Health Consultation

Exposure Investigation

Ambient Airborne Exposures to Hydrogen Sulfide and Particulate Matter

INDUSTRIAL PIPE INC.
BELLE CHASSE, LOUISIANA
COST RECOVERY NUMBER: AP6I00

AUGUST 21, 2017

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared By:

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry (ATSDR)
Division of Community Health Investigations

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Acronyms

Acronym	*Definition*
AQI	Air Quality Index
ATSDR	Agency for Toxic Substances and Disease Registry
DAS	data acquisition system
DQO	data quality objectives
C&D	construction and demolition
CDC	Centers for Disease Control and Prevention
E-BAM	beta attenuation monitor (MetOne)
EI	exposure investigation
EPA	Environmental Protection Agency
ERG	Eastern Research Group, Inc.
H_2S	hydrogen sulfide
HASP	health and safety plan
LA	Louisiana
LDEQ	Louisiana Department of Environmental Quality
mA	milliamps
$\mu g/m^3$	micrograms per cubic meter
mg/m^3	milligrams per cubic meter
MRL	Minimal Risk Level
NAAQS	National Ambient Air Quality Standards
$PM_{2.5}$	particulate matter with aerodynamic diameter less than 2.5 microns
ppb	parts per billion
ppm	parts per million
QA	quality assurance
QC	quality control
REL	reference exposure level
SPM	single point monitor

Executive Summary

Background/Request

The Industrial Pipe Landfill is a large construction and demolition debris (C&D) landfill (disposal area of 65.7 acres) located immediately to the north of the Oakville community (Figure 1). The Industrial Pipe Landfill began as an unpermitted dump in the 1980s. In 2004, it received a C&D solid waste permit from Louisiana Department of Environmental Quality (LDEQ). In September of 2015, LDEQ issued a renewal permit (LDEQ 2015) that allows the landfill to continue operating for another 15 years. Other industrial facilities in the area include a metal recycling facility immediately east of the landfill and a refinery approximately 1.8 miles northeast of the Oakville community.

At the request of local residents, the Agency for Toxic Substances and Disease Registry (ATSDR) conducted an Exposure Investigation (EI) to evaluate ambient air quality in residential areas located near Industrial Pipe Landfill. During initial site visits to plan the EI, area residents indicated that, in addition to smelling sulfur odors, they sometimes saw smoke coming from facilities immediately north of the Oakville community. In order to address this concern, in addition to concerns about hydrogen sulfide, particulate matter with an aerodynamic diameter less than 2.5 microns ($PM_{2.5}$) was also included in the EI.

Conclusions

All of the concentrations of hydrogen sulfide measured during the 6-weeks of air testing were below health-based comparison values for acute and intermediate exposure. The 6-week average concentration of $PM_{2.5}$ was below the chronic health-based comparison value. All 24-hour concentrations of $PM_{2.5}$ were below the 24-hour National Ambient Air Quality Standard (NAAQS) for $PM_{2.5}$. On four days, the 24-hour average $PM_{2.5}$ concentration was in the moderate Air Quality Index (AQI) range.

Based on the six weeks of available data, there were no measured concentrations that would result in expected harm to health or likely health effects from inhalation of hydrogen sulfide or $PM_{2.5}$ in the vicinity of Industrial Pipe Landfill. ATSDR was not able to replicate the maximum concentrations measured during monitoring conducted by community members. ATSDR notes that hydrogen sulfide regularly exceeded its lowest odor threshold (0.5 ppb) and was sometimes measured at concentrations that would likely have an obvious odor. For some people, smelling a noxious smell like the rotten egg odor of hydrogen sulfide can be stressful and may lead to odor-related health symptoms, such as, headaches, and nausea. Odor related symptoms usually go away when the odor is gone. Community concern about reoccurring odors in the area is likely associated with hydrogen sulfide in the ambient air.

Limitations

A limitation of the EI is that the results are only applicable to the 6-week air sampling time-frame and areas tested (six weeks in January – February 2017). Contaminant levels may be higher or lower during other times of year, different weather conditions, or during different landfill operations. The results cannot be generalized to other populations because this investigation focused on people in the Belle Chasse area located in proximity to Industrial Pipe

Landfill. In addition, results of this EI cannot predict the past, current, or future occurrence of adverse health effects or symptoms in individuals. An additional limitation of the EI is that $PM_{2.5}$ was only measured at one of the three sampling locations.

Recommendations

ATSDR makes the following recommendations:

1. Area residents are encouraged to keep odor diaries documenting the frequency, intensity, duration, and offensiveness of any odors they smell while at their homes. These odor diaries can be shared with the state or local health department to provide documentation of the location, frequency, and magnitude of odors smelled in the community. Odor diaries can be shared with the Louisiana Department of Health at 1-888-293-7020. More information on environmental odors and odor diaries is available at https://www.atsdr.cdc.gov/odors/index.html.

2. If residents observe smoke coming from the landfill, or if odors become so severe that they affect regular activities, they should notify the Louisiana Department of Health at 1-888-293-7020.

3. Although, based on the air monitoring data collected during this EI, harmful health effects are not expected from the concentrations of hydrogen sulfide around Industrial Pipe Landfill, residents who experience symptoms related to environmental odors should try to reduce their exposure as much as possible. Steps to take include limiting exertion when odors are present or avoiding exposure during periods when odors may be more common (8:00 – 10:00 AM).

Purpose of the Exposure Investigation

The purpose of this Exposure Investigation (EI) was to measure hydrogen sulfide (H_2S) and particulate matter with an aerodynamic diameter less than 2.5 microns ($PM_{2.5}$) in ambient air at residences near the Industrial Pipe Landfill in Belle Chasse, LA. Community residents requested ATSDR assistance in this effort by submitting a petition with their concerns. A community-based ambient air sampling program was conducted over a six-week period in winter 2017 to obtain representative concentrations of H_2S and $PM_{2.5}$, as well as meteorological parameters at residential properties near Industrial Pipe Landfill.

This investigation was designed to evaluate community exposures to the selected pollutants; it was not designed to determine regulatory adherence to any National Ambient Air Quality Standards (NAAQS) or other national, state, or local regulatory air quality standards.

Background and Community Concerns

The petitioner contacted ATSDR in April, 2015 and requested that it evaluate the health impacts of hydrogen sulfide emissions from the Industrial Pipe Landfill to residents of the Oakville community of Belle Chasse, Louisiana. The petitioner indicated that residents are being adversely impacted from landfill gas emissions in the community.

The Environmental Protection Agency (EPA) defines C&D debris as waste material from construction, renovation, or demolition of structures (EPA 2016a). Most C&D waste results from renovation and demolition of buildings, roads, and bridges and from debris secondary to natural disasters. Overall, C&D waste is composed of wood products, asphalt, drywall, and masonry. Other components often present in significant quantities include metals, plastics, soil, shingles, insulation, and paper (EPA 2016).

The anaerobic degradation of drywall often leads to the formation of hydrogen sulfide (H_2S). Drywall is composed of an inner core of gypsum (calcium sulfate) with a paper facing and backing (Gypsum Association 1992). When exposed to water, the sulfate in the gypsum dissolves. The production of hydrogen sulfide occurs in C&D landfills through the anaerobic breakdown of calcium sulfate (Florida 2004). Hydrogen sulfide emissions from C&D landfills can cause serious harm to human health and the environment. Air sampling studies on and near C&D landfills have demonstrated that hydrogen sulfide is emitted and does affect off-site air quality (Yang et al. 2006).

C&D landfills are capable of emitting hydrogen sulfide at levels that exceed the ATSDR Minimal Risk Level (MRL) of 70 parts per billion (ppb) for acute exposures, 20 ppb for intermediate exposure, and US EPA's chronic reference concentration of 1.4 ppb (ATSDR 2016; EPA 2015). Hydrogen sulfide characteristically has a very strong odor at very low concentrations (10 – 100 ppb) and is known to cause health effects in humans at high concentrations. However, it can be smelled at concentrations as low as 0.5 ppb (ATSDR 2014). C&D waste landfills often offer an ideal environment for H_2S production because they frequently contain moisture, little or no oxygen, and may contain other waste components and organic matter. When large amounts of

gypsum drywall are present in a landfill, and a sufficient amount of water is present, hydrogen sulfide is produced at high concentrations.

The Industrial Pipe Landfill is a large C&D landfill (disposal area of 65.7 acres) and is located at 11266 Highway 23, Belle Chasse, Louisiana. The landfill operates immediately to the north of the Oakville community (Figure 1). The Industrial Pipe Landfill began as an unpermitted dump in the 1980s (approximately 2.3 million cubic yards of C&D waste have been disposed of in the landfill). In 2004 it received a C&D solid waste permit from Louisiana Department of Environmental Quality (LDEQ). LDEQ has issued a renewal permit in September, 2015 (LDEQ 2015) that allows the landfill to continue operating for another 15 years. The waste is disposed in unlined pits to a depth of 15 feet, which is significantly below the water table in the area. Residents in the area get drinking water from a municipal water supply, not local wells that could be impacted by groundwater contamination. The permitted height of the landfill is 60 feet and the landfill does not have a landfill gas collection system (LDEQ 2015).

Community complaints were presented in the petition request ATSDR received related to this site:

> "Oakville residents complain of sickening odors from the landfill. Residents say that they smell odors from the landfill whenever the wind is coming from the direction of the landfill towards the community. They describe the odors as smelling like rotten eggs, sulfur, or "a burning stink." A former resident said that he had to move from the community because the landfill gases caused his baby to suffer severe respiratory problems. Another resident wonders if emissions from the landfill caused the crib death of her grandchild who died after a fire at the landfill burned for several weeks after accepting huge volumes of hurricane debris. During a recent trial involving the landfill, a resident said that the odors from the landfill can be so bad that at times "he can't be outside." Others say that they shut their windows to keep the odors out." (Tulane 2015).

Limited air sampling for hydrogen sulfide (no quality assurance/quality control [QA/QC] information is available) was performed by the petitioner in 2014 on behalf of the Oakville Community Action Group. Air samples were reported to be taken downwind (no meteorological information is available) of the landfill with a portable Jerome® J605 Hydrogen Sulfide Analyzer. The measured H_2S concentrations (from below detection levels up to a maximum measured concentration of 169 ppb) in the air occasionally exceeded the ATSDR health-based comparison values (intermediate MRL of 20 ppb and acute MRL of 70 ppb). Community sampling was performed for a few hours over approximately one week (May 30 – June 6, 2014). While this monitoring only captured moments in time, it did confirm the presence of H_2S in the ambient air in Oakville. During a site visit in May 2016, ATSDR and Eastern Research Group (ERG) staff collected hydrogen sulfide measurements with a Jerome® 631X Hydrogen Sulfide Analyzer. These readings were collected on two mornings in and around Oakville. Concentrations ranged from non-detect to 4 ppb for the readings collected by ATSDR and ERG.

Based on conversations with community members, odors are strongest in Oakville during periods when winds are from the north. Residents also noted that odors are strongest between December and March and in the morning and evening hours. Based on these observations from

residents, and the analysis of prevailing wind directions, a six week EI in January-February had the potential to capture worst case odor conditions within Oakville.

There have been complaints of periodic fires from the landfill or "burning" odors within Oakville. During the site visit in May 2016, ATSDR staff observed evidence of smoke and burning smells in and around Oakville. These fires may or may not be associated with the landfill as the source of the odors was not always apparent. Because of these observations, one of the two hydrogen sulfide monitoring locations within Oakville for this EI was also outfitted with a monitor for $PM_{2.5}$ to provide a surrogate measurement for the smoke observed in the area.

There is other industrial activity in the vicinity of Belle Chasse, including a petroleum refinery approximately 1.8 miles northeast of the Oakville community. The sampling strategy for the EI was designed in such a way that information about the likely source of any H_2S or particulate matter in Oakville can be obtained (i.e., sampling locations both to the north and south of the Industrial Pipe Landfill were included).

Methods

Exposure Investigation Design

The design of the EI was detailed in an EI Protocol that was developed specifically for this site (ATSDR 2016b). The protocol included guidelines for siting of sampling locations, selecting an appropriate duration and season for the EI, and descriptions of the instrumentation to be used in the EI. The EI protocol is provided as Appendix A.

The EI included a network of sites staged in a pattern that placed monitoring/sampling equipment in areas where community exposures to landfill emissions were expected to exist. Two sites were located in Oakville (south of the facility) that were predicted to be downwind of the landfill most frequently. One site was located to the north of the facility to provide improved spatial coverage of the area.

The EI was conducted over six weeks from January 11, 2017 through February 23, 2017. Three sampling locations were selected for H_2S with collocated monitors at one location. $PM_{2.5}$ was also measured at one location. Monitoring locations are shown in Figure 1. Residents at these three locations were requested to complete odor logs to track how frequently they were able to smell any unpleasant odors during the EI. EI field staff also completed odor logs while in and around the community. An example of an odor log is provided as Appendix B.

Measurements of H_2S were made using Honeywell single point monitors (SPM). The linear detection range for instruments used to monitor outdoor and indoor low levels is 3-90 ppb. However the instruments were calibrated from 0-90 ppb. Continuous measurements of $PM_{2.5}$ were made using a Met One Instruments, Inc. E-BAM real-time beta attenuation monitor. The E-BAM is a portable self-contained unit that meets or exceeds all EPA requirements for automated particulate measurement. The measurement range for the unit is 0-10 mg/m^3.

Data Quality Objectives

Data Quality Objectives (DQOs) are measures used to determine how good data must be in order to achieve the project goals. For this EI, there were both operational and technical DQOs specified in the EI protocol. All operational DQOs were satisfied in the design of the EI and the data collected met the technical DQOs. A quantitative discussion of the DQOs is provided in Appendix C.

Results

Hydrogen Sulfide

Measurements of hydrogen sulfide during the EI are summarized in Table 1. Small negative concentrations (-0.8 to -002 ppb) occurred during 40 -56% of the 1-minute monitor readings. According to the manufacturer of the instrument, this could be the result of moisture. These slightly negative concentrations are not uncommon when air concentrations of hydrogen sulfide are low. Although small in magnitude, negative 1-minute results are physically unrealistic. Therefore, all reported negative concentrations were set to 0 ppb when calculating concentrations for longer averaging times. This data treatment is conservative but it could potentially add a slight positive bias to calculations of mean concentrations. Only periods with at least 75% data completeness (23 measurements for 30 minute averages, 45 measurements for 1-hour averages, and 1,080 measurements for 24-hour averages) were included in the calculations. Period average (6-week) concentrations were calculated from 24-hour averages.

