Air Pollution and Public Health in Galena Park, Texas

July 2014

Air Alliance Houston
Clean Air Healthy Future

gcm Global Community Monitor
empowering communities

About Us

Air Alliance Houston wants clean air so our economy, quality of life, and children can thrive.

Our mission is to reduce air pollution in the Houston region and protect public health and environmental integrity through research, education, and advocacy. We are the Houston region's leading environmental health and air quality nonprofit.

Air Alliance Houston was formed more than twenty-five years ago as GHASP, the Galveston Houston Association for Smog Prevention. Now we are bigger and better than ever. We are strong advocates for Houston's environmental justice communities. Our educational programs, including Ozone Theater and Air Pollution Solutions, reach 5,000 students every year. We also host Earth Day Houston, Houston's premier celebration of our planet.

Global Community Monitor (GCM), founded in 2001, trains and supports communities in the use of environmental monitoring tools to understand the impacts of industrial pollution on their health and the environment. GCM's work focuses on disempowered "fenceline" communities often low income and people of color harmed by serious air pollution. These communities struggle with environmental health issues related to pollution from mobile sources and industrial facilities. These community concerns are often ignored by the agencies and the corporations responsible for causing the problem. Over the past dozen years, GCM has developed and pioneered the use of "bucket brigades" (a grassroots air monitoring program) as a method for communities to document and understand the impacts of industrial pollution to launch advocacy efforts against polluters and to win stunning victories.

GCM's primary activity consists of providing training and on-going technical assistance to community organizations fighting pollution as well as strengthening an international movement of people negatively impacted by industrial pollution and climate change. We have worked with more than 100 community partners and partners in 27 countries.

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Executive Summary

Galena Park, Texas is an environmental justice community of some 10,000 residents on the Houston Ship Channel. The community is surrounded by the ship channel; industry, particularly that associated with Houston petrochemical industry; rail lines; and high traffic roadways, including I-10 to the north and 610 to the west.

Air Alliance Houston has been active in Galena Park for several years. It is a community in which concerns about pollution and public health run high. However, a lack of resources and knowledge leads to very little public engagement on issues that impact environmental quality and health. Although citizens are worried about their health, there is little sense that they can personally affect change.

Air Alliance Houston and Global Community Monitor conducted a community health impact survey, and community mapping workshop, and a community air monitoring project. Air monitoring was conducted over the course of a year for fine particulate matter and elemental carbon, a surrogate for diesel pollution. The results of the yearlong community air monitoring project form the basis of this report. An independent report was produced by a graduate student at the Rice University Department of Statistics.

Diesel pollution presents an unacceptable health risk in Galena Park. Cancer risk due to diesel pollution exposure may exceed 1 in 10,000. Fine particulate matter pollution may exceed federal health standards as well.

Galena Park must act now to reduce diesel and particulate matter pollution in order to protect its residents' health. We recommend aggressive steps to limit diesel pollution by banning older, dirty trucks and diverting trucks from Galena Park roads. We also recommend further testing to determine the extent of air pollution in Galena Park, and its impacts.

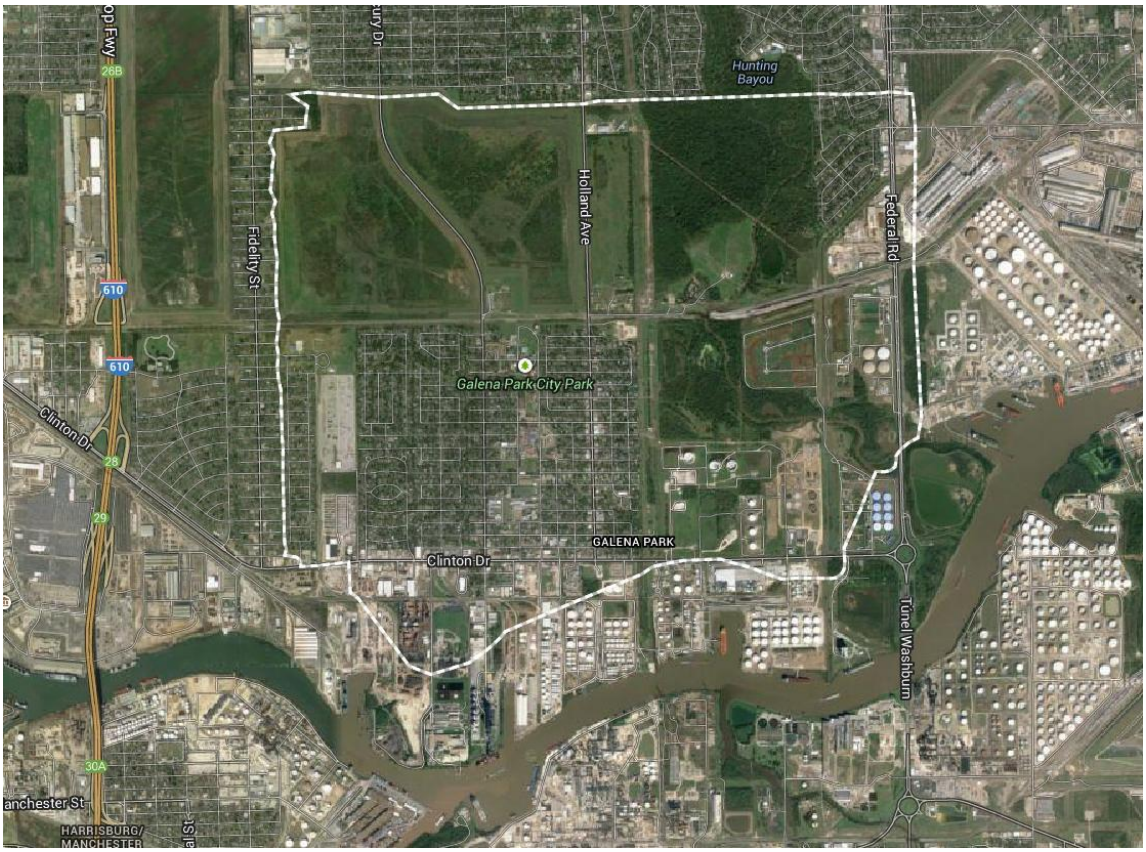
Galena Park recently elected a new mayor and city council. This new administration has an opportunity to take a fresh look at the pollution challenges their residents face. It is our hope that Galena Park will work with the Port of Houston Authority, Harris County, and the City of Houston to address these challenges and protect the health of the citizens of Galena Park, Texas.

I. Background and Profile of Galena Park

A. Community Profile

Galena Park, Texas is an environmental justice community located in East Houston on the north side of the Houston Ship Channel. The residents of Galena Park face many problems that are associated with the environment: poor housing, the lack of local health care and nutritional food, heavy traffic congestion, limited public transportation, toxic chemicals, air pollution, water pollution, and other environmental stressors.

Figure 1: Map of Galena Park, TX



According to the U.S. Census 2005-2009 American Community Survey, Galena Park has a predominantly Hispanic population of around 10,256, which represent approximately 2,900 households. African-Americans, many of whom live in the Galena Manor subdivision, represent less than 10% of the population. The city has a median household income of $33,250, which is 65% of the U.S. median household income. Twenty-two percent of families live below the poverty level, more than twice the national percentage. The age dependency ratio is 69%, 14% elderly and 55% children. Eighteen percent of the population is aged 5 to 14 and 44% is aged 15 to 44. About 50% of the population are high school graduates, and only 3.2% are college graduates or higher. The major occupations are related to production and the goods movement industry, followed by construction and service occupations.

Although the City of Galena Park has limited resources, it is a small and quiet community that works together to maximize available resources. Community members are acquainted with and care about one another. The City's motto is "A community where citizens work hand in hand."

B. Pollution Challenges in Galena Park

Galena Park, Texas was selected for this project because it is a small community with large health challenges. Galena Park is located on the north side of the Houston Ship Channel, which serves the Port of Houston, one of the largest and busiest ports in the nation.[1] Galena Park receives pollution from the variety of mobile sources associated with the Houston Ship Channel, including barges and other large ships, support vessels, stationary engines such as cranes and generators, and associated mobile sources such as trucks and trains.

Truck traffic in Galena Park. Photo by Denny Larson.

Clinton Drive, which borders Galena Park to the south, is a thoroughfare for diesel trucks coming and going to the Port of Houston. Clinton Drive sees several thousand diesel trucks each day. Trucks often idle for hours at a time as that wait at the Port. Galena Park is also home to several rail lines. Steady rail traffic in the area contributes to the excessive diesel pollution that residents of Galena Park are exposed to.

Galena Park is the only area in Harris County that is listed on the Texas Commission on Environmental Quality's (TCEQ) Air Pollutant Watch List (APWL), which is designed to "alert technical staff to cities or counties within the state that have areas with elevated air concentrations of special interest pollutants."[2] Galena Park is listed on the APWL for benzene, a volatile organic compound and known human carcinogen emitted by industrial and mobile sources.

The TCEQ produces maps of all APWL areas that identify nearby sources of air pollution. Because the APWL site in Galena Park is for benzene, the map focuses on sources of benzene in the area. Benzene pollution was not part of this study, but the map is a useful illustration of the heavy industry surrounding Galena Park.

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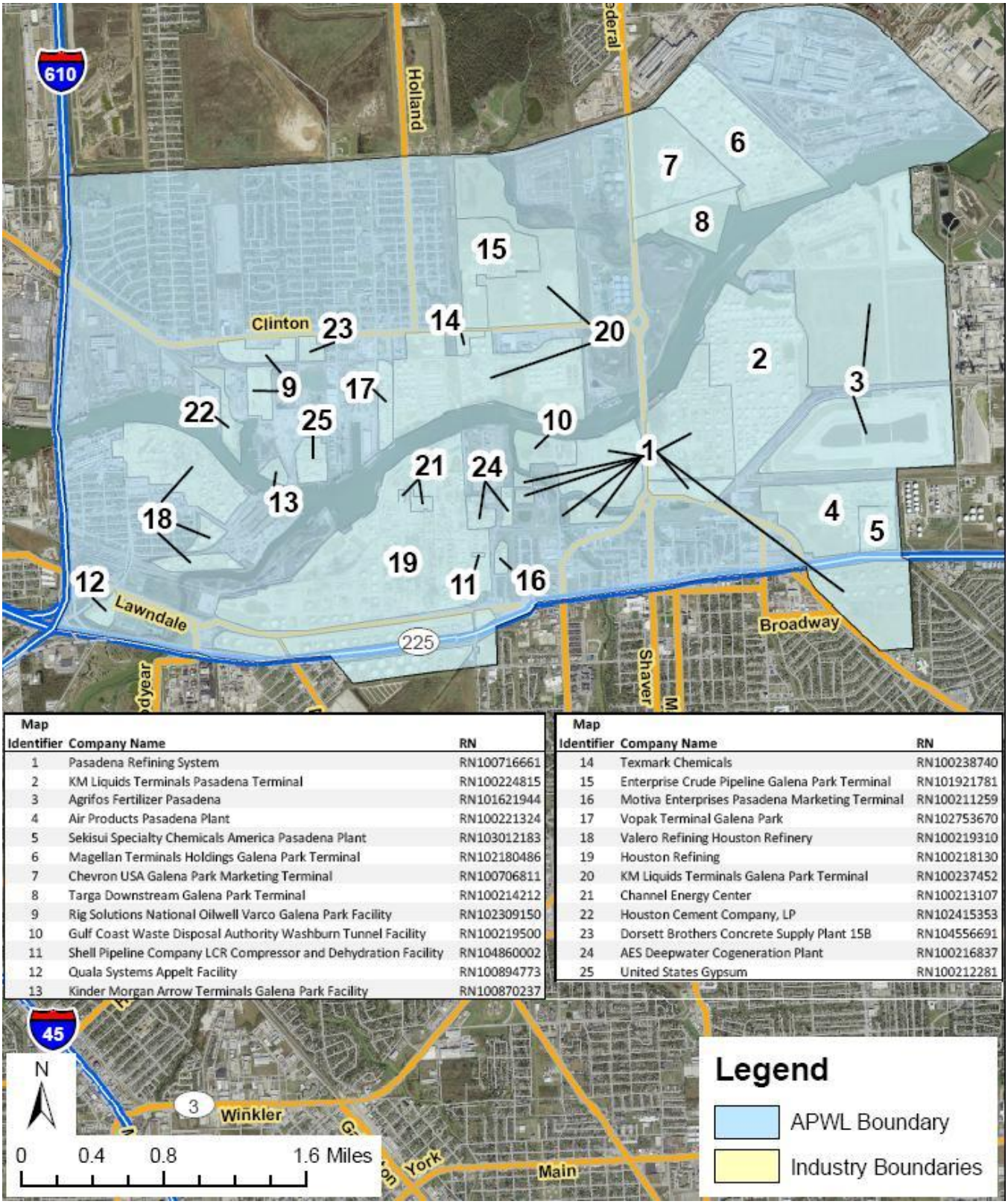
[1] *See, e.g.,* http://www.portofhouston.com/business-development/trade-development-and-marketing/trade-statistics/.

[2] *See* https://www.tceq.texas.gov/toxicology/AirPollutantMain/APWL.html.

Figure 2: Industrial sources in and around Galena Park



Map Identifier	Company Name	RN
1	Pasadena Refining System	RN100716661
2	KM Liquids Terminals Pasadena Terminal	RN100224815
3	Agrifos Fertilizer Pasadena	RN101621944
4	Air Products Pasadena Plant	RN100221324
5	Sekisui Specialty Chemicals America Pasadena Plant	RN103012183
6	Magellan Terminals Holdings Galena Park Terminal	RN102180486
7	Chevron USA Galena Park Marketing Terminal	RN100706811
8	Targa Downstream Galena Park Terminal	RN100214212
9	Rig Solutions National Oilwell Varco Galena Park Facility	RN102309150
10	Gulf Coast Waste Disposal Authority Washburn Tunnel Facility	RN100219500
11	Shell Pipeline Company LCR Compressor and Dehydration Facility	RN104860002
12	Quala Systems Appelt Facility	RN100894773
13	Kinder Morgan Arrow Terminals Galena Park Facility	RN100870237

Map Identifier	Company Name	RN
14	Texmark Chemicals	RN100238740
15	Enterprise Crude Pipeline Galena Park Terminal	RN101921781
16	Motiva Enterprises Pasadena Marketing Terminal	RN100211259
17	Vopak Terminal Galena Park	RN102753670
18	Valero Refining Houston Refinery	RN100219310
19	Houston Refining	RN100218130
20	KM Liquids Terminals Galena Park Terminal	RN100237452
21	Channel Energy Center	RN100213107
22	Houston Cement Company, LP	RN102415353
23	Dorsett Brothers Concrete Supply Plant 15B	RN104556691
24	AES Deepwater Cogeneration Plant	RN100216837
25	United States Gypsum	RN100212281

C. Health Risks of Particulate Pollution

Particulate matter air pollution is comprised of dust, dirt, soot, smoke, metals, liquids, and other small particles. Fine particulate matter pollution ("PM2.5") is defined as particles that are less than 2.5 microns in aerodynamic diameter, or about 1/40th the width of a human hair. These particles are small enough to be inhaled into the lungs and pass into the blood stream. Exposure to fine particulate matter causes a range of health effects, from coughing, difficulty breathing, reduced lung function, aggravation of respiratory illnesses such as asthma, increased risk of heart attacks and other cardiovascular disease, increased risk of lung cancer mortality, and premature death.[3]

Diesel Engine Exhaust is classified as a group I human carcinogen by the International Agency for Research on Cancer, a division of the World Health Organization.[4] In this project, elemental carbon (EC) was used as a surrogate for diesel pollution. Elemental carbon levels were sampled using mechanical PM monitors with filters. Diesel pollution levels were estimated from EC measurements via a method established by Fraser et al. 2002.[5]

Small metal particles or "metal aerosols" present a wide range of carcinogenic and noncarcinogenic health impacts. PM2.5 samples collected were analyzed for forty individual elements, including many metals.[6]

II. Air Alliance Houston's Work in Galena Park

Air Alliance Houston (AAH) partnered with Global Community Monitor (GCM) for a multi-year project in Galena Park, Texas. Air Alliance Houston is the Houston region's leading air quality and public health organization. Our mission is to reduce air pollution in the Houston region and protect public health and environmental integrity through research, education, and advocacy.

Global Community Monitor is an international environmental health and justice nonprofit that trains communities to monitor the air they breathe and take action to clean up their air.

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[3] *See, e.g.,* "Particle Pollution and Your Health," United States Environmental Protection Agency (Sept. 2003), *available at* http://www.epa.gov/airquality/particlepollution/pdfs/pm-color.pdf.

[4] "IARC: Diesel Engine Exhaust Carcinogenic," International Agency for Research on Cancer, World Health Organization (12 June 2012), *available at* http://www.iarc.fr/en/media-centre/pr/2012/pdfs/pr213_E.pdf.

[5] Fraser MP, Lakshmanan K, Fritz SG, Ubanwa B., "Variation in composition of fine particulate emissions from heavy-duty diesel vehicles," Journal of Geophysical Research 2002; 37:2117-2123.

[6] Sodium (Na), magnesium (Mg), aluminum (Al), silicon (Si), phosphorus (P), sulphur (S), chlorine (Cl), potassium (K), calcium (Ca), titanium (Ti), vanadium (V), chromium (Cr), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), gallium (Ga), germanium (Ge), arsenic (As), selenium (Se), bromine (Br), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), molybdenum (Mo), palladium (Pd), silver (Ag), cadmium (Cd), indium (In), tin (Sn), antimony (Sb), barium (Ba), lanthanum (La), mercury (Hg), and lead (Pb).

Our work in Galena Park was built around three main components: a community health impact survey, a community mapping workshop, and a community air monitoring project.

A. Community Health Impact Survey

Air Alliance Houston conducted a Community Health Impact Survey in Galena Park during 2012. The survey was conducted by upper-level students from Galena Park High School. Out of approximately 2,900 households in Galena Park, 860 responded to the survey, an impressive response rate of 30%. Survey respondents were 78% Hispanic/Latino, 13% white, and 9% black. Sixty-seven percent of respondents owned their own homes and 38% had resided there for more than 20 years.

GPISD high school students conduct community survey.

The Community Health Impact Survey identified a lack of public transportation, access to nutritional foods, and green space. Limited access to health care is a major issue, with no private medical practices in Galena Park and 56% of residents unaware of the City's public pediatric clinic. Thirty-two percent of respondents did not have health insurance during the previous year. Rates of illness were elevated over state averages. In Texas, approximately 12.7% of adults have asthma or another respiratory disease,[7] compared to 16% of adults in Galena Park and 24% of children. Adult cancer rates in Texas were 3.69% in 2013,[8] compared to 8% of adults and 1% of children in Galena Park in 2012.

Pollution concerns were also high in Galena Park. Sixty-nine percent of residents were concerned about pollution, 74% were concerned about effects on their health, and 76% had specific concerns that included refineries, chemical plants, 18-wheeler traffic, cars, the Clinton Dredge Material Placement Area (DMPA), and air and water pollution in general. Despite these numbers, four out of five Galena Park residents had never tried to communicate their concerns about pollution to anyone.

Air Alliance Houston released a full report on the results of the Community Health Impact Survey. It is available as Appendix C to this report.

B. Community Mapping Workshop

In Spring 2012 Air Alliance Houston and Global Community Monitor held a Community Mapping Workshop that was attended by twenty residents of Galena Park. The Workshop was lead by Catalina Garzon and Eli Moore with Community Strategies for Sustainability & Justice Program, Pacific Institute in California and Denny Larson, Executive Director of Global Community Monitor.

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[7] Corgey, Hilary, "Healthy Port Communities Coalition: Port Community Survey," (Oct. 2013), *available at* http://www.citizen.org/documents/HPCC%20survey%20report%20final.pdf.

[8] Id.

The Community Mapping exercise asked participants to map out "community treasures," both past and present; "environmental hazards" that could affect community health and quality of life; and "opportunity sites" that could be used to realize a vision for the future of the community.

Belinda Vasquez-St. John leads community mapping workshop.

Another goal of the Community Mapping Workshop was to identify "hot spots": places where community members would like to see air monitoring to document problems with air pollution in their community. This was followed by the first placement of a community-led air monitor was placed on the Galena Park Early Head Start Center for twenty-four hours on May 16-17, 2012.

The Mapping Workshop was followed with a groundtruthing project whose participants compared the maps they produced to "the truth on the ground." Groundtruthing also identified locations for the community air monitoring phase of the project.

III. Community Monitoring Project

A year-long air monitoring project began in Galena Park in November 2011. Together, Air Alliance Houston, Global Community Monitor, and the people of Galena Park developed a plan for a community based participatory research project to monitor for particulate matter pollution.

Denny Larson trains participants in the use of MiniVols.

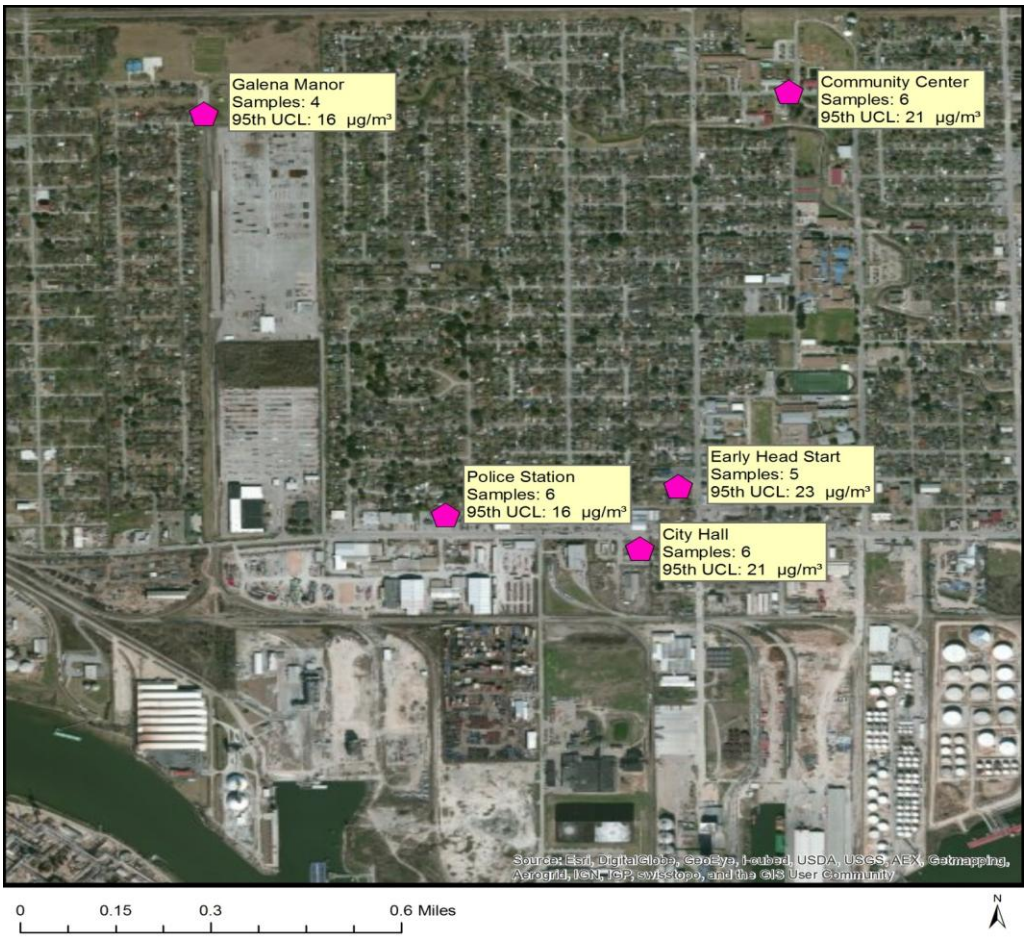
Galena Park residents were trained in the use of air monitoring equipment and invited to join Air Alliance Houston in the deployment of our monitors. Sites for monitoring were selected based on information gathered during the community health survey and community mapping workshop.

A. Monitoring Locations Selected with Public Input

Five public buildings were chosen for the monitoring project.[9] These locations were identified by residents during the community mapping workshop. They were chosen for their distribution throughout Galena Park, particularly with relation to Clinton Drive. The following map indicates the monitoring locations:

[9] Special thanks to the Galena Park City administration and Police Department, whose members were very helpful throughout the project.

Figure 3: Map of Monitoring Locations



Map by Laura Campos.

1. Galena Manor Recreation Building

The Galena Manor Recreation Building is located at 1508 Hunter St., Galena Park, TX 77547. Galena Manor is a historically African-American community located on the western edge of Galena Park. It is separated from the rest of Galena Park by a railroad switchyard and two industrial facilities. Access in and out of Galena Manor is limited, with only Clinton Drive to the south providing access to the rest of the town. This was the only sampling location in Galena Manor.

2. Galena Park Resource and Training Center

The Galena Park Resource and Training Center (also known as the "Resource Center" or "Community Center") is located at 1721 16th St, Galena Park, TX 77029. It was the site of Air Alliance Houston's field office during this project. It is the furthest site from the Houston Ship Channel.

3. Galena Park Police Department

The Galena Park Police Department is located at 2207 Clinton Dr, Galena Park, TX 77547. This location was chosen because it is on the north side of Clinton Drive.

4. Galena Park City Hall

Galena Park City Hall is located at 2000 Clinton Dr, Galena Park, TX 77547. It was chosen for its location on the south side of Clinton Drive. It is the furthest site south and the closest site to the Houston Ship Channel.

5. Galena Park ISD Early Head Start

The Galena Park ISD Early Head Start center is located at 1908 2nd St Galena Park, TX 77547. It is the site of a federally funded program for low-income families, infants/ toddlers, and pregnant women.[10] Early Head Start was the source of the highest average PM2.5 measurements in the study. Its Fatherhood/Partnership Specialist, Ernesto Paredes Jr., is a close ally of Air Alliance Houston and a strong partner throughout the project.

B. Monitoring Equipment and Analysis

Particulate matter samples were gathered using two MiniVol[11] Tactical Air Samplers (TAS).[12] Our partners Global Community Monitor have much experience using MiniVols. They are manufactured by Airmetrics, a Eugene, OR based company providing innovative air sampling equipment. Although the MiniVol is not a reference method sampler, its manufacturer states that "the MiniVol™ TAS gives results that closely approximate data from Federal Reference Method samplers."[13]

The two MiniVols used throughout the project.

The MiniVol uses a system that includes a pump, impactors, and a mechanical filter. Each MiniVol is calibrated by Airmetrics before it is sold. The calibration ensures that the pump draws 5.0 liters of ambient air per minute. The monitor is equipped with a flow meter that allows operators to check the flow rate before and after each use. With a flow-rate of 5 liters per minute (approximately the same as that of the human lungs), each MiniVol collected 7.2 cubic meters of air during a 24-hour sample.

The MiniVol can be configured using a variety of impactors to sample particulate matter in the ranges of 10 microns (PM-10), 2.5 microns (PM2.5), and total suspended particles (TSP). For this project. Air Alliance Houston collected only PM2.5 samples for 24-hour periods.

Samples are collected in a 47 millimeter (mm) mechanical filter. Filters were purchased and prepared for use by CHESTER LabNet (CLN), a Tigard, OR based specialty laboratory that focuses on inorganic air

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[10] More information about Galena Park ISD Early Head Start is available at http://www.galenaparkisd.com/head_start.php.

[11] MiniVol is a trademark of Airmetrics.

[12] Initially, the project included sampling with a DustTrakII aerosol meter. Early difficulties with the DustTrakII led to its data being discarded. It has since been repaired and recalibrated and will be included in future studies.

[13] *See* http://www.airmetrics.com/products/minivol/index.html.

quality analysis. Samples were collected using CLN's procedures for proper handling, storage, and shipment of filters. Samples were returned to CLN for analysis.[14]

Two types of filters were used: Teflon and quartz. Samples taken with Teflon filters were analyzed using two analytical protocols. A gravimetric analysis yields a total PM2.5 mass. CLN weighs each filter after conditioning at a constant temperature and relative humidity prior to shipment using a balance accurate to one microgram. After sampling, the filter is reconditioned and then CLN reweighs the filter to determine the total weight of material present. Dividing this weight by the total volume of air sampled (7.2 m^3 for a 24-hour sample) gives an average concentration of PM2.5 in the ambient air during the 24-hour sample collection. Teflon filters were also analyzed using an x-ray fluorescence (XRF) analysis that determined concentrations of forty different elements.

Quartz filters were used to sample for elemental and organic carbon. Quartz filters must be refrigerated before and after use, and during shipping, in order to limit volatilization of collected material. Quartz filters were analyzed using the National Institute for Occupational Safety and Health (NIOSH) Method 5040 for diesel particulates as elemental carbon. Method 5040 determines total carbon as organic carbon and elemental carbon. Elemental carbon was then used to calculate the concentration of diesel particulates.

C. Monitoring Protocol and Quality Control

All participants in the study handling the MiniVols were trained in their use by Denny Larson of Global Community Monitor. Two monitors were deployed side-by-side throughout the project. Each monitor includes an on-board programmable timer. Timers are programmed to sample for twenty-four hours and independently verified. Monitors are powered by on-board battery packs. Battery packs are exchanged after each run for freshly charged batteries.

Monitors were placed in secure locations on the roofs of one or two story buildings. Each monitor was positioned according to manufacturer specifications and GCM training to avoid nearby objects or conditions that could impact sample collection and accuracy. Monitor flow rates were checked before and after each sample collection. Programmable timers were also checked to ensure samples were collected for twenty-four hours. Procedures were documented on field data sheets required by CLN. A detailed protocol checklist developed and used by Air Alliance Houston throughout the project is included as Appendix D.

Adrian Shelley places a monitor at the Police Dept.

[14] Full data reports, field data sheets, and chain of custody forms for this project are available upon request.

1. Duplicate Samples

Typically, one monitor used a Teflon filter and the other a quartz filter. However, on five occasions, the same filter type was placed in each monitor in order to perform a duplicate sample analysis. Three duplicates were performed using Teflon filters; two with quartz filters. Results of duplicate samples are reported as the average of the two samples.

A regression analysis of the three Teflon duplicates is included in the independent analysis of this project performed by Laura Campos, a graduate student with the Rice University Department of Statistics.[15] Two of those duplicates showed good precision. A third showed poor precision, with a relative error of 91%. Possible causes for this error were discussed, but no conclusions were reached. Mark Chernaik, Ph.D., Science for Citizens, offered this explanation:

> First, the two samples collected at 2000 Clinton Drive (City Hall) on 22-23 January 2013 were co-located. However, the PM2.5 levels are not comparable, differing by almost 100% (19 versus 36.2 ug/m3. Interestingly, the XRF levels of these two collated samples are comparable (for example, iron levels of 0.157 versus 0.161 ug/m3). Since the XRF levels are comparable, my best guess is that some error with the gravimetry analysis may have produced the anomalous result.[16]

The two duplicate samples performed on quartz filters were not included in Ms. Campos' regression analysis. Those duplicates were found to have relative errors of 4% and -31%, respectively.

2. Field Blanks

Several field blanks were also included in the project. Each field blank was transported to the monitoring site, removed from its package, placed in the monitor while it was turned off, immediately removed from the monitor, returned to its package, and placed in the closed casing of the monitor during its 24-hour run. Three field blanks were included using this procedure: one quartz and two Teflon. The results of their analysis are below:

Table 1: Field Blanks

Lab ID	Start Date	Total PM2.5 (µg)	Total Organic Carbon (µg)	Total Elemental Carbon (µg)	Total Carbon (µg)
13-U164	1/20/2013		4.309 ± 1.668	0.0000 ± 1.390	4.309 ± 3.058
12-T3958	5/21/2013	130 ± 10			
12-T4053	8/7/2013	8 ± 10			

The single blank quartz filter was found to have 4.309 µg of organic carbon. The blank quartz filter was not found to contain elemental carbon.

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[15] *See* Campos, Laura, "Are the current TCEQ PM2.5 Monitors representative of the Galena Park Community?" (June 2014). *See* Appendix A.

[16] Email from Mark Chernaik to Adrian Shelley (8 Feb. 2013).

The two Teflon filter blanks contained 130 µg and 8 µg of total PM2.5, respectively. The Teflon blank handled on 5/21/2013, Lab ID 12-T3958, was found to be damaged by CLN. The filter had an indentation that may have been caused by it being bumped during handling. This sampling error was a likely source of contamination for this blank. The second Teflon blank, Lab ID 12-T4053, yielded 8 µg of total PM2.5 and did not exceed the margin of error.

In addition to these planned field blanks, two filters were placed in monitors that, due to user error, did not turn on and drew no air through their filters during the 24-hour sampling period. Rather than discard these filters, they were also sent to CLN for analysis as a sort of field blank. The result of this analysis is below:

Table 2: Additional Field Blanks

Lab ID	Start Date	Total PM2.5 (µg)	Total Organic Carbon (µg)	Total Elemental Carbon (µg)	Total Carbon (µg)
12-T3952	3/5/2013	3 ± 10			
13-U396	3/5/2013		15.29 ± 2.085	0.0000 ± 1.390	15.29 ± 3.475

For the Teflon filter, the total PM2.5 mass of 3 µg does not exceed the margin of error.

For the quartz filter, the total organic carbon mass was 15.29 µg. Again, this exceeds the margin of error and can be compared to the average organic carbon mass of all quartz filters of 63.98 µg. This quartz filter was also not found to contain elemental carbon.

Given the limited size of this study, and of the number of duplicate and blank samples included, it is difficult to draw conclusions from these results. Several duplicate samples did show good precision, but others—and one in particular—did not. One Teflon field blank showed large amounts of total PM2.5, but others did not. Some quartz field blanks indicated organic carbon, but none showed any elemental carbon, which was used in this study to estimate diesel pollution. A larger study would be needed to more fully understand these findings.

3. Data Translated or Removed from Analysis

On two occasions, monitors did not run for the standard 24 hours. Sample 12-T4096, collected on 1/21/2013 at Early Head Start, ran for 25 hours due to a timer programming error. The resulting sample volume was 7.5 m^3, rather than the usual sample volume of 7.2 m^3. The net mass for this sample was 81 µg, resulting in a concentration of 25.4 µg/m^3. This concentration was correctly calculated and reported to us by CLN.

Sample 12-T3951, collected on 3/4/2013 at the Resource Center, ran for 21.8 hours due to a dead battery. The resulting sample volume was therefore 6.54 m^3. The net mass for this sample was 166 µg, resulting in a concentration of 25.4 µg/m^3. This sample was mistakenly calculated by CLN using the typical sample volume of 7.2 m^3, resulting in an incorrect report of 23.06 µg/m^3. This was corrected in our analysis.

Two samples were removed from analysis. A sample collected at Galena Manor on 3/5/2013 used the wrong type of filter. A sample collected on 8/8/2013 was discovered to have a hole in the filter.

D. Analysis of Results

Data gathered during the community monitoring project were independently analyzed by several individuals and groups. Mark Chernaik, Ph.D., with Science for Citizens, providing periodic analysis and interpretation. A table of his analysis is included in this report as Appendix B. His narrative interpretations are excerpted in the sections below.

An independent analysis was performed and a report completed by Laura Campos, a graduate student in the Rice University Department of Statistics. Ms. Campos was assisted by Loren Raun, Ph.D., Department of Statistics, Rice University. Some suggestions and minor edits were provided by Air Alliance Houston board member Thomas H. Stock, PhD, MPH, Program in Environmental and Occupational Health Sciences, Division of Epidemiology, Human Genetics and Environmental Sciences, University of Texas School of Public Health. The Campos Report is included in this report at Appendix A.

This report was produced by Adrian Shelley, Executive Director of Air Alliance Houston, with extensive help as noted in the Acknowledgements.

IV. Diesel Particulate Pollution Presents Unacceptable Health Risks

Diesel pollution presents unacceptable health risks in Galena Park, including elevated risks of cancer, cardiovascular mortality, and cardiovascular and respiratory hospitalization. Twenty nine samples were collected between November 2012 and September 2013 for evaluation of diesel pollution. Samples were analyzed for elemental carbon/organic carbon and total carbon content by NIOSH method 5040 using an OC-EC Aerosol Analyzer. Elemental carbon was used as a diesel surrogate.

A. Diesel Pollution Exposure in Galena Park can Present Excess Risk of Cardiovascular Mortality and Cardiovascular and Respiratory Hospitalizations.

Dr. Chernaik's analysis identifies excess risks of cardiovascular mortality and cardiovascular and respiratory hospitalizations in Galena Park due to exposure to diesel pollution. Dr. Chernaik used certain thresholds for risk factors for exposure to elemental carbon in his analysis. In his words:

> When EC levels are above 1 microgram per cubic meter ($\mu g/m^3$), then one can conclude that this location is an area impacted by diesel engine emissions.[17]

[17] Even in urban areas, levels of EC in air samples almost never exceed 1 $\mu g/m^3$ unless the sample is within a few hundred feet of road traffic. See: "Traffic emissions of elemental carbon (EC) and organic carbon (OC) and their contribution to PM2.5 and PM10 urban background concentrations (figures 2-12 and 2-13 on page 25)." http://www.mnp.nl/bibliotheek/rapporten/500099011.pdf

When 24-hour EC levels at a location are above 1.36 µg/m^3, then they are high enough to be associated with an excess risk of cardiovascular mortality two and three-days post exposure.[18]

When 24-hour EC levels at a location are above 0.838 µg/m^3, then they are high enough to be associated with an excess risk of cardiovascular and respiratory hospitalizations on the day of exposure.[19] [20]

The following table lists all elemental carbon results and compares them to the exposure thresholds identified by Dr. Chernaik.

[18] In 2008, scientists from the California Office of Environmental Health Hazard Assessment (OEHHA) published a study about the relationship between cardiovascular mortality and the chemical composition of pollutant levels in ambient air in California. These scientists examined the relationship between cardiovascular mortality and the interquartile range (IQR = the difference between the third and first quartiles) of EC levels. The scientists found strongly significant associations between excess risk of cardiovascular mortality two and three-days post exposure and the IQR for EC. The average level of EC in ambient air samples in the study was 0.966 µg/m^3. The IQR for EC was 0.795 µg/m^3. In this study, the 4th quartile level of EC was 1.36 (0.966 + [0.795/2]) µg/m^3. Ostro, et al. (2008) "The impact of components of fine particulate matter on cardiovascular mortality in susceptible subpopulations," *Occup. Environ. Med.*, 65;750-756.

[19] In 2009, scientists from Yale University, the Johns Hopkins University School of Public Health and the Keck School of Medicine, University of Southern California, published a study about the relationship between cardiovascular and respiratory hospitalizations, and the chemical composition of pollutant levels in ambient air in 106 different counties across the United States. These scientists examined the relationship between cardiovascular and respiratory hospitalizations and the IQR of EC levels. The scientists found strongly significant associations between excess risk of cardiovascular and respiratory hospitalizations and the IQR for EC. The average level of EC in ambient air samples in the study was 0.715 µg/m3. The IQR for EC was 0.245 µg/m3. In this study, the 4th quartile level of EC was 0.838 (0.715 + [0.245/2]) µg/m3. Bell, et al. (2009) "Hospital Admissions and Chemical Composition of Fine Particle Air Pollution," Am J Respir Crit Care Med, 179:1115–1120.

[20] Email from Mark Chernaik to Adrian Shelley (18 Jan. 2013). Citations in original.

