Health Consultation

Exposure Investigation Report

Airborne Exposures to Hydrogen Sulfide

APAC-RENO LANDFILL

City of Overland Park, Kansas

2008

DEPARTMENT OF HEALTH & HUMAN SERVICES · USA

ATSDR
AGENCY FOR TOXIC SUBSTANCES
AND DISEASE REGISTRY

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ACRONYMS

Acronym	Definition
ATSDR	Agency for Toxic Substances and Disease Registry
A-MRL	Acute Minimal Risk Level
DAS	Data Acquisition System
DQO	Data Quality Objective
EI	Exposure Investigation
ERG	Eastern Research Group, Inc.
GPS	Global Positioning System
H_2S	Hydrogen Sulfide
I-MRL	Intermediate Minimal Risk Level
JCWW	Johnson County Waste Water
KDHE	Kansas Department of Health and Environment
MSA	Metropolitan Statistical Area
NEI	National Emissions Inventory
NWS	National Weather Service
OJC	Olathe-Johnson City
ppbv, ppb	parts per billion by volume, (parts per billion)
ppmv, ppm	parts per million by volume, (parts per million)
QA	Quality Assurance
QC	Quality Control
RSD	Relative Standard Deviation
SOP	Standard Operating Procedures
SPM	Single Point Monitor
TPY	Tons Per Year
UV	Ultraviolet

Executive Summary

The APAC-Reno Landfill is an active disposal site and asphalt plant located in Overland Park, Kansas. The active landfill spans approximately 50 acres and operates under permits regulated by the Kansas Department of Health and the Environment. The landfill is permitted to receive waste material produced during the construction, renovation, and demolition of structures. Examples of materials routinely disposed of at the APAC-Reno Landfill include asphalt, concrete, wood, tiles, shingles, furniture, certain appliances, trees, and shrubs.

In the fall and summer of 2005, residents who live in and near Overland Park filed numerous odor complaints to local and state authorities. The odors were believed to result from hydrogen sulfide gases released from the APAC-Reno Landfill. Only limited information was available on the actual airborne levels of hydrogen sulfide in the communities of Overland Park near the landfill. To fill this data gap, ATSDR conducted an exposure investigation during the summer of 2006. The purpose of the exposure investigation was to directly measure the amount of hydrogen sulfide in the outdoor air that local residents breathe and to determine if exposures to hydrogen sulfide presented a public health hazard.

During the 5-week exposure investigation, ATSDR continuously measured airborne concentrations of hydrogen sulfide. The measurements were collected at three locations where residents may have the potential for exposure to landfill emissions: a private business next to the landfill, a residence in close proximity to the landfill, and a nearby elementary school. The measurements occurred during July and August because residents indicated that odors tended to be worse during the summer months. ATSDR also collected information on local meteorology at a fourth location to help in the evaluation of community exposures to the hydrogen sulfide.

In July and August 2006, ATSDR collected nearly 100,000 valid observations of airborne hydrogen sulfide concentrations at three locations near the APAC-Reno Landfill. At all three locations, hydrogen sulfide was often detected at low levels during the nighttime hours and extended into the morning, but was typically not detected, or detected at low levels during the daytime. Sometimes, hydrogen sulfide was detected when winds blew directly from the landfill, suggesting that landfill emissions contributed to the measured levels. However, hydrogen sulfide was also detected when winds blew from other directions, suggesting that other local sources may be releasing hydrogen sulfide as well. Overall, the measured airborne levels of hydrogen sulfide during the ATSDR exposure investigation were lower than levels shown to cause adverse health effects.

Objectives and Rationale

In order to better assess potential human exposure to airborne concentrations of hydrogen sulfide (H_2S) in ambient air in the community(s) and schools near the APAC Reno Landfill (Reno, site, facility) located in the City of Overland Park, Kansas, the Agency for Toxic Substances and Disease Registry (ATSDR) conducted an Exposure Investigation (EI). ATDSR was assisted with the exposure investigation field activities by its mission support contractor, Eastern Research Group, Inc. (ERG). This EI consisted of an ambient air monitoring program conducted over a five-week period. The purpose of the EI was to obtain representative concentration data of hydrogen sulfide gas (H_2S) as well as meteorological parameters in areas where residents live and work.

Exposure Investigation (EI)

An exposure investigation is an approach ATSDR uses to fill data gaps in evaluating community exposure pathways. Its purpose is to better characterize past, present, and possible future exposures to hazardous substances in the environment and evaluate possible health effects related to those exposures.

Background

The APAC-Reno landfill is located in the City of Overland Park, near Kansas City, Kansas. Since 1986, the landfill has operated as a construction and demolition debris (C&DD) landfill within the site of a former rock quarry. The Reno site occupies 140 acres, with about 50 acres used for landfilling. The APAC-Reno Landfill is the largest C&D landfill in Kansas and the seventh largest landfill in Kansas. Reno accepts wood, bricks, roofing material, concrete, floor covering, plaster, drywall, plumbing fixtures, electrical wiring and construction related packaging. Reno had been adding ground sheetrock as an amendment in its yard waste composting operation. Excess ground sheetrock was disposed in the landfill. Grinding this material can increase the reactive surface for decomposition and accelerate H_2S gas production. Anaerobic breakdown of sulfur/sulfate-containing building materials such as gypsum wall board can generate hydrogen sulfide gas (KDHE, 2006).

The property also includes a small hot-mix asphalt plant and 2 ponds. One pond is located in the northwest corner of the landfill; the other pond is near the eastern boundary of the site. Historically water from the northwest pond has been used as a coolant for the asphalt plant, and then allowed to flow overland to the 40 foot down-gradient east pond. The water is then pumped back to the northwest pond and then passes through a charcoal filter treatment system.

A community of approximately 200 residencies is located within a ½ mile of the landfill (across Metcalf Avenue). Some of the houses in this community are located as close as 50 feet from the eastern APAC-Reno site boundary. Odors from seeping leachate and the east pond have been noted at some of these residencies. An elementary and high school campus, serving about 1000 students, is located northeast of the landfill, approximately one mile away. Another school campus consisting of an elementary school, middle school, and high school is located due west of the landfill, also about one mile from the site boundary. Several commercial businesses are located north of the landfill.

For several years, nearby residents and neighboring business owners have complained primarly of foul smelling, “rotten egg” odors. In June 2005, following a three week period of heavy rains (10-15 inches), a dramatic increase of odors, as well as a corresponding increase in the number of odor complaints occurred. These complaints were initially directed to the Johnson County Waste Water facility (JCWW) located north of the landfill. However, JCWW was ruled out as to the source of the odors. The Johnson County Environmental Department (JCED) was contacted. JCED inspected the APAC Reno Landfill, noted uncovered fill next to the east pond along with seepage areas where strong odors emanated. The water reportedly had a “septic” appearance. The landfill operator agreed to cover the exposed seepage area with shale and to begin surface aeration of both ponds. Seeps and leaks were also reported along the northwest pond dam areas which were repaired with clay plugs.

In late June 2005 an Odalog H_2S meter was placed by JCWW along a catwalk just above the east pond where odors continued to be a problem. Ferrous chloride was used to treat both the east and northwest ponds which resulted in a decrease of noticeable odors. Measurements in early July were 0.3-0.4 parts per million (ppm) at the east pond location. Odors continued intermittently during the month of July. By late July, strong odors were again reported.

By early August readings as high as 10 ppm were being measured just above the largest leachate stream coming from the base of the covered fill area below the east pond. Other leachates streams were also identified and plugged with shale.

In late August 2005, strong odors were beginning to occur along Highway 69, just west of the landfill. Hydrogen sulfide measurements as high as 2 ppm were obtained along the west end of the property. Another untreated leachate stream was identified close to the northwest pond. Concentrations of 25-30 ppm of hydrogen sulfide were measured. Following treatment of this stream with ferrous chloride, H_2S concentrations dropped to 2 ppm. The Kansas Department of Health and Environment (KDHE) sent a “letter of warning” to Reno (KDHE, 2005).

On August 23, 2005 Reno began perimeter H_2S monitoring using a 1 sensor Drager meter at 4 site locations chosen by the JCED. Intermittent readings were obtained at 7 am, noon, and at 5pm.

Odor complaints continued well into late August. Measurements of H_2S at 2 ppm along the east pond and 24-30 ppm at a discharge stream near the waste fill area were being obtained. A high-water discharge culvert at the northwest pond had readings as high as 9 ppm. In an effort to divert water flow away from the waste fill area, Reno rerouted the asphalt plant discharge water away from the east pond in late August 2005.

In early September, two additional monitors were installed. One monitor was located at the mid-section of the east pond and the second monitor was placed at the covered fill discharge outflow stream.

Reno continued chemical treatments (with NaOH) of both the east and the northwest ponds during September 2005. A biological (bacterial) treatment to increase the microbiological activity in the east pond was conducted along with an underwater aeration system.

On September 19, 2005, KDHE held a public meeting to present information about the steps taken to reduce odors in the community. Approximately 80 to 85 people attended the public meeting.

From late September until early November, 2005, the monitored H_2S concentrations had decreased to less than 1 ppm. However, on November 9 another significant odor event occurred with H_2S levels near the east pond reportedly exceeding the upper limit of the meter.

The KDHE has directed Reno to conduct a hydro-geological investigation of the property which will help to quantify the volume of leachate within the landfill. The facility is currently installing a leachate collection system consisting of a French drain and 10 to 12 wells.

Community Health Concerns

There are approximately 5000 residencies within a 1.5 mile radius of the landfill. Community members have reported health complaints associated with environmental odors including difficulty breathing, asthma exacerbations, headaches, and nausea. Business owners north of the landfill have also complained of foul indoor odors when they arrive at work in the morning. Community members have specifically expressed concerns about H_2S levels at the school campuses to the west and northeast, a child day care center approximately one block from the site, as well as homes east of the Reno property.

The Kansas Department of Health and Environment indicated it lacks the equipment and expertise to conduct appropriate H_2S air monitoring and to evaluate the results. KDHE formally requested assistance from ATSDR in conducting air monitoring and addressing the community's concerns about potential health effects.

Demographics

The City of Overland Park is located in the Kansas City, Kansas metropolitan area. The City of Overland Park has a population of approximately 149,080 with 76,910 females (51%) and 72,170 males (48%). Most of the population of Overland Park are white (90.6%), the majority of adults have at least a high school diploma (95.8%), the median age is 36 years old, and have a median household income in 1999 of $62,116 (U.S. Census Bureau, 2000).

Exposure Investigation Methods

An Exposure Investigation Protocol and associated Sampling and Analysis/Health and Safety Plan (EI Protocol) was developed for this EI. The EI Protocol details exposure investigation parameters such as types of equipment used, monitoring site selection, data quality objectives, and sampling methods. The Exposure Investigation Protocol and Sampling and Analysis/Health and Safety Plan are included in this report in Appendix A.

Investigators/Collaborators

Agency for Toxic Substances and Disease Registry

The EI Manager and Technical Monitor for this project was Ms. Debra Gable. Ms. Gable also served as ATSDR's field team member. Dr. Michael Patterson served as the EI Medical Officer. The regional representative for the site was Ms. Denise Jordan-Izaguirre.

Eastern Research Group, Inc.

The ERG Project Director for this EI was Mr. Scott Sholar. The ERG Senior Technical Advisor for this EI was Mr. Dave Dayton. They reported directly to the ATSDR EI Manager. The ERG field team members for this EI were Mr. Scott Sholar and Mr. Dave Dayton. Mr. Regi Oommen served as the ERG Field Report Task Leader.

See Appendix A, Exposure Investigation Protocol, for a more complete description of the EI Team roles and responsibilities.

Targeted Pollutant

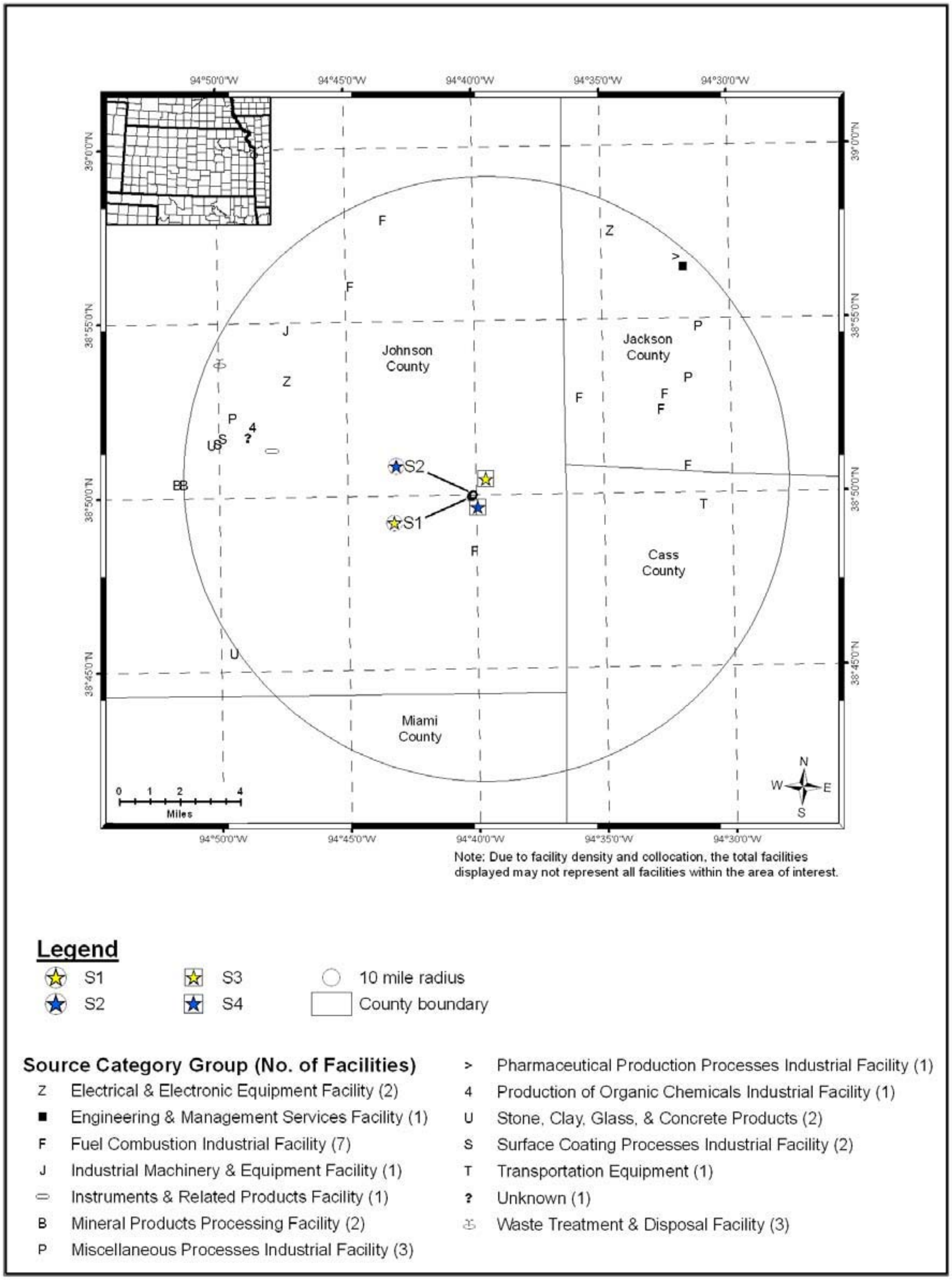
The compound selected for monitoring during this exposure investigation was hydrogen sulfide because it presents a high potential to be emitted from the Reno Landfill. Although other airborne pollutants may be emitted from the landfill, H_2S was chosen to be measured during the EI as an indicator of landfill gas emissions. Other stationary sources of H_2S exist in the Overland Park area (see Figure 1), (EPA, 2002). Documented stationary sources of hydrogen sulfide are located beyond a 1-mile radius of the landfill.

Hydrogen sulfide is a poisonous, flammable, colorless gas with a characteristic odor of rotten eggs. Humans can smell H_2S at low concentrations, ranging from 0.0005 to 0.3 part per million by volume (ppmv).

Once emitted to the air, H_2S typically remains airborne for less than 1 day (MESB, 2000). Many mechanisms affect the atmospheric fate of H_2S, but the principal removal mechanism is believed to be reaction with hydroxyl radicals (EPA, 2002), ultimately leading to formation of sulfur dioxide and sulfates. Ambient concentrations of hydroxyl radicals exhibit considerable diurnal variations, with concentrations highest during the daylight hours and dropping considerably at night (Ren, 2001). Accordingly, the principal removal mechanism for H_2S is expected to be most active during the daylight hours.

ATSDR has established an acute minimal risk level (A-MRL) for H_2S of 70 parts per billion by volume (ppbv) for up to 14 days of continuous exposure and an intermediate minimal risk level (I-MRL) of 20 ppbv for exposure durations between 15 and 364 days (ATSDR, 2006) .

Figure 1. Stationary Sources of Hydrogen Sulfide within 10-mile Radius of the RENO Landfill



Siting (Selection of Monitoring Locations)

As part of the site selection process, the exposure investigation field team visited Overland Park to perform a pre-site survey and met with the petitioners that requested ATSDR's assistance. During this survey, the field team became familiar with the layout of the city and its proximity to the landfill, and determined the location of critical potential exposure areas (i.e., schools, parks, resources for the elderly, etc.). This information was used to determine candidate monitoring site locations and to prepare the overall design of the monitoring approach. To aid in the site selection process, two wind roses with data from the Olathe-Johnson City (OJC) National Weather Service (NWS) station were prepared (see Figures 2 and 3), (NCDC, 2006). The NWS station is located approximately 10 miles northwest of Overland Park. The area average annual wind information and area average summertime wind information is shown in Figures 2 and 3, respectively. These wind rose assessments were considered representative of area wind patterns. Since representative wind rose data was available, the assessments were used to establish area typical wind flow patterns and to choose monitoring locations for the exposure investigation.

During the pre-site survey, the field team visited each of the candidate monitoring locations. Based on this survey, four monitoring locations were selected. Monitoring locations were documented by longitude and latitude using a hand held global positioning system (GPS). Field team members determined all needs associated with installing and operating the monitoring systems (i.e., access, adequate power, internal/external physical constraints, and compatibility with equipment specifications prior to deployment). ATSDR secured consent from the associated parties to monitor at those sites (public and private).

Monitoring locations and equipment used at each location is presented in Table 1. Plots of the monitoring locations are shown in Figure 4. Digital pictures of individual monitoring locations and deployed equipment are presented in Figures 5-8.

Table 1. Measurement Descriptions by Monitoring Locations

Site Number	Monitoring Locations	Measurement Type
1	APAC Reno Facility/North Berm	Meteorology
2	Private Business	H_2S
3	Elementary School	H_2S
4	Private Residence	H_2S