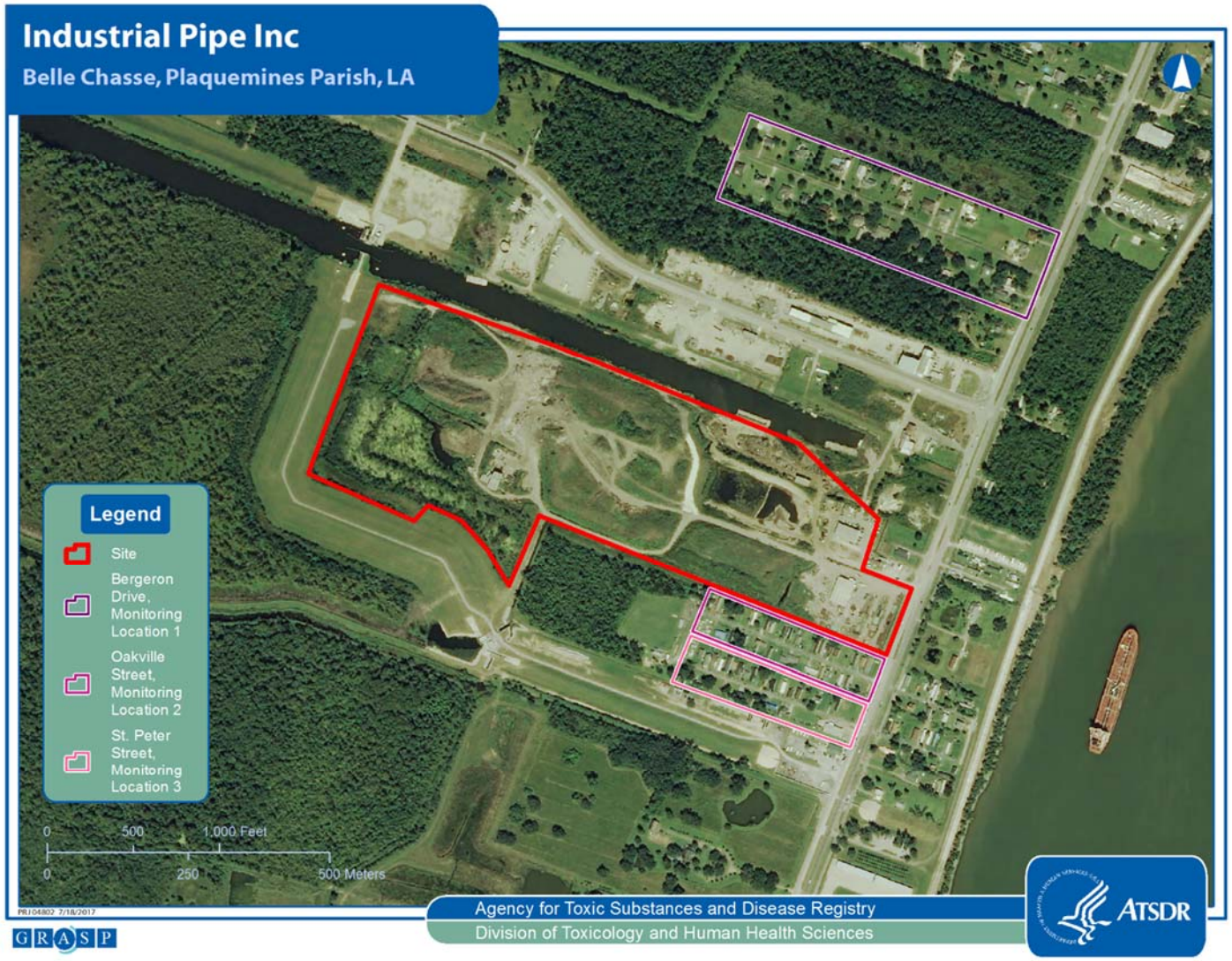

Figure 1. Study Area with Monitoring Locations

Table 1. Hydrogen Sulfide Results

Monitoring Location	*Maximum Measured Concentrations (ppb)*				*6-Week Concentrations (ppb)*		*Percent of Hours Downwind*
	1-Minute	*30-Minute*	*1-Hour*	*24-Hour*	*Mean*	*95th Percentile UCL of Mean*	
Monitoring Location 1 (Bergeron Dr)	43.71	39.89	25.72	2.86	1.54	1.57	31%
Monitoring Location 2 (Oakville St)	56.80	46.21	27.97	4.24	1.44	1.48	16%
Monitoring Location 3 Primary (St. Peter St)	23.16	22.29	21.35	3.31	1.30	1.32	14%
Monitoring Location 3 Collocated (St. Peter St)	21.10	20.58	20.05	3.12	1.13	1.15	14%

UCL: Upper Confidence Limit

All acute concentrations (1-minute, 30-minute, 1-hour, and 24-hour) were below the ATSDR acute Minimal Risk Level of 70 ppb.

All intermediate concentrations (6-week mean and 95th percentile UCL of 6-week mean) were below the ATSDR intermediate Minimal Risk Level of 20 ppb.

The maximum measured concentration of hydrogen sulfide at a monitoring location during the exposure investigation was 56.8 ppb measured as a 1-minute concentration at Monitoring Location 2. Winds were from the WSW when this maximum concentration was measured. Monitoring Location 2 also had the highest measured 30-minute and 1-hour concentrations, but all of the measured concentrations were below the ATSDR acute MRL for hydrogen sulfide of 70 ppb. Monitoring Location 1 had the highest period mean concentration of 1.54 ppb (and 95th percentile upper confidence limit (UCL) of the mean of 1.57 ppb). The 95th percentile UCL of the mean concentration is a conservative estimate of the mean concentration and was below the ATSDR intermediate MRL of 20 ppb at all monitoring locations.

Particulate Matter

Measurements of $PM_{2.5}$ during the EI are summarized in Table 2. Negative hourly concentrations reported by the E-BAM were set to 0 $\mu g/m^3$ in the averaging process. 25% of the hourly E-BAM readings were negative (ranging from -5 to -1 $\mu g/m^3$). Negative hourly concentrations were discussed with the instrument manufacturer representatives, and these can occur due to the nature of the instrument detection system when air concentrations are low. Only days with at least 75% data completeness (18 1-hour measurements) were included in the calculations. Period average (6-week) concentrations were calculated from 24-hour averages.

Table 2. Particulate Matter Results

Monitoring Location	*Maximum Measured Concentrations ($\mu g/m^3$)*		*6-Week Concentrations ($\mu g/m^3$)*		*Percent of Hours Downwind*
	1-Hour	*24-Hour*	*Mean*	*95th Percentile UCL of Mean*	
Monitoring Location 2 (Oakville St)	83.0	15.2	8.5	8.6	16%

UCL: Upper Confidence Limit

All 24-hour concentrations of $PM_{2.5}$ were below the 24-hour National Ambient Air Quality Standard for $PM_{2.5}$ (35 $\mu g/m^3$).

Four 24-hour concentrations were in the Air Quality Index moderate range (12.1 – 35 $\mu g/m^3$).

All intermediate concentrations (6-week mean and 95th percentile UCL of 6-week mean) were below both the World Health Organization's air quality guideline and the Environmental Protection Agency's National Ambient Air Quality Standard for chronic exposure.

The maximum 1-hour concentration of $PM_{2.5}$ measured during the EI was 83 $\mu g/m^3$. Health-based comparisons values for $PM_{2.5}$ are based on exposure of 24-hours or on an annual average basis. The highest 24-hour average $PM_{2.5}$ concentration of 15.2 $\mu g/m^3$ is below both the nominal value of the EPA's National Ambient Air Quality Standard (NAAQS) for $PM_{2.5}$ of 35 $\mu g/m^3$. It is slightly above the cutoff for moderate Air Quality Index (AQI) of 12.1 $\mu g/m^3$. There were four 24-hour concentrations in the moderate AQI range out of 41 valid daily measurements collected. For concentrations in the moderate AQI range, EPA states that there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution (EPA 2016b). The 95th percentile UCL of the mean $PM_{2.5}$ concentration is 8.6 $\mu g/m3$ which is below both the nominal value of the annual NAAQS for $PM_{2.5}$ (12 $\mu g/m^3$) and the annual World Health Organization (WHO) guideline for $PM_{2.5}$ (10 $\mu g/m^3$). There were no reports of fires or observations of smoke during the EI data collection period so it is not possible to evaluate the effect of those events on $PM_{2.5}$ concentrations in Oakville.

Odor Logs

Each resident who had equipment placed on their property to measure contaminant concentrations during the EI was also provided with odor logs that could be completed to indicate the frequency, intensity, duration, and offensiveness of any odors observed during the EI. None of the residents returned completed odor logs to ATSDR upon completion of the EI. At the end of the EI, residents indicated that they did not complete the odor logs because they did not smell any odors during the EI. EI field staff completed a log of all odors detected during field measurements, but field staff were not in the community overnight or in the early morning hours to observe potential odors during those times. Field staff noted odors on four occasions during the EI, three times at Monitoring Location 1 (Bergeron Drive) and once at Monitoring Location 2 (Oakville Street). A mild manure smell was observed at Monitoring Location 1 on January 11 at 12:05 pm. A mild odor of sewage was observed at Monitoring Location 1 twice, on January 22 at 12:11 pm and on January 31 at 11:30 am. A strong sulfur odor (described as a "firecracker"

smell) was observed at Monitoring Location 2 on January 27 at 2:17 pm. None of the odors observed by field staff affected normal activities of a healthy adult while working in the community. The hydrogen sulfide concentrations measured at the monitoring locations when these odors were detected were all below the 3 ppb detection limit. It is possible that the odor detected was a different sulfur compound (sulfuric acid, dimethyl sulfide, dimethyl disulfide, or methyl mercaptan) that was not detected by the chemical-specific monitor used to measure hydrogen sulfide.

Meteorological Data

Meteorological measurements collected during the EI are summarized in Appendix D. All meteorological data were collected from Monitoring Location 2 on Oakville Street. These data are used in the discussion section to place the contaminant measurements in context. Additionally, data from a permanent station to the north of Industrial Pipe Landfill (at Naval Air Station Joint Reserve Base New Orleans [NAS]) are used to compare meteorological conditions measured during the EI to typical meteorological conditions for winter. There was measureable precipitation on seven days during the exposure investigation with a maximum daily rainfall of 0.29 inches and total rainfall during the EI of 1.13 inches. The percentage of hourly averaged hydrogen sulfide and $PM_{2.5}$ observations where the sites were downwind of the landfill are shown in Table 1 and Table 2.

Discussion

All of the measured concentrations of both hydrogen sulfide and $PM_{2.5}$ during this EI were below the applicable ATSDR (hydrogen sulfide) or EPA/WHO ($PM_{2.5}$) health-based comparison values for both acute and intermediate/chronic exposure. The discussion provided here attempts to place the measured concentrations in context by examining general health effects associated with environmental odors, daily patterns in the measured data, and the wind conditions measured during the EI.

General Health Effects Associated with Environmental Odors

ATSDR's chemical-specific evaluation for hydrogen sulfide and particulate matter relies upon dose-effect relationships from the scientific literature to determine if exposure to a chemical could result in an irritant or toxic response. However, a substantial body of literature shows that offensive or objectionable odors themselves can cause health symptoms (Schiffman and Williams 2005, Bulsing et al. 2009). These symptoms may result from protective inborn or learned aversions to offensive odors, which may signal danger or threats to health (Bulsing et al. 2009, Schiffman et al. 2000, Shusterman 2002). The presence of odors in a community can also lead to a diminished comfort and sense of well-being for community members (ATSDR 2017).

Health complaints reported from exposure to offensive odors (such as emanating from animal processing facilities, wastewater treatment plants, or landfills) include eye, nose, and throat irritation; headache; nausea; diarrhea; hoarseness; sore throat; cough; chest tightness; nasal congestion; palpitations; shortness of breath; stress; drowsiness; and alterations in mood (Shusterman 2002). Usually the symptoms occur at the same time as the odor and resolve when the odor goes away. However, in sensitive people, such as those with asthma, the very young, or the very old, odors can result in symptoms that last longer and may aggravate existing medical

conditions (Schiffman et al. 2000). In addition, previous exposure to high levels of an irritating substance has been shown to make some people acutely sensitive to the substance in the future. If these people smell even very low levels of the substance, they might experience symptoms ranging from headaches and nausea to effects associated with panic attacks, such as lightheadedness or shortness of breath (Shusterman 2002).

ATSDR notes that hydrogen sulfide regularly exceeded its lowest odor threshold (0.5 ppb) and was sometimes measured at concentrations that would likely have an obvious odor. For some people, smelling a noxious smell like the rotten egg odor of hydrogen sulfide can lead to discomfort, stress, and distress and may lead to odor-related health symptoms, such as, headaches, and nausea. Odor-related symptoms usually go away when the odor is gone.

ATSDR has developed a website with information on environmental odors. The website (http://www.atsdr.cdc.gov/odors/index.html) contains additional reference information on effects of odors on health as well as resources for residents who are concerned about odors in their community.

Daily Patterns

Time variation plots showing the average concentration of hydrogen sulfide by hour of the day are presented in Figure 2 for each monitoring location. The solid lines in Figure 2 are the mean concentrations for each hour and the shading shows the 95th percentile confidence limits for the mean. In general, the daily (diurnal) concentration profile is similar among the three monitoring locations. Concentrations are lowest during the middle of the day, increase slightly overnight, and have a peak between 8:00 and 9:00 AM before decreasing to close to zero by noon. Peak concentrations at Monitoring Location 3 are lower than those measured at Monitoring Location 1 and Monitoring Location 2. While the concentrations during the peak hours are still below all ATSDR health-based comparison values, the data indicate that exposure is greatest in the morning between 8:00 and 10:00 AM. The higher concentrations measured during this time of day suggest that odors may be more prevalent in the morning than at other times of day. This agrees with anecdotal reports about the frequency of odors from area residents and is consistent with typical diurnal meteorological patterns.

No clear daily pattern in $PM_{2.5}$ concentrations was observed over the duration of the EI. Average concentrations of $PM_{2.5}$ for all hours of the day were less than 20 $\mu g/m^3$.

