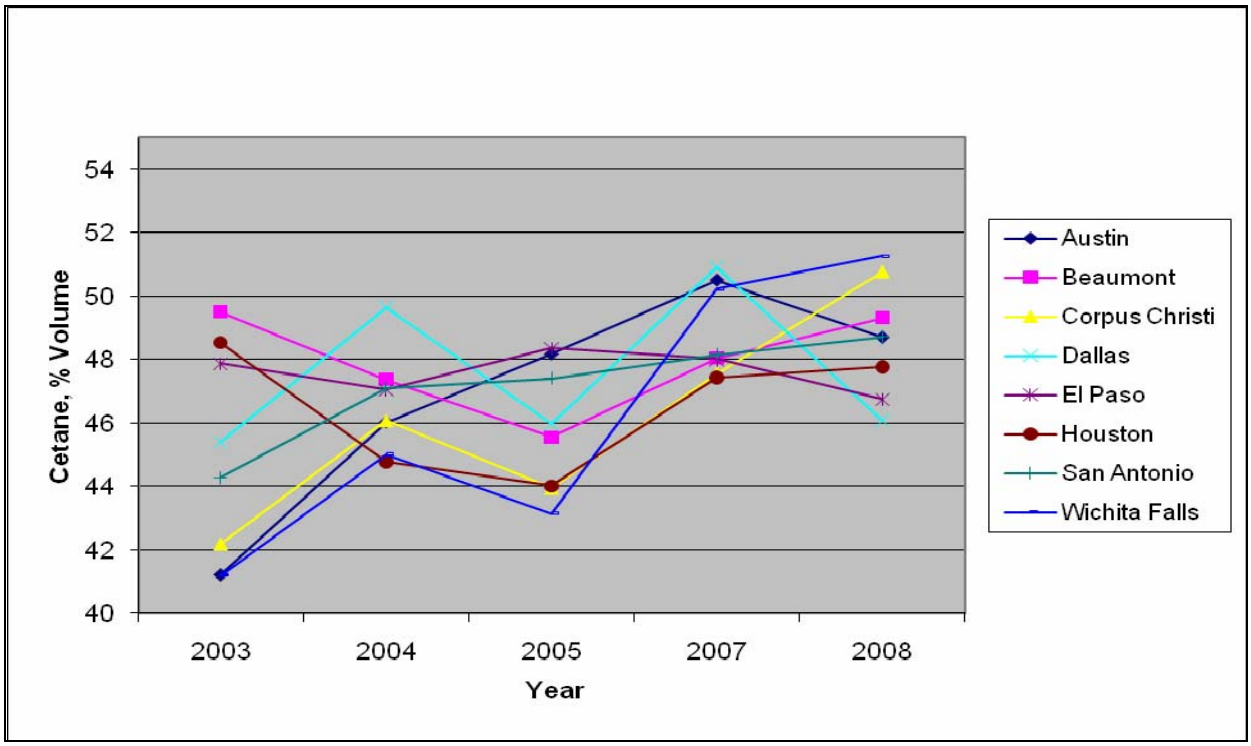


Figure 20. Diesel Specific Gravity Trends for Selected Regions