Figure 2. Olathe-Johnson City (OJC): Average Annual Wind Rose

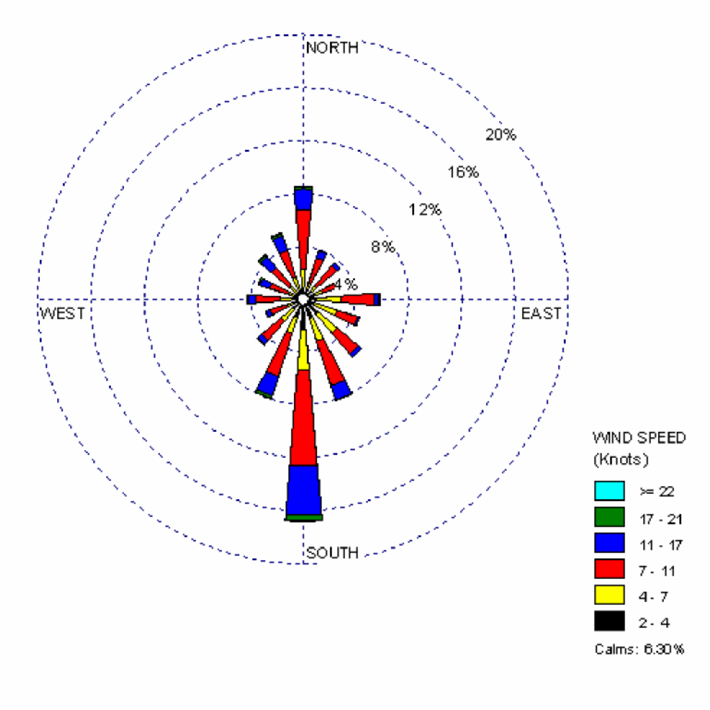


Figure 3. Olathe-Johnson City (OJC): Average Summertime Wind Rose

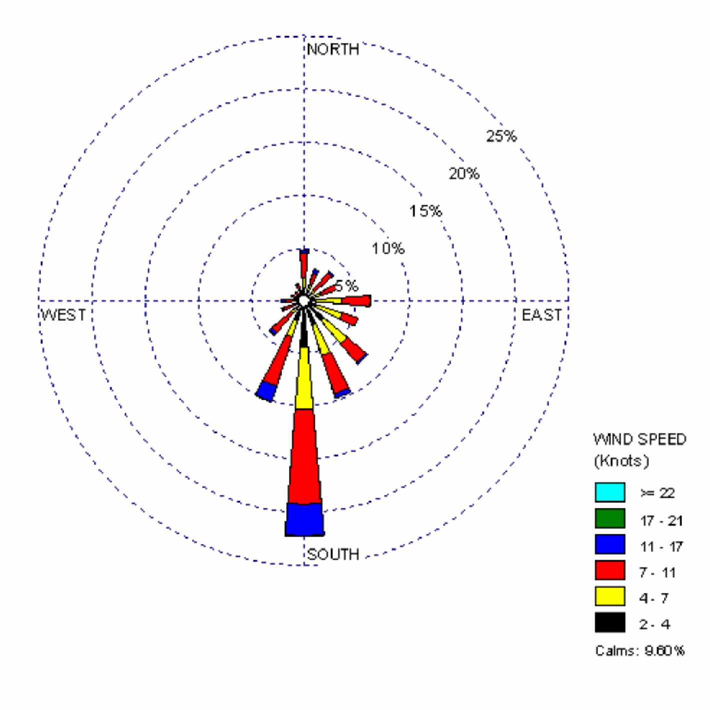


Figure 4. Monitoring Location Map for the Exposure Investigation

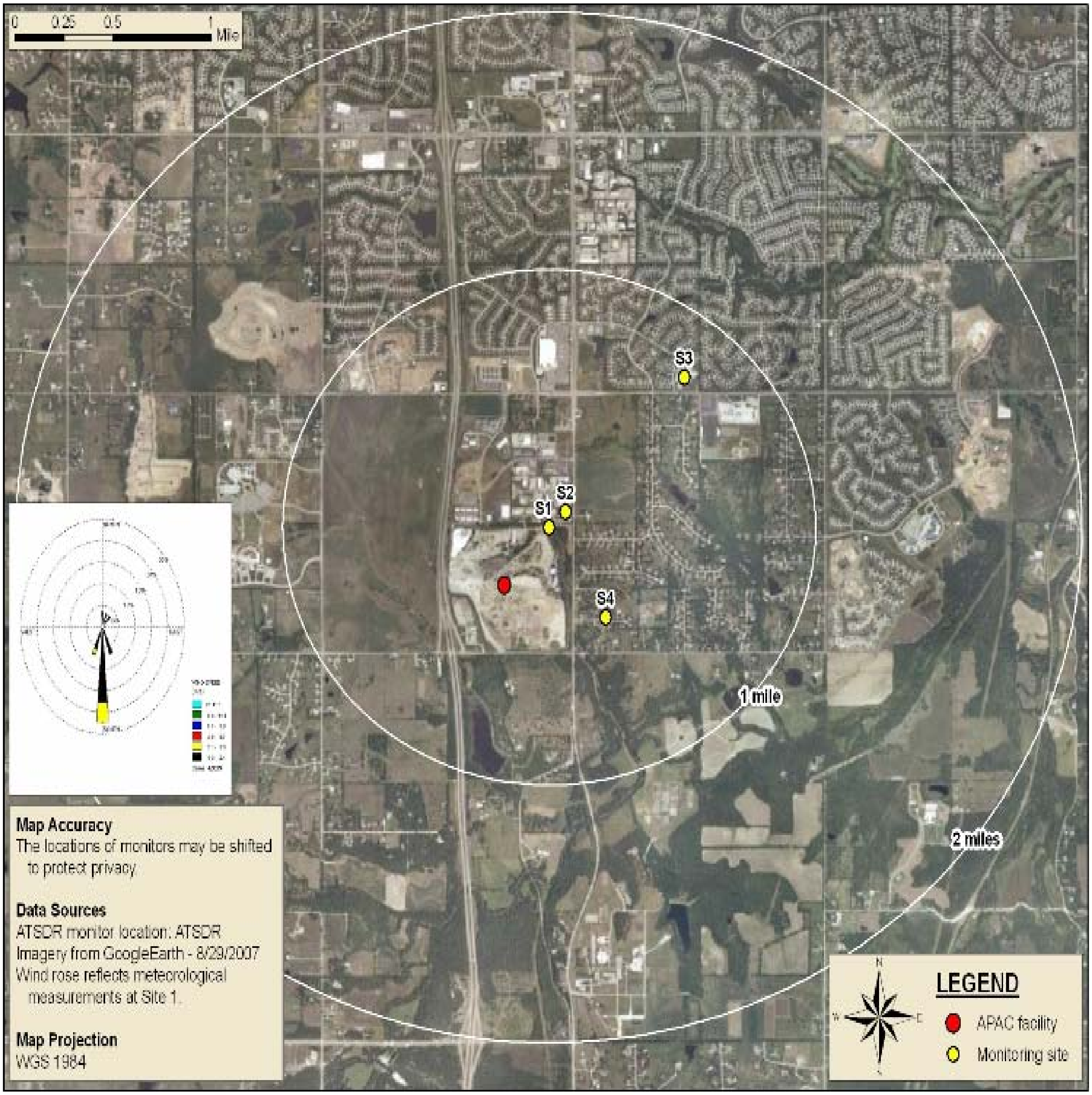


Figure 5. Site 1 Equipment and Setup

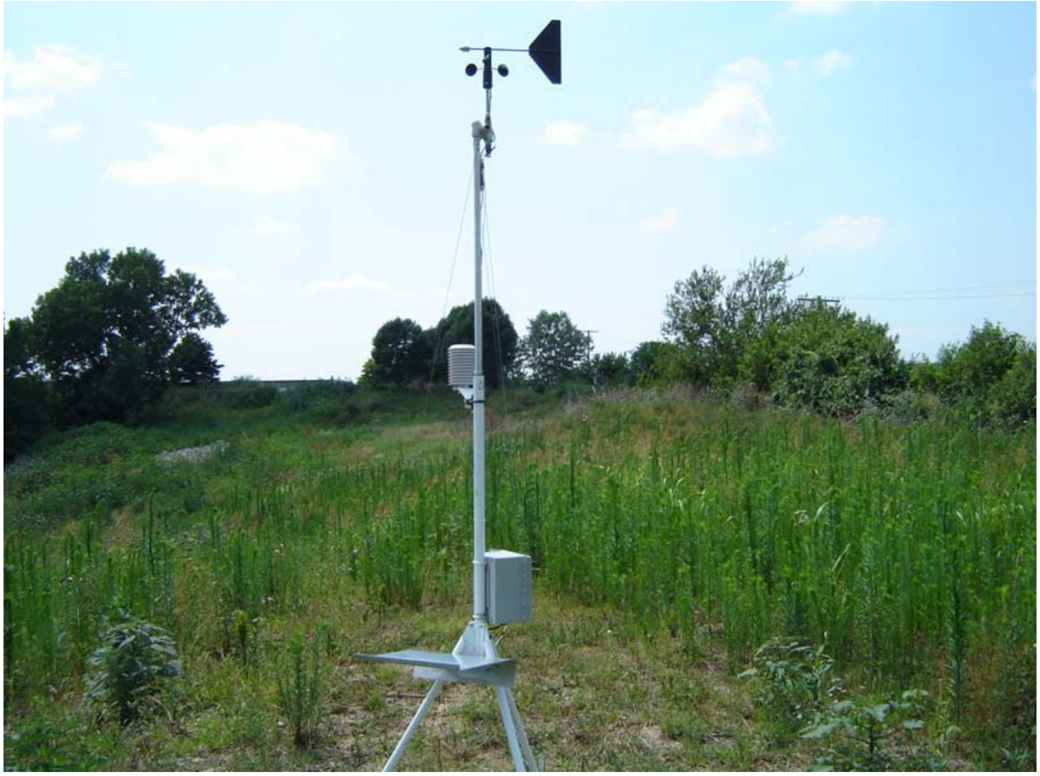


Figure 6. Site 2 Equipment and Setup

Figure 7. Site 3 Equipment and Setup

Figure 8. Site 4 Equipment and Setup

Deployment
The monitoring equipment was shipped to the exposure investigation area and the chemical measurement and the meteorological measurement systems at each site were installed in accordance with the approach developed during a pre-site survey and the EI Protocol. Table 1 presents the equipment configuration that was employed at each site. Once equipment was installed, each system was tested to ensure that damage had not occurred during shipment.

Once the H_2S measurement systems were determined to be operating correctly, internal optical 2-point calibration checks were initiated, and each system was brought on-line. The meteorological monitoring system was tested. Quality control checks were conducted of the wind speed sensors (using a constant speed motor), wind direction sensors (using a compass), and temperature sensors (using a traceable temperature measurement device). The meteorological monitoring system was brought on-line once the system was determined to be operating correctly.

Study Duration/Schedule
Air monitoring was conducted continuously for five weeks. A field team member visited the monitoring sites twice each week to assess the functional status of the chemical and meteorological measurement equipment, and to correct any problems identified. Data was downloaded from the H_2S monitor dataloggers. Chemcassetes were changed weekly. Visual checks of the meteorological sensors and data downloads were performed weekly. A weekly status report was transmitted to the ATSDR lead investigator. In addition, any issues, concerns, and/or changes were discussed with the ATSDR lead investigator as they occurred.

Sample Collection/Monitoring Methods

Hydrogen Sulfide
Measurements of H_2S were made using Honeywell Single Point Monitors (SPMs). Primary calibration of these instruments was performed at the ERG laboratory prior to deployment. The instruments were calibrated from 0-90 ppbv. However, the linear detection range for these instruments is 2-90 ppbv. Accordingly, measured values between 2-90 ppbv are considered to be quantitative, while measured values between 0-2 ppbv are considered to be qualitative.

Ambient air was drawn through a humidifier filled with distilled water and into the instrument through a length of Teflon tubing (0.250 inch outside diameter), outfitted with an inverted glass funnel connected at the inlet end. Measurement of H_2S was continuous and automatic, and collected at a height of approximately 6-9 feet above grade (considered generally reflective of the “breathing zone”). Resulting data were stored in a data acquisition system (DAS). The distilled water was changed in each humidifier biweekly during the monitoring period.

Meteorological Parameters
Measurements of meteorological parameters were made using a stand alone meteorological monitoring system, attached to a secured mast assembly. This system incorporated 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 temperature probe to measure ambient temperature. Meteorological measurements were made at a height of approximately

9 feet above grade. Measurements were collected continuously and resulting data were stored in a dedicated DAS.

Quality Assurance/Quality Control

The Data Quality Objectives (DQOs) for a project 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. Data quality objectives for this EI are presented in Table 2.

A detailed description of the Data Quality Objectives and DQOs results are presented in Appendix B.

Table 2. Data Quality Objectives

DQO	Element	Objective
1	Where to Conduct Monitoring	All sites must be located in close proximity to the potentially impacted populous.
2	Number of Sites Required	Three monitoring sites will provide a representative and direct relationship to the potentially impacted populous (i.e., schools, public buildings, private residences and/or businesses, etc.)
3	When to Conduct Monitoring	Daily – from 0000 to 2359 hours
4	Frequency of Monitoring	Continuous for H_2S so that short duration excursions can be assessed, and hourly and daily average concentration can be calculated.
5	Overall Completeness	80% data capture
6	Acceptable Measurement Precision for SPMs	+/- 20% relative standard deviation (RSD)
7	Acceptable Measurement Accuracy for SPMs	+/- 15% Bias

RESULTS

The measurement results are presented statistical summaries for the various pollutants and meteorological parameters in this section.

Hydrogen Sulfide
Overall statistical summaries of H_2S sampling by site are presented in Table 3.. The overall 1-hour average H_2S concentration ranged from 0.93 ppbv (Site 3) to 1.13 ppbv (Site 2). Forty-seven measured minute-level concentrations at Site 2 were greater than 20 ppbv. The maximum concentration sampled was 24.04 ppbv at Site 2. These "spikes" generally lasted between 10 and 15 minutes in duration, and occurred on three separate days. The total number of 1-minute hydrogen sulfide samples collected during the investigation period was 95,995.

All of the sites experienced a morning peak (although the time frames varied slightly). Minute-level maximums generally occurred during a distinct 4-hour time period. To quantify this peak, rolling 4-hour averages were calculated during the morning hours, and the highest averaged concentration and corresponding time period also are presented in Table 3. This morning peak was typically more than double the overall average concentration for all three sites. As with the overall average concentration, the Site 2 morning peak average concentration was the highest (2.57 ppbv).

Table 3. Overall H_2S Statistical Summary

Site	Minimum 1-minute Concentration (ppbv)	Maximum 1-minute Concentration (ppbv)	Overall 1-hour Average Concentration (ppbv)	Standard Deviation (ppbv)	Total Number of Samples	Highest 4-hour Average Concentration (ppbv)	Time Period Highest 4-hour Average Concentration Observed
Site 2	0	24.04	1.13 ± 0.02	1.49	37,771	2.57	6am-10am
Site 3	0	16.14	0.93 ± 0.01	1.00	39,630	1.95	7am-11am
Site 4	0	14.80	1.05 ± 0.02	1.06	18,594	2.22	8am-12pm

Note: Site 1 was a suitable location to record meteorological data but not H2S. Therefore a SPM was not located at Site 1.

Minute-level H_2S concentration plots for each site are presented in Appendix D, along with minute-level temperature and relative humidity data. As presented in the graphs, maximums and minimums in the H_2S concentration profile occurred in a diurnal pattern at each site. Concentrations typically rose overnight and throughout the morning and decreased in the afternoon through late evening; this cycle repeated daily throughout the study duration. The H_2S concentrations exhibited similar trends to the relative humidity measurements and opposite trends to temperature measurements. Figures 9 - 11 present composite hourly averaged H_2S data, which also illustrate observed diurnal patterns.

The potential health impacts of measured hydrogen sulfide were evaluated by comparing detected H_2S concentrations to health based guideline values and observed health effect levels.

Overall 1-hour average concentrations were similar across the three sites (0.93, 1.05, and 1.13 ppb). During the periods of highest detections (nighttime and morning), average (4-hour) hydrogen sulfide concentrations ranged from 1.95 to 2.57 ppb. ***None of the measured site-specific daily or average concentrations of hydrogen sulfide exceeded ATSDR's acute (70 ppbv) or intermediate (20 ppbv) minimal risk levels (MRLs) for hydrogen sulfide*****.**

Health Effects of Hydrogen Sulfide

ATSDR established MRLs for hydrogen sulfide based on a comprehensive review of the scientific literature. The respiratory tract and nervous systems are the targets for hydrogen sulfide. Symptoms can range from mild and temporary or reversible (e.g., eye irritation, nausea, headaches) to severe (e.g., respiratory or brain injury) depending on the type and extent of exposure. For perspective, a study of a small number of asthmatics (considered a sensitive subpopulation) exposed to 2,000 ppb for 30 minutes showed mild changes in airway resistance (in 20 percent of the subjects) (Jappinen et al. 1990). This study reflects one of the lowest observed effect levels for acute exposures. Other studies document changes in oxygen uptake (Bhambini & Singh, 1991), and an inhibition of the aerobic capacity of muscle tissue in healthy men exposed to between 5,000 and 10,000 ppb for 30-minute intervals (Bhambini et al., 1996a, 1996b). The highest hydrogen sulfide level detected during the exposure investigation (24 ppb) is nearly 100 times lower and average concentrations are about 1000 - 2000 times lower than effect levels reported in these studies. Though detected hydrogen sulfide levels are not considered harmful, some people can smell hydrogen sulfide at levels as low as 0.5 parts per billion (ppb).

Minimal Risk Levels (MRL)

ATSDR's MRLs represent estimates of human exposure that are likely to be without appreciable risk of adverse non-cancer health effects over a specified period of time. Acute MRLs are for exposure durations of 1-14 days; intermediate MRLs are for exposure durations of 15-365 days. ATSDR has not derived a chronic MRL for hydrogen sulfide for exposures greater than 365 days.

Less documentation is available to evaluate longer-term exposures to low-level hydrogen sulfide. A recent study in a community exposed to low levels of hydrogen sulfide reports that after days when hydrogen sulfide levels are above 30 ppb, an increase in asthma-related hospital visits exist among children (Campagna et al., 2004). Laboratory animals exposed to 0 to 80,000 ppb hydrogen sulfide for a 10-week period showed no effects at 0 or 10,000 ppb; at higher levels (>30,000 ppb), lesions were observed in the nasal cavities of exposed animals (Brenneman et al. 2000).

Measurements of hydrogen sulfide near the APAC-Reno Landfill during ATSDR's exposure investigation were lower than these reported effect levels.

According to ATSDR's Toxicological Profile for hydrogen sulfide and a literature search conducted for this report of published reports, H_2S is not known to cause cancer.

Figure 9. Composite Hourly H_2S Concentrations at Site 2

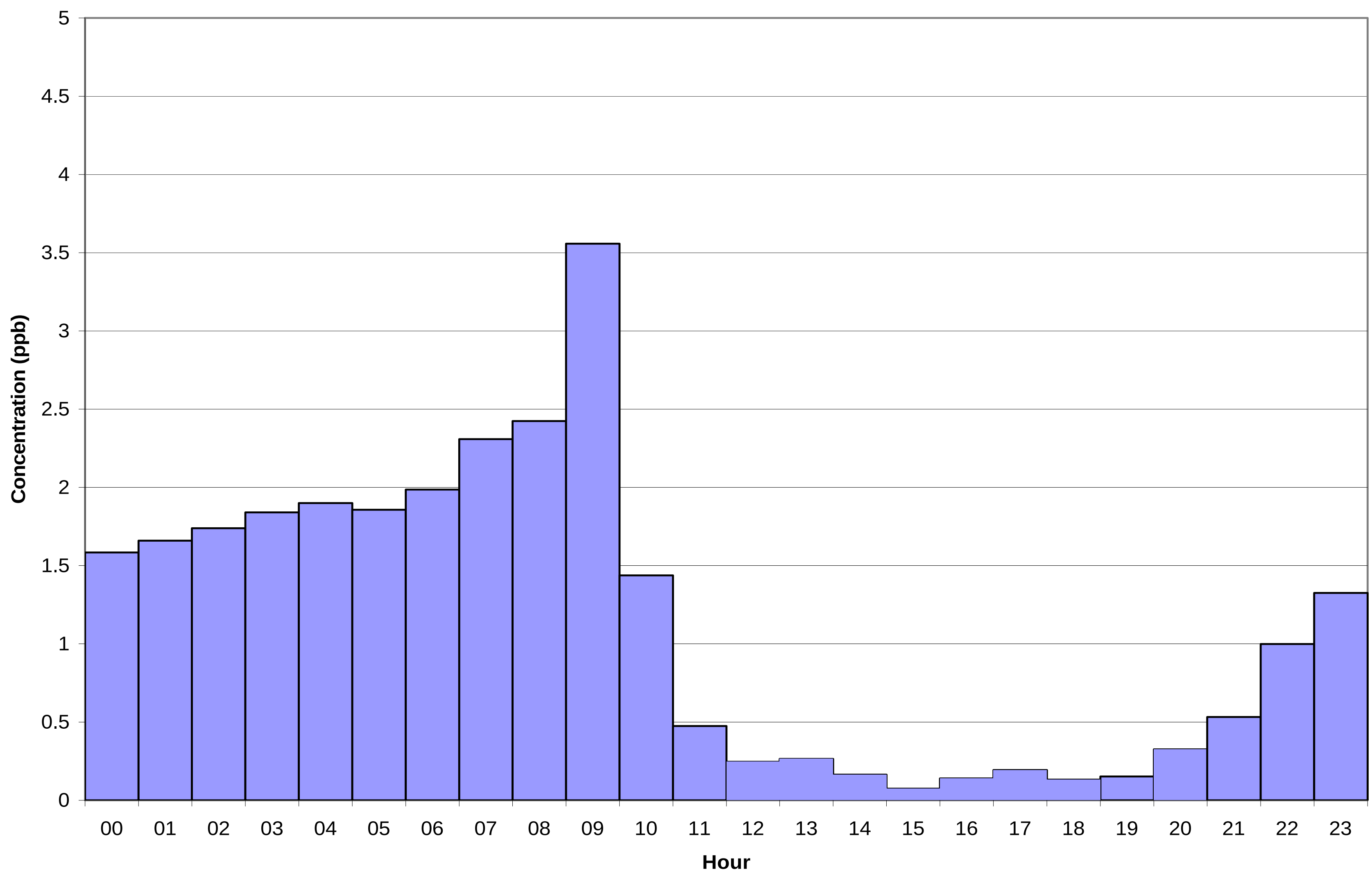


Figure 10. Composite Hourly H_2S Concentrations at Site 3

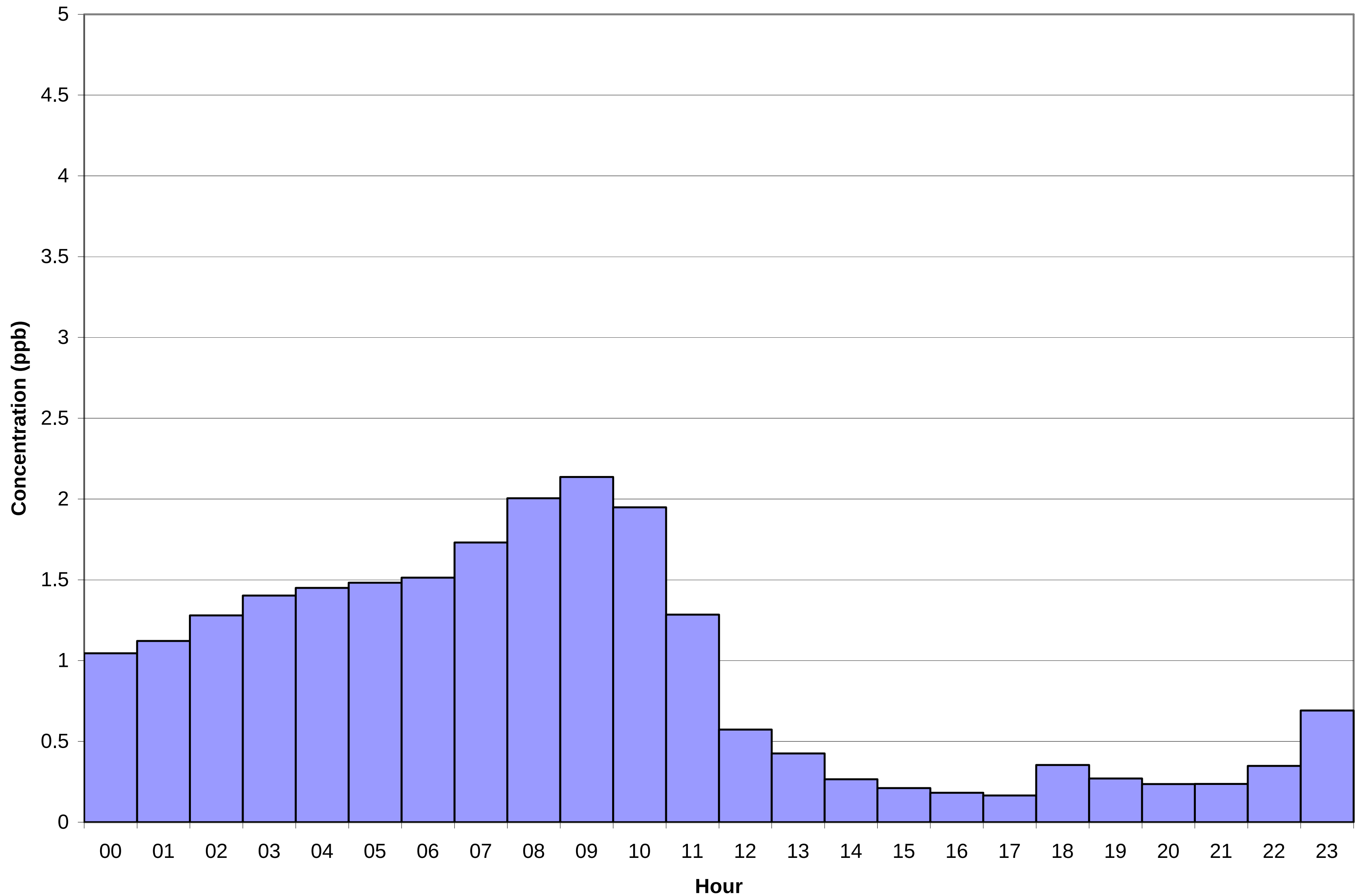
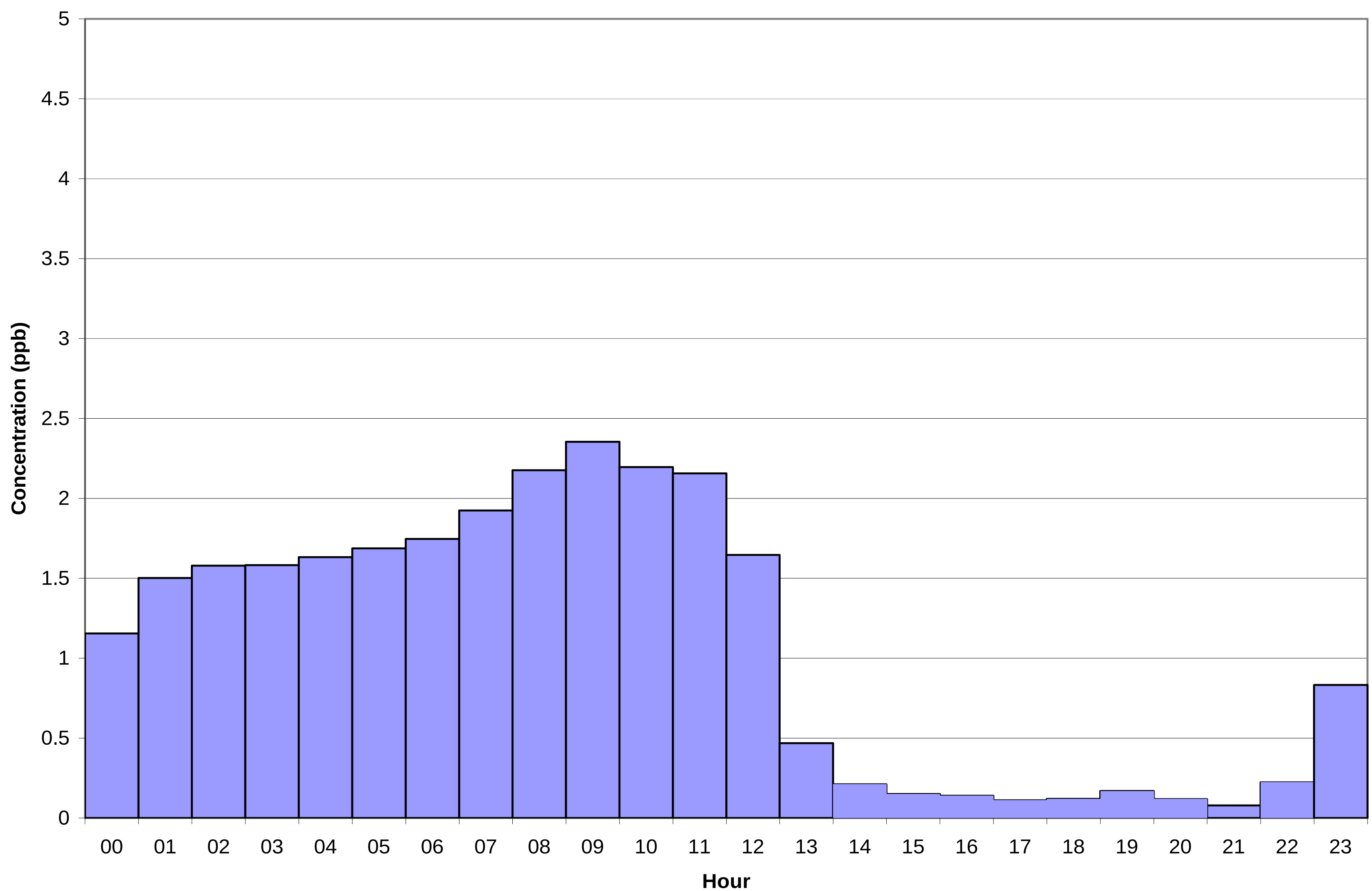


Figure 11. Composite Hourly H_2S Concentrations at Site 4



Meteorological Parameters
For this exposure investigation, one on-site system (Site 1) was used to collect meteorological data continuously. This site used a mast height of three meters above ground level (approximately 9 feet). Data from the closest National Weather Service station in Olathe-Johnson City, KS were retrieved for the same time period and were compared to the investigation area measurements. The Olathe-Johnson County (OJC) NWS station is approximately 4 miles from Site 1. The NWS station used a tower height of 10 meters (approximately 30 feet) above ground level.

