→ Jim

Summary of TCEQ Actions relating to the Barnett Shale
11/13/09

Since 2002, gas producing activity in the Barnett Shale area has experienced significant growth. For several years the TCEQ has pursued improving data regarding emissions from the sources associated with oil and gas production. Recently, the TCEQ has begun in-depth ambient and source measurement to fully evaluate potential health effects. Numerous TCEQ projects use state-of-the-art science and technology to assess and address emissions from Barnett Shale activities and oil and gas operations in general (i.e., drilling, pipelines, frac sand, saltwater disposal, water usage, compressor stations, flaring, etc.). These initiatives have and will continue to reduce emissions directly as well as result in emissions reductions through improved agency policies, guidance for regulated entities, and possible enforcement if necessary. Various agency activities that relate to the Barnett Shale are briefly described below, with attachments providing detailed information. As additional background information, included in the package are detailed responses to questions from Representative Lon Burnam and the TCEQ's review of private air quality studies conducted in the Barnett Shale area.

Attachment 1 – Provides a map of Texas showing oil and gas wells as of January 2008.
Attachment 2 - Provides a map of the Barnett Shale area, showing the location of oil/natural gas wells in the Barnett Shale area including Dallas/Fort Worth (DFW) ozone monitors, as of January 2009.
Attachment 3 – Provides a map of all TCEQ monitors in the North Texas area.

Flyover Camera Surveys
The 2005 and 2007 Remote Sensing volatile organic compounds (VOC) Projects identified many oilfield storage tanks with significant hydrocarbon plumes. A helicopter-mounted HAWK passive infrared (IR) camera was used to aerially survey and image hydrocarbon plumes. TCEQ used these images to identify VOC emissions sources that may potentially be unreported or under-reported.

Ten sites imaged during the 2007 aerial surveys in the Dallas-Fort Worth areas were selected for follow-up investigations based on the apparent magnitude of the hydrocarbon plumes imaged. TCEQ is actively conducting investigations and outreach to address these emissions. Ten sites were also selected in the Gulf Coast area.

Attachment 4 - Provides additional information concerning this study.

Pollution Prevention Outreach
The TCEQ has provided a total of nine free workshops for oil and gas companies to offer strategies on how to improve efficiency and prevent pollution. In 2008, the workshops were held in Midland, Victoria, and Wichita Falls. In 2009, the workshops were held in Austin, Longview and Hebbronville. Total attendance was 435.

Additional workshops are being planned. The workshops will continue to build on past workshops themes, which highlighted potential cost saving by installing vapor recovery units. However, the new workshops will also focus on potential compliance issues associated with the increase in urban area drilling.

For the past two years, oil and gas workshops have been held in conjunction with the agency's Advanced Air Permitting Workshop held in Austin.

Ground-based Monitoring
The TCEQ is in the process of studying the emissions from gas production and their impacts in the Barnett Shale area. In an effort to gather information, the Mobile Monitoring Team has conducted two trips to monitor emissions in this area. Phase I of the study was conducted August 24-28 and Phase II occurred October 9-16, 2009. These trips included surveying the area using infrared (IR) imagery, total vapor analyzers (TVA), hydrogen sulfide monitors, monitoring for nitrogen oxides (NOx) and collecting volatile organic compound (VOC) samples. Over sixty locations were monitored in the five county area of Tarrant, Parker, Wise, Denton,

and Johnson Counties. Air samples and other relative data collected from the two trips are currently being processed through the TCEQ Air Laboratory for quality assurance and reviewed by the TCEQ Toxicology Division. The TCEQ anticipates the comprehensive report detailing the monitoring results and their potential environmental impacts will be finalized by the end of the December.

Future plans for monitoring in this area include a third phase to monitor for sulfide related compounds, such as carbon disulfide, which were indicated to be present in reports commissioned by the City of DISH and a private citizen. This trip is planned for late November 2009. A fourth phase will occur in conjunction with a proposed study funded by the Chief Engineers Office and will include determining emission rates and characteristics of emissions at sources along with off site impacts of the emissions. The fourth phase is tentatively planned to occur during the spring 2010.

Attachment 5 – Provides additional information on the studies and a map showing the numbered locations where monitoring occurred. Raw data from the August trip is included in this attachment. Some of the canister samples collected during the August trip were collected adjacent or in close proximity to emission sources located on company property for information purposes only and may not be representative of off property ambient air concentrations. Thus, a higher concentration may be more reflective of a source's direct emissions rather than an exposure level. Specifically, canister sample BSF0908-16 was collected within five feet of a natural gas wellhead, and samples BSF0908-24 and BSF0908-25 were collected within 20 feet of a disposal trough located on company property.

The TCEQ is reviewing the stationary monitoring network to determine if a VOC monitoring site should and could be established in the area.

The TCEQ has a contract with the University of Texas at Austin (UT) to conduct ambient monitoring in the Barnett Shale area. The UT monitoring van is outfitted with instruments to sample ambient air quality around oil and gas facilities in Northeast Texas, including the Barnett Shale area. The purpose of the project is to sample ambient emissions, primarily downwind of gas compressor engines and develop typical compressor engine ambient signature of emissions. Additional emission signatures will be developed for oil and gas wells and pipelines. These signatures should allow the agency to identify the impact gas compressors and oil/gas extraction has on ozone levels in the DFW area under varying conditions.

Region-based Investigative Activities

In this area, the region receives complaints related to odor, noise, dust, truck traffic, property rights, and water rights. Through approximately 50 investigations in this area in the last fiscal year, the region has reviewed all phases of the oil and gas process from drilling to production and has also looked at frac sand and saltwater disposal operations. Most complaints in this area are about odor and dust during the drilling phase. Though TCEQ does not have authority over on-site drilling activities, the region does assess the potential offsite impacts of drilling activities (including flaring) in response to complaints.

Rule Changes

The commission adopted rules to require substantial reductions in nitrogen oxides (NO_X) emissions from major and minor NO_X sources in the Dallas-Fort Worth nonattainment area, including stationary gas-fired engines in the oil and gas industry, and from stationary rich-burn gas-fired engines in the oil and gas industry in northeast Texas.

Improved Emission Factors and Emission Calculation Methods

In conjunction with the Houston Advanced Research Center, TCEQ identified thousands of tons of VOC flash emissions from upstream oil and gas operations and developed emissions factors to quantify these emissions.

The TCEQ is researching the most representative calculation methodologies for upstream oil and gas storage tank emissions. The results of the report are anticipated to improve agency guidance and policy on calculating upstream oil and gas emissions. The draft report has been published on the Web for comments.

The TCEQ conducted a comprehensive, statewide 2008 emissions inventory for drilling rig engines. The results showed, when compared to a previous 2007 study (2005 base year), a significant reduction in emissions estimates in the statewide NO_x emission estimate for 2005 (42,854 tons per year in this study compared to 119,647 tons per year in the 2007 study). In addition, there were also significant decreases in the sulfur dioxide (SO_2) and carbon monoxide (CO) emission estimates based on this study. For VOC, particulate matter with an aerodynamic diameter of less than 10 microns (PM_{10}), and particulate matter with an aerodynamic diameter of less than 2.5 microns ($PM_{2.5}$), the estimates contained in this study show slightly higher estimates than in the previous study.

The agency is working on updating all oil and gas calculation methods and is developing updated permits requirements for the upstream oil and gas industry.

Attachment 6 – Provides a list of past, current, and future activities that have been or will be conducted to improve emissions factors and emissions calculation methods of upstream oil and gas activities.

Permitting

Preconstruction authorization review ensures that emissions from new and modified sources have representative worst-case emission estimates using the best information available and that the appropriate permit conditions are set. All emission estimates are checked for accuracy and good engineering judgment. A large percentage of these facilities appear to be authorized under 30 TAC Section 106.352 which does not require TCEQ review or company registration (**see Attachment 7**).

Historically, the TCEQ has not required permit authorizations for oil and gas exploration activities. The Railroad Commission has jurisdiction over onsite activities in the drilling phase. Once they enter the production phase, the initial permitting authorization by the TCEQ occurs at the first piece of equipment located downstream of the well.

Air Quality Issues (Ozone)

Modeling and data analyses have consistently shown that NOx reductions are far more effective at reducing ozone in DFW than VOC reductions. The model's response to anthropogenic (man-made) VOC reductions is weak and linear, whereas the response to NOx reductions gets stronger with larger NOx reductions. A modeling test removed 75% of anthropogenic VOCs across all sources, and several monitors were still predicted to have ozone above the standard. VOC reductions alone will not bring the area into attainment of the 85 ppb ozone standard.

2009 biogenic emissions are 70% of the total VOCs in the 21-county area. Oil and gas VOC emissions for the same area are 7% of the total VOCs. Thus, even if VOC emissions from oil and gas activities were controlled, there would be enough biogenic VOCs to carry ozone reactions forward.

The majority of Barnett Shale sources are north and west of the DFW nonattainment area. 80% of the time between May and October (months with weather conditions most conducive to ozone formation) winds blow emissions from the Barnett Shale away from the DFW area, and thus, from that perspective are also not expected to significantly affect ozone in the DFW area.

With the new ozone standard coming (expected proposed in December 2009), the area's State Implementation Plan will be revisited, and all potential measures will be back on the table and open for consideration.

Health effects review of ambient air monitoring data collected by a 3rd party for the town of DISH, Texas

The TCEQ's Toxicology Division (TD) reviewed the ambient air monitoring analysis conducted by Wolf Eagle Environmental Engineers and Consultants (Wolf Eagle) for the town of DISH, Texas. Air monitoring was conducted to characterize the ambient air quality adjacent to several natural gas compression stations in and around DISH.

- The highest potential 1-hour maximum benzene concentration is below the health effects level observed in short-term animal and human studies; however, it is possible that adverse health effects

could occur from exposure to this concentration. It was not possible to determine if residents were exposed to this concentration of benzene based on the information provided.

- The TD is concerned that the monitored concentrations of benzene at several of the sampling locations could pose a long-term health risk to residents in the area if the concentrations are representative of normal and prolonged ambient conditions.
- Several monitored and potential 1-hour maximum concentrations of target compounds and tentatively identified compounds (TICs) could have resulted in odorous conditions. Persistent or recurrent exposure to levels that significantly exceed the odor threshold may cause odor-related effects such as headache and nausea. This is consistent with citizen reports of odors in the area.
- The TD strongly recommends additional sampling in the area and possibly long term (at least one year) monitoring for VOC, NOx, ozone, including an Automatic Gas Chromatograph (AutoGC) monitoring station, to fully evaluate the long term ambient concentrations.

Attachment 8 – Provides the Toxicology Division's memo evaluation of ambient air monitoring conducted for the town of DISH, Texas.

Review of Environmental Defense Fund's (EDF) October 19, 2009, press release concerning Barnett Shale air emissions

The EDF released an analysis that compared trends in air pollution collected by the state with public records of oil and gas activity in the Barnett Shale and found "a correlation between the ambient levels of common hydrocarbons and the amount of condensate produced by natural gas wells in Denton County." There are some statements in the presentation at could not be verified. Some of these statements are addressed below:

- EDF states no one has looked the impact of oil and gas production in the Barnett Shale on ozone.
  - The agency has conducted modeling sensitivities runs during the preparation of the DFW SIP that tested variations on NO_X emissions in the DFW area.
  - VOC has not been as tested because the area's ozone is still shown to be more responsive to NO_X reductions than VOC.
- The speaker's notes say VOC is a source of concern in the DFW area because they contribute to the formation of ground level ozone. Again, while VOC is a precursor to ozone, the area is more NO_X-limited, particularly in the areas north and west of the urban core.
- The presentation mentions that the highest ozone readings are near the highest density of oil and gas activity. While that is a true statement, it is misleading to imply that the readings are due to oil and gas activity. A more likely cause of high ozone is the transport of urban core pollution. These monitors are northwest of the urban core and are in the direction of the prevailing wind.
- Material for some of the slides was developed from a report by Dr. Al Armendariz, Ph. D., "Emissions from Natural Gas Production in the Barnett Shale Area and Opportunities for Cost-Effective Improvements." The Armendariz report appears to overestimate the growth in NO_X, VOC, and hazardous air pollutant emissions.

Review of EDF's "Analysis of AutoGC and VOC Canister Data in the DFW Area."

The TCEQ's Air Quality Division agrees that emissions from activities over the Barnett Shale are observed at monitors in the DFW nonattainment area. Preliminary review of AutoGC data from the Fort Worth Northwest site shows significant natural gas field related emissions, and mobile source emissions are equally large.

Regarding the Wind Directional Analysis section of the report, although the EDF analysis states that emissions from the Barnett Shale can be ozone precursors and uses ozone season months in the analysis, it does not show that any correlation exists between Barnett Shale emissions and ozone concentrations. TCEQ wind direction analyses have shown south to southeast winds prevail on high ozone days in the DFW nonattainment area, not the north to northwest direction of the Barnett Shale. North to northwest winds appear to be associated with frontal passages during the fall and winter months.

In general, the EDF source apportionment factors lack comparison to known source profiles. The TCEQ is continuing to investigate the Barnett Shale natural gas and oil field emissions and its contribution to DFW nonattainment ozone.