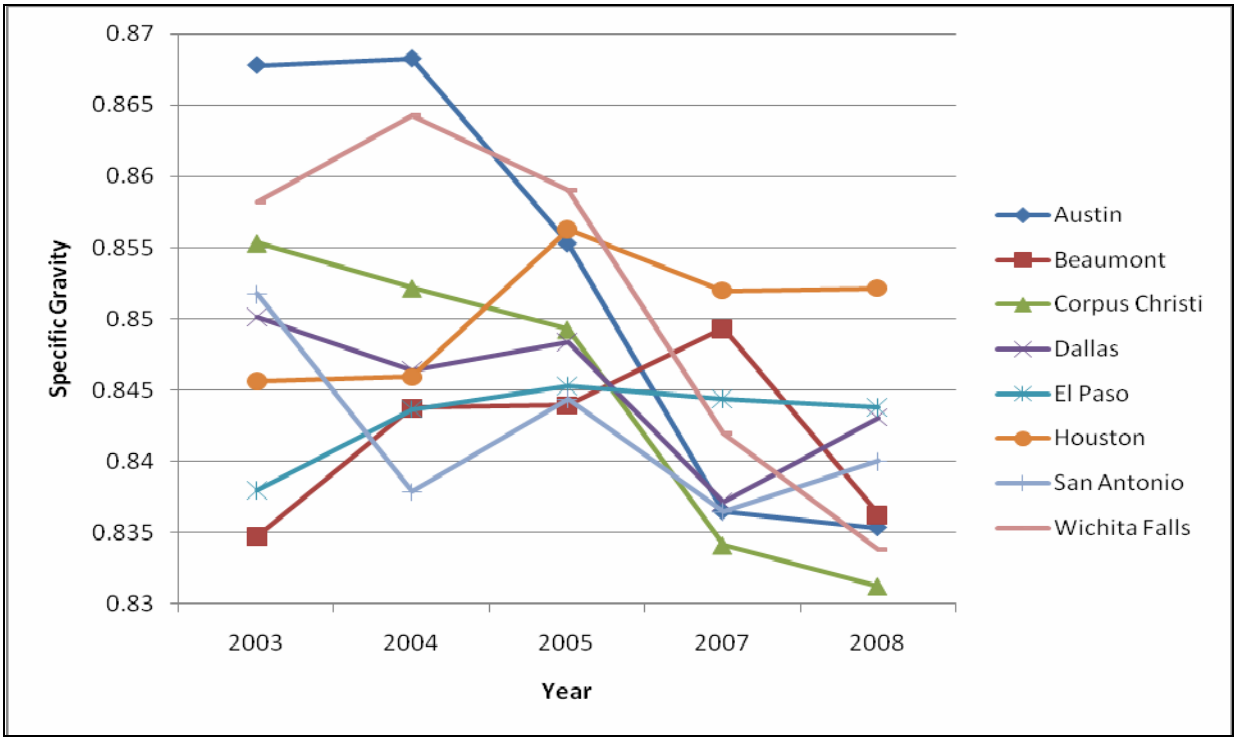
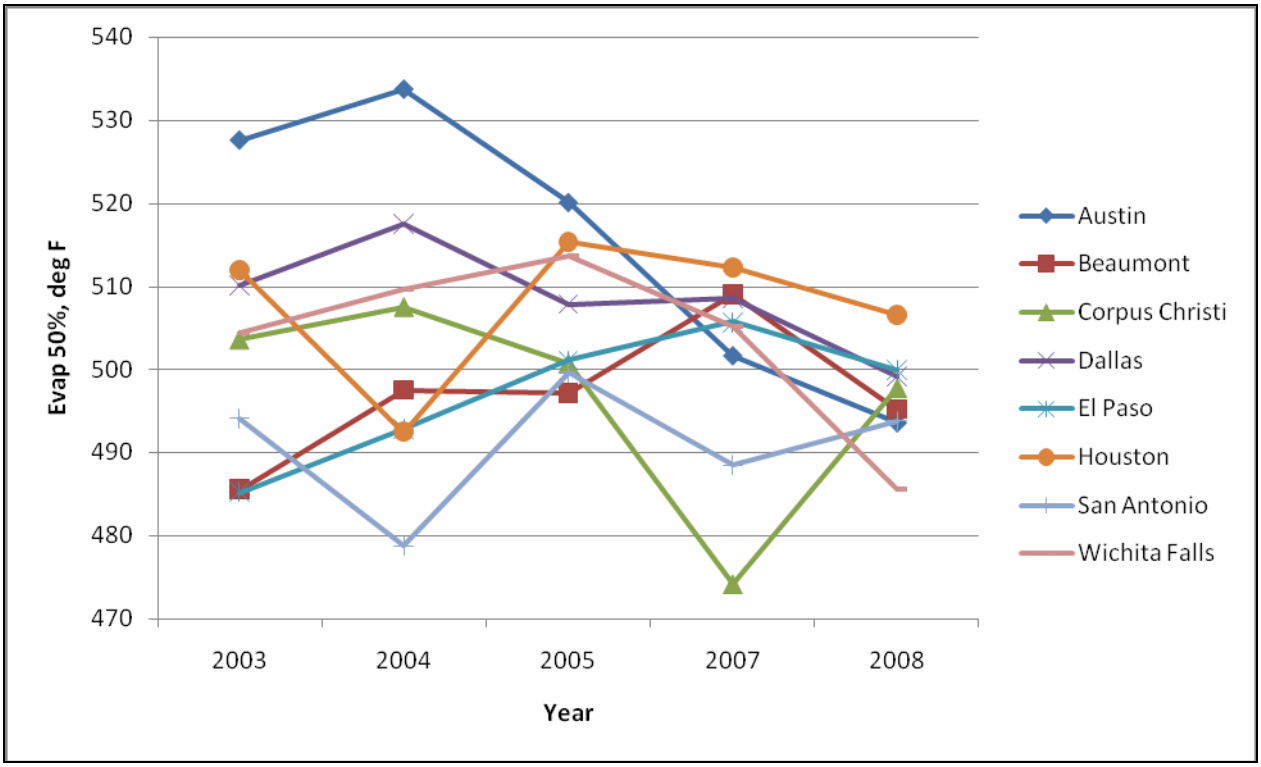