Wind Direction and Speed
Presented in Table 4 is the average wind speed and direction measured at Site 1 over the study period. Winds were light and out of the south on average (176°).

Table 4. Average Wind Information

Site	Time Interval	Wind Speed (m/s)	Wind Direction (degrees)
Site 1	1=0000-0759	0.75	177
	2=0800-1559	1.65	182
	3=1600-2359	0.75	163
	Overall	1.03	176
OJC NWS	Overall	1.63	174

For evaluation purposes, a 24-hour day was divided into three, 8-hour time intervals. Average wind speeds and directions at Site 1 during the three time intervals are shown in Table 4. Wind speeds were generally lighter during time intervals 1 and 3. On average, wind direction was from the south-southeast to south, and did not change significantly between time intervals. This is visually represented in Figure 12, which presents the wind rose generated for the sampling period at Site 1.

Temperature
Presented in Table 5 is the statistical summary of temperature measurements at Site 1. Generally, maximum daytime temperatures were 90-95°F and minimum overnight temperatures were 60-65°F during the investigation period. Overall, the investigation area temperatures match well with the corresponding temperature measurements obtained from the OJC NWS station. Also shown in Table 5 is the temperature at Site 1 summarized by time interval. As expected, average temperature measurements were lower in the early morning hours compared to the rest of the day (approximately 75°F versus approximately 85°F).

Relative Humidity
The statistical summary of relative humidity measurements at Site 1 is presented in Table 6. The minimum, maximum, and average relative humidity measurements are comparable to the measurements obtained from the OJC NWS station. Relative humidity summarized by time interval is also shown in Table 6. As expected, relative humidity measurements during the study period were higher in the early morning hours compared to the rest of the day (approximately 80% versus approximately 60%).

Figure 12. Wind Rose for the Site 1 Meteorological Station

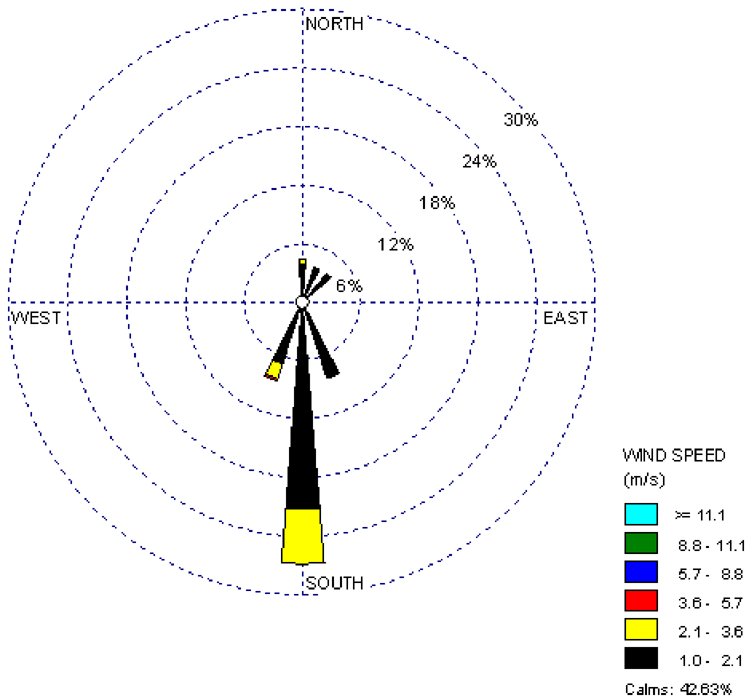


Table 5. Temperature Data Summary

Site	Time Interval	Minimum Temperature (°F)	Maximum Temperature (°F)	Average Temperature (°F)	Standard Deviation (°F)	Total Number of Samples
Site 1	1=0000-0759	62.17	86.55	74.55	5.58	18,720
	2=0800-1559	64.22	102.60	85.12	8.44	18,746
	3=1600-2359	66.28	103.41	85.26	8.69	18,718
	Overall	62.17	103.41	81.65	9.19	56,184
OJC NWS	Overall	63.00	102.00	81.03	8.56	960

Table 6. Relative Humidity Data Summary

Site	Time Period	Minimum Relative Humidity (%)	Maximum Relative Humidity (%)	Average Relative Humidity (%)	Standard Deviation (%)	Total Number of Samples
Site 1	1=0000-0759	49.25	99.75	82.05	14.08	18,720
	2=0800-1559	28.25	99.25	61.83	17.85	18,746
	3=1600-2359	25.25	98.75	60.73	19.03	18,718
	Overall	25.25	99.75	68.20	19.72	56,184
OJC NWS	Overall	30.00	97.00	66.04	16.91	960

Data Characterization

Integration of the statistical, meteorological, and geographic information system (GIS) data allows for data characterizations to be performed. The following characterizations are presented in this section: pollution roses and Pearson Correlations.

Pollution Roses – Hydrogen Sulfide

A pollution rose is a plot of the ambient concentration versus the wind direction. These plots can sometimes help generalize pollutants and emission sources. For this project, each minute-level H_2S concentration was plotted against wind direction for each site (see Figures 13–15). Winds classified as calm (less than 1 meter per second (m/s)) were not plotted. Note that the graph scale was adjusted to capture the maximum concentrations and are not consistent from site-to-site. In general, concentrations were low and dispersed around the center at all sites.

The pollution rose for Site 2 (Figure 13), a private business, shows that the highest concentrations occurred when the wind was out of the south-southeast to south-southwest. Site 2 is northeast of the nearby landfill (Figure 4). At Site 3 (Figure 14), the elementary school, the highest concentrations occurred when the wind was out of the east, southeast, and south. However, it is important to note that the highest concentration measured at Site 3 occurred with calm winds, which are not represented on the pollution rose. At Site 4 (Figure 15), the highest concentrations occurred when the wind was primarily from the north. Site 4 is southeast of the nearby landfill (Figure 4).

Data Characterization Conclusions

Winds were generally light and from the south during the monitoring program. At some monitoring locations, some of the higher hydrogen sulfide concentrations occurred when winds blew from the direction of the landfill, suggesting that landfill emissions contributed to the measured levels. However, hydrogen sulfide was also detected when winds blew from other directions, suggesting that other local emissions sources contributed to the measured concentrations as well.

Figure 13. Pollution Rose for Site 2 (Private Business)

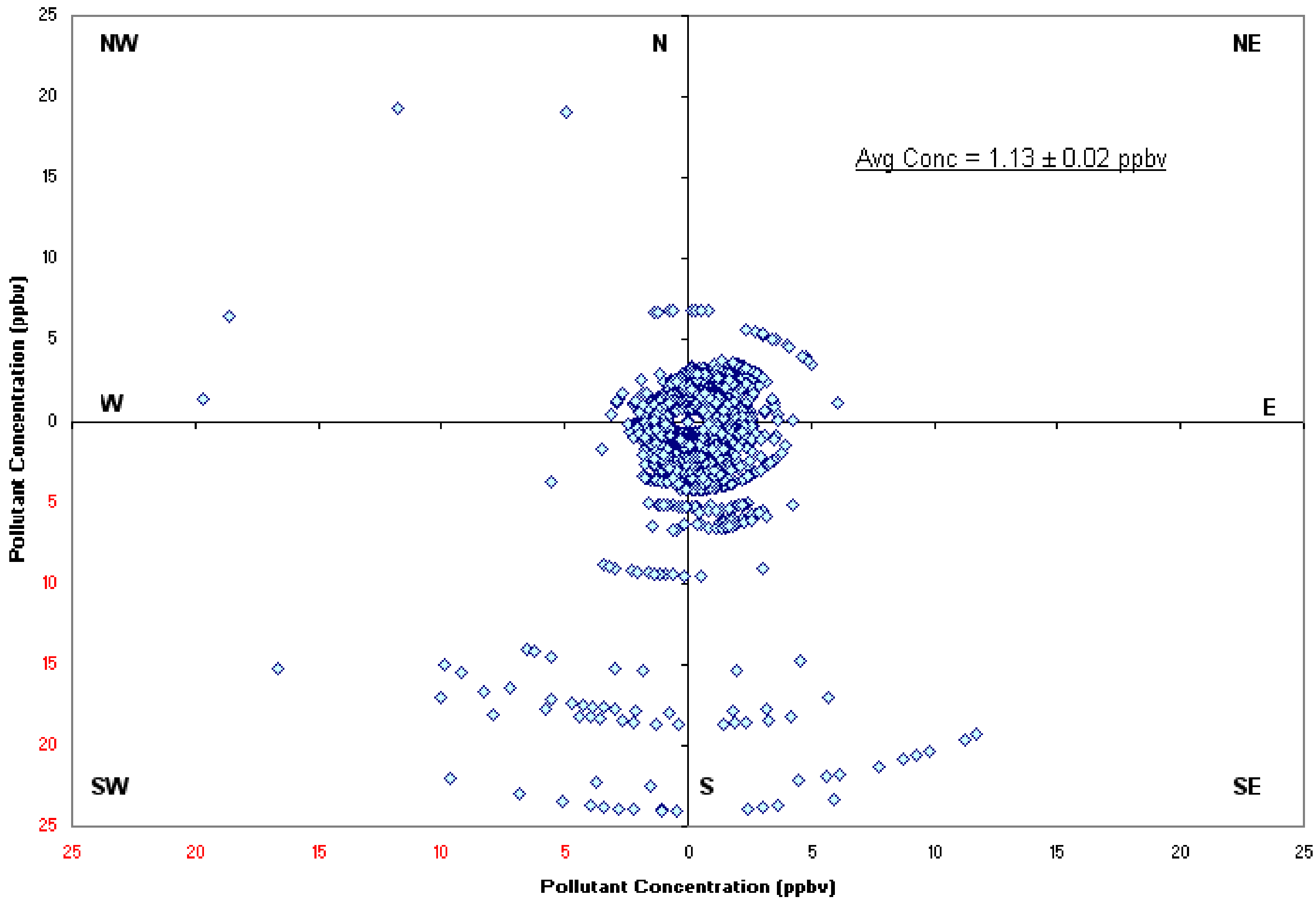


Figure 14. Pollution Rose for Site 3 (Elementary School)

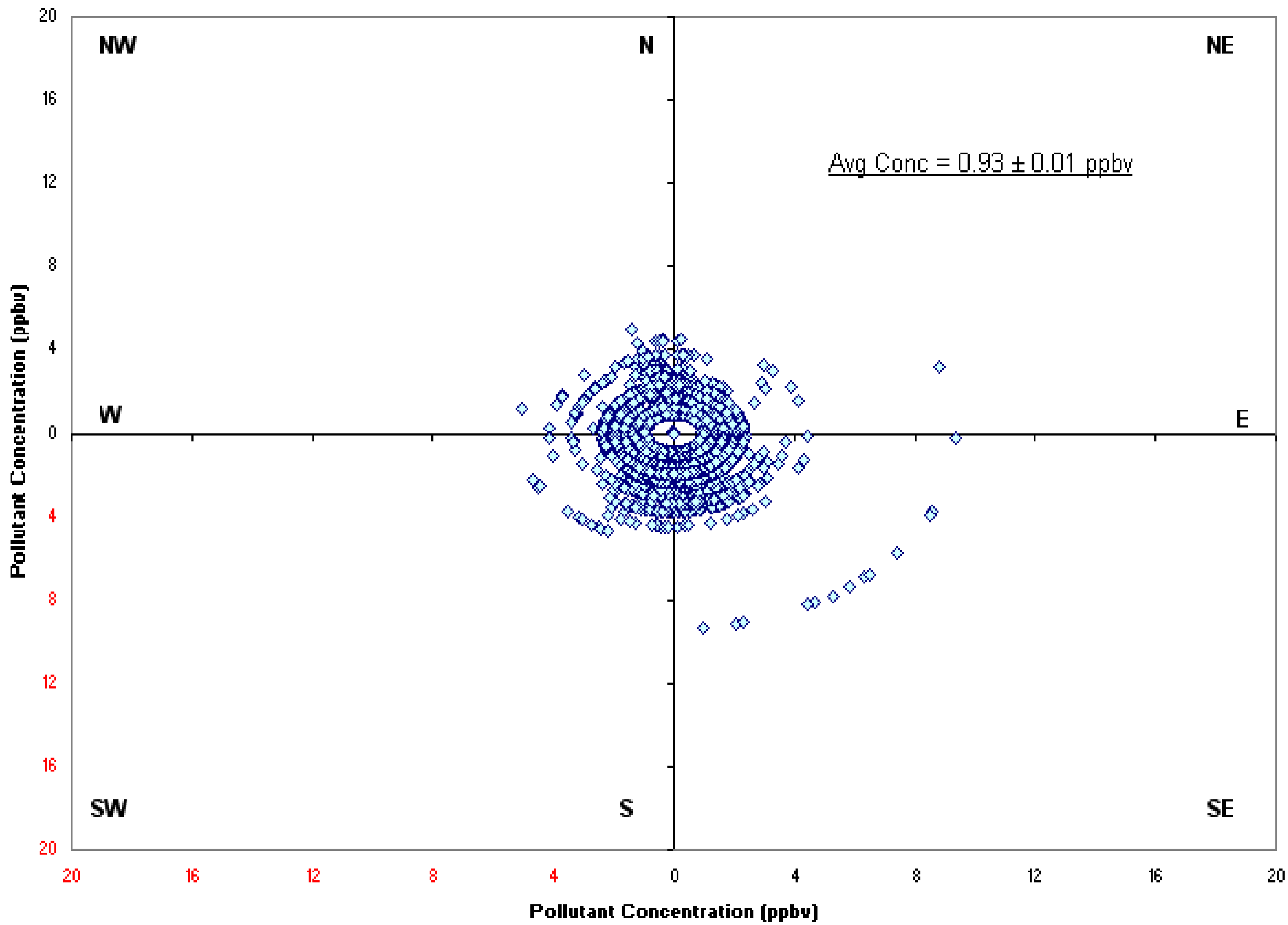
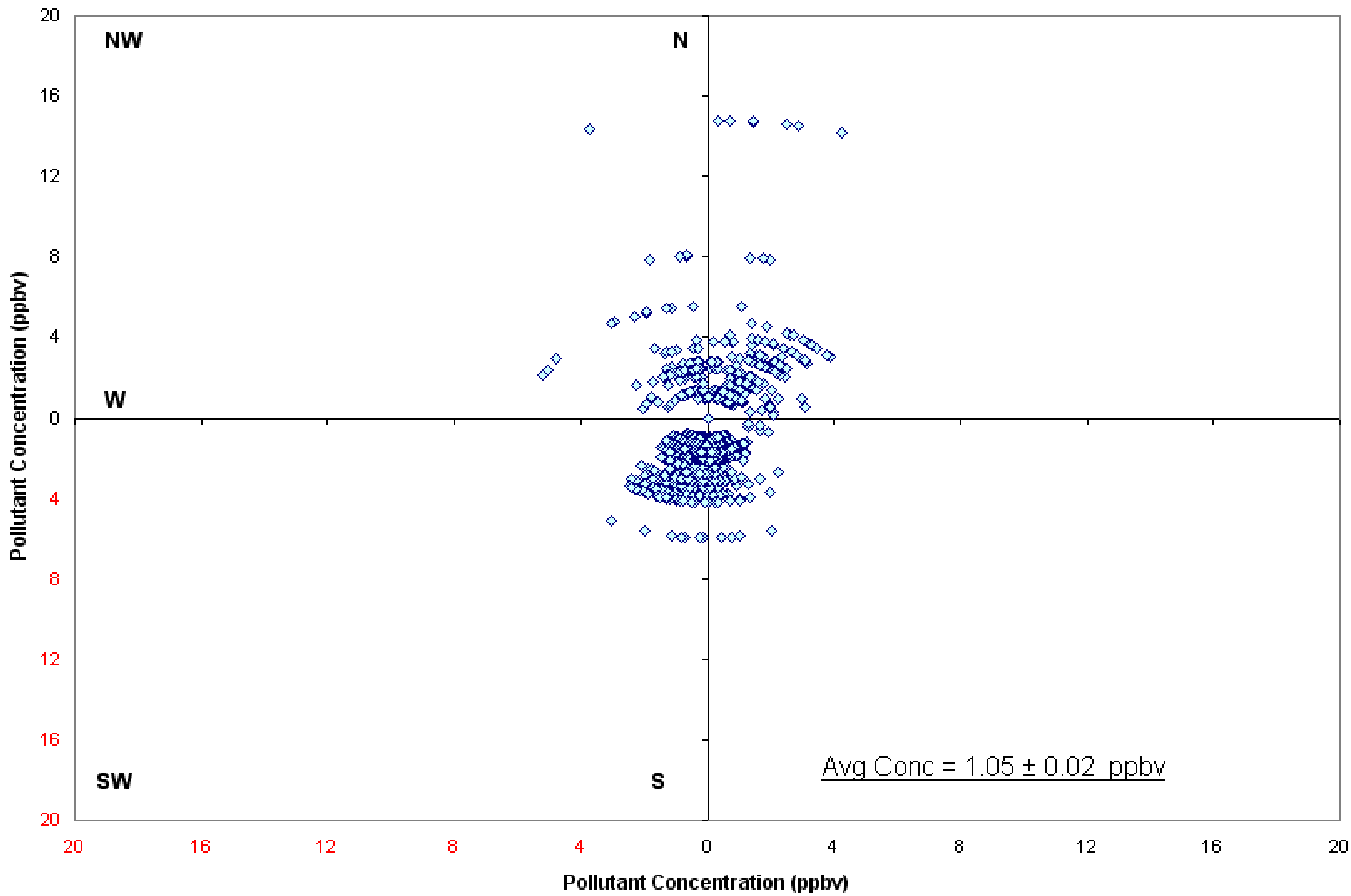


Figure 15. Pollution Rose for Site 4 (Private Residence)



Correlation Analyses

Pearson correlation coefficients are used to measure the degree of correlation between two variables. By definition, Pearson correlation coefficients always lie between -1 and +1 and are interpreted as follows:

- A correlation coefficient of -1 indicates a perfectly "negative" relationship, indicating that increases in the magnitude of one variable are associated with proportionate decreases in the magnitude of the other variable, and vice versa;
- A correlation coefficient of +1 indicates a perfectly "positive" relationship, indicating that the magnitudes of two variables both increase and both decrease proportionately.
- Data that are completely uncorrelated have a Pearson correlation coefficient of or near zero.

Table 7 summarizes the Pearson correlation calculations performed. Site 1 meteorological data was used for these correlation calculations.

Table 7. H_2S Concentration Pearson Correlations with Selected Meteorological Parameters

Site	Temperature	Relative Humidity
Site 2	-0.47	0.36
Site 3	-0.49	0.42
Site 4	-0.49	0.46

All of the sites exhibited negative correlations between H_2S concentrations and temperature, suggesting an inverse relationship between the two parameters (i.e. the higher the measured temperature the lower the measured concentration of H_2S). The correlations ranged from -0.47 at Site 2 to -0.49 at Site 3 and Site 4. Increasing temperature around mid-day often correlated to a decreasing H_2S concentration, as illustrated in the Appendix C graphs.

All of the sites exhibited positive correlations between H_2S concentrations and relative humidity, suggesting a parallel relationship between the two parameters (i.e. the higher the measured relative humidity the higher the measure H_2S concentration). The correlations ranged from 0.36 at Site 2 to 0.46 at Site 4. Increasing relative humidity (overnight) often correlated to increasing H_2S concentration (also illustrated in the Appendix C graphs).

Correlation Analyses Conclusions

As expected, temperature and relative humidity exhibited diurnal profiles. Temperatures were consistently higher during the daylight hours, while relative humidity was consistently lower during the daylight hours. Accordingly, ambient air concentrations of hydrogen sulfide were negatively correlated with temperature (i.e., concentrations were lower during the warmer daylight hours) and positively correlated with relative humidity (i.e., concentrations were higher during night time, when relative humidity also was higher).

Limitations

This EI had two main limitations. These limitations were identified in the EI Protocol. The first limitation was that the EI only captured ambient air quality at three locations (four locations including the met station) during a five week period. This time frame may not have been long enough to fully evaluate characteristic exposures to community members/residents. However, by choosing five weeks in July-August as the monitoring period, the EI collected data during what was expected to be the worst case scenario and allowed ATSDR to measure ambient air near local schools.

The second limitation of the EI was that only one of the numerous potential contaminants were measured. All efforts in this EI were made to measure that contaminant considered most likely to be of health concerns based on information provided by community members, environmental departments, and currently available information of facilities in the immediate vicinity of the City of Overland Park.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

Many children live close to or attend school close to the APAC-Reno Landfill. A community of approximately 200 residencies is located within a ½ mile of the landfill (across Metcalf Avenue). Some of the houses in this community are located as close as 50 feet from the eastern APAC-Reno site boundary. An elementary and high school campus, serving about 1000 students, is located northeast of the landfill, approximately one mile away. Another school campus consisting of an elementary school, middle school, and high school is located due west of the landfill, also about one mile from the site boundary. Given the proximity of residences and schools to the landfill, monitoring locations for this exposure investigation were selected so that hydrogen sulfide was measured in areas where children and their families are expected to spend a significant percentage of time.

Based on the information collected through this EI, measured concentrations of hydrogen sulfide are not expected to pose a public health concern for children.

Conclusions

ATSDR conducted a five week ambient air monitoring exposure investigation in Overland Park, KS, from July 6 through August 14, 2006. The purpose of the EI was to obtain representative concentration data of ambient hydrogen sulfide as well as meteorological parameters in areas near the APAC Reno Landfill where residents live and work. The data generated by the EI were used to evaluate potential human exposure to hydrogen sulfide to community members near the APAC Reno Landfill. The success of the monitoring program was measured against seven data quality objectives specific to the intended use of the data generated (i.e. to characterize community exposures to hydrogen sulfide). The DQOs were generally met during the program and high quality, representative data were obtained. Technical conclusions and pertaining observations are presented below.

Hydrogen Sulfide

Hydrogen sulfide was measured continuously at three sites during this monitoring program. An overview of H_2S concentration levels observed is presented in Table 11. ***None of the measured, site-specific daily average concentration values of hydrogen sulfide exceeded ATSDR's acute MRL (70 ppbv), nor did any of the measured site-specific monitoring program average concentration values exceed ATSDR's intermediate MRL (20 ppbv) for hydrogen sulfide.***

Measured concentrations of hydrogen sulfide during this EI are not expected to pose a public health concern.

Table 8. Overview of H_2S Concentration Levels Observed

Site ID	Highest 1-minute Concentration (ppbv)	Highest 1-hour Average Concentration (ppbv)	Overall 1-hour Average Concentration (ppbv)
Site 2	24.04	17.24	1.13
Site 3	16.14	5.26	0.93
Site 4	14.80	6.46	1.05

A very well defined diurnal pattern of hydrogen sulfide concentrations was apparent at every site. The pattern provided for low-to-zero concentration levels from midday through the evening hours, and elevated concentration levels overnight and through the morning hours.

Meteorology

Meteorological data was measured continuously at a fourth site during the monitoring program. The meteorological parameters measured were temperature, humidity, wind speed, and wind direction.

Temperature and humidity. As expected, temperature and relative humidity also exhibited diurnal profiles. Temperatures were consistently higher during the daylight hours, while relative humidity was consistently lower during the daylight hours. Accordingly, ambient air concentrations of hydrogen sulfide were negatively correlated with temperature (i.e., concentrations were lower during the warmer daylight hours) and positively correlated with relative humidity (i.e., concentrations were higher during night time, when relative humidity also was higher).

Winds. Winds were generally light and from the south during the monitoring program. At some monitoring locations, some of the higher hydrogen sulfide concentrations occurred when winds blew from the direction of the landfill, suggesting that landfill emissions contributed to the measured levels. However, hydrogen sulfide was also detected when winds blew from other directions, suggesting that other local emissions sources contributed to the measured concentrations as well.