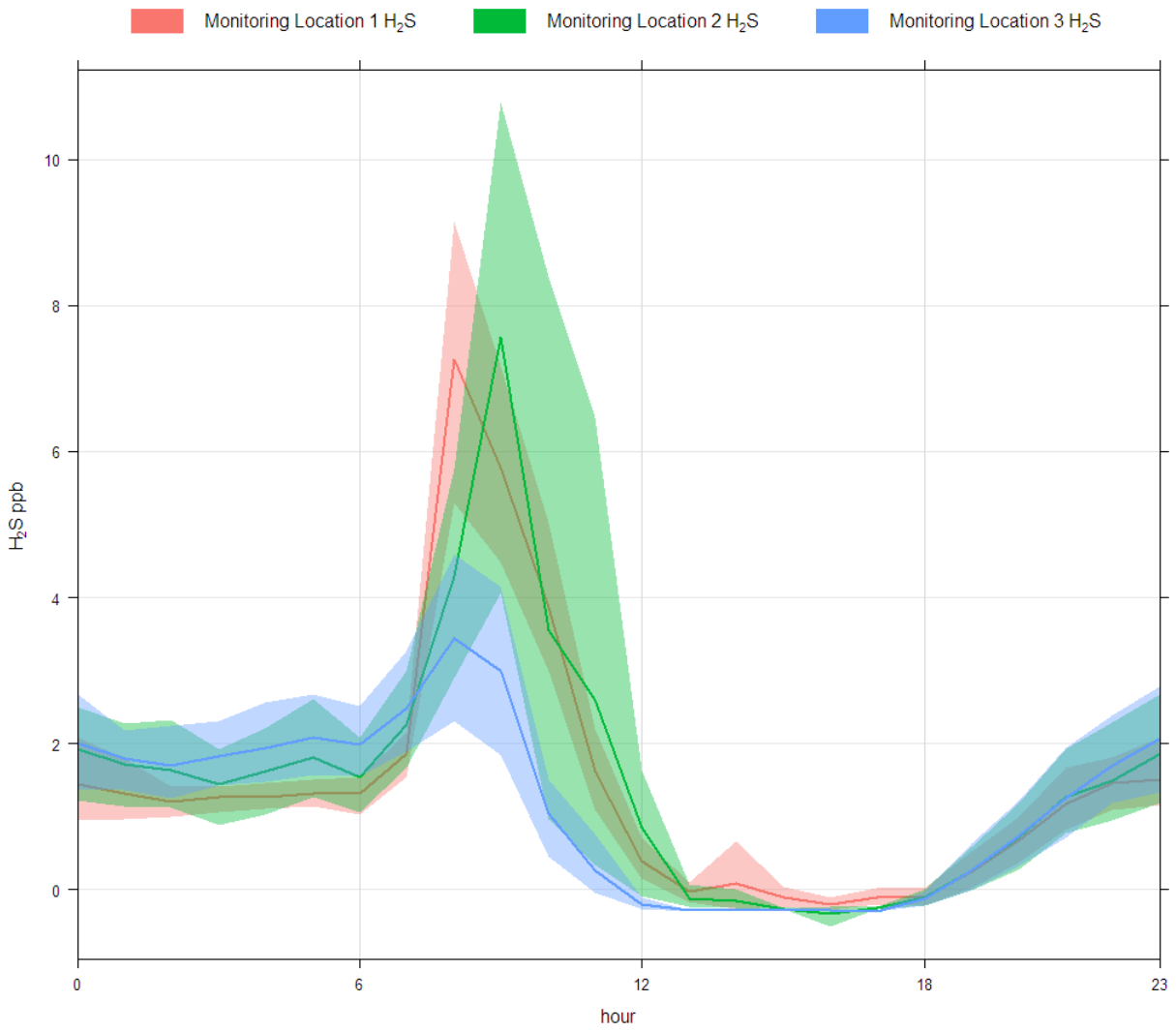

Figure 2. Time variation plot of hydrogen sulfide (H_2S) concentration by hour of the day for three monitoring locations in Belle Chasse, LA.

Wind Speed and Direction

The measured wind speed and direction from the onsite station (Figure 3) show some differences when compared to data collected during the EI time period from a permanent station located at NAS to the north of Oakville (Figure 4). Data from NAS show higher wind speeds than measured at the onsite station, but this is expected as the onsite data were collected at approximately 2 meters while the data from NAS are from a 10 meter meteorological tower. Onsite data give a predominant wind direction from the SSE while data from NAS show winds from the South as the most common. Onsite data also show more winds from the NW than observed at the NAS. While wind data between the two stations do show some differences, the general patterns, with most winds being generally from the south (SSE to SSW) are evident at both stations.

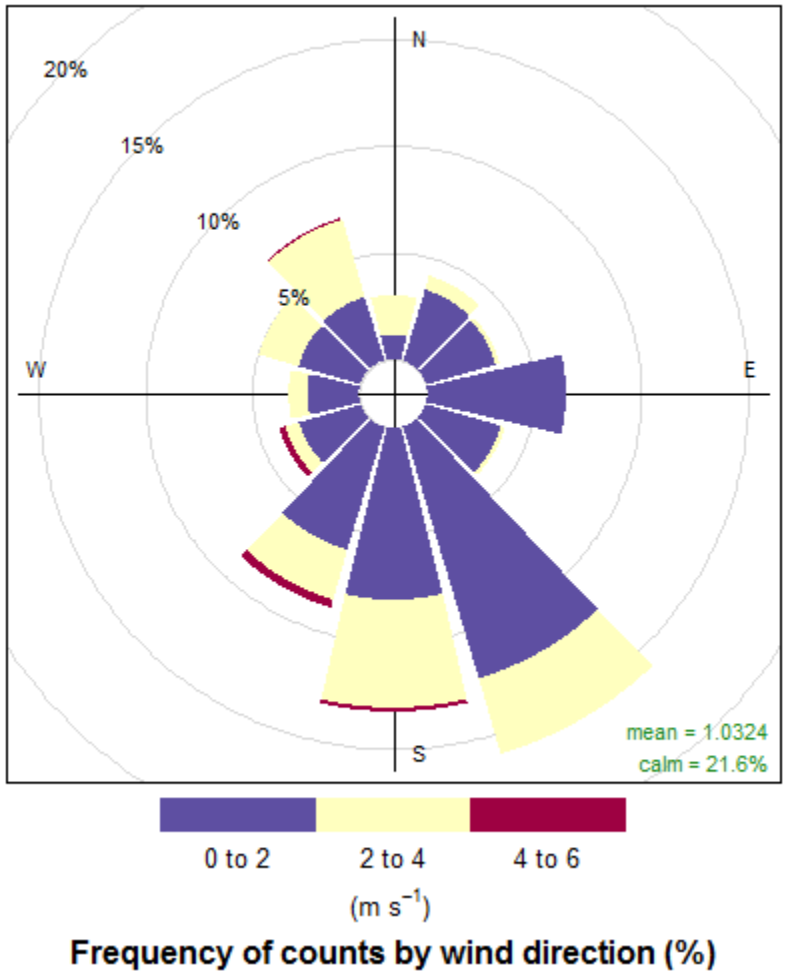

Figure 3. Wind rose for data collected at Monitoring Location 2 on Oakville Street from January 11 – February 23, 2017.

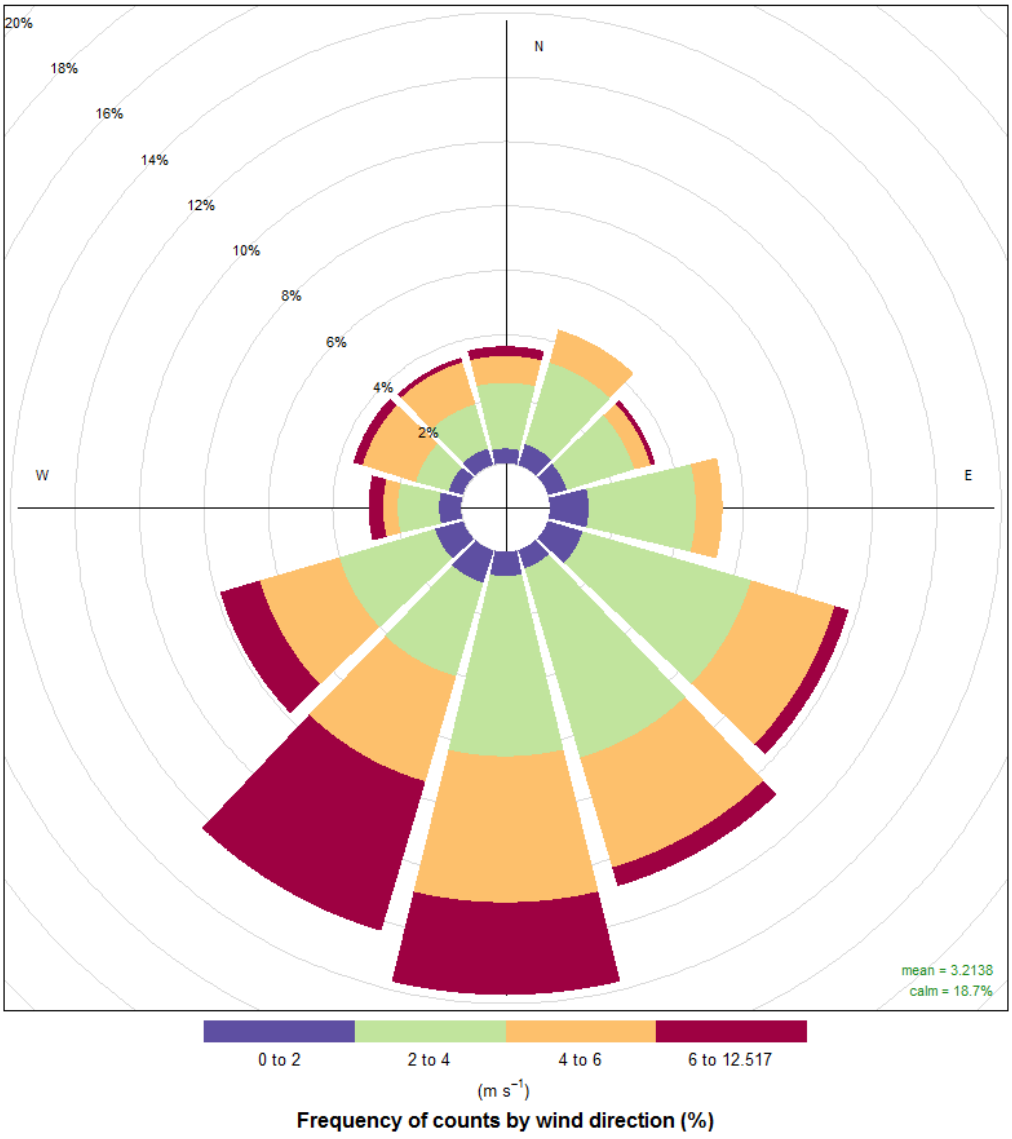

Figure 4. Wind rose for data collected at Naval Air Station Joint Reserve Base New Orleans from January 11 – February 23, 2017.

The observed wind patterns during the EI are not, however, typical of the winds usually observed during this time of year. Seasonal wind roses from NAS for 2011 through 2015 are shown in Figure 5. During a typical winter, winds are most often from the north or northeast at NAS. The winds observed during the EI time period more closely match typical spring or summer winds than winter winds. The EI was conducted during the winter so that winds from the north would be likely to transport any hydrogen sulfide emitted from the landfill to the Oakville community. Since these northerly winds were not very common during the EI measurement campaign, it is possible that the concentrations measured during the EI may not be representative of typical winter exposure in Oakville. While winds from the north were less frequent than expected, there were still some hours/days with winds from the north (including during the morning hours, which typically had higher measured concentrations). Even during these times with winds from the north, the maximum 1-minute concentrations of hydrogen sulfide measured in the

community were below ATSDR's acute MRL for hydrogen sulfide. While winters with more winds from the north might result in more odors being detected in the community, it is unlikely that measured concentrations of hydrogen sulfide would rise to levels of health concern if the wind pattern was more representative of winter conditions.

The relationship between measured concentrations of hydrogen sulfide and wind speed and direction was investigated at all monitoring locations but there was no clear pattern indicating that concentrations were higher when winds were blowing from the landfill to a monitoring location.

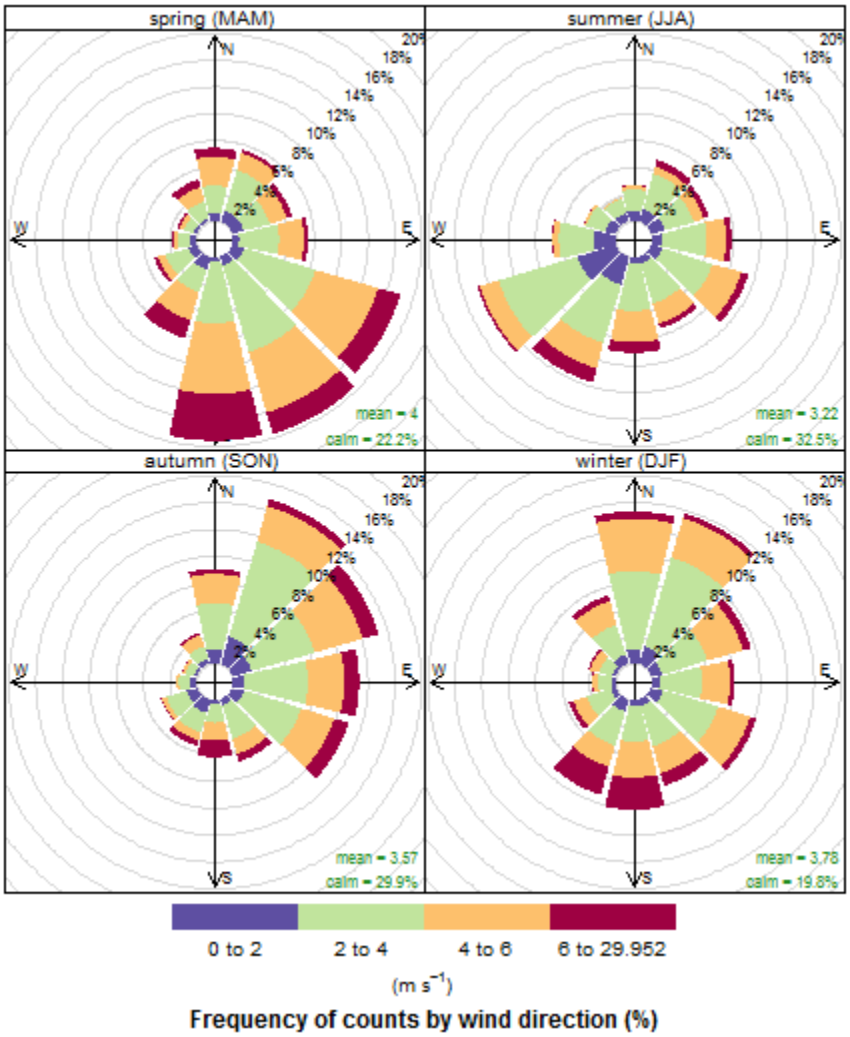

Figure 5. Seasonal wind roses at Naval Air Station Joint Reserve Base New Orleans, 2011 – 2015.

Conclusions

All of the concentrations of hydrogen sulfide measured during the 6-weeks of air testing were below health-based comparison values for acute and intermediate exposure. The 6-week average concentration of $PM_{2.5}$ was below the chronic health-based comparison value. All 24-hour

concentrations of $PM_{2.5}$ were below the 24-hour NAAQS for $PM_{2.5}$. On four days, the 24-hour average $PM_{2.5}$ concentration was in the moderate AQI range.

Concentrations of hydrogen sulfide were highest during the 8:00 and 9:00 AM hours at all monitoring locations. Hydrogen sulfide concentrations during these hours were often above odor detection thresholds so health effects associated with environmental odors are possible even though health effects due to toxic effects are not expected.

Based on the six weeks of available data, there were no measured concentrations that would result in expected harm to health or likely health effects from inhalation of hydrogen sulfide or $PM_{2.5}$ in the vicinity of Industrial Pipe Landfill. ATSDR was not able to replicate the maximum concentrations measured during monitoring conducted by community members. ATSDR notes that hydrogen sulfide regularly exceeded its lowest odor threshold (0.5 ppb) and was sometimes measured at concentrations that would likely have an obvious odor. For some people, smelling a noxious smell like the rotten egg odor of hydrogen sulfide can be stressful and may lead to odor-related health symptoms, such as, headaches, and nausea. Odor related symptoms usually go away when the odor is gone. Community concern about reoccurring odors in the area is likely associated with hydrogen sulfide in the ambient air.

The meteorological conditions during the EI were unusual for winter months in Belle Chasse. During the EI, winds were from the north less than half as often as during a typical winter. Complaints from residents mentioned winds from the north as an important factor in observing odors in their community so this unusual wind pattern may have resulted in reduced concentrations during the EI compared to a normal winter, and thus exposure may be underestimated. There was no clear relationship observed between higher measured concentrations and winds from the landfill to a monitoring location.

Concentrations of $PM_{2.5}$ measured during the EI were all below health-based comparison values for both 24-hour and annual average concentrations. There were no fires or smoke observed from the landfill during the EI so it is not possible to assess what the impact of such events would be on measured concentrations of $PM_{2.5}$ in Oakville.

Limitations

A limitation of the EI is that the results are only applicable to the 6-week air sampling time-frame and areas tested (six weeks in January – February 2017). Contaminant levels may be higher or lower during other times of year, different weather conditions, or during different landfill operations. The results cannot be generalized to other populations because this investigation attempts to specifically target people in the Belle Chasse area located in proximity to Industrial Pipe Landfill. Based on their location, these areas have the potential to have higher ambient air concentrations of contaminants that may be emitted from Industrial Pipe Landfill, resulting in a higher likelihood of exposure for the residents who breathe the air in this area. The wind directions during the EI was unusual for winter in Belle Chasse. An additional limitation of the EI is that $PM_{2.5}$ was only measured at one of the three monitoring locations.

Recommendations

ATSDR makes the following recommendations:

1. Area residents are encouraged to keep odor diaries documenting the frequency, intensity, duration, and offensiveness of any odors they smell while at their homes. These odor diaries can be shared with the state or local health department to provide documentation of the location, frequency, and magnitude of odors smelled in the community. Odor diaries can be shared with the Louisiana Department of Health at 1-888-293-7020. More information on environmental odors and odor diaries is available at https://www.atsdr.cdc.gov/odors/index.html.

2. If residents observe smoke coming from the landfill, or if odors become so severe that they affect regular activities, they should notify the Louisiana Department of Health at 1-888-293-7020.

3. Although, based on the air monitoring data collected during this EI, harmful health effects are not expected from the concentrations of hydrogen sulfide around Industrial Pipe Landfill, residents who experience symptoms related to environmental odors should try to reduce their exposure as much as possible. Steps to take include limiting exertion when odors are present or avoiding exposure during periods when odors may be more common (8:00 – 10:00 AM).

Public Health Action Plan

1. ATSDR will hold a Public Availability Session to provide information to the community regarding measured ambient air quality in the community.
2. ATSDR will share the results of this EI with the Louisiana Department of Health to make them aware of the findings and community concerns.

Author

Bradley P. Goodwin, Ph.D

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Attachments

Appendix A: Exposure Investigation Protocol

Appendix B: Odor Log

Appendix C: Data Quality Objectives

Appendix A. Exposure Investigation Protocol

Exposure Investigation Protocol

Ambient Airborne Exposures to Hydrogen Sulfide and Particulate Matter in Belle Chasse, LA

Industrial Pipe Landfill

Belle Chasse, LA

Cost Recovery Number AP6I00

September 2016

Prepared by:

Brad Goodwin
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations

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Acronyms

Acronym	*Definition*
ATSDR	Agency for Toxic Substances and Disease Registry
DAS	data acquisition system
DQO	data quality objectives
C&D	construction and demolition
CDC	Centers for Disease Control and Prevention
E-BAM	beta attenuation monitor (MetOne)
EI	exposure investigation
EPA	Environmental Protection Agency
ERG	Eastern Research Group, Inc.
H_2S	hydrogen sulfide
HASP	health and safety plan
LA	Louisiana
LDEQ	Louisiana Department of Environmental Quality
mA	milliamps
µg/m^3	micrograms per cubic meter
mg/m^3	milligrams per cubic meter
MRL	Minimal Risk Level
NAAQS	National Ambient Air Quality Standards
$PM_{2.5}$	particulate matter with aerodynamic diameter less than 2.5 microns
ppb	parts per billion
ppm	parts per million
QA	quality assurance
QC	quality control
REL	reference exposure level
SPM	single point monitor

Introduction

Purpose of the Exposure Investigation

The Agency for Toxic Substances and Disease Registry (ATSDR) proposes to conduct an Exposure Investigation (EI) to assess human exposure to airborne concentrations of hydrogen sulfide (H_2S) and particulate matter ($PM_{2.5}$, particulates) in ambient (outdoor) air at residential properties near Industrial Pipe Landfill operations in Belle Chasse, LA. Exposure to H_2S and $PM_{2.5}$ is of concern to area residents due to the close proximity of Industrial Pipe Landfill to residential areas. During this EI, a community-based ambient air monitoring program will be conducted over a six week period in winter 2017 to obtain representative community-based concentrations of hydrogen sulfide and particulates, as well as meteorological parameters at several residential/commercial properties near Industrial Pipe Landfill.

This EI is designed to provide information that can be used in the evaluation of public health implications of possible community exposures to airborne contaminants in areas near a construction and demolition (C&D) debris landfill in Belle Chasse, LA. This investigation is designed to evaluate community exposures to the selected pollutants and is not designed to determine regulatory adherence to any National Ambient Air Quality Standards (NAAQS).

Objective of the Exposure Investigation

The objective of this EI is to collect data that will allow ATSDR to evaluate whether people living in the vicinity of Industrial Pipe Landfill are being exposed to H_2S or $PM_{2.5}$ at concentrations that may pose a health hazard. Ambient air concentrations of these pollutants will be measured at 3-4 outdoor locations near the facility. ATSDR will examine the data for health implications by considering the measured concentration data, and the magnitude, frequency, duration, and location of exposure, as well as meteorological conditions.

Explanation of an Exposure Investigation

An EI is an approach ATSDR uses to fill data gaps in evaluating community exposure pathways. Its purpose is to better characterize human exposures to hazardous substances in the environment and to evaluate possible public health consequences related to those exposures.

An EI is not an exposure study. It is an effort to identify and measure exposure of those individuals who are most highly exposed. Our results are a public health service directed to the local population and are not generalizable to other populations. There is no control group for this investigation.

Exposure investigations must meet four criteria. They are:

1. Can an exposed population be identified?
2. Does a data gap exist that affects your ability to determine if a health hazard exists?
3. Can an EI address the data gap?
4. How would the EI results impact public health decisions?

Responses to these four criteria used in the decision making process for the Belle Chasse EI are presented in Appendix A.

Results of EI

The results of this EI will be evaluated in a health consultation prepared by ATSDR. A health consultation includes evaluation of the data, recommendations for appropriate actions to reduce exposures, and appropriate public health follow-up activities in the community. Appropriate health education and outreach activities will also be conducted. The data collected from this EI will enable health agencies to more accurately inform Belle Chasse community members about the potential health impacts of hydrogen sulfide and particulate matter concentrations measured near Industrial Pipe Landfill and at their homes.

This exposure investigation's data will be shared with Belle Chasse community members, the U.S. Environmental Protection Agency (U.S. EPA), Louisiana Department of Environmental Quality, Industrial Pipe Landfill, and other public health and environmental partners in the region. Data generated by this EI may lead to stricter permitting requirements and other health-protective policies and actions.

Investigators/Collaborators

Agency for Toxic Substances and Disease Registry

The ATSDR Principal Investigator, and Technical Lead for this project will be Brad Goodwin, PhD. Dr. Goodwin will serve as the primary liaison and contact between ATSDR, the community, and Eastern Research Group, Inc. (ERG, see below). Dr. Goodwin will obtain participant consent and deploy monitoring/sampling systems along with the ERG Field Scientist. The Site Team of Aaron Young, Luly Rosales-Guevara, and Jennifer Lyke will assist in developing the EI protocol, overseeing the field program, and communicating with community members. The Site Team will assist with data evaluation and composition of the health consultation.

Eastern Research Group, Inc.

As ATSDR's mission support contractor, ERG will assist ATSDR with the Belle Chasse EI. The ERG Program Manager for this EI will be Ms. Naida Gavrelis. Ms. Gavrelis will be responsible for the administrative oversight and quality assurance for this project. The ERG Project Director for this EI will be Mr. Scott Sholar. The ERG Senior Technical Advisor will be Mr. Dave Dayton. The ERG Program Manager, Project Director, and Senior Technical Advisor will work directly with the ATSDR EI team and will oversee all ERG activities associated with the EI, from planning through reporting. They will be supported by ERG data analysts and staff scientists.

Mr. Sholar also will serve as the primary Field Scientist. In this capacity, Mr. Sholar will secure equipment, perform the pre-deployment check out of the measurement and sample collection systems, deploy those systems, perform daily site visits, perform sample collections, perform data downloads, and conduct equipment recovery efforts. Mr. Sholar will coordinate and train other qualified ERG staff, as needed, to implement these activities on his behalf over the life of the field program.

Background and Community Concerns

The petitioner contacted ATSDR in April, 2015 and requested that it evaluate the health impacts of hydrogen sulfide emissions from the Industrial Pipe Landfill to residents of the Oakville community of Belle Chasse, Louisiana. The petitioner indicated that residents are being adversely impacted from landfill gas emissions in the community.

C&D debris landfills produce a significant amount of waste in the United States. The Environmental Protection Agency (EPA) defines C&D debris as waste material from construction, renovation, or demolition of structures (EPA 2016). Most C&D waste results from renovation and demolition of buildings, roads, and bridges and from debris secondary to natural disasters. Overall, C&D waste is composed of wood products, asphalt, drywall, and masonry. Other components often present in significant quantities include metals, plastics, soil, singles, insulation, and paper (EPA 2016).

The degradation of drywall often leads to the formation of hydrogen sulfide (H_2S). Drywall is composed of an inner core of gypsum (calcium sulfate) with a paper facing and backing (Gypsum Association 1992). When exposed to water, the sulfate in the gypsum dissolves. The production of hydrogen sulfide occurs in C&D landfills through the anaerobic breakdown of calcium sulfate (Florida 2004). Hydrogen sulfide emissions from C&D landfills can cause serious harm to human health and the environment. Air sampling studies on and near C&D landfills have demonstrated that hydrogen sulfide is emitted and does affect off-site air quality (Yang et al. 2006).

C&D landfills are capable of emitting hydrogen sulfide at levels that exceed the ATSDR Minimal Risk Level (MRL) of 70 parts per billion (ppb) for acute exposures, 20 ppb for intermediate exposure, and US EPA's reference concentration of 1.4 ppb (ATSDR 2016; EPA 2015). Hydrogen sulfide characteristically has a very strong odor at very low concentrations (10 – 100 ppb) and is known to be toxic to humans at high concentrations. However, it can be smelled at concentrations as low as 0.5 ppb (ATSDR 2014). C&D waste landfills often offer an ideal environment for H_2S production because they frequently contain moisture, little or no oxygen, and may contain other waste components and organic matter. When large amounts of gypsum drywall are present in a landfill, and a sufficient amount of water is present, hydrogen sulfide is produced at high concentrations.

The Industrial Pipe Landfill is a large C&D landfill (disposal area of 65.7 acres) and is located at 11266 Highway 23, Belle Chasse, Louisiana. The landfill operates immediately to the north of the Oakville community (Figure 1). The Industrial Pipe Landfill began as an unpermitted dump in the 1980s (approximately 2.3 million cubic yards of C&D waste have been disposed of in the landfill). In 2004 it received a solid waste permit from Louisiana Department of Environmental

Quality (LDEQ). LDEQ has issued a renewal permit in September, 2015 (LDEQ 2015) that allows the landfill to continue operating for another 15 years. The waste is disposed in unlined pits to a depth of 15 feet, which is significantly below the water table in the area. Residents in the area get drinking water from a municipal water supply, not local wells that could be impacted by groundwater contamination. The permitted height of the landfill is 60 feet and the landfill does not have a landfill gas collection system (LDEQ 2015).

Figure 1. Aerial View of Industrial Pipe Landfill and Surrounding Area

Oakville residents complain of sickening odors from the landfill. Residents say that they smell odors from the landfill whenever the wind is coming from the direction of the landfill towards the community. They describe the odors as smelling like rotten eggs, sulfur, or "a burning stink." A former resident said that he had to move from the community because the landfill gases caused his baby to suffer severe respiratory problems. Another resident wonders if emissions from the landfill caused the crib death of her grandchild who died after a fire at the landfill burned for several weeks after accepting huge volumes of hurricane debris. During a recent trial involving the landfill, a resident said that the odors from the landfill can be so bad that at times "he can't be outside." Others say that they shut their windows to keep the odors out.

Limited air sampling for hydrogen sulfide (no quality assurance/quality control [QA/QC] information is available) was performed by the petitioner on behalf of the Oakville Community Action Group. Air samples were reported to be taken downwind (no meteorological information is available) of the landfill with a portable Jerome® J605 Hydrogen Sulfide Analyzer. The measured H_2S concentrations (from below detection levels up to a maximum measured concentration of 169 ppb) in the air occasionally exceeded the ATSDR health-based comparison values (intermediate MRL of 20 ppb and acute MRL of 70 ppb). Community sampling was performed for a few hours over approximately one week (May 30 – June 6, 2014). While this monitoring only captured moments in time, it did confirm the presence of H_2S in the ambient air in Oakville. During a site visit in May 2016, ATSDR and ERG staff collected hydrogen sulfide measurements with a Jerome® 631X Hydrogen Sulfide Analyzer. These readings were collected on two mornings in and around Oakville. Concentrations ranged from non-detect to 4 ppb for the readings collected by ATSDR and ERG.

There have been complaints of periodic fires from the landfill or "burning" odors within Oakville. During the site visit in May 2016, ATSDR staff observed evidence of smoke and burning smells in and around Oakville. These fires may or may not be associated with the landfill as the source of the odors was not always apparent. Because of these observations, one of the two hydrogen sulfide monitoring locations within Oakville will also be outfitted with a monitor for $PM_{2.5}$ to provide a surrogate measurement for the smoke observed in the area.

There is other industrial activity in the vicinity of Belle Chasse, including a petroleum refinery approximately 1.8 miles northeast of the Oakville community. The sampling strategy for the EI will be designed in such a way that information about the likely source of any H_2S or particulate matter in Oakville can be obtained (i.e., include sampling locations both to the north and south of the Industrial Pipe Landfill).

Monitoring/Sampling Approach

Criteria for Choosing Monitoring and Sampling Locations (Siting)

ATSDR visited the area in May 2016 to develop consensus on the parameters and objectives of the EI. During this trip, ATSDR met with residents of Oakville and the surrounding area and visited the potential EI area. Information gathered through these meetings and observations was used to develop this EI protocol and to determine candidate monitoring/sampling site locations and develop the overall design of the monitoring approach. Upon approval of this EI Protocol, ATSDR will obtain consent agreements from participating property owners.

The EI will include a network of monitoring/sampling locations (sites) staged in a pattern that places monitoring/sampling equipment in areas where community exposures are expected to exist. The network is expected to consist of as few as three, or as many as four, monitoring/sampling locations. See Figure 2 for a map of the C&D landfill and the study areas of Oakville and Bergeron Drive which will be the potential EI monitoring locations near Belle Chasse.

ATSDR will place 3-4 samplers on private properties that are close to the C&D landfill. The locations of air sampling equipment in these areas will be chosen to represent potential exposures at residential locations to allow ATSDR to evaluate possible community exposures to airborne concentrations of hydrogen sulfide and particulates.

To aid in the monitoring/sampling location selection process, a series of wind roses for 2011-2015 (annual, winter, autumn, spring, and summer) were prepared using data from the closest National Weather Service station located at Naval Air Station Joint Reserve Base New Orleans. This meteorological station is approximately 3 miles north of the Industrial Pipe Landfill and is the closest weather station that was able to provide validated meteorological data. The annual average wind rose is shown in Figure 3. Winds are from the north (from the landfill to the Oakville community, 315° – 45°) approximately 18% of the time and winds are calm approximately 25% of the time. Seasonal wind roses are shown in Figure 4. Winds are most likely from the landfill during winter months (December – February, 28%), followed by autumn (September – November, 22%). Winds are less likely to be from the landfill in spring (March – May, 14%) and summer (June – August, 9%). During winter, north is the dominant wind direction while other seasons are dominated by winds from other directions. There are fewer calm periods during the winter with only around 20% calm conditions, compared to 22% calm in spring, 32% calm in summer, and 30% calm in autumn. Based on the wind roses, worst case meteorological conditions for exposure in the Oakville community would be expected to occur during winter.

Sampling will be conducted at two locations within the Oakville community (ideally one sampling location will be in a property adjacent to the landfill and the second will be located to give some separation of the two Oakville sampling locations) which is immediately to the south of the C&D landfill (Figure 2). Sampling for $PM_{2.5}$ will also be conducted at one of these locations. Additionally, sampling will be conducted at one location in a community to the north of the C&D landfill and south of the refinery (Bergeron Drive). Meteorological data may be collected from one of the hydrogen sulfide monitoring locations or may be collected at a fourth location (within Oakville) that meets siting criteria. No sampling is planned to the west of the C&D landfill because there are not populated areas to the west within 2.5 miles of the facility.

A background location is not planned as part of this EI since the objective of this exposure investigation is to evaluate possible community exposures in Belle Chasse to hydrogen sulfide and particulates and is not intended to characterize emissions from area sources or to compare exposure data to other communities.

Figure 2. Study Areas – Oakville Community and Bergeron Drive

The final number and placement of locations will be dependent on actual site conditions at the time of equipment deployment, siting constraints (i.e. availability of electrical power, ability to secure equipment, etc.), and if willing EI participants can be identified. Some monitoring/sampling locations may only collect a subset of the target pollutants or meteorological data. Hydrogen sulfide will be measured at three or four locations while $PM_{2.5}$ and meteorological parameters will be measured at one location each. Once the protocol is approved by ATSDR, final monitoring/sampling locations will be identified and potential EI participants will be contacted. Although exact monitoring locations may be withheld to provide anonymity for EI participants, the general area of the monitor will be described (e.g. south side of Bergeron Street west of Highway 23, etc.).

Figure 3: Annual Average Wind Rose at Naval Air Station Joint Reserve Base New Orleans, 2011 – 2015

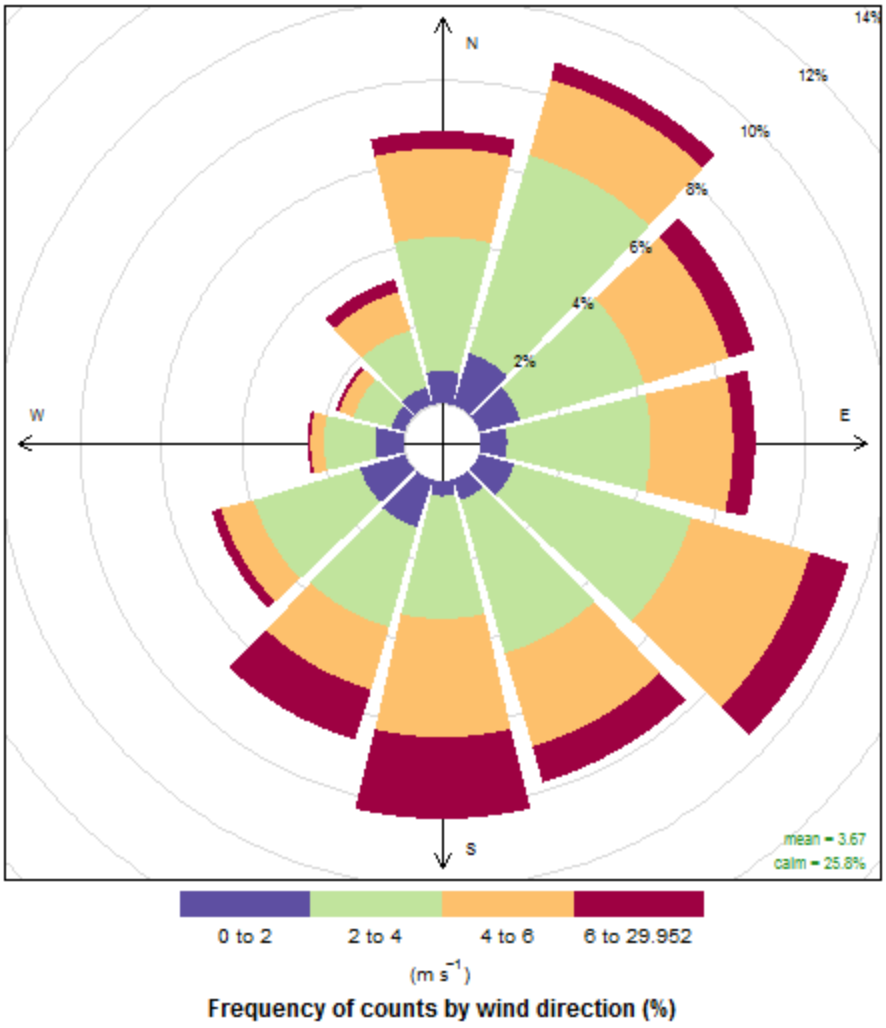
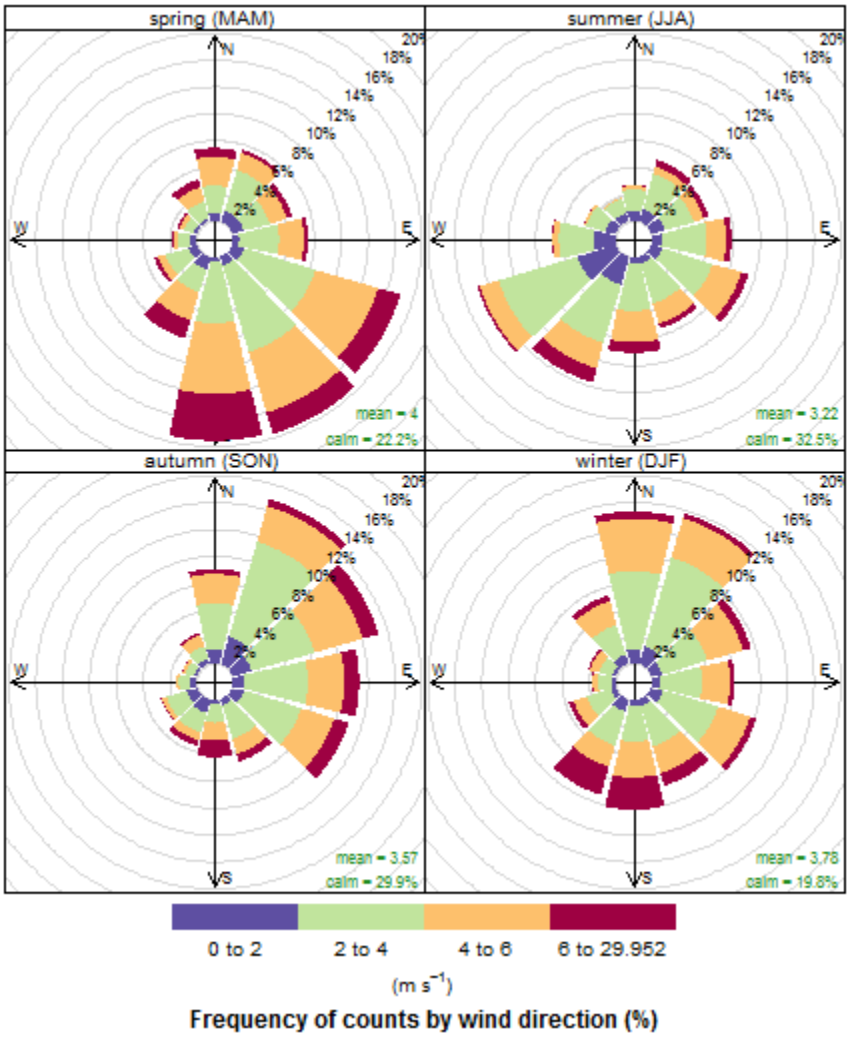


Figure 4: Seasonal Wind Roses at Naval Air Station Joint Reserve Base New Orleans, 2011 – 2015



Selecting the Investigation Time Period and Duration

The objectives of an EI, by design, are to fill data gaps relating to community exposures to environmental contaminants. Exposure investigations are not designed to be long-term environmental sampling programs that may consist of sampling across several years. If longer-term sampling is identified as being needed as a result of an EI, the health agencies may recommend to the appropriate agency or authority that additional sampling data be collected and indicate the sampling duration needed. An EI is also not designed to characterize emissions from commercial operations or to monitor commercial emissions.

The monitoring period for the EI was chosen to coincide with the expected worst-case ambient concentrations of hydrogen sulfide and particulates that may impact communities in Belle Chasse, LA.

Based on conversations with community members, odors are strongest in Oakville during periods when winds are from the north. Residents also noted that odors are strongest between December and March and in the morning and evening hours. Based on these observations from residents, and the analysis of prevailing wind directions, a six week EI in January-February has the potential to capture worst case odor conditions within Oakville.

Measurements and Data Acquisition

This EI will focus on ambient air monitoring/sampling of hydrogen sulfide and particulate matter. These chemicals were selected for monitoring/sampling during this EI because these compounds:

- present a high potential to be released by activities of the C&D landfill located near residential areas in Belle Chasse,
- were identified by the community and ATSDR as chemicals of concern,
- will be useful during the health implication evaluation,
- have environmental health comparison values (see Table 1), and
- ATSDR has little data to assess the significance of the potential community exposures to these pollutants.

Table 1 lists the chemicals that will be measured during the EI and associated comparison values. Table 2 lists the chemicals to be measured and associated detection range (Range).

Table 1. Exposure Investigation Contaminants and Associated Health-based Screening Values

Chemical Measured	*Comparison Value*	*Source**
H_2S	20 ppb	ATSDR Intermediate MRL
	70 ppb	ATSDR Acute MRL
$PM_{2.5}$	12 µg/m^3 (annual mean averaged over 3 years)	U.S. EPA: NAAQS, Annual Primary†
	35 µg/m^3 (98th percentile averaged over 3 years)	U.S. EPA: NAAQS, 24-Hour Primary†

U.S. EPA: U.S. Environmental Protection Agency
MRL: Minimal Risk Level
NAAQS: National Ambient Air Quality Standards
ppb: parts per billion

*In the absence of ATSDR-derived health-based comparison values, health-based screening values from other authoritative/reliable sources are used. Health-based screening values are periodically updated.
†NAAQS are used in this document for comparison purposes only. This investigation is not designed to determine adherence to any NAAQS.

Table 2. Exposure Investigation Contaminants, Sampling Device, and Detection Range (Range)

Chemical Measured	*Sampling Device*	*Range*
H_2S	Honeywell SPM	3-90 ppb* (0.004-0.126 mg/m^3)
$PM_{2.5}$	MetOne E-BAM	0-65 mg/m^3

mg/m^3: milligrams per cubic meter
ppb: parts per billion
SPM: Single Point Monitor
E-BAM: Beta Attenuation Monitor

*This range may be adjusted if higher concentrations are detected.

Hydrogen Sulfide

Hydrogen sulfide will be measured as part of this EI in that H_2S is of special concern to community members in Belle Chasse. Community members report odors consistent with hydrogen sulfide. Hydrogen sulfide has a characteristic odor often described as a rotten egg smell. Additionally, H_2S is a pollutant shown to be produced by C&D landfills.

Measurements of H_2S will be made using Honeywell single point monitors (SPM). Primary calibration of these instruments is performed at the factory. Two-point internal optical calibration performance checks will be conducted (i.e., initially before deployment, weekly onsite, as tapes are changed, if SPM alarms are tripped, and again after equipment recovery). The linear detection range for instruments used to monitor outdoor and indoor low levels is 3-90 ppb. However the instruments will be calibrated from 0-90 ppb. The linear range of instruments used to monitor outdoor mid-range levels is 52-1,200 ppb and high-range level is 1.1-30 parts per million (ppm). Measurement of the H_2S detected is automatic, and the resulting data are stored in a data acquisition system (DAS).

ATSDR is currently investigating alternative hydrogen sulfide monitoring technologies for future use. While the SPMs will be the primary hydrogen sulfide instruments used for this EI, ATSDR may deploy an alternative monitor as well to gather side by side data that can be used to evaluate the comparability of the alternative monitor to the SPM. Any data collected from this type of deployment will be analyzed similarly to SPM data but if there is a discrepancy between the monitors the SPM data will be used to draw public health conclusions.

Particulate Matter

Particulate matter ($PM_{2.5}$) will be measured in this EI. Particles in this size range may be associated with C&D landfills and are an important consideration for community exposures in Belle Chasse. Community members have complained of "burning odors" that may be due to operations at the Industrial Pipe Landfill that have the potential to emit particulate matter. This EI is intended to address community concerns and to fill some of the data gaps identified in earlier studies. However, this EI is not intended to be a long-term health study that evaluates health effects or determines compliance with any regulatory requirements.

Continuous measurements of $PM_{2.5}$ will be made using a Met One Instruments, Inc. E-BAM real-time beta attenuation monitor. The E-BAM is a portable self-contained unit that meets or exceeds all EPA requirements for automated particulate measurement. The measurement range for the unit is 0-10 mg/m^3. The E-BAM will provide measurement data on an hourly basis. Data are stored automatically to an internal DAS. The monitor will incorporate a PM_{10} pre-cutter inlet followed by a Sharp Cut $PM_{2.5}$ cyclone.

Meteorological Parameters

Meteorological parameters will be measured using a stand-alone meteorological monitoring system attached to a secured tripod or mast assembly. The system incorporates a cup anemometer to measure wind speed, a directional mast and vane to measure wind direction, a wound bobbin assembly to measure relative humidity, and a thermistor temperature probe to measure ambient temperature. Measurements will be made at a height of approximately 10 feet above grade (to approximate breathing height without ground level interferences) or roof top level (site dependent).

Electronic signals from the meteorological monitoring system will be collected and stored using HOBO Micro Station DASs with 4-20 milliamp adapters and BoxCar® Pro 4.3 software. Each DAS is capable of collecting four channels of input signal simultaneously, and offers internal storage for 1 million data points per system.

Field staff will download data weekly and perform a visual check of the meteorological sensors daily. If a failure occurs, it will be repaired as quickly as possible and returned to the network.

Data Acquisition

Electronic signals from the hydrogen sulfide and meteorological measurement systems will be collected and stored using HOBO Micro Station Data Acquisition Systems with 4-20 mA adapters and BoxCar Pro 4.3 software. Each DAS is capable of collecting 6 channels of amperage input simultaneously and offers internal storage for 1 million data points per system.

Particulate matter data will be stored automatically to a unit specific internal DAS located with the E-BAM system.

Electronic data will be transferred each week to the Report Database Manager. Electronic copies of the data will be kept in a separate file on-site for field staff use.

Odor Logs

In addition to monitoring for hydrogen sulfide and particulate matter, ATSDR will ask the 3- 4 residents hosting hydrogen sulfide monitors to complete odor logs. Odor logs (or odor diaries) are a daily recording of environmental odors that are observed. These logs will help with a qualitative analysis of when and where odors are worst and will be used to place measurements in context. Participants will be asked to describe the odor's frequency, intensity, duration, and offensiveness (FIDO characteristics). In addition, odor logs will be used to document any changes in behavior (staying indoors or limiting physical activity) due to odors. EI field staff will also maintain an odor log during sampling activities but information directly from residents will be very valuable in evaluating the impact of any odors on the community. During the May, 2016 site visit, community members were informed about odor logs and their potential utility. Residents were provided with example odor logs but were not required to complete them. No completed odor logs were collected following the May, 2016 site visit.

Schedule of Major EI Events

Table 3 lists EI major program events and timelines for the 6-week program.

Table 3. Belle Chasse EI Major Events and Timelines

Event	*Activity*	*Timeframe*
Pre-Deployment	Assess equipment prior to deployment. Make any necessary adjustments or repairs prior to deployment. Bring systems on line.	Pre-Deployment
Deployment	Install/set up all equipment. Check out and calibrate equipment. Bring systems on line. Repeat for all other sites.	Prior to sampling
Monitoring	Week 1 – Check and service equipment daily.	Week 1
Monitoring	Week 1 – Download data, electronically transfer data to Reporting Task Manager.	Week 1
Monitoring	Week 2 – Check and service equipment daily.	Week 2
Monitoring	Week 2 – Download data, electronically transfer data to Reporting Task Manager.	Week 2
Monitoring	Week 3 – Check and service equipment daily.	Week 3
Monitoring	Week 3 – Download data, electronically transfer data to Reporting Task Manager.	Week 3
Monitoring	Week 4 – Check and service equipment daily.	Week 4
Monitoring	Week 4 – Download data, electronically transfer data to Reporting Task Manager, and perform calibration checks.	Week 4
Monitoring	Week 5 – Check and service equipment daily.	Week 5
Monitoring	Week 5 – Download data, electronically transfer data to Reporting Task Manager.	Week 5
Monitoring	Week 6 – Check and service equipment daily.	Week 6
Monitoring	Week 6 – Download data, electronically transfer data to Reporting Task Manager.	Week 6

Event	*Activity*	*Timeframe*
Recovery	Breakdown and pack equipment for storage and transport. Return sites to their pre-deployment status.	Week 7
Recovery	Transport equipment as needed to Research Triangle Park.	Week 7
Recovery	Set up instruments at the equipment laboratory; perform instrument calibrations and post-deployment QC checks as needed.	Week 8
Recovery	Perform any required service on ATSDR owned equipment Return or dispose of any unconsumed materials/supplies (as appropriate).	TBD
Reporting	Perform preliminary data review.	TBD

Quality Assurance and Control

Data Quality Objectives

Data Quality Objectives (DQOs) are measures used to determine how good data must be in order to achieve the project goals. DQOs are used to develop the criteria that a data collection design should satisfy including where to conduct monitoring, when to conduct monitoring, measurement frequency, and acceptable measurement precision and accuracy. Considering the targeted compounds, information obtained during the site visits to date, and specifications associated with the monitoring and sample collection systems that will be used, preliminary DQOs for this EI are presented in Table 4.

Table 4. Preliminary Data Quality Objectives

	Element	*Objective*
Operational DQOs	Where to Conduct Monitoring	All sites must be located in close proximity to the potentially impacted populous.
	Number of Sites Required	3-4 monitoring sites will provide a representative and direct relationship to the potentially impacted populous (e.g., private residences, and/or businesses).
	When to Conduct Monitoring	Daily – from 0000 to 2359 hours during winter
	Frequency of Monitoring	Continuous for H_2S, $PM_{2.5}$, and meteorology so that short duration excursions can be assessed, and the hourly and daily average concentrations can be calculated.
Technical DQOs	Overall Completeness	80% data capture from start to finish of the sampling event
	Acceptable Measurement Precision for SPMs	+/- 20% relative percent difference (RPD)
	Acceptable Measurement Accuracy for SPMs	+/- 15% relative standard deviation (RSD)
	Acceptable Measurement Precision for E-BAMs	+/- 25% RPD
	Acceptable Measurement Accuracy for E-BAMs	+/- 20% RSD

Measurement Completeness

For this EI, completeness is defined as the number of valid measurements collected, compared to the number of possible measurements. Monitoring/sampling programs that consistently generate valid results tend to have higher measurement completeness than programs that consistently invalidate samples. Therefore, the completeness of an air monitoring program is a qualitative

measure of the reliability of air sampling and laboratory analytical equipment and the efficiency with which the field program and laboratory analysis was managed.

Measurement Precision

For this EI, measurement precision is defined as the ability to acquire the same concentration from two independent instruments with an acceptable level of uncertainty, while concurrently sampling the same air stream. In other words, precision characterizes the repeatability of measurements made by a particular monitoring or measurement approach. ATSDR will measure SPM precision by collocating two SPMs at one site consistent with 40 CFR Part 58, Appendix A, Section 3.2.5. One monitor will be labeled as the primary system and the other will be labeled as the collocated system. The measurements recorded above the detection limit will be compared and expressed as the percentage coefficient of variation (%CV), as defined in Eq. 1:

$$\%CV = 100 \cdot \sqrt{\frac{\sum_{i=1}^{n}\left[\frac{(p_i - r_i)}{0.5 \cdot (p_i + r_i)}\right]^2}{2n}}$$

Where

p_i=the principal result for the sample i

r_i= the replicate result for the sample i

n = the number of samples having primary-collocate result pairs

Measurement Accuracy

Measurement accuracy for this project is defined as the ability to acquire the correct concentration measurement from an instrument or analysis with an acceptable level of uncertainty, while it is sampling a known concentration. Accuracy will be assessed to determine whether systematic deviations occurred from the true concentrations being reported.

The initial calibration for the E-BAM established by the equipment manufacturer MetOne is valid and serves as the primary demonstration of accuracy. Several quality assurance checks will be performed according to the manufacturer's recommendation. The accuracy for the SPMs will also be assessed according to quality assurance checks developed by the manufacturer.

Data Management

Electronic Data. Electronic data from the E-BAM and meteorological monitoring system will be downloaded and stored on a laptop. Data will then be backed up onto a project USB storage device. The data files will be sent electronically to ERG's database administrator for processing at the end of each sampling week. The data will be stored on a project-specific shared drive on the ERG laboratory server and backed up daily. All spreadsheets and databases that are generated for EI-related purposes will be restricted to project staff. When data analysis is complete and quality reviews completed, applicable calculation cells and spreadsheets will be locked. Data processing steps will be detailed in the EI field report. All electronic data will be stored for 5 years after the close of the contract.

Hard copy data. Copies of all field generated forms generated for the EI will be kept in a project specific file along with any other paper records that are generated specific to the Belle Chasse EI. All hardcopy information will be filled out in indelible ink. Corrections will be made by inserting one line through the incorrect entry, initialing the correction, and placing the correct entry alongside the incorrect entry, if this can be accomplished legibly, or by providing information on a new line.

Field staff will use field notebooks throughout the duration of the Belle Chasse EI. Individual notebooks will be uniquely numbered and associated with the project field personnel. The notebooks will be used to record additional information about the program operation such as exposure conditions and equipment malfunctions. Field notebooks will be specific to this investigation only and maintained as part of the program records. The NCEH/ATSDR Data Management Plan Form is included as Appendix B.

Confidentiality

The only personal identifiers collected during the EI will be adult names and property addresses for correlation with monitoring/sampling results. Each EI participant will be given an identification number (ID) that does not include personal identifiers. ID numbers will be used in datasets and reports. Personal identifiers will not be included in any reports produced for the investigation and will not be used for any other purpose. Adult names and addresses will be used to provide a copy of the final summary report to each EI participant. Personal identifiers and corresponding IDs will be kept in a locked cabinet or on a password protected computer.

Biologic sampling will not be part of this EI.

Risks/Benefits Information

There are minimal risks for those participating in this EI. The primary risks are that property owners/occupants could be slightly inconvenienced during set-up, checks, and demobilization of equipment. To reduce any inconvenience associated with the operation of the EI, field personnel will adhere to predetermined timeframes as agreed by participants to access property. The second risk is that electric power will be required to operate sampling equipment. A single 110 volt power source will be needed for most sampling locations. Field personnel will provide all supplies and equipment needed to access electrical power and will ensure all equipment is secured. Although electrical power usage is expected to minimal, EI participants will be given a one-time payment of $25 to ensure participants do not incur costs to engage in the EI. Should any participant decide to withdraw from being part of the EI before the EI is completed, payment will be based on the $25 payment prorated on the number of days participation occurred. Payment information is also included in the consent agreement.

The potential benefits for this EI are that participants will learn whether they and/or the community are being exposed to the measured EI target compounds at levels of health concern. The results of the EI are expected to provide ATSDR or other agencies, information to evaluate public health concerns of community members in Belle Chasse, LA. The results of this EI may also be used to inform decisions by the U.S. EPA, Louisiana Department of Environmental Quality, Louisiana Department of Health & Hospitals, and other public health and environmental partners in the region addressing this issue.

Informed Consent Procedures

If participants indicate a willingness to allow air monitoring/sampling on their property, ATSDR personnel will explain what the EI will entail, and will obtain written, informed consent (see Appendix C).

If property owners have tenants living on the property and the tenants and the property owner agree to participant in the EI, both property owner and tenant will need to sign the consent form. If property owners have tenants living on the property and the tenants do not want air monitoring equipment on the property they are occupying, ATSDR will not include the property in the EI.

It will be stressed that participation in the EI is strictly voluntary, and if they choose to participate, EI participants may withdraw from the investigation at any time without penalty.

Reporting of Results

Analysis of Data

Exposure investigation contaminant measurement results will be used to answer the following questions:

1. Do contaminant levels, on average, exceed their respective chronic comparison values?
2. Do maximum contaminant levels exceed their respective acute comparison values?
3. Are there temporal, meteorological, or spatial factors that affect contaminant levels measured?

Exceeding a health based comparison value does not imply that a health hazard exists. In the health consultation, ATSDR will perform a detailed analysis using the methods described in Chapter 8 of the ATSDR Public Health Assessment Guidance Manual (ATSDR 2005) if CVs are exceeded. Analysis of the data for question 1 will be by calculating a sample mean and two-sided 95% confidence interval of the mean, either by fitting a parametric distribution to the data or nonparametric bootstrap. If some results are below the limits of detection, appropriate statistical methods will be used to account for non-detected values as outlined in Helsel (2012). Comparison of maximum values will directly be made to acute comparison values (after appropriate time averaging is made). Analysis of temporal, environmental, and spatial factors will be made using the R package *openair* (Carslaw and Ropkins 2012).

Reporting Results to Participants

Community members who host monitors on their property will be mailed the health consultation report when the report is published. ATSDR staff will provide an opportunity to answer questions about the monitoring results.

Early Notification Process, If Needed

If during the monitoring/sampling phase of the EI, measured concentrations are determined to be such that ATSDR deems early notification of results to area stakeholders is warranted, ATSDR will implement the following notification plan:

During the monitoring/sampling phase of the EI, field staff will review real-time data when data downloads occur. If measured concentrations of H_2S exceed 70 ppb for at least two concurrent 30 minute periods, field staff will request the EI Database Manager to provide averaging data for the time periods in question. Should measured concentrations of H_2S exceed 70 ppb for three or more hours over a two day period, ATSDR will collocate an instrument with a higher range tape (at one location if exceedances at multiple locations occur) for the remainder of the EI. If average measured concentrations exceed 1,000 ppb for two 60 minute averaging periods within 24 hours, ATSDR will notify LDEQ in a timely manner

Summary Report

At the conclusion of this investigation, ATSDR will prepare a report in the form of an exposure investigation (EI)-health consultation (HC) that will include data evaluation and an overall public health interpretation. In the report, private/residential EI participants will be given an identifier that does not include a person's names or address**.** Upon completion of the investigation ATSDR will send a copy of the EI-HC report to each EI participant. ATSDR staff will offer to meet individually with each EI participant to discuss the report. ATSDR staff will conduct a community availability session to share results of the EI with community members and answer any questions they may have. Depending on the findings, the report will make appropriate recommendations to protect the public health as outlined in Chapter 9 of ATSDR's Public Health Assessment Guidance (2005).

Limitations

This EI has two main limitations. The first limitation of the EI is that only a selected number of potential contaminants associated with a C&D landfill will be measured. The selection of contaminants measured has been based on community concerns. All efforts in this EI have been made to measure those contaminants considered most likely to be of health concern based on current scientific knowledge.

The second limitation of the EI is that the monitoring/sampling period will only capture ambient air quality measurements during a six week period. This time frame may not be long enough to fully evaluate characteristic exposures to community members/residents in that ambient concentrations of hydrogen sulfide near a C&D landfill depend, in part, on a number of environmental and meteorological conditions that change daily and seasonally. However, by choosing the selected times as the monitoring period, the EI will collect data during what is expected to be seasonally favorable conditions for exposure.

If site conditions change or if additional EI procedures are determined to be needed during the course of the EI, the scope of the EI may be revised. This EI will not determine the cause of any medical conditions experienced by participants or other residents of Oakville and will not investigate or correct actions taken by other agencies.

Health and Safety Plan

All field staff should read, understand, and sign the Health and Safety Plan (HASP) for this EI. The HASP is included in Appendix D.

References

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Attachments

Appendix A: Summary of Exposure Investigation Criteria for the Belle Chasse EI

Appendix B: NCEH/ATSDR Data Management Plan Form

Appendix C: Consent Form

Appendix D: Health and Safety Plan

Appendix A. Summary of Exposure Investigation Criteria for the Belle Chasse EI

Belle Chasse Exposure Investigation

1. Can an exposed population be identified?

Yes. ATSDR was asked, at the request of local residents in the Oakville community, to investigate odors from the Industrial Pipe Landfill they allege are harmful to the health of people living and working nearby. The residential community of Oakville is in close proximity to the construction and demolition debris landfill. Residents have reported odors associated with hydrogen sulfide as well as odors described as "burning". There are approximately 50 residential properties in this area, as well as three churches. Preliminary air monitoring data collected by the petitioner show ambient concentrations of hydrogen sulfide that occasionally exceed ATSDR screening levels.

2. Does a data gap exist that affects ability to determine if a public health hazard exists?

Yes. Although there are some data indicating hydrogen sulfide may be present in ambient air in the Oakville community, the data are anecdotal and cannot be used to determine if a public health hazard exists. There are no particulate matter data available so no assessment can be made of if there is a public health hazard related to exposure to particulate matter. Data from other sites near C&D landfills have indicated the potential for exposure to hydrogen sulfide and particulate matter that may be at levels of health concern. No data are available to determine if air concentrations of these compounds are at levels of health concern in Belle Chasse.

3. Can an EI address the data gap?

Yes. The proposed EI would provide community-based air monitoring in an area potentially impacted hydrogen sulfide and particulate matter emissions from the Industrial Pipe Landfill. ATSDR has previously conducted exposure investigations for hydrogen sulfide and particulate matter near other C&D landfills to address data gaps at those sites. Site-specific considerations such as emission rates, the proximity of the community to the landfill, and meteorological characteristics do not allow those previous results to be generalized to Belle Chasse. The EI will be combined with a health consultation and appropriate health education and outreach activities.

4. How would the EI results impact public health decisions?

The data collected from this proposed EI will enable health agencies to more accurately inform Belle Chasse residents about the potential health impacts of hydrogen sulfide and particulate matter at the concentrations measured around their homes. Residents are concerned about the odors they detect and potential health effects associated with exposure to compounds from Industrial Pipe Landfill. Data will be shared with the USEPA, Louisiana Department of Environmental Quality, Louisiana Department of Health & Hospitals, and other public health and environmental partners in the region addressing this issue.

Appendix B. NCEH/ATSDR Data Management Plan Form

NCEH/ATSDR Data Management Plan Form

This plan describes the anticipated use and release by CDC of the dataset named below. All CDC DMPs are required to be in compliance with the CDC/ATSDR Policy on Releasing and Sharing data, available at http://isp-v-maso-apps.cdc.gov/Policy/Doc/policy385.pdf. This plan is modifiable and does not represent a legal contract between CDC and any other entity. The elements included do not necessarily constitute an exhaustive list of all possible elements for a DMP, so users should add elements as needed.

The DMP is submitted through eClearance for review and approval. Use "TBD" if you cannot determine some of this information at the time of submission. Elements with an asterisk (*) are required data fields for metadata.

Table 1 – Core DMP Elements *(should be filled out when project approval is sought)*

Label *(Definition)*
***Title:** Belle Chasse, Louisiana Hydrogen Sulfide Exposure Investigation
***Description** *(Human-readable description with sufficient detail to enable a user to quickly understand whether the project or data set is of interest. Short clear description is ideal.)* Ambient air pollutant data for particulate matter ($PM_{2.5}$) and hydrogen sulfide (H_2S) and meteorology data collected in Belle Chasse, Louisiana during the winter of 2017.
***Last DMP Update** September 29, 2016
Contact Name and Email
CDC PI or POC Name (last, first): Brad Goodwin
CDC PI or POC e-mail address: ylm5@cdc.gov
CDC PI or POC phone number: 770-488-3795
Organization ATSDR/DCHI/SSB
***Unique Identifier** *(A unique identifier for the project as maintained within an Agency catalog or database. For intramural submissions, protocol/S3P number can be used. For extramural submissions, grant/Co Ag/contract number can be used to map to related documents.)* AP6I00
Public Access Level *(The degree to which the data collected as part of this project could be made publicly available, regardless of whether it has been made available.)*
□ Public release *(Data set can be made available without restrictions; data steward no longer controls data.)*
□ Release by request *(Data set is available to members of the public by request only; data steward no longer controls data.)*

X Restricted use data sharing *(Data set is available to particular parties under certain use restrictions; data not always under CDC custody.)*
□ Restricted access data sharing *(Data set is only available in an RDC; data need to remain under CDC custody.)*
□ Summary data or data tables only *(Underlying data set cannot be released or shared, but summary data or data tables can.)*
□ No release or data sharing
Access Rights/Restrictions *(Include information regarding access or restrictions based on privacy, security, or other policies of the owner of the data. Include an explanation for the selected "Public Access Level" above.*) Air monitoring data and meteorology data will be available upon request after the publication of the ATSDR Exposure Investigation Report, without identifying information i.e., private address locations. Locations of air monitoring stations on private residences will not be released without specific direction from CDC Office of General Counsel.
License/Other Agreements *(The license or non-license [i.e. Public Domain] status with which the data set will be published. See Open Licenses for more information. May include DTA, MTA, IAA, MOU or other agreements concerning data use and access.)* None
***Publisher/Owner** *(The publishing entity and optionally their parent organization(s). This could be the "owner" of the data.)* ATSDR/DCHI/SSB
Access URL, If Known *(URL providing indirect access to the DMP, data set, data dictionary [variable names and valid values], data collection instrument and other relevant information, including the research protocol if possible.)* none
Download URL, If Known *(URL providing direct access to a downloadable file of the data set, summary data, or data tables.)* Not applicable.
Spatial *(The range of spatial applicability of a data set. Could include a geographic region or a named place [city, county, state, region, country].)* Belle Chasse, Plaquemines Parish, Louisiana, USA

Temporal
(The range of temporal applicability of project [i.e., a start and end year of applicability for the data]. Include the years for the project or data set.)

January to February 2017

Table 2 – Additional DMP Elements *(should be filled out where possible when project approval is sought; however, many fields can only be filled out later when publication/report is cleared)*

Label *(Definition)*			
***Tags** *(Keywords to help users discover the data set; include terms that would be used by technical and non-technical users.)* Exposure Investigation, Ambient Air Pollutants, Particulate, $PM_{2.5}$, Hydrogen Sulfide			
Project Type *(Multiple selections may apply.)*			
X Intramural			
□ Extramural (grant, cooperative agreement, contract, IAA, CDC Foundation, other) *Specify mechanism*:			
□ Surveillance			
□ Research			
□ Ongoing collection			
□ Other			
Project Status Estimated start date (year, month): Estimated date of release (year, month):			
Data Category *(For explanation of D1 to D10 codes, see Table on page 1)*			
X D1	□ D2	□ D3	
□ D4	□ D5	□ D6	□ D7
□ D8	□ D9	□ D10	
Population Represented *(e.g., "residents of x," "inpatients at x," "users of product x")* Residents of Belle Chasse, Louisiana exposure to air pollutants ($PM_{2.5}$, Hydrogen Sulfide)			
Data Collection Protocol *(Brief description with reference to document or website that provides detailed information.)* Data collection is described in the "Ambient Airborne Exposures to Hydrogen Sulfide and Particulate Matter in Belle Chasse, LA" Exposure Investigation Protocol. Continuous hydrogen sulfide, particulate matter, and meteorology data will be collected at 3-4 locations over a period of six weeks.			
Data Management Protocol *(Brief description with reference to system/sources where data will be housed (internal SQL database, external SQL database, etc.) and to data formats (proprietary vs. open source data formats.)* Data will be housed within the ATSDR/DCHI Exposure Investigation Database			

Process for Omitting Identifying Information
(Description of what identifiers are in the database, how they will be removed, and by whom.)

Identifiers (addresses and latitude/longitude coordinates) of air monitoring locations on private residences will be flagged and housed in special subdirectory by the Database manager and will not be released unless directed by the CDC Office of General Counsel.

Data Quality Protocol (to address issues of confidentiality protection and statistical stability)
(Brief description with reference to document or website that provides detailed information. Describe methods for data validation and error resolution, removal or shielding of any proprietary information, removal or shielding of sensitive information [i.e. data with dual use applicability], removal or shielding of any individually identifying information including indirect identification.)

"Ambient Airborne Exposures to Hydrogen Sulfide and Particulate Matter in Belle Chasse, LA" describes the Data Quality Objectives. Metrics for data completeness, precision, and accuracy are included in the referenced document.

Data Retention/Disposal Plan
(State when and how the dataset will be archived or destroyed [in accordance with CDC/ATSDR Records Control Schedule: http://isp-v-maso-apps/RecSched/images/RCS.pdf].)

EI data are considered as a component of the ATSDR "Site Files" (Section 3.6, page 64). These files are maintained in the Records and Information Management Branch, are transferred to an FRC 5 years after publication of final health assessment, consultation, or advisory report, and are destroyed when 30 years old.

Data Analysis Plan
(Brief description of planned use of the data. Can include reference to document [e.g. Information Collection Request, Research Protocol, or other] that provides more detailed information.)

"Ambient Airborne Exposures to Hydrogen Sulfide and Particulate Matter in Belle Chasse, LA" describes the data analysis plan. Ambient air pollution and meteorology data will be collected and analyzed to assess Belle Chasse residents' exposure to environmental pollutants.

Publication Plan
(Brief description of planned CDC-authored and CDC-coauthored publications, including topic, type of publication, and estimated timeline.)

ATSDR will use the data to publish an ATSDR Exposure Investigation Report and possibly peer-reviewed journal article.

Access URL *(URL providing indirect access to the DMP, data set, data dictionary [variable names and valid values], data collection instrument and other relevant information, including the research protocol if possible.)* Not applicable
Download URL *(URL providing direct access to a downloadable file of the data set, summary data, or data tables.)* Not applicable
Data Set Name To be determined
Data Release Documentation *(List documents provided to users, e.g. variable definitions, codebook, metadata file, guidance on data use.)* To be determined
Data Release Format *(Specify dataset formats, e.g., Excel, SAS, ASCII, etc.; interactive data query website; mixed mode. Also specify data dictionary file format, e.g., JSON, RDF, SAS.)* Various electronic file formats e.g. Excel, Word, and Adobe.
Data Release Notification *(State how potential users will be informed of dataset availability.)* ATSDR will include a notice in the final Belle Chasse Exposure Investigation report.

Appendix C. Consent Form

Consent Form for EI Participants

(Flesch-Kincaid reading level = 8.0)

ATSDR Exposure Investigation (EI)

Ambient Air Exposures to Hydrogen Sulfide and Dust Particles

Belle Chasse, LA

Who are we and why we are doing this EI?	▪ We are from the Agency for Toxic Substances and Disease Registry (ATSDR), Centers for Diseases Control and Prevention (CDC) ▪ We are doing this Exposure Investigation to find out if people living near Industrial Pipe Landfill are breathing outdoor air with elevated levels of hydrogen sulfide and small dust particles. ▪ We are inviting you to be part of this effort by allowing us to put air monitoring equipment on your property.
Where will testing occur?	▪ The air monitoring will occur in several areas near Industrial Pipe Landfill.
What is involved in this EI?	▪ We will put air monitoring equipment on your property. ▪ We may need to keep the equipment on your property for about 6 weeks in January-February, 2017. ▪ We will make all arrangements to have the equipment on your property. You will not have to do anything with the equipment. ▪ We will check the equipment every day. ▪ We will lock the equipment so that children or pets cannot open the equipment. ▪ You will not be responsible if damage happens to the equipment on your property.
When will you get the results?	▪ You will receive a report about the testing on your property that summarizes the exposure investigation and provides our overall findings in about 12-18 months after testing is completed.
What are the benefits from being in this EI?	▪ You will find out if any of the chemicals we test are in the outdoor air near your home or property. ▪ By being part of this effort, you will help your community find out if any of the chemicals we test are in your community.
What are the risks from participating in this EI?	▪ We will run an extension cord from one of your outdoor electrical outlets. You may be bothered by having an extension cord used at your property. ▪ You may also be bothered by us checking the equipment each day. We will arrange a time with you for us to be on your property so that we bother you as little as possible. ▪ You may have a small increase in your electric bill since we will need to use your electrical power outlets. We will give you a one-time payment of $25 to pay for any increase in your electric bill that may result from us using your electrical outlets. Should you decide to withdraw from being part of the EI before this effort is completed, your payment will be based on the $25 payment and the number of days you were able to able to be a part of this effort.

What about privacy?

- We will protect your privacy as much as the law allows.
- We will give you an identification (ID) number.
- This ID number, not your name, will be used in reports we write.
- We will keep a password protected file of your name, address and ID number so that we can send you the final report.

When can you ask questions?

- If you have any questions about this testing, you can ask us now
- If you have questions later, you can call:
  - Brad Goodwin 770-488-3795
  - Or the ATSDR toll free number 1-888-320-5291

I give permission to allow air monitoring equipment to be put on my property. If there is a tenant living on the property, both of us will need to agree to be part of this EI. I was given the chance to ask questions and feel my questions were answered. I know that my participation is my/our choice. I know that even though I have agreed to this testing, I may change my mind at any time without penalty.

Signatures

Printed name of property owner or designate

_____

Signature of property owner or designee/tenant Date

_____ _____

Address of Property owner or designate/tenant

_____

_____

_____

Telephone_____

Certification of Consent Form Administrator:

I have read the consent form to the person named above. He/she had an opportunity to ask questions about the EI.

_____

Signature of person administering consent

Appendix D. Health and Safety Plan

Purpose

The purpose of this Health and Safety Plan (HASP) is to inform field personnel of known or potential health and safety hazards that may be encountered during ambient air monitoring activities planned for Belle Chasse, LA. Accordingly, this HASP describes the possible hazards and the procedures required to minimize the potential for exposure, accidents, and/or injuries during the scheduled work activities.

Scope

In order to better assess potential human exposure to selected chemicals in ambient air in Belle Chassse, LA, ATSDR will conduct an Exposure Investigation (EI). During this EI, an ambient air monitoring program will be operated to obtain representative concentration data for hydrogen sulfide, particulates, and meteorological data over a six week period.

Physical Hazards Assessment

Possible dangers associated with project activities include physical hazards related to cold stress; slips, trips, or falls; electrical hazards; excessive noise; lifting; and animals, poisonous plants, and poisonous insects. Brief descriptions of these potential physical hazards and measures for preventing, or mitigating the consequences of, the hazards follow:

Hypothermia. Conditions in Belle Chasse may be cold during the testing period and personnel will be working outdoors. Hypothermia occurs when the normal body temperature drops below 95° F. With mild hypothermia a worker may begin to shiver and stomp feet in order to generate heat. With more severe cases, shivering may stop and additional symptoms include loss of coordination, disorientation, dilation of pupils, inability to walk or stand, or loss of consciousness. Staff should take care to limit their exposure to cold temperatures and wear appropriate cold weather clothing to protect against hypothermia. Staff should change out any clothing that becomes wet as dry clothes will reduce the risk of hypothermia. If symptoms are noted, staff should seek medical treatment immediately.

Frostbite. Frostbite is the freezing of skin and other tissues. It is most common in the feet and hands and the risk of frostbite increases with colder temperatures. Symptoms of frostbite include gray or white patches developing on reddened skin, numbness, skin that is firm to the touch, or blisters in severe cases. Staff should wear warm gloves, socks, and hats when working in cold conditions to reduce the risk of frostbite. Care should be taken to keep clothing and extremities warm. Personnel should limit their time outside in weather below freezing and take breaks in a warm area as often as necessary to reduce risk of cold related injury. If symptoms are noted, staff should seek medical treatment immediately.

Slips, Trips, and Falls. Testing at the site is expected to occur primarily at ground level. Field personnel will use good safety sense in evaluating walking and working surfaces. It is expected that ATSDR will select monitoring sites such that neither testing personnel nor the general public will be injured by tripping or falling over test equipment. If work must be done above ground level (e.g., on rooftops, etc.), field personnel must take measures to ensure the safe access to these areas, including the use of safe equipment and remaining at a safe distance (at least 10 feet) from a building's edge. All ladders or stairways must meet OSHA standards. Where possible, roofs should be accessed from windows or stairways. Field team leaders will review applicable OSHA rules with team members prior to assigning employees to work on roofs.

Electrical. Prior to installing equipment in the field, field staff will verify that all electrical equipment and cords are in good working condition. If additional extension cords are needed after arriving on site, the field team leader will purchase a high quality extension cord that works well under the testing conditions. Field personnel will be instructed to immediately report to their team leaders any signs of malfunctioning electrical equipment.

Lifting Hazards. When carrying and lifting equipment, field personnel should practice good lifting techniques and avoid carrying heavy loads.

Animals, Poisonous Insects, and Poisonous Plants. Field personnel should be alert for and stay clear of wild and unsupervised animals, poisonous insects, and poisonous plants (e.g., poison ivy, poison sumac). Particularly, team member should also be aware of poisonous spiders (e.g., black widow). As Belle Chasse, LA is a rural area, poisonous snakes could also be encountered.

Field personnel will wear thick leather gloves, long pants, and a long sleeve shirt. When entering the room that houses the monitoring equipment turn on all lights, if lights not available use a flash light to look around the sampling area before opening the sampling container. Be aware of your surroundings, do not just blindly wander in the monitoring locations. Observation is critical to avoidance. Learn to check around with a sweeping glance for anything that seems out of place. Your subconscious may notice a camouflaged animal. All monitoring equipment wil be kept in a large sealed container. The vents will be screened to reduce the chance of animals and insects from entering the container.

Tap the monitoring container before opening the container. Snakes and other animals have many sensing devices to warn them of your presence. Make plenty of noise and movements while entering the monitoring room to announce your presence.

If a field staff is bitten by a snake, rodent, or spider, they should be taken to a medical facility immediately for treatment. Give the medical staff as much detailed information about the animal as possible. Describe the size, shape, and color of the animal.

Appendix B. Odor Log

AIR POLLUTION ODOR DIARY (LOGS).

About Odors

Historically unpleasant odors were recognized as warning signs of potential risks to human health. In general most people can smell most chemicals in ambient air before they are at harmful levels. Community members, in many areas where environmental odors is a problem have complained that their comfort, functioning, and sense of well-being are decreased because of the smell. We know that odors from environmental sources might cause health symptoms depending on individual & environmental factors.

Odor Diary (Logs)

The attached odor diary (log) documents:

1. Date,
2. Time odor started,
3. Time odors ended,
4. Location(s) where the odor was detected,
5. Type of odors,
6. **F**requency of the odor,
7. **I**ntensity of the odor,
8. **D**uration,
9. **O**ffensiveness,
10. Effects on normal activities,
11. Weather conditions at the time of the odors (windy, calm, raining, snow, fog etc.,)

Odor diary (logs) are easy to fill out, and can produce useful information in as little as 2 weeks.

Odor Diary (Log) Uses

Communities and environmental health agencies can assess the community's response to odors with an odor diary (log). Odor diaries (logs) can help determine the following:

- The nature of the odor that trigger a response (what type of smell people log the most frequently)
- Date and time when odors are worse and if there is a correlation between weather conditions, times of day/season, and/or personal activities (e.g., jogging, gardening)

The results of the odor logs can have many of the following practical uses:

- Make suggestions to the managers from the odor-generating facilities and/or local legislators/regulators, and provide alternatives solutions such as:
    - Restrictions in the operation time of the day or night
    - Zoning restrictions
    - Suggestions on ways to reduce emissions (e.g., planting trees, use of technologies) when odors are worse.

  All of these are ways for reducing environmental odors through local implementation

of legislation or good-neighbor relationships with the managers of the odor-producing facility.

- Determine personal actions the people can take to cope with the odors such as
  - Exercising indoors
  - Staying indoors if environmental odors are strong that day, and if able
  - Leaving the area for a few hours etc.
- If air sampling is planned,
  - **Before sampling**, use the results of the odor logs to narrow what chemicals to include in a sampling plan and the best times and locations to sample.
  - **During sampling**, use the results of your sampling to compare the recorded concentrations of the chemical in air with the odor responses. The information of the odor log may provide information on what makes the odor responses worse.

References:

Schiffman SS, Williams CM. Science of odors as a potential health issue. J. Environmental Quality 34: 129-138 (2005).

Steinheider, B., Environmental Odours & Somatic Complaints. Zol. Hyg. Unweltmed 202, 101-119 1998/1999.Urban & Fischer Verlag. http://www.urbanfischer.de/journals/zblhyg

Schiffman SS, Gutierrez-Osuna R, Nagle TH, Measuring Odor Intensity with E-Noses and Other Sensor Types. Proceedings of the 9th Intl. Symp. on Olfaction and Electronic Nose, Rome, Sept 29 - Oct 2, 2002 http://research.cs.tamu.edu/prism/publications/isoen02_schiffman.pdf

AIR POLLUTION ODOR DIARY (LOG)

Directions:

1. **LOCATION & CONTACT INFO:** If you are putting together your information with other community members, fill in the location (address of your house), your age, and sex. Provide your contact information (name and phone number) if you want to be contacted.
2. **WHEN TO FILL OUT:** Fill out the daily log on page 2 for at least two weeks, even when there is no odor.
3. **DATE:** Enter the date. You can log more than one odor event per day.
4. **TIME START/END:** Enter the time the odor started and ended. Be sure to indicate if it is a.m. or p.m.
5. **LOCATION:** Write down where you were when you smelled the odor. If you were inside your house, indicate which room.
6. **ODOR TYPE:** As best you can, describe the odor. For example sweet, fruity, rotten eggs, moldy, garbage/trash, musty, bleach
7. **ODOR F**REQUENCY**:** How often did it happen?
8. **ODOR I**NTENSITY**:** Was the odor/scale: light (you notice it – 1 to 3), moderate (you notice it and can describe the smell – 4 to 7), or severe (you notice it and it is annoying – 8 to 10)
9. **ODOR D**URATION**:** How long did the odor episode last?
10. **ODOR O**FFENSIVENESS**:** Mildly offensive, moderately offensive, very offensive.
11. **EFFECT ON NORMAL ACTIVITIES:** Write down if you changed your normal habits (e.g., exercising, gardening, working, or playing outdoors, closing windows, etc) because of the odor.
12. **WEATHER CONDITIONS:** Note the following: Wind speed: calm or windy, Precipitation: rain, snow, fog, Cloud cover: cloudy, sunny, and Temperature

Prepared by (PLEASE PRINT)
Name: _____
Address: _____
_____
_____
Phone: _____
Have _____ years living in the area: _____

Spend _____hours home/day: _____ Spend _____ hours away from home/day.
Age: _____ Sex: M ___ F ___

COMMENTS: Add comments such as visual observations (e.g., dark or white smoke, fire, etc.), health conditions (nausea, headache, asthma episode, etc.)

Industrial Pipe Landfill, Oakville, Louisiana Environmental Odors Questions

(Instructions: Fill out the Odors Diary for 2 Weeks Even if there are no Odors).

Date	**Odor Start Time**	**Odor End Time**	**Location** of Odor? (Be specific)	**Odor Type**	**F**requency	**I**ntensity	**D**uration	**O**ffensiveness	**Effects on Normal Activities**	**Weather Conditions at time of the odor(s)** (Wind, Calm, Rain, Snow, Fog, Cloudy, Sunny, Temperature)

Appendix C. Data Quality Objectives

Data Quality Objectives

Data Quality Objectives (DQOs) are measures used to determine how good data must be in order to achieve the project goals. DQOs are used to develop the criteria that a data collection design should satisfy including where to conduct monitoring, when to conduct monitoring, measurement frequency, and acceptable measurement precision and accuracy. Considering the targeted compounds, information obtained during the site visits to date, and specifications associated with the monitoring and sample collection systems that will be used, DQOs for this EI are presented in Table C-1. The table of DQOs included in the EI protocol for this EI included a DQO for measurement precision for $PM_{2.5}$ but that DQO has been removed from Table 1 since only one E-BAM was deployed to measure $PM_{2.5}$. The operational DQOs were all satisfied through the design of the EI. Technical DQOs are discussed in more detail below.

Table C-1. Data Quality Objectives

	Element	***Objective***
Operational DQOs	Where to Conduct Monitoring	All sites must be located in close proximity to the potentially impacted populous.
	Number of Monitoring Locations Required	3-4 monitoring locations will provide a representative and direct relationship to the potentially impacted populous (e.g., private residences, and/or businesses).
	When to Conduct Monitoring	Daily – from 0000 to 2359 hours during winter
	Frequency of Monitoring	Continuous for H_2S, $PM_{2.5}$, and meteorology so that short duration excursions can be assessed, and the hourly and daily average concentrations can be calculated.
Technical DQOs	Overall Completeness	80% data capture from start to finish of the sampling event
	Acceptable Measurement Precision for SPMs	+/- 20% relative percent difference (RPD)
	Acceptable Measurement Accuracy for SPMs	+/- 15% relative standard deviation (RSD)
	Acceptable Measurement Accuracy for E-BAMs	+/- 20% RSD

Measurement Completeness

For this EI, completeness was defined as the number of valid measurements collected, compared to the number of possible measurements. Monitoring/sampling programs that consistently generate valid results tend to have higher measurement completeness than programs that consistently invalidate samples. Therefore, the completeness of an air monitoring program is a qualitative measure of the reliability of air sampling and laboratory analytical equipment and the efficiency with which the field program and laboratory analysis was managed. Completeness statistics are shown in Table C-2 for each of the instruments used in the EI.

Table C-2. Measurement Completeness

Monitoring Location/Instrument	*Total Possible Measurements*	*Total Valid Measurements*	*Total Invalid Measurements*	*Completeness (%)*
Monitoring Location 1 SPM (H_2S)	61,721	61,700	21	99.97
Monitoring Location 2 SPM (H_2S)	61,822	61,358	464	99.25
Monitoring Location 3 Primary SPM (H_2S)	61,945	61,742	203	99.67
Monitoring Location 3 Collocated SPM (H_2S)	61,945	61,739	206	99.67
Monitoring Location 2 E-BAM ($PM_{2.5}$)	1,030	1,019	11	98.93
Monitoring Location 2 Meteorology	61,830	61,830	0	100

Hydrogen sulfide data were collected at 1-minute resolution by the SPMs. Data completeness is evaluated based on these 1-minute observations while 30-minute and 1-hour averages are used for comparison with health-based comparison values. Differences in the number of possible measurements among the four SPMs are due to slight differences in the setup and take down times at each monitoring location. All of the SPMs had data completeness greater than 99% which meets the 80% completeness DQO. Invalid measurements were due to power outages, audits, and on instrument malfunction at Monitoring Location 2 that lasted 190 minutes on January 30th.

For the $PM_{2.5}$ data, there were 1,019 valid hourly measurements collected out of 1,030 possible hours during the EI. The data completeness for $PM_{2.5}$ is 98.9% which meets the 80% completeness DQO. The invalid hours were due to routine maintenance, a few short power disruptions (1-2 hours), and one longer power outage (4 consecutive hours).

A solar power source was used for the meteorological instruments so there were no power disruptions for this data stream. Meteorological data were collected every minute for 61,830 total data points with 100% data completeness which meets the 80% completeness DQO.

Measurement Precision

For this EI, measurement precision was defined as the ability to acquire the same concentration from two independent instruments with an acceptable level of uncertainty, while concurrently sampling the same air stream. In other words, precision characterizes the repeatability of measurements made by a particular monitoring or measurement approach. ATSDR measured SPM precision by collocating two SPMs at one monitoring location consistent with 40 CFR Part 58, Appendix A, Section 3.2.5. One monitor was labeled as the primary system and the other was labeled as the collocated system. The measurements recorded above the detection limit (3 ppb) were compared and expressed as the percentage coefficient of variation (%CV), as defined in Eq. 1:

$$\%CV = 100 \cdot \sqrt{\frac{\sum_{i=1}^{n}\left[\frac{(p_i - r_i)}{0.5 \cdot (p_i + r_i)}\right]^2}{2n}}$$

Where

p_i=the principal result for the sample i

r_i= the replicate result for the sample i

n = the number of samples having primary-collocate result pairs

For hydrogen sulfide, precision was assessed for all measurement pairs when the primary instrument from Monitoring Location 3 reported a concentration of greater than 3 ppb (7,228 sample measurements). The %CV for these 7,228 measurements is 16.68%, which meets the DQO of ±20%.

Since only a single E-BAM was deployed to measure $PM_{2.5}$, measurement precision was not evaluated for this parameter.

Measurement Accuracy

Measurement accuracy for this project was defined as the ability to acquire the correct concentration measurement from an instrument or analysis with an acceptable level of uncertainty, while it is sampling a known concentration. Accuracy was assessed to determine whether systematic deviations occurred from the true concentrations being reported.

The initial calibration for the E-BAM established by the equipment manufacturer MetOne is valid and serves as the primary demonstration of accuracy. Several quality assurance checks were performed according to the manufacturer's recommendation. The accuracy for the SPMs was also assessed according to quality assurance checks developed by the manufacturer. All accuracy checks for both the E-BAM and the SPMs were within manufacturer's recommendations during the EI.