Figure 21. Diesel T50 Trends for Selected Regions



Some general observations about the diesel sampling data follow.

- Aromatics are down from 2007 levels in all districts;
- Olefins are down for most districts from 2007 levels, although Wichita Falls and El Paso showed an increase in olefin averages;
- Most regions saw a moderate decrease in saturate concentrations, although Corpus Christi and Beaumont regions showed an increase;
- The Houston region showed a slight increase in sulfur averages. This is due to one high sample from this region. However, without more widespread testing in the Houston area, it is impossible to know if this is reflective of conditions in the area or an outlier in the data;
- Specific gravity and T50 averages show no clear long-term trends;
- Cetane averages showed a sharp decrease in the Dallas region while there is a slight increase in cetane averages in most other regions;
- Ten regions had an average cetane level below 48.

These results may have implications for the Texas Low Emission Diesel Rule (30 TAC 114.312) that requires a nominal 10% aromatic cap and a minimum cetane number of 48 for counties located in eastern Texas, in addition to the national sulfur requirements (e.g., 15 ppm in 2006; 500 ppm is allowed until then). However, the Texas Low Emission Diesel Rule does have provisions for alternative diesel fuel formulations that may account for lower cetane levels, especially since these districts have average cetane levels only slightly less than the required 48 by the TxLED rule.

These findings also indicate that TCEQ could perhaps re-evaluate the emission reductions claimed by the original rule. The original rule assumed an average base cetane number of 43, which would be increased to a minimum of 48. The data from the 2003, 2004, and 2005 sampling seem to indicate that average base cetane levels were higher than 43.

Supplemental Testing – Houston Area Stations

In addition to the testing described above, a second round of sampling and lab analysis was conducted for a subset of fueling stations (the seven located in the Houston area). This testing took place approximately six weeks after the first round of sampling, to ensure complete tank turnover. Previous fuel sampling and analysis studies have gone to great lengths to assess geographic variation in fuel parameters, but little is known about how fuel quality varies over a season. Therefore this second round of sampling was intended to make a preliminary assessment of the temporal variability of fuel parameters at the station level.

Tables 8 and 10 below identify the seven stations that were sampled for gasoline and diesel, respectively, in the HGB area and the Station ID assigned to each. Tables 9 and 11, for gasoline and diesel fuels, respectively, show the results of the second round of testing compared to the first round of testing for the seven stations in the HGB area. Attachment 6 provides the SAS program used to create Table 9.

Table 8. HGB Station IDs – Gasoline

Station ID	Station Name
1	BROOKSHIRE CONOCO
2	EXXONMOBIL RS 62674
3	FLYING J TRAVEL PLAZA
4	NORMANDY TRUCKSTOP
5	PORT AUTO TRUCK STOP
6	SAMS CHEVRON
7	SUNMART 400