Recommendations

ATSDR recommends the APAC-Reno Landfill management continue efforts and procedures to reduce landfill emissions. If landfill conditions change, the landfill management and the Kansas Department of Health and Environment should ensure that landfill emissions do not adversely impact the communities in Overland Park, Kansas.

Public Health Action Plan

A copy of this report and the accompanying factsheet will be sent to each of the exposure investigations participants, the City of Overland Park, Johnson County Health Department, the City of Overland Park School Superintendent, and other federal, state, and local environmental and public health agencies, and the APAC-Reno Landfill management. If requested, ATSDR will meet with interested groups to discuss the findings of the exposure investigation.

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Appendix A. Exposure Investigation Protocol

Exposure Investigation: Airborne Exposures to Hydrogen Sulfide, City of Overland Park, Kansas City, Kansas.

Exposure Investigation Protocol

Airborne Exposures to Hydrogen Sulfide
APAC Reno Landfill
City of Overland Park
Kansas City, Kansas

Cost Recovery Number A06N

May 2006

Prepared by:

Debra Gable
ATSDR/DHAC/EICB

Purpose of Exposure Investigation

In order to better assess potential human exposure to airborne concentrations of hydrogen sulfide (H_2S) in ambient air in the community(s) and schools surrounding the APAC Reno Landfill located in the City of Overland Park, Kansas, the Agency for Toxic Substances and Disease Registry (ATSDR) will conduct an Exposure Investigation (EI). During this EI, an ambient air monitoring program will be conducted over a four week period to obtain representative concentration data of hydrogen sulfide as well as meteorological parameters in areas where residents live and work.

Background

The APAC Reno landfill is located in the City of Overland Park, a suburb of Kansas City, Kansas. Since 1986, it has operated as a construction and demolition debris (C&DD) landfill within the site of a former rock quarry. Sheetrock (gypsum wallboard) and “green” yard waste have been included among the materials accepted by the landfill. Until recently, the facility was required to grind up the gypsum board. Construction and demolition debris (C&DD) landfills are known sources of H_2S gas emissions, because of the anaerobic breakdown of sulfur/sulfate containing building materials such as gypsum wall board. The State of Kansas is currently reviewing the facility’s permit requirements, but the landfill was grandfathered in under a city permit and continues to operate.

The site occupies 140 acres, with about 50 acres used for land filling. The property also includes a small hot-mix asphalt plant and 2 ponds. One pond is located in the northwest corner of the landfill, and the other pond is near the eastern boundary of the site. Historically water from the NW pond has been used as a coolant for the asphalt plant, and then allowed to flow overland to the 40 foot down-gradient East pond. The water is then pumped back to the NW pond and passes through a charcoal filter treatment system.

Investigators/Collaborators

Agency for Toxic Substances and Disease Registry
The EI Manager and Technical Monitor for this project will be Ms. Debra Gable. In the capacity of EI Manager, Ms. Gable will serve as the primary interface between ATSDR and ERG. She will be responsible for providing direction on the overall goals and approaches of the EI to ensure that the objectives of the monitoring project are met. Ms. Gable will develop, review and/or provide comments on the Monitoring Protocol and Health and Safety Plan, progress reports, and the Draft and Final EI Reports. She will also be the primary contact with other interested agencies (i.e., federal, state, and local) and be responsible for obtaining consent agreements from potential program participants identified. In the capacity of Technical Monitor, Ms. Gable will be responsible for overseeing overall coordination and logistics, and serve as a technical advisor. Ms. Gable will also serve as a field team member.

Dr. Michael Patterson will serve as the EI Medical Officer. Dr. Patterson will interface with medical staff in the City of Overland Park and will assist with data interpretation and report generation.

Eastern Research Group, Inc.

The ERG Project Director for this EI will be Mr. Scott Sholar. The Senior Technical Advisor for this EI will be Mr. Dave Dayton. They will report directly to the ATSDR EI Manager. In the capacity of Project Director, Mr. Sholar will be responsible for the overall quality of the work conducted by ERG. He will oversee all activities associated with the monitoring project, from planning through reporting. As well as managing the monitoring project and providing technical direction, Mr. Sholar and Mr. Dayton will also be very involved in the actual monitoring effort including securing equipment, equipment checkout, equipment deployment, data downloading, and equipment recovery.

Mr. Regi Oommen will serve as the ERG Field Report Task Leader. In this capacity he will assist in the preparation of the Draft and Final Field Reports and provide the monitoring data to ATSDR in electronic and hard copy forms.

The ERG field team members for this EI will be Mr. Scott Sholar and Mr. Dave Dayton. In the capacity of field team members, they will perform the pre-deployment check out of the measurement and sample collection systems, deploy them, perform daily sites visits, perform the sample collections, perform data downloading, and conduct the equipment recovery efforts.

Description of the Potentially Affected Population and Community Health Concerns

A residential community of approximately 200 residencies is located within a ½ mile of the landfill (across Metcalf Avenue). Some of the houses in this community are located as close as 50 feet from the eastern Reno site boundary. Odors from seeping leachate and the east pond have been noted at some of these residencies. There is an elementary and high school campus, serving about 1000 students, located northeast of the landfill, approximately one mile away. Another school campus consisting of an elementary school, middle school, and high school is located due west of the landfill, also about one mile from the site boundary. Several commercial businesses are located north of the landfill.

For several years, nearby residents and neighboring business owners have periodically complained of foul smelling, “rotten egg” odors. In June 2005, following a three week period of heavy rains (10-15 inches), a dramatic worsening of odors as well as a corresponding increase in the number of odor complaints occurred. These complaints were initially directed to the Johnson County Waste Water facility (JCWW) located north of the landfill. However, JCWW was ruled out as to the source of the odors. The Johnson County Environmental Division (JCED) was contacted. JCED inspected the Reno Landfill, noted uncovered fill next to the east pond along with seepage areas where strong odors emanated. The water reportedly had a “septic” appearance. The landfill operator agreed to cover the exposed seepage area with shale and to begin surface aeration of both ponds. Seeps and leaks were also reported along the northwest pond dam areas which were repaired with clay plugs.

In late June 2005 an Odalog H_2S meter was placed by JCWW along a catwalk just above the east pond where odors continued to be a problem. Ferrous chloride was used to treat both the east and northwest ponds which resulted in decrease of noticeable odors. Measurements in early July were 0.3-0.4 parts per million (ppm) at the east pond location. Odors continued intermittently during the month of July. By late July, strong odors were again reported.

By early August readings as high as 10 ppm were being measured just above the largest leachate stream coming from the base of the covered fill area below the east pond. Other leachates streams were also identified and plugged with shale.

In late August 2005, strong odors were beginning to occur along Highway 69, just west of the landfill. Hydrogen sulfide measurements as high as 2 ppm were obtained along the west end of the property. Another untreated leachate stream was identified close to the northwest pond. Concentrations of 25-30 ppm of hydrogen sulfide were measured. Following treatment of this stream with ferrous chloride, H_2S concentrations dropped to 2 ppm. The Kansas Department of Health and Environment (KDHE) sent a "letter of warning" to Reno (KDHE, 2005).

On August 23, 2005 Reno began perimeter H_2S monitoring using a 1 sensor Drager meter at 4 site locations chosen by the JCED. Intermittent readings were obtained at 7 am, noon, and at 5pm.

Odor complaints continued well into late August. Measurements of H_2S at 2 ppm along the east pond and 24-30 ppm at a discharge stream near the waste fill area were being obtained. A high-water discharge culvert at the northwest pond had readings as high as 9 ppm. In an effort to divert water flow away from the waste fill area, Reno rerouted the asphalt plant discharge water away from the east pond in late August 2005.

In early September, two additional monitor locations were installed. One monitor was located at the mid-section of the east pond and the second monitor was placed at the covered fill discharge outflow stream.

Reno continued chemical treatments (with NaOH) of both the east and the northwest ponds during September 2005. A biological (bacterial) treatment to increase the microbiological activity in the east pond was conducted along with an underwater aeration system.

On September 19, 2005, KDHE held a public meeting to present information about the steps taken to reduce odors in the community. Approximately 80 to 85 people attended the public meeting.

From late September until early November, 2005, the monitored H_2S concentrations had decreased to less than 1 ppm. However, on November 9 another significant odor event occurred with H_2S levels near the east pond reportedly exceeding the upper limit of the meter.

The State of Kansas has directed the Reno to conduct a hydro-geological investigation of the property which will help to quantify the volume of leachate within the landfill. The facility is currently installing a leachate collection system consisting of a French drain and 10 to 12 wells.

Community Health Concerns

There are approximately 5000 residencies within a 1.5 mile radius of the landfill. Community members have reported health complaints associated with these odors, including difficulty breathing, asthma exacerbations, headaches, and nausea. Businesses north of the landfill have also complained of foul indoor odors when they arrive at work in the morning. The community has specifically expressed concern about H_2S levels at the school campuses to the west and northeast as well as homes east of the property.

The Kansas Department of Health and Environment has indicated it lacks the equipment and expertise to conduct appropriate H_2S air monitoring and evaluate the results. KDHE has formally requested assistance from ATSDR in conducting the air monitoring and addressing the community's concerns about potential health effects.

Criteria for Choosing the Target Area

The primary health concerns of the residents in the City of Overland Park as expressed to ATSDR are hydrogen sulfide gas emissions from the APAC Reno Landfill. Many area residents live, work, and attend school near the landfill. To address community concerns, ambient air monitoring will be concentrated in areas near the City of Overland Park public schools, local businesses, and residential properties. A metrological monitoring station will be located on the landfill to characterize met data (wind speed, wind direction, temperature, and barometric pressure) during the monitoring period. Proposed air monitoring locations are as follows:

A hydrogen sulfide monitor will be placed northeast of the landfill at a worship center close to an elementary school and a high school.

A second hydrogen sulfide monitor will be located at a private residence on the east side of the landfill. This location is expected to be characteristic of the residential area closest to the landfill.

A third hydrogen sulfide monitor will be placed at a small business directly across the street (north-northeast) from the landfill and located in the direction of the estimated predominant wind direction (wind blowing from the landfill).

The residential property, worship center, and the small business selected for monitoring stations represent typical community exposure scenarios.

Due to equipment limitations, a background monitoring station will not be established.

Description of Target Population

Demographics

The City of Overland Park is located within Kansas City, Kansas. The City of Overland Park has a population of approximately 149,080. Most of the population of Overland Park are white (90.6%), the majority of adults have at least a high school diploma (95.8%), the median age is 36 years old, and have a median household income in 1999 (dollars) of $62,116.

Age, Gender and Ethnicity of the Target Population

In the City of Overland Park there are 76,910 females (51%) and 72,170 males (48%). The median age is 36.3 years. Approximately 73.8% of the population is over 18 years old and 11.4% older than 65 years (U.S. Census Bureau, 2000).

Race/ Ethnicity

Most of the population of the City of Overland Park is white (90.6%).

Special Populations

Pregnant women, children, the elderly, and people with chronic health conditions are considered as populations that may have increased susceptibility within the general target population. To address this concern, the EI will include areas where children range in age from 5 to 17 years and areas where residents live.

Exclusion Criteria

Biologic sampling will not be conducted.

Exposure Investigation Objectives

This EI has two objectives. First, is to characterize concentrations, including peak concentrations and time-weighted average values, of hydrogen sulfide in residential areas near the APAC Reno Landfill.

The second objective is to provide information to evaluate if exposures are occurring at levels of health concern for residents and particularly to children and the elderly in the community.

Rationale for Environmental Sampling

Continuous ambient air monitoring is needed in the community(s) and/or schools for several reasons:

- H_2S concentrations have only been measured on the landfill property. The monitors closest to the nearest residencies and businesses are set up along the periphery of the landfill. Only a limited number of monitors have been used and only intermittent measurements have been collected.

- No community or residential locations have been monitored for H_2S, despite odor complaints from the community which have occurred sporadically for several years.

- Community members, located east and northeast, as well as business owners to the north of the landfill, have expressed health concerns, both for themselves and their children. There are 5 schools located to the northeast and west within a 1 mile radius of the landfill which have reported odor complaints.

- Continuous real-time air monitoring at potentially impacted locations in residential and school areas will provide exposure data for public health evaluation.

- The data may assist state and local health and environmental agencies in identifying appropriate measures to mitigate H_2S releases from the landfill.

- Continuous monitoring will provide a lower level of detection limit of 0-1 ppb.

Confidentiality

The only personal identifiers collected during the EI will be adult names and property addresses for correlation with sampling results. Names will be used to ensure a point of contact for reporting results of testing. These personal identifiers will not be included in any data sets produced for the study and will not be used for any other purpose.

Risks/Benefits Information

There are minimal risks associated with this exposure investigation. 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 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 are secured.

The potential benefits for this EI are that participants will learn whether they and/or their children are being exposed to levels at health concern of the measured EI target compounds. The results of the EI are expected to provide ATSDR or other agencies, information to evaluate public health concerns of community members in Overland Park. The results of this EI may also be used to inform decisions by the Overland Park Mayor, School Superintendent, and other public health agencies and environmental agencies.

Informed Consent Procedures

If participants indicate a willingness to allow air monitoring/sampling near or on their property, ATSDR personnel will explain what the exposure investigation will entail, and will obtain written, informed consent [Appendix A]. It will be stressed that participation in the EI is strictly voluntary, and if they choose to participate, participants may withdraw from the investigation at any time without penalty.

Methods

The methodologies to be followed in this EI are provided in the attached Monitoring Protocol Health and Safety Plan [Appendix B]. Detailed information regarding the EI include monitoring/sampling methods, equipment siting, staging, data collection, monitoring, monitoring schedules, project schedule, quality assurance and control, and the site health and safety plan. A summary of sample collection method for hydrogen sulfide and meteorological parameters are given below.

Hydrogen Sulfide

Measurements of H_2S will be made using Zellweger 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, and again after equipment recovery). The linear detection range for this instrument is 2-90 ppbV. Ambient air is drawn through a humidifier filled with distilled water and into the instrument through a length of Teflon tubing (i.e., 0.250 inch outside diameter), outfitted with an inverted glass funnel connected at the inlet end. Measurement of the H_2S detected is automatic, and the resulting data are stored in a Data Acquisition System (DAS).

A Jerome 631-X portable H_2S Analyzer, if available, will be used to make roving measurements. The analyzer will also be used as a safety device for application while approaching potential sites/areas/locations where high levels of H_2S are possible. A two-point calibration (i.e., zero and 9 ppmV) will be performed weekly. The analyzer has a measurement range of 0.003 – 50 ppmV. The Jerome 631-X utilizes a patented gold film sensor. The sensor's selectivity to H_2S eliminates interferences from sulfur dioxide, carbon dioxide, carbon monoxide, and water vapors. An internal pump draws air into the instrument. Any H_2S in the sample is adsorbed by the sensor, which registers a proportional change in electrical resistance. The H_2S concentration is displayed on the LCD, where it remains until the next sample is taken.

Meteorological Parameters

Measurements of meteorological parameters will be made using a stand alone meteorological monitoring system. This 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 temperature probe to measure ambient temperature. Measurements will be made at a height of approximately 6-10 feet above grade. Resulting data are stored in a dedicated Data Acquisition System.

Reporting of Results

Reporting Results to Participants

ATSDR will evaluate the results of this EI for health significance. ATSDR's MRL for hydrogen sulfide will be used during the health evaluation. Upon completion of the investigation ATSDR will send a copy of the EI report to each exposure investigation participant.

Final Report

At the conclusion of this investigation, ATSDR will prepare a written summary in the form of an exposure investigation along with an overall public health interpretation. If contaminants are found at levels of health concern, appropriate local, state, and/or federal environmental and health agencies will be notified. The report will be available to community residents, the City of Overland Park Mayor, the City of Overland Park School Superintendent, and other federal, state, and local environmental and public health agencies. Depending on the findings, recommendations for follow-up activities may include additional sampling, educating community members on mitigating exposures, and/or further study.

Limitations of Exposure Investigation

This EI has two main limitations. The first is that the EI will only capture ambient air quality at three locations (four locations including the met station) during a four week period. This time frame may not be long enough to fully evaluate characteristic exposures to community members/residents. However, by choosing four weeks in July-August as the monitoring period, the EI will collect data during what is expected to be the worst case scenario and will allow ATSDR to measure ambient air near local schools.

The second limitation of the EI is that only one of the numerous potential contaminants will be measured. All efforts in this EI have been made to measure that contaminant considered most likely to be of health concerns based on information provided by community members, environmental departments, and currently available information of facilities in the immediate vicinity of the City of Overland Park.

References

1. Bureau of the Census. Census 2000 Demographic Profile Highlights for City of Overland Park: US Department of Commerce. Available from: URL: http://factfinder.census.gov/servlet/SAFFFacts?_event=Search&geo_id=&_geoContext=&_street=&_county=Overland+Park&_cityTown=Overland+Park&_state=04000US20&_zip=&_lang=en&_sse=on&pctxt=fph&pgsl=010

2. KDHE. Kansas Department of Health and Environment. 2005. Letter of Warning from the Kansas Department of Health and Environment to Reno Construction CDL.

Attachments

EI Protocol Appendix A: Consent Form

EI Protocol Appendix B: Monitoring Protocol Health and Safety Plan

EI Protocol

Appendix A: Consent Form

Consent for Environmental Testing

Overland Park Community
Kansas City, Kansas

We are from the Agency for Toxic Substances and Disease Registry (ATSDR). We would like to invite you to be part of an Exposure Investigation to learn what levels of hydrogen sulfide (H_2S) may be present in the outdoor air in your community. We have asked you to help in this investigation because your home/school/property or business is located in areas in Overland Park that may have high levels of the chemical we want to measure. We want to test the outside air of several areas in your city for about 4 weeks.

Procedure

We will place air measuring equipment, about the size of a briefcase, on your property. The air equipment will be on your property for 4 to 8 weeks. We will set-up the air monitoring equipment. It will take a few hours to set-up. Some of the equipment contains a small pump that draws in air for measuring. The pump sounds like a fish tank air pump. We will need to plug the equipment into one or two of your electric outlets.

Periodically, we will schedule a time to visit your home to check that the air monitors are working properly. These visits will be scheduled at a time that is good for you. These checks will take about 30 minutes. We will give you a phone number to call if the air monitors stop working properly or if you want us to take them away.

Benefits

Being part of this project will benefit you because you will find out if any of the chemicals we measure are in the outdoor air near your home or property. Also, by being part of this project you will help your community find out if any of the chemicals we measure are in the outdoor air in your community.

Risks

You may be bothered by the air monitors on your property. You may also be bothered by our contractor checking the equipment. 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 also have a small increase in your electric bill since we will need to use your power outlets.

Participation

You are free to choose whether or not to be part of this project. If you agree to help us, you may change your mind any time and drop out of the project. If you do this nothing will happen to you. You must sign this form to be part of the project.

Results

We expect to mail you the results of the air test within nine to twelve months of when we remove the air measuring equipment.

Confidentiality

We will protect your privacy as much as the law allows. The reports we write about this project will group all of the results together. We will not use your name or address in any of our reports. Still we are only including a small number of people in this project and it might be possible for someone to know that you were part of this. We will keep the forms with your personal information in a locked cabinet at ATSDR. We may share the results of the project with other federal, state, or local government agencies. They will also protect your information in the same way.

Contacts

If you have any more questions, you may call Debra Gable at ATSDR toll-free at 1 (888) 422-8737.

Consent

This exposure investigation has been explained to me. My questions have been answered. I agree of my own free will to allow the air monitoring described in this paper.

I, (print) ____, agree to have air monitoring on my property.

Signature: ____ Date: _______________

Address: ____
Street

____
City State Zip Code

Phone #: ______________________________

Witness: ____
(signature)

EI Protocol

Appendix B: Monitoring Protocol Health and Safety Plan

EXPOSURE INVESTIGATION

Monitoring Protocol
Health and Safety Plan

City of Overland Park Study
Overland Park, KS

Prepared by:

Debra Gable
Agency for Toxic Substances and Disease Registry
1825 Century Boulevard
Atlanta, Georgia 30333

Scott Sholar
Eastern Research Group, Inc.
1600 Perimeter Park
Morrisville, North Carolina 27560

June 2006

APPROVED BY

Ms. Debra Gable
Exposure Investigation Manager
Technical Monitor
Agency for Toxic Substances
and Disease Registry ______________________________

Mr. Scott Sholar
Project Director
Eastern Research Group, Inc. ______________________________

Mr. Dave Dayton
Senior Technical Advisor
Eastern Research Group, Inc. ______________________________

DISTRIBUTION LIST

Copies of this plan and all revisions will be provided to the following individuals:

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ACRONYMS

Acronym	Definition
ATSDR	Agency for Toxic Substances and Disease Registry
DAS	Data Acquisition System
DQO	Data Quality Objectives
EI	Exposure Investigation
ERG	Eastern Research Group, Inc.
HASP	Health and Safety Plan
HAZWOPER	Hazard Waste Operations
H_2S	Hydrogen Sulfide
MDL	Method Detection Limit
MSA	Metropolitan Statistical Area
PPE	Personal Protective Equipment
QA	Quality Assurance
QC	Quality Control
RSD	Relative Standard Deviation
SOP	Standard Operating Procedures
SPM	Single Point Monitor

A – EXPOSURE INVESTIGATION OVERVIEW

SECTION 1
PROBLEM DESCRIPTION

1.1 Background

Overland Park is a medium sized city located on the South side of the greater Kansas City, Kansas area. It is part of the Kansas City Metropolitan Statistical Area (MSA). According to 2003 census data, approximately 160,366 people live within the boundaries of Overland Park. The primary business entities are retail sales, light manufacturing, and asphalt production. There is also a landfill dedicated to the disposal of construction materials located there.

1.2 Problem Definition

Residents in the vicinity of Overland Park have complained of the presence of unpleasant odors. In particular, odor's believed to have originated from the construction materials landfill has resulted in numerous complaints being officially submitted to local health agencies. To address these complaints, the Agency for Toxic Substances and Disease Registry (ATSDR) has planned an Exposure Investigation (EI) in the Overland Park area.

1.3 Project Objectives

In order to better assess potential human exposure to hydrogen sulfide (H_2S) in ambient air in the area around Overland Park, Kansas, an ambient air monitoring program will be conducted to obtain representative concentration data for H_2S and meteorological parameters, over a 4-week period. ATSDR will be assisted with the field activities of this exposure investigation by Eastern Research Group, Inc. (ERG).

The compound that will be measured during the EI (i.e., H_2S) was selected because it presents a high potential to be emitted from the local stationary, mobile, and area sources in and around Overland Park.

SECTION 2
PROJECT ORGANIZATION

2.1 Agency for Toxic Substances and Disease Registry

The EI Manager and Technical Monitor for this project will be Ms. Debra Gable. In the capacity of EI Manager, Ms. Gable will serve as the primary interface between ATSDR and ERG. She will be responsible for providing direction on the overall goals and approaches of the EI to ensure that the objectives of the monitoring project are met. Ms. Gable will review and provide comments on the Monitoring Protocol and Health and Safety Plan, progress reports, and the Draft and Final EI Reports. She will also be the primary contact with other interested agencies (i.e., federal, state, and local) and be responsible for obtaining consent agreements from potential program participants identified. In the capacity of Technical Monitor, Ms. Gable will be responsible for overseeing overall coordination and logistics, and serve as a technical advisor and field team member.

2.2 Eastern Research Group, Inc.

The Project Director for this EI will be Mr. Scott Sholar. The Senior Technical Advisor for this EI will be Mr. Dave Dayton. They will report directly to the ATSDR EI Manager. In the capacity of Project Director, Mr. Sholar will be responsible for the overall quality of the work conducted by ERG. He will oversee all activities associated with the monitoring project, from planning through reporting. As well as managing the monitoring project and providing technical direction, Mr. Sholar and Mr. Dayton will also be very involved in the actual monitoring effort including securing equipment, equipment checkout, equipment deployment, data downloading, and equipment recovery.

Mr. Regi Oommen will serve as the Report Task Leader. In this capacity he will assist ATSDR in preparing the Draft and Final Reports and provide the monitoring data to ATSDR in electronic and hard copy forms.

The field team members for this EI will be Mr. Scott Sholar and Mr. Dave Dayton. In the capacity of field team members, they will perform the pre-deployment check out of the measurement and sample collection systems, deploy them, perform daily sites visits, perform the sample collections, perform data downloading, and conduct the equipment recovery efforts.