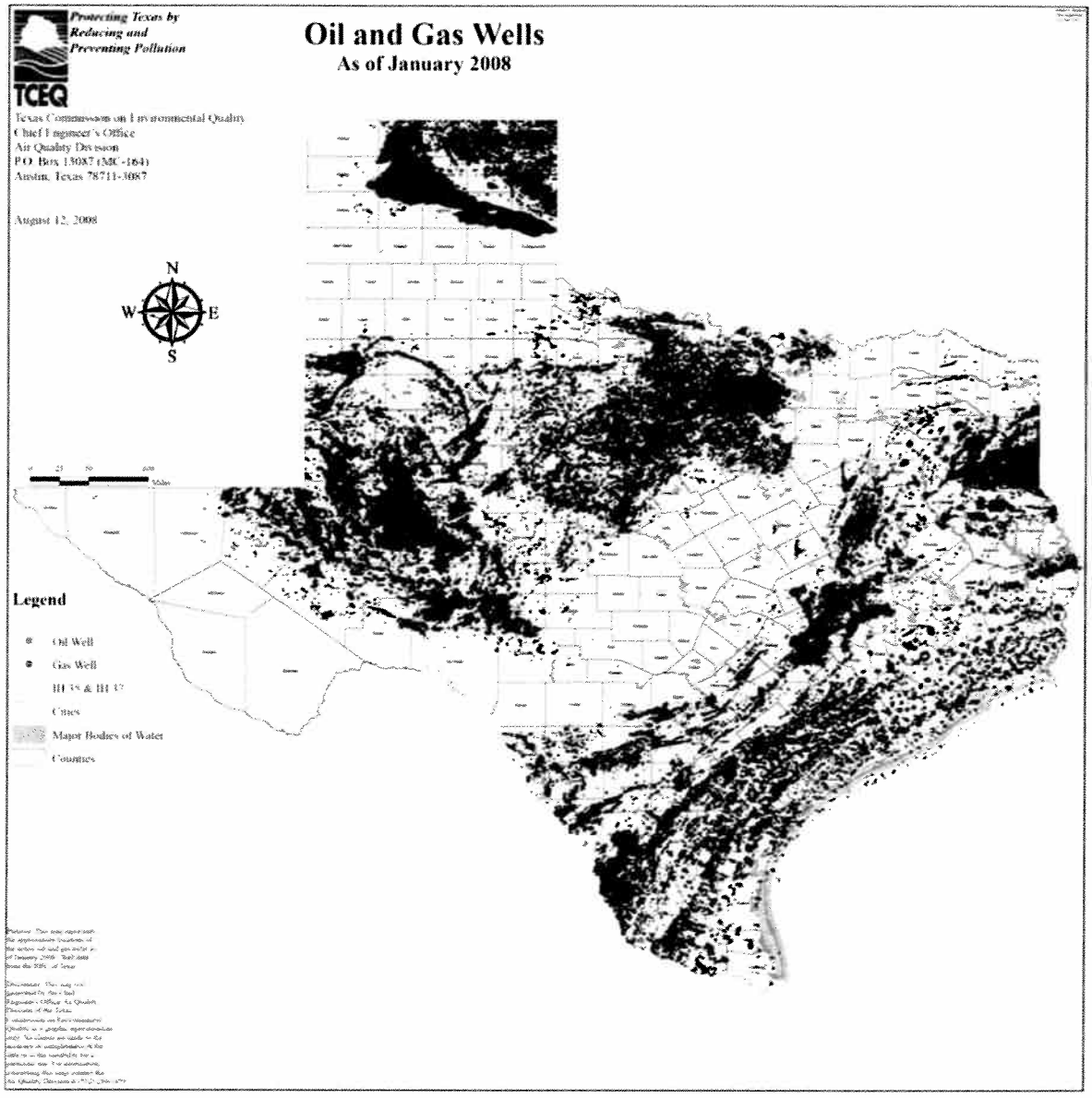
Response to questions asked by Representative Lon Burnam

The TCEQ received a letter from Representative Burnam on October 1, 2009, requesting "information about the TCEQ's use of the infrared camera in the upstream oil and gas sector, subsequent investigations by the TCEQ and remedial actions undertaken by facilities, and any resulting refinements made to methodologies to estimate emissions."

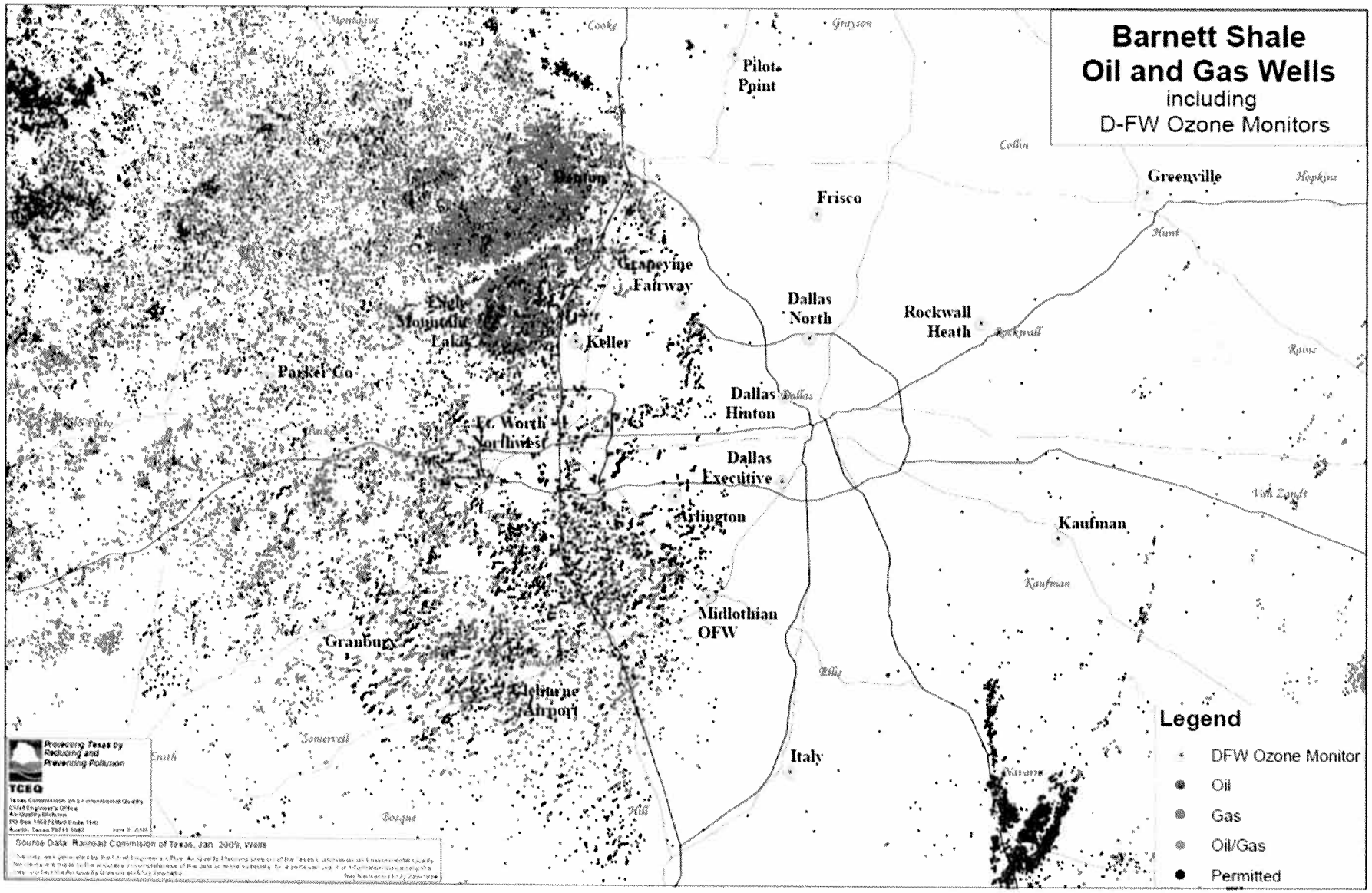
Attachment 9 - Provides the responses to the specific questions asked by Representative Burnam. The responses should provide you with additional background information concerning activities that the TCEQ has conducted throughout the State and specifically in the Barnett Shale area.

kas/11-13-09

Attachment 1

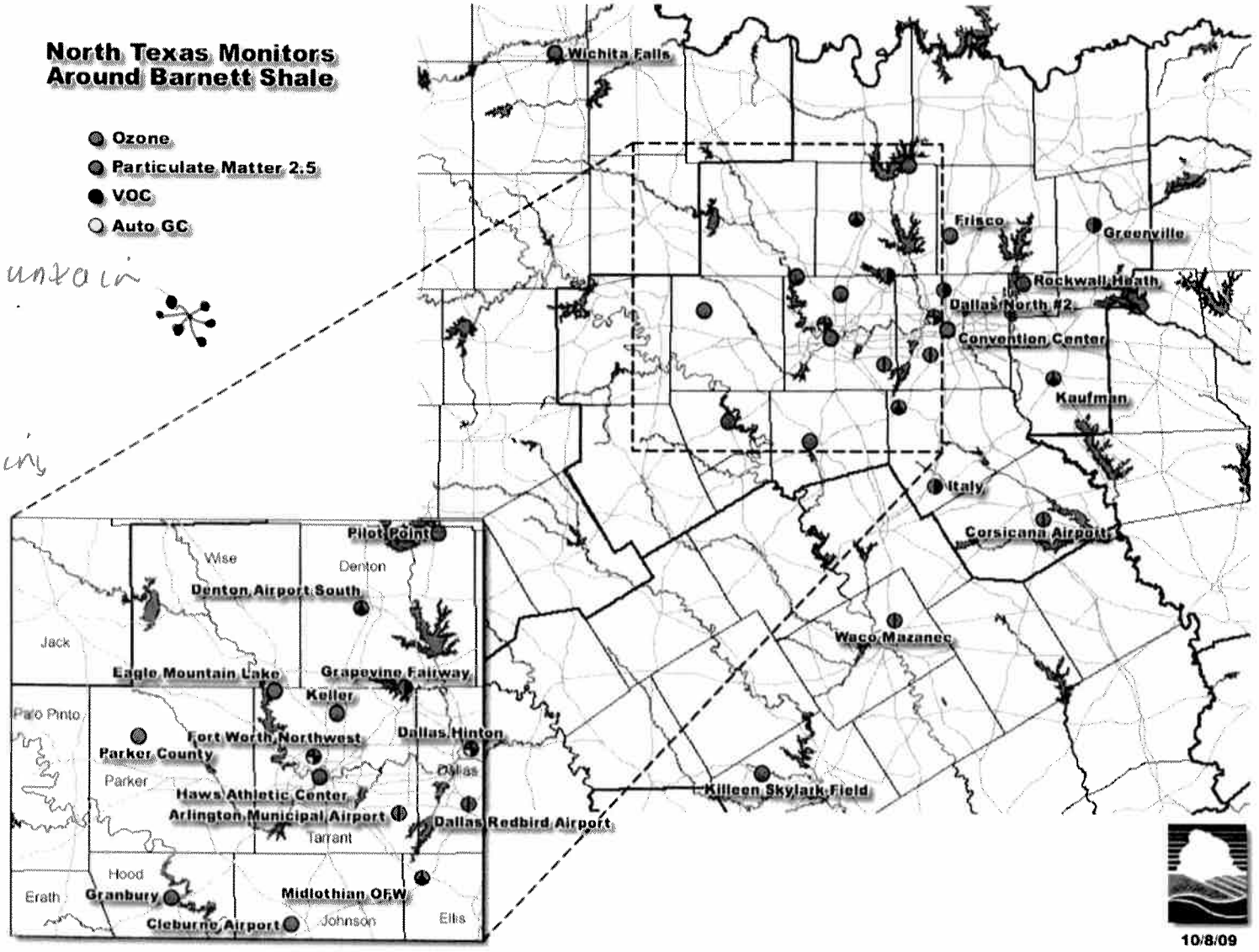

Protecting Texas by Reducing and Preventing Pollution
TCEQ
Oil and Gas Wells
As of January 2008
Texas Commission on Environmental Quality
Chief Engineer's Office
Air Quality Division
P.O. Box 13087 (MC-164)
Austin, Texas 78711-3087
August 12, 2008
N
W
E
S
Legend
Oil Well
Gas Well
Cities
Major Bodies of Water
Counties

Attachment 2


Barnett Shale
Oil and Gas Wells
including
D-FW Ozone Monitors
Pilot Point
Frisco
Greenville
Grapevine
Fairway
Eagle
Mountain
Lake
Keller
Parker Co
Dallas
North
Rockwall
Heath
Dallas
Hinton
Ft. Worth
Northwest
Dallas
Executive
Arlington
Kaufman
Midlothian
OFW
Granbury
Italy
Legend
DFW Ozone Monitor
Oil
Gas
Oil/Gas
Permitted
Protecting Texas by
Reducing and
Preventing Pollution
TCEQ
Source Data: Railroad Commission of Texas, Jan. 2009, Wells

Attachment 3

- Benzene
- Below 1.4



- Eagle mountain
-
- ambiana
v.
source
monitoring

Attachment 4

North/Central Texas and Gulf Coast Aerial Surveys
Oil & Gas Partnership Update

Purpose

- **To update management on the progress made with the Oil and Gas Industry**

Background

- The Chief Engineer's Office contracted Leak Surveys, Incorporated (LSI) to conduct aerial surveys of the Gulf Coast area in June/July 2007 and the North/Central Texas area in August 2007 with the HAWK GasFindIR camera
- Most sites are not registered with the TCEQ and operate under PBR 30 TAC §106.352 that does not require registration and are not required to submit an annual emissions inventory.