Gasoline Results

Table 9. Station-Specific Gasoline Sampling, Round 1 vs. Round 2

Station ID	Component	Round 1	Round 2	Difference (Round 2 – Round 1)
1	RVP, psi	6.85	6.87	0.02
	Sulfur, ppm	42.70	27.90	-14.80
	Aromatics, % volume	17.89	19.17	1.27
	Olefins, & volume	11.20	9.79	-1.41
	Benzene, % volume	0.52	0.56	0.04
	EtOH, % volume	2.93	0.50	-2.43
	MTBE, % volume	0.00	0.00	0.00
	ETBE, % volume	0.00	0.00	0.00
	TAME, % volume	0.00	0.00	0.00
	E200	49.22	48.95	-0.27
	E300	86.05	85.91	-0.14
2	RVP, psi	6.92	7.10	0.18
	Sulfur, ppm	28.80	31.00	2.20
	Aromatics, % volume	18.71	21.82	3.10
	Olefins, & volume	9.71	8.18	-1.53
	Benzene, % volume	0.67	0.81	0.14
	EtOH, % volume	6.64	3.06	-3.58
	MTBE, % volume	0.08	0.00	-0.08
	ETBE, % volume	0.00	0.00	0.00
	TAME, % volume	0.01	0.00	-0.01
	E200	52.04	54.24	2.20
	E300	88.78	88.23	-0.55
3	RVP, psi	6.83	6.96	0.13
	Sulfur, ppm	40.00	48.00	8.00
	Aromatics, % volume	18.81	21.30	2.49
	Olefins, & volume	14.16	11.10	-3.06
	Benzene, % volume	0.40	0.46	0.07
	EtOH, % volume	2.86	3.33	0.48
	MTBE, % volume	0.00	0.00	0.00
	ETBE, % volume	0.00	0.00	0.00
	TAME, % volume	0.00	0.00	0.00
	E200	49.36	49.42	0.05
	E300	84.94	84.92	-0.02
4	RVP, psi	7.05	7.00	-0.05
	Sulfur, ppm	26.00	20.80	-5.20

Station ID	Component	Round 1	Round 2	Difference (Round 2 – Round 1)
	Aromatics, % volume	16.30	15.03	-1.27
	Olefins, & volume	18.17	15.01	-3.16
	Benzene, % volume	0.44	0.54	0.11
	EtOH, % volume	3.51	3.41	-0.10
	MTBE, % volume	0.01	0.00	-0.01
	ETBE, % volume	0.00	0.00	0.00
	TAME, % volume	0.00	0.00	0.00
	E200	52.01	49.64	-2.38
	E300	87.15	86.50	-0.66
5	RVP, psi	7.19	7.02	-0.17
	Sulfur, ppm	31.30	49.80	18.50
	Aromatics, % volume	19.47	21.82	2.35
	Olefins, & volume	9.51	10.44	0.93
	Benzene, % volume	0.60	0.47	-0.14
	EtOH, % volume	6.96	3.01	-3.95
	MTBE, % volume	0.10	0.00	-0.10
	ETBE, % volume	0.00	0.00	0.00
	TAME, % volume	0.00	0.00	0.00
	E200	50.76	49.16	-1.59
	E300	87.48	84.52	-2.96
6	RVP, psi	7.20	6.94	-0.26
	Sulfur, ppm	20.50	15.50	-5.00
	Aromatics, % volume	15.53	13.32	-2.21
	Olefins, & volume	12.37	12.10	-0.26
	Benzene, % volume	0.52	0.54	0.03
	EtOH, % volume	7.36	3.45	-3.91
	MTBE, % volume	0.13	0.00	-0.13
	ETBE, % volume	2.24	0.00	-2.24
	TAME, % volume	0.00	0.00	0.00
	E200	52.59	50.89	-1.70
	E300	88.14	88.51	0.37
7	RVP, psi	7.21	6.94	-0.27
	Sulfur, ppm	18.50	16.30	-2.20
	Aromatics, % volume	15.77	14.09	-1.68
	Olefins, & volume	12.92	12.12	-0.80
	Benzene, % volume	0.54	0.54	0.00
	EtOH, % volume	6.80	3.28	-3.52
	MTBE, % volume	0.10	0.00	-0.10
	ETBE, % volume	0.00	0.00	0.00

Station ID	Component	Round 1	Round 2	Difference (Round 2 – Round 1)
	TAME, % volume	0.00	0.00	0.00
	E200	54.10	49.34	-4.76
	E300	89.38	87.55	-1.83

Diesel Results

Table 10. HGB Station IDs – Diesel

StationID	Name
1	BROOKSHIRE CONOCO
2	EXXONMOBIL RS 62674
3	FLYING J TRAVEL PLAZA
4	NORMANDY TRUCKSTOP
5	PORT AUTO TRUCK STOP
6	SAMS CHEVRON
7	LOVES TRAVEL STOP 23