SECTION 3
PROJECT DESCRIPTION

3.1 Siting

Siting will be the joint responsibility of ATSDR and ERG. ATSDR will recruit participants (i.e., private and/or public) located in the greater Overland Park area, and inform them of what is involved in general program participation. After the recruiting efforts have been completed, ATSDR will select participants to host monitoring site locations. ATSDR will secure signed consent forms from each of the host sites. ATSDR will not release any vital information pertaining to the participants, except to agencies, and only with prior consent from each participant. After the sites have been selected, and participation consent has been obtained, ERG will contact the participants directly to schedule site events (i.e., pre-survey, deployment, operation, and recovery).

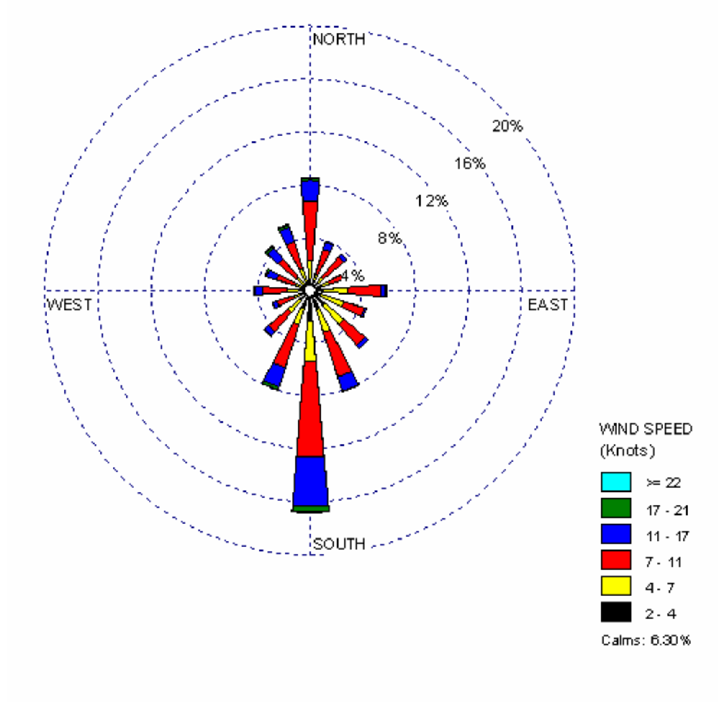
It must be noted that ERG will not assume any liability for damages or injuries resulting from locating/operating the ambient air monitoring equipment that will be used during the monitoring program. Should liabilities be encountered they will be project/contract borne.

3.2 Pre-Site Survey

As part of the site selection process, ATSDR and ERG staff will visit Overland Park, KS to perform a site-selection survey and meet with the petitioner(s) that issued the request for assistance from the agency. During this survey, ATSDR and ERG staff will become familiar with the layout of the city, determine the location of potential emission sources, and determine the location of high potential exposure areas. This information will be used to determine candidate monitoring site locations and prepare the overall design of the monitoring approach. To aid in the site selection process, Annual Average and Summertime Average wind roses presenting 2005 data from the National Weather Service station located in Olathe-Johnson City, Kansas were prepared. Olathe, Kansas is located approximately 10 miles to the Northwest of Overland Park. This wind rose data will be used to establish the typical wind flow patterns for the study area, and the relationship to sites being considered. The wind roses are presented in Figure 1.

During the pre-site survey, the field team will visit each of the potential monitoring site locations determined. The site locations will be documented by longitude and latitude using a hand held global positioning system (GPS). The field team will determine all needs associated with installing and operating the monitoring systems (i.e., access, ability to utilize sampling probes, adequate power, internal/external physical constraints, compatibility with the specifications of the equipment to be deployed, special materials needed) prior to deployment, or identify problems that may preclude use of a selected site. The field team will develop site-specific approaches for deploying the systems/equipment in the field.

Olathe-Johnson City (OJC): Average Annual Windrose



Olathe-Johnson City (OJC): Average Summertime Windrose

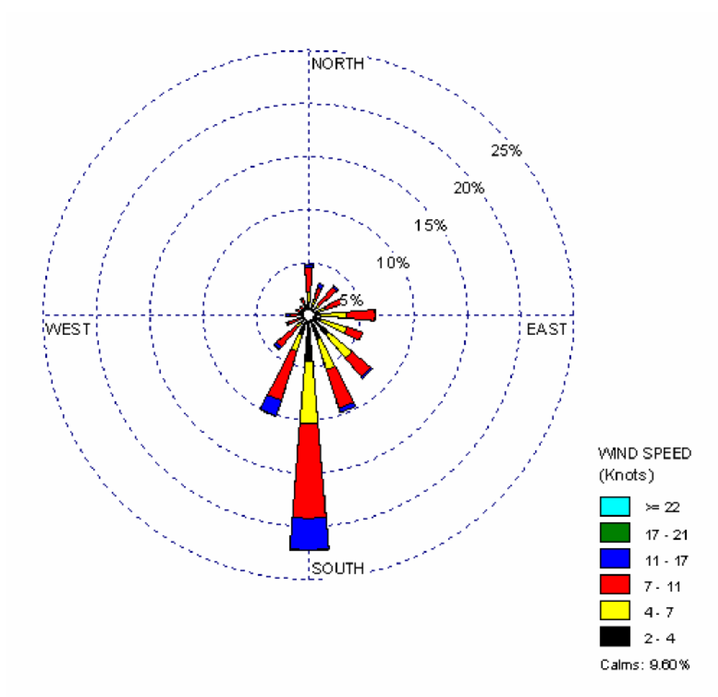


Figure 1. Annual and Summertime Average Wind Roses

3.3 Staging

Continuous measurement systems for this project will be provided by ATSDR. These systems include 2 single point monitors (SPM) for H_2S, a meteorological monitoring system, and three data acquisition systems (DAS). All of the systems/equipment supplied by ATSDR will originate from, or be shipped to, ERG's laboratory facility in Research Triangle Park, North Carolina. The systems/equipment will be set up and rigorously checked to insure that everything is functioning correctly. For the SPMs, ERG will then perform pre-deployment calibration and mid-point Quality Control (QC) checks to qualify precision and accuracy before the systems are deployed. Each site specific DAS will be set up, configured, and tested. ERG will obtain all required ancillary equipment/hardware/parts that will be utilized for this EI. ERG will obtain all required compressed gas standards as required. ERG will design and fabricate any specialty hardware needed to support effective deployment and/or operation of the systems in the field. When all design, fabrication, and checkout activities are completed, ERG will pack the equipment for shipping to the ERG office in Prairie Village, KS.

3.4 Deployment

Field team members will obtain equipment stored at the ERG office in Prairie Village, KS. The field team will set up each of the chemical measurement systems and the meteorological measurement system in accordance with the site specific approaches developed during the pre-site survey. Table 1 presents the equipment configuration that will be employed at each site. Once the equipment is set up the field team will test each system to ensure that no damage occurred during transport. When the H_2S measurement systems are determined to be operating correctly, internal optical 2-point calibration checks will be initiated, and the systems will be brought on-line. The meteorological monitoring systems will be tested and a QC check of the wind speed sensors (using a constant speed motor), wind direction sensors (using a compass), and temperature sensors (using a traceable temperature measurement device) will be performed.. The meteorological system will be brought on-line once it is considered to be operating correctly.

Table 1. Measurement Descriptions by Site

Site Number	Site Description	Measurement Type
1	APAC Reno Facility / North Berm	Meteorology
2	Private Business	H_2S
3	Worship Center / High School	H_2S

3.5 Monitoring

From the point that the H_2S and meteorological monitoring systems are brought on-line, monitoring will be conducted continuously for duration of 4-weeks. A field team member will visit the sites biweekly to assess the functional status of the chemical and meteorological measurement equipment and correct any problems identified. Data will be downloaded from the H_2S monitors, chemcassetes reloaded, and 2-point internal optical calibration checks will be performed weekly. Data downloads of the met system and visual checks of the meteorological sensors will occur weekly.

As there are presently no redundant or backup systems planned for this project, in the event that there is a failure of one of the primary H_2S monitors, the primary systems will be repaired as quickly as possible and then returned to the network. If there is a failure of one of the meteorological parameters monitoring sensors, it will be repaired as quickly as possible and returned to the network.

3.6 Recovery

When the 4-week duration of the monitoring effort has been completed, field team members will visit each site and perform the internal optical 2-point calibration checks for the SPMs and download data for the last time. After these activities have been completed, all site equipment will be packed, and shipped to the ERG Laboratory in Research Triangle Park, North Carolina. To the greatest extent possible, the monitoring sites will be returned to the condition these were in prior to installing the equipment. ERG will set up the H_2S monitors at the ERG Laboratory and perform post-deployment calibration and QC checks to qualify precision and accuracy. Equipment that was loaned or rented for use during the EI will be returned to the associated agency/vendor. Equipment belonging to ATSDR and/or ERG will be serviced, packed, and properly stored for use in future projects.

3.7 Reporting

After all data collection activities have been completed, a Draft and Final EI Report will be prepared. The report will address the following items:

- Introduction / Background
- Site descriptions
- Monitoring Approach and Methodology
- Quality Assurance (QA) and QC
- Data Characterization and Statistical Treatments
- Results and Conclusions (specific to the actual data collection effort)
- Recommendations

3.8 Project Schedule

The schedule of major program events is presented in Table 2. Meeting this schedule is contingent on receiving new equipment from ATSDR in time to perform required calibrations. Prior to the proposed equipment shipping date (i. e., May 30, 2006), if the schedule has to be modified, changes will happen in 1 week increments.

Table 2. Schedule of Major Program Events

Event	Activity	Date
Pre-selection/ siting Survey	Meet with the petitioner, identify potential site locations determine site specifics for monitoring.	April 27 – April 29
Siting	Site selection and agreements obtained with host residents (ATSDR responsibility).	April 29 – May 30
Management	Preparation, review, revision (as needed) and acceptance of the cost estimate.	April 29 – May 30
Staging	Acquire/obtain instrumentation and related ancillary equipment and materials. Fabricate all support systems and equipment.	May 1 – May 18
Staging	Mount data acquisition systems in protective chassis boxes, and configure associated software for data collection and retrieval for each site.	May 15 – May 25
Staging	Set up and perform a functional checkout on all instrumentation at the ERG laboratory.	May 15 – May 25
Staging	Perform instrument calibrations and pre-deployment QC checks.	May 15 – May 25
Staging	Breakdown and pack all instrumentation, equipment, materials, and supplies, and prepare them for transport to the sites.	June 12 – June 15
Deployment	Ship all equipment to ERG office in Prairie Village, KS where it will be collected for setup.	June 16
Deployment	Install/set up all equipment associated with the APAC – Reno site. Check out and calibrate equipment. Bring systems on line. Repeat for all other sites.	July 6 – 7
Monitoring	Week 1 – Franklin Associates (A Division of ERG) staff visits all H2S monitor sites to assure monitors are functioning properly and change out DI water in sample stream humidifers.	July 12
Monitoring	Week 1 – Check and service equipment. Download data, electronically transfer data to ERG Reporting Task Manager, and perform optical calibration checks.	July 15 – July 16
Monitoring	Week 2 – Franklin Associates (A Division of ERG) staff visits all H_2S monitor sites to assure monitors are functioning properly and change out DI water in sample stream humidifiers.	July 19

Table 2. Schedule of Major Program Events (Continued)

Event	Activity	Date
Monitoring	Week 2 – Check and service equipment daily. Download data, electronically transfer data to ERG Reporting Task Manager, and perform optical calibration checks.	July 22 – July 23
Monitoring	Week 3 – Franklin Associates (A Division of ERG) staff visits all H2S monitor sites to assure monitors are functioning properly and change out DI water in sample stream humidifiers.	July 26
Monitoring	Week 3 – Check and service equipment daily. Download data, electronically transfer data to ERG Reporting Task Manager, and perform optical calibration checks.	July 29 – July 30
Monitoring	Week 4 – Franklin Associates (A Division of ERG) staff visits all H_2S monitor sites to assure monitors are functioning properly and change out DI water in sample stream humidifiers.	August 2
Monitoring	Week 4 – Check and service equipment daily. Download data, electronically transfer data to ERG Reporting Task Manager, and perform optical calibration checks.	August 7
Recovery	Breakdown and pack equipment for transport, return residences to their pre-deployment status.	August 7 – 8
Recovery	Ship equipment to Research Triangle Park.	August 8
Recovery	Set up instruments at the ERG laboratory, perform instrument calibrations and post-deployment QC checks.	August 10 – August 31
Recovery	Perform any required service on ATSDR owned equipment and store for future application. Return any borrowed or rented equipment. Return or dispose of any unconsumed materials/supplies (as appropriate).	August 10 – August 31
Reporting	Prepare the Draft and Final EI Reports.	September 2006 – February 2007.

SECTION 4
QUALITY ASSURANCE AND CONTROL

4.1 Data Quality Objectives

The project Data Quality Objectives (DQOs) provide the answer to the critical question of 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 selection survey, and specifications associated with the monitoring and sample collection systems that will be utilized, DQOs for this EI are presented in Table 3.

Table 3. Data Quality Objectives

Element	Objective
Where to Conduct Monitoring	All sites must be located in close proximity to the potentially impacted populous.
Number of Sites Required	3 monitoring sites will provide a representative and direct relationship to the potentially impacted populous (i.e., schools, public buildings, private residences and/or businesses, etc.
When to Conduct Monitoring	Daily – from 0000 to 2359 hours
Frequency of Monitoring	Continuous for H_2S so that short duration excursions can be assessed, and hourly and daily average concentration can be calculated.
Overall Completeness	80 % data capture
Acceptable Measurement Precision for SPMs	+/- 20 % relative standard deviation (RSD)
Acceptable Measurement Accuracy for SPMs	+/- 15 % RSD

4.2 Measurement Accuracy

Measurement accuracy for this project is defined as the ability to acquire the correct concentration data from an instrument or analysis while it is sampling a known concentration gas stream, with an acceptable level of uncertainty.

To determine the measurement accuracy associated with the SPM instruments used on this EI, an instrument type specific QC sample will be measured. The difference between the concentrations obtained from each instrument compared to the known concentration of the corresponding instrument type specific QC check standard will be calculated and expresses as RSD. Measurements accuracy checks will be performed initially (i.e., while the systems are being checked out during the staging efforts) and again after the equipment has been recovered and returned to the ERG Laboratory.

4.3 Measurement Precision

Measurement precision for this project is defined as the ability to acquire the same concentration from different instruments, with an acceptable level of uncertainty, while they are sampling the same gas stream. For this monitoring program, measurement precision will be assessed two ways as follows:

- *Across instruments by type*—As part of the pre- and post-deployment QC checks, the two H_2S instruments will simultaneously perform 10 concentration determinations each. The average concentration from the 10 determinations will be calculated on an instrument specific basis. The eight averages will then be compared to each other and expressed as RSD.

SECTION 5
SPECIAL TRAINING REQUIREMENTS

ATSDR and ERG field personnel involved in this project have been trained in their tasks and have from 6 to 32 years of experience in the duties they will be performing. ERG staff will be subject to surveillance from the ERG QA Officer (Dr. Raymond Merrill) with appropriate corrective action enforced, if necessary. No additional special personnel will be required to augment the ERG personnel. ERG provides employee training through both specialized, in-house training classes, and by on-the-job training by their supervisors and co-workers. There are no unusual hazards and no special safety training or equipment other than standard personal protective equipment (PPE) will be required. Safety and hazard communication training have been completed by ERG laboratory staff. The ATSDR EI Manager and ERG Project Director and Senior Technical Advisor are both 40-hour Hazardous Waste Operations (HAZWOPER) certified, and the ATSDR EI Manager and other ERG Project Director is American Red Cross First Aid and CPR certified.

SECTION 6
DOCUMENTS AND RECORDS

A field project notebook will be used to record the monitoring systems' operational parameters. Analysis documentation will include the use of bound laboratory notebooks to record experimental conditions, data, and pertinent observations. Hard copies of instrumentation records including calibration, QC checks, and any raw data will be archived in a Project Masterfile.

The project final summary report will include all applicable raw data and records. A summary of any outliers or findings will be presented in the report. The report will undergo a technical review before submission. After submission, the report will be filed at ERG for a period of no less than three years. The file will also include electronic copies of all data used in the development of the report.

B – MEASUREMENTS / DATA ACQUISITION

SECTION 7
MONITORING APPROACHES

7.1 Hydrogen Sulfide

Measurements of H_2S will be made using Zellweger SPMs owned by ATSDR. 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, and again after equipment recovery). The linear detection range for this instrument is 2-90 ppbV. However, the instrument will be calibrated for a range of 0-90 ppbV. Ambient air is drawn through a humidifier filled with distilled water and into the instrument through a length of Teflon tubing (i.e., 0.250 inch outside diameter), outfitted with an inverted glass funnel connected at the inlet end. Measurement of the H_2S detected is automatic, and the resulting data are stored in the DAS. The distilled water will be changed in each humidifier twice each week.

7.2 Meteorological Parameters

Measurements of meteorological parameters will be made using a stand alone meteorological monitoring system, attached to a secured tripod assembly. This 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 temperature probe to measure ambient temperature. Measurements will be made at a height of approximately 8 feet above grade. Resulting data are stored in the DAS.

7.3 Data Acquisition

Electronic signals from the H_2S and meteorological measurement system will be collected and stored using HOBO Micro Station DASs with, 4-20 mA adapters and BoxCar Pro 4.3 software. Each DAS is capable of collecting 4 channels of amperage input simultaneously, and offers internal storage for 1 million data points per system.

SECTION 8
DATA VALIDATION AND USABILITY

8.1 Verification and Usability Processes

The ERG Project Director will perform a two-step process of verification and validation for data review. This process will begin with an objective review of whether or not the data collection plans and protocols were followed and whether the basic operations, calculations, and statistical evaluations were performed correctly. Ongoing QA review that started with the development of this Monitoring Plan will be reviewed to verify that the sampling and analytical methodology planned for this project was accomplished or that changes were identified, documented and met project quality objectives. ERG will be concerned only with the review and validation of data collected by ERG.

The second step will be to validate the technical usability of the data by determining whether the procedures followed were appropriate for the actual situations encountered, and whether the results make sense in the context of the study objectives. This validation will be done by comparing the original study objectives and data quality objectives with the actual circumstances encountered by field team.

8.2 Verification Methods

Evaluation of the Experimental Design—The first step in validating the data set is to assess if the project, as executed, meets the requirements of the sampling design.

Sample Collection Procedures—Actual sample collection procedures will be documented in the field notebook and on applicable data sheets, and checked against any applicable requirements contained in this Monitoring Plan. Deviations from the Monitoring Plan will be classified as acceptable or unacceptable, and critical or noncritical.

Sample Handling—Internal sample handling and tracking procedures for samples generated in the laboratory will be checked. Holding times will be monitored to ensure timely analysis and reporting of analytical results. Labeling and sample identification will be checked for variation from the Monitoring Plan; Good Laboratory Practices will be followed in the labeling of samples and standards. All deviations will be documented in the final summary report.

8.3 Validation Methods

Calibration—Documentation of equipment calibration (i.e., where applicable) will be assessed to ensure that the values obtained are appropriate for data collection. Errors and omissions will be discussed in the final summary report. The documentation will be checked to ensure that the calibrations: (1) were performed at the specified intervals, (2) included the proper number of calibration points, and (3) were performed using appropriate approaches/standards for the reported measurements. Results generated during periods when calibration requirements are met will be considered conditionally valid and ready for Quality Control Validation review.

Data Reduction and Processing—The data processing system will be checked by using example raw data for which calculated values are already known. The example data are input into the system and the calculated results are compared to the known. Hand calculations will be used to check the data processing system. Findings from these audits will be included in the final report. Data will be considered conditionally valid if manual calculations are reconciled with automated data processing results.

QC Results and Procedures—QC measurements and QC procedures performed during the experimental program will be checked against the monitoring program requirements. Omissions will be discussed in the final summary report. Quality control results will be reviewed. Results that meet the DQOs and all other validation are considered valid. All results outside specified parameters will be discussed with the ATSDR EI Manager for corrective action.

SECTION 9
HEALTH AND SAFETY PLAN

9.1 Purpose

The purpose of this Health and Safety Plan (HASP) is to inform ERG personnel of known or potential health and safety hazards that may be encountered during ambient air monitoring activities planned for Overland Park, KS. 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. This HASP has been reviewed by the ERG Laboratory Health and Safety Coordinator.

9.2 Scope

In order to better assess potential human exposure to selected chemical species in ambient air in the area of Overland Park, KS, ATSDR will conduct an EI. During this EI, an ambient air monitoring program will be operated to obtain representative concentration data for H_2S and meteorological data, over a 4-week period.

9.3 Physical Hazards Assessment

Possible dangers associated with project activities include physical hazards related to 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:

- Slips, Trips, and Falls — Testing at the site is expected to occur primarily at ground level. ERG 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.), ERG 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, ERG 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. Fieldworkers will be instructed to immediately report to their team leaders any signs of malfunctioning electrical equipment.

- Lifting Hazards — When carrying and lifting equipment, ERG field staff should practice good lifting techniques and avoid carrying heavy loads.

Animals, Poisonous Insects, and Poisonous Plants — ERG field staff should be alert for and stay clear of wild and unsupervised animals, poisonous insects and poisonous plants (e.g., poison ivy). Team members should also be aware of multiple poisonous spiders (e.g. brown recluse and black widow that are known to live in such areas.

- ERG field staff will wear thick leather gloves, leather boots, long pants, and 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 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 will 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 an ERG 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.

9.4 Chemical Hazards Assessment

No chemicals will be used by the field staff conducting the monitoring for this EI.

9.5 Contacts for Local Emergency Services

Prior to the first ERG field activity, ERG will provide each of its field staff with the pertinent emergency contact information for Overland Park, KS. This information will include the phone number(s) and address for the following:

For ALL emergencies call 911.

Saint Luke's South
12300 Metcalf Avenue
Overland Park, KS 66213

Overland Park, KS Police
Main Station
12400 Foster
Overland Park, KS 66213
913-895-6300

Stanley Fire Station
15935 Metcalf Ave.
Overland Park, KS 66223
Phone: 913-888-6066

9.6 Staff Concurrences

Prior to working on this ambient air monitoring program, ERG will require all of it’s associated field staff to read and understand this HASP.

ERG STAFF CONCURRENCE SHEET

I have read, understood, and agree to comply with this Project Health and Safety Plan.

Signature	Printed Name	Date
Signature	Printed Name	Date
Signature	Printed Name	Date
Signature	Printed Name	Date

Appendix B. Quality Assurance/Quality Control

Quality Assurance/Quality Control

The Data Quality Objectives (DQOs) for a project 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. Data quality objectives for this EI are presented in Table 1.

Table 1. Data Quality Objectives

DQO	Element	Objective
1	Where to Conduct Monitoring	All sites must be located in close proximity to the potentially impacted populous.
2	Number of Sites Required	Three monitoring sites will provide a representative and direct relationship to the potentially impacted populous (i.e., schools, public buildings, private residences and/or businesses, etc.)
3	When to Conduct Monitoring	Daily – from 0000 to 2359 hours
4	Frequency of Monitoring	Continuous for H_2S so that short duration excursions can be assessed, and hourly and daily average concentration can be calculated.
5	Overall Completeness	80% data capture
6	Acceptable Measurement Precision for SPMs	+/- 20% relative standard deviation (RSD)
7	Acceptable Measurement Accuracy for SPMs	+/- 15% Bias

Completeness

Completeness refers to the number of valid measurements collected compared to the number of possible measurements expected from continuous monitoring. During the five week monitoring period, the H_2S completeness was lower than the specified DQO at two of the four monitoring sites (Site 2 and Site 4). The other two sites met the DQO for completeness of 80% data capture. The overall program completeness was 84.54%. Project data completeness at each monitoring site by measurement system is presented in Table 2.

Each of the H_2S monitoring sites (Sites 2, 3, and 4) did not record hydrogen sulfide measurements for a considerable amount of time because of instrument errors. Site 2 missed nearly 2 weeks of sampling in the middle of the sample period. Site 4 did not measure data the first 2 ½ weeks of sampling and nearly five days in the middle of the sampling period. Because of the problems encountered with the hydrogen sulfide instruments and the resulting gaps in measured data, ATSDR extended the duration of the monitoring period from the planned four weeks to five weeks of monitoring. Site 3 did not measure data almost all of the extended (fifth) week of sampling. Nonetheless, the extension of the monitoring period allowed for an increase in measured data across the exposure investigation area. The total number of 1-minute hydrogen sulfide samples collected during the investigation period was 95,995 (see Results section).