Aerial Survey Results

- The GasFindIR images do not quantify the emissions
- The emissions do appear to be significant at many locations
- Coastal: 64 sites with 107 areas of visible emissions detected
- North/Central: 93 sites with 145 areas of visible emissions detected

Initial Course of Action

- Partner with Oil and Gas Industry through respective Industry Groups
    - Pick 10 sites in North Central and 10 sites in the Coastal Area to investigate and collect data
    - Follow the "Find and Fix" protocol for sites with noted leaks from the survey
    - Requested data on production, operations, and oil/condensate composition
    - OCE coordinated collection of data, CEO analyzed and estimated potential emissions
    - CEO conducted follow-up phone calls to gather additional data, results were minimal

Follow-up Course of Action

- 7 sites with insufficient response to first data request were sent a letter from OCE requesting cooperation
- 10 sites with sufficient responses were sent letters from CEO requesting verification of emissions estimates
    - Responses from 3 sites that produced only salt water not due until 9/23/2009
- Asked sites what actions they have or will take to address and possibly mitigate future VOC emissions

Results

- 9 different companies own or operate the 20 sites selected for this project
- Some companies conducted testing to determine composition of oil/condensate/saltwater tank contents
- Where sufficient data was supplied CEO estimates indicated most emissions over PBR limits (<25 tons per year)
    - 6 sites did not submit initial data sufficient for emissions estimation
    - 14 sites from 7 companies had emissions that were over the PBR emission limits
    - All companies indicated their emissions are now below PBR limits
- All companies indicated they have reviewed the videos and addressed the issue
    - Most through decreased production
    - 4 companies with 10 sites through actual operation or maintenance changes
- Improved maintenance to contain and re-rout hydrocarbon emissions
- Potential process improvements to decrease hydrocarbon emissions
- Discussion of potential on-site tank testing to be conducted/coordinated by TCEQ
    - Data will help improve the emissions calculations
    - Help identify the emissions
- Creation of an Agency workgroup to exchange information related to O&G issues
    - Future cooperative workshops with Trade Organizations

2007 Survey - Company and TCEQ VOC Estimates

			Operations		Estimated VOC emissions				
			Reported oil/condensate production (bbl/day)		Company Estimated VOC (tpy)		TCEQ estimate VOC (tpy)*		
	Site	Area	2007	2009	2007	2009	2007	2009	Summary of Company Response
1	JL Martin 1H	DFW	---	---	---	---	---	---	No condensate produced. Discussed possible options to minimize venting
2	Bonds Ranch Rd	DFW	---	---	---	2.425 VOC 40 THC flash**	---	---	No condensate produced. Plume due to separator liquid dump valve struck open. Corrected
3	Gertrude McPeek	DFW	---	---	---	---	---	---	No condensate produced. Company conducting analysis of saltwater
4	McCutchin 2H	DFW	---	---	---	---	---	---	Water production too high for separator, due to work over on adjacent well.
5	RBR A 1H	DFW	4	3	---	---	24	18	Company conducting analysis
6	JW Hodges & Greystone	DFW	---	---	---	---	---	---	No condensate produced.
7	Jones 1H	DFW	---	---	---	---	---	---	No condensate produced.
8	Johnson D1H and D2H	DFW	7	5	---	---	42	30	
9	Moncrief 14H	DFW	42	4	1.47 mscf/d 25.6 tpy***	0.15 mscf/d 2.6 tpy***	254	24	Emissions due to open hatches, pumpers instructed to keep hatches closed.
10	Moncrief 17H	DFW	23	3	0.54 mscf/d 9.4 tpy***	0.07 mscf/d 1.2 tpy***	139	18	Emissions due to separator carry0over from newly completed well. Separator operation adjusted.
11	Bell Valley 1	Corpus	24	---	---	---	145	---	Company conducting new sampling
12	Narrow road GU1	Corpus	20	---	---	---	121	---	Company conducting new sampling
13	Valley 1	Corpus	5	---	---	---	30	---	Company conducting new sampling
14	Apex GU1	Corpus	28	---	---	---	169	---	Company conducting new sampling
15	Franks Field	HGB	25	---	8	---	151	---	
16	Alta Loma	HGB	82	---	4.88	---	495	---	Analysis being performed, will send.
17	Trust	HGB	95	---	15.22	---	574	---	Analysis being performed will send.
18	Butts	HGB	45,000 (saltwater)	---	6.302	---	85	---	Saltwater disposal only, sampled at pump discharge
19	Curkeet	HGB	27,000 (saltwater)	---	10.504	---	42	---	Saltwater disposal only, sampled at pump discharge

20	Wooster	HGB	7,658 (saltwater)	---	1.72	---	26	---	Saltwater disposal only, sampled at pump discharge

Since several sites claimed no condensate production, there were not sufficient data to perform an VOC estimate using E&P Tanks program.
--- No results have been entered, because sufficient data was not made available to calculate an estimate. In some cases, additional sampling may still occur.
* TCEQ estimates based on HARC 51C VOC emission factors for condensate production of 33.1 lb VOC/bbl condensate, with the exception of #18, 19, and 20. Saltwater disposal emissions based on company reported concentrations of hydrocarbons in saltwater.
** Company calculated total hydrocarbon flash emissions. It is unknown what portion may be VOC flash.
*** Ideal gas law used to convert company reported volume emissions to mass emissions.

Follow-up Course of Action Summary

#	Company/Site	Area	Company Response
1	EOG: Bell Valley #1	Corpus Christi	
2	EOG: Narrow Road GU #1	Corpus Christi	
3	EOG: Valley #1	Corpus Christi	Initial data submitted did not accurately reflect current potential VOC emissions. Will submit supplemental data as soon as it is available. Issues seen in video related mainly to open thief hatches. Have stressed to personnel the importance of closing thief hatches.
4	EOG: Apex GU #1	Corpus Christi	
5	JW Operating: JL Martin #1H	DFW	Submitted gas and wellhead (produced water?) sample analysis. Company has discussed possible ways of mitigating VOC emissions during phone discussions.
6	Crow Creek: Bonds Ranch Road	DFW	Response not yet due
7	Pioneer: Gertrude McPeek	DFW	Response not yet due
8	Western Chief Operating: McCutchin 2H	DFW	Well was being worked on and venting of gas was not part of normal operations. Submitted gas analysis.
9	Pioneer: RBR A1H	DFW	Response not yet due
10	XTO: JW Hodges & Greystone	DFW	
11	XTO: Jones 1H	DFW	
12	XTO: Johnson D1H & D2H	DFW	Submitted updated production data. In discussion with company to potentially conduct on-site testing.
13	XTO: Franks Field	HGB	Indicated during first data request that site maintenance had been performed to route all vapors to flare.
14	Hilcorp: Alta Loma	HGB	Submitted updated production data and recent analysis that indicate emissions below PBR. Will insure that all hatches are closed and seals are intact.
15	Hilcorp: Trust	HGB	
16	Moncrief: 14H & 17H	DFW	
17	Moncrief: 14H & 17H	DFW	Images in video were the result of separator carry-over due to a new well being brought to completion. Current production has decreased and improved operational practices are in place.
18	Denbury Onshore, LLC: Butts	HGB	
19	Denbury Onshore, LLC: Curkeet	HGB	
20	Denbury Onshore, LLC: Wooster	HGB	Submitted updated production data and recent analysis that indicate emissions below PBR.

Attachment 5

Summary of Mobile Monitoring Activities relating to the Barnett Shale

The TCEQ is in the process of studying the emissions from gas production and their impacts in the Barnett Shale area. In an effort to gather information, the Mobile Monitoring Team has conducted two trips to monitor emissions in this area. Phase I of the study was conducted August 24-28 and Phase II occurred October 9-16, 2009. These trips included surveying the area using infrared (IR) imagery, total vapor analyzers (TVA), hydrogen sulfide monitors, monitoring for nitrogen oxides (NOx) and collecting volatile organic compound (VOC) samples. Over sixty locations were monitored in the five county area of Tarrant, Parker, Wise, Denton, and Johnson Counties (see attached map).

Phase I

The first phase of the study looked at 12 sites that were identified through odor complaints received in the region. Emission sources were identified at 11 of the 12 sites. Images were also taken at various locations throughout the area and identified storage tanks, compressor stations, wells, and associated equipment with significant hydrocarbon emissions. Also monitored during the trip were associated businesses such as water disposal facilities. A GasFindIR camera along with a TVA were used to identify VOC emission sources. At several sites, canister samples were taken to characterize the plumes detected (limited raw data is attached).

Phase II

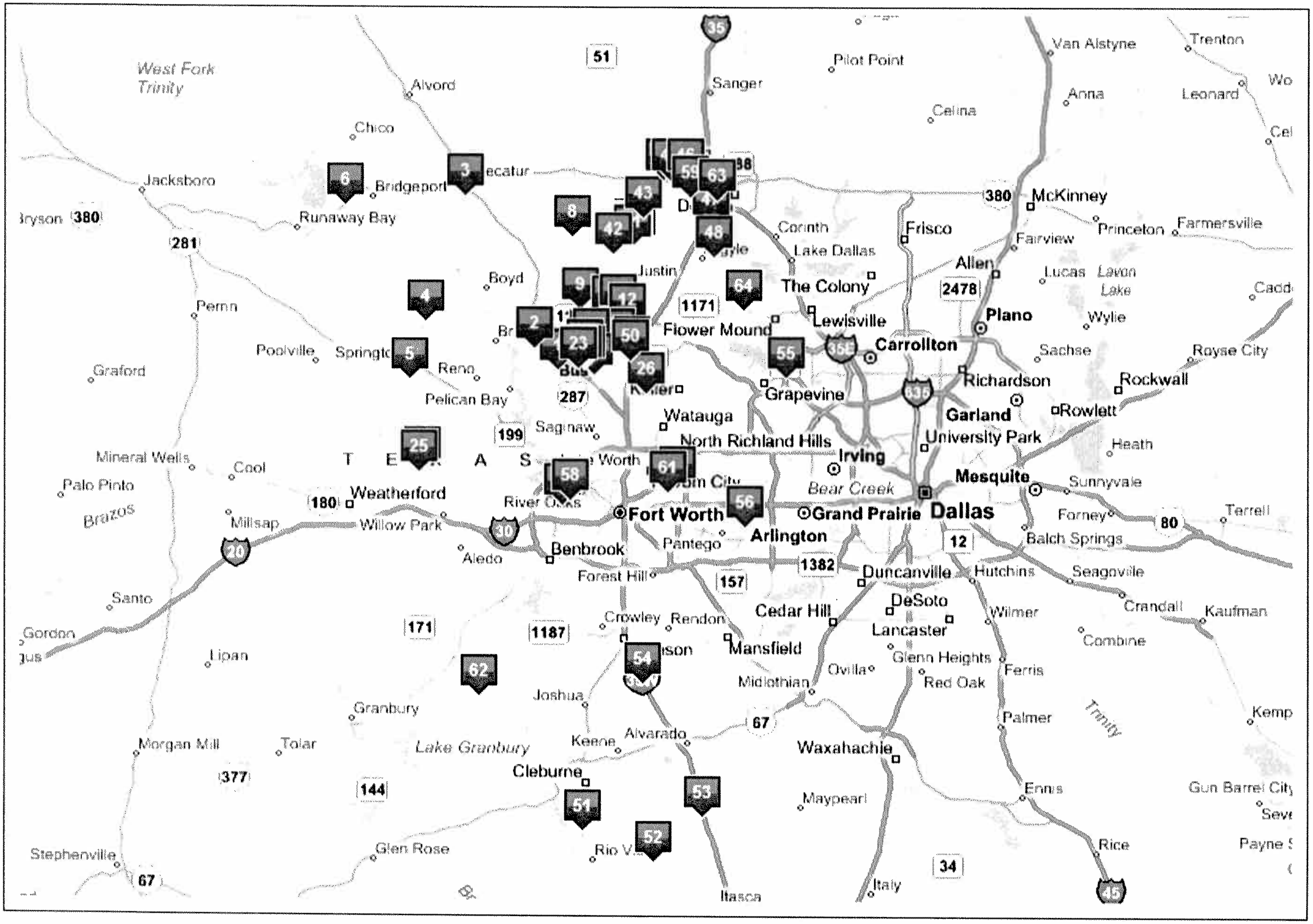
The second phase included returning to many of the sites identified in the first phase to conduct a more comprehensive evaluation of the emissions. Data on VOC emissions was collected using real time gas chromatographs along with IR imaging and canister sampling to more thoroughly characterize the emissions. In addition, monitoring for NOx was conducted to provide information on the impact these types of facilities have on local concentrations of this ozone precursor.

Preliminary results indicate that some elevated emission levels were detected. A maximum benzene concentration of 1000 parts per billion by volume (ppbv) and hourly average of 540 ppbv was detected west of DISH (Site 8). The short term Effects Screening Level for benzene is 180 ppbv. Elevated NOx levels of 40-70 ppbv (Site 2) and 85 ppbv (Site 4) were detected downwind of compressor stations at these sites.

Future Plans

Future plans for monitoring in this area include a third phase to monitor for sulfide related compounds, such as carbon disulfide, which were indicated to be present in reports commissioned by the City of DISH and a private citizen. This trip is planned for November. A fourth phase will occur in conjunction with a proposed study funded by the Chief Engineers Office and will include determining emission rates and characteristics of emissions at sources along with off site impacts of the emissions. The fourth phase is tentatively planned to occur during the spring of 2010.