Table 11. Station-Specific Diesel Sampling, Round 1 vs. Round 2

Station ID	Component	Round 1	Round 2	Difference (Round 2 - Round1)
1	Aromatics, % vol	34.0	38.4	4.4
	Olefins, % vol	3.7	3.0	-0.7
	Saturate, % vol	62.3	58.6	-3.7
	Sulfur, ppm	6.5	7.7	1.2
	Cetane No.	48.4	47.4	-1.0
	Specific Gravity	0.8633	0.8638	0.0
	T50 (ºF)	530.5	525.3	-5.2
2	Aromatics, % vol	37.3	41.5	4.2
	Olefins, % vol	3.1	3.4	0.3
	Saturate, % vol	59.6	55.1	-4.5
	Sulfur, ppm	7.9	9.2	1.3
	Cetane No.	44.6	42.7	-1.9
	Specific Gravity	0.8486	0.8538	0.0
	T50 (ºF)	488.3	495.3	7.0
3	Aromatics, % vol	37.2	39.8	2.6
	Olefins, % vol	4.3	3.2	-1.1
	Saturate, % vol	58.5	57.0	-1.5
	Sulfur, ppm	6.2	7.6	1.4
	Cetane No.	48.8	48.7	-0.1
	Specific Gravity	0.8641	0.8638	0.0
	T50 (ºF)	528.4	524.1	-4.3

Station ID	Component	Round 1	Round 2	Difference (Round 2 - Round1)
4	Aromatics, % vol	27.9	34.8	6.9
	Olefins, % vol	2.5	3.7	1.2
	Saturate, % vol	69.6	61.5	-8.1
	Sulfur, ppm	6.0	8.8	2.8
	Cetane No.	49.3	45.1	-4.2
	Specific Gravity	0.8407	0.8488	0.0
	T50 (ºF)	481.9	483.5	1.6
5	Aromatics, % vol	27.4	36.9	9.5
	Olefins, % vol	4.0	4.2	0.2
	Saturate, % vol	68.6	58.9	-9.7
	Sulfur, ppm	5.6	8.6	3.0
	Cetane No.	49.2	46.4	-2.8
	Specific Gravity	0.8471	0.8528	0.0
	T50 (ºF)	502.1	492.9	-9.2
6	Aromatics, % vol	26.1	33.5	7.4
	Olefins, % vol	3.6	2.3	-1.3
	Saturate, % vol	70.3	64.2	-6.1
	Sulfur, ppm	4.0	8.0	4.0
	Cetane No.	49.3	47.0	-2.3
	Specific Gravity	0.8401	0.8503	0.0
	T50 (ºF)	491.5	501.8	10.3
7	Aromatics, % vol	44.5	35.1	-9.4
	Olefins, % vol	3.1	2.8	-0.3
	Saturate, % vol	52.4	62.1	9.7
	Sulfur, ppm	387.4	13.2	-374.2
	Cetane No.	44.8	52.5	7.7
	Specific Gravity	0.8611	0.8329	0.0
	T50 (ºF)	523.1	518.1	-5.0

Some general observations about the second round of test results are discussed below.

- Even though there is substantial variation *between* stations, gasoline testing shows little variability for the same station between Round 1 and Round 2, with most parameters within the statewide standard deviation values shown in Table 3.
- One exception for gasoline lies in oxygenate content, with ethanol levels falling markedly between Round 1 and 2 for five of the seven stations sampled.
- As with the gasoline samples, most diesel parameters showed relatively little change between Round 1 and 2, with the exception of sulfur content at station 7, which witnessed a drop of more than an order of magnitude for this parameter. Both samples from station 7 were drawn from pumps labeled Low Sulfur Diesel, however.

Quality Assurance

ERG performed a review of the lab analysis results for all gasoline and diesel samples, looking for possible outliers or unusual data distributions. ERG first flagged any observation that was more than four standard deviations from the average value for a given parameter. ERG also flagged observations that should a markedly bi-modal distribution. The results of this screening exercise are shown in Tables 12 and 13 below.

ERG consulted with the SwRI program manager to obtain insight on the reasonableness of these values.[5] SwRI noted that sulfur variance, even above the cap, is seen around the country fairly frequently, for both gasoline and diesel samples. It was also noted that diesel nitrogen content was highly variable, did not follow a normal distribution, and was not a cause for performance concern. Finally, it was noted that initial boiling points and evaporative fractions can vary widely from batch to batch, even outside of specifications.

[5] Personal communication with Michelle Ratchford, Southwest Research Institute, August 21, 2008.