The approved protocol for this sampling program called for checking the H_2S instruments twice per week, rather than daily. The completeness results for Sites 2 and 4 and observations during this EI revealed that checking monitoring sites daily would increase the probability of collecting a more complete dataset. This conclusion is corroborated by completeness results at exposure investigation sites where daily checks have been conducted, and for which completeness DQOs have been fully achieved.

Also presented in Table 2 is the completeness of data capture for the Site 1 meteorological parameters. Completeness for meteorological data was nearly 100%.

Table 2. DQO: Project Overall Completeness

Site ID	Pollutant	Total # of Potential Measurements	Total # of Actual Measurements	Total # of Invalid Measurements	% Completeness
Site 2	H_2S	56,066	37,771	18,295	67.37
Site 3	H_2S	39,634	39,630	4	99.99
Site 4	H_2S	28,111	18,594	9,517	66.14
Overall H_2S		**123,811**	**95,995**	**27,816**	**77.53**
Site 1	Meteorology	56,189	56,184	5	99.99
Overall Program		**180,000**	**152,179**	**27,521**	**84.54**

Note: Percent completeness for Site 3 is based on measurements during the original 4-week sampling period, and does not include the limited measured data collected during the fifth (extended) week of the program.

Measurement Precision

Measurement precision for this project is defined as the ability to acquire the same concentration from different instruments while they are sampling the same gas stream with an acceptable level of uncertainty. For this monitoring program, measurement precision was assessed across instruments by type. As part of the pre- and post-deployment QC checks, the three H_2S instruments simultaneously performed ten concentration determinations each of the same known concentration gas (Appendix C). The average concentration from the ten determinations was calculated on an instrument specific basis. Each instrument average was then compared to the standard deviation of its ten concentrations and expressed as % Relative Standard Deviation (%RSD), which is calculated as follows:

$$\%RSD = \frac{\sigma}{\overline{X}} \times 100$$

Where:

Φ is the standard deviation of the 10 instrument-specific concentration determinations;

$\overline{X}$ is the average of all 10 instrument-specific concentration determinations.

As summarized in Table 3, the system precision RSDs ranges from 0.76% to 1.26% during the pre- and post-deployment checks. These values easily met the data quality objective of 20% RSD.

Measurement Accuracy

Measurement accuracy for this project is defined as the ability to acquire the correct concentration data from an instrument or sample analysis with an acceptable level of uncertainty while measuring a known concentration reference gas stream.

To determine the measurement accuracy associated with the H_2S measurements acquired during this EI, a known concentration reference gas stream was measured. Pre- and post-deployment checks were calculated on each system to assess the measurement accuracy of each system (Appendix B). The difference between the concentrations measured by each instrument compared to the known concentration of the reference gas stream was calculated and expressed as % Bias, which is calculated as follows:

$$\%Bias = \frac{X_1 - X_2}{X_1} \times 100$$

Where:

X_1 is the known concentration; and
X_2 is the average of the 10 measured concentrations.

As summarized in Table 3, measurement accuracy ranged from -1.61% to 1.74% during the pre- and post-deployment checks. These values are well within the DQO of ± 15% Bias.

Table 3. DQO: Pre- and Post-Deployment SPM Quality Control Data

Site ID	Pollutant/ Units	QC Deployment Type	Reference Concentration (ppbv)	Average Measurement (10 samples)	Standard Deviation	DQO 6: System Precision (% RSD)	DQO 7: System Accuracy (% bias)
Site 2	H_2S/ppbv	Pre-deployment	83.0	82.7	0.7	0.82	0.36
		Post-deployment	80.5	79.1	1.0	1.26	1.74
Site 3	H_2S/ppbv	Pre-deployment	83.0	82.7	0.7	0.82	0.36
		Post-deployment	80.5	80.0	0.7	0.83	0.62
Site 4	H_2S/ppbv	Pre-deployment	83.0	82.8	0.6	0.76	0.12
		Post-deployment	80.5	81.8	0.9	1.12	-1.61

Notes:
Site 1 was a suitable location to record meteorological data but not H_2S. Therefore a SPM was not located at Site 1.

Post-deployment quality checks were conducted after necessary instrument repairs were made.

Other Data Quality Indicators

Throughout the monitoring period, the SPM optical sensors were checked to ensure that the instrument was functioning properly (Appendix B). As shown in Table 4, the instrument response range fell within the acceptable performance range.

Table 4. Two-Point Optical Performance Check Data

Site ID	Pollutant	Acceptable Response Range (mA)[a]	Instrument Response Range (mA)[a]	Date Checks Performed
Site 2	H_2S	10.000 – 13.000	11.157 – 11.380[b]	7/6/06; 7/23/06; 8/14/06
Site 3	H_2S		11.108[c]	
Site 4	H_2S		11.258 – 11.313[d]	

[a] mA – milliamp

[b] Optical checks performed only on 7/6/2006 and 7/23/2006

[c] Optical check performed only on 7/6/2006

[d] Optical checks performed only on 7/6/2006 and 8/14/2006

Note: Site 1 was a suitable location to record meteorological data but not H2S. Therefore a SPM was not located at Site 1.

Appendix C

Quality Control Raw Data

Pre-deployment Quality Control Data

Site I.D.	Ref. Conc.	M-1	M-2	M-3	M-4	M-5	M-6	M-7	M-8	M-9	M-10	M-Avg.
Site 2; H_2S/ppbv	83.0 ppbv	83	83	82	83	82	83	83	84	83	82	82.9
Site 3; H_2S/ppbv		82	82	82	83	82	83	83	84	83	83	82.7
Site 4; H_2S/ppbv		83	83	82	83	82	82	83	83	84	82	82.7

Pre-deployment Quality Control Results

Site I.D.	Standard Deviation	Sys. Precision (% RSD)	Overall Precision (% RSD)	Sys. Accuracy (% bias)	Overall Accuracy (% bias)
Site 2; H_2S/ppbv	0.63	0.76%	0.80%	-0.12%	-0.28%
Site 3; H_2S/ppbv	0.67	0.82%		-0.36%	
Site 4; H_2S/ppbv	0.67	0.82%		-0.36%	

Post-deployment Quality Control Data

Site I.D.	Ref. Conc.	M-1	M-2	M-3	M-4	M-5	M-6	M-7	M-8	M-9	M-10	M-Avg.
Site 2; H_2S/ppbv	80.5 ppbv	82	82	83	82	82	83	82	81	81	80	81.8
Site 3; H_2S/ppbv		80	80	79	80	80	79	80	81	80	81	80.0
Site 4; H_2S/ppbv		78	79	80	79	78	78	79	79	80	81	79.1

Post-deployment Quality Control Results

Site I.D.	Standard Deviation	Sys. Precision (% RSD)	Overall Precision (% RSD)	Sys. Accuracy (% bias)	Overall Accuracy (% bias)
Site 2; H_2S/ppbv	0.92	1.12%	1.07%	1.61%	-0.25%
Site 3; H_2S/ppbv	0.67	0.83%		-0.62%	
Site 4; H_2S/ppbv	0.99	1.26%		-1.74%	

Field SPM 2-point Optical Performance Check Data Log

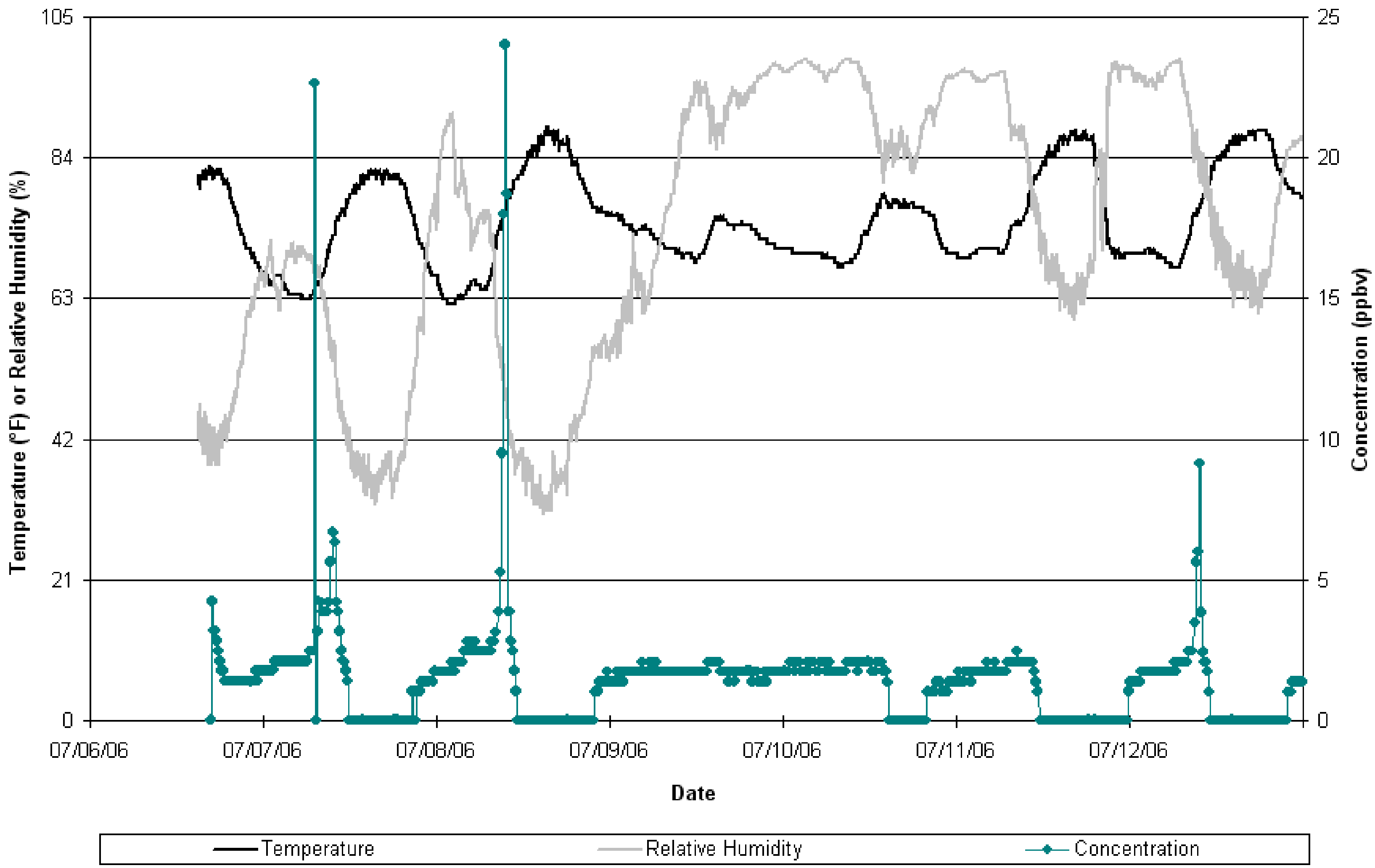
SITE I.D. / HOBO I.D. (*)	INSTRUMENT RESPONSE[1]					
	(mA) / Date-Time		(mA) / Date-Time		(mA) / Date-Time	
S1-H2S-1 * 795332	11.157	7/6/06 16:16	11.380	7/23/06 15:00	---	---
S2-H2S-1 * 795345	11.108	7/6/06 17:25	---	---	---	---
S2-H2S-2 * 795335	11.313	7/6/06 09:00	---	---	11.258	8/14/06 16:00

[1] mA values between 10 and 13 represent appropriate performance of the system optics.

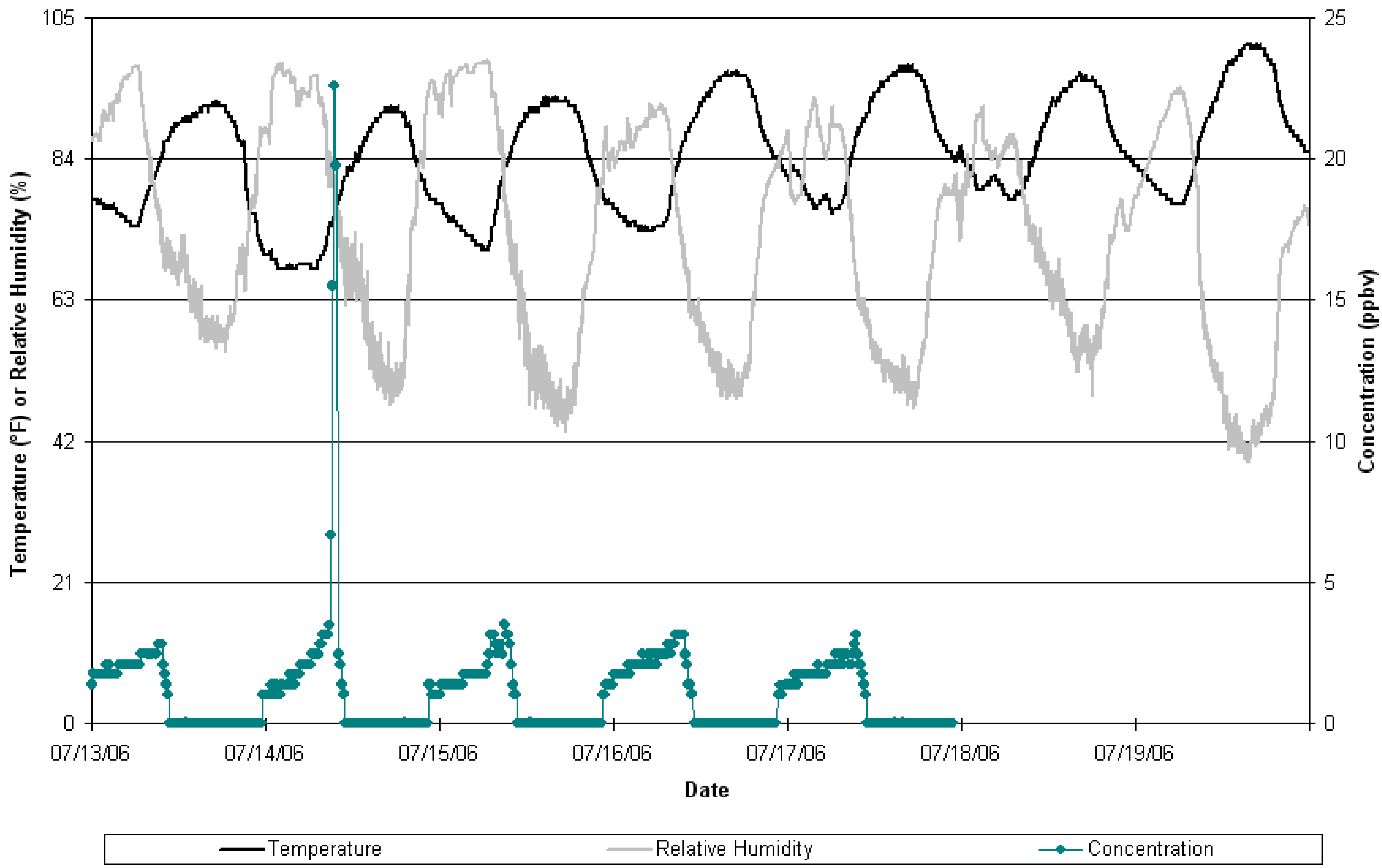
Appendix D

H_2S Concentrations vs. Relative Humidity and Temperature Profiles

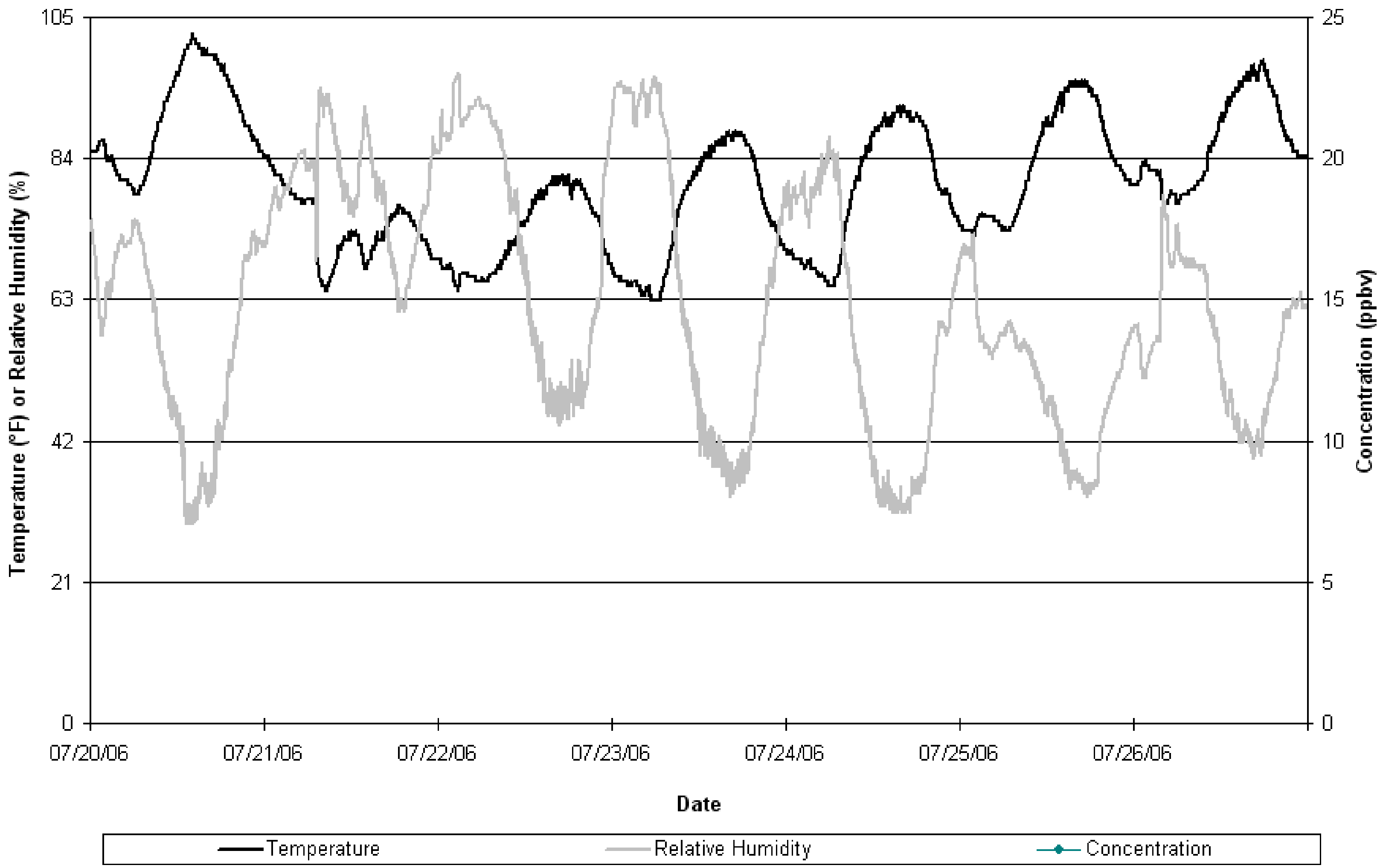
Site 2 H_2S Concentration vs. Relative Humidity and Temperature for the Week of July 6-12



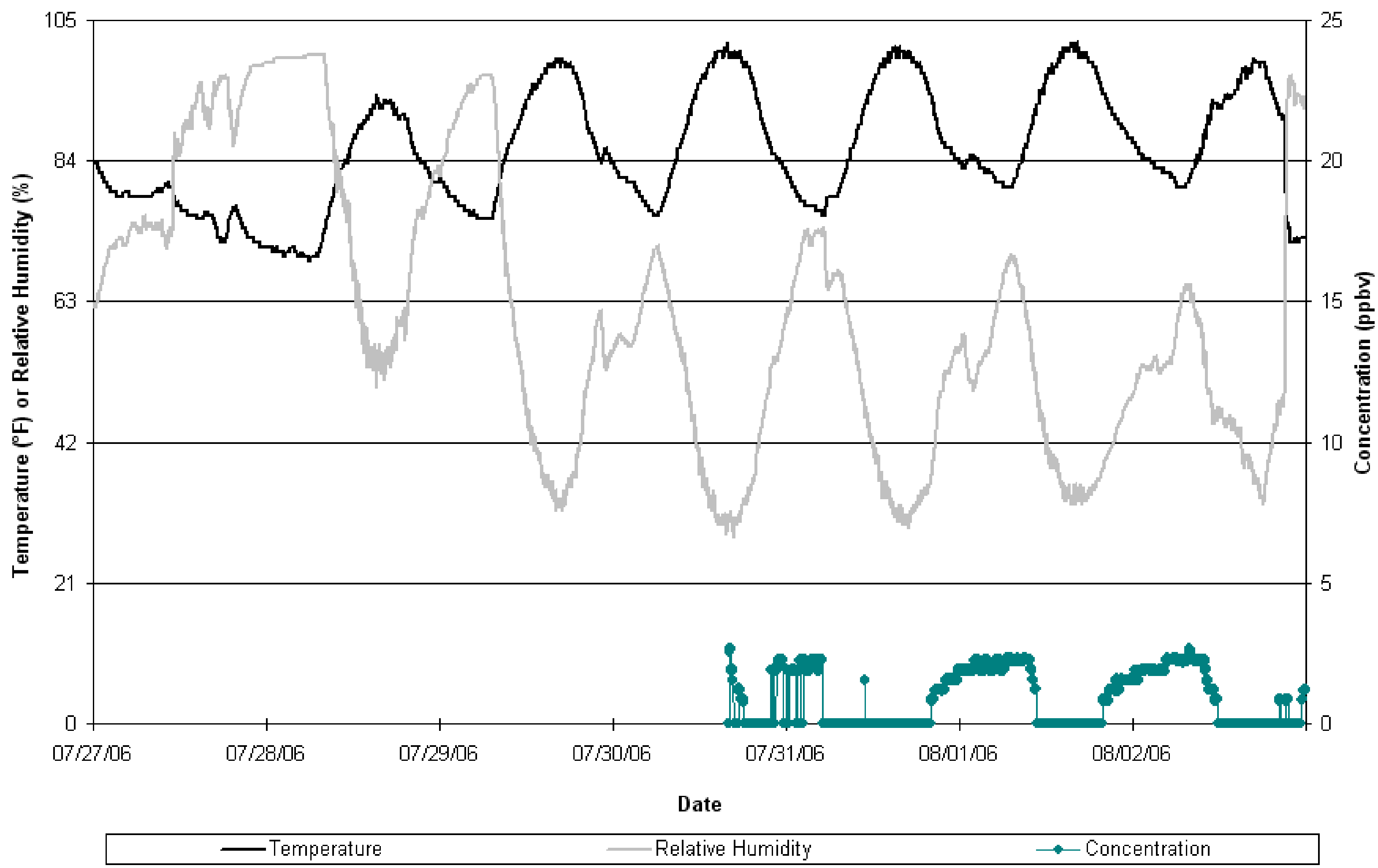
Site 2 H_2S Concentration vs. Relative Humidity and Temperature for the Week of July 13-19



