# Health Consultation
(Public Comment Draft)

## Rolling Hills Landfill Site

## Pensacola, Escambia County, Florida

## FDEP Waste Cleanup Facility Site ID COM_3397
## WACS ID 3133

March 3, 2015

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**Prepared by:**
**Florida Department of Health**
**Division of Disease Control and Health Protection**
**Under Cooperative Agreement with**
**U. S. Department of Health and Human Services**
**Agency for Toxic Substances and Disease Registry**

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## Foreword

The Florida Department of Health (FDOH) evaluates the public health risk of hazardous waste sites through a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ASTDR) in Atlanta, Georgia. This is a state report, meaning FDOH health professionals reviewed it. FDOH prepared this report using the same guidelines and equations we use for EPA (US Environmental Protection Agency) sites that ATSDR reviews by mandate. This health consultation is part of an ongoing effort to evaluate health effects associated with air surrounding the Rolling Hills Construction and Demolition Debris Disposal Facility. The FDOH evaluates site-related public health issues through the following processes:

*Evaluating exposure:* FDOH scientists review available information about environmental conditions at the site. The first task is to find out how much contamination is present, where it is on the site, and how human exposures might occur. Escambia County provided the data for this assessment.

*Evaluating health effects:* If we find evidence that exposures to hazardous substances are occurring or might occur, FDOH scientists next determine whether that exposure could be harmful to human health. We focus on potential health effects for the community as a whole. We base our conclusions and recommendations on current scientific information.

*Developing recommendations:* FDOH lists its conclusions regarding any potential health threat posed by groundwater, air, and soil. FDOH then offers recommendations for reducing or eliminating human exposure. The role of the FDOH in dealing with hazardous waste sites is primarily advisory. Our public health assessments will typically recommend actions for other agencies. If a health threat is actual or imminent, FDOH will issue a public health advisory warning people of the danger and will work with the regulatory agencies to resolve the problem.

*Soliciting community input*: The evaluation process is interactive. FDOH starts by soliciting and evaluating information from various government agencies, individuals, or organizations responsible for cleaning up the site, and those living in communities near the site. We share any conclusions about the site with the groups and organizations providing the information, and we ask for feedback from the public.

*If you have questions or comments about this report, please write to us at*

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## Summary

**INTRODUCTION**

At the Rolling Hills Construction and Demolition Debris Disposal Facility (Rolling Hills Landfill), the Florida Department of Health (FDOH)'s top priority is to ensure nearby residents have the best information to safeguard their health.

The Rolling Hills Landfill is at 6990 Rolling Hills Road, Pensacola, Florida. During the spring and summer of 2014, hydrogen sulfide ($H_2S$) odors from the landfill became stronger when large amounts of flood-related debris in the landfill began to decay. Nearby residents in the Wedgewood community are concerned these odors may harm their health. For this report, FDOH reviewed $H_2S$ gas data that Escambia County collected from July 21 to December 31, 2014 to determine if levels could have affected people's health.

FDOH reached seven conclusions.

**CONCLUSION #1**

FDOH concludes that the hydrogen sulfide levels in air near the Rolling Hills Landfill between July 21 and December 31, 2014 were a public health hazard.

**BASIS FOR DECISION #1**

Inhaling (breathing) the highest level of $H_2S$ measured near the Rolling Hills Landfill for 30 minutes between July and December 2014 could have harmed people's health. The highest level of $H_2S$ found in the Wedgewood community (590 parts per billion or ppb) is too close to levels known to cause headaches and nose/throat irritation (2,000 ppb) to rule out these effects.

**NEXT STEPS #1**

FDOH recommends the landfill owners/operators manage the Rolling Hills Landfill to prevent 30-minute $H_2S$ levels from exceeding 70 ppb in the adjacent Wedgewood community. ATSDR estimates that breathing 70 ppb or less of $H_2S$ between 1 and 14 days is unlikely to cause illness.

**CONCLUSION #2**

FDOH concludes that the $H_2S$ levels in the Wedgewood community air are generally highest during the evening, night time, and early morning hours when the wind is still. Levels of $H_2S$ in the Wedgewood community generally decreased between July and December 2014. $H_2S$ levels may, however, increase in the future with warmer temperatures, more rain, more sheetrock,

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| | reductions in landfill cover, or changes in landfill management practices. |
| BASIS FOR DECISION #2 | Between September and December 2014, air monitoring data show the highest levels of $H_2S$ in the Wedgewood community air occurring during the evening, night time, and early morning hours. The highest $H_2S$ levels coincide with periods of less wind. Without winds and mixing of the atmosphere caused by solar heating, $H_2S$ from the landfill can seep from the landfill at night at high levels.<br><br>In July 2014, Escambia County measured the highest daytime level of $H_2S$ along the northern Rolling Hills Landfill boundary. In August, $H_2S$ levels decreased after the landfill operators reportedly covered the debris along the northern site boundary. |
| NEXT STEPS #2 | FDOH recommends that while the Rolling Hills Landfill is in operation, Escambia County continue around-the-clock $H_2S$ air monitoring in the Wedgewood community. |
| CONCLUSION #3 | FDOH cannot conclude whether breathing airborne dust (particulate matter or PM) near the Rolling Hills Landfill could harm people's health. |
| BASIS FOR DECISION #3 | Airborne dust can cause breathing and heart problems, mostly in the elderly, the very young, and people with asthma or heart disease. Airborne dust, however, has not been the focus of air quality monitoring near the Rolling Hills Landfill. Therefore, too little dust air monitoring data is available to evaluate the public health threat. |
| NEXT STEPS #3 | FDOH recommends that while the Rolling Hills Landfill is in operation, Escambia County routinely test for airborne dust (inhalable coarse particulates) between 2.5 and 10 micrometers in diameter ($PM_{10}$). |
| CONCLUSION #4 | FDOH concludes that since July 2014, Wedgewood community residents have frequently been able to smell the distinct rotten egg odor of $H_2S$ from the Rolling Hills Landfill. |
| BASIS FOR DECISION #4 | Levels of $H_2S$ in the Wedgewood community frequently exceed the odor threshold (0.6 ppb). |

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| CONCLUSION #5 | FDOH concludes that that it is uncertain if levels of $H_2S$ measured in the Wedgewood community caused eye irritation and respiratory problems. |
| BASIS FOR DECISION #5 | Very high levels of $H_2S$ (more than 10,000 ppb) cause eye irritation. $H_2S$ is also a respiratory irritant. Levels of $H_2S$ causing eye irritation and respiratory problems in field studies differ significantly from levels reported to cause these effects in controlled laboratory studies. |
| CONCLUSION #6 | FDOH concludes that the highest levels of $H_2S$ measured in the Wedgewood community did not likely cause heart problems, kidney problems, or cancer. |
| BASIS FOR DECISION #6 | Wedgewood community residents are concerned that breathing $H_2S$ caused heart problems, kidney problems, and cancer. Laboratory studies did not find heart problems in volunteers exposed to very high levels of $H_2S$. The kidneys are not a major target organ for $H_2S$ toxicity. $H_2S$ has not been shown to cause cancer in humans. |
| CONCLUSION #7 | FDOH cannot determine the public health threat in the Wedgewood community before July 2014 or in other areas without air monitoring. FDOH also cannot determine the health threat from pollutants other than $H_2S$. |
| BASIS FOR DECISION #7 | Air monitoring for $H_2S$ did not begin in the Wedgewood community until July 2014. Because $H_2S$ levels vary throughout the day, between seasons, and between places, FDOH can only evaluate the health threat at times and places with air measurements. Also, FDOH did not have air measurements of pollutants other than $H_2S$. |
| FOR MORE INFORMATION | If you have concerns about your health or the health of your children, you should contact your health care provider. You may also call the FDOH toll-free at 877-798-2772 and ask for information about the Rolling Hills Landfill. |

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## Background and Statement of Issues

The purpose of this health consultation report is to assess the public health threat from hydrogen sulfide gas from the Rolling Hills Construction and Demolition Debris Disposal Facility (Rolling Hills Landfill). The Florida Department of Health (FDOH)-Escambia County requested this assessment.

Health scientists look at what chemicals are present and in what amounts. They compare those amounts to national guidelines. These guidelines are set far below known or suspected levels associated with health effects. FDOH uses guidelines developed to protect children. If chemicals are not present at levels high enough to harm children, they would not likely harm adults.

This assessment considers health concerns of nearby residents and explores possible associations with hydrogen sulfide gas and particulate matter. It requires the use of assumptions, judgments, and incomplete data. These factors contribute to uncertainty in evaluating the health threat. Assumptions and judgments in this assessment err on the side of protecting public health and may overestimate the risk.

This assessment estimates the health risk for individuals exposed to the highest measured levels of hydrogen sulfide. The concentration of hydrogen sulfide that people actually breathed may have been higher or lower. Those without exposure have no health risk from hydrogen sulfide.

### Site Description

The Rolling Hills Landfill is at 6990 Rolling Hills Road, Pensacola, Escambia County, Florida, 32505 (Figure 1). South Palafox Properties owns the landfill. The landfill has a 39.4-acre total disposal area [Enviro-Pro-Tech 2013a]. Figure 2 shows the approximate area of the landfill's active cell.

In April 2014, over two feet of rain fell within 24 hours in the Pensacola area, causing severe flooding. Following this flood, the landfill accepted large amounts of flood-related drywall (also known as wallboard or sheet rock). When drywall decomposes, it creates hydrogen sulfide gas, which has a distinctive "rotten egg" smell. Therefore, the decay of the flood-related debris in the landfill caused existing odors from the landfill to become stronger.

As a result of increasing community odor complaints, in July Escambia County began measuring discrete (e.g., non-continuous) hydrogen sulfide gas concentrations near the landfill during the day. On July 22, the county measured a hydrogen sulfide gas concentration of 340 parts per billion (ppb) at the landfill's northeast property line, near the Marie K. Young-Wedgewood Community Center (Figure 2, Photo 1). FDOH-Escambia County issued an air quality health alert on the same day advising people experiencing eye, nose, and throat irritation to stay inside. The FDOH-Escambia County lifted the alert on August 5, 2014 after hydrogen sulfide gas levels subsided. Escambia

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County continued to take discrete hydrogen sulfide measurements during the day at various locations near the landfill in August. In September, they began continuous (around-the-clock) hydrogen sulfide gas monitoring at the community center.

In addition to the influx of flood-related debris, landfill management practices may have increased hydrogen sulfide gas production during the spring and summer of 2014. Landfill operators placed ground up debris in the landfill and did not grade the landfill to prevent rain infiltration (Brent Schneider, Escambia County, personal communication, 2014). Both practices increase hydrogen sulfide gas production [EPA 2014]. Also, the landfill operators did not cover the landfill area near the community center until after FDOH-Escambia County issued the health alert (Robert Merritt, FDOH-Escambia County, personal communication, 2014). Landfill covers reduce both hydrogen sulfide production and the quantity of hydrogen sulfide emissions [EPA 2014].

On September 30, 2014, FDOH staff visited the site. They observed that the landfill was covered in the area near the community center and hydrogen sulfide odors were minimal. They also noted a gap in the landfill fence near the community center.

### Demographics

FDOH examines demographic and land use data to identify sensitive populations, such as young children, the elderly, and women of childbearing age, to determine whether these sensitive populations are exposed to any potential health risks. Demographics also provide details on population mobility and residential history in a particular area. This information helps FDOH evaluate how long residents might have been exposed to contaminants.

Approximately 2,872 people live within one mile of the site. Forty-four percent (44%) are white, 48% are African-American, 5% are Asian origin, and 2% are some other race. Seventeen percent (17%) are less than 18 years old and 83% are older than 18. Fifty-five percent (55%) of adults 25 years old or older have a high school diploma or less. Ninety-one percent (91%) speak only English and 72% make less than $50,000 a year [EPA 2010].

### Land Use

The landfill is bordered to the north by West Pinestead Road, the Wedgewood community center, and the Wedgewood neighborhood. It is bordered to the east by a railroad track and residences, to the west by residences and Rolling Hills Road, and to the south by commercial businesses and residences on Marcus Point Road.

## Hydrogen Sulfide Background

### Occurrence

Hydrogen sulfide ($H_2S$) is a flammable, colorless gas with a characteristic rotten egg smell.

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Hydrogen sulfide gas occurs naturally in areas with low oxygen: volcanoes, sulfur springs, swamps, stagnant water bodies, crude petroleum, and natural gas. Approximately 90% of the hydrogen sulfide in the atmosphere comes from these natural sources. Thus, exposure to low-level background concentrations (0.1 to 0.3 ppb) is common. Hydrogen sulfide also comes from man-made sources: municipal sewers and sewage treatment plants, swine containment/manure-handling operations, pulp/paper operations, petroleum refineries, natural gas plants, petrochemical plants, food processing plants, and tanneries. Cigarette smoke and car exhaust contain low levels of hydrogen sulfide as well [ATSDR 2006; ATSDR 2014].

Hydrogen sulfide is a common by-product of construction and demolition debris landfills. In low or no-oxygen areas common within landfill disposal cells, sulfur-reducing bacteria convert sulfate in drywall to hydrogen sulfide gas. Bacterial hydrogen sulfide production also requires moisture. Sulfur-reducing bacteria are most active at neutral pH (between 6 and 9) but also have been observed in more acidic environments [EPA 2014]. People might also be exposed to higher-than-normal levels of hydrogen sulfide gas if they live near a waste water treatment plant, a gas/oil drilling operation, or a farm with manure storage/ livestock confinement facilities.

Hydrogen sulfide gas is slightly heavier than air and may accumulate in low-lying areas outside landfill boundaries. Hydrogen sulfide odor problems near construction and demolition debris landfills occur most frequently in the early morning before sunrise, when there is less wind to mix the atmosphere and disperse the gas [Xu and Townsend 2014]. Landfill hydrogen sulfide levels can be highly variable, even when measured at the same time of day and in the same location [EPA 2014]. Hydrogen sulfide levels tend to decrease with increasing distance from the landfill [EPA 2014].

Well water can contain low levels of hydrogen sulfide. Hydrogen sulfide can form in hot water heaters, giving the water a rotten egg odor.

### Hydrogen Sulfide Exposure and Human Health

Hydrogen sulfide enters your body primarily through the air you breathe. When you breathe air with hydrogen sulfide, it is absorbed into the blood stream and distributed throughout the body. The body then rapidly converts hydrogen sulfide to sulfate and excretes it in the urine.

People can smell hydrogen sulfide at concentrations much lower than those that cause illness. There is, however, a wide range in the reported odor threshold for hydrogen sulfide. The odor threshold for hydrogen sulfide has been reported as low as 0.5 ppb and as high as 300 ppb [ATSDR 2006; ATSDR 2014]. One recent study that looked only at data collected with similar methodologies found the odor threshold to be 0.6 ppb [Ruijten et al. 2009].

No health effects have been found in humans exposed to hydrogen sulfide at background outdoor air concentrations (0.1 to 0.3 ppb). Exposure to low concentrations of hydrogen sulfide above background outdoor levels, however, may cause irritation of the eyes, nose, or throat. It may also cause difficulty in breathing for some asthmatics. These symptoms

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typically disappear once hydrogen sulfide concentrations return to background levels [ATSDR 2006].

At very high concentrations, hydrogen sulfide is poisonous. Brief exposures to very high concentrations (greater than 500,000 ppb) can cause rapid loss of consciousness and death. According to the U.S. Occupational Safety and Health Administration (OSHA), there were 80 deaths due to hydrogen sulfide poisoning between 1984 and 1994 [Fuller and Suruda 2000]. Very high concentrations of hydrogen sulfide can also cause rapid/irregular heartbeat, difficult breathing, and fluid in the lungs. Very high concentrations usually occur only in enclosed spaces such as sewers, animal processing plants, waste dumps, sludge plants, oil/gas well drilling sites, tanks, and cesspools. For individuals who recover, most regain consciousness without any lingering health effects. A few, however, may suffer permanent or long-term headaches, poor attention span, poor memory, and poor motor function. At very high concentrations (above 100,000 ppb), hydrogen sulfide also damages the nerves in the nose and people can no longer smell it [ATSDR 2014, NRC 2010].

Hydrogen sulfide has not been shown to cause cancer in humans. Its ability to cause cancer in animals has not been studied thoroughly [EPA 2003a].

Because hydrogen sulfide is quickly excreted from the body, medical monitoring is rarely useful. Hydrogen sulfide can be measured in exhaled air, but samples must be taken within 2 hours after exposure to be useful. Hydrogen sulfide can also be measured in the urine but samples must be taken within 12 hours of exposure. Both tests require special equipment, which is not routinely available in a doctor's office. These tests can tell whether you have been exposed to hydrogen sulfide, but they cannot determine exactly how much hydrogen sulfide you have been exposed to or whether harmful effects will occur. Therefore, urine and exhaled air are rarely tested. Although there are tests that can measure nervous system function, they are not specific for hydrogen sulfide [ATSDR 2006].

## Dust (Particulate Matter)

Assessment of dust (particulate matter) was not the focus of this study. Dust is, however, commonly associated with landfills.

Particle pollution is a mixture of microscopic solids and liquid droplets suspended in air. This pollution, also known as particulate matter or "PM," is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, soil or dust particles, and allergens (such as fragments of pollen or mold spores).

Particle exposure can lead to a variety of health effects. Long-term exposures, such as those experienced by people living for many years in areas with high particle levels, have been associated with problems such as reduced lung function and the development of chronic bronchitis and even premature death. Short-term exposures to particles (hours or days) can aggravate lung disease, causing asthma attacks and acute bronchitis, and may

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increase susceptibility to respiratory infections. In people with heart disease, short-term exposures have been linked to heart attacks and arrhythmias. Healthy children and adults have not been reported to suffer serious effects from short-term exposures, although they may experience temporary minor irritation (coughing, chest discomfort, wheezing, shortness of breath, and unusual fatigue) when particle levels are elevated [EPA 2003b].

## Community Health Concerns

FDOH reviewed news reports and spoke to FDOH-Escambia County staff about community health concerns. Community health concerns included odor, the prevalence of cancer (including brain tumors), respiratory problems (including shortness of breath and coughing), renal (kidney) failure, cardiac (heart) problems, headaches and eye irritation [Savage 2014; Outzen 2014]. Most community health concerns have been from the Wedgewood neighborhood close to the Wedgewood community center (Robert Merritt, FDOH-Escambia County, personal communication, 2014). The Wedgewood neighborhood may be most affected by the hydrogen sulfide odors because it is close to the landfill's active cell and is downwind of the landfill during the summer months (Robert Merritt, FDOH-Escambia County, personal communication, 2014). Community members have also expressed concerns about dust generated at the landfill [Outzen 2014].

## Discussion

### Environmental Data

#### Hydrogen Sulfide Discrete, Mobile Daytime Testing

During the afternoon of July 21, 2014, Escambia County began to monitor hydrogen sulfide for short periods of time at several locations. The purpose of this discrete monitoring included gauging the relative concentrations of hydrogen sulfide, determining the extent of elevated concentrations, and identifying the source of hydrogen sulfide (Brent Wipf, Escambia County, personal communication, 2015). Escambia County began measuring hydrogen sulfide concentrations at the northeastern landfill boundary and at the community center using a Jerome® 631-X hydrogen sulfide analyzer (Appendix 3). County staff continued this discrete (non-continuous) testing during the day near the northern end of the landfill and at many nearby locations (Figure 3). Daytime testing ended on August 27, 2014. The highest measured hydrogen sulfide levels are presented in Figures 4 and 5.

Escambia County staff took air samples between 6:00 a.m. and 7:00 p.m. They took samples for 25 to 30 seconds at varying sample frequencies and durations. The county based sample times largely on staff workload and availability (Brent Wipf, Escambia County, personal communication, 2014). In all, the county took 1,040 daytime samples at 48 locations (Table 1).

The highest hydrogen sulfide gas measurements were nearly all at the northeast property line (Figure 4) on July 21 and 22, likely before the landfill covered the debris in that area.

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The one exception was at the Longleaf Landfill West Gate location. At this location, Escambia County once measured a hydrogen sulfide concentration of 230 ppb on August 8 (Figure 5). The Longleaf Landfill is 0.75 miles west of the Rolling Hills Landfill, is inactive, and covered with a geomembrane (Brent Wipf, Escambia County, personal communication, 2014). Concentrations before and after this high reading were low (between 3 and 7 ppb) and the County did not find any other elevated concentrations near the Longleaf Landfill.

Daytime testing may not have captured the highest concentrations of hydrogen sulfide at the landfill property boundary. Escambia County measured concentrations during the day when there is more wind and mixing in the atmosphere and therefore hydrogen sulfide concentrations are typically lower. In addition, rain fell while the county measured the highest concentrations of hydrogen sulfide on July 22, 2014 at the northeast fence (Figure 4). Rain tends to remove hydrogen sulfide from the air (Joe Pecha, Arizona Instrument LLC, personal communication, 2014). Still, because hydrogen sulfide concentrations tend to decrease with distance from the landfill, concentrations in the community were likely lower than those measured at the landfill boundary.

FDOH cannot estimate the duration of exposures based on discrete (non-continuous) daytime testing.

### Hydrogen Sulfide Continuous, Stationary Testing

In early September 2014, Escambia County installed a continuous monitoring station to provide a more consistent dataset and assess overnight hydrogen sulfide concentrations. (Brent Wipf, Escambia County, personal communication, 2015).The county installed a Jerome® 651 hydrogen sulfide monitor approximately five feet off the ground on a pole next to the Wedgewood community center (Figure 2). The Jerome® 651 is composed of a Jerome® 631-X hydrogen sulfide analyzer, a data logger for storing data, and a weather station (Photo 2).

The Jerome® hydrogen sulfide meter took one 25 to 30-second air sample every 30 minutes starting at 6 p.m. on September 4, 2014. FDOH analyzed data taken up to 11:30 p.m. December 31, 2014.

The detection limit of the Jerome® 631-X is 3 ppb. Although the instrument will record readings of less than 3 ppb, these measurements may not be accurate. Therefore it is not possible to assess the exact number of measurements between the odor detection threshold (0.6 ppb) and the method detection limit (3 ppb). However, given that about 35% of the measurements were equal to or greater than the method detection limit and another 53% of the measurements were between the odor threshold (0.6 ppb) and the method detection limit (3 ppb), it is reasonable to conclude that more than half of the time, people were exposed to concentrations that they could smell. As discussed previously in this report, people can smell levels of hydrogen sulfide below levels known to affect human health.

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Concentrations of hydrogen sulfide exceeding the US Agency for Toxic Substances and Disease Registry (ATSDR) comparison values generally did not last very long (usually less than an hour). The highest concentrations of hydrogen sulfide tended to peak during times when the on-site anemometer recorded lulls in the wind, often in the evening, night or early in the morning (Table 3). During the nighttime and early morning, fewer people are likely to be outdoors, and therefore fewer people would be exposed.

### Particulate Matter (PM) Testing

Although assessment of particulate matter (PM) was not the focus of this study, FDOH reviewed the available PM data.

During the afternoon of July 21 and morning of July 22, 2014, Escambia County measured PM at locations north and south of the landfill using a DustTrak DRX Aerosol Monitor 8534. All measurements were below the federal NAAQS (National Ambient Air Quality Standards) for particulate matter (150 $\mu g/m^3$). FDOH would need data taken over a longer period of time to assess the potential health effects of particulate matter near the landfill.

## Pathway Analyses

Chemical contamination in the environment can only harm someone's health if he or she contacts those contaminants. If there is no exposure, there can be no associated harm to health. If exposure does occur, how much of the contaminants someone contacts (concentration), how often the contaminants are contacted (frequency), for how long they are contacted (duration), and the danger of the contaminant (toxicity) all contribute to the risk of harm.

To assess any contaminant's public health importance, FDOH estimates the frequency with which people could have contact with that contaminant. The method for assessing whether people face a health risk is to determine whether a completed exposure pathway connects them to a contaminant source, and whether exposures to that contaminant source are high enough to be of health concern.

For this report, FDOH only investigated the air exposure pathway.

### The Exposure Pathway

An exposure pathway is a series of steps starting with the release of a contaminant in environmental media and ending at contact with the human body. A completed exposure pathway consists of five elements:

1. Source of contamination, such as a hazardous waste site;
2. An environmental medium such as air, water, or soil that can hold or move the contamination;
3. A point where people come into contact with a contaminated medium, such as water at the tap or soil in the yard;

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4. An exposure route, such as ingesting (contaminated soil or water) or breathing (contaminated air); and
5. A population, such as people who live near or work on a contaminated waste site.

Generally, the ATSDR and FDOH consider three exposure categories:

- Completed exposure pathways—all five elements of a pathway are present;
- Potential exposure pathways—one or more of the elements might not be present, but information is insufficient to eliminate or exclude the element; and
- Eliminated exposure pathways—at least one element is not present and will not likely be present.

Exposure pathways evaluate specific ways in which people were, are, or might be exposed to environmental contamination in the past, present, and future.

### Completed Exposure Pathways

FDOH considers exposure to hydrogen sulfide gas in the vicinity of the Rolling Hills Landfill to be a past, current, and future completed exposure pathway (Table 4). FDOH assumes the source of the hydrogen sulfide contamination is the Rolling Hills Landfill. Air is the environmental medium. People living or working near the landfill or using the community center are the exposed population. The exposure route is inhalation. The points of exposure are the community center and the neighborhoods near the landfill.

## Public Health Risk

This assessment requires the use of assumptions, judgments, and relies on incomplete data. These factors contribute to uncertainty in evaluating the health threat. Assumptions and judgments in the assessment of the site's impact on public health err on the side of protecting public health and may overestimate the risk.

FDOH provides site-specific public health recommendations based on toxicological literature, levels of environmental contaminants, evaluation of potential exposure pathways, duration of exposure, and characteristics of the exposed population. Whether a person will be harmed depends on the type/amount of contaminant, how they are exposed, how long they are exposed, and how much contaminant is absorbed. Genetics and individual lifestyles also affect the risk of illness.

### Identifying Contaminants of Concern

For the analysis of contaminants of concern in air, FDOH compares contaminant concentrations directly to air comparison values. When determining which comparison value to use, FDOH follows ATSDR's general hierarchy and also uses professional judgment.

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FDOH selects contaminants with maximum concentrations above the air comparison values for further evaluation. Comparison values, however, are not thresholds of toxicity. FDOH does not use them to predict health effects or to establish clean-up levels. A concentration above a comparison value does not necessarily mean harm will occur. It does indicate, however, the need for further evaluation.

Because the highest concentration of hydrogen sulfide measured in the air near the Rolling Hills Landfill (590 ppb) was greater than the ATSDR acute duration (1 to 14-day) Minimal Risk Level (MRL) comparison value (70 ppb), FDOH selected hydrogen sulfide as a contaminant of concern.

Hydrogen sulfide is a sentinel air contaminant at construction and demolition debris landfills. Hydrogen sulfide is the only gas the county tested for at the Rolling Hills Landfill. The same landfill conditions that produce hydrogen sulfide also produce lesser amounts of other reduced sulfur compounds such as methyl mercaptan, carbon disulfide, dimethyl sulfide, and carbonyl sulfide [Lee et al. 2006]. Like hydrogen sulfide, people can smell these other compounds at low concentrations. Health scientists, however, know less about the toxicity of these other reduced sulfur compounds than hydrogen sulfide.

## Public Health Implications

### Hydrogen Sulfide

Several human studies have examined the chronic toxicity of inhaled hydrogen sulfide. Most of these studies reported increases in the occurrence of subjective symptoms of respiratory irritation in workers or residents living near paper mills. Limitations, such as poor exposure characterization (including the lack of information on peak exposure levels) and co-exposure to other chemicals, limit the use of these field studies for establishing concentration-response relationships. Although case reports concerning temporary eye, nose, and throat irritation in humans are abundant, exposure parameters, concentration, and duration are often either unreported or only estimated [ATSDR 2006; ATSDR 2014]. Therefore, although this report considers the results of field studies and case reports, it relies primarily on studies of human exposure to hydrogen sulfide under controlled laboratory conditions.

ATSDR established an acute duration (1 to 14-day) MRL screening guideline of 70 ppb for hydrogen sulfide in air. ATSDR estimates that breathing 70 ppb or less of hydrogen sulfide between 1 and 14 days is unlikely to cause illness. The basis for this guideline is a study of 10 people with mild to moderate asthma who breathed air with a concentration of 2,000 ppb hydrogen sulfide for 30 minutes under controlled laboratory conditions. After breathing hydrogen sulfide, 3 of the 10 people complained of headaches. There was no change in lung function but changes suggestive of bronchial obstruction were observed in two individuals [Jappinen et al. 1990]. ATSDR applied a safety factor of 27 to the 2,000 ppb level in this study to ensure the MRL of 70 ppb is protective of health. ATSDR derived the safety factor of 27 based on the product of a) 3 for use of a minimal

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lowest observed adverse effect level (LOAEL), b) 3 for human variability, and c) 3 for database deficiencies [ATSDR 2006; ATSDR 2014].

ATSDR also established an intermediate duration (15 to 365-day) MRL screening guideline of 20 ppb for hydrogen sulfide in air. ATSDR estimates that breathing 20 ppb or less of hydrogen sulfide between 15 and 365 days is unlikely to cause illness. The basis for this guideline is a study of rats exposed to 10,000, 30,000, or 80,000 ppb hydrogen sulfide 6 hours/day, 7 days/week for 10 weeks. Breathing 30,000 and 80,000 ppb damages the nerves in the rat's nose that enable them to smell [Brenneman et al. 2000]. ATSDR applied a safety factor of 30 to the adjusted no observed adverse effect level (NOAEL) in this study (adjusted NOAEL = 10,000 ppb x 6 hours/24 hours x 7 days/7 days = 2,500 ppb). ATSDR derived the safety factor of 30 based on the product of a) 3 for extrapolation from animals to humans with dosimetric adjustment and b) 10 for human variability. ATSDR also used a factor of 0.184 to take into account the differences in surface area of the upper respiratory tract and inhalation rates between rats and humans. This ensures the intermediate duration MRL of 20 ppb (2,500 ppb/30 x 0.184, rounded to the nearest factor of 10) is protective of health [ATSDR 2006; ATSDR 2014].

Based on the available air monitoring data near the Rolling Hills Landfill, the 70 ppb acute duration MRL is a more appropriate guideline than the 20 ppb intermediate duration MRL for two reasons. First, ATSDR bases the 70 ppb acute duration MRL on a human study and bases the 20 ppb intermediate duration MRL on a study of rats. Use of a human study is preferable because it avoids the uncertainty that people may react differently than animals. Second, ATSDR bases its 70 ppb acute duration MRL on a study of people exposed to hydrogen sulfide for 30 minutes. Exposures in the rat study used for the basis of the 20 ppb intermediate duration MRL were for 6 hours. Thirty minutes is the same frequency that Escambia County measured continuous hydrogen sulfide concentrations at the Wedgewood Community Center. It is preferable to use a study that more closely matches the exposure conditions at the site in question. Therefore, the 70 ppb acute duration MRL is the more appropriate guideline. ATSDR MRLs estimate hydrogen sulfide concentrations below which illness is unlikely. Because MRLs incorporate safety factors, levels slightly above the MRL do not necessarily cause illness.

In the past, FDOH assessed the health risk from hydrogen sulfide at both Saufley [ATSDR 2007] and Coyote [ATSDR 2008] landfills. Both reports relied on epidemiological studies (e.g. non-controlled studies of groups of people with varying contaminant exposures) rather than on carefully controlled laboratory studies. There are weaknesses of using epidemiological studies to estimate health risks. First, epidemiological studies often do not measure levels of hydrogen sulfide people are actually exposed to. Instead, they estimate or model hydrogen sulfide levels. Second, people are usually exposed to other contaminants at the same time that may or may not be measured. Third, while these studies may show an association between hydrogen sulfide and a health affect, they cannot prove causation. Therefore, epidemiological studies are suggestive but not definitive. This assessment of the Rolling Hills Landfill relies on more definitive human laboratory studies for its assessment of the health risk.

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The following paragraphs describe the risk of illness from hydrogen sulfide measured near the Rolling Hills Landfill.

### Odor

On many occasions since air monitoring began on July 21, 2014, the concentration of hydrogen sulfide in the Wedgewood community exceeded the odor threshold of 0.6 ppb. Therefore, residents of the Wedgewood community were frequently able to smell the distinct rotten egg odor of hydrogen sulfide from the Rolling Hills Landfill.

### Cancer

Hydrogen sulfide has not been shown to cause cancer in humans, and its possible ability to cause cancer in animals has not been studied thoroughly. Hydrogen sulfide has not been classified for its ability to cause or not cause cancer [ATSDR 2006; ATSDR 2014].

### Eye Irritation

Hydrogen sulfide causes eye irritation at high levels but its ability to do so at levels measured in the Wedgewood community is unclear.

The highest hydrogen sulfide concentration measured in the Wedgewood community was 590 ppb. The threshold for eye irritation by hydrogen sulfide by itself is 10,000 to 20,000 ppb [WHO 1981], but only 6,000 ppb in the presence of other reduced sulfide compounds [Vanhoorne et al. 1995]. People exposed to hydrogen sulfide under controlled laboratory conditions at 2,000 ppb for 30 minutes did not report eye irritation [Jappinen et al. 1990].

In a less controlled field study of people living near a paper mill with estimated peak outdoor hydrogen sulfide concentrations of 70 ppb, residents self-reported eye irritation 12 times more often than people without exposure [Jaakkola et al. 1990]. Eye irritation in this study may have also have been due to methyl mercaptan as well as other air pollutants. Hydrogen sulfide causes eye irritation at 400,000 ppb in rats [Lopez at al. 1988] and at 20,000 ppb in guinea pigs [Haider et al. 1980].

Therefore, although high concentrations of hydrogen sulfide cause eye irritation, it is unclear whether the levels measured in the Wedgewood community could have caused eye irritation.

### Headache

The highest hydrogen sulfide concentration measured in the Wedgewood community is too close to the levels known to cause headache to rule out this effect.

The highest 30-minute hydrogen sulfide concentration measured in the Wedgewood community (590 ppb) is only about 3 times less than the 2,000 ppb levels that caused headache in people exposed under controlled laboratory conditions for 30 minutes [Jappinen et al. 1990]. This is too close to rule out the possibility of headache.

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**Heart Problems**

It is unlikely that the highest concentration of hydrogen sulfide measured in the Wedgewood community (590 ppb) caused heart problems.

Although very high concentrations of hydrogen sulfide can cause irregular and/or rapid heartbeat, researchers found no effect on the cardiovascular system of volunteers exposed to hydrogen sulfide between 5,000 and 10,000 ppb for 16 to 30 minutes [Bhambhani and Singh 1991; Bhambhani et al. 1994; Bhambhani et al. 1997].

**Kidney Problems**

It is unlikely that the highest concentration of hydrogen sulfide measured in the Wedgewood community (590 ppb) caused kidney problems. The kidneys are not a major target organ for hydrogen sulfide toxicity. Hydrogen sulfide did not affect the kidneys of rats and mice that breathed 80,000 ppb hydrogen sulfide 6 hours/day, 5 days/week, for 90 days [CIIT 1983a, 1983b, 1983c].

**Nose and Throat Irritation**

The highest hydrogen sulfide concentration measured in the Wedgewood community is too close to the levels known to cause nose and throat irritation to rule out this effect.

The highest 30-minute hydrogen sulfide concentration measured in the Wedgewood community (590 ppb) is only about 3 times less than the 2,000 ppb levels that caused nose and throat dryness in people exposed under controlled laboratory conditions for 30 minutes [Jappinen et al. 1990]. This is too close to rule out the possibility of nose and throat irritation.

**Respiratory Problems (Including Asthma)**

It is unclear if the highest concentrations of hydