TCEQ Interoffice Memorandum

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From: Stephanie Shirley, Ph.D. SS
Toxicology Division, Office of the Executive Director

Date: October 17, 2012

Subject: Health Effects Review of 2011 Ambient Air Network Monitoring Data in Region 4, Dallas/Fort Worth

Conclusions

- All hourly average concentrations of volatile organic compounds (VOCs) reported at Texas Commission on Environmental Quality (TCEQ) Region 4-Dallas/Fort Worth 1-hour automated gas chromatograph (autoGC) monitoring sites were below their short-term air monitoring comparison values (AMCVs) and would not be expected to cause short-term adverse health effects, vegetation effects, or odor concerns.

- All annual average concentrations of VOCs and carbonyls were below their respective TCEQ long-term AMCVs and would not be expected to cause chronic adverse health effects or vegetation effects.

- Except for nickel and lead, annual average concentrations of all the other 13 speciated metals were less than their respective TCEQ long-term AMCVs and would not be expected to cause chronic adverse health effects.

- At the Dallas-Morrell monitoring site, the annual average concentration of nickel, 0.07µg/m^3, reported as total suspended particulate (TSP) exceeded the long-term AMCV of 0.059 µg/m^3 for respirable carcinogenic forms of nickel (i.e., PM_{10}). However, exceedances of the long-term nickel AMCV at the Dallas-Morrell site do not necessarily mean that chronic adverse effects will occur. Because:

  - Comparing concentrations of primarily metallic nickel (i.e., noncarcinogenic form of nickel) emitted by Dal Chrome Co., Inc. to the long-term AMCV for carcinogenic forms of nickel is likely to be overly conservative. The annual average nickel TSP concentration of 0.07 µg/m^3 is below the noncarcinogenic chronic AMCV of 0.23 µg/m^3.
  - In addition, results from a special monitoring study of the more toxicologically relevant nickel PM fraction (i.e., particulate matter less than 2.5 µm or $PM_{2.5}$) indicated that the average reported nickel $PM_{2.5}$ concentration of 0.010 µg/m^3, collected at the Dallas-Morrell site from April 1, 2009 to August 6, 2010 , was below the long-term AMCV of 0.059 µg/m^3. The estimated annual average nickel $PM_{2.5}$ concentrations have likely been below the TCEQ long-term AMCV of 0.059 µg/m^3 since 1996 based on the conclusions

of the special monitoring study (i.e., 11.48% of TSP measurements were in the $PM_{2.5}$ fraction from 1987 to 2010 at the Dallas-Morrell site).

- The air monitoring data from the Dallas-Morrell site are representative of total nickel concentrations and do not specify the specific forms of nickel. Therefore, to be conservative, the Toxicology Division (TD) recommends emission reductions from Dal Chrome Co., Inc. and any other potential sources impacting this site. Nickel at the Dallas-Morrell site currently remains on TCEQ's Air Pollutant Watch List (APWL0401). Detailed information about the long-term AMCV and noncarcinogenic chronic AMCV for nickel is available in the nickel Development Support Document (DSD).

- Although reported ambient air lead TSP concentrations from monitors around Exide Technologies, Inc. (Exide), Frisco, Texas exceeded the 2008 National Ambient Air Quality Standard (NAAQS) for lead, blood lead levels of Frisco residents did not indicate levels of health concern. That is, the US Centers for Disease Control and Prevention's 10µg/dL (micrograms of lead per deciliter of blood) blood lead level of concern for children or the more recent reference value of 5 µg/dL based on the 97.5th percentile of the NHANES dataset[1]. This conclusion is based on:

  - Results from the Blood Lead Exposure Investigation in Frisco during March 2011 by the Texas Department of State Health Services (TDSHS) and
  - Children's blood lead levels predicted by the Integrated Exposure Uptake Biokinetic (IEUBK) model.

- Air quality in the Barnett Shale area is currently being monitored. Detailed information is available on the TCEQ's Barnett Shale Web page at: http://www.tceq.state.tx.us/goto/barnettshale.

Background

The TD has reviewed ambient air sampling data collected from 21 network monitoring sites in TCEQ Region 4, Dallas/Fort Worth. The TD reviewed air monitoring summary results for VOCs and carbonyls from 1-hour and 24-hour samples collected continuously and every sixth day, respectively. The TD also reviewed summary results of metals from 24-hour filter samples ($PM_{2.5}$, PM_{10}, or TSP) collected every third or sixth day as well as a special monitoring study at the Dallas-Morrell site, where a new $PM_{2.5}$ monitor was collocated with the TSP monitor from April 2009 to August 2010 and had the same sampling schedule. In addition, the TD evaluated the criteria pollutant lead from a health perspective in this memorandum. For complete lists of all chemicals evaluated, please see Lists 1 through 4 in Attachment A. Table 1 lists the monitoring sites and provides a link to more information about the sites. A brief summary of the monitoring sites is provided below:

- 1-hour autoGC VOC monitoring at 7 sites
- Every sixth day 24-hour canister VOC sampling at 9 sites
- Every sixth day 24-hour carbonyl sampling at 2 sites
- Metals sampling at 9 sites

[1] http://www.cdc.gov/nceh/lead/ACCLPP/blood_lead_levels.htm

- Every sixth day lead TSP sampling at 6 sites
- Every sixth day chromium and nickel TSP or PM_{10} sampling at 4 sites
- Every third day or sixth day 14 metals $PM_{2.5}$ sampling at 3 sites

Table 1. Monitoring Sites Located in TCEQ Region 4

Site Name and Location	County	EPA Site ID	Monitored Compounds
Frisco 5th Street, 7471 South 5th Street	Collin	48-085-0003	Lead (TSP)
Frisco 7, 6931 Ash Street	Collin	48-085-0007	Lead (TSP)
Frisco Eubanks, 6601 Eubanks Street	Collin	48-085-0009	Lead (TSP)
Frisco Stonebrook, 7202 Stonebrook Parkway	Collin	48-085-0029 (Activation Date: January 7, 2011)	Lead (TSP)
Dallas Hinton, 1415 Hinton Street	Dallas	48-113-0069	VOCs (autoGC, 24-hour canister), Carbonyl, Metals ($PM_{2.5}$)
Dallas Morrell, 3049 Morrell Street	Dallas	48-113-0018	Metals (TSP, PM_{10})
Dallas Convention Center, 717 South Akard Street	Dallas	48-113-0050	Metals ($PM_{2.5}$)
Denton Airport South, Denton Municipal Airport	Denton	48-121-0034	VOCs (24-hour canister)
DISH Airfield, 9800 Clark Airport Road	Denton	48-121-1013	VOCs (autoGC)
Flower Mound Shiloh, 4401 Shiloh Road	Denton	48-121-1007	VOCs (autoGC)
Midlothian OFW, 2725 Old Fort Worth Road	Ellis	48-139-0016	VOCs (24-hour canister), Metals ($PM_{2.5}$)
Italy, 900 Farm to Market Road 667	Ellis	48-139-1044	VOCs (24-hour canister)
Greenville, 824 Sayle Street	Hunt	48-231-1006	VOCs (24-hour canister)

Site Name and Location	County	EPA Site ID	Monitored Compounds
Alvarado, Johnson County Luisa, 2420 Luisa Lane	Johnson	48-251-1008	VOCs (24-hour canister)
Kaufman, 3790 South Houston Street	Kaufman	48-257-0005	VOCs (24-hour canister)
Terrell Temtex, 2988 Temtex Boulevard	Kaufman	48-257-0020	Lead (TSP)
Eagle Mountain Lake, 14290 Morris Dido Newark Road	Tarrant	48-439-0075	VOCs (autoGC)
Everman Johnson Park, 633 Everman Parkway	Tarrant	48-439-1009 (Activation Date: June 28, 2011)	VOCs (autoGC)
Fort Worth Northwest, 3317 Ross Avenue	Tarrant	48-439-1002	VOCs (autoGC, 24-hour canister), Carbonyls
Grapevine Fairway, 4100 Fairway Drive	Tarrant	48-439-3009	VOCs (24-hour canister)
Decatur Thompson, 301 E Thompson Street	Wise	48-497-0088	VOCs (autoGC)

The TCEQ Monitoring Division reported the data for all chemicals evaluated in this memorandum. All data (84 VOCs (canister), 46 VOCs (autoGC), 17 carbonyls, 14 metals ($PM_{2.5}$ PM_{10}, or TSP)) highlighted in this evaluation met TCEQ's data completeness objective of 75 percent data return.

One-hour autoGC VOC samples were compared to TCEQ's short-term AMCVs. Twenty-four-hour air samples collected every third or sixth day for a year are designed to provide representative long-term average concentrations. Short-term or peak concentrations are not captured by 24-hour samples; therefore, daily maximum concentrations have limited use in evaluating the potential for acute health effects. The TD evaluated the reported annual average concentrations from 1-hour autoGC and 24-hour samples for each target analyte for potential chronic health and vegetation concerns by comparing measured chemical concentrations to long-term AMCVs. More information about AMCVs is available online at: http://www.tceq.texas.gov/toxicology/AirToxics.html#amcv. As lead is a criteria pollutant, applicable lead TSP levels (i.e., rolling three-month averages) were compared to the lead NAAQS; however, annual average lead TSP concentrations were also evaluated since they are more representative of long-term lead exposure from a health perspective.

Evaluation

VOCs

Short-Term Data

All hourly average concentrations of the 46 VOCs reported at the seven autoGC sites were either not detected or below their respective short-term AMCVs. Therefore, acute adverse health effects, odorous conditions, or vegetation effects would not be expected to occur as a result of exposure to the reported levels of VOCs at these seven autoGC monitoring sites.