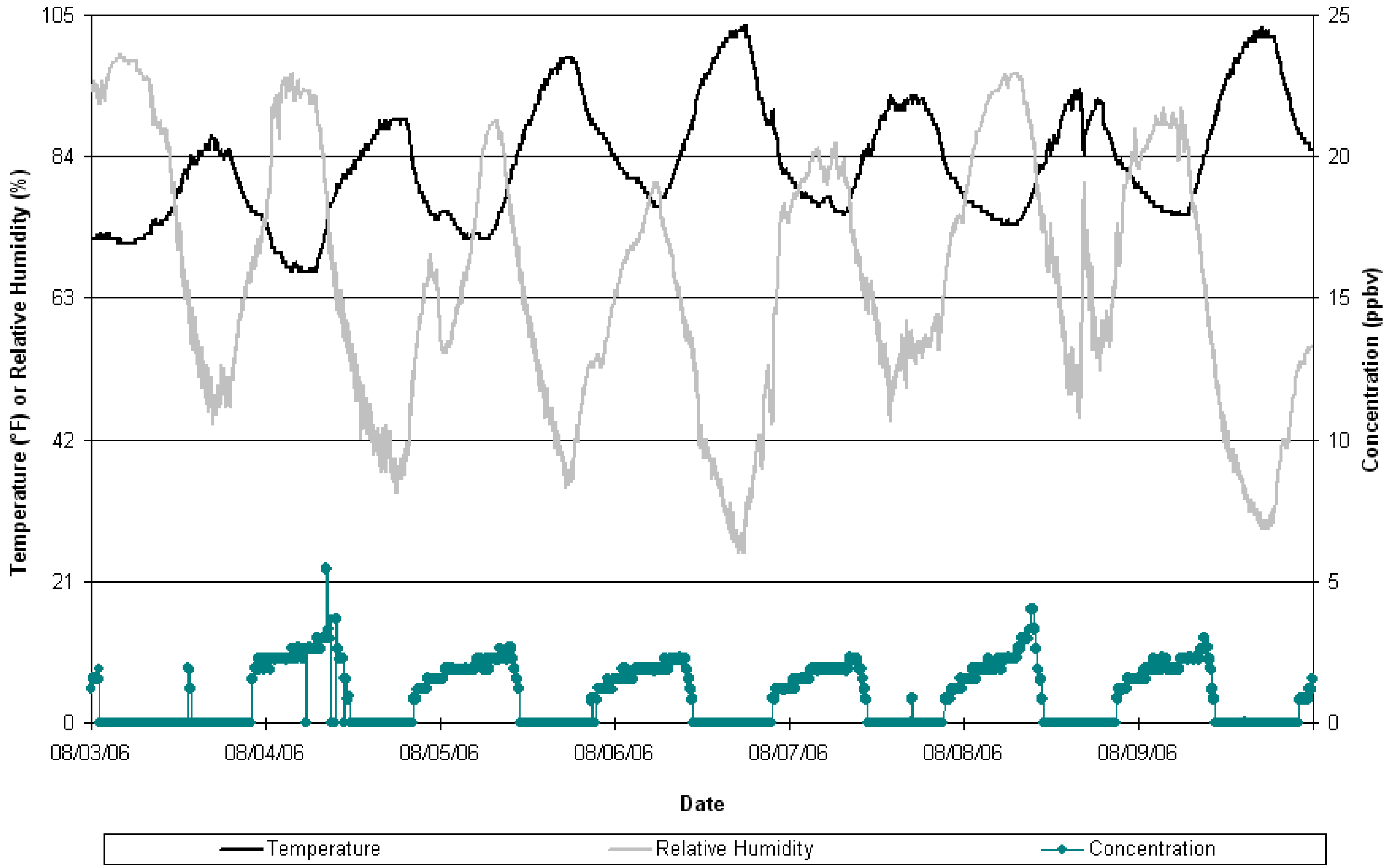
Site 2 H_2S Concentration vs. Relative Humidity and Temperature for the Week of July 20-26



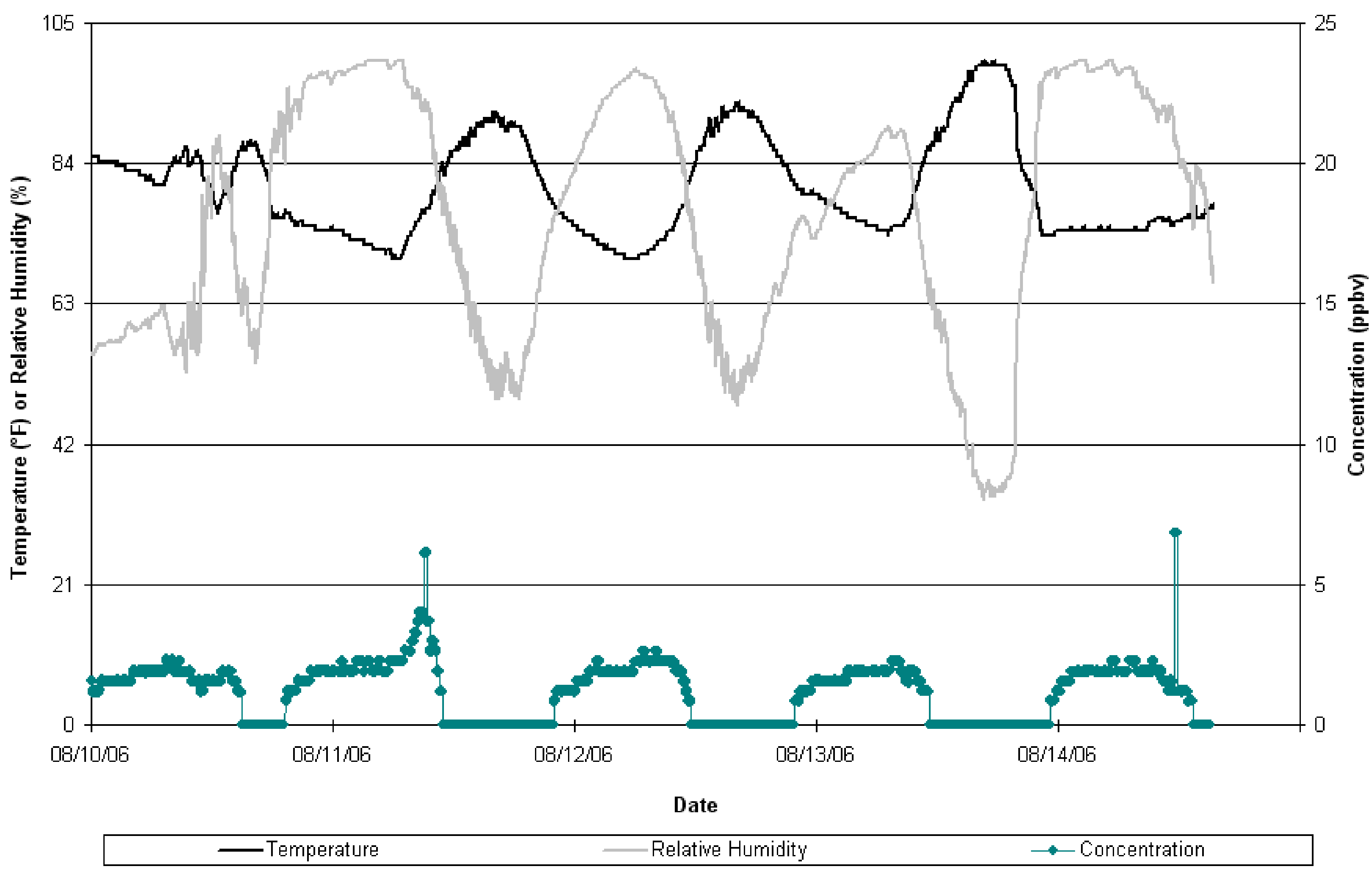
Site 2 H_2S Concentration vs. Relative Humidity and Temperature for the Week of July 27 – August 2



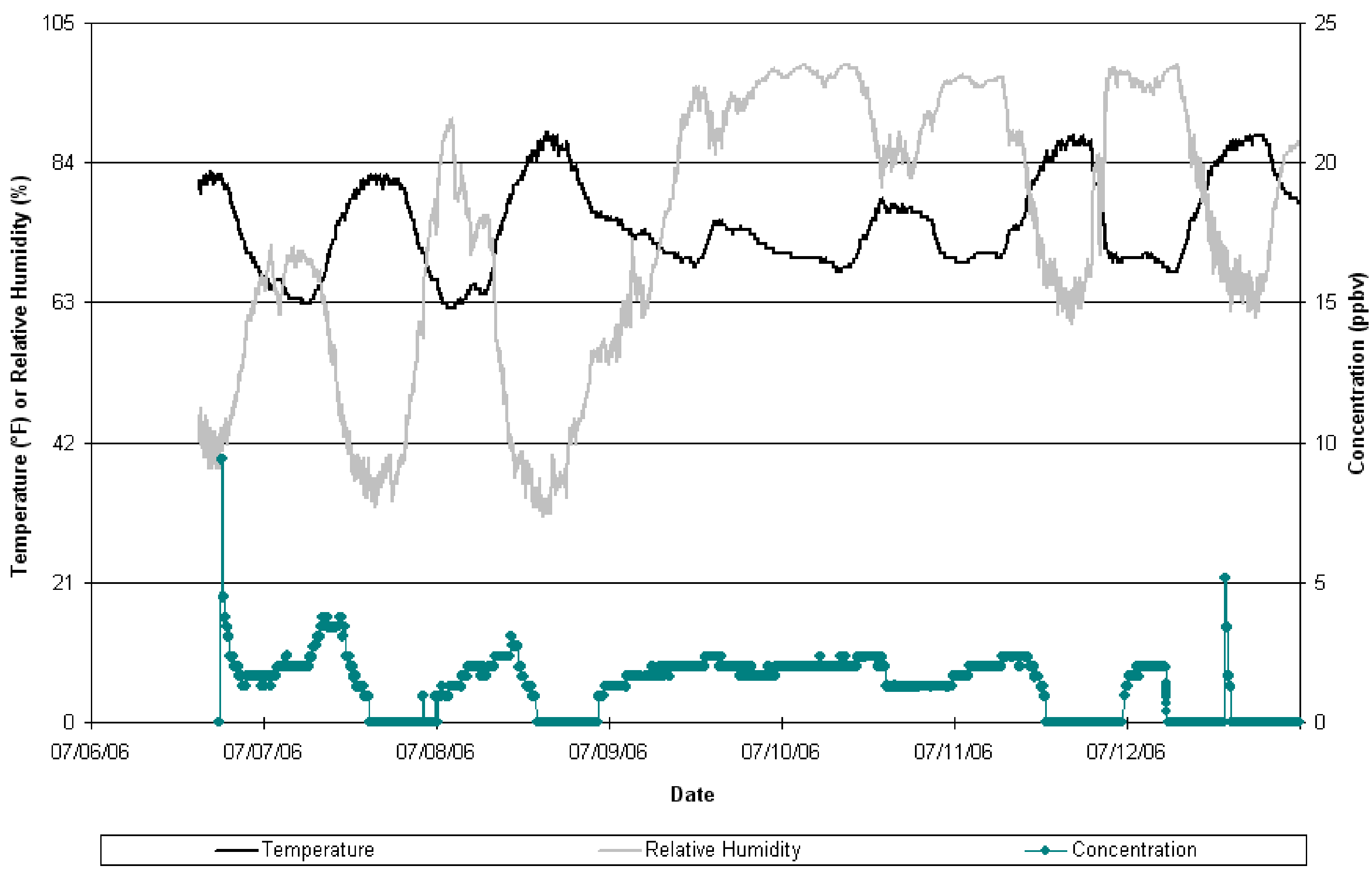
Site 2 H_2S Concentration vs. Relative Humidity and Temperature for the Week of August 3-9



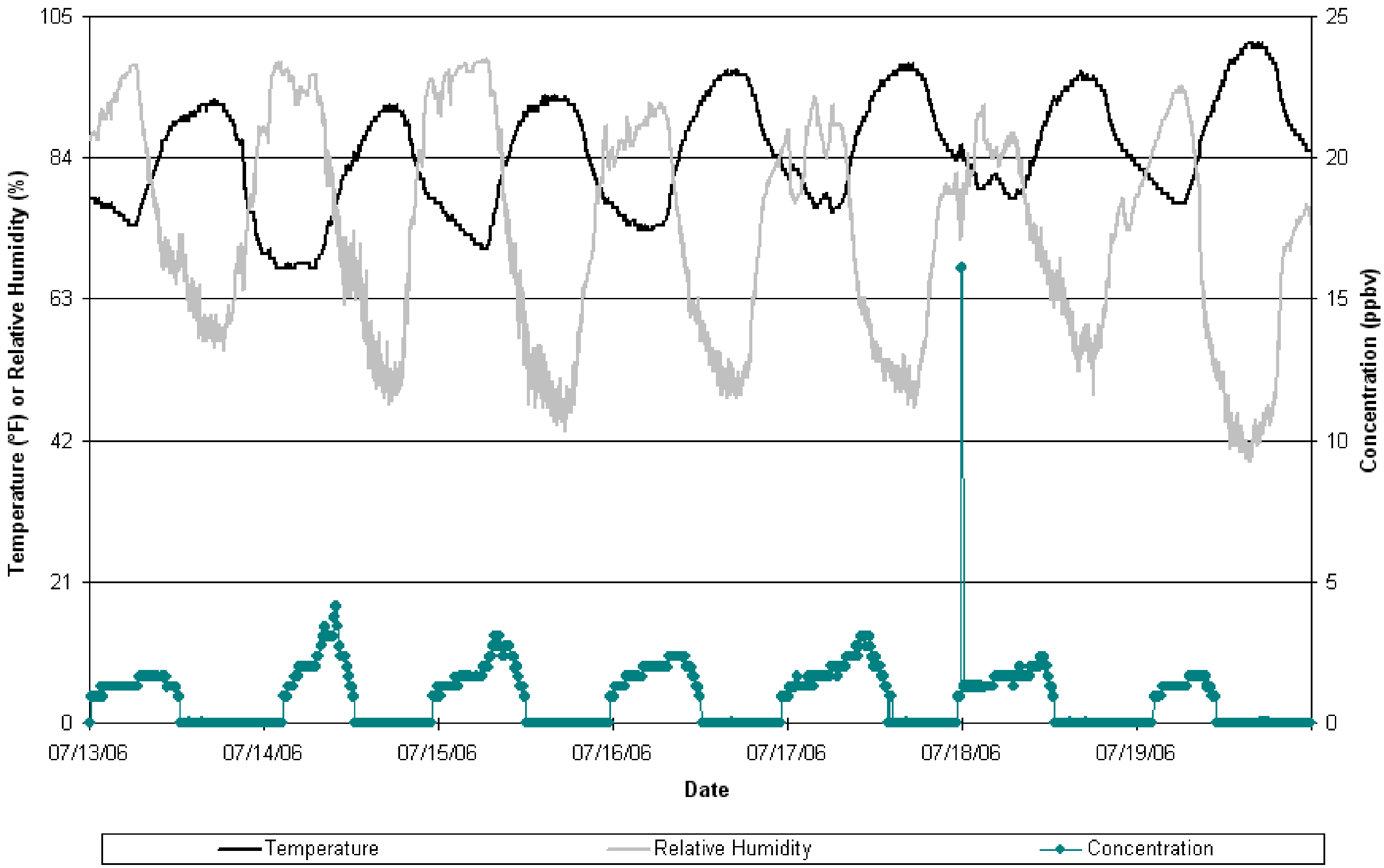
Site 2 H_2S Concentration vs. Relative Humidity and Temperature for the Week of August 10-14



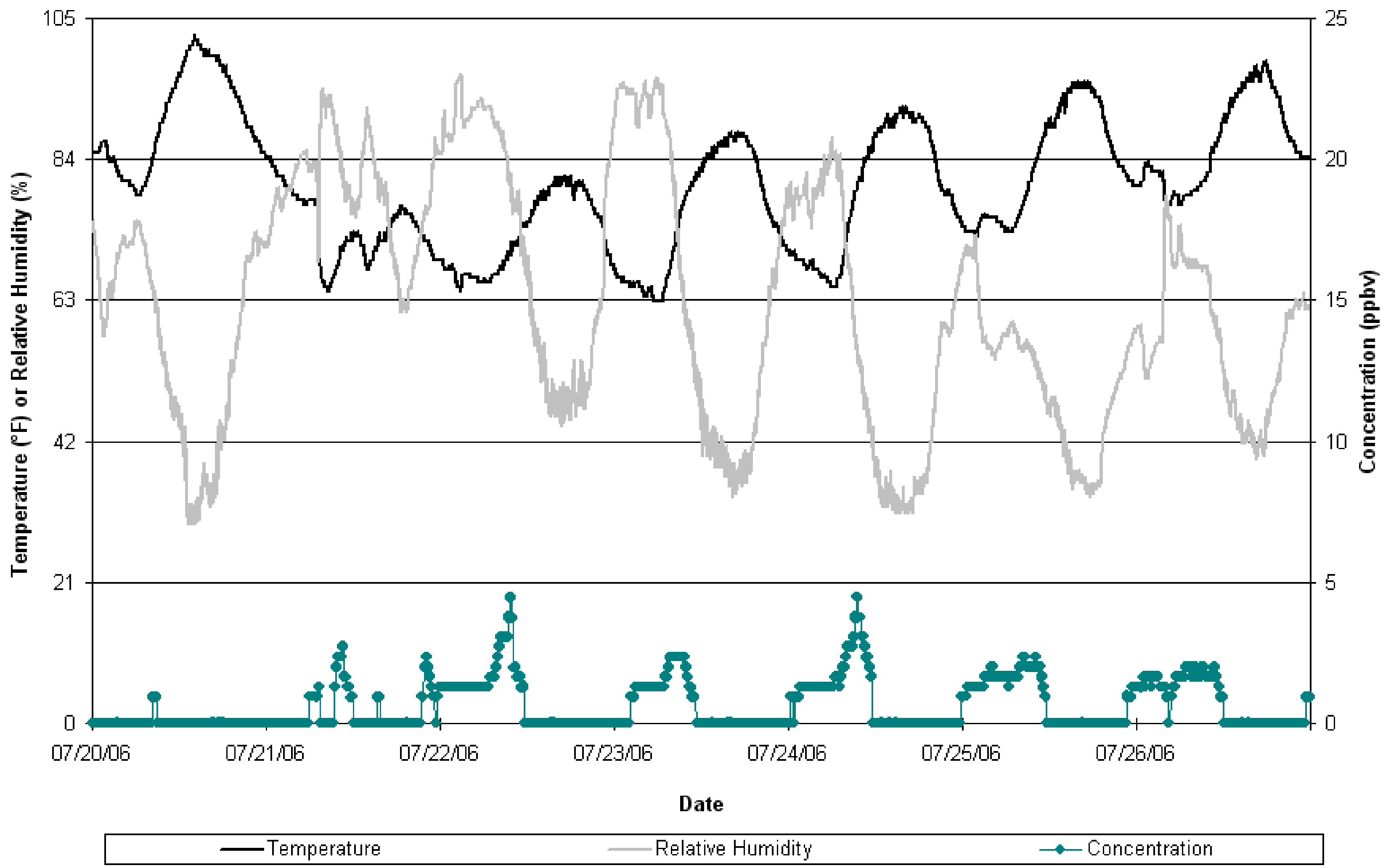
Site 3 H_2S Concentration vs. Relative Humidity and Temperature for the Week of July 6-12



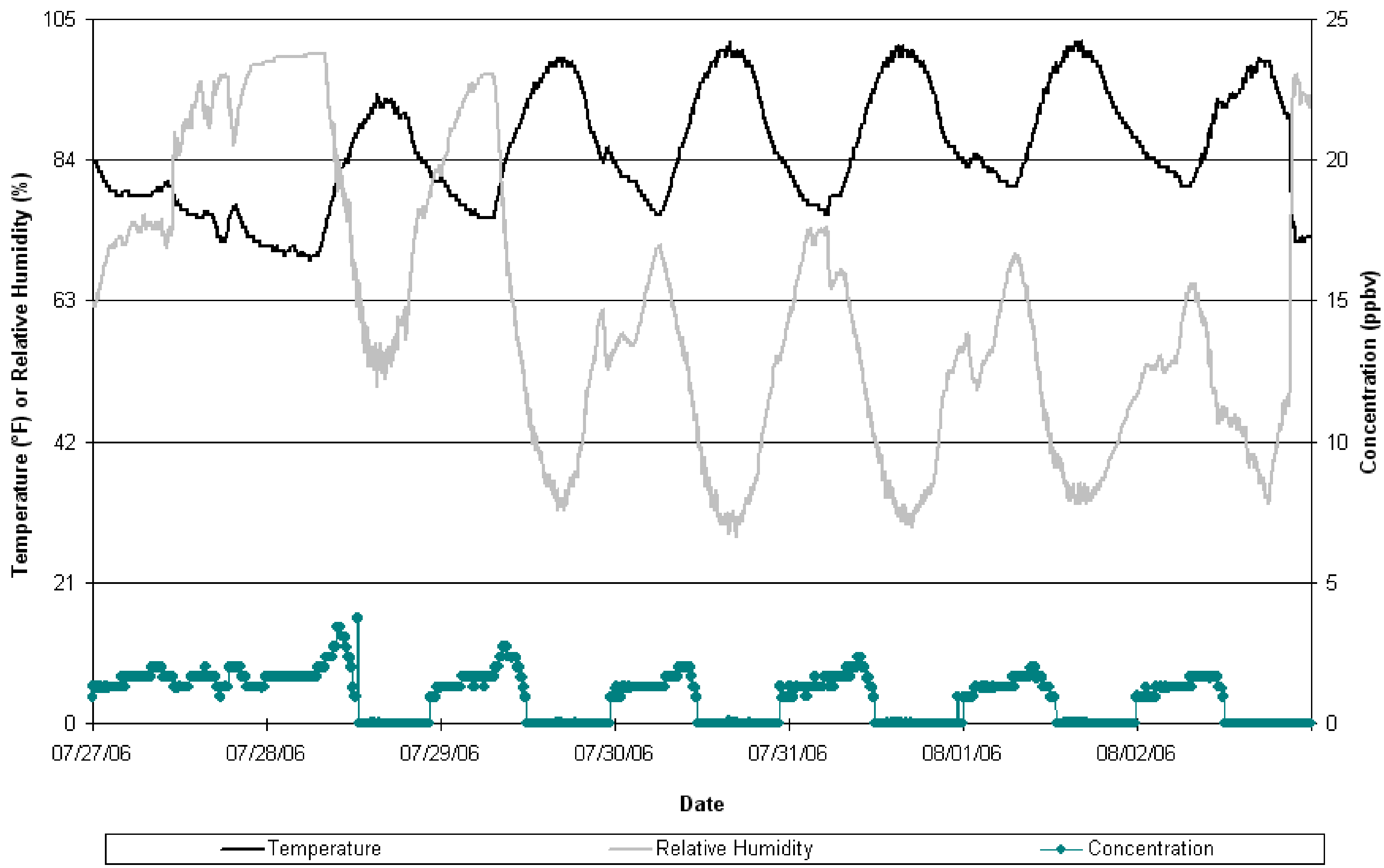
Site 3 H_2S Concentration vs. Relative Humidity and Temperature for the Week of July 13-19



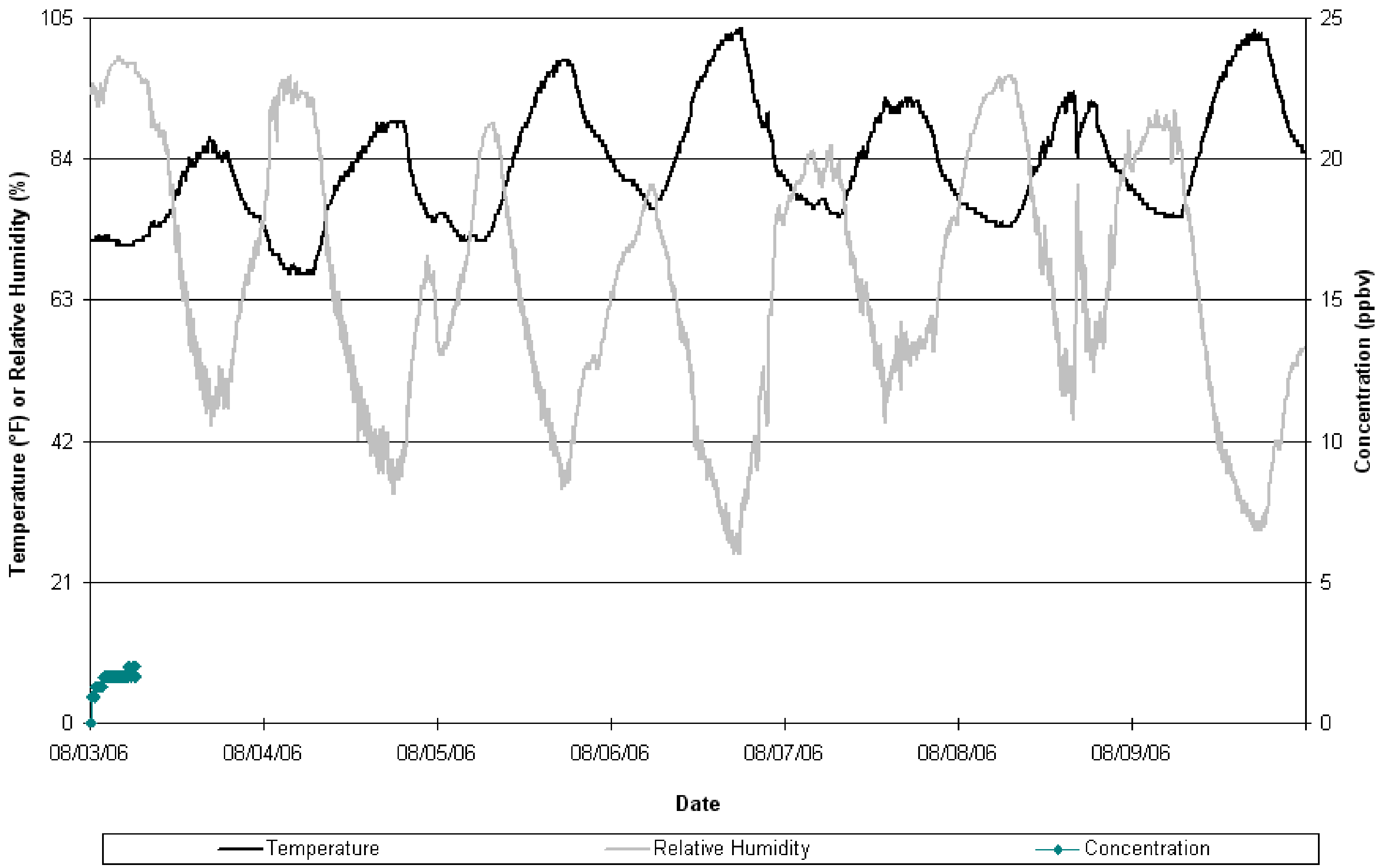
Site 3 H_2S Concentration vs. Relative Humidity and Temperature for the Week of July 20-26