Barnett Shale Mobile Monitoring Sites



Barnett Shale Phase I Canister Results
August 24-28 sampling trip

Sample Number		BSF0908-01			BSF0908-02			BSF0908-16			BSF0908-17		
Sample Date		8/25/09			08/25/09			08/26/09			08/25/09		
Sample Time		18:08			17:50			17:00			20:47		
Sample Site		**Site 16** HWY 171 Between Covington and Cleburne			**Site 16**			**Site 8** 5 to 10 miles west of Dish Taken at wellhead			**Site 2** NE of Weatherford		
Compound	**Short-term ESL**	**SDL**	**(ppbv)**	**Flags**	**SDL**	**(ppbv)**	**Flags**	**SDL**	**(ppbv)**	**Flags**	**SDL**	**(ppbv)**	**Flags**
ethane	10000	1.0	7.4	D1	10.00	2000	D2	200000	45000000	D3	100	12000	D4
ethylene	1200	1.0	0.41	J,D1	10.00	ND	D2	200000	ND	D3	100	28	J,D4
acetylene	25000	1.0	ND	D1	10.00	ND	D2	200000	ND	D3	100	ND	D4
propane	10000	1.0	0.72	J,D1	10.00	350	D2	200000	15000000	D3	100	3900	D4
propylene	68000	1.0	0.21	J,D1	10.00	ND	D2	200000	ND	D3	100	ND	D4
dichlorodifluoromethane	10000	0.40	0.52	L,D1	4.00	0.50	J,D2	80000	2700	J,D3	40	1.9	J,D4
methyl chloride	500	0.40	0.68	L,D1	4.00	0.74	J,D2	80000	12000	J,D3	40	9.7	J,D4
isobutane	2000	0.46	0.09	J,D1	4.6	73	D2	92000	3900000	D3	46	680	D4
vinyl chloride	50	0.34	ND	D1	3.4	ND	D2	68000	ND	D3	34	1.8	J,D4
1-butene	360	0.40	0.21	J,D1	4.00	1.0	J,D2	80000	23000	J,D3	40	15	J,D4
1,3-butadiene	50	0.54	ND	D1	5.4	ND	D2	110000	ND	D3	54	ND	D4
n-butane	8000	0.40	0.14	J,D1	4.00	76	D2	80000	4000000	D3	40	1000	D4
t-2-butene	2100	0.36	ND	D1	3.6	ND	D2	72000	ND	D3	36	ND	D4
bromomethane	30	0.54	0.01	J,D1	5.4	ND	D2	110000	ND	D3	54	2.7	J,D4,A1
c-2-butene	2100	0.54	ND	D1	5.4	ND	D2	110000	ND	D3	54	1.4	J,D4
3-methyl-1-butene	250	0.46	ND	D1	4.6	ND	D2	92000	ND	D3	46	ND	D4
isopentane	1200	0.54	0.05	J,D1	5.4	26	D2	110000	1500000	D3	54	330	D4
trichlorofluoromethane	5000	0.58	0.26	J,D1	5.8	ND	D2	120000	ND	D3	58	2.6	J,D4
1-pentene	100	0.54	ND	D1	5.4	ND	D2	110000	ND	D3	54	ND	D4
n-pentane	1200	0.54	ND	D1	5.4	15	L,D2	110000	880000	D3	54	280	D4
isoprene	5	0.54	2.0	D1	5.4	1.4	J,D2	110000	ND	D3	54	2.1	J,D4
t-2-pentene	2600	0.54	ND	D1	5.4	ND	D2	110000	ND	D3	54	2.1	J,D4
1,1-dichloroethylene	180	0.36	ND	D1	3.6	ND	D2	72000	ND	D3	36	2.9	J,D4
c-2-pentene	2600	0.50	ND	D1	5	ND	D2	100000	ND	D3	50	1.8	J,D4
methylene chloride	75	0.28	0.04	J,D1	2.8	ND	D2	56000	6400	J,D3	28	2.3	J,D4

2-methyl-2-butene	250	0.46	ND	D1	4.6	ND	D2	92000	ND	D3	46	ND	D4
2,2-dimethylbutane	1000	0.42	ND	D1	4.2	1.2	J,D2	84000	65000	J,D3	42	8.1	J,D4
cyclopentene	2900	0.40	ND	D1	4.00	ND	D2	80000	ND	D3	40	1.8	J,D4

Sample Number		BSF0908-01			BSF0908-02			BSF0908-16			BSF0908-17		
Sample Date		8/25/09			08/25/09			08/26/09			08/25/09		
Sample Time		18:08			17:50			17:00			20:47		
Sample Site		Site 16 HWY 171 Between Covington and Cleburne			Site 16			Site 8 5 to 10 miles west of Dish Taken at wellhead			Site 2 NE of Weatherford		
Compound	Short-term ESL	SDL	(ppbv)	Flags	SDL	(ppbv)	Flags	SDL	(ppbv)	Flags	SDL	(ppbv)	Flags
4-methyl-1-pentene	20	0.44	ND	D1	4.4	ND	D2	88000	ND	D3	44	1.8	J,D4
1,1-dichloroethane	1000	0.38	ND	D1	3.8	ND	D2	76000	ND	D3	38	1.3	J,D4
cyclopentane	1200	0.54	ND	D1	5.4	0.30	J,D2	110000	10000	J,D3	54	5.9	J,D4
2,3-dimethylbutane	1000	0.56	ND	D1	5.6	0.87	J,D2	110000	46000	J,D3	56	9.0	J,D4
2-methylpentane	83	0.54	ND	D1	5.4	5.3	J,D2	110000	310000	D3	54	78	L,D4
3-methylpentane	1000	0.46	ND	D1	4.6	3.5	J,D2	92000	190000	L,D3	46	47	L,D4
2-methyl-1-pentene + 1-hexene	20	0.40	ND	D1	4.00	ND	D2	80000	ND	D3	40	ND	D4
n-hexane	1500	0.40	ND	D1	4.00	5.7	L,D2	80000	310000	D3	40	110	L,D4
chloroform	20	0.42	0.01	J,D1	4.2	ND	D2	84000	ND	D3	42	ND	D4
t-2-hexene	20	0.54	ND	D1	5.4	ND	D2	110000	ND	D3	54	ND	D4
c-2-hexene	20	0.54	ND	D1	5.4	ND	D2	110000	ND	D3	54	1.0	J,D4
1,2-dichloroethane	40	0.54	ND	D1	5.4	ND	D2	110000	ND	D3	54	1.7	J,D4
methylcyclopentane	750	0.54	ND	D1	5.4	0.57	J,D2	110000	26000	J,D3	54	21	J,D4
2,4-dimethylpentane	910	0.54	ND	D1	5.4	ND	D2	110000	16000	J,D3	54	4.6	J,D4
1,1,1-trichloroethane	2000	0.52	0.01	J,D1	5.2	ND	D2	100000	ND	D3	52	ND	D4
benzene	180	0.54	0.07	J,D1	5.4	0.64	J,D2	110000	15000	J,D3	54	24	J,D4
carbon tetrachloride	20	0.54	0.1	J,D1	5.4	0.10	J,D2	110000	ND	D3	54	1.0	J,D4
cyclohexane	420	0.48	ND	D1	4.8	ND	D2	96000	70000	J,D3	48	39	J,D4
2-methylhexane	750	0.54	ND	D1	5.4	1.9	J,D2	110000	120000.00	L,D3	54	37	J,D4
2,3-dimethylpentane	910	0.52	ND	D1	5.2	ND	D2	100000	20000	J,D3	52	7.5	J,D4
3-methylhexane	750	0.40	ND	D1	4.00	1.4	J,D2	80000	87000	L,D3	40	35	J,D4
1,2-dichloropropane	250	0.34	ND	D1,A5	3.4	ND	D2,A5	68000	ND	D3,A5	34	ND	D4,A2
trichloroethylene	250	0.58	ND	D1	5.8	ND	D2	120000	ND	D3	58	1.1	J,D4
2,2,4-trimethylpentane	750	0.48	ND	D1	4.8	ND	D2	96000	1400	J,D3	48	ND	D4
2-chloropentane	190	0.54	ND	D1	5.4	ND	D2	110000	ND	D3	54	1.1	J,D4
n-heptane	850	0.50	ND	D1	5	1.30	J,D2	100000	72000	J,D3	50	50	J,D4
c-1,3-dichloropropylene	10	0.40	ND	D1	4.00	ND	D2	80000	ND	D3	40	1.2	J,D4

methylcyclohexane	4000	0.52	ND	D1	5.2	ND	D2	100000	41000	J,D3	52	42	J,D4
t-1,3-dichloropropylene	10	0.40	ND	D1	4.00	ND	D2	80000	ND	D3	40	1.5	J,D4
1,1,2-trichloroethane	100	0.42	ND	D1	4.2	ND	D2	84000	ND	D3	42	ND	D4

Sample Number		BSF0908-01			BSF0908-02			BSF0908-16			BSF0908-17		
Sample Date		8/25/09			08/25/09			08/26/09			08/25/09		
Sample Time		18:08			17:50			17:00			20:47		
Sample Site		Site 16 HWY 171 Between Covington and Cleburne			Site 16			Site 8 5 to 10 miles west of Dish Taken at wellhead			Site 2 NE of Weatherford		
Compound	Short-term ESL	SDL	(ppbv)	Flags	SDL	(ppbv)	Short-term ESL	SDL	(ppbv)	Flags	SDL	(ppbv)	Short-term ESL
2,3,4-trimethylpentane	750	0.48	ND	D1	4.8	ND	D2	96000	ND	D3	48	ND	D4
toluene	170	0.54	0.06	J,D1	5.4	0.97	J,D2	110000	21000.00	J,D3	54	120	L,D4
2-methylheptane	750	0.40	ND	D1	4.00	0.27	J,D2	80000	16000	J,D3	40	19	J,D4
3-methylheptane	750	0.46	ND	D1	4.60	0.27	J,D2	92000.00	12000	J,D3	46	14	J,D4
1,2-dibromoethane	0.5	0.40	ND	D1	4.00	ND	D2	80000	ND	D3	40	0.92	J,D4
n-octane	750	0.38	ND	D1	3.8	0.29	J,D2	76000	17000	J,D3	38	25	J,D4
tetrachloroethylene	770	0.48	ND	D1	4.8	ND	D2	96000	ND	D3	48	ND	D4
chlorobenzene	100	0.54	ND	D1	5.4	ND	D2	110000	ND	D3	54	ND	D4
ethylbenzene	460	0.54	0.02	J,D1	5.4	0.40	J,D2	110000	7400	J,D3	54	10	J,D4
m & p-xylene	480	0.54	0.06	J,D1	5.4	1.1	J,D2	110000	20000	J,D3	54	93	L,D4
styrene	25	0.54	ND	D1	5.4	ND	D2	110000	18000	J,D3	54	4.2	J,D4
1,1,2,2-tetrachloroethane	10	0.40	ND	D1	4.00	ND	D2	80000	ND	D3	40	1.4	J,D4,A3
o-xylene	1000	0.54	ND	D1	5.4	0.40	J,D2	110000	ND	D3	54	18	J,D4
n-nonane	2000	0.44	ND	D1	4.4	ND	D2	88000	14000	J,D3	44	14	J,D4
isopropylbenzene	100	0.48	ND	D1	4.8	ND	D2	96000	ND	D3	48	3.3	J,D4
n-propylbenzene	250	0.54	ND	D1	5.4	ND	D2	110000	ND	D3	54	1.9	J,D4
m-ethyltoluene	250	0.22	ND	D1	2.2	0.64	J,D2	44000	ND	D3	22	3.1	J,D4
p-ethyltoluene	250	0.32	ND	D1	3.2	0.26	J,D2	64000	ND	D3	32	1.8	J,D4
1,3,5-trimethylbenzene	250	0.5	ND	D1	5	0.29	J,D2	100000	ND	D3	50	3.0	J,D4
o-ethyltoluene	250	0.26	ND	D1	2.6	0.27	J,D2	52000	ND	D3	26	1.6	J,D4
1,2,4-trimethylbenzene	250	0.54	0.04	J,D1	5.4	1.3	J,D2	110000	ND	D3	54	5.3	J,D4
n-decane	1800	0.54	ND	D1	5.4	ND	D2	110000	ND	D3	54	8.7	J,D4
1,2,3-trimethylbenzene	250	0.54	ND	D1	5.4	0.38	J,D2	110000	4500	J,D3	54	2.5	J,D4
m-diethylbenzene	460	0.54	ND	D1	5.4	ND	D2	110000	ND	D3	54	ND	D4
p-diethylbenzene	460	0.54	ND	D1	5.4	ND	D2	110000	ND	D3	54	ND	D4
n-undecane	200	0.54	0.03	J,D1	5.4	ND	D2	110000	10000	J,D3	54	7.3	J,D4

Sample Number		BSF0908-24			BSF0908-25		
Sample Date		08/26/09			08/26/09		
Sample Time		12:50			13:10		
Sample Site		Site 5 South of Springtown Parker County taken onsite at Disposal well			Site 5 taken onsite at Disposal well		
Compound	Short-term ESL	SDL	(ppbv)	Flags	SDL	(ppbv)	Flags
ethane	10000	0.50	34		25	580	D5
ethylene	1200	0.50	ND	J	25	9.8	J,D5
acetylene	25000	0.50	ND		25	ND	D5
propane	10000	0.50	10		25	48	L,D5
propylene	68000	0.50	0.07	J	25	ND	D5
dichlorodifluoromethane	10000	0.20	0.51	L	10	1.8	J,D5
methyl chloride	500	0.20	0.69		10	2.7	J,D5
isobutane	2000	0.23	2.4		12	13	L,D5
vinyl chloride	50	0.17	ND		8.5	3.5	J,D5
1-butene	360	0.20	0.29	L	10	5.8	J,D5
1,3-butadiene	50	0.27	ND		14	2.6	J,D5
n-butane	8000	0.20	4.7		10	26	L,D5
t-2-butene	2100	0.18	ND		9	0.75	J,D5
bromomethane	30	0.27	0.02	J,A1	14	ND	D5,A1
c-2-butene	2100	0.27	0.02	J	14	0.90	J,D5
3-methyl-1-butene	250	0.23	0.01	J	12	0.56	J,D5
isopentane	1200	0.27	3.7		14	23	L,D5
trichlorofluoromethane	5000	0.29	0.23	J	15	1.2	J,D5
1-pentene	100	0.27	ND		14	ND	D5
n-pentane	1200	0.27	4.1		14	24	L,D5
isoprene	5	0.27	1.3		14	3.2	J,D5
t-2-pentene	2600	0.27	ND		14	0.29	J,D5
1,1-dichloroethylene	180	0.18	0.01	J	9	1.4	J,D5
c-2-pentene	2600	0.25	0.01	J	13	ND	D5
methylene chloride	75	0.14	0.04	J	7	2.7	J,D5
2-methyl-2-butene	250	0.23	0.02	J	12	0.41	J,D5
2,2-dimethylbutane	1000	0.21	0.21	L	11	1.7	J,D5
cyclopentene	2900	0.20	ND		10	ND	D5