Long-Term Data

The 2011 annual average concentrations of the 46 VOCs evaluated at the seven autoGC monitoring sites and the 84 VOCs reported at each of the nine 24-hour canister monitoring sites were well below their respective long-term AMCVs. Exposure to the reported annual average concentrations would not be expected to cause chronic adverse health or vegetation effects.

Carbonyls

The 2011 annual average concentrations of the 17 carbonyls reported at the Fort Worth Northwest and Dallas-Hinton sites were below their respective long-term AMCVs. Exposure to the reported annual average concentrations would not be expected to cause chronic adverse health or vegetation effects.

Metals

At the three sites reporting $PM_{2.5}$ metals data, annual average concentrations of all 14 metals were well below their respective long-term AMCVs. Exposures to the reported levels of these metals would not be expected to cause chronic adverse health and vegetation effects.

At the Dallas-Morrell site, only nickel and chromium were reported. The annual average concentration of chromium was below its long-term health-based AMCV. Exposure to the reported annual average concentration of chromium would not be expected to cause chronic adverse health effects. The annual average concentration of nickel was above the long-term AMCV, and is discussed below.

Nickel at Dallas-Morrell Site

The annual average nickel concentration of 0.07 $\mu g/m^3$ exceeded the long-term AMCV of 0.059 $\mu g/m^3$ for respirable nickel particles. Elevated annual nickel levels have been detected at the Dallas-Morrell site since 1987 (Figure 1). Beginning in 1995, the annual average nickel concentrations have decreased and stabilized in the range of 0.07 to 0.3 $\mu g/m^3$ from 1998 through 2011. The reductions in annual nickel levels first observed in 1995 are attributed to actions taken by Dal Chrome Co., Inc., which is an automotive chrome bumper recycling facility located predominantly upwind from the Dallas-Morrell site. The air monitoring data from the Dallas-Morrell site are representative of total nickel concentrations and do not specify the specific forms of nickel. However, Dal Chrome Co., Inc. is known to emit mainly metallic nickel based on the type of facility and is expected to be the predominant nickel emissions source in the vicinity of the Dallas-Morrell site.

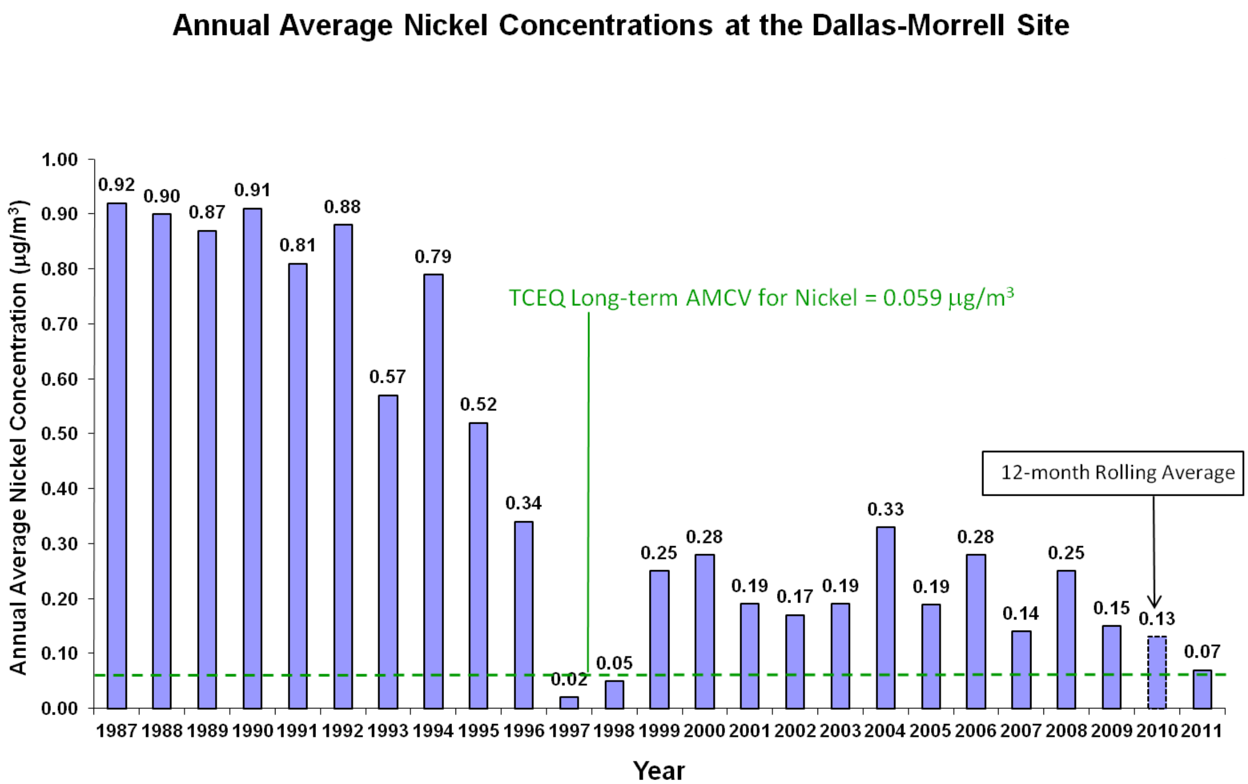

Figure 1. Annual Average Nickel TSP Concentrations at the Dallas-Morrell Site from 1987 to 2010 (Note: a 12-month rolling average concentration from August 17, 2009 to August 12, 2010 was used for 2010)