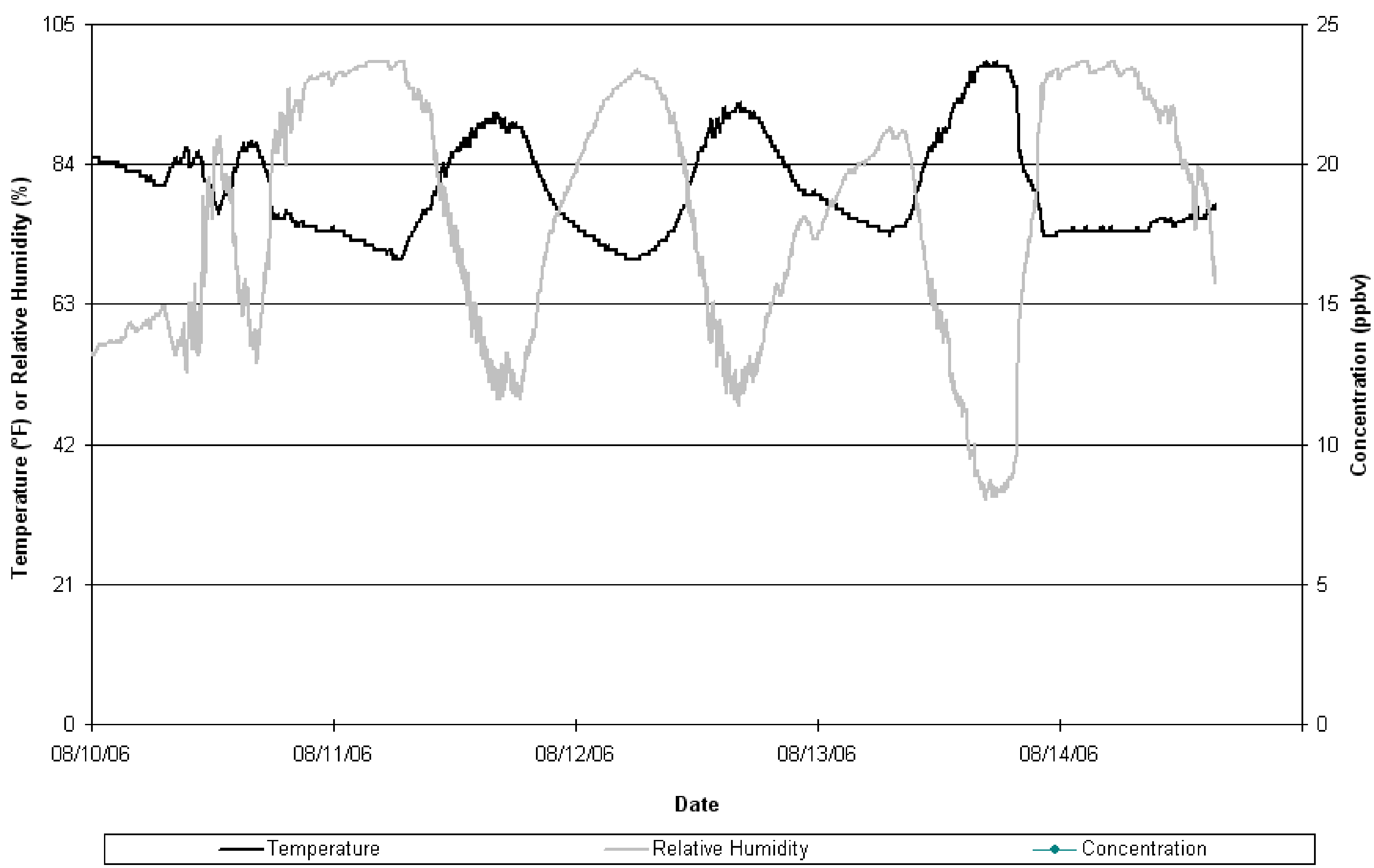
Site 3 H_2S Concentration vs. Relative Humidity and Temperature for the Week of July 27 – August 2



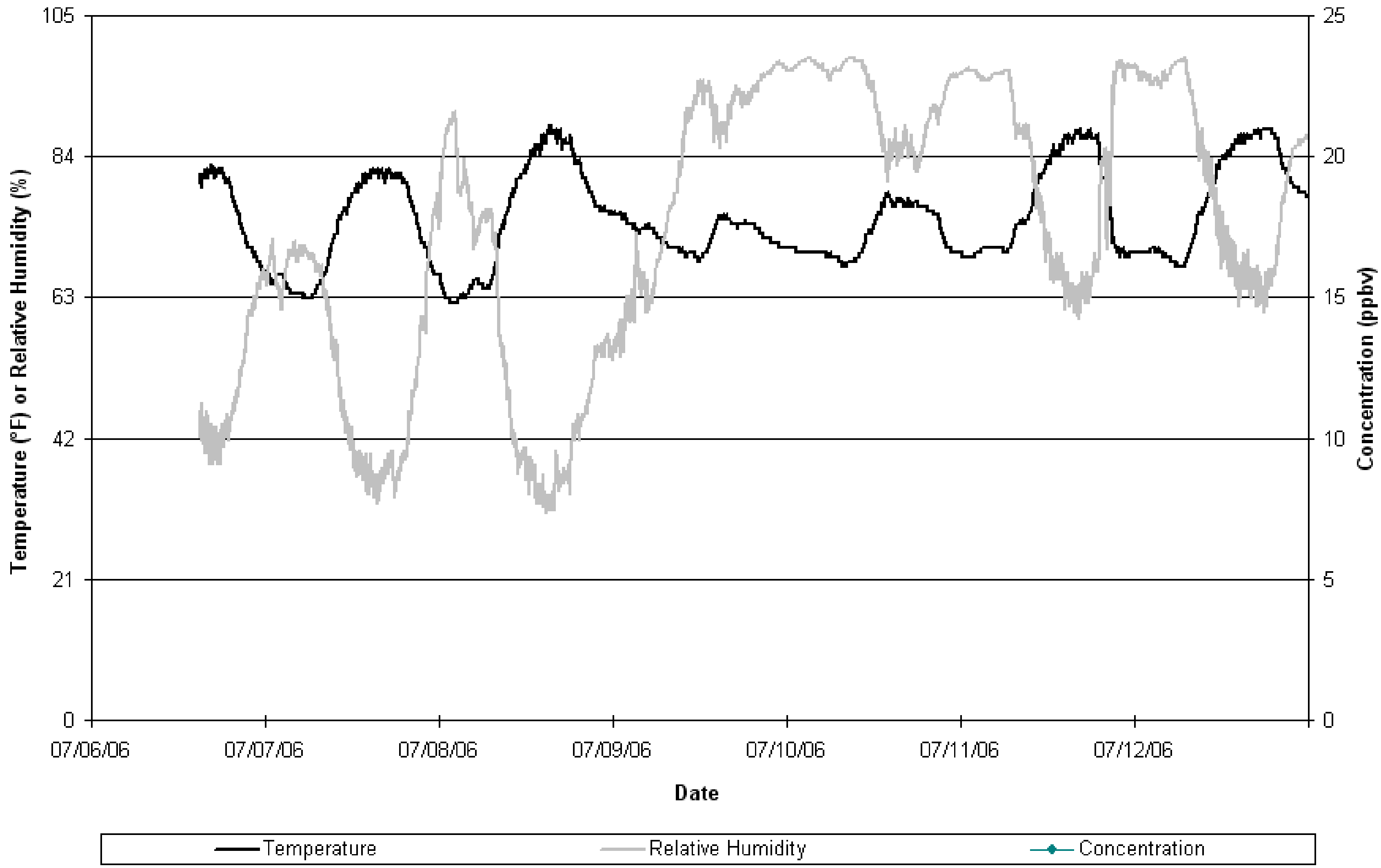
Site 3 H_2S Concentration vs. Relative Humidity and Temperature for the Week of August 3-9



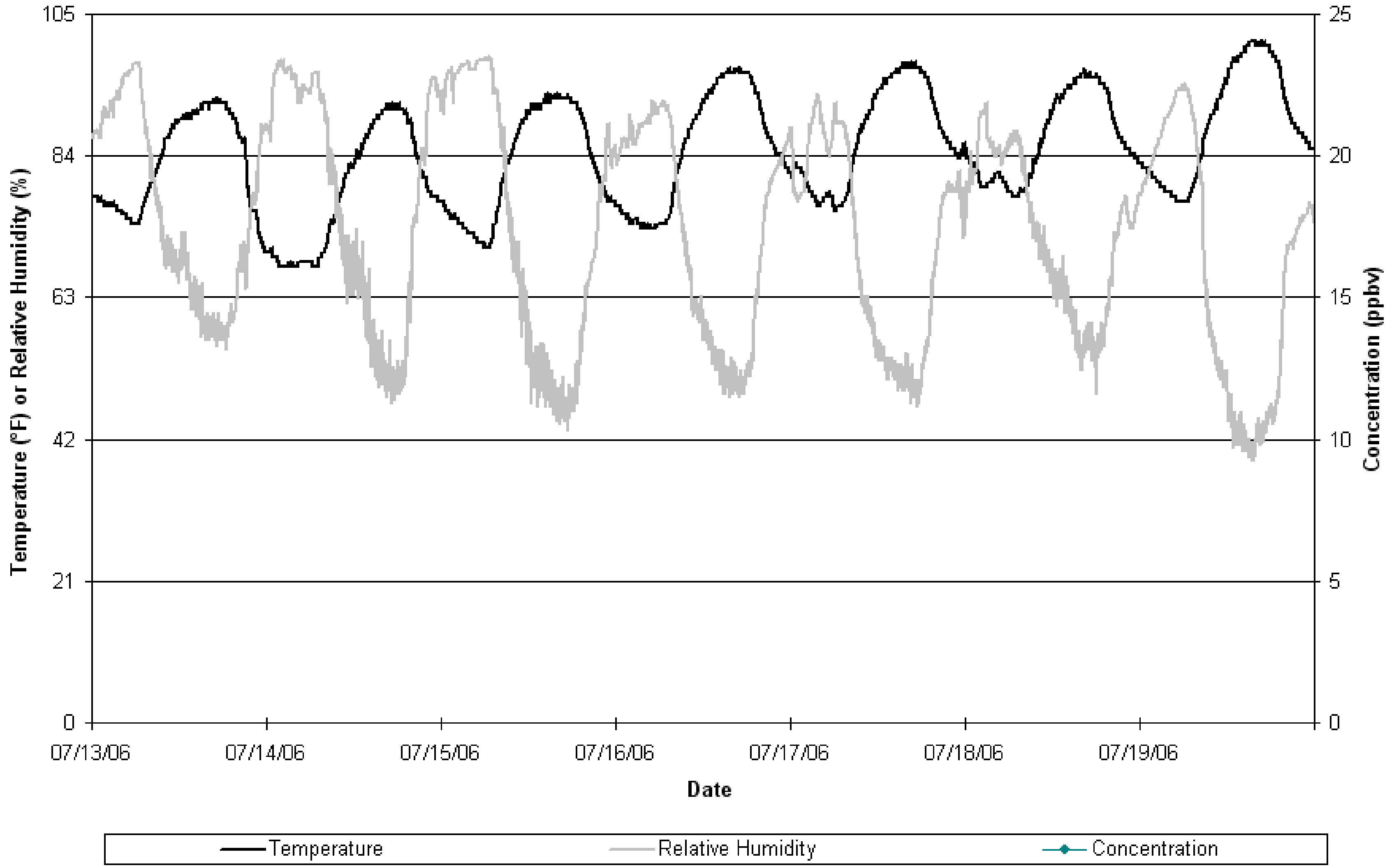
Site 3 H_2S Concentration vs. Relative Humidity and Temperature for the Week of August 10-14



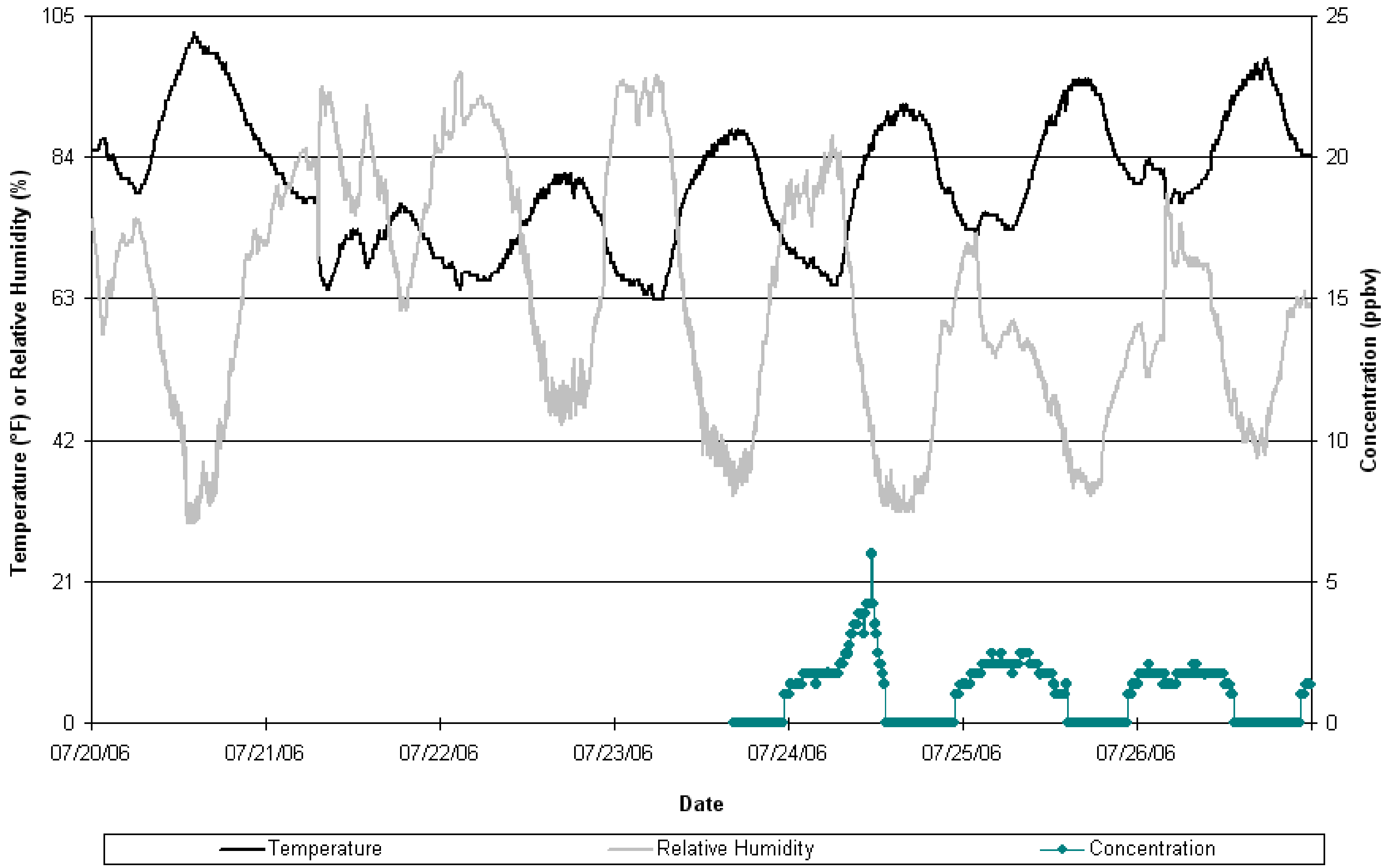
Site 4 H_2S Concentration vs. Relative Humidity and Temperature for the Week of July 6-12



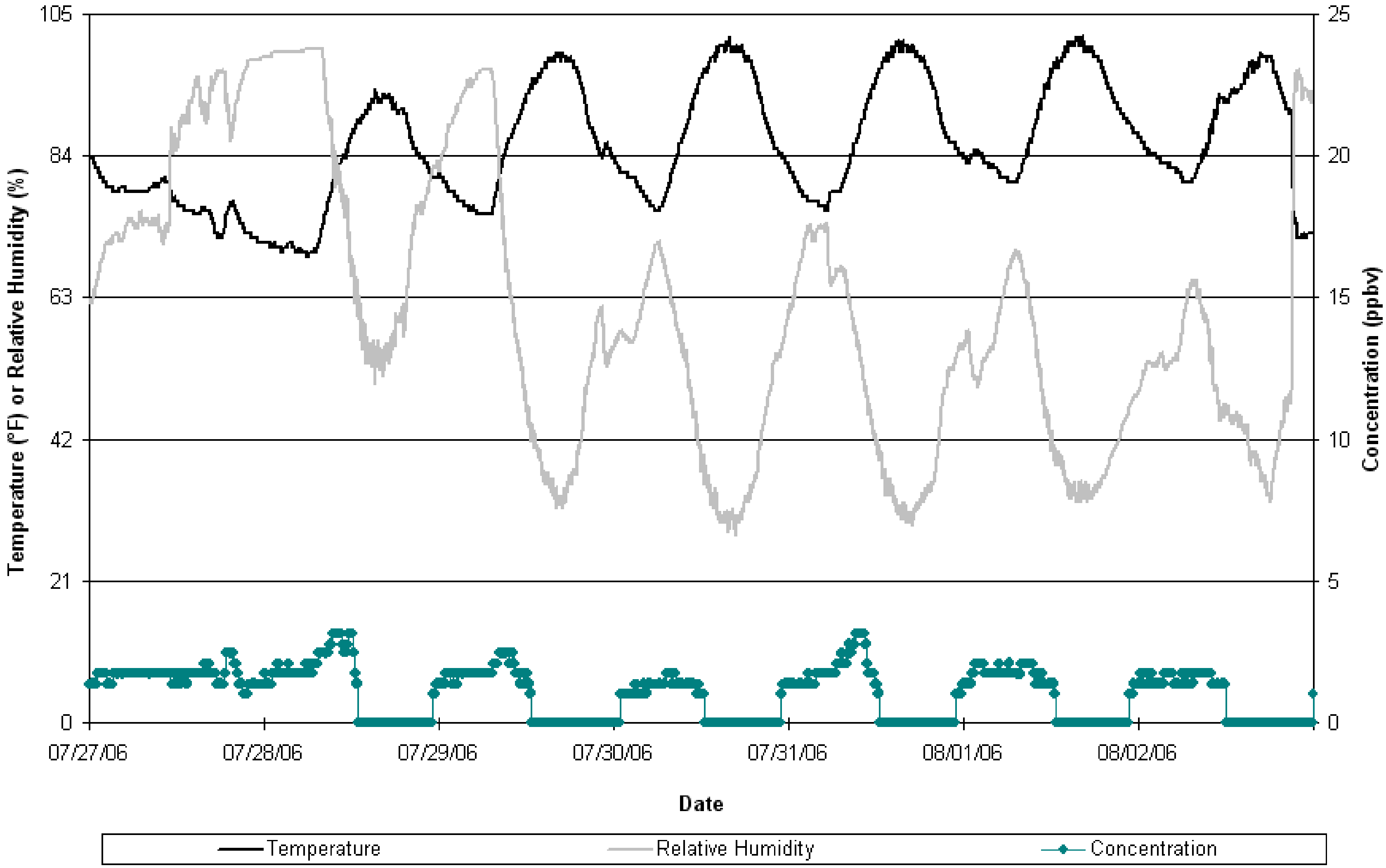
Site 4 H_2S Concentration vs. Relative Humidity and Temperature for the Week of July 13-19



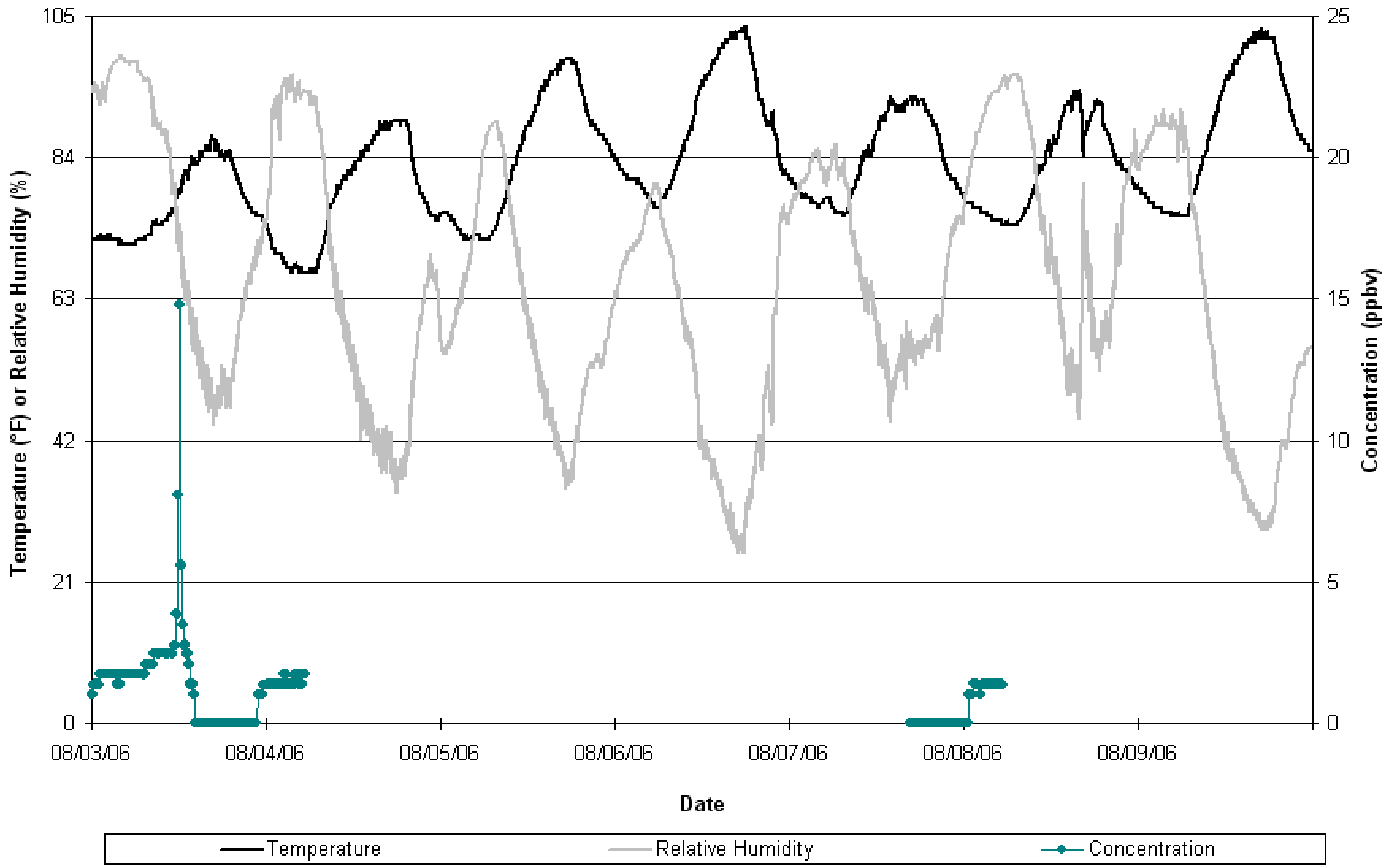
Site 4 H_2S Concentration vs. Relative Humidity and Temperature for the Week of July 20-26



Site 4 H_2S Concentration vs. Relative Humidity and Temperature for the Week of July 27 – August 2



Site 4 H_2S Concentration vs. Relative Humidity and Temperature for the Week of August 3-9



Site 4 H_2S Concentration vs. Relative Humidity and Temperature for the Week of August 10-14