Sample Number		BSF0908-24			BSF0908-25		
Sample Date		08/26/09			08/26/09		
Sample Time		12:50			13:10		
Sample Site		Site 5 South of Springtown Parker County taken onsite at Disposal well			Site 5 taken onsite at Disposal well		
Compound	Short-term ESL	SDL	(ppbv)	Flags	SDL	(ppbv)	Flags
4-methyl-1-pentene	20	0.22	ND		11	0.78	J,D5
1,1-dichloroethane	1000	0.19	ND		9.5	ND	D5
cyclopentane	1200	0.27	0.21	J	14	1.8	J,D5
2,3-dimethylbutane	1000	0.28	0.28	L	14	2.8	J,D5
2-methylpentane	83	0.27	2.5		14	18	L,D5
3-methylpentane	1000	0.23	1.8		12	12	L,D5
2-methyl-1-pentene + 1-hexene	20	0.20	ND		10	ND	D5
n-hexane	1500	0.20	4.4		10	32	D5
chloroform	20	0.21	ND		11	ND	D5
t-2-hexene	20	0.27	ND		14	ND	D5
c-2-hexene	20	0.27	0.01	J	14	ND	D5
1,2-dichloroethane	40	0.27	ND		14	18	L,D5
methylcyclopentane	750	0.27	0.99		14	6.1	J,D5
2,4-dimethylpentane	910	0.27	0.27	L	14	2.1	J,D5
1,1,1-trichloroethane	2000	0.26	ND		13	0.25	J,D5
benzene	**180**	**0.27**	**3.2**		**14**	**93**	**D5**
carbon tetrachloride	20	0.27	0.09	J	14	0.48	J,D5
cyclohexane	420	0.24	2.0		12	17	L,D5
2-methylhexane	750	0.27	3.1		14	22	L,D5
2,3-dimethylpentane	910	0.26	0.57	L	13	4.2	J,D5
3-methylhexane	750	0.20	3.2		10	21	L,D5
1,2-dichloropropane	250	0.17	ND	A2	8.5	ND	D5,A2
trichloroethylene	250	0.29	ND		15	0.28	J,D5
2,2,4-trimethylpentane	750	0.24	ND		12	ND	D5
2-chloropentane	190	0.27	0.02	J	14	0.35	J,D5
n-heptane	850	0.25	5.4		13	32	D5
c-1,3-dichloropropylene	10	0.20	ND		10	ND	D5
methylcyclohexane	4000	0.26	5.1		13	30	L,D5

Sample Number		BSF0908-24			BSF0908-25		
Sample Date		08/26/09			08/26/09		
Sample Time		12:50			13:10		
Sample Site		Site 5 South of Springtown Parker County taken onsite at Disposal well			Site 5 taken onsite at Disposal well		
Compound	Short-term ESL	SDL	(ppbv)	Flags	SDL	(ppbv)	Flags
t-1,3-dichloropropylene	10	0.20	ND		10	0.24	J,D5
1,1,2-trichloroethane	100	0.21	ND		11	ND	D5
2,3,4-trimethylpentane	750	0.24	0.04	J	12	0.57	J,D5
toluene	170	0.27	5.70		14	120	D5
2-methylheptane	750	0.20	2.8		10	20	L,D5
3-methylheptane	750	0.23	2.2		12	17	L,D5
1,2-dibromoethane	0.5	0.20	0.02	J	10	ND	D5
n-octane	750	0.19	3.8		9.5	29	L,D5
tetrachloroethylene	770	0.24	ND		12	0.23	J,D5
chlorobenzene	100	0.27	0.15	J	14	ND	D5
ethylbenzene	460	0.27	0.40	L	14	29	L,D5
m & p-xylene	480	0.27	5.7		14	130	D5
styrene	25	0.27	ND		14	42	D5
1,1,2,2-tetrachloroethane	10	0.20	0.02	J,A3	10	ND	D5,A3
o-xylene	1000	0.27	1.3		14	39	D5
n-nonane	2000	0.22	5.1		11	57	D5
isopropylbenzene	100	0.24	0.10	J	12	29	D5
n-propylbenzene	250	0.27	0.28	L	14	2.3	J,D5
m-ethyltoluene	250	0.11	0.90		5.5	9.1	L,D5
p-ethyltoluene	250	0.16	0.29	L	8.0	2.9	J,D5
1,3,5-trimethylbenzene	250	0.25	1.6		13	17	L,D5
o-ethyltoluene	250	0.13	0.49	L	6.5	3.9	J,D5
1,2,4-trimethylbenzene	250	0.27	3.2		14	28	L,D5
n-decane	1800	0.27	9.4	D6	14	89	D5
1,2,3-trimethylbenzene	250	0.27	1.8		14	9.7	J,D5
m-diethylbenzene	460	0.27	ND		14	ND	D5
p-diethylbenzene	460	0.27	2.4		14	12	J,D5
n-undecane	200	0.27	20	D6	14	110	D5

Attachment 6

Improved Emissions Factors and Emissions Calculation Methods: Upstream Oil and Gas Activities

Past Activities

1. **2005 Remote Sensing VOC Project:** identified oilfield storage tanks with significant hydrocarbon plumes on the Texas Gulf Coast. **The project focused on industrial areas; however, during these surveys, approximately 50 storage tanks of the 500 tanks in upstream oil and gas service that were surveyed appeared to emit significant plumes.** The TCEQ contractor that conducted these projects, Leak Surveys, Inc. (LSI), uses a helicopter-mounted HAWK passive infrared (IR) camera to aerially survey and image hydrocarbon plumes.

As a direct result of these surveys, the TCEQ developed a project to test tanks in upstream oil and gas services, as detailed in item 2 below.

2. **HARC 51C Storage Tank Project:** In 2006, the TCEQ and the Houston Advanced Research Center (HARC) published project H51C (http://projects.tercairquality.org/AQR/H051C), **which identified thousands of tons of VOC flash emissions from upstream oil and gas operations (approximately 750,000 tpy).** This project, which began in 2005, developed emissions factors to quantify these emissions, which the TCEQ has **added to the area source inventory. This project also resulted in new guidance for point source EI development that was published in 2005.**

3. HGB Flash Emissions Control: The H51C project directly led to Chapter 115 rules controlling VOC flash emissions from upstream oil and gas tanks in the Houston-Galveston-Brazoria (HGB) nonattainment area. These rules resulted in significant emissions reductions as well as potential economic payback for the companies that invested in vapor recovery controls. Depending on production rate of the well and related tank battery, the cost of controls can be much less than the value of the product recovered.

4. **Engine Fleet Surveys:** In 2007 and 2009, respectively, the TCEQ conducted surveys that characterized the nonattainment DFW and HGB area engine fleets to evaluate the effectiveness of different control strategies. These engine surveys categorized area source engines by type, load, and horsepower rating, as well as estimating NO_X emissions. **Results from this project verified that current techniques used to develop area source emissions estimates for engines were representative.**

Current Activities

1. 2009 Flyovers: The TCEQ and LSI recently completed (summer 2009) aerial surveys of both oil and gas production areas and industrial areas in the Tyler-Longview-Marshall and Gulf Coast (HGB, Beaumont-Port Arthur, and Corpus Christi) areas. The results are currently being analyzed.

2. **Flash Emissions Model Evaluation:** The TCEQ is currently conducting a research project to identify the most representative calculation methodologies for upstream oil and gas storage tank emissions. **The results of the report are anticipated to improve agency guidance and policy on calculating upstream oil and gas tank emissions. The TCEQ has accepted informal comments on the draft report; the final report will be published on the Web by December 2009.**

3. **Emissions Inventory Guidance Improvement:** The TCEQ annually updates and publishes *Emissions Inventory Guidelines* (RG-360A), a comprehensive guidance document that explains all aspects of the point source EI process. Currently, six technical supplements provide detailed guidance on determining emissions from potentially under-reported VOC emissions sources such as cooling towers, flares, and upstream oil and gas storage tanks. **Guidance on upstream oil and gas storage tanks states direct measurement of storage tank emissions is the most preferred emissions determination method, and emphasizes the use of site-specific data (versus default data) in emissions determinations. The 2009 guidance will remove the Environmental Consultants and Research, Inc., (EC/R) equation as an allowed determination method.**

4. **Drilling Rig Emissions Project:** The TCEQ recently completed a research project **to improve emissions inventory estimates for drilling rig engines.** Results are being reviewed and are expected to be used for area source EI development.

5. **DFW Compressor Engine Project:** The TCEQ currently is sponsoring a contract project with the University of Texas at Austin. The purpose of the project is to **sample ambient emissions primarily downwind of gas compressor engines and develop typical compressor engines ambient signatures.** These ambient signatures may provide the TCEQ the ability to identify days when oil and gas compressor engines influence ozone levels in the Dallas-Fort Worth (DFW) area. The project is scheduled to be completed in December 2010.

Future Planned Activities

1. **Oil and Gas Platform Inventory Improvement Project:** During the previous oil and gas EI improvement work, inconsistencies were discovered in the number and characterization of possible oil and gas platforms in Texas state waters. **This project will develop an improved inventory that identifies and characterizes expected equipment and emissions, as well identifying platform locations.**

2. **Oil and Gas Model Evaluation: This project will evaluate existing methods and models for estimating oil and gas production emissions for multiple area sources such as compressor engines, heater-treaters, storage tanks, well completions, pneumatic devices, fugitives, and dehydrators.** This study will identify what processes and operational data will be required to calculate emissions for each source type on a county basis. Also, it will analyze the accuracy of conventional emissions estimation methods to determine oil and gas production emissions by comparing the results of multiple studies (Western Regional Air Partnership, TCEQ, Central Regional Air Planning Association, etc.). Finally, a Texas-specific spreadsheet calculator capable of generating future area source inventories will be developed.

3. **Produced Water Storage Tank Project:** Produced water/saltwater storage tanks are a potentially under-reported source of volatile organic compound (VOC) emissions in the emissions inventory (EI). **This project will estimate VOC emissions from the storage of water produced during upstream oil and gas activities.** This project will collect tank measurement data from previous site assessments/studies and develop an activity-based emissions factor for area source EI development.

4. **Upstream Oil and Gas Tank Emission Measurements: This project would provide storage tank measurement data that would further the CEO and OCE analysis and investigations resulting from the 2007 Remote Sensing Survey Project. The study would directly measure emissions from storage tanks at 10 to 20 sites originally identified in the 2007 surveys at an estimated cost of $5,000 per site.**

EAS/AQD/CEO KCC/SBD 10/8/09

Attachment 7

§106.352. Oil and Gas Production Facilities.

Any oil or gas production facility, carbon dioxide separation facility, or oil or gas pipeline facility consisting of one or more tanks, separators, dehydration units, free water knockouts, gunbarrels, heater treaters, natural gas liquids recovery units, or gas sweetening and other gas conditioning facilities, including sulfur recovery units at facilities conditioning produced gas containing less than two long tons per day of sulfur compounds as sulfur are permitted by rule, provided that the following conditions of this section are met. This section applies only to those facilities named which handle gases and liquids associated with the production, conditioning, processing, and pipeline transfer of fluids found in geologic formations beneath the earth's surface.

(1) Compressors and flares shall meet the requirements of §106.512 and §106.492 of this title (relating to Stationary Engines and Turbines, and Flares).

(2) Total emissions, including process fugitives, combustion unit stacks, separator, or other process vents, tank vents, and loading emissions from all such facilities constructed at a site under this section shall not exceed 25 tons per year (tpy) each of sulfur dioxide (SO2), all other sulfur compounds combined, or all volatile organic compounds (VOC) combined; and 250 tpy each of nitrogen oxide and carbon monoxide. Emissions of VOC and sulfur compounds other than SO2 must include gas lost by equilibrium flash as well as gas lost by conventional evaporation.

(3) Any facility handling sour gas shall be located at least 1/4 mile from any recreational area or residence or other structure not occupied or used solely by the owner or operator of the facility or the owner of the property upon which the facility is located.

(4) Total emissions of sulfur compounds, excluding sulfur oxides, from all vents shall not exceed 4.0 pounds per hour (lb/hr) and the height of each vent emitting sulfur compounds shall meet the following requirements, except in no case shall the height be less than 20 feet:

Total as Hydrogen Sulfide (lb/hr)	**Minimum vent height (feet)**
0.27	20
0.60	30
1.94	50
3.00	60
4.00	68

NOTE: Other values may be interpolated.

(5) Before operation begins, facilities handling sour gas shall be registered with the Commission's Office of Permitting, Remediation, and Registration in Austin using Form PI-7 along with supporting documentation that all requirements of this section will be met. For facilities constructed under §106.353 of this title (relating to Temporary Oil and Gas Facilities), the registration is required before operation under this section can begin. If the facilities cannot meet this section, a permit under Chapter 116 of this title (relating to Control of Air Pollution by Permits for New Construction or Modification) is required prior to continuing operation of the facilities.

Adopted August 9, 2000 Effective September 4, 2000

Attachment 8

Texas Commission on Environmental Quality

INTEROFFICE MEMORANDUM

To: Distribution **Date:** October 27, 2009

From: Shannon Ethridge, M.S.
Toxicology Division, Chief Engineer's Office

Subject: Health Effects Review of Ambient Air Monitoring Data Collected by Wolf Eagle Environmental Engineers and Consultants for DISH, TX

SUMMARY

- The highest potential 1-hour maximum benzene concentration is below the health effects level observed in short-term animal and human studies; however, it is possible that adverse health effects could occur from exposure to this concentration. It was not possible to determine if residents were exposed to this concentration of benzene based on the information provided.
- The Toxicology Division (TD) is concerned that the monitored concentrations of benzene at several of the sampling locations could pose a long-term health risk to residents in the area if the concentrations are representative of normal and prolonged ambient conditions.
- Several monitored and potential 1-hour maximum concentrations of target compounds and tentatively identified compounds (TICs) could have resulted in odorous conditions. Persistent or recurrent exposure to levels which significantly exceed the odor threshold may cause odor-related effects such as headache and nausea. This is consistent with citizen reports of odors in the area.
- The TD strongly recommends additional sampling in the area.

BACKGROUND

Ambient air monitoring analysis was conducted by Wolf Eagle Environmental Engineers and Consultants (Wolf Eagle) for the town of DISH, Texas. The report is available at the following website: http://www.townofdish.com/. Air monitoring was conducted to characterize the ambient air quality adjacent to several natural gas compression stations on town property and adjacent to town boundaries. The TD was requested to complete a health effects review of the air monitoring results. For the purposes of this evaluation, the TD assumed that sample collection and data analysis met appropriate quality assurance/quality control requirements.

According to the Wolf Eagle report, a total of seven 24-hour canister samples were collected beginning at 12:12 pm on August 17, 2009. All canister locations were on or near residential property. Canisters were placed on residential property located at 9217 Chisum, 9213 Chisum, 9203 Chisum, Burgess property, and Guthries property. The canister sample Airfield 1:29 was placed at the southeast corner of an airfield adjacent to a residential area. The canister sample Airfield 1:32 was placed at the southwest corner of an airfield adjacent to a residential area. Please refer to the Wolf Eagle report for a map showing canister locations.

Wolf Eagle obtained meteorological data from the Denton Municipal Airport and reported the wind direction during the time of the sampling event to be out of the southeast at an average wind speed of 9 miles per hour with gusts up to 20 miles per hour. Wind roses generated from meteorological data obtained from the Denton Airport South CAMS 56 site for the sampling period are presented in Figure 1.

Samples were analyzed for 40 target volatile organic compounds (VOCs) as well as TICs, fixed gases, and NOx. TICs are observed measurements in the sample for which the gas chromatograph-mass spectrometer (GC/MS) was not specifically calibrated; however, the tentative identification of a compound can be made by comparing the mass spectrum from the environmental sample to a computerized library of mass spectra. The comparison of the sample spectra and that of the library are scored for their similarity to the mass spectrum of a particular TIC and the tentative identification is made based on the most similar spectra. This is a commonly used technique; however, the absolute identity of a TIC is uncertain. Quantifying TICs is also less accurate than for target compounds because the true relative response factor is not known, since the instrument was not calibrated for the TIC. It is important to note these uncertainties when evaluating TICs.

Air samples collected over a 24-hour period are designed to provide representative long-term average concentrations when samples are collected at a minimum of every sixth day for an entire year. In this case, sampling was conducted for one 24-hour period; therefore, the sampling results would not be considered representative of a long-term average. The TD evaluated the reported concentrations for each target analyte and TIC for potential short-term odor, health, and vegetative concerns by comparing the measured chemical concentrations to appropriate short-term comparison values. Additionally, the TD evaluated the potential 1-hour maximum concentrations of all reported chemicals for each target analyte and TIC for potential short-term odor, health, and vegetative concerns by comparing the potential 1-hour maximum chemical concentrations to appropriate short-term comparison values. To determine the potential 1-hour maximum concentrations of all reported chemicals, the reported 24-hour concentration was multiplied by 24. This calculation conservatively assumes that the chemical had a maximum concentration for one hour and was not detected for the remaining 23 hours. This may or may not represent actual conditions.

EVALUATION

A total of seven 24-hour canister samples were collected beginning at 12:12 pm on August 17, 2009, and analyzed for 40 target VOCs as well as TICs, fixed gases, and NOx.

Target compound analysis

Of the 40 target VOCs analyzed, m&p xylenes were monitored at concentrations that could have caused odorous conditions. Of the 40 target VOCs, benzene, ethylbenzene, styrene, toluene, 1,2,4-trimethylbenzene, m&p xylenes, and o-xylenes had potential 1-hour maximum concentrations that exceeded TCEQ short-term applicable comparison levels.

Benzene
None of the monitored concentrations of benzene exceeded the short-term health-based comparison level of 180 parts per billion (ppb). Three potential 1-hour maximum concentrations of benzene exceeded the short-term health-based comparison value of 180 ppb: 257 ppb (Chisum 9213), 295 ppb (Chisum 9203), and 1865 ppb (Airfield 1:29). Actual monitored concentrations were 10.7 ppb, 12.3 ppb, and 77.7 ppb, respectively. Three subacute animal studies as reviewed in ATSDR (2005) and TCEQ (2007) reported adverse hematological effects after inhalation exposure to approximately 10,000 ppb benzene. All other reported health effects from short-term benzene exposure occur at higher concentrations (ATSDR 2005). The highest potential 1-hour maximum concentration of 1865 ppb is below 10,000 ppb; however, it is possible that adverse health effects could occur from exposure to this concentration given differences between animals and humans and possible sensitive humans. It was not possible to determine if residents were actually exposed to this concentration of benzene based on the information provided in the report. In addition, the TD is concerned that the monitored concentrations of benzene at several of the sampling locations could pose a long-term health risk to residents if representative of normal and prolonged ambient conditions.

Ethylbenzene
None of the monitored concentrations of ethylbenzene exceeded the short-term odor-based comparison level of 170 ppb. Two potential 1-hour maximum concentrations of ethylbenzene exceeded the short-term odor-based

comparison level of 170 ppb: 331 ppb (Chisum 9203) and 516 ppb (Airfield 1:29). These potential 1-hour maximum concentrations of ethylbenzene could have resulted in odorous conditions.

Styrene
None of the monitored concentrations of styrene exceeded the short-term odor-based screening level of 25 ppb. One potential 1-hour maximum concentration of styrene exceeded the short-term odor-based comparison level of 25 ppb: 31 (Airfield 1:29). This potential 1-hour maximum concentration of styrene could have resulted in odorous conditions.

Toluene
None of the monitored concentrations of toluene exceeded the short-term odor-based screening level of 170 ppb. Three potential 1-hour maximum concentrations of toluene exceeded the short-term odor-based comparison value of 170 ppb: 809 ppb (Chisum 9213), 1481 ppb (Chisum 9203), and 3336 ppb (Airfield 1:29). These potential 1-hour maximum concentrations of toluene could have resulted in odorous conditions.

1,2,4-Trimethylbenzene
None of the monitored concentrations of 1,2,4-trimethylbenzene exceeded the short-term health-based screening level of 250 ppb. Three potential 1-hour maximum concentrations of 1,2,4-trimethylbenzene exceeded the short-term health-based comparison value of 250 ppb: 461 ppb (Chisum 9213), 1450 ppb (Chisum 9203), and 1130 ppb (Airfield 1:29). These potential 1-hour maximum concentrations are much lower than those reported to cause health effects in humans and animals (ACGIH 2001) and would be unlikely to cause adverse health effects.

m&p xylenes
Two of the monitored concentrations of m&p xylenes exceeded the short-term odor-based comparison value of 41 ppb: 46 ppb (Chisum 9203) and 84 ppb (Airfield 1:29). Four potential 1-hour maximum concentrations of m&p xylenes exceeded the short-term odor-based comparison value of 41 ppb: 554 ppb (Chisum 9213), 1109 ppb (Chisum 9203), 2028 ppb (Airfield 1:29), and 45 (Burgess). These concentrations of 1,2,4-trimethylbenzene could have resulted in odorous conditions. The potential 1-hour maximum concentration of 2028 was slightly above the short-term health-based comparison value of 1700 ppb and would be unlikely to cause adverse health effects.

o xylenes
None of the monitored concentrations of o xylenes exceeded the short-term odor-based comparison value of 41 ppb. Three potential 1-hour maximum concentrations of o xylenes exceeded the short-term odor-based comparison value of 41 ppb: 252 ppb (Chisum 9213), 394 ppb (Chisum 9203), and 954 ppb (Airfield 1:29). These potential 1-hour maximum concentrations of o xylenes could have resulted in odorous conditions.

TIC analysis

A total of 28 TICs were identified in at least one canister sample. Six TICs were reported in more than one canister including carbonyl sulfide, carbon disulfide, dimethyl disulfide, methyl ethyl disulfide, trimethyl benzene, and diethyl benzene. Of the 28 total reported TICs, six had potential 1-hour maximum concentrations that exceeded short-term odor-based comparison levels: carbonyl sulfide, dimethyl pyridine, dimethyl disulfide, methyl ethyl disulfide, and naphthalene. It is possible that these concentrations could have resulted in odorous conditions. An additional 17 TICs had at least one potential 1-hour maximum concentration that exceeded short-term health-based screening levels: 2-methyl butane, 2,4-dimethylpentane, 2,3-dimethylpentane, carbon disulfide, propyl benzene, methyl pyridine, ethyl methyl ethyl disulfide, ethyl methyl benzene, trimethyl benzene, diethyl benzene, methyl-methyl ethyl benzene, tetramethyl benzene, undecane, 1-methyl propenyl benzene, dodecane, 1-methylene-1H-indene, and 2-methyl propenyl benzene. Given the uncertainties in identification and quantification of these compounds and the method used to determine potential 1-hour maximum concentrations, it is not possible to accurately draw conclusions about the potential for adverse health effects.

Fixed gases and NOx

Fixed gases and NOx were either not detected or detected below levels of health concern in all canister samples.

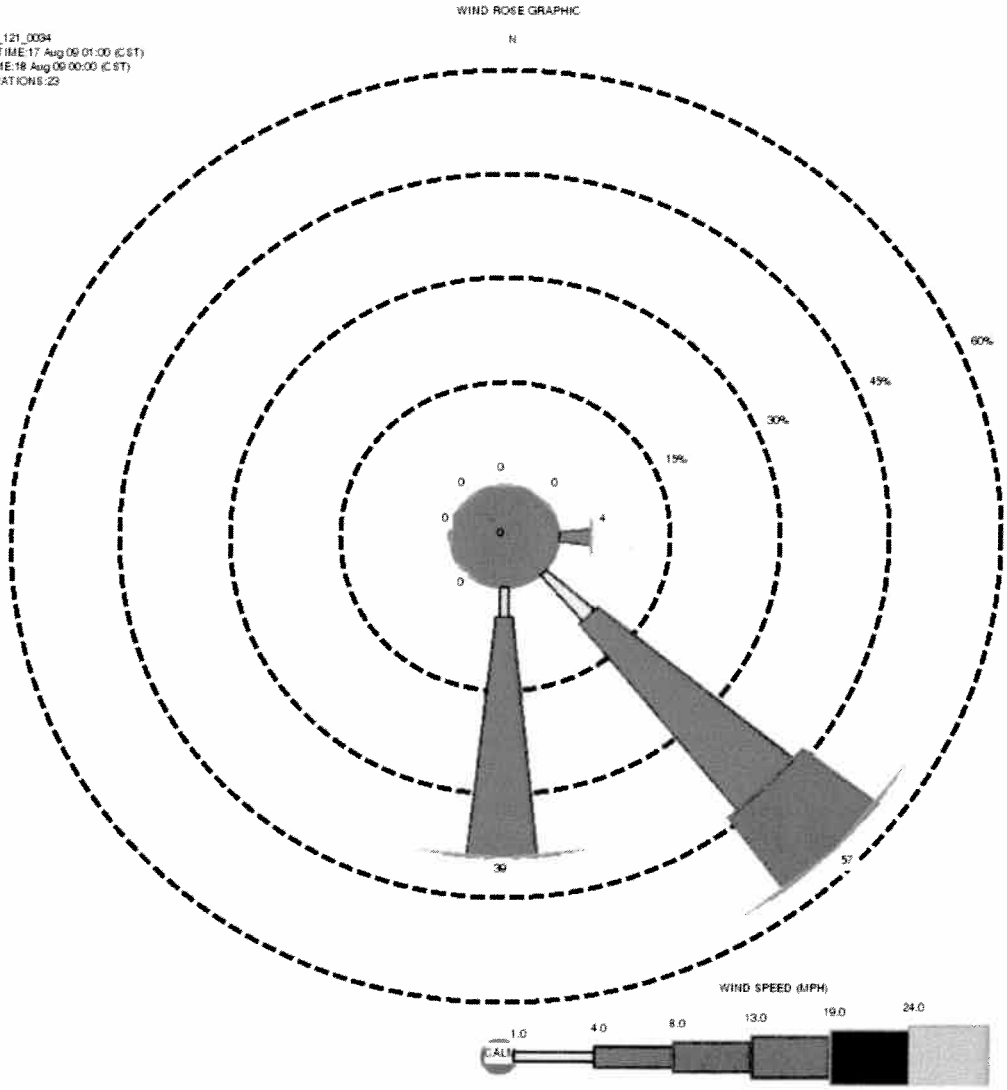
Additional Concerns

The community has expressed concerns about exposure to carbon disulfide. Carbon disulfide was reported as a TIC in three of the seven canister samples: 103 ppb (Chisum 9203), 97.6 ppb (Airfield 1:29), and 7.33 ppb (Airfield 1:32). Two of the three reported concentrations exceeded the TCEQ short-term health-based comparison value of 10 ppb. All potential 1-hour maximum concentrations exceeded the short-term health-based comparison value of 10 ppb: 2472 ppb (Chisum 9203), 2342 ppb (Airfield 1:29), and 176 ppb (Airfield 1:32). One animal study reports adverse liver effects after 8 hours of inhalation exposure to 20,000 ppb in rats (Freundt et al. 1974 in ATSDR 1996). All other reported health effects from short-term animal studies occur at higher concentrations. Human studies report that adverse health effects can occur after long-term exposure (1 year or more) to 1,000 – 3,000 ppb and above (ATSDR 1996, ACGIH 2006). All monitored and potential 1-hour maximum concentrations were well below short-term and long-term health effect levels. Given the uncertainties in identification and quantification of carbon disulfide and the method used to determine potential 1-hour maximum concentrations, it is not possible to accurately draw conclusions about the potential for adverse health effects. The TD recommends additional sampling in the area using methodology that would more precisely identify and quantify carbon disulfide.

CONCLUSIONS

The highest potential 1-hour maximum benzene concentration is below the lowest concentration that has been shown to cause health effects in short-term human and animal studies; however, it is possible that adverse health effects could occur from exposure to this concentration. In addition, the TD is concerned that the monitored concentrations of benzene at several of the sampling locations could pose a long-term health risk to residents in the area if the concentrations are representative of normal ambient conditions. Several monitored and potential 1-hour maximum concentrations of target compounds and TICs could have resulted in odorous conditions. Persistent or recurrent exposure to levels which significantly exceed the odor threshold may cause odor-related effects such as headache and nausea. This is consistent with citizen reports of odors in the area. The TD strongly recommends additional air sampling in the area.

Figure 1. Wind rose graphic developed from meteorological data obtained from the Denton Airport South CAMS 56 site located in Denton, Texas (EPA site 48-121-0034).



If you have any questions about this evaluation, please call me at (512) 239-1822 or email me at sethridg@tceq.state.tx.us.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2005. Toxicological profile for benzene. U.S. Department of Health and Human Services.

Agency for Toxic Substances and Disease Registry (ATSDR). 1996. Toxicological profile for carbon disulfide. U.S. Department of Health and Human Services.