The long-term AMCV of 0.059 µg/m^3 for respirable nickel particles was derived based on risk of developing lung cancer following exposure to carcinogenic forms of nickel in occupational workers. Therefore, comparing nickel PM_{10} (post 2010) or TSP data (pre 2010) to the long-term AMCV for respirable nickel particles may be overly conservative for several reasons, including: differences in PM size fractions; differences in forms of nickel; and differences in health effects evaluated (i.e., non-carcinogenic and carcinogenic effects).

Nickel TSP incorporates all particle size fractions less than 50 µm and contains size fractions which are not in the respirable fraction. Available animal and human inhalation nickel and nickel compound studies have demonstrated that the serious adverse health effects (non-carcinogenic and carcinogenic) are related to exposure to the smaller fractions, specifically $PM_{2.5}$ and smaller, which are taken deep into the lungs.

The available cancer studies of metallic nickel do not adequately support that it is a probable human carcinogen via inhalation exposure. Comparing concentrations of primarily metallic nickel (i.e., noncarcinogenic form of nickel) emitted by Dal Chrome Co., Inc. to the long-term AMCV is likely to be overly conservative, as the long-term AMCV is based on carcinogenic forms of nickel, whereas the nickel emitted by Dal Chrome Co., Inc. is a different form of nickel and less toxic.

The TD also developed a noncarcinogenic chronic AMCV of 0.23 µg/m^3 for respirable nickel particles based on studies with nickel sulfate. The annual average nickel concentration of 0.07 µg/m^3 is below the noncarcinogenic chronic AMCV of 0.23 µg/m^3. Comparing the average nickel concentration of 0.07 µg/m^3 to the noncarcinogenic chronic AMCV for nickel is appropriate and is also likely a conservative comparison since chronic (and acute) animal toxicity studies have shown that soluble forms of nickel, such as that used to derive the noncarcinogenic chronic AMCV (nickel sulfate), are more toxic than insoluble forms, such as metallic nickel (the form evaluated here).

Desert Research Institute Monitoring Study of Collocated TSP and $PM_{2.5}$ Monitors at Dallas-Morrell Site

In order to address the issue of particle size at the Dallas-Morrell site, and to better characterize the more toxicologically relevant nickel PM fraction for risk assessment of nickel exposure, a special monitoring study was conducted from April 2009 to August 2010 at the Dallas-Morrell site. As mentioned above, only TSP samples have historically been collected at this site. During the special monitoring study, however, a new $PM_{2.5}$ monitor was collocated with the TSP monitor and had the same sampling schedule. For additional details on this study, please see the 2010 regional memo available here:
http://www.tceq.texas.gov/assets/public/implementation/tox/monitoring/evaluation/2010/reg_4_dallas.pdf

Summary of Nickel Concentrations at the Dallas-Morrell Site

The air monitoring data from the Dallas-Morrell site are representative of total nickel concentrations and do not specify the specific forms of nickel. Therefore, to be conservative, the TD recommends emission reductions from Dal Chrome Co., Inc. and any other potential sources impacting this site. Nickel at the Dallas-Morrell site currently remains on TCEQ's APWL (APWL0401). Detailed information about the long-term AMCV and noncarcinogenic chronic AMCV for nickel is available in the nickel DSD.

Lead

On November 12, 2008, the U.S. Environmental Protection Agency (EPA) finalized the new 0.15 µg/m^3 NAAQS for lead based on a rolling three-month average concentration (73 Federal Register 66964). In general, the rule requires source-oriented ambient air lead monitoring at sites with actual annual lead emissions of one or more tons per year. Two lead-acid battery recycling facilities, namely Exide Technologies, Inc. and ECS Refining Texas LLC (hereafter called Exide and ECS, respectively), were identified as the facilities that are required to have source-oriented lead monitoring in TCEQ Region 4. The rolling 3-month averages of lead TSP around the Terrell Temtex site are reported as 0.06 µg/m^3, and are below the 0.15 µg/m^3 NAAQS for lead. The rolling three-month averages of lead TSP around Exide exceeded the 0.15 µg/m^3 NAAQS for lead. A health effect evaluation of airborne lead exposure around the Exide facility is provided below.

Lead TSP Monitors around Exide

Four lead TSP monitors (Frisco 7, Frisco Eubanks, and Frisco 5th St.) were established in mid-1990 or earlier and a new monitor (Frisco Stonebrook) was activated on January 7, 2011. The locations of lead monitors around the Exide facility are shown in Figure 3. With dominant wind direction being from the south and southeast, the Frisco Eubanks and Frisco 7 monitors are downwind of the Exide facility and the Frisco Stonebrook monitor is upwind of the Exide facility. Ambient air concentrations reported for the Frisco Eubanks monitor are more representative of a worst-case scenario based on predominant winds, proximity to the Exide facility, and possible public access, while concentrations reported for the Frisco 7 monitor are more representative of community lead exposure in the neighborhood.

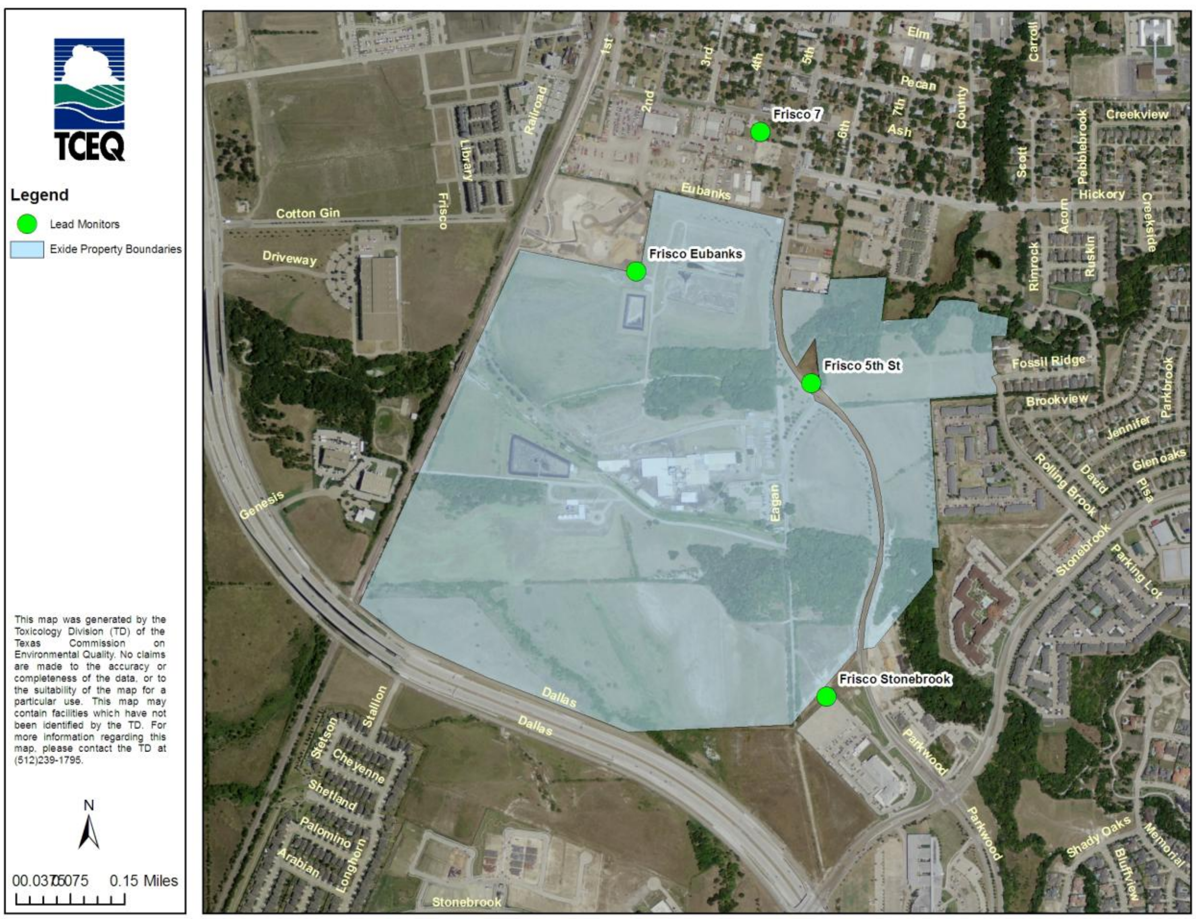

Figure 3. Locations of Lead TSP Monitors around Exide Facility

Reported Lead TSP Concentrations from Monitors around Exide

Annual average concentrations of lead TSP from Frisco 7, Frisco Eubanks, and Frisco 5th St. monitors were fairly consistent since 1995, though with some variations (Figure 4). Higher concentrations have been reported from the Frisco Eubanks monitor and lower lead TSP concentrations were reported from all other monitors. Although the ambient lead TSP concentrations around Exide have not changed significantly, the NAAQS for lead was lowered tenfold in 2008 from 1.5 to 0.15 μg/m^3 and the area around Exide is now exceeding the NAAQS.

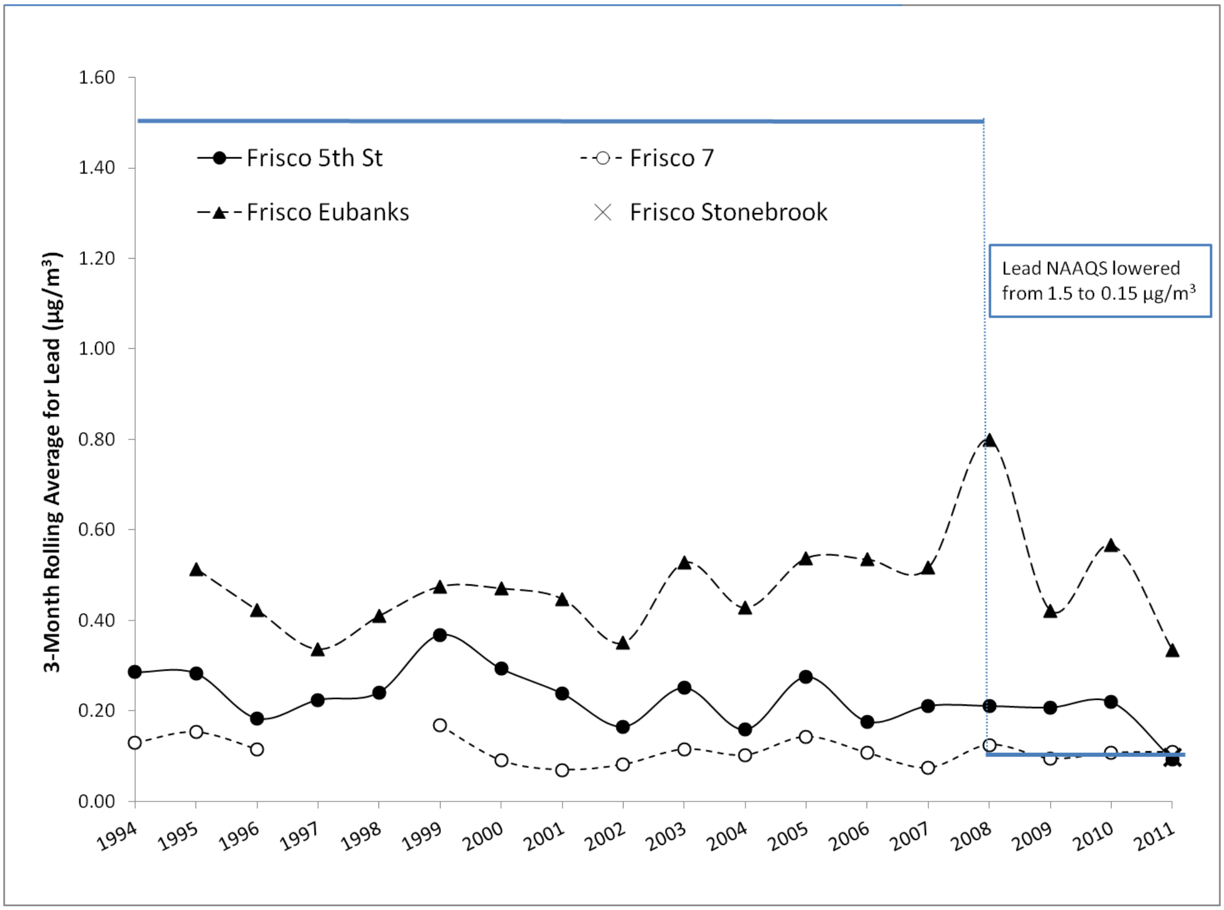

Figure 4. Annual Average Lead TSP Concentrations from Monitors around Exide Facility from 1994 to 2011

Results from Frisco Blood Lead Exposure Investigation by the TDSHS

The TDSHS conducted a Blood Lead Exposure Investigation in Frisco during March 2011. A person's blood lead level is the best indicator of lead exposure from all sources (e.g., soil, food, toys, lead-based paint, drinking water, ambient air). The results of the blood lead levels of Frisco residents did not show levels of health concern (e.g., they were below CDC's blood lead level of concern for children of 10 μg/dL [2]). Specifically, of the 608 blood samples tested by the TDSHS laboratory, 575 (95%) did not contain detectable levels of lead (the detection limit was 2 μg/dL). Only two samples, both from adults who were potentially exposed to lead at their workplace, were found to have blood lead levels above 10 μg/dL. Although above the threshold set for children, these two adult blood samples were below the 25 μg/dL level of concern for adults. Detailed information is available in the Fact Sheet or the Final Report for the investigation. The

[2] Note that the CDC has recently updated its "level of concern" to reference value of 5μg/dL based on the NHANES dataset. More information is available here: http://www.cdc.gov/nceh/lead/ACCLPP/blood_lead_levels.htm

Fact Sheet is available at: http://www.dshs.state.tx.us/epitox/education.shtm and the Final Report is available at: http://www.dshs.state.tx.us/epitox/assess.shtm.

Children's Blood Lead Levels Predicted by the Integrated Exposure Uptake Biokinetic (IEUBK) Model under Assumed Exposure Conditions

Lead exposure involves multiple pathways from soil/dust, diet, drinking water, and ambient air. The EPA developed the IEUBK model to estimate the blood lead concentrations of children less than seven years old being exposed to lead from multiple sources and pathways. The TD used the IEUBK model (version 1.1, build 11) to compare children's predicted blood lead levels resulting from exposure to lead in ambient air, to a monitored annual air concentration that meets the NAAQS and the highest monitored three-month air concentration that exceeds the NAAQS. Reported 2011 results for the Frisco 7 monitor were used as they are more representative of community lead exposure. Default IEUBK model parameters were used, except the TD used representative soil concentrations (i.e., the average Frisco soil lead concentration) and the assumed air exposure concentrations being evaluated (i.e., the NAAQS, the monitored annual average, and the highest rolling three-month average). Using the average Frisco soil lead concentration of 38.31 mg/kg (from EPA soil sampling around Exide in March 2010), the estimated geometric mean blood lead levels for children were similar (1.22 to 1.25 µg/dL) regardless of whether the reported annual average (0.11 µg/m^3), or the highest rolling three-month average or NAAQS (0.15 µg/m^3), lead concentration from the Frisco 7 community monitor was used as an input to the IEUBK model (Table 2). More importantly, 0% of children were predicted to exceed the blood lead level of concern of 10 µg/dL and less than 0.2% of children were predicted to exceed the recently-proposed reference value of 5 µg/dL, based on the NHANES dataset [3] (Table 2).

Table 2. Predicted Children Blood Lead Levels Based on the Reported Lead TSP Concentrations from the Frisco 7 Community Monitor in 2011 with an Average Frisco Soil Concentration of 38.31 mg/kg.

Parameter	2008 NAAQS	Annual Average	Highest Rolling 3-month Average
Ambient Air Concentration Input (µg/m^3)	0.15	0.11	0.15
Estimated Geometric Mean Blood Lead (µg/dL)	1.25	1.22	1.25
Predicted % Blood Lead over 10 µg/dL	0.00	0.00	0.00
Predicted % Blood Lead over 5 µg/dL	0.16	0.13	0.16

Note: the detection limit for the blood lead analytical method is 2 µg/dL

[3] Note that the CDC has recently updated its "level of concern" to reference value of 5µg/dL based on the NHANES dataset. More information is available here: http://www.cdc.gov/nceh/lead/ACCLPP/blood_lead_levels.htm

These IEUBK model results predict non-detectable levels of lead in children's blood under assumed exposure conditions (i.e., air monitoring results and soil sampling results) and are consistent with TDSHS results, which did not identify any children with elevated blood lead based on results from their Blood Lead Exposure Investigation in Frisco during March 2011.

Lead Summary

Although reported ambient air lead TSP concentrations around Exide exceeded the 2008 lead NAAQS, neither the results of the Blood Lead Exposure Investigation in Frisco during March 2011 by the TDSHS nor predicted children blood lead levels by the IEUBK model indicate blood lead levels of concern.

Investigations of Air Quality and Barnett Shale Activities

In response to concerns about Barnett Shale oil and gas operations, the TCEQ has performed extensive mobile monitoring and is in the process of significantly expanding the network of stationary samplers that measure VOCs. In addition, as of December 17, 2009, the agency implemented a 12-hour response time for all complaints received concerning oil and gas facilities in the 24 county Barnett Shale area. As of February 27, 2012, the 12-hour complaint response was modified to complaints about odors or emissions from oil and natural gas activities in the Barnett Shale that are currently occurring and constitute an imminent threat to public health, safety, or the environment. Complaints concerning odor from an oil or natural gas site in the Barnett Shale that has substantiated odor nuisance conditions in the previous 12 months will be given an "Immediate Response" priority. An on-site investigation will be conducted by the Dallas/Fort Worth Region staff within 12 hours of receipt of the complaint by the regional office. All other oil and natural gas related complaints will be given priority in accordance with the Field Operations Standard Operating Procedures. In addition, the DFW regional staff conducts periodic reconnaissance investigations in selected areas and the regional office also conducts monitoring, as time and resources permit, at the request of the public and other interested parties. Scheduled compliance investigations are also conducted at natural gas sites to determine compliance with applicable rules and regulations. The regional office also conducts monitoring, as time and resources permit, at the request of the public and other interested parties. Detailed information is available on the TCEQ's Barnett Shale Web page at: http://www.tceq.state.tx.us/goto/barnettshale.

If you have any questions regarding the contents of this review, please do not hesitate to contact me at (512) 239-1808 or via email at stephanie.shirley@tceq.texas.gov.

cc (via email):

Mr. Ruben Casso - EPA Region 6, Dallas
Ms. Susan Prosperie - Department of State Health Services

Attachment A

List 1. Target VOC Analytes in Canister Samples

1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethylene
1,2,3-Trimethylbenzene
1,2,4-Trimethylbenzene
1,2-Dichloropropane
1,3,5-Trimethylbenzene
1,3-Butadiene
1-Butene
1-Hexene+2-Methyl-1-Pentene
1-Pentene
2,2,4-Trimethylpentane
2,2-Dimethylbutane (Neohexane)
2,3,4-Trimethylpentane
2,3-Dimethylbutane
2,3-Dimethylpentane
2,4-Dimethylpentane
2-Chloropentane
2-Methyl-2-Butene
2-Methylheptane
2-Methylhexane
2-Methylpentane (Isohexane)
3-Methyl-1-Butene
3-Methylheptane
3-Methylhexane
3-Methylpentane
4-Methyl-1-Pentene
Acetylene
Benzene
Bromomethane
Carbon Tetrachloride
Chlorobenzene
Chloroform
Chloromethane (Methyl Chloride)
Cis 1,3-Dichloropropene
Cis-2-Butene
Cis-2-Hexene
Cis-2-Pentene
Cyclohexane
Cyclopentane
Cyclopentene
Dichlorodifluoromethane
Dichloromethane (Methylene Chloride)
Ethane
Ethylbenzene
Ethylene
Ethylene Dibromide (1,2-Dibromoethane)
Ethylene Dichloride (1,2-Dichloroethane)
Isobutane
Isopentane (2-Methylbutane)
Isoprene
Isopropylbenzene (Cumene)
M-Diethylbenzene
M-Ethyltoluene
M/P Xylene
Methyl Chloroform (1,1,1-Trichloroethane)
Methylcyclohexane
Methylcyclopentane
N-Butane
N-Decane
N-Heptane
N-Hexane
N-Nonane
N-Octane
N-Pentane
N-Propylbenzene
N-Undecane
O-Ethyltoluene
O-Xylene
P-Diethylbenzene
P-Ethyltoluene
Propane
Propylene
Styrene
Tetrachloroethylene
Toluene
Trans-1-3-Dichloropropylene
Trans-2-Butene
Trans-2-Hexene
Trans-2-Pentene
Trichloroethylene
Trichlorofluoromethane
Vinyl Chloride

List 2. Target Carbonyl Analytes

2,5-Dimethylbenzaldehyde	Formaldehyde	o-Tolualdehyde
Acetaldehyde	Heptaldehyde	Propanal - Propionaldehyde
Acetone	Hexanaldehyde	p-Tolualdehyde
Acrolein	Isovaleraldehyde	Valeraldehyde
Benzaldehyde	Methyl Ethyl Ketone (MEK)/Methacrolein	
Butyraldehyde	m-Tolualdehyde	
Crotonaldehyde - 2-Butenal		

List 3. Target Metal Analytes

Aluminum ($PM_{2.5}$)	Chromium ($PM_{2.5}$, PM_{10} and TSP)	Molybdenum ($PM_{2.5}$)
Antimony ($PM_{2.5}$)	Cobalt ($PM_{2.5}$)	Nickel ($PM_{2.5}$, PM_{10} and TSP)
Arsenic ($PM_{2.5}$)	Copper ($PM_{2.5}$)	Selenium ($PM_{2.5}$)
Barium ($PM_{2.5}$)	Lead (TSP and $PM_{2.5}$)	Tin ($PM_{2.5}$)
Cadmium ($PM_{2.5}$)	Manganese($PM_{2.5}$)	Zinc ($PM_{2.5}$)

List 4. Target VOC Analytes in AutoGC

1-Butene	Benzene	n-Decane
1-Pentene	c-2-Butene	n-Heptane
1,2,3-Trimethylbenzene	c-2-Pentene	n-Hexane
1,2,4-Trimethylbenzene	Cyclohexane	n-Nonane
1,3-Butadiene	Cyclopentane	n-Octane
1,3,5-Trimethylbenzene	Ethane	n-Pentane
2-Methylheptane	Ethyl Benzene	n-Propylbenzene
2-Methylhexane	Ethylene	o-Xylene
2,2-Dimethylbutane	Isobutane	p-Xylene + m-Xylene
2,2,4-Trimethylpentane	Isopentane	Propane
2,3-Dimethylpentane	Isoprene	Propylene
2,3,4-Trimethylpentane	Isopropyl Benzene - Cumene	Styrene
2,4-Dimethylpentane	Methylcyclohexane	t-2-Butene
3-Methylheptane	Methylcyclopentane	t-2-Pentene
3-Methylhexane	n-Butane	Toluene
Acetylene		