Table 12. Diesel Sample Quality Assurance Screening

Sample Id	Sulfur, D 5453, ppm	Nitrogen, D 4629, ppm	Flash point, deg F, D 93	Polyaromatic, D 5186, mass %	Initial Boiling Point, deg F	5%, deg F, D 86	10%, deg F, D 86
809065		43.80					
809093		144.10					
809161	114.6 (ULSD)	51.10					
809197		104.00					
809213		214.02		13.53			
809217		144.36					
809225		143.19					
809237		44.10					
809269		33.57					
809281						443.3	452.8
809293		22.13					
809305			80		166.0		
809345		43.02					
809353		62.15			148.6		
809357		50.60					
809361		56.85					
809381		137.95					
809385		62.82					
809393		120.90					
809401		126.30					

Table 12. Gasoline Sample Quality Assurance Screening

SwRI Sample Id	Sulfur, D 2622, wt%	Evap_5, deg F, D 86	Evap_10, deg F, D 86	Evap_15, deg F, D 86	Evap_50, deg F, D 86	Evap_60, deg F, D 86	Evap_90, deg F,
809064	0.019						
809136					156.7	163.0	
809118	0.002	126.7	140.5	152.2	228.7	241.9	335.2
809119	0.004	114.3	129.9	141.0	222.6	242.7	338.4
809355							
809343							
809344							
809292							
809290							259.6
809291							
809192							
809188							
809192	0.023						
809188	0.022						
809187							
809184	0.022						
809191							
809368	0.017						
809367							
809266							
809316		82.4	82.3	82.2			
809268							
809352							
809351							
809351	0.016						
809360							

Conclusions

Evaluating the most recent three years of data a few points can be made:

1) The EPA gasoline regulations require the following transition to low sulfur gasoline by 2007:

   - 2004: 300 ppm max, 120 ppm corporate pool average
   - 2005 – 300 ppm max, 90 corporate pool average, 30 refinery average
   - 2006 – 80 ppm max, 30 refinery average

   The results of the 2008 data collection found two areas with sulfur values above the 80 ppm limit. These districts are:

   - El Paso
   - Tyler

2) The EPA diesel regulations require the following transition to low sulfur blends by 2010:

   - Mid-2006: 80% at 15 ppm maximum sulfur (up to 20% at 500 ppm sulfur under the TCO Hardship Provisions)
   - Mid-2010: 100% at 15 ppm maximum sulfur

   The results of the 2007 data collection found seven districts with average sulfur values above the 15 ppm limit:

   - Corpus Christi
   - Houston
   - Yoakum

3) The preliminary analysis of temporal variability at the station level, as evidenced in the second round test results for the Houston area, appear to indicate low variability for gasoline and diesel fuel parameters, with the exception of gasoline oxygenates, and in one instance, diesel sulfur.

Attachment 1
Station Selection List

Survey Area	Location Name	Address	City	Zip
ABILENE	CROSSROADS CONOCO	1702 COMMERCIAL	ANSON	79501
ABILENE	SWEETWATER TRAVEL CENTER	I 20 & HOPKINS RD	SWEETWATER	79556
ABILENE	FLYING J TRAVEL PLAZA	101 N FM 707	TYE	79563
AMARILLO	LOVES COUNTRY STORE 200	6930 E IH 40	AMARILLO	79120
AMARILLO	TOOT N TOTUM FOOD STORES 57	301 S ROSS	AMARILLO	79102
AMARILLO	HADLEY FUEL	513 MAIN ST	SUNRAY	79086
ATLANTA	THE GENERAL STORE	18418 FM 31	ELYSIAN FIELDS	75642
ATLANTA	EAST TEXAS FUELS 209	100 E END BLVD N	MARSHALL	75670
ATLANTA	HAMITER CHEVRON	845 SPUR 156 & IH 20	WASKOM	75692
AUSTIN	LEOS SERVICE STATION	1149 1/2 AIRPORT BLVD	AUSTIN	78702
AUSTIN	SHOPPERS MART 44	11300 N IH 35	AUSTIN	78758
AUSTIN	BOOMERS	13801 HWY 29 W	LIBERTY HILL	78642
AUSTIN	LOVES COUNTRY STORE 264	190 US HIGHWAY 90	LULING	78648
AUSTIN	SPEEDY STOP 248	15829 N HWY 35	PFLUGERVILLE	78660
BEAUMONT	ANGELS GAS & GROCERY	10403 I 10 E	MONT BELVIEU	77580
BEAUMONT	STATE LINE CHEVRON	2323 LUTCHER DR	ORANGE	77630
BEAUMONT	TEXAS COUNTRY STORE 2	7411 IH 10 E	ORANGE	77630
BEAUMONT	EXPRESS MART 16	11707 US HIGHWAY 69 S	WARREN	77664
BEAUMONT	SPEEDY STOP 15	I 10 & FM 1663	WINNIE	77665
BROWNWOOD	SPORTSMAN CENTER	2721 BELLE PLAIN	BROWNWOOD	76801
BROWNWOOD	GINAS FOOD MART 2	2296 HWY 67 & 377	PROCTOR	76468
BROWNWOOD	PROCTOR GROCERY	2201 HWY 67	PROCTOR	76468
BRYAN	4 CORNERS MOBIL	3239 WILKES DR	BRYAN	77803
BRYAN	COOKS POINT STORE	7025 HWY 21 E	CALDWELL	77836
BRYAN	DIAMOND SHAMROCK 588	2811 11TH ST	HUNTSVILLE	77340
CHILDRESS	TAYLOR FOOD MART FFP 5139	HWY 287 & TAYLOR	CLARENDON	79226
CHILDRESS	CHECKERED FLAG CONVENIENCE STORE	219 S BOYKIN DR	MEMPHIS	79245
CHILDRESS	TPC 17	415 N BOYKIN DR	MEMPHIS	79245
CORPUS CHRISTI	TIMES MARKET 299	1205 S US HIGHWAY 281	ALICE	78332
CORPUS CHRISTI	CIRCLE K 7128	14901 FM 624	CORPUS	78410
CORPUS CHRISTI	DIAMOND SHAMROCK 135	4502 US HIGHWAY 181	CORPUS	78402
CORPUS CHRISTI	ECONOMY DRIVE IN FFP 270	HWY 77 S & 7TH ST	DRISCOLL	78351
DALLAS	EXXON RS 67764	8201 E R L THORNTON FWY	DALLAS	75228
DALLAS	NEW CHURCH FUEL CENTER	10650 NEW CHURCH RD	DALLAS	75230
DALLAS	REGAL ROW FINA	1607 REGAL ROW	DALLAS	75247
DALLAS	TUCKER FUEL & OIL*	408 N MAIN ST	HUTCHINS	75141
EL PASO	FLYING J TRAVEL PLAZA	3001 MOUNTAIN PASS BLVD	ANTHONY	79821
EL PASO	7 ELEVEN 57650	1330 N ZARAGOSA	EL PASO	79936
EL PASO	GOOD TIME STORE 26	1421 RV Dr	EL PASO	79927
EL PASO	HOWDYS TRANSMOUNTAIN	6990 N DESERT BLVD	EL PASO	79935
FT WORTH	NEW K & T QUICK STOP	2500 NE 28TH ST	FT WORTH	76106
FT WORTH	QUIK TRIP 873	101 W EVERMAN PKWY	FT WORTH	76134
FT WORTH	ROSEDALE TEXACO	6101 E ROSEDALE ST	FT WORTH	76112
FT WORTH	SHELL FOOD MART	801 N MAIN ST	MANSFIELD	76063
HOUSTON	SUNMART 400	10330 IH 10 E	BAYTOWN	77520
HOUSTON	BROOKSHIRE CONOCO	306 FM 359 S	BROOKSHIRE	77423
HOUSTON	EXXONMOBIL RS 62674	12590 WESTHEIMER	HOUSTON	77077
HOUSTON	FLYING J TRAVEL PLAZA	15919 N FREEWAY	HOUSTON	77090
HOUSTON	NORMANDY TRUCKSTOP	12823 EAST FWY	HOUSTON	77015
HOUSTON	SAMS CHEVRON	389 UVALDE RD	HOUSTON	77015
HOUSTON	PORT AUTO TRUCK STOP	904 W BARBOURS CUT BLVD	LA PORTE	77571

Survey Area	Location Name	Address	City	Zip
LAREDO	TETCO STORE 70	I 35 @ FM 468	COTULLA	78014
LAREDO	TRAVEL MART 13	801 W LAFAYETTE	LAREDO	78040
LAREDO	DIAMOND SHAMROCK 1504	711 E TRAVIS	SAN DIEGO	78384
LUBBOCK	CORNELIUS CONOCO	420 S 2ND	FLOYDADA	79235
LUBBOCK	TOWN & COUNTRY 203	2500 HALL Ave	LITTLEFIELD	79339
LUBBOCK	OLTON GRAIN COOP INC	910 W FIRST ST	OLTON	79064
LUFKIN	CURRY GROCERY & STATION	HWY 7	KENNARD	75847
LUFKIN	NORTH STREET TEXACO	2830 NORTH ST	NACAGDOCHES	75965
LUFKIN	COLEMANS EXXON	STATE HWY 63 & INT 147	ZAVALLA	75980
ODESSA	SUNMART 109	10400 E I 20 @ FM 1788	MIDLAND	79711
ODESSA	PARKS CONVENIENCE 4	912 W COUNTY RD	ODESSA	79763
ODESSA	TOWN & COUNTRY 104	4020 KERMIT HWY	ODESSA	79760
PARIS	JCS QUIK SHOP	205 W BELLS BLVD	BELLS	75414
PARIS	QUIX 857	5001 WESLEY ST	GREENVILLE	75401
PARIS	KWIK CHEK 17	101 N STATE HIGHWAY 121	TRENTON	75490
PHARR	LOVES TRAVEL STOP	HWY 281 & FM 2812	EDINBURG	78539
PHARR	AZIZ CONVENIENCE STORE 1	HWY 83 S SIDE E LEO ST	LA JOYA	78560
PHARR	RIVERMART	914 W MILITARY RD	PHARR	78577
SAN ANGELO	SHELTON OIL & GAS CO INC	HWY 67	MERTZON	76941
SAN ANGELO	TOWN & COUNTRY 119	3925 S BRYANT	SAN ANGELO	76903
SAN ANGELO	TOWN & COUNTRY 191	610 SE CROCKETT AVE	SONORA	76950
SAN ANTONIO	AB FOOD & GAS	11050 IH 35 N	SAN ANTONIO	78233
SAN ANTONIO	COLONIES MOBIL	3822 COLONY DR	SAN ANTONIO	78230
SAN ANTONIO	DIAMOND SHAMROCK 0005	703 N ZARZAMORA ST	SAN ANTONIO	78207
SAN ANTONIO	PILOT TRAVEL CENTER 306	5619 I 10 E	SAN ANTONIO	78219
SAN ANTONIO	STOP N GO 2031	10402 INTERSTATE 35 N	SAN ANTONIO	78233
TYLER	PHILIP TEXACO 1	HWY 175 & 155	FRANKSTON	75763
TYLER	R & K KWIK STOP	411 US HIGHWAY 79 S	HENDERSON	75652
TYLER	SEVEN POINTS 15	HWY 85 & FM 274	SEVEN POINTS	75143
TYLER	GLASS OIL 248	2523 E SE LOOP 323	TYLER	75701
TYLER	Bens Mobil	308 N 4th St	WILLS POINT	75169
WACO	LOVES COUNTRY STORE 232	2808 S CENTRAL	TROY	76579
WACO	FLYING J INC	2409 S NEW RD	WACO	76711
WACO	BIG CZEH OIL FUEL/BUDS TIGER STOP	201 W OAK ST	WEST	76691
WICHITA FALLS	ELECTRA FOOD MART	806 E US HIGHWAY 287	ELECTRA	76360
WICHITA FALLS	HILLTOP SERVICE	4501 N INTERSTATE 35	GAINESVILLE	76240
WICHITA FALLS	RED RIVER FARM COOP	1330 N DIXON	GAINESVILLE	76241
YOAKUM	JONES FOOD MART 1	1817 N SAINT JOSEPH ST	GONZALES	78629
YOAKUM	N & B TEXACO	STATE HWY 95 & MOORE ST	MOULTON	77975
YOAKUM	FASTOP 4	3508 N NAVARRO	VICTORIA	77901
YOAKUM	FISHBECK TEXACO	801 S EAGLE ST	WEIMAR	78962

Attachment 2
SwRI Testing Results for Gasoline – provided electronically

Attachment 3
SwRI Testing Results for Diesel – provided electronically

Attachment 4
SAS Program for Processing Round 1 Gasoline Data – provided electronically

Attachment 5
Data Analysis for Gasoline – provided electronically

Attachment 6
SAS Program for Round 1 vs Round 2 Gasoline Comparison – provided electronically

Attachment 7
Data Analysis for Diesel Samples – provided electronically