American Conference of Industrial Hygienists (ACGIH). 2006. Documentation for the Threshold Limit Value for Carbon Disulfide.

American Conference of Industrial Hygienists (ACGIH). 2001. Documentation for the Threshold Limit Value for Trimethyl Benzene Isomers.

Texas Commission on Environmental Quality (TCEQ). 2007. Development support document for benzene.

Attachment 9

Responses to Representative Lon Burnam's Oil and Gas Questions for October 1, 2009

Question 1: In what counties has the TCEQ deployed the infrared gas-imaging camera to study emissions from individual tanks or tank batteries associated with upstream oil and gas production, and over what time frame?

There are three programs in the agency that conduct studies or investigations using the infrared hydrocarbon gas-imaging camera system. The three programs are the Monitoring Operations Program and the Field Operations Regional Offices both in the Office of Compliance and Enforcement and the Air Quality Division in the Chief Engineer's Office. In total, the agency has conducted infrared gas-imaging camera (IR camera) surveys at oil and natural gas sources in 58 Texas counties, which are listed below. In the majority of the cases, the surveys were conducted around individual tanks or tank batteries, with some surveys being conducted at natural gas compressor stations.

The Monitoring Operations Program has been conducting ambient monitoring surveys of oil and natural gas sources using handheld infrared gas-imaging camera systems (IR camera). Surveys have been conducted in the following counties: Aransas, Brazoria, Calhoun, Chambers, Denton, Ector, El Paso, Galveston, Glasscock, Gregg, Harris, Howard, Jefferson, Jim Wells, Johnson, Kleberg, Limestone, Midland, Nueces, Orange, Rusk, San Patricio, Smith, Tarrant, Victoria, and Wise.

The agency's regional offices have also been conducting ambient monitoring surveys of oil and natural gas sources using handheld IR cameras. In the DFW Region, the TCEQ has deployed the IR camera to study emissions in Hood, Johnson, Navarro, Palo Pinto, Parker, and Tarrant counties during two separate time frames: December 5 through 20, 2008, and May 8 through June 11, 2009.

In the Amarillo Region, the IR camera has been deployed to study emissions in Carson, Dallam, Gray, Hartley, Hemphill, Hutchinson, Moore, Potter, Randall, and Wheeler counties beginning May 1, 2008, through September 15, 2009.

The Midland Region has deployed the IR camera in Andrews, Crane, Ector, Howard, Midland, Pecos, Sterling, Winkler counties from September 12, 2007, through September 29, 2009.

The Houston Region has been deploying the IR camera continuously from July 2006. The IR Camera has been used at sites in Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty and Montgomery counties.

In the Corpus Christi Region, the IR camera was deployed at sources in Calhoun, Jim Wells, Nueces, Refugio, and San Patricio counties from August 2006, through September 2009.

Since 2005, the Air Quality Division in the Chief Engineer's Office, has conducted numerous studies that used the IR camera system. These projects used both an IR camera system mounted in a helicopter and handheld cameras. In July 2005, the Gulf Coast Survey was conducted in Chambers, Galveston, Harris, Hardin, Liberty, and Jefferson counties. In a July 2007 aerial survey project the following Gulf Coast counties and Dallas/Fort Worth (DFW) counties were surveyed: Brazoria, Chambers, Galveston, Harris, Liberty, Orange, San Patricio, Denton, Johnson, Parker, and Tarrant counties. A June 2009 aerial survey was conducted in the following Tyler/Longview/Marshall area counties: Gregg, Harrison, Panola, Rusk, Smith, Upshur, and Wood. Finally, in August 2009 an aerial survey was conducted in the Gulf Coast area again, this time in Jefferson, Harris, and Nueces counties.

Question 2: How many different upstream oil or condensate tanks or tank batteries has the TCEQ analyzed with an infrared gas imaging camera? What percentage of the facilities evaluated indicated the presence of VOC, methane, or other fugitive emissions?

The table below provides the best available estimation of the number of upstream oil and natural gas tank batteries that the TCEQ has surveyed with the IR camera system. Also provided is the estimated percentage of tank batteries that had visible emissions. This percentage of visible emissions is based on the fact that the IR camera cannot speciate the compounds or quantify the amount being emitted and it is assumed that any visible emissions are in the general group of a hydrocarbon, which would include methane, ethane, and volatile organic compounds (VOC).

Agency Program	**Total # of sites surveyed**	**Percentage with visible emissions**
Monitoring Operations	150	75%
Field Operations Regional Offices		
Dallas/Fort Worth	12	100%
Amarillo	175	95%
Midland	150	100%
Houston	46	90%
Corpus Christi	25	95%
Air Quality Division (helicopter surveys)		
2005 Gulf Coast survey	500 tanks	50 tanks for 10%
2007 Gulf Coast survey	64 sites with visible emissions – total number surveyed is unknown	
2007 DFW survey	93 sites with visible emissions – total number surveyed is unknown	
2009 Tyler/Longview survey	49 sites with visible emissions – total number surveyed is unknown	
2009 Gulf Coast survey	10 sites with visible emissions – total number surveyed is unknown – Mainly an industrial source survey	

When conducting a survey at an oil and/or natural gas tank storage battery with a handheld IR camera, due to the close proximity of the IR camera to the equipment, normally there is some level of visible emissions noted. Visible emissions detected by the IR camera do not necessarily indicate that the source is not operating correctly or not operating within its authorization. Typically, where there are no visible emissions noted, it is normally an indication of an inactive site. When visible emissions are detected by the IR camera, further investigation may indicate emissions from equipment that is designed to vent hydrocarbons as a means of pressure relief, while at other times the images indicate hydrocarbons emitted from unauthorized sources such as open hatches, leaks, ruptures, or loss of system integrity. As stated above, the IR camera cannot speciate the compounds or quantify the amount being emitted; therefore by itself the camera cannot be used to determine if the site is in compliance with its authorizations.

Question 3: What is the minimum concentration of hydrocarbons in air that the infrared camera can detect being released? Please provide an estimate of the minimum mass of hydrocarbons released, in pounds per hour that this minimum detectable concentration would represent from a typical condensate tank. To the extent possible, please provide estimates of the relative quantities of VOC, methane, and other hydrocarbons in those emissions.

The IR camera technology offers a unique technological advancement in pollution detection capability and has proved to be highly effective in the detection of hydrocarbon emissions. However, the IR camera system is not considered a quantitative or a qualitative tool. While the technology is not capable of measurements, and results do not lend themselves to interpretation in terms of concentration, minimum detection limits have been estimated by the IR camera manufacturers and EPA. Results vary dramatically due to the following factors:

- The relative temperatures of the gas under observation and the background.
- The relative IR absorption coefficient of the specific gas or gases being observed.
- Atmospheric conditions such as rain, fog or high humidity, wind, blown dust etc.
- The physical characteristics of the emission themselves – volumetric flow, orifice size and location, presence of steam or particulate matter.
- Physical and thermal conditions at the site – distance from the camera, reflected and radiated heat, masking by steam and particulate matter etc.
- Operator dependent parameters such as use of temperature sensitivity range (hi, mid, low), manual or auto tune, High Sensitivity Mode (HSM) if camera is so equipped, polarity, lens focal length (e.g. 25, 50 or 100mm telephoto), age and condition of the camera's eyepiece, state of operator fatigue (optical and general), operator training, experience and effort, etc.

In light of the stated limitations, a reasonable estimate of the technology's current minimum detection limit (best conditions assumed) ranges from a 0.001 pounds per hour (lb/hr) to approximately 0.22 lb/hr. The low end of this assessment is based on the manufacturer's estimates, while the high end is based on the expectations of the new EPA Alternative Work Practice. This number will vary significantly with the relative absorption coefficient of the target compound(s), the actual temperature difference, and other potential interferences as described above. As an example of this variability, the table below is information obtained from the manufacture of the FLIR GasFindIR camera. Independent laboratory (third party) testing determined that the GasFindIR cameras can detect the following gases at the minimum detected leak rate (MDLR) (http://www.flir.com/thermography/americas/us/content/?id=18296):

Minimum Detected Leak Rate

Hydrocarbon Compound	Minimum Detected Leak Rate	MDLR Converted to Pounds/Hour
1-Pentene	5.6 g/hr	0.012
Benzene	3.5 g/hr	0.008
Butane	0.4 g/hr	0.001
Ethane	0.6 g/hr	0.001
Ethanol	0.7 g/hr	0.002
Ethylbenzene	1.5 g/hr	0.003
Ethylene	4.4 g/hr	0.010
Heptane	1.8 g/hr	0.004
Hexane	1.7 g/hr	0.004
Isoprene	8.1 g/hr	0.018
Methyl ethyl ketone	3.5 g/hr	0.008
Methane	0.8 g/hr	0.002
Methanol	3.8 g/hr	0.008
Methyl isobutyl ketone	2.1 g/hr	0.005
Octane	1.2 g/hr	0.003
Pentane	3.0 g/hr	0.007
Propane	0.4 g/hr	0.001
Propylene	2.9 g/hr	0.006
Toluene	3.8 g/hr	0.008
Xylene	1.9 g/hr	0.004

In practice, the TCEQ has informally evaluated IR camera images collected as part of an upstream oil and gas flash emissions model evaluation study. IR camera images were captured from 36 upstream oil and gas tank batteries at varying distances under varying conditions. On average, these tank batteries, which had source testing performed, had emissions rates that ranged from 1.5 to 408 pounds per hour. Although differences between flow rate and intensity were noted among the images, no correlation between the hydrocarbon emissions rate and image intensity or image dynamics was readily observed.

As to the question, "To the extent possible, please provide estimates of the relative quantities of VOC, methane, and other hydrocarbons in those emissions," as previously discussed the current IR technology is not capable of measuring or estimating these values. This sort of analysis is best achieved via chemical sampling and analytical methodologies, such as gas capture in canisters and analysis via gas chromatograph and/or GC/Mass Spectroscopy, or other real-time vapor recovery and analysis methods. Another less-desirable option may be production data that indicates the relative quantities of these compounds within the product.

Oil or condensate composition depends upon the formation from which it is obtained and the associated gas's characteristics, such as whether the gas does or does not contain significant quantities of entrained liquids ("wet" versus "dry" gas). However, a 'typical' gas composition obtained from the Gas Processors Association, by well type, is reproduced below for reference.

Typical Raw Gas Compositions

	Casinghead (Wet) Gas		Gas Well (Dry) Gas		Condensate Well Gas	
	mole %	gallons/1000 ft^3	mole %	gallons/1000 ft^3	mole %	gallons/1000 ft^3
Carbon Dioxide	0.63					
Nitrogen	3.73		1.25		0.53	
Hydrogen Sulfide	0.57					
Methane	64.48		91.01		94.87	
Ethane	11.98		4.88		2.89	
Propane	8.75	2.399	1.69	0.463	0.92	0.252
iso-Butane	0.93	0.303	0.14	0.046	0.31	0.101
n-Butane	2.91	0.914	0.52	0.163	0.22	0.069
iso-Pentane	0.54		0.09		0.09	
n-Pentane	0.8		0.18		0.06	
Pentanes or greater		0.777		0.203		0.103
Hexanes	0.37		0.13		0.05	
Heptanes plus	0.31		0.11		0.06	
Total	**100**	**4.393**	**100**	**0.875**	**100**	**0.525**

Source: Gas Processors Association, "The Gas Processing Industry: Its Function and Role in Energy Supplies"

Question 4: At the April 20 hearing, Mr. Sheedy indicated the TCEQ was following up with 20 of the facilities that were analyzed with the IR camera by contacting the facility owners in order to quantify emissions and, potentially, pursue voluntary actions to reduce emissions. What was the outcome of these efforts? Specifically, please indicate the amount of emissions ultimately determined to be released at these facilities, and any steps already taken, or commitments made, by facility owners to reduce emissions, including any estimates of emissions expected to be reduced through these actions.

As commented in the question above, the Chief Engineer's Office conducted an aerial survey of the Gulf Coast and North/Central Texas areas in 2007, using an IR camera. Results of the imaging showed that 64 sites in the Gulf Coast area and 93 sites in the North/Central area had visible emissions. The agency's initial course of action was to work with the oil and gas industry through respective industry groups, selecting 10 sites in the North/Central area and 10 sites in the Gulf Coast area to investigate and collect data. The agency contacted the owners of the sites and requested data on production, operations, oil/condensate composition, and what action they have taken or will take to address and possibly mitigate future VOC emissions. Responses to the request were minimal and/or delayed, so a second round of requests were issued. From the initial 20 sites, seven sites with insufficient response to the first data request were sent a letter from OCE, our enforcement office, requesting cooperation. Ten sites with sufficient responses were sent letters from CEO requesting verification of emissions estimates. Three sites that produced only salt water were given more time to respond due to unique nature of that operation.

Results of the data review showed that nine companies own or operate the 20 sites. Some of the companies have conducted testing to determine composition of oil/condensate/saltwater tank contents and provided this information to the agency. Where sufficient data was supplied, estimates indicated most of the sites exceeded Permit By Rule limits:

- Six sites did not submit initial data sufficient for emission estimation

- 14 sites had emissions that were over the PBR emissions limits
- All companies modified their operation to reduce their emissions below PBR emissions limits
    - Most reductions were achieved by decreased production
    - 10 sites achieved the reductions through actual operation or maintenance changes.

The agency is planning to work with the involved companies to conduct storage tank emission testing, with the goal of using this direct measurement information along with the data previously collected to help improve the calculations used to determine the emissions from these sources.

The following table summarizes the emissions data for the 20 sites that were selected from the 2007 aerial survey. The emissions information contained in the table was developed using information supplied by the site operators and calculated using the factor developed from the "VOC EMISSIONS FROM OIL AND CONDENSATE STORAGE TANKS" (HARC 51C) August 31, 2007, report and company estimated emissions.

2007 Survey - Company and TCEQ VOC Estimates

			Operations		Estimated VOC emissions				
			Reported oil/condensate production (bbl/day)		Company Estimated VOC (tpy)		TCEQ estimate VOC (tpy)*		
	Site	Area	2007	2009	2007	2009	2007	2009	Summary of Company Response
1	JL Martin 1H	DFW	---	---	---	---	---	---	No condensate produced. Discussed possible options to minimize venting
2	Bonds Ranch Rd	DFW	---	---	---	2.425 VOC 40 THC flash**	---	---	No condensate produced. Plume due to separator liquid dump valve struck open. Corrected
3	Gertrude McPeek	DFW	---	---	---	---	---	---	No condensate produced. Company conducting analysis of saltwater
4	McCutchin 2H	DFW	---	---	---	---	---	---	Water production too high for separator, due to work over on adjacent well.
5	RBR A 1H	DFW	4	3	---	---	24	18	Company conducting analysis
6	JW Hodges & Greystone	DFW	---	---	---	---	---	---	No condensate produced.
7	Jones 1H	DFW	---	---	---	---	---	---	No condensate produced.
8	Johnson D1H and D2H	DFW	7	5	---	---	42	30	
9	Moncrief 14H	DFW	42	4	1.47 mscf/d 25.6 tpy***	0.15 mscf/d 2.6 tpy***	254	24	Emissions due to open hatches, pumpers instructed to keep hatches closed.
10	Moncrief 17H	DFW	23	3	0.54 mscf/d 9.4 tpy***	0.07 mscf/d 1.2 tpy***	139	18	Emissions due to separator carry0over from newly completed well. Separator operation adjusted.
11	Bell Valley 1	Corpus	24	---	---	---	145	---	Company conducting new sampling
12	Narrow road GU1	Corpus	20	---	---	---	121	---	Company conducting new sampling
13	Valley 1	Corpus	5	---	---	---	30	---	Company conducting new sampling
14	Apex GU1	Corpus	28	---	---	---	169	---	Company conducting new sampling
15	Franks Field	HGB	25	---	8	---	151	---	
16	Alta Loma	HGB	82	---	4.88	---	495	---	Analysis being performed, will send.
17	Trust	HGB	95	---	15.22	---	574	---	Analysis being performed will send.
18	Butts	HGB	45,000 (saltwater)	---	6.302	---	85	---	Saltwater disposal only, sampled at pump discharge
19	Curkeet	HGB	27,000 (saltwater)	---	10.504	---	42	---	Saltwater disposal only, sampled at pump discharge
20	Wooster	HGB	7,658 (saltwater)	---	1.72	---	26	---	Saltwater disposal only, sampled at pump discharge

Since several sites claimed no condensate production, there were not sufficient data to perform an VOC estimate using E&P Tanks program.

--- No results have been entered, because sufficient data was not made available to calculate an estimate. In some cases, additional sampling may still occur.
* TCEQ estimates based on HARC 51C VOC emission factors for condensate production of 33.1 lb VOC/bbl condensate, with the exception of #18, 19, and 20. Saltwater disposal emissions based on company reported concentrations of hydrocarbons in saltwater.
** Company calculated total hydrocarbon flash emissions. It is unknown what portion may be VOC flash.
*** Ideal gas law used to convert company reported volume emissions to mass emissions.

Question 5: Has the TCEQ initiated any enforcement actions or investigations, issued notices of violation, as a result of the information collected with the infrared camera? If so, how many? Please summarize the results of each such enforcement action or investigation (company names may be removed, if needed). Please quantify the total amount of emissions reduced through these actions.

NOTE: The responses below are not solely concerning oil and natural gas, but included other source types.

No enforcement actions (notices of violation (NOV) or notices of enforcement (NOE)) have been directly issued based on the information collected with the IR camera. As previously discussed the IR camera only demonstrates the presence or absence of a hydrocarbon and does not quantify or qualify the gases detected. The information collected with the IR camera, however, has lead to follow-up investigations, which have or may lead to enforcement actions and subsequent emission reductions. The amount of emissions reduced from these investigations cannot be quantified at this time.

In the DFW Region there have been 25 investigations. None of these have lead to an NOV or NOE.

In the Amarillo Region there have been 13 investigations. Three investigations have resulted in NOVs. Two were due to the company having no established maintenance program for proper care of thief hatches, manways, pressure relief valves, gauge openings, etc. One NOV was for a fiberglass tank manufacturer running the fan with no filters in place.

In the Midland Region, there have been 24 investigations. One of these resulted in an NOV being issued for registration misrepresentations and the regulated entity was required to correct the unauthorized emissions. Another of these resulted in an NOE when it was revealed that the regulated entity had made changes to their process and had not retested the vent stack. This was an EPA High Priority Violation.

In the Houston Region, there have been 46 investigations. Eleven resulted in NOVs for failure to maintain control equipment. One resulted in an NOV for failure to have authorization for emissions. Two resulted in NOEs for failure to have authorization for emissions.

In the Corpus Christi Region there have been three investigations. An NOV was issued for venting VOCs into a water impoundment that then exhausted to the atmosphere uncontrolled and the other for a condensate tank top that was allowing uncontrolled VOCs to vent to the atmosphere. Additionally, the regulated entity registered several tanks that were previously omitted, a flare was erected to control the VOC emissions from the tanks, and a corrective maintenance schedule was submitted to the Corpus Christi Regional office. An NOV was issued for emissions from two different tanks for different causes. An NOE was issued when the IR camera was used to support the existence of a VOC release from a cooling tower. The investigation was triggered by an emissions event notification and resulted in an excessive emissions event determination.

Question 6: Has TCEQ refined the methods used to inventory emissions from tanks used in upstream oil and gas production subsequent to obtaining the videos taken with the infrared camera? If so, how do the total emissions estimated using the refined methodology compare to estimates derived using prior methods?

As a direct result of the 2005 passive infrared camera aerial surveys, the TCEQ, in conjunction with the Houston Advanced Research Center (HARC), developed a project to test emissions from storage tanks used in the upstream oil and gas industry. This project, known as HARC 51C, developed average emissions factors to quantify upstream oil and gas storage tank emissions for the state's area source inventory.

The TCEQ used the H51C emissions factors in conjunction with available production data to revise upstream oil and gas storage tank emissions in the area source inventory. Based on the H51C emissions factors, VOC emissions from condensate storage tanks in the area source inventory increased by a factor of 11 and VOC emissions from crude oil storage tanks in the area source inventory increased by a factor of three, which increased the annual inventory by 620,000 tons. This 620,000 ton increase assumes that 25 percent of the sources had some type of control.

The final report for project H51C is available at: http://projects.tercairquality.org/AQR/H051C.

These emissions inventory projects resulted in new guidance for point source EI development that published in 2005. The TCEQ annually updates and publishes *Emissions Inventory Guidelines* (RG-360A), a comprehensive guidance document that explains all aspects of the point source EI process. Guidance on upstream oil and gas storage tanks was revised in 2005 to emphasize direct measurement of storage tank emissions is the most preferred emissions determination method and to stress the importance of using site-specific data (versus default data) in emissions determinations. The 2009 version of the storage tank guidance will remove one of the previously accepted equations as an allowed determination method for estimating flash loss emissions. The Air Permits Division has also published guidance on preferred calculation methods, paralleling the EI guidance. This memo is available at:
http://www.tceq.state.tx.us/permitting/air/announcements/nsr_announce_9_30_09.html.

Question 7: Using the best available date, please estimate the total amount of methane, quantified in scf, released from storage tanks or tank batteries used in upstream oil and gas production in Texas. Separately, please estimate the total amount of VOC, quantified in barrels of oil and/or condensate, released from storage tanks or tank batteries used in upstream oil and gas production in Texas.

Based on methane and VOC sampling data contained in "VOC EMISSIONS FROM OIL AND CONDENSATE STORAGE TANKS" (HARC 51C) August 31, 2007, final report prepared for Houston Advanced Research Center, potential methane and VOC released from storage tanks in upstream oil and gas production are listed in the table below.

Potential Methane and VOC Emissions from Oil and Natural Gas Production Tanks

	2008 Crude Oil Production	2008 Condensate Production
2008 Annual production in barrels per year	351,492,019	50,905,249
Cubic feet of methane per barrel of liquid produced	15	58
Cubic feet per year of methane statewide	5,272,380,285	2,952,504,442
Tons per year of VOC statewide	281,194	847,572
Equivalent barrels of petroleum**	1,912,882	6,726,765

All emissions estimates assume no control of tank emissions.
Crude oil and condensate production numbers are from Texas Railroad Commission.
** Assumptions
42 gallons of petroleum in a barrel
1 gallon of crude oil weighs 7 pounds
1 gallon of condensate weighs 6 pounds
1 pound of VOC has the energy equivalent of1 pound of liquid petroleum

Question 8: What permit requirements or other emissions limitations apply to the owner of an oil or condensate tank or tank battery in Texas?

(1) **Permit by Rule (PBR)** - owners or operators of an oil or condensate tank or tank battery may qualify for PBR §106.352, contained in 30 TAC Chapter 106, Subchapter O. Other related equipment at oil and gas sites covered by this PBR may include heaters, dehydration units, tank vents including flash, process fugitives, and loading operations. Operators often also claim PBR §106.512 for engines and turbines used for oil and gas compression, and PBR §106.492 for flares, which control process and emission event releases. Emissions from all related equipment under PBR must be less than 25 tons per year (tpy) of volatile organic compounds (VOC), particulate matter (PM_{10}), and sulfur dioxide (SO_2); and less than 250 tpy each of nitrogen oxide (NO_x) and carbon monoxide (CO).

The §106.352 PBR requires that any tank or tank battery that handles sour gas or liquids (greater than 24 parts per million by volume of hydrogen sulfide (H_2S)) must be located at least 1/4 mile from any off-site receptor and must be registered with the TCEQ.

Claims under PBR do not require individual evaluations of Best Available Control Technology (BACT) or off-property health impacts evaluation.

(2) **Oil and Gas standard permit** - the owner or operator can register for an Oil and Gas standard permit under §116.620, contained in 30 TAC Chapter 116, Subchapter F if the tank or tank battery cannot qualify for PBR §106.352, or if the tank or tank battery handles sour gas and is located less than 1/4 mile from an off-site receptor. The Oil and Gas standard permit was written with specific conditions to ensure compliance with Best Available Control Technology (BACT) and off-property health impacts.

To ensure protection of the public health and welfare, applicants are required to demonstrate compliance with the emission limitations of PBRs §106.261 and §106.262, which establishes short-term and annual emission limits for contaminants that do not have an established national ambient air quality standard. This demonstration requires a speciated VOC analysis from all emission sources.

Examples of control requirements in the Oil and Gas standard permit:

(A) Fixed roof tanks must be less than 25,000-gallons or the vapor pressure of the stored compound must be less than 0.5 psia at maximum short-term storage temperature. If emissions from a fixed-roof tank exceed 10 tpy of VOC, the tank emissions must be controlled with a destruction device, vapor recovery system, or equivalent control method.

(B) Tanks greater than 25,000 gallons are required to have floating roofs or emissions must be routed to a destruction device, vapor recovery system, or equivalent control method.

(C) Glycol dehydration units emitting uncontrolled emissions greater than 10 tpy of VOC must be controlled using a condenser and a separator (or flash tank), destruction device, vapor recovery system, or equivalent control device.

(D) Facilities located less than 500 feet from the nearest off-plant receptor are required to implement a Leak Detection and Repair (LDAR) program when fugitive emissions are equal to or greater than 10 tpy of VOC.

(E) Facilities located greater than 500 feet from the nearest off-plant receptor are required to implement a Leak Detection and Repair (LDAR) program when fugitive emissions are equal to or greater than 25 tpy of VOC.

(3) **New Source Review (NSR) Permit** - owners/operators of a tank or tank battery that does not qualify for PBR or the Oil and Gas standard permit can submit a New Source Review (NSR) permit application under 30 TAC Chapter 116.

The NSR permit requires public notice, BACT emission controls, and evaluation of off-property health impacts.

(4) **Federal Standards** - The tank or tank battery and associated facilities may also be subject to federal regulations, including but not limited to 40 CFR 60 New Source Performance Standards (NSPS) subparts K, Ka, Kb, KKK, IIII, JJJJ; 40 CFR 61 National Emissions Standards for Hazardous Pollutants (NESHAPs) subpart HH.

(5) **Federal Major Sources** - Depending on the potential emissions and locations, these sites may also require federal preconstruction permits, including Prevention of Significant Deterioration (PSD) or Nonattainment New Source Review (NNSR) permits.

If determined to be a major source, as defined in 30 TAC §122.10, of air contaminants, sites may also need to obtain a federal operating permit under 40 CFR Part 70, Title V which may consist of a General Operating Permit (GOP) or a Site Operating Permit (SOP).

Question 9: Making reasonable assumptions to define a 'typical' oil producing well in East Texas and a "typical" condensate-producing gas well in Texas, please estimate the simple pay-back period in months if a commercially available vapor recovery unit were installed on tanks servicing these 'typical' wells.

In the absence of a 'typical' oil producing or condensate producing well, published reports and case studies were evaluated to identify reportable pay-backs. The Environmental Protection Agency's (EPA) Natural Gas Star program has developed a Lessons Learned report to showcase the benefits of installing vapor recovery units. EPA documented paybacks between three and 19 months with an assumed $7.00/Mcf gas price. However, current natural gas spot price is around $3.70/Mcf as of mid-October, so payback would be expected to be much longer. Furthermore, the payback timeline could be extended further if there is not a natural gas field gathering pipeline located near the crude oil storage tanks, because of necessity of a delivery means for any recovered gas.

The Environmental Technology Verification Program at EPA evaluated the Eductor Vapor Recovery Unit (EVRU) from COMM Engineering. The $108,000 EVRU recovered 175 Mscf/day. Assuming a prices value of $5.46 per Mscf, the total value of recovered gas was estimated at $650,000 per year for an approximate two month payback.

Many factors affect the overall cost and pay-back of installing a vapor recovery unit. In an effort to help facilities work through the factors necessary to identify potential pay-back, the EPA's Natural Gas Star program developed a tool to estimate costs and assumptions. The tool allows users to define certain assumptions and calculates a payback timeframe. The tool is available online at: http://www.ergweb.com/gasstar/analytical_tool/vaporrecovery.asp.