Table 3: Elemental Carbon Pollution Results

Lab ID	Location	Start Date	End Date	Elemental Carbon (µg/m³)	Notes
13-U1	Resource Center	11/8/2012	11/9/2012	0.66	
13-U2	Early Head Start	11/27/2012	11/28/2012	0.81	
13-U3	Galena Manor	11/28/2012	11/29/2012	1.16	Exceeds 0.838 µg/m3.
13-U4	Police Station	11/29/2012	11/30/2012	0.79	
13-U5	City Hall	12/5/2012	12/6/2012	0.85	Exceeds 0.838 µg/m3.
13-U162	Resource Center	1/19/2013	1/20/2013	0.75	
13-U163	Galena Manor	1/20/2013	1/21/2013	0.89	Exceeds 0.838 µg/m3.
13-U165	Early Head Start	1/21/2013	1/22/2013	1.51	Exceeds 1.36 µg/m3.
13-U166	Police Station	1/23/2013	1/24/2013	0.77	
13-U39	Resource Center	3/4/2013	3/5/2013	0.23	
13-U397	Galena Manor	3/6/2013	3/7/2013	0.77	Duplicate sample = 0.78.
13-U398	Galena Manor	3/6/2013	3/7/2013		Duplicate sample = 0.75.
13-U399	City Hall	3/7/2013	3/8/2013	0.70	
13-U400	Police Station	3/14/2013	3/15/2013	1.02	Exceeds 0.838 µg/m3.
13-U401	Early Head Start	3/15/2013	3/16/2013	0.46	
13-U712	Galena Manor	5/20/2013	5/21/2013	0.48	
13-U713	Resource Center	5/21/2013	5/22/2013	0.46	
13-U714	Early Head Start	5/22/2013	5/23/2013	0.62	
13-U715	City Hall	5/30/2013	5/31/2013	0.42	
13-U1029	City Hall	8/5/2013	8/6/2013	0.70	
13-U1030	Galena Manor	8/6/2013	8/7/2013	0.48	Duplicate sample = 0.56.
13-U1031	Galena Manor	8/6/2013	8/7/2013		Duplicate sample = 0.39.
13-U1032	Resource Center	8/7/2013	8/8/2013	0.46	
13-U1033	Early Head Start	8/8/2013	8/9/2013	0.83	
13-U1034	Police Station	8/9/2013	8/10/2013	0.81	
13-U1185	Resource Center	9/23/2013	9/24/2013	0.54	
13-U1186	Police Station	9/24/2013	9/25/2013	2.05	Exceeds 1.36 µg/m3.
13-U1187	Galena Manor	9/26/2013	9/27/2013	0.54	
13-U1188	Early Head Start	9/28/2013	9/29/2013	0.48	
AVERAGES	**TOTAL**			**0.75**	
	Early Head Start			**0.79**	
	Resource Center			**0.52**	
	Galena Manor			**0.72**	
	Police Station			**1.09**	Exceeds 0.838 µg/m3.
	City Hall			**0.67**	

Denny Larson of Global Community Monitor adds that two samples are within 75% of the 1.36 µg/m^3 threshold and an additional eight samples are within 75% of the 0.838 µg/m^3 threshold. This means that more than half of all samples (15 of 29) either exceeded the 0.838 µg/m^3 or 1.36 µg/m^3 thresholds or

were within 75% of those numbers. The average of all samples, 0.75 µg/m^3, is 89% of the lower threshold 0.838 µg/m^3.[21]

GPISD Early Head Start Center.

Larson also notes that the Early Head Start Center had both the second highest average elemental carbon levels and the second highest single measurement of elemental carbon. The Early Head Start Center is used by infants and toddlers aged six weeks to three years. This is trouble because, as Larson explains, "the most vulnerable population is at serious risk due to diesel. While the City's intention in creating the Center is laudable, because of the Port, it is actually creating a hazard by attracting children to a location very heavily impacted by diesel and the Port."[22]

This is a crucial point. The Early Head Start Center is an important resource for families and children in Galena Park. City officials owe it to the children of Galena Park to create safe, healthy environments in which they can thrive.

B. Cancer Risk in Galena Park due to Diesel Exposure Exceeds 1 in 10,000

Ms. Campos's analysis found that cancer risk due to diesel exposure exceeds 1 in 10,000. The cancer risk at each location follows:[23]

Table 4: Cancer Risk due to Diesel

Location	Cancer Risk
City Hall	*
Resource Center	9.21E-05
Early Head Start	1.62E-04
Galena Manor	1.13E-04
Police Station	2.49E-04

* *Insufficient data.*

Many scientists and health professionals consider an acceptable cancer risk to be one additional cancer case in one million people, or 1E-06.[24] By this standard, all four of the sampling locations with sufficient data have an unacceptable risk of cancer due to diesel pollution exposure. Cancer risk at the Resource Center is nearly 1 case in 10,000; cancer risk at Early Head Start, Galena Manor, and the Police Station exceeds 1 in 10,000. The highest risk measured, at the Police Station, is nearly 1 in 4,000.

[21] Email from Denny Larson to Adrian Shelley (30 June 2014).
[22] Email from Denny Larson to Adrian Shelley (7 July 2014).
[23] This analysis is presented in more detail in the Campos Report. *See* Appendix A.
[24] *See, e.g.,* http://www.epa.gov/ttn/atw/nata/natsafaq.html#B3.

V. Total PM2.5 Results

The averages of all samples as well as the means at each monitoring site exceeded the Environmental Protection Agency (EPA) and World Health Organization (WHO) annual fine particulate matter standards. Fine particulate matter pollution may present a health risk to the residents of Galena Park.

A. PM2.5 Samples Exceed EPA and WHO Health Standards

Thirty-one samples were collected between November 2012 and September 2013, with one early sample collected May 2013. Samples were analyzed for PM 2.5 by gravimetric analysis.

Dr. Chernaik offers this explanation of the health effects of PM2.5 and of the EPA and WHO standards:

> There is a robust association between health effects and ambient levels of particulate matter. Very small (fine) particles exert disproportionately more health effects than do larger particles. According to the U.S. EPA:
>
> "Particles less than 10 micrometers in diameter (PM_{10}) pose a health concern because they can be inhaled into and accumulate in the respiratory system. Particles less than 2.5 micrometers in diameter ($PM_{2.5}$) are referred to as "fine" particles and are believed to pose the largest health risks. Because of their small size (less than one-seventh the average width of a human hair), fine particles can lodge deeply into the lungs.
>
> "Health studies have shown a significant association between exposure to fine particles and premature mortality. Other important effects include aggravation of respiratory and cardiovascular disease (as indicated by increased hospital admissions, emergency room visits, absences from school or work, and restricted activity days), lung disease, decreased lung function, asthma attacks, and certain cardiovascular problems such as heart attacks and cardiac arrhythmia. Individuals particularly sensitive to fine particle exposure include older adults, people with heart and lung disease, and children."[25]
>
> Both the U.S. EPA[26] and the WHO have adopted short-term (24-hour) and long-term (annual average) standards for exposure to fine particulate matter in order to prevent both acute and chronic effects of exposure to particulates, respectively. [27]

The EPA and WHO standards are:

Table 5: PM2.5 Standards

EPA 24-hour standard	35.0 µg/m³
WHO 24-hour standard	25.0 µg/m³
EPA annual standard	12.0 µg/m³
WHO annual standard	10.0 µg/m³

[25] http://www.epa.gov/ttn/naaqs/pm/pm25_index.html
[26] http://www.epa.gov/air/criteria.html
[27] Email from Mark Chernaik to Adrian Shelley (18 Jan. 2013). Citations in original.

The following table lists all PM2.5 results and compares them to the relevant standards above:

Table 6: PM2.5 Pollution Results

Lab ID	Location	Start Date	End Date	PM2.5 (µg/m³)	Notes
P0215486	Early Head Start	5/16/2012	5/17/2012	22.9	
12-T4054	Resource Center	11/8/2012	11/9/2012	6.9	
12-T4057	Early Head Start	11/27/2012	11/28/2012	21.5	
12-T4056	Galena Manor	11/28/2012	11/29/2012	15.8	
12-T4055	Police Station	11/29/2012	11/30/2012	12.6	
12-T4058	City Hall	12/5/2012	12/6/2012	15.4	
12-T3950	Resource Center	1/19/2013	1/20/2013	14.2	
12-T4060	Galena Manor	1/20/2013	1/21/2013	14.6	
12-T4096	Early Head Start	1/21/2013	1/22/2013	25.4	Monitor ran for 21.8 hours. Exceeds WHO 24-hr standard.
12-T4097	City Hall	1/22/2013	1/23/2013	27.6	Duplicate sample = 19.0.
12-T4098	City Hall	1/22/2013	1/23/2013		Duplicate sample = 36.2. Exceeds EPA 24-hr standard.
12-T4059	Police Station	1/23/2013	1/24/2013	13.9	
12-T3951	Resource Center	3/4/2013	3/5/2013	10.8	Monitor ran for 25 hours.
12-T3953	City Hall	3/7/2013	3/8/2013	15.6	
12-T3954	Police Station	3/14/2013	3/15/2013	12.4	
12-T3955	Early Head Start	3/15/2013	3/16/2013	7.8	
12-T3956	Galena Manor	5/20/2013	5/21/2013	15.4	
12-T3957	Resource Center	5/21/2013	5/22/2013	15.1	
12-T3959	Early Head Start	5/22/2013	5/23/2013	15.4	
12-T3960	Police Station	5/23/2013	5/24/2013	12.3	Duplicate sample = 12.5.
12-T3961	Police Station	5/23/2013	5/24/2013		Duplicate sample = 12.1
12-T3962	City Hall	5/30/2013	5/31/2013	8.6	
12-T4051	City Hall	8/5/2013	8/6/2013	11.1	
12-T4052	Resource Center	8/7/2013	8/8/2013	30.0	Exceeds WHO 24-hr standard.
12-T3964	Police Station	8/9/2013	8/10/2013	11.1	
13-T2854	Resource Center	9/23/2013	9/24/2013	11.4	
13-T2855	Police Station	9/24/2013	9/25/2013	18.5	
13-T2856	City Hall	9/25/2013	9/26/2013	15.0	Duplicate sample = 14.6
13-T2910	City Hall	9/25/2013	9/26/2013		Duplicate sample = 15.4
13-T2911	Galena Manor	9/26/2013	9/27/2013	13.3	
13-T2912	Early Head Start	9/28/2013	9/29/2013	9.7	
AVERAGES	**TOTAL**			**15.2**	Exceeds EPA annual standard.
	Early Head Start			**17.1**	Exceeds EPA annual standard.
	Resource Center			**14.7**	Exceeds EPA annual standard.
	Galena Manor			**14.8**	Exceeds EPA annual standard.
	Police Station			**13.5**	Exceeds EPA annual standard.
	City Hall			**15.6**	Exceeds EPA annual standard.

Two individual samples exceeded the WHO's 24-hour standard. The average of two duplicate samples also exceeds this standard, but it should be noted that the average of 27.6 µg/m³ combines two widely different samples of 19.0 µg/m³ and 36.2 µg/m³. The duplicate sample measuring 36.2 µg/m³ exceeds the EPA's 24-hour standard, but again, this result was not confirmed by the collocated duplicate sample.

The average of all twenty-nine samples collected throughout the year, 15.2 µg/m³, far exceeds the EPA's primary annual National Ambient Air Quality Standard of 12.0 µg/m³.[28] This raises a serious question whether the health of the people of Galena Park is at risk due to high ambient air levels of fine particle pollution.[29]

Significantly, the highest single site on average was the Early Head Start center, which is a facility used by low income families, infants and toddlers, and pregnant women. According to the EPA, children are among those most likely to be affected by exposure to particle pollution.[30]

B. Narrative Interpretation by Dr. Chernaik

Dr. Chernaik offered narrative interpretations of the results throughout the project. Portions of these narratives are excerpted below:

> What is new about the [data] is that I think we have enough data points for the consistently sampled locations to say something meaningful about the long-term average PM2.5 and EC levels at these locations, and what differences in the long-term averages at the location may be telling us about pollution sources. []
>
> I would conclude that the site 'Early Head Start,' with an average PM2.5 level of 16.7 µg/m^3 (n=6) and an average EC level of 0.78 µg/m^3 (n=5) is more impacted by particulate matter and diesel emissions than 'Community Resource Center,' with an average PM2.5 level of 11.7 µg/m^3 (n=5) and an average EC level of 0.53 µg/m^3 (n=5). Port activities would be a likely explanation for these differences in pollutant levels, considering the relative close proximity of Early Head Start (1908 2nd Street) to the port area compared to the Community Resource Center (1721 16th Street).[31]

Dr. Chernaik also provided the following analysis of possible pollution sources:

> One doesn't need to have information about wind speed and direction to interpret the health significance of the pollutant levels; the wind speed and direction data is mostly to answer the question of what sources are responsible for elevated levels.

---

[28] *See* http://www.epa.gov/air/criteria.html.
[29] The MiniVol is not a federal reference method monitor. The data collected in this study cannot be certified by the EPA and used for regulatory purposes. Neither was it intended for that use.
[30] *See* http://www.epa.gov/airquality/particlepollution/health.html.
[31] Email from Mark Chernaik to Adrian Shelley (22 Oct. 2013).

For example, in the latest dataset, there is a very high EC level (diesel emissions) - 2.046 µg/m^3, one of the highest I've seen - at Galena Park police station for the sample collected Sept 24-25. The Field Data Sheet for this filter (GP29) shows fairly light winds coming from the N-NNE. So, to answer the question of what source(s) might have been responsible for this very high EC level, then I would rely on local knowledge of the area about locations where there is likely to be a lot of heavy vehicle (bus & truck & locomotive) traffic or use of stationary diesel engines.

I have not been to Galena Park, but looking at Google Earth, most of the area directly to the N-NNE of the police station looks like a residential area - an unlikely source of EC (diesel) emissions. Most of the locations I would expect to be sources of diesel emissions are south of the police station (e.g. the rail lines and the container load/unloading port facility). Since we know that winds were very light on Sept 24-25, and that light winds are usually variable winds, then I would recommend fine tuning the analysis by seeing how winds fluctuated that day.

Most of the sample was collected on the 25th (the end time was 5:00) and on the 25th, according to weather underground, there were frequent light winds from the SW:

http://www.wunderground.com/history/airport/KHOU/2013/9/25/DailyHistory.html

...which is exactly what you would expect to see if the rail lines and the container load/unloading port facility were the sources of the high EC level in this sample.[32]

C. AAH/GCM Measurements are Consistently Higher than TCEQ's, but the Difference is not Statistically Significant

The Campos Report compares AAH/GCM monitor values to corresponding daily values at the Clinton Drive monitor.[33] The measurements were shown to be highly correlated. Although AAH/GCM values were frequently higher than those at the Clinton Drive monitor, the difference was not statistically significant. The conclusions that can be drawn from this are limited. As explained by Ms. Campos:

> While this analysis did not find a statistically significant difference between concentrations measured at AAH locations compared with TCEQ locations, care should be taken in drawing a decisive conclusion based on these analyses because AAH and TCEQ use different sampling and analysis methods. Differences introduced by using different sampling and analysis techniques should be

Clinton Drive regulatory monitoring site.

[32] Email from Mark Chernaik to Adrian Shelley (14 Oct. 2013).
[33] *See* Appendix A.

better understood possibly through co-location of an AAH monitor at the Clinton Drive location.[34]

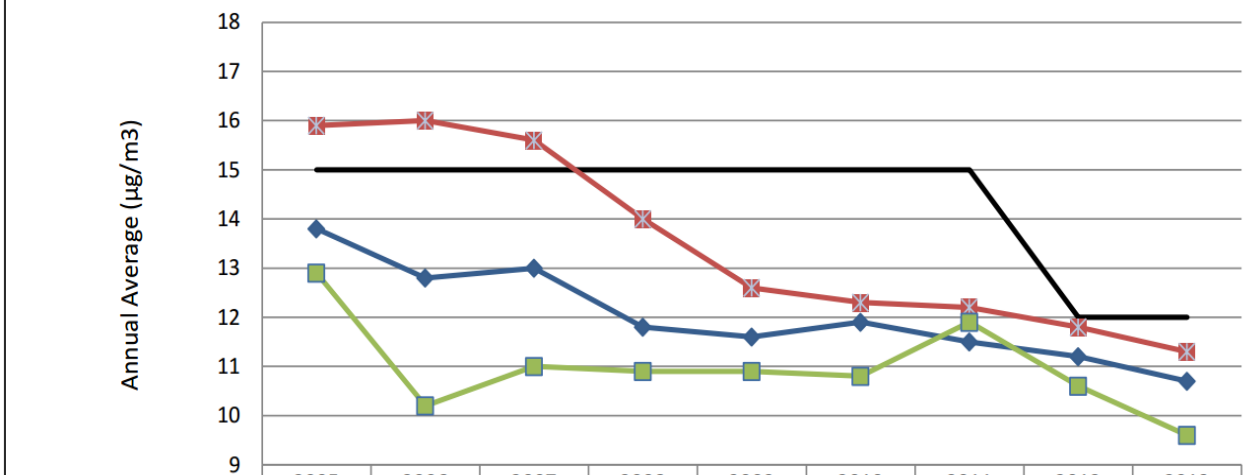
VI. Regulatory Monitoring Sites and Efforts to Reduce PM Pollution in Galena Park

A. Regulatory Monitoring Sites Show Reduction in PM Over Time, but may not be Representative of Community Exposure

For several years, fixed air monitoring sites in Houston maintained by the City of Houston and the Texas Commission on Environmental Quality have delivered regulatory data to the EPA that show the area to be very close to the standard for fine particulate matter pollution. This was true when the standard was 15.0 µg/m³ and has remained true since the standard was lowered to 12.0 µg/m³ in 2012. Because of this, an effort has been underway in Houston for some time to reduce PM pollution. To the city's credit, PM pollution values reported by regulatory monitoring locations have steadily dropped, as the following graph shows.

Figure 4: PM2.5 Levels at Several Houston Monitors

Preliminary Annual $PM_{2.5}$ Averages for Clinton, Aldine and Baytown Regulatory Monitors[8]



	2005	2006	2007	2008	2009	2010	2011	2012	2013
Annual Standard	15	15	15	15	15	15	15	12	12
Clinton	15.9	16	15.6	14	12.6	12.3	12.2	11.8	11.3
Aldine	13.8	12.8	13	11.8	11.6	11.9	11.5	11.2	10.7
Baytown	12.9	10.2	11	10.9	10.9	10.8	11.9	10.6	9.6

This graph was produced for the Houston-Galveston-Brazoria (HGB) PM2.5 Advance Path Forward document, see footnote 38 below.

[34] *See* Campos Report, at p. 3. Plans for the recommended collocation are underway.

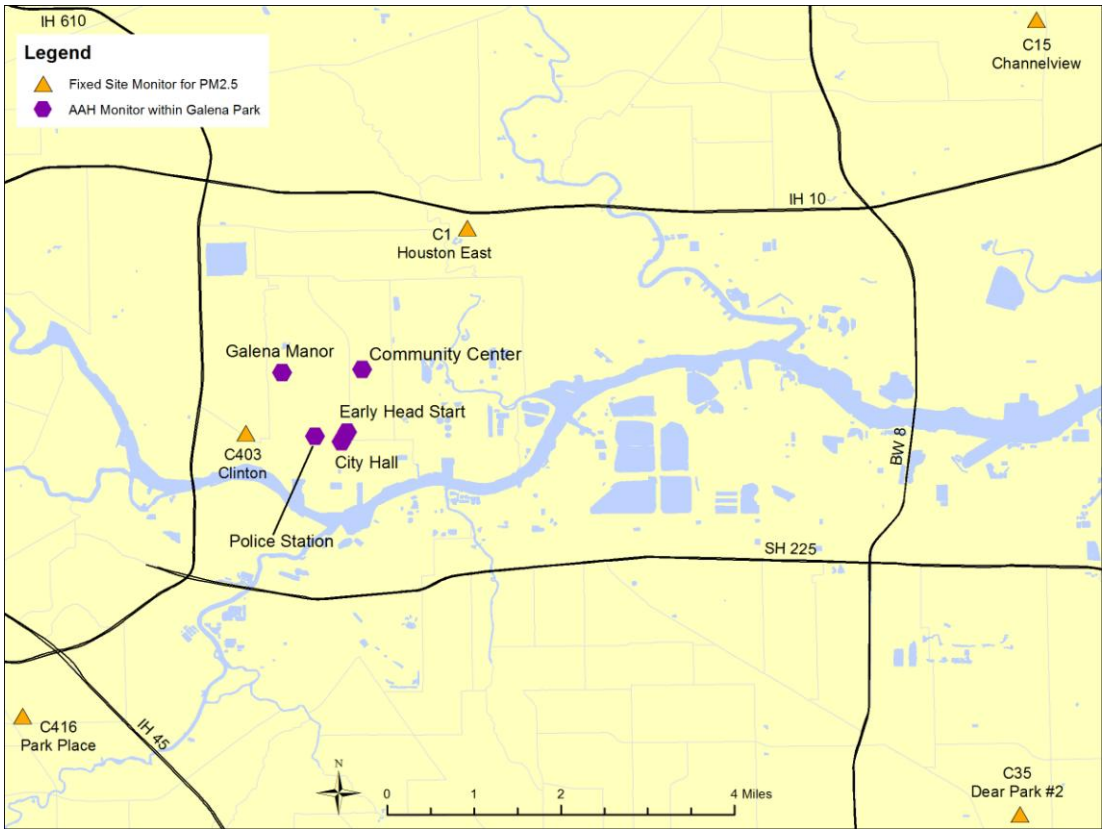
Despite this trend, it is our contention that the city's monitors are not representative of actual community exposure. As Figure 4 shows, the Clinton Drive monitor has reported annual averages below 12.0 µg/m³ for the last two years. But the official annual average reported to the EPA by a regulatory monitor is subject to certain data manipulations and interpretations. So-called "exceptional events" are removed from the data because they are "unusual or naturally occurring events that affect air quality and are not reasonably controllable or preventable."[35]

Air Alliance Houston and other public health and air quality advocacy organizations including Environmental Defense Fund, Public Citizen, the Sierra Club Lone Star Chapter, and Texas Environmental Justice Advocacy Services have disputed the removal of exceptional events.[36] It does not matter if particulate matter pollution comes from Mexico, or Africa, it still impacts human health. The stated purpose of the Clean Air Act is "to protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population[.]"[37] It is our belief that artificially lowering the reported ambient air quality defeats the intent of the Clean Air Act.

Galena Park is located just one mile east of the Clinton Drive monitor. The locations chosen for this monitoring project are all less than two miles from the Clinton Drive monitor. This is illustrated in Figure 5 below, in which the Clinton Drive monitor is identified as "C403 Clinton."

[35] *See* http://www.tceq.state.tx.us/airquality/monops/pm_flags.html.
[36] *See, e.g.,* letter to Janet McCabe, Acting Assistant Administrator, Office of Air and Radiation, U.S. Environmental Protection Agency, from Adrian Shelley, et. al. (20 Sept. 2013).
[37] 42 U.S.C. §7401(b)(1).

Figure 5: Location of nearby fixed-site monitors and AAH/GCM monitoring sites



Map by Laura Campos.

Although the difference in our measurements was not statistically significant from those at the Clinton Drive monitor, we believe that monitor is not representative of actual community exposure. As explained above, regulatory monitoring data is manipulated. There has also been a concerted effort to reduce PM pollution in the area immediate surrounding the Clinton Drive monitor.

B. Efforts to Reduce PM in the area around the Clinton Drive Monitor do not Provide Health Benefits to Most of the Residents of Galena Park

The Clinton Drive monitor consistently shows the highest PM2.5 values of any monitor in Houston. It has been the subject of a targeted, years-long campaign to specifically reduce particulate matter in the area immediately surrounding the monitor. As a result, this monitor is no longer representative of area-wide air quality.

Efforts to reduce PM2.5 pollution near the Clinton Drive monitor are documented in the Houston-Galveston-Brazoria PM2.5 Advance Path Forward document produced by the Houston-Galveston Area Council Regional Air Quality Planning Advisory Committee. The Clinton Drive monitor has long been identified as a PM2.5 hotspot in the region, and efforts to reduce PM2.5 in the area immediately surrounding the area have been occurring for several years. Those efforts are documented in a section

of the PM2.5 Advance Path Forward document titled "Dust Suppression Projects in the Clinton Drive area." This section is worth quoting in full:

> TCEQ, EPA Region 6, the City of Houston, Harris County Precinct 2, Port of Houston Authority, Port Terminal Rail Authority and local industry have partnered to address PM2.5 sources and implement dust suppression strategies to reduce PM2.5 emissions near the Clinton Drive area.
>
> TCEQ approved a supplemental environmental project (SEP) to pave the parking lot directly adjacent to the Clinton Drive monitoring station. The paving was completed in summer 2009.
>
> The City of Houston has installed barriers to keep trucks from driving onto the unpaved shoulder.
>
> Additionally, a traffic light was installed at Clinton Drive and Industrial Park East to control traffic. A landscaping project was completed along Clinton Drive. Since implementation, these dust suppression projects have proven PM2.5 reduction benefits (not solely PM10 benefits). Speciation data from the Clinton Drive monitor show decreases in dust and soil following the implementation of dust suppression measures.
>
> The Port of Houston Authority (PHA) has established a program to regularly apply emulsified asphalt to reduce dust emissions at steel yards within the Terminal at Turning Basin (since 2009). PHA has applied emulsified asphalt at Industrial Park East (IPE). PHA has also paved 18 acres of land at IPE. Since 2008, PHA has sprayed approximately 48 acres with emulsified asphalt. PHA has also paved the Upper Level Road at Turning Basin, and added capacity from two lanes to four lanes from the main entry gate off of I- 610 to the Port Coordination Center.
>
> In addition, industry has undertaken dust suppression efforts near the Port. The Port Terminal Railroad Association (PTRA) has stopped steel loading activities on a dirt area to the south of the Clinton Drive monitor to reduce dust. DuPont, a PHA tenant, implemented new dust control best management practices at its fluorspar unloading and storage facility. Valero Asphalt paved its large land leases located across Clinton Drive to the southeast of the Clinton monitor.[38]

Although we certainly approve of efforts to reduce PM2.5 pollution, it is our opinion that too much attention has been paid to the area immediately surrounding the Clinton Drive monitor. Furthermore, paving activities are not likely to provide health benefits, since they do not reduce the particles of greatest concern, i.e., those from high-temperature combustion, including diesel PM. Generally speaking, we hope that particulate matter reduction efforts not target monitoring sites, but be applied

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[38] "Houston-Galveston-Brazoria (HGB) PM2.5 Advance Path Forward," prepared in partnership by members of the Houston-Galveston Area Council Regional Air Quality Planning Advisory Committee (2014), p. 21, *available at* http://www.h-gac.com/taq/airquality/raqpac/documents/2014/May%2029/Path%20Forward%20FINAL%202014.pdf. Full disclosure: Air Alliance Houston Executive Director Adrian Shelley served as the chair of the PM Advance Task Force that drafted the Path Forward document.

across regions. Cleaning up a small area around a monitor only provides health benefits to those few lucky individuals who live next to that monitor. We are concerned that efforts to clean up the area around the Clinton Drive monitor have not benefitted the health of most residents of Galena Park, TX.

VII. Recommendations

A. Diesel Pollution Must be Reduced

Exposure to diesel pollution is impacting the health and lives of the residents of Galena Park. We recommend several steps to reduce the impact of diesel pollution.

1. Truck Traffic Should be Removed from Clinton Drive

Heavy-duty truck traffic should be removed from Clinton Drive entirely. The vast majority of diesel trucks using Clinton Drive are entering or exiting the Port of Houston. A dedicated land or road should be built to divert Port Traffic from Clinton Drive. This road should be funded by local industry, perhaps by a tax on vehicle miles traveled in the Port of Houston, or on entries into the Port.

2. Alternatively, the Impact of Truck Traffic on Clinton Drive Should be Minimized

Millions of dollars have been invested in recent years to improve Clinton Drive and minimize the impact of truck traffic. Although we are critical of pollution reduction efforts that are skewed toward projects near regulatory monitors—like many of those undertaken on Clinton Drive—we recognize and applaud the reductions achieved by the Clinton Drive improvements.

If truck traffic must remain on Clinton Drive, then further improvements are necessary along the street where it borders Galena Park. These should include:

- Regular repair of roads that are heavily damaged by intense truck traffic.
- More barriers to prevent trucks from driving on shoulders.
- More vegetative barriers to reduce air pollution.

3. The Port of Houston Should Provide Trucks with Appropriate Waiting Areas

Trucks waiting to enter the Port of Houston often idle for hours at a time. Truck drivers also engage in a practice known as “hoteling,” in which they sleep in idling trucks. Waiting areas similar to the “cell phone parking lots” commonly found at airports should be created. Truck drivers need options that will allow them to reduce idling, whether that means plugging into an electrical power source, or turning off a truck altogether and using a common waiting/recreation space provide by the Port of Houston.

4. Older Vehicles Must be Retrofitted or Replaced

Many of the trucks serving the Port of Houston—particularly the short-haul drayage trucks—are some of the oldest, dirties vehicles on the road. The Port of Houston should phase out these older vehicles in favor of model year 2010 or newer trucks, which are vastly cleaner. This process should take advantage of incentive programs available for this purpose, including the Diesel Emissions Reduction Act and the

Texas Emissions Reduction Plan. These incentives are already used at the Port of Houston, but a more aggressive effort to phase out and eventually ban all older diesels must begin now.

We are mindful of the fact that some 80% of truck drivers in the Port of Houston are owner/operators who contract with the companies they serve. These drivers are contractors who are often treated as company employees without enjoying benefits such as health insurance. Experiences at the ports of Los Angeles and Long Beach have shown that the costs associated with replacing or repairing older diesel trucks are often diverted to these small business owners. It is our hope that any effort to clean up the diesel fleet in Houston be done with careful attention paid to the impact on owner/operators.

B. Galena Park Should Adopt a No-Idling Ordinance

In 2012, the Houston-Galveston Area Council (H-GAC) developed the Engine Off Program, a voluntary idling reduction program entered into by many local organizations including Galena Park ISD, Harris County, and the Port of Houston.[39] This voluntary program is a step in the right direction and we applaud H-GAC and program participants for their effort. However, voluntary programs do not go far enough, and experience has shown that the idling restrictions and the more than 100 idling reduction signs in place at the Port of Houston, for example, are largely ignored.

Galena Park should adopt and enforce a city ordinance that restricts vehicle idling. Texas allows local governments to sign a Memorandum of Adoption with the TCEQ to implement limitations on motor vehicle idling.[40] Adopting the ordinance prohibits vehicles over 14,000 pounds from idling for more than five consecutive minutes while not in motion.[41] We recommend that the City of Galena Park adopt the ordinance and provide funds for its implementation and enforcement.

C. More Monitoring of Particulate Matter and Diesel Pollution are Needed

Belinda Vasquez-St. John places monitors at Galena Park City Hall.

As stated above, we do not believe that regulatory monitors around Galena Park are representative of actual community exposure. We believe that the health of Galena Park residents is at risk, and that current regulatory monitors are not capturing that risk. First, we recommend that a comprehensive study of diesel exposure be conducted in Galena Park. Second, we recommend that a PM2.5 monitor be located near the source of our highest PM2.5 measurements: the Galena Park ISD Early Head Start Center, which is used by low-income families, infants and toddlers, and pregnant women.

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[39] *See* http://www.h-gac.com/taq/airquality/engineoff/default.aspx.
[40] 30 T.A.C. § 114.511.
[41] 30 T.A.C. § 114.512.

D. The Citizens of Galena Park Should Take Steps to Limit Pollution Exposure

If you live in Galena Park, you are exposed to ambient air pollution that jeopardizes your health and your family's health. You should take steps now to protect your health and limit your exposure to harmful air pollution.

Certain people are unusually sensitive to the effects of air pollution: children, the elderly, and people with respiratory illnesses such as asthma. It is your responsibility to know who in your family may be unusually sensitive and protect them if they cannot protect themselves. Asthma and other respiratory illnesses should be controlled with medication. If you lack health insurance, your children can go to the Southside Health Clinic.[42] Adults and children can go to the Strawberry Health Center in Pasadena.[43]

You can also view daily air quality forecasts online and sign up to receive forecasts by email. Visit http://www.tceq.state.tx.us/airquality/monops/forecast_today.html. When ambient air pollution is high, you should take steps to limit your exposure, such as limiting activity outdoors during peak driving hours.

E. The Port of Houston Authority Should Implement Recommendations made to it last year by the Healthy Port Communities Coalition

The Healthy Port Communities Coalition (HPCC), of which Air Alliance Houston is a member, produced a report last year that included recommendations for the Port of Houston Authority (PHA) to reduce air pollution.[44] Efforts by the PHA to reduce pollution will benefit the residents of Galena Park and other ship channel communities.

The recommendations in the HPCC report have largely been ignored by the PHA. We renew our call for the PHA to implement those recommendations.

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[42] The Southside Health Center is open Monday through Friday, 7 a.m. – 3:30 p.m. and is located at the Galena Park Community Resource & Training Center, 1721 16th Street, Galena Park, Texas 77547. You can call 713-873-5437 for appointment information. For more details, visit https://www.harrishealth.org/en/services/locations/pages/southside-health-clinic.aspx.

[43] The Strawberry Health Center is open Monday through Friday, 8 a.m. – 5 p.m. and is located at 927 E. Shaw Road Pasadena, Texas 77506-1430. You can call 713-526-4243 for appointment information. For more details, visit https://www.harrishealth.org/en/services/locations/pages/strawberry-health-center.aspx.

[44] *See* Corgey, Hilary, "Healthy Port Communities Coalition: Port Community Survey," (Oct. 2013) *available at* http://www.citizen.org/documents/HPCC%20survey%20report%20final.pdf.

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Air Alliance Houston
2409 Commerce St., Ste. A
Houston, TX 77003
www.airalliancehouston.org

Global Community Monitor
PO Box 1784
El Cerrito, CA 94608
info@gcmonitor.org

Appendix A: Campos Report

Are the current TCEQ PM2.5 Monitors representative of the Galena Park Community?

by
Laura Campos
Rice University
Department of Statistics
6100 Main Street
June 2014

CONTENTS

ABSTRACT

OBJECTIVES: The primary objective of this study was to determine if PM2.5 concentrations measured at current Texas Commission on Environmental Quality (TCEQ) fixed site monitors in the Galena Park area are representative of those within the Galena Park community by comparing the PM2.5 concentrations from TCEQ area fixed site monitors to the Air Alliance Houston (AAH) Monitors located in the community.

METHODS: Concentrations of PM2.5 at TCEQ fixed site monitors and at the AAH monitors were statistically compared. Because there are no TCEQ monitors within the Galena Park community, the TCEQ concentrations were obtained from surrounding TCEQ monitors. A comparison was made with the AAH monitor concentrations and the nearest TCEQ monitor concentrations. In addition, a similar comparison was made with the AAH monitor concentrations and a concentration within the Galena Park community derived from inverse distance weighting of several surrounding TCEQ fixed site monitor concentrations.

RESULTS AND CONCLUSIONS: The nearest TCEQ monitoring is located between 1 and 1.5 miles from the AAH monitoring locations on Clinton Drive. No statistically significant difference was found between the concentrations at this site and the AAH concentrations. Because both the Clinton Drive location and Galena Park community are proximate to similar particulate emission sources (i.e., heavy diesel traffic and other Port of Houston activities), and the Clinton Drive monitor location is much nearer than the next closest TCEQ monitors, comparison with Clinton Drive concentrations is most appropriate.

In addition, no statistically significant difference was found between the PM2.5 concentration from surrounding TCEQ fixed site monitor estimated from inverse distance weighting and the AAH concentrations. This result is consistent with the direct comparison to Clinton Drive, and anticipated because the distance to other monitors is much greater than that of Clinton Drive (i.e., Clinton Drive concentrations heavily influence the inverse distance weighting estimate).

While this analysis did not find a statistically significant difference between concentrations measured at AAH locations compared with TCEQ locations, care should be taken in drawing a decisive conclusion based on these analyses because AAH and TCEQ use different sampling and analysis methods. Differences introduced by using different sampling and analysis techniques should be better understood possibly through co-location of an AAH monitor at the Clinton Drive location.

INTRODUCTION

Air Alliance Houston (AAH) (1) conducted community monitoring of fine particulate matter of aerodynamic diameter smaller than 2.5 µm (PM2.5) concentrations within the Galena Park community from November 2012 to September 2013. 34 air samples were taken during the study period. These samples were also analyzed for sodium (Na), magnesium (Mg), aluminum (Al), silicon (Si), phosphorus (P), sulphur (S), chlorine (Cl), potassium (K), calcium (Ca), titanium (Ti), vanadium (V), chromium (Cr), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), gallium (Ga), germanium (Ge), arsenic (As), selenium (Se), bromine (Br), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), molybdenum (Mo), palladium (Pd), silver (Ag), cadmium (Cd), indium (In), tin (Sn), antimony (Sb), barium (Ba), lanthanum (La), mercury (Hg), lead (Pb) and elemental carbon (EC).

METHODS

Fine particulate sample data from AAH monitors within Galena Park were compared (A) directly with data from the nearest TCEQ fixed site monitor located on Clinton Drive and (B) with estimates at the AAH monitors derived from spatial interpolation of Texas Commission on Environmental Quality (TCEQ) fixed site monitors. These comparisons were made to determine if the concentrations of PM2.5 at the fixed site locations are representative of levels found within Galena Park.

First, descriptive statistics were calculated for all data collected e.g., (mean, median, standard deviation, min, and max).

Then, the following approach was taken:

(A) PM2.5 concentrations from the Clinton Drive TCEQ fixed site monitor located in the vicinity of the AAH monitors were statistically compared to the AAH data within Galena Park using statistical hypothesis tests for inference.

(B) PM2.5 concentrations were estimated at each AAH monitor location within Galena Park using the inverse distance weighting method and data from the five closest TCEQ fixed sites. The difference between the estimated concentration and the AAH monitor concentration was calculated. The absolute and relative error differences between the estimate and measured values were calculated.

The chemical composition of PM2.5 from the AAH monitor samples was also analyzed. Ambient diesel PM concentrations were estimated from the elemental carbon levels measured in the AAH monitor samples. The chemical concentrations were compared with cancer risk and noncancer hazard screening levels. Cancer risk and noncancer hazards were calculated by AAH location for each detected chemical with toxicity information that exceeded the screening level. SAS version 9.3 and ProUCL version 4.1 were used in this study (2,3).

RESULTS

AAH monitor data

AAH monitors are shown in Figure 1 along with the PM2.5 sample size for each location and the 95% upper confidence limit of the mean for PM2.5. Two samples were removed from the analysis due to error in the sample procedure. Duplicate samples were included as the average of the two values. Two field blanks were not included in the analysis (shown in Table 1). Figure 2 shows boxplots of PM2.5 concentrations by AAH monitor location. The highest spread of PM2.5 concentrations came from the Early Head Start location, while the Police Station location had the lowest average PM2.5 concentration.

Table 2 shows the descriptive statistics for PM2.5 by AAH monitor location. Average concentrations range from 13.5 µg/m^3 to 15.6 µg/m^3. The Early Head Start location had the highest average PM2.5 concentration while the Community Center location had the maximum concentration with 30.0 µg/m^3. The Early Head Start location had the highest 95% upper confidence limit of the mean with a PM2.5 concentration of 22.0 µg/m^3.

TCEQ Fixed site monitors compared to AAH monitors

Figure 3 shows the locations of the AAH monitors and the TCEQ fixed site monitors used in this analysis. TCEQ employs a PM monitoring method (i.e., Tapered Element Oscillating MicroBalance (TEOM) that yields continuous hourly-average measurements). Twenty-four hour averages from the TCEQ fixed site (TEOM) monitors were calculated based on the start time of the integrated 24-hr AAH monitor samples and matched by date. Then, using the TCEQ fixed site monitors, a weighted average estimate of concentration for each AAH monitor location was calculated by sample date using the inverse distance weighting method (4). These weighted averages of PM2.5 concentrations from the TCEQ fixed site monitors were calculated for each AAH monitor location. The differences in terms of absolute error between the inverse distance weighted average PM2.5 concentration and the AAH measured concentrations were calculated (Table 3). Absolute error ranged from -2.9 to 11.4 $\mu g/m^3$. A negative difference indicates the estimated concentration is greater than the measured value from the AAH monitor. In other words, a -2.9 means the estimated value was 2.9 $\mu g/m^3$ more than the measured value from AAH. 20 out of the 27 samples had a difference less than 2.5 $\mu g/m^3$. Relative error ranged between -27.2% for a Community Center sample and 41.1% for a City Hall sample. In almost every sample, measured concentrations were higher than those estimated from the fixed site monitors.

Figure 4 shows boxplots of PM2.5 estimated from fixed site versus measured PM2.5 concentrations. Notice the estimated is slightly lower than the measured data. Figure 5 shows the linear relationship between measured PM2.5 concentrations from AAH monitors and estimated from TCEQ fixed sites. A least squares regression analysis indicates that the correlation coefficient is high (0.90). That is, 82% of the variation in the estimated PM2.5 is explained by the measured PM2.5 concentration. This relationship appears reasonably linear. The majority of estimated values are lower in concentration than the measured values. More samples are needed to verify this conclusion.

Hypothesis testing between TCEQ fixed site and AAH monitor PM2.5 concentrations

Data taken from the fixed site monitors were matched with AAH monitors by date and time of sample measurement. All AAH monitors were grouped as one data set and assumed representative of Galena Park. This aggregate was compared to the concentrations at the Clinton Drive TCEQ fixed site monitor to determine if they were statistically different (not representative of Galena Park community). Normality tests were done for each data set. Since AAH data appear to follow a nonnormal distribution, a nonparametric hypothesis test (Willcoxon Mann Whitney) was chosen to compare the data sets. H_o was defined as μ of AAH monitors $\leq \mu$ of fixed site monitors. Results of this test are shown in Table 4. Results of the hypothesis testing yielded no significant difference between concentrations.

For comparison purposes, the two data sets were also evaluated using a two-sample t-test (Table 4). While this test is not recommended for nonnormal data, it is considered robust and so also used here. Results in this testing are consistent with the nonparamterric test, no statistically significant difference was found.

AAH monitor chemical analysis

Chemical elemental composition of PM2.5 samples from AAH monitors was analyzed. The following chemicals had concentrations that were less than three times the uncertainty level in over 50% of the samples: Na, Mg, P, Cr, Co, Cu, Ga, Ge, As, Se, Rb, Sr, Y, Zr, Mo, Pd, Ag, Cd, In, Sn, Sb, Ba, La, Hg, and Pb. These elements were not analyzed. Chemicals that had concentrations that were less than three times the uncertainty 50% of the time or less were kept in the analysis and used as is. Descriptive statistics and 95% upper confidence limit of the mean, recommended by ProUCL, of the analyzed elements are shown in Table 5. Galena Manor had too few samples to be able to calculate statistics.

Elemental carbon can be used to estimate ambient diesel PM. Sources of elemental carbon include gas/diesel vehicles, fuel oil combustion, and meat cooking (6). Figure 6 shows nearby facilities to the City Hall AAH monitor location. Ambient diesel PM was estimated using total elemental carbon from the AAH monitor dataset using the method from previous research by Fraser et al. 2002 (7). Elemental carbon acts as a surrogate

for ambient diesel PM concentrations. Elemental carbon concentration for each AAH sample date was multiplied by the conversion factor calculated by the Fraser et al. 2002 study (equation below).

APMD = EC * 1.12

where APMD is ambient particulate matter diesel and EC is elemental carbon (7). Descriptive statistics for ambient diesel PM are shown in Table 5.

Chemicals detected at AAH locations that had an EPA air screening level available in the EPA Regional Screening Levels Risk Calculator (5) are shown in Table 6a along with their respective screening level. Human health risk is evaluated separately for cancer and noncancer health endpoints. Screening levels shown are the more stringent (lower) concentration of cancer or noncancer health endpoint. AAH concentrations were compared with the screening level. A concentration is considered of potential concern if it exceeds the screening level. These screening levels are protective of a cancer risk of one in a million, $1x10^{-6}$ risk, and a noncancer hazard of 1. The concentration was bolded if the chemical exceeded the screening level.

The cancer risk and noncancer hazard were calculated for each detected chemical with toxicity information that exceeded the screening level (Table 6b). Risks were bolded if they exceed one in a million risk, $1x10^{-6}$, for a cancer endpoint or a hazard ratio of 1 for a noncancer endpoint. The methodology used to calculate the cancer risk and noncancer hazard is outlined in (5). The calculations are representative of chronic exposure for a residential receptor.

REFERENCES

1. Air Alliance Houston. 2409 Commerce St. Suite A Houston, Texas 77003. Available: http://airalliancehouston.org/content/air-alliance-houston

2. SAS/STAT software, Version [9.3] of the SAS System for [Unix]. Copyright © [2010] SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA. Available: from http://www.sas.com/presscenter/guidelines.html.

3. ProUCL Version 4.1.00 U.S. Environmental Protection Agency. Office of Research and Development. Washington, DC 20460. Available: http://www.epa.gov/osp/hstl/tsc/software.htm.

4. ArcGIS Resource Center. How inverse distance weighted interpolation works. ESRI.com Available: http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#//00310000002m000000

5. Regional Screening Levels for Chemical Contaminants at Superfund Sites. EPA. 2013. Available: http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search

6. Mayor's Task Force on the Health Effects of Air Pollution. Report. A closer look at air pollution in Houston: identifying priority health risks. Institute for Health Policy. The University of Texas. Available http://www.greenhoustontx.gov/reports/UTreport.pdf.

7. Fraser MP, Lakshmanan K, Fritz SG, Ubanwa B. Variation in composition of fine particulate emissions from heavy-duty diesel vehicles. Journal of Geophysical Research 2002;37:2117-2123.

8. Thermo Scientific. Applications tip of the week: laboratory duplicates and matrix spike duplicates. Available http://fscimage.fishersci.com/cmsassets/downloads/segment/Scientific/pdf/WaterAnalysis/Log113TipLaboratoryDuplicatesMatrixSpikeDuplicates.pdf

Table 1. Data removed or transformed from analysis.

Date	Location	PM2.5 Concentration ($\mu g/m^3$)	Reason
3/5/2013	Galena Manor	NA	wrong filter used, removed from analysis
5/21/2013	Fire Station	18.1	field blank, not used in analysis
8/7/2013	Fire Station	1.1	field blank, not used in analysis
8/8/2013	Early Head Start	44.7	hole in filter, removed from analysis

Table 2. Descriptive statistics for PM2.5 by AAH monitor location and 95% upper confidence limit of the mean.

AAH Monitor Location	No. Samples	Detected Samples	% Detect	Min	Max	Mean	Median	SD	CV	95% UCL
				($\mu g/m^3$)						
City Hall	6	6	100	8.6	27.7	15.6	15.3	6.6	0.4	21.0
Community Center	6	6	100	6.9	30.0	14.7	12.8	8.1	0.5	21.3
Early Head Start	5	5	100	7.8	23.1	15.5	15.4	6.8	0.4	22.0
Galena Manor	4	4	100	13.3	15.8	14.8	15.0	1.1	0.1	NA
Police Station	6	6	100	11.1	18.5	13.5	12.5	2.6	0.2	15.6

Table 3. Estimated versus measured PM2.5 concentrations.

Location	Measured from AAH Monitor	Estimate from TCEQ Fixed Site	Absolute Error	Relative Error (%)
	($\mu g/m^3$)			
City Hall	8.6	6.8	1.8	20.9
	11.1	7.8	3.3	30.1
	15.5	10.6	4.9	31.9
	15.6	13.2	2.4	15.7
	15.0	12.9	2.1	14.0
	27.7	16.3	11.4	41.1
Community Center	6.9	5.6	1.3	18.3
	11.4	10.4	1.0	8.9
	14.2	13.1	1.1	7.8
	10.0	8.4	1.6	15.5
	10.8	13.7	-2.9	-27.2
	30.0	32.1	-2.1	-7.1
Galena Manor	15.8	12.7	3.1	19.6
	15.4	14.1	1.3	8.5
	14.6	12.2	2.4	16.1
	13.3	13.4	-0.1	-0.9
Police Station	12.4	10.5	1.9	15.3
	12.3	11.2	1.1	8.7
	11.1	11.8	-0.7	-6.5
	13.9	12.7	1.2	8.6
	18.5	17.4	1.1	5.8
	11.1	11.3	-0.2	-2.2
Early Head Start	7.8	6.2	1.6	20.0
	9.7	8.2	1.5	15.7
	15.4	12.0	3.4	21.8
	21.5	18.0	3.5	16.3
	23.1	19.6	3.5	15.0

Relative Error = [(measured – estimate) / measured]*100

Table 4. Hypotheis Testing Results for TCEQ C403 (Clinton Drive) Fixed Site Monitor

Null Hypothesis H_o: μ of AAH monitors ≤ μ of fixed site monitors (α: 0.05)

Monitor	Detected Obs.	Min	Max	Mean	Median	Result	p-value
		($\mu g/m^3$)					
Wilcoxon Mann Whitney hypothesis result							
AAH	27	6.9	30	14.9	14.2		
C403	26	5.1	33.9	12.9	11.61	Do Not Reject H_o, AAH ≤ C403	0.069
t-Test hypothesis result							
AAH	27	6.9	30	14.9	14.2		
C403	26	5.1	33.9	12.9	11.61	Do Not Reject H_o, AAH ≤ C403	0.105

Table 5. Descriptive statistics for elements and diesel PM sampled (µg/m^3) and 95% upper confidence limit of the mean.

AAH Monitor Location	Chemical	No. Samples	Min	Max	Mean	Median	SD	CV	95% UCL
			(µg/m^3)						
City Hall	Aluminum	6	0.030	0.180	0.070	0.040	0.060	0.850	0.140
	Bromine	6	0.002	0.005	0.004	0.004	0.001	0.297	0.004
	Calcium	6	0.161	0.517	0.294	0.261	0.123	0.419	0.396
	Chlorine	6	0.001	0.655	0.146	0.008	0.262	1.793	2.461
	Iron	6	0.049	0.210	0.121	0.110	0.057	0.475	0.168
	Manganese	6	0.001	0.010	0.006	0.006	0.003	0.525	0.009
	Nickel	6	0.001	0.007	0.004	0.004	0.002	0.486	0.005
	PM Diesel	4	0.476	0.951	0.746	0.778	1.980	0.265	NA
	Potassium	6	0.028	0.084	0.053	0.050	0.019	0.357	0.068
	Silicon	6	0.076	0.399	0.163	0.124	0.121	0.739	0.303
	Sulfur	6	0.618	1.266	0.972	1.019	0.245	0.251	1.174
	Titanium	6	0.002	0.013	0.008	0.009	0.005	0.545	0.012
	Vanadium	6	0.002	0.011	0.005	0.006	0.003	0.620	0.008
	Zinc	6	0.004	0.018	0.010	0.009	0.005	0.535	0.014
Community Center	Aluminum	6	0.004	2.158	0.411	0.050	0.858	2.085	5.614
	Bromine	6	0.002	0.006	0.003	0.003	0.002	0.574	0.005
	Calcium	6	0.036	0.739	0.235	0.147	0.262	1.118	0.668
	Chlorine	6	0.024	1.086	0.363	0.172	0.435	1.199	0.720
	Iron	6	0.045	1.110	0.246	0.077	0.424	1.719	2.831
	Manganese	6	0.001	0.022	0.006	0.003	0.008	1.343	0.020
	Nickel	6	0.000	0.011	0.004	0.002	0.005	1.237	0.008
	PM Diesel	6	0.249	0.843	0.562	0.562	0.205	0.355	0.747
	Potassium	6	0.037	0.472	0.138	0.073	0.168	1.215	0.381
	Silicon	6	0.033	4.409	0.859	0.136	1.744	2.029	9.943
	Sulfur	6	0.346	1.194	0.819	0.905	0.327	0.134	1.088
	Titanium	6	0.004	0.109	0.024	0.006	0.042	1.707	0.438
	Vanadium	6	0.001	0.018	0.007	0.005	0.007	0.910	0.013
	Zinc	6	0.004	0.010	0.008	0.008	0.002	0.258	0.010
Early Head Start	Aluminum	5	0.034	0.148	0.070	0.050	0.046	0.656	0.114
	Bromine	5	0.004	0.008	0.006	0.005	0.002	0.288	0.007
	Calcium	5	0.051	0.285	0.179	0.219	0.097	0.538	0.271
	Chlorine	5	0.025	0.211	0.119	0.142	0.082	0.687	0.197
	Iron	5	0.037	0.320	0.123	0.075	0.115	0.941	0.233
	Manganese	5	0.000	0.010	0.004	0.004	0.004	0.905	0.008
	Nickel	5	0.000	0.008	0.003	0.002	0.003	1.008	0.006
	PM Diesel	6	0.519	1.861	0.908	0.800	0.498	0.549	1.318
	Potassium	5	0.026	0.116	0.074	0.062	0.039	0.523	0.111
	Silicon	5	0.064	0.326	0.152	0.151	0.106	0.697	0.254
	Sulfur	5	0.526	1.355	1.057	1.144	0.318	0.301	1.361
	Titanium	5	0.000	0.020	0.010	0.009	0.008	0.788	0.017
	Vanadium	5	0.001	0.010	0.005	0.003	0.004	0.848	0.008
	Zinc	5	0.004	0.120	0.034	0.008	0.050	1.486	0.182

Table 5. continued.

AAH Monitor Location	Chemical	No. Samples	Min	Max	Mean	Median	SD	CV	95% UCL
Galena Manor	Aluminum	4							
	Bromine	4	0.003	0.007	0.004	0.004	0.002	0.416	
	Calcium	4	0.060	0.279	0.135	0.100	0.099	0.734	
	Chlorine	4	0.025	1.115	0.316	0.062	0.533	1.687	NA
	Iron	4	0.065	0.229	0.128	0.110	0.072	0.564	
	Manganese	4	0.002	0.009	0.006	0.006	0.003	0.503	
	Nickel	4	0.001	0.004	0.002	0.002	0.001	0.706	
	PM Diesel	6	0.530	1.297	0.804	0.730	0.305	0.380	1.055
	Potassium	4	0.034	0.175	0.083	0.061	0.063	0.764	
	Silicon	4	0.056	0.762	0.265	0.122	0.332	1.253	
	Sulfur	4	0.784	1.425	1.018	0.932	0.294	0.288	NA
	Titanium	4	0.007	0.019	0.012	0.011	0.006	0.510	
	Vanadium	4	0.002	0.005	0.003	0.003	0.001	0.413	
	Zinc	4	0.004	0.047	0.016	0.007	NA		
Police Station	Aluminum	6	0.000	0.133	0.072	0.070	0.051	0.719	0.114
	Bromine	6	0.000	0.006	0.004	0.004	0.002	0.657	0.005
	Calcium	6	0.156	0.463	0.297	0.307	0.114	0.386	0.391
	Chlorine	6	0.001	0.165	0.041	0.021	0.061	1.509	0.174
	Iron	6	0.059	0.633	0.318	0.304	0.207	0.561	0.488
	Manganese	6	0.005	0.113	0.042	0.029	0.041	0.976	0.076
	Nickel	6	0.001	0.006	0.004	0.004	0.002	0.493	0.005
	PM Diesel	5	0.865	2.292	1.219	0.908	0.610	0.500	2.022
	Potassium	6	0.038	0.079	0.058	0.057	0.013	0.230	0.069
	Silicon	6	0.075	0.289	0.189	0.214	0.087	0.463	0.261
	Sulfur	6	0.477	1.166	0.899	0.928	0.245	0.272	1.101
	Titanium	6	0.009	0.025	0.017	0.015	0.006	0.346	0.021
	Vanadium	6	0.000	0.006	0.003	0.003	0.002	0.606	0.005
	Zinc	6	0.005	0.074	0.024	0.018	0.025	1.054	0.062

NA = sample size too small to calculate statistics
95% UCL=95% upper confidence limit of the mean

Table 6a. 95% upper confidence limit of the mean and screening levels by AAH location.

AAH Monitor Location	Chemical	95% UCL of the mean	Screening Level	Health Endpoint
		($\mu g/m^3$)		
City Hall	Aluminum	1.40E-01	5.21E+00	Noncancer
	Manganese	8.60E-03	5.21E-02	Noncancer
	Nickel	5.45E-03	1.01E-02	Cancer
	PM Diesel	NA	8.11E-03	Cancer
	Vanadium	8.27E-03	1.04E-01	Noncancer
Community Center	Aluminum	**5.61E+00**	5.21E+00	Noncancer
	Manganese	1.99E-02	5.21E-02	Noncancer
	Nickel	7.70E-03	1.01E-02	Cancer
	PM Diesel	**7.47E-01**	8.11E-03	Cancer
	Vanadium	1.26E-02	1.04E-01	Noncancer
Early Head Start	Aluminum	1.14E-01	5.21E+00	Noncancer
	Manganese	8.01E-03	5.21E-02	Noncancer
	Nickel	6.12E-03	1.01E-02	Cancer
	PM Diesel	**1.32E+00**	8.11E-03	Cancer
	Vanadium	8.14E-03	1.04E-01	Noncancer
Galena Manor	Aluminum		5.21E+00	Noncancer
	Manganese	NA	5.21E-02	Noncancer
	Nickel		1.01E-02	Cancer
	PM Diesel	**1.06E+00**	8.11E-03	Cancer
	Vanadium	NA	1.04E-01	Noncancer
Police Station	Aluminum	1.14E-01	5.21E+00	Noncancer
	Manganese	**7.64E-02**	5.21E-02	Noncancer
	Nickel	5.41E-03	1.01E-02	Cancer
	PM Diesel	**2.02E+00**	8.11E-03	Cancer
	Vanadium	4.76E-03	1.04E-01	Noncancer

Concentrations were compared with EPA screening levels obtained from EPA Risk Calculator for residential chronic exposure (5). Bold text indicates concentration is greater than screening level.

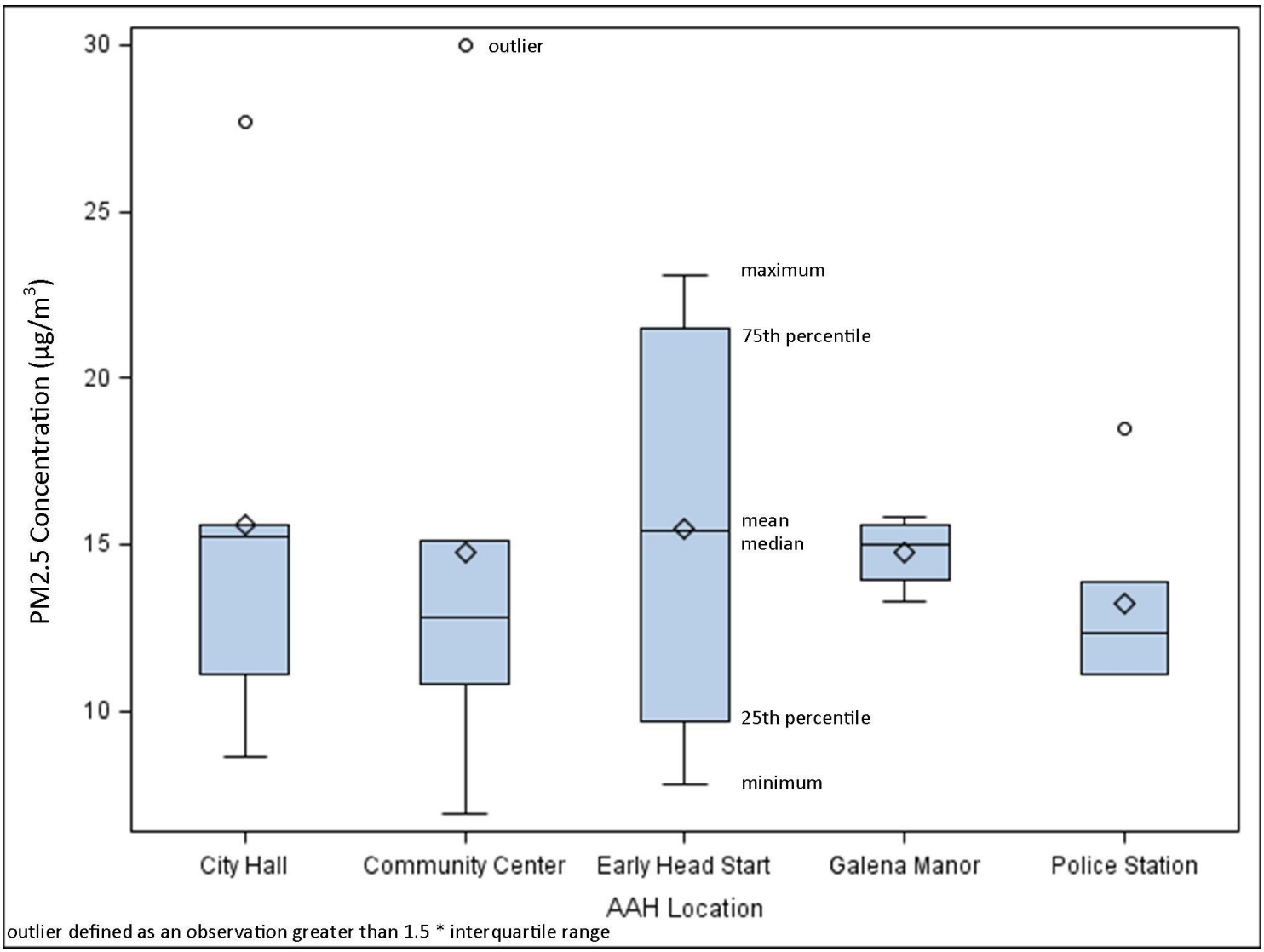
Table 6b. Cancer Risk or Noncancer Hazard of chemicals exceeding screening levels by AAH Location.

AAH Monitor Location	Chemical	Cancer Risk	Noncancer Hazard
City Hall	No chemicals exceeded screening level		
Community Center	Aluminum		**1.08E+00**
	PM Diesel	**9.21E-05**	
Early Head Start	PM Diesel	**1.62E-04**	
Galena Manor	PM Diesel	**1.13E-04**	
Police Station	Manganese		**1.46E+00**
	PM Diesel	**2.49E-04**	

The cancer risk and noncancer hazard were calculated for each detected chemical with toxicity information that exceeded the screening level by AAH location. The cancer risk and noncancer hazard at each location are bolded if they exceed $1x10^{-5}$ for a cancer endpoint or 1 for a noncancer endpoint.

Figure 1. Location of AAH monitors with PM2.5 sample size and 95% upper confidence limit of the mean.

Figure 2. **Boxplot of PM2.5 concentrations by AAH monitor location.**



outlier defined as an observation greater than 1.5 * interquartile range

Figure 3. AAH monitors and TCEQ fixed site monitors.

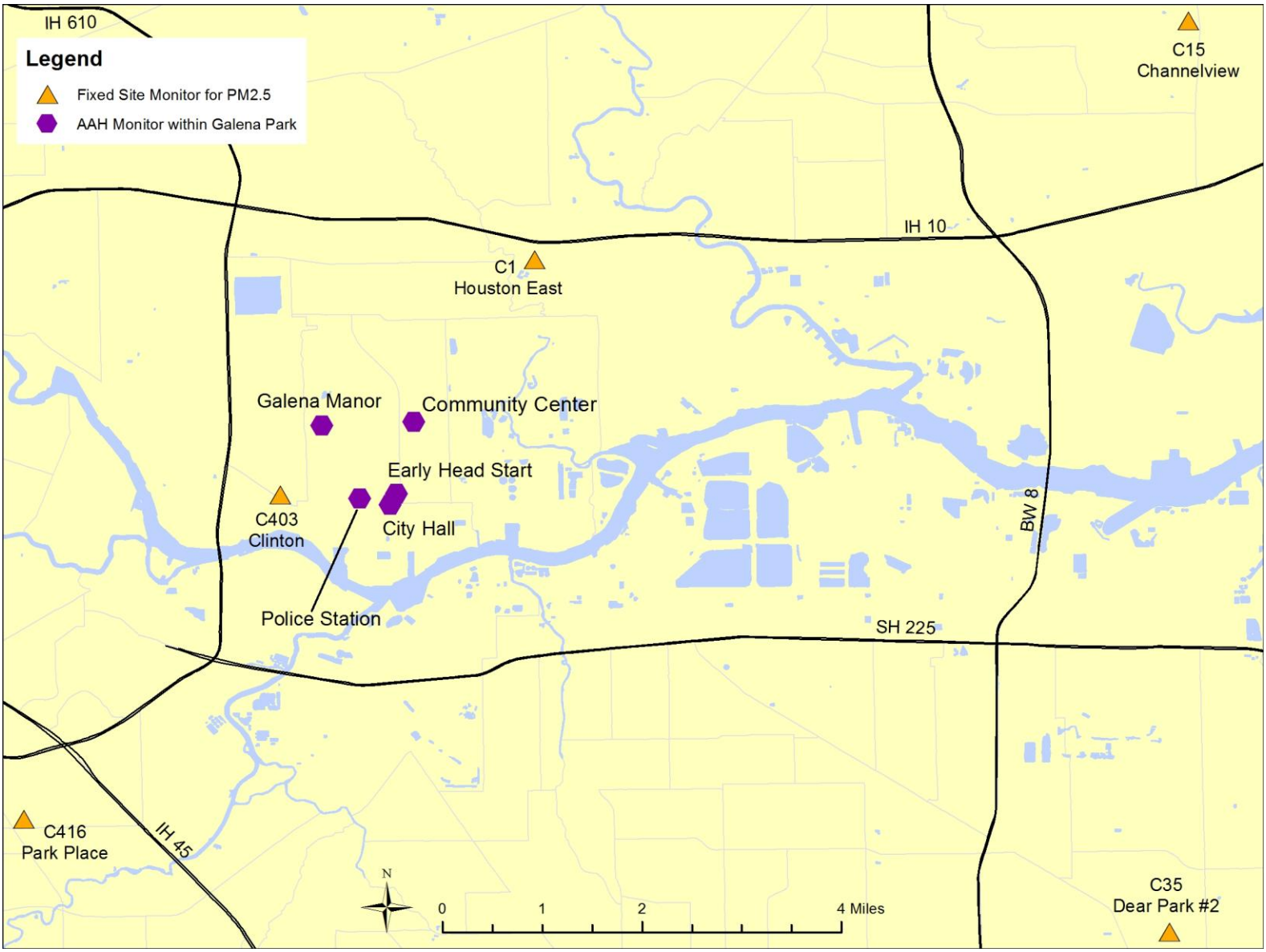


Figure 4. Boxplot of inverse distance weighting estimated PM2.5 concentrations from TCEQ fixed site monitors and measured concentrations from AAH monitor locations.

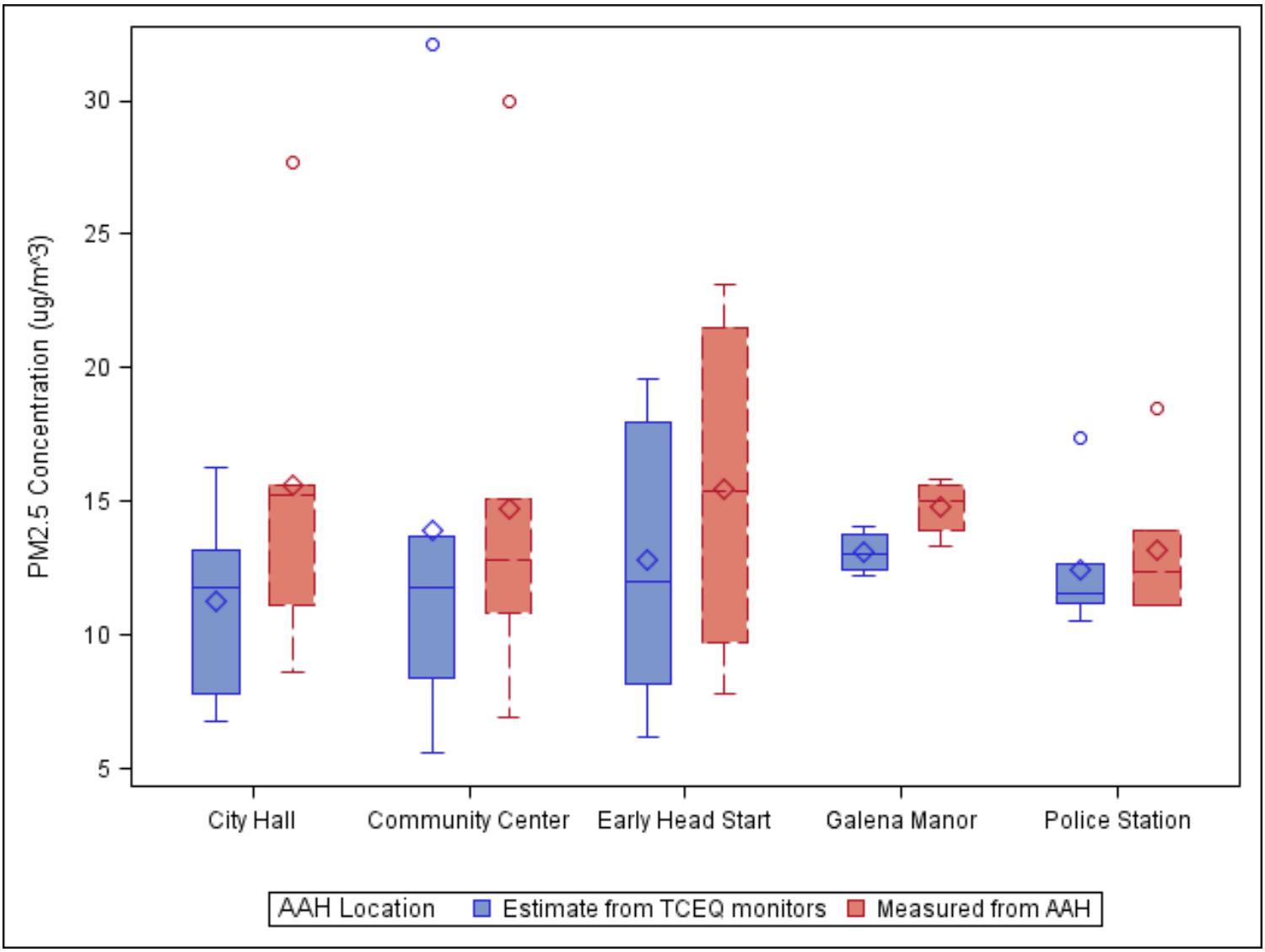


Figure 5. Linear relationship between PM2.5 concentrations: AAH measured vs. estimate from TCEQ fixed sites.

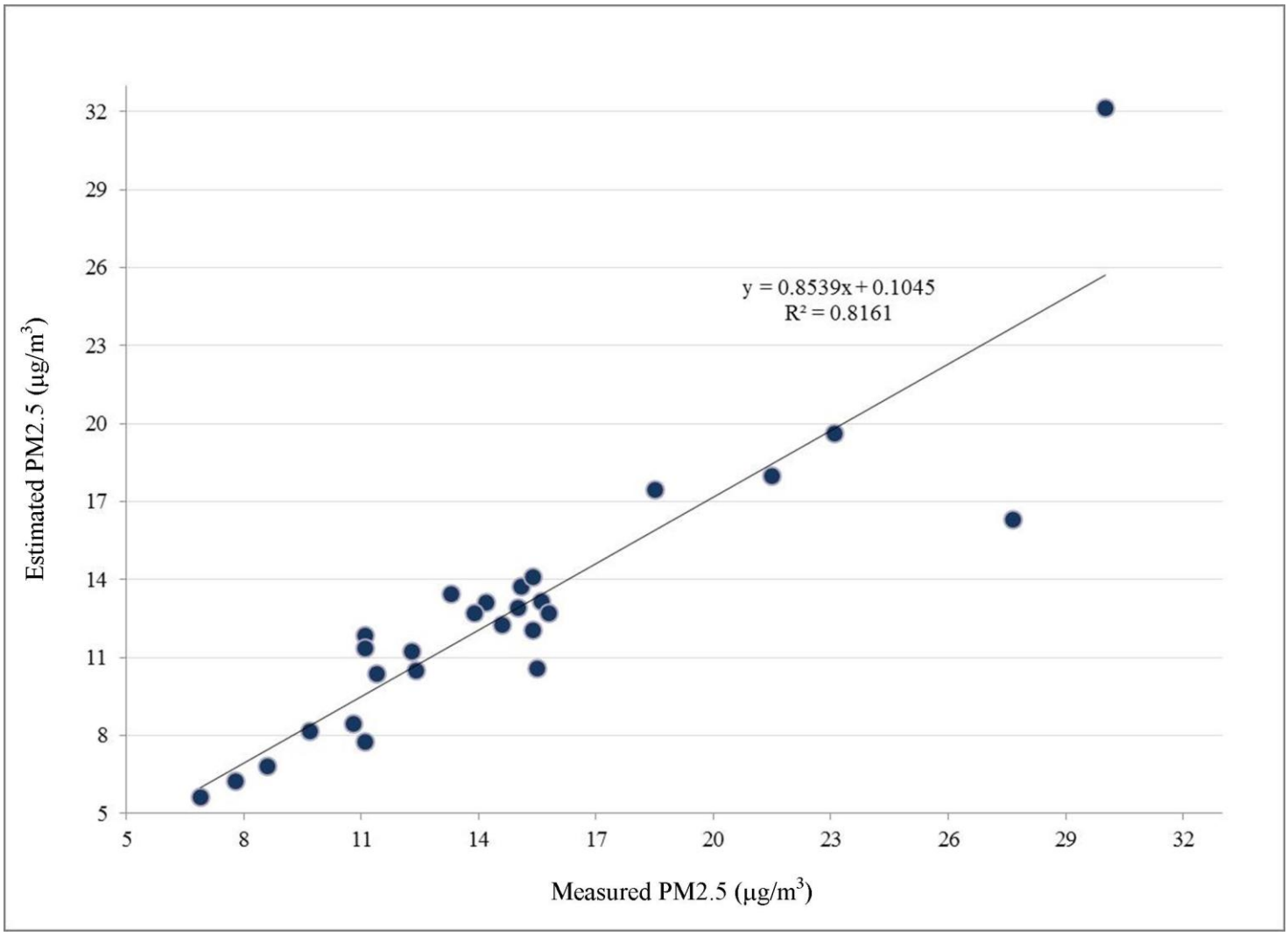


Figure 6. AAH monitors in close proximity to Clinton Drive (C403) fixed site monitor, and nearby facilities.

APPENDIX

AAH PM2.5 concentration association with windspeed and direction.

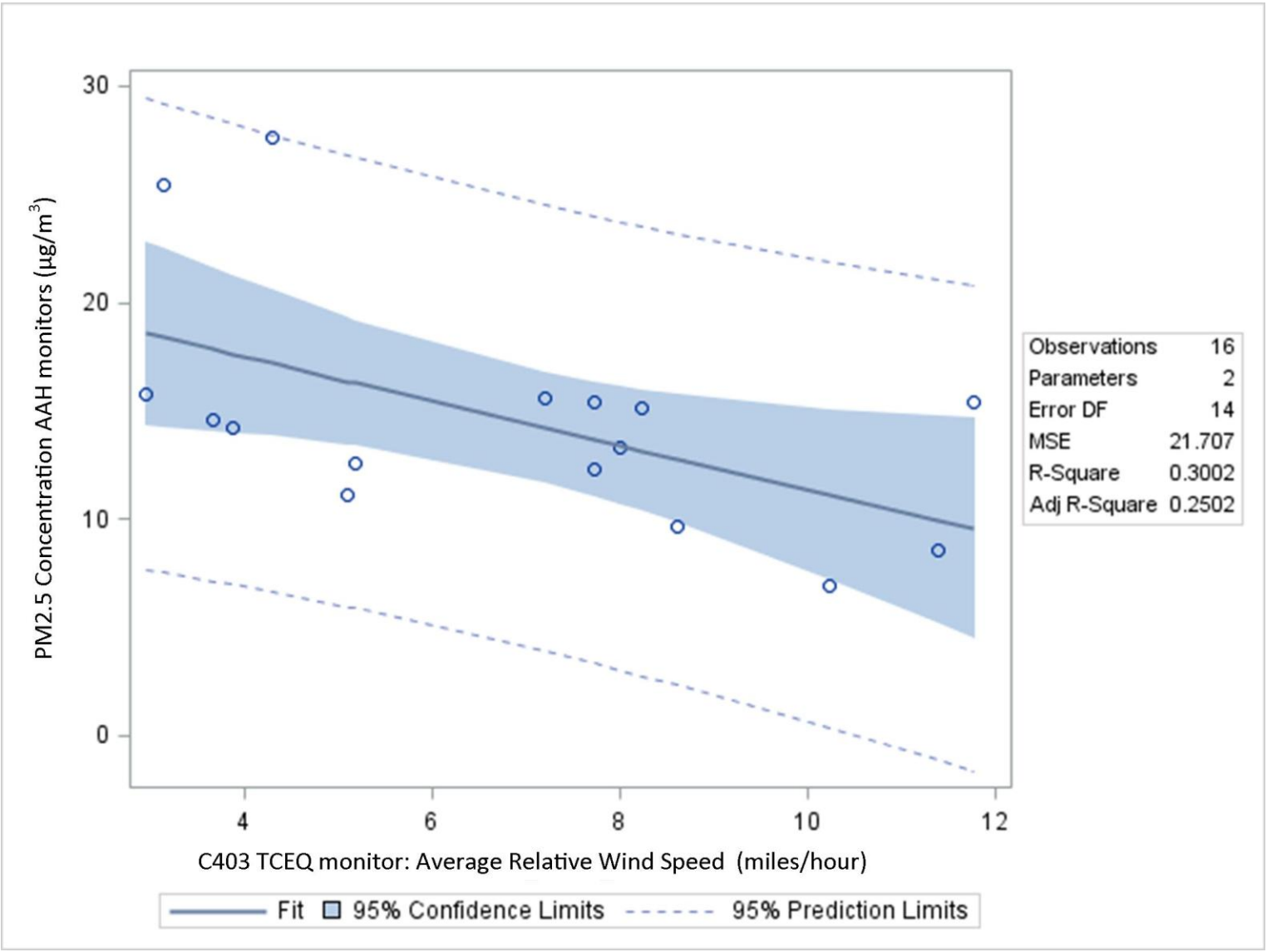
Table A-1 presents the sample start date, start time, average PM2.5 concentration, resultant wind direction, and resultant wind speed at TCEQ fixed site C403, AAH PM2.5 concentrations and the resultant wind direction category (northeast (NE), southeast (SE), and southwest (SW)).

The predominant wind direction during the study (for 16 of the 27 samples) was from the southeast (SE). A linear least squares regression of PM2.5 concentrations within Galena Park were related to windspeeds measured at the Clinton monitor when wind was from the southeast. There is a statistically significant association between AAH concentrations and windspeed. Thirty percent of the variability in the PM2.5 concentration can be attributed to windspeed. As windspeed increases concentrations decrease (Figure A-1).

Table A-1. Descriptive statistics for variables by AAH Location and date.

Sample Date	AAH Location	PM2.5 C403 (µg/m^3)	Resultant Wind Direction (degrees compass)	Resultant Wind Speed (miles/hour)	PM2.5 AAH Monitor (µg/m^3)	Wind Direction Category
11/8/2012	Community Center	6.84	167	10.24	6.90	SE
11/27/2012	Early Head Start	17.71	73	4.46	21.50	NE
11/28/2012	Galena Manor	5.13	106	2.95	15.80	SE
11/29/2012	Police Station	NA	121	5.18	12.60	SE
12/5/2012	City Hall	10.82	62	2.95	15.50	NE
1/19/2013	Community Center	11.13	137	3.88	14.20	SE
1/20/2013	Galena Manor	11.40	144	3.67	14.60	SE
1/21/2013	Early Head Start	18.35	160	3.14	23.10	SE
1/22/2013	City Hall	16.17	128	4.30	27.65	SE
1/23/2013	Police Station	12.85	222	7.09	13.90	SW
3/4/2013	Community Center	12.48	233	13.43	10.80	SW
3/7/2013	City Hall	14.42	130	7.20	15.60	SE
3/14/2013	Police Station	10.65	197	7.59	12.40	SW
3/15/2013	Early Head Start	7.96	208	10.15	7.80	SW
5/20/2013	Galena Manor	9.98	171	11.76	15.40	SE
5/21/2013	Community Center	14.56	161	8.24	15.10	SE
5/22/2013	Early Head Start	14.01	159	7.73	15.40	SE
5/23/2013	Police Station	11.28	151	7.73	12.30	SE
5/30/2013	City Hall	8.75	180	11.38	8.60	SE
8/5/2013	City Hall	9.84	218	8.65	11.10	SW
8/7/2013	Community Center	33.88	215	7.69	30.00	SW
8/9/2013	Police Station	11.83	132	5.11	11.10	SE
9/23/2013	Community Center	10.62	41	4.37	11.40	NE
9/24/2013	Police Station	17.49	181	2.82	18.50	SW
9/25/2013	City Hall	15.30	215	5.15	15.00	SW
9/26/2013	Galena Manor	13.70	147	8.00	13.30	SE
9/28/2013	Early Head Start	9.04	160	8.61	9.70	SE

Figure A-1. Linear least squares regression of PM2.5 concentrations and relative wind speed.



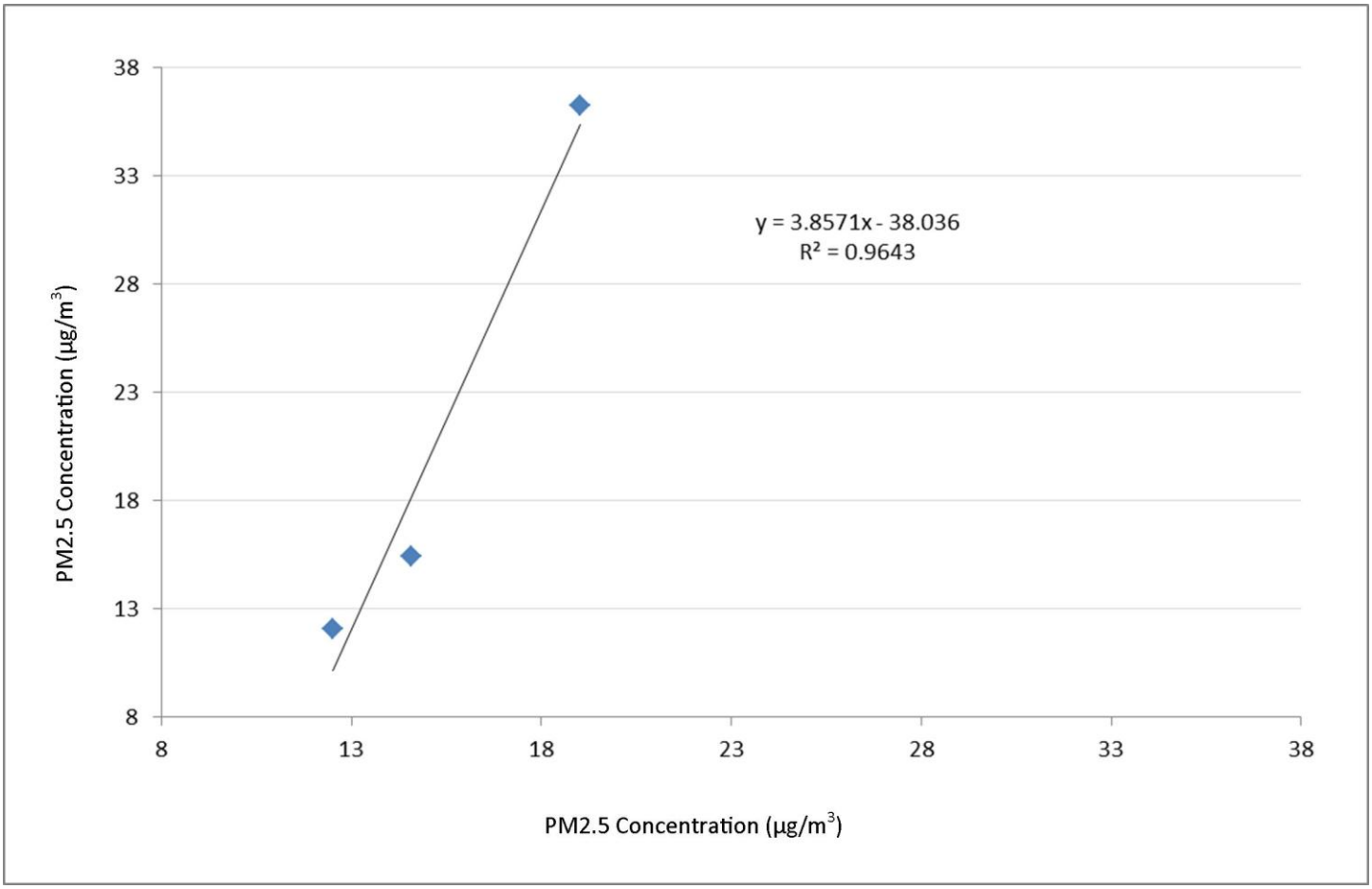
Duplicate Sample Regression

Table B-1 shows the duplicate samples from the AAH monitors, relative error and relative percent difference (8). Sample 2 on 1/22/2013 is much greater than its duplicate sample compared to the other dates. A least squares regression analysis indicates that the correlation coefficient between duplicate samples for PM2.5 is high (Figure B-1). That is, 96% of the variation in the first duplicate sample for PM2.5 is explained by the second sample of PM2.5 concentration by date. However, the slope of the line should ideally be 1 with 0 intercept. The high concentration sample taken on 1/22/2013 appears to be the cause of the high slope and intercept.

Table B-1. Duplicate samples for PM2.5 from AAH monitors.

Date	Sample 1 (control)	Sample 2 (collocated)	Relative Error (%)	% RPD	Precision
1/22/2013	19	36.3	-91	-62.6	poor
5/23/2013	12.5	12.1	3	3.3	good
9/25/2013	14.6	15.4	-6	-5.3	good

Figure B-1. Regression of duplicate samples for PM2.5.



Appendix B: Chernaik Interpretation

Lab ID	Location	Start Date	End Date	Field Notes	PM2.5	Elemental Carbon	TC	
P0215486	1908 2nd Street (Early Head Start)	5/16/2012	5/17/2012		22.9	NA	NA	
12-T4054	1721 16th Street (Community Resource Center)	11/8/2012	11/9/2012	Clear & cool, breezy	6.9	NA	NA	
13-U1	1721 16th Street (Community Resource Center)	11/8/2012	11/9/2012	Clear & cool, breezy	NA	0.66	8.5	
12-T4057	1908 2nd Street (Early Head Start)	11/27/2012	11/28/2012	Overcast, gusty	21.5	NA	NA	
13-U2	1908 2nd Street (Early Head Start)	11/27/2012	11/28/2012	Overcast, gusty	NA	0.81	8.3	
12-T4056	Galena Manor	11/28/2012	11/29/2012	Clear - light breeze	15.8	NA	ND	
13-U3	Galena Manor	11/28/2012	11/29/2012	Clear - light breeze	NA	1.16	7.6	
12-T4055	2207 Clinton Drive (Galena Park Police Station)	11/29/2012	11/30/2012	Sunny - scattered clouds	12.6	NA	ND	
13-U4	2207 Clinton Drive (Galena Park Police Station)	11/29/2012	11/30/2012	Sunny - scattered clouds	NA	0.79	5.9	
12-T4058	2000 Clinton Drive (City Hall)	12/5/2012	12/6/2012	Clear & partly cloudy	15.4	NA	NA	
13-U5	2000 Clinton Drive (City Hall)	12/5/2012	12/6/2012	Clear & partly cloudy	NA	0.85	5.2	
12-T3950	1721 16th Street (Community Resource Center)	1/19/2013	1/20/2013	Fair day, scattered clouds, he	14.2	NA	ND	
13-U162	1721 16th Street (Community Resource Center)	1/19/2013	1/20/2013	Fair day, scattered clouds, he	NA	0.75	39.1	
12-T4060	Galena Manor	1/20/2013	1/21/2013	Fog in the morning	14.6	NA	NA	
13-U163	Galena Manor	1/20/2013	1/21/2013	Fog in the morning	NA	0.89	7.5	
13-U164	Galena Park Fire Station	1/20/2013	1/21/2013	Fog in the morning	Field Blank			
12-T4096	1908 2nd Street (Early Head Start)	1/21/2013	1/22/2013	Partly cloudy	23.1	NA	NA	
13-U165	1908 2nd Street (Early Head Start)	1/21/2013	1/22/2013	Partly cloudy	NA	1.51	10.5	
12-T4097	2000 Clinton Drive (City Hall)	1/22/2013	1/23/2013	Light breeze sunny	19.0	NA	NA	duplicate
12-T4098	2000 Clinton Drive (City Hall)	1/22/2013	1/23/2013	Light breeze sunny	36.2	NA	NA	duplicate
12-T4059	2207 Clinton Drive (Galena Park Police Station)	1/23/2013	1/24/2013	Partly cloudy, breeze light	13.9	NA	NA	
13-U166	2207 Clinton Drive (Galena Park Police Station)	1/23/2013	1/24/2013	Partly cloudy, breeze light	NA	0.77	40.5	
12-T3951	1721 16th Street (Community Resource Center)	3/4/2013	3/5/2013	Sunny, clear	10.8	NA	NA	
13-U39	1721 16th Street (Community Resource Center)	3/4/2013	3/5/2013	Sunny, clear	NA	0.23	4.5	
12-T3952	Galena Manor	3/5/2013	3/6/2013	Cloudy - partly sunny, windy	Monitor Did Not Turn On			
13-U396	Galena Manor	3/5/2013	3/6/2013	Cloudy - partly sunny, windy	Monitor Did Not Turn On			
13-U397	Galena Manor	3/6/2013	3/7/2013	Sunny - clear w/ few clouds	NA	0.78	6.7	duplicate
13-U398	Galena Manor	3/6/2013	3/7/2013	Sunny - clear w/ few clouds	NA	0.75	6.4	duplicate
12-T3953	2000 Clinton Drive (City Hall)	3/7/2013	3/8/2013	Sunny, clear, windy	15.6	NA	NA	
13-U399	2000 Clinton Drive (City Hall)	3/7/2013	3/8/2013	Sunny, clear, windy	NA	0.70	7.1	
12-T3954	2207 Clinton Drive (Galena Park Police Station)	3/14/2013	3/15/2013	Sunny, Clear, slightly windy	12.4	NA	NA	
13-U400	2207 Clinton Drive (Galena Park Police Station)	3/14/2013	3/15/2013	Sunny, Clear, slightly windy	NA	1.02	6.7	
12-T3955	1908 2nd Street (Early Head Start)	3/15/2013	3/16/2013	Clear w/ a few clouds, sunny	7.8	NA	NA	
13-U401	1908 2nd Street (Early Head Start)	3/15/2013	3/16/2013	Clear w/ a few clouds, sunny	NA	0.46	5.6	
12-T3956	Galena Manor	5/20/2013	5/21/2013	Cloudy - partly sunny, windy	15.4	NA	NA	

Lab ID	Location	Start Date	End Date	Field Notes	PM2.5	Elemental Carbon	TC	
13-U712	Galena Manor	5/20/2013	5/21/2013	Cloudy - partly sunny, windy	NA	0.48	4.6	
12-T3957	1721 16th Street (Community Resource Center)	5/21/2013	5/22/2013	Cloudy - partly sunny, windy	15.1	NA	NA	
13-U713	1721 16th Street (Community Resource Center)	5/21/2013	5/22/2013	Cloudy - partly sunny, windy	NA	0.46	4.7	
12-T3958	Galena Park Fire Station	5/21/2013	5/22/2013	Cloudy - partly sunny, windy	18.1	NA	NA	
12-T3959	1908 2nd Street (Early Head Start)	5/22/2013	5/23/2013	Cloudy, fog in morning, light b	15.4	NA	NA	
13-U714	1908 2nd Street (Early Head Start)	5/22/2013	5/23/2013	Cloudy, fog in morning, light b	NA	0.62	5.3	
12-T3960	2207 Clinton Drive (Galena Park Police Station)	5/23/2013	5/24/2013	Muggy, cloudy, light breeze	12.5	NA	NA	duplicate
12-T3961	2207 Clinton Drive (Galena Park Police Station)	5/23/2013	5/24/2013	Muggy, cloudy, light breeze	12.1	NA	NA	duplicate
12-T3962	2000 Clinton Drive (City Hall)	5/30/2013	5/31/2013	Cloudy, partly sunny	8.6	NA	NA	
13-U715	2000 Clinton Drive (City Hall)	5/30/2013	5/31/2013	Cloudy, partly sunny	NA	0.42	5.3	
12-T4051	2000 Clinton Drive (City Hall)	8/5/2013	8/6/2013		11.1	NA	NA	
12-T4052	1721 16th Street (Community Resource Center)	8/7/2013	8/8/2013		30.0	NA	NA	
12-T4053	Galena Park Fire Station	8/7/2013	8/8/2013		Field Blank			
12-T3963	1908 2nd Street (Early Head Start)	8/8/2013	8/9/2013		44.7	NA	NA	
12-T3964	2207 Clinton Drive (Galena Park Police Station)	8/9/2013	8/10/2013		11.1	NA	NA	
13-U1029	2000 Clinton Drive (City Hall)	8/5/2013	8/6/2013		NA	0.70		
13-U1030	Galena Manor	8/6/2013	8/7/2013		NA	0.56		duplicate
13-U1031	Galena Manor	8/6/2013	8/7/2013		NA	0.39		duplicate
13-U1032	1721 16th Street (Community Resource Center)	8/7/2013	8/8/2013		NA	0.46		
13-U1033	1908 2nd Street (Early Head Start)	8/8/2013	8/9/2013		NA	0.83		
13-U1034	2207 Clinton Drive (Galena Park Police Station)	8/9/2013	8/10/2013		NA	0.81		
13-T2854	1721 16th Street (Community Resource Center)	9/23/2013	9/24/2013		11.4	NA	NA	
13-U1185	1721 16th Street (Community Resource Center)	9/23/2013	9/24/2013		NA	0.54	8.1	
13-T2855	2207 Clinton Drive (Galena Park Police Station)	9/24/2013	9/25/2013		18.5	NA	NA	
13-U1186	2207 Clinton Drive (Galena Park Police Station)	9/24/2013	9/25/2013		NA	2.05	12.7	
13-T2856	2000 Clinton Drive (City Hall)	9/25/2013	9/26/2013		14.6	NA	NA	duplicate
13-T2910	2000 Clinton Drive (City Hall)	9/25/2013	9/26/2013		15.4	NA	NA	duplicate
13-T2911	Galena Manor	9/26/2013	9/27/2013		13.3	NA	NA	
13-U1187	Galena Manor	9/26/2013	9/27/2013		NA	0.54	5.9	
13-T2912	1908 2nd Street (Early Head Start)	9/28/2013	9/29/2013		9.7	NA	NA	
13-U1188	1908 2nd Street (Early Head Start)	9/28/2013	9/29/2013		NA	0.48	10.7	

			PM2.5	Elemental Carbon	TC
	Average levels		15.4	0.75	
	Health-based standards	EPA 24-hour standard	35.0	1.36 [FN 1]	
		WHO 24-hour standard	25.0	.836 [FN 2]	
		EPA annual standard (see no	12.0		
		WHO annual standard	10.0		

Location Averages	# of PM2.5 Samples	# of Elemental Carbon Sampl	PM2.5	EC
1908 2nd Street (Early Head Start)	7	5	20.7	0.79
1721 16th Street (Community Resource Center)	6	6	14.8	0.52
Galena Manor	4	6	14.8	0.71
2207 Clinton Drive (Galena Park Police Station)	6	4	13.4	1.09
2000 Clinton Drive (City Hall)	6	4	13.7	0.67
Galena Park Fire Station	1	0	18.1	NA

Health-based standards	EPA 24-hour standard	35.0	1.36 [FN 1]	
	WHO 24-hour standard	25.0	.836 [FN 2]	
	EPA annual standard (see no	12.0		
	WHO annual standard	10.0		

FN1 excess risk of cardiovascular mortality two and three-days post exposure

FN2 excess risk of cardiovascular and respiratory hospitalizations on the day of exposure

Appendix C: Community Health Impact Survey Report

WHY A COMMUNITY HEALTH IMPACT SURVEY OF GALENA PARK, TEXAS?

The Community Health Impact Survey administered by Air Alliance Houston, a nonprofit group focused on air quality, is part of a project funded by the Houston Endowment Foundation. As advocates for air quality, Air Alliance Houston has been working in Galena Park since 2008 to reduce air pollutants, such as the chemical benzene and particulate matter from diesel combustion, road dust, and industrial processes. From our involvement we learned that Galena Park has many challenges associated with the environment: poor housing, lack of local health care, local access to nutritional food, heavy traffic congestion, limited public transportation, pollution, and environmentally related stress. We also learned that although the city government has limited resources, the residents are known for their resourcefulness.

This project, devoted exclusively to the City of Galena Park, is a continuation of the 2010 *Galena Park Community Action Plan,* the result of a two-year planning process led by Harris County Public Health and Environmental Services, in partnership with MD Anderson Cancer Center for Health Equity and Evaluation Research, with the guidance and involvement of the Environmental Community Assessment Team (ECAP-AT) which included City of Galena Park elected officials, Harris County Commissioners and agencies, Galena Park Independent School District, local residents and community-based organizations. Additional input from focus groups and a city-wide community forum contributed to the planning. Through this process three priority issues were identified: air quality, access to health care, and the built environment (infrastructure, housing, parks and other human-made surroundings). One immediate outcome of these meetings was the repaving of Clinton Drive in 2011, which contributed to increased traffic safety and reduced the amount of particulate matter generated by road traffic and deteriorated road conditions.

Solving complex issues requires committed involvement and dedicated leadership of individuals from many sectors of society. By collaborating and engaging the community at all levels, strategies can be developed to move toward a more vibrant economy and healthier, safer community. Defined strategies were established as a result of this effort, and the creation of the *Environmental Community Advocates of Galena Park* (ECAGP), a non-profit advocacy group, was formed to continue the legacy of this community plan.

With the support of ECAGP, the process of canvassing the entire city began. Teams of upper level Galena Park High School students with their adult supervisor took to the streets in February, 2012 canvassing with a 59-question survey. Along the way, the students learned more about their community, and the residents who opened their doors to participate had an opportunity to voice their concerns and learn from the students. Walking the neighborhoods provides a different experience. We saw the lack of street signs, sidewalks, address numbers, and flooding streets. The high school students did their job well, reaching 860 households out of an estimated 2900 (30%). The survey is reflective of the population of Galena Park as a whole according to the 2010 U.S. Census numbers:

Surveyed Households	**U.S. Census Percentage for Galena Park, Texas**
78% Hispanic /Latino	81.4%
13% White	11.4%
9% Black	6.8%

(Sixty-three percent (63%) of the households have family members who speak only Spanish.)

The majority of respondents, 67%, owned their own homes, and most were between 19 – 64 years of age with the youngest at 14 and the oldest 87. From this group, 88% reported that they believed Galena Park is a good place to live. And as shown, Galena Park citizens are long-term residents.

Length of Residency

38%	20+ years
17%	13-20 years
18%	8-12 years
11%	4-7 years
16%	0-3 years

MAJOR SURVEY TOPICS – 860 Household Reporting
The major categories addressed in the survey were transportation; availability of grocery stores; parks and outdoor recreation; health problems and care; and environmental concerns.

TRANSPORTATION

Bus Transit

In 1978 the City of Galena Park's Mayor Alvin Baggett signed an agreement with the Metropolitan Transit Authority of Harris County (METRO) to provide four trips daily through the city. The route was under review this year by METRO for possible termination, but the route and the agreement remain unaltered.

Route #30 Clinton runs Monday through Friday with two departures in the morning (example 11th @ Holland at 7:09am & 7:49am) and two returns (example 11th @ Holland at 5:53pm & 6:33pm). This route runs east on Clinton, north on Main, east on 11th, south on Holland, and returns to Clinton going west towards Houston.

- 80% believe that Galena Park should have a public transportation system.
- 76% **do not use** METRO to travel to a non-emergency medical appointment.
- 64% **do not use** METRO to travel into Houston.

If routes were made available with frequent stops, the survey shows the willingness of residents to travel some distance for education, health care, or grocery shopping.

- 60% would travel METRO to San Jacinto College North Campus or another community college or university.
- 63% would travel to Harris County Hospital District's Strawberry Clinic in Pasadena.
- 57% would travel to Denver Harbor Clinic.
- 60% would use the bus to go to the grocery store.

Bicycle Lanes

While residents polled did not indicate the use of bicycles as a means of transportation, 80% stated that they would use bicycle lanes if provided within the city.

Personal Vehicle

When asked what mode of transportation is used to grocery shop, an overwhelming 98% responded their personal vehicle. This is not surprising since the majority surveyed travel outside the city for most of their needs.

GROCERY STORES – Access to nutritional foods

Low income and minority areas contain fewer supermarkets on average; these areas also tend to have a higher density of convenience stores and fast food outlets offering fewer healthful choices and higher prices. Within Galena Park's city limits there is one small grocer, Middleton Super Market, located at 2014 Clinton Drive, and a few convenience stores scattered in the city. The American Planning Association determined that the average consumer base for a supermarket is 8,412. Galena Park's population is 10,887, which would in theory support a major supermarket or at least a mid-size grocer of 20,000 – 50,000 sq ft. A walkable neighborhood grocer means a 15 minute walk one-way. As for the residents surveyed, the household's vehicle is the main source of transportation.

Sellers Brothers in Jacinto City was the number one grocer mentioned. However, many families rely on at least two grocers for their food and household products.

Top Four Grocers Most Frequented

1) Sellers Brothers, Jacinto City 57%
2) Kroger's (Houston & Pasadena) 20%
3) Wal-Mart, Pasadena 13%
4) Middleton, Galena Park 9%

PARK IMPROVEMENT – More than green space

Where there are parks near homes, the result is more physical activity and better health for residents. Given that physical activity in daily life has decreased, the increase dependence of motorized transportation and sedentary occupations, the role of parks has become increasingly critical to maintain health and fitness. With the increase of obesity and diseases related to inactive lifestyles, especially cardiac disease and diabetes, local parks offer benefits to combat these types of health problems. Park and recreation services provide close-to-home, no or low cost facilities and programs, which provide pleasurable physical activity, social interaction, and community pride.

Of residents surveyed about park improvements 86% would like to see improvements.

74% visit the parks.

- 37% visit the parks monthly
- 29% visit weekly
- 8% visit daily

Top Five Park Improvements Cited

1) Security and safety (patrolling, lighting), including fencing of areas around culverts.
2) Upgrade of existing playground equipment, purchase of new equipment designed for toddlers exclusively and other equipment designed for school age children.
3) Improved maintenance of the parks, including graffiti removal and overall beautification of green areas with shade trees and plantings.
4) Recreational programs for the children at the local community centers, and additional sport activities. Improve existing and build new basketball and tennis courts, soccer and baseball fields, running tracks, and bike/walk paths.
5) Regarding public structures and furnishings: improvement and addition of public restrooms, additional benches in shaded areas, and water fountains.

HEALTH CARE

It is well known among residents that there is not one private medical practice in the city, but the city does have two dental practices. However, we were surprised to learn that **56% of the residents interviewed were not aware of the Harris County Hospital District's school-based clinic, Southside Health Clinic.** Only 23% stated that a family member had visited the clinic.

Southside Health Clinic accepts infants to age 18 with CHIP, Medicaid, or the County Gold Card. The clinic offers preventive and acute healthcare services **all year long** and is located at the Galena Park Community Resource and Training Center. To schedule an appointment, call 713-873-5437.

Southside Health Clinic
1721 16th Street
Galena Park, Texas 77547
713-671-2461
Behavioral Health Clinic 713-676-1475

So the question follows, where does someone in the household go when sick or in need of health advice?

The answers were scattered and tended to identify locations rather than specific clinics or doctors. People traveled to Jacinto City, East Houston, Pasadena, north of I-10, to the Texas Medical Center, Gulfgate, and as far away as Mexico.

Top Five Health Care Responses

1) East Houston Medical Group, Houston, TX
2) Strawberry Clinic, Harris County Hospital District, Pasadena, TX
3) Holland Street Clinics, e.g. Family Medical Clinic, Jacinto City, TX

4) Texas Medical Center (Texas Children's, Hermann Memorial, The Methodist and St. Luke's), Houston, TX
5) Bayshore Medical Center, Pasadena, TX and Kelsey Seybold, Pasadena, TX

Overall Rate of Health of Respondent

- 62% surveyed stated their health as good
- 30% fair
- 7% poor

Covered Under Health Insurance /Managed Care Program

- 63% have current insurance
- 32% **did not** have insurance in the last 12 months (as of February -March 2012)

When asked if anyone would visit an adult health clinic located in Galena Park, 88% stated YES.

Last Adult Routine Physical or General Checkup

- 85% had a routine physical/checkup within the last two years

Adult Health Problems

Asthma/ other Respiratory	16%
Cancer	8%
Diabetes	31%
Hypertension	41%

Out of the 518 households indicated as having children 18 and under, the following was reported:

Child Health Problems

Asthma/ other Respiratory	24%
Cancer	1%
Diabetes	3%

Of the 499 households with children who responded to the question "Do all the children in your household under the age of 6 have their immunizations", eighty-nine percent (89%) said YES.

Two percent of respondents age 18 and under stated they had been diagnosed as hypertensive even though they were not asked specifically in the survey.

ENVIRONMENTAL POLLUTION

What do Galena Park residents say about pollution in their community?

1. Are there any types of pollution that you are concerned about? 69% said YES
2. Are you concerned about links between pollution and your health? 74% said YES
3. Are there specific sources of pollution that concern you? 76% said YES

The #1 concern is refineries and chemical plants (97%).

Other concerns mentioned were 18-wheeler truck traffic, cars, air and water pollution, and the dredge material placement area (DMPA), known as the Clinton site.

DMPA

4. Are you aware of the land between Galena Park and Jacinto City? 75% said NO
5. Do you know who owns the land between Galena Park and Jacinto City? 87% said NO

So what is an Upland Dredged Material Placement Site (DMPA)?
The Clinton site is a DMPA owned by the Port of Houston since 1929. It is an upland area where submerged sediments from dredging activities required for navigation is deposited. The tract of land is within the city limits of Galena Park. The first dredging according to the Port of Houston Authority was in 1938. The Army Corp of Engineers began testing the sediment in the 1970s and the Port of Houston Authority began in the 1990s. The Clinton site, like the others, is not lined and is not regulated like a waste site or landfill. The sediment comes from several sources, such as Sims Bayou, Woodhouse, Agrifos, Glanville-Vulcon Material, Greens Bayou, Industrial Real Estate and Kinder Morgan Liquid Terminals. There are other sites like the Clinton tract but the other closest to Galena Park due west boundary is the House-Stimson, purchased in 1935. Any resident can request copies of the test reports on the sediment from either the US Army Corp of Engineers or the Port of Houston Authority through the Freedom of Information Act (FOIA).

TAKING ACTION - REPORT ENVIRONMENTAL POLLUTION

Do residents feel free to contact officials about pollution concerns? Who do they call when they want to complain? For the majority of the residents surveyed, their concerns never leave the house, and for the 14% who have contacted someone, the response has not been well – not responsive. Most of the residents surveyed have never heard of Air Alliance Houston, Environmental Community Advocates of Galena Park or the Community Industry Partnership. And most are not aware of Harris County Pollution Control Services or the Texas Commission for Environmental Quality (TCEQ).

1) Have you ever tried to communicate your concerns about pollution?
82% said NEVER
2) Have representatives from the refineries and chemical plants ever reached out to you about these concerns?
92% said NEVER
3) Have government officials responded to these concerns?
92% said NEVER
4) Have organizations responded to these concerns?
91% said NEVER

MAKE THE RIGHT CALL TO REPORT POLLUTION

When you go outside you notice a strong odor that burns or irritates your eyes, nose, or lungs. You don't necessarily see anything, but this is the second time this week you smell the same odor. You see illegal dumping into the street's storm drain. What is illegal? That would be anything other than uncontaminated rainwater. You see what could be hazardous waste (batteries, drums, etc.) left on an empty lot. You wonder what you can do or if the authority knows about the problem.

Government agencies depend on community residents to be their eyes and ears when it comes to investigating pollution problems in a timely manner. Problems like water pollution, hazardous waste, nuisance from odor, smoke, or dust, and other discharges to air, soil, and water. That's why it is important for you to report pollution concerns directly to local agencies to ensure that potential violations are properly investigated and addressed.

Unless it is an emergency situation where you would call 911, Galena Park residents should call first Harris County Pollution Control Services at 713-920-2831. The Texas Commission for Environmental Quality (TCEQ) can also be called at (713) 767-3500. You may be asked for your name, address and phone number. This is kept confidential and is necessary if you want to be contacted by an investigator. If there is a case number for your complaint, then make sure you write it down before you hang up.

Before reporting an air pollution problem make sure you gather the necessary information including: 1) the nature of the problem, like smoke or odor; 2) the date and time of the problem, and 3) the source of the problem if known. Where air quality problems are common, consider keeping an odor log (Appendix I). It will be helpful in tracking your complaints.

Appendix D: Air Monitoring Checklist

Air Monitoring Checklist - p. 1/5

For use on-location with two MiniVol TAS and one Dust Trak air monitors.

MiniVol TAS supplies:

- Two MiniVol TAS air monitors in cases with all components
  - Charged battery
  - Grease
  - Knife for grease application
  - Instruction manual
  - Calibration certificate
- Filters:
  - Use monitoring schedule to determine which filters are required.
  - Typically—but not always—one quartz and one Teflon filter are needed for each day.
- Quart Ziploc bags for transporting filters
- Two Field Data Sheets
- Monitoring Schedule
- Pen
- Double sided tape
- One stand assembly for <u>each</u> monitor, consisting of:
  - Two milk crates
  - Brick for weight
  - Two bungee cords
  - Zip ties
- Smart phone to check weather conditions

Dust Trak supplies:

- Dust Trak air monitor in outer soft case with all components:
  - PM2.5 sampling component
  - Zero calibration component
  - Inlet hose
  - Outdoor power cord
  - Both Keys: hard case lock and cable lock
- 50 ft. extension cord
- Compressed air canister

Other supplies:

- Ladder for accessing rooftop sites.
- If monitors must be locked down at site: chains, locks, and keys.
- Camera and/or camcorder to take pictures and video of set-up and take-down.
- For mailing completed filters to CHESTER LabNet:
  - Insulated mailers (check closet under stairs).
  - Three or four ice packs.

<u>To Do before Setup</u>

1. Select and prepare the site:
   - Choose site location, date, and time.
   - Notify site owner/supervisor of date and time to setup and takedown monitors.

- Where necessary, arrange for site supervisor to meet at location.
- Arrange for community volunteers to meet at location.

2. Check the weather for the chosen week:
    - Do not monitor during inclement weather.
    - A little rain is OK.
    - Anything more than a light drizzle for an hour or two is not.
    - Delaying for a day or two is OK. Runs need not start on Monday.
3. Update the Monitoring Schedule:
    - Enter the information from the last monitoring run into the Schedule
    - Update or revise the schedule as needed
        - Account for weather delays.
        - Vary the days of the week for each site as much as possible.
        - Include field blanks and collocations (target of 10% for each).
4. Prepare Dust Trak
    - Check case for all necessary components.
    - If necessary, program new site location.
5. Prepare each MiniVol (refer to manual for detailed instructions)
    - Check each case for all necessary components.
    - Charge MiniVol batteries.
    - Check for leaks
        - Press the ON/Auto/Off button to start the sampler pump.
        - Cover the inlet tube with your palm.
        - The flowmeter ball should drop to zero. The pump may stall momentarily. This is normal.
        - If the ball does not drop to zero, refer to section 2.5 of the manual.
        - If the sampler is leak-free, continue with preparations.
    - Every fifth use, clean and grease impactor target disks. Refer to manual section 6.1.
6. Prepare filters
    - Consult the monitoring schedule to determine how many of each filter are needed.
    - Assign a unique ID letter to the quartz filter. Write the letter on the plastic mailer that stores the filter.
    - Record both assigned ID letter for quartz filter and given ID number for Teflon filter.
    - Prepare refrigeration bag, blue-ice packs, and quart Ziploc bag for filter transport to site. Note that while only quartz filters must be refrigerated, we store all filters in freezer for ease.

MiniVol TAS Setup

1. Check battery life and insert battery.
2. Check flow rate
    - Press the On/Auto/Off button and allow the sampler to run in a vertical position until the flowmeter stabilizes.
    - Both monitors are calibrated so that a flowmeter reading of 4.5 is equivalent to a flow rate of 5.0 liters per minute (lpm). This information is found on the Flow Calibration form included with the monitor. When the flowmeter reads “4.5,” the flow rate is recorded as “5.0 lpm.”
    - The center of the ball in the flowmeter should align with the pencil marks at approximately 4.5. If the ball aligns with the pencil mark, the flow rate is correct and should be recorded as “5.0 lpm.”

- If the ball does not align, adjust the flow rate using the flow adjustment knob until the center of the ball is at the pencil line. Once the flow is properly adjusted, record the flow rate as "5.0 lpm."
- Press the On/Auto/Off button to stop the sampler pump.

3. Assemble milk-crate stand with two milk crates, brick for weight, and zip ties.
4. Assemble PM2.5 impactor/filter holder assembly. Refer to Fig. 4.3 in manual.
5. Check monitoring schedule to determine which filters to load.
    - Loading a filter:
        - Keep quartz filter in refrigeration bag with blue ice until loading.
        - Load indoors or in vehicle.
        - Touch only the cartridge, not the surface of the filter.
        - Remove filter from plastic package (save package for later use).
        - Place filter in inlet with the letters on the filter facing up.
        - Keep inlet vertical once filter is loaded.
        - Be sure to record filter ID on Field Data Sheet.
    - Loading a field blank filter:
        - Keep field blanks with other filters at all times.
        - Load field blank first using above procedure.
        - After loading, immediately remove field blank from monitor.
        - Return field blank filter to package.
        - Place package in monitor case:
            - Use double-sided tape to attach package to case door.
            - Make sure that package does not interfere with flow adjust knob or other monitor equipment.
        - Record filter ID on Field Data Sheet. *DO NOT* indicate on FDS that a filter is a field blank (the lab can't know). Instead, enter the dummy location preselected as the field blank indicator.
        - After the sample, keep field blank with other filters at all times.
    - Collocating filters:
        - When collocating, both monitors are loaded with filters of the same type (2 quartz or 2 Teflon).
        - Consult the monitoring schedule to determine which type of filter to use for collocation.
        - Follow normal procedures for filter loading.
        - Designate one monitor as the sampling monitor, the other as the collocation monitor.
        - Be sure to record which is which on Field Data Sheet (it's ok if the lab knows).
6. Attach impactor/filter holder assembly to monitor.
7. Extend inlet tube. Inlet tube may need to be loosened by unscrewing.
8. Position milk-crate stands at location using ladder. Satisfy siting criteria:
    - *NO* objects impeding air flow within 12 inches of inlet.
    - *NO* nearby trees.
    - Position inlet 36 inches from ground or roof surface.
    - Keep MiniVols three feet apart from each other.
    - Flat, stable surface for placing milk-crate stands.
    - Where necessary, find an anchor for attaching locks.
    - Minimal visibility from roads or public areas.
9. Program the timer (refer to manual section 2.4)
    - Verify that the Real-Time clock has the correct day and time.

- Set "Prog 1" "ON" and "OFF" times for a 24-hour run.
- Choose an ON time at least ten minutes in the future to allow for monitor placement.
- Pay close attention to Day and Time to ensure that the run is exactly 24 hours.
- Do not set more than one program.
- Have someone else independently verify programmed settings for a 24-hour run.

10. Attach air monitor to milk-crate stand with bungee cord.
11. Lock down monitors where necessary.
12. Set monitor to "AUTO."
13. Verify that monitor switches on at programmed time.
14. Note initial elapsed time reading.
15. Record initial flow rate. Refer to step 2 above. Flow rate should be 5.0 lpm.
16. Complete Field Data Sheet. Use smart phone or computer for weather conditions (wind speed, temperature, barometric pressure). Include any comments about weather or site.
17. Arrange to retrieve monitors in 24 hours.

Dust Trak Set-Up

1. Clean Dust Trak components with compressed air.
2. Place monitor on location. Satisfy citing criteria:
    - *NO* objects impeding air flow.
    - *NO* nearby trees.
    - Flat, stable surface for placing monitor.
    - Available site power within 50 feet.
    - Where necessary, anchor for attaching locks.
    - Minimal visibility from roads or public areas.
3. Attach outdoor power cord to Dust Trak.
4. Attach 50 foot extension cord to outdoor power cord.
5. Plug extension cord into site power.
6. Calibrate the monitor:
    - Put the zero calibration component on the monitor inlet.
    - Push the power button to turn the monitor on.
    - Use the stylus to navigate the menus.
    - Select "Setup" to get to the setup menu.
    - Select "zero calibration."
    - Allow the monitor to calibrate.
    - Remove the zero calibration component.
7. Assemble inlet components:
    - Ensure that water catch bottle is empty.
    - Attach inlet hose from inlet to monitor.
    - Attach PM2.5 sampling component.
8. Program a 24-hour run with 5 minute sampling:
    - Select "Run Mode."
    - Select existing site or enter new site name.
    - Set testing length for 1 day, 0 hours, 0 minutes. Save.
    - Select log interval of 5 minutes.
    - Do not program more than one test.
    - Ignore "time between tests."
    - Select start date.

- For "Use start time" select "Yes."
- Set start time.
- For "Auto Zero" select "No."
- Ignore "Auto Zero Interval."
- Return to Main Menu.
- Set "Run Mode" to "Program."
- Select "Start."

9. Have someone else independently verify programming.
10. Verify that monitor switches on at programmed time.

MiniVol TAS Takedown:

1. Verify that monitor switched off (listen for pump).
2. If a field blank was included:
    - Open monitor case and remove field blank in package.
    - Verify that field blank ID matches Field Data Sheet.
    - Return field blank to refrigerated back.
    - Keep field blank with other filters at all times.
3. Check final elapsed time reading: should be initial elapsed time reading plus 1.0 days.
4. Check final flow rate and record on Field Data Sheet. Refer to step 3 in MiniVol TAS setup.
5. Disassemble inlets and remove Teflon and quartz filters:
    - Take off inlets, remove filters from inlets indoors or in vehicle.
    - Return filters to plastic packages.
    - If a field blank was included, open its package briefly when taking it out of the monitor case.
    - Verify that filter IDs match those on Field Data Sheets.
    - Store filters in refrigerated bags with blue ice for transport. Note that while only quartz filters must be refrigerated, we store all filters in freezer for ease.
    - Return filters to freezer.
6. Complete Field Data Sheets.
7. Return all monitoring components and accessories to Air Alliance office.
8. Store batteries outside of sampler and with 40% or less charge. Failure to do so will shorten battery life.
9. Use Chain of Custody form to track filters until shipment for analysis.
10. Inform site owner/contact of completed run.

Dust Trak Takedown

1. Verify that Dust Trak completed 24-hour run.
2. Disassemble power cord and inlet components, place in case for storage.
3. Power down monitor.
4. Close and lock hard case, place in soft case.
5. Store all monitor components and accessories in Air Alliance office.
6. Download completed run data to Air Alliance computer.
7. Email run data to GCM.
8. Inform site owner/contact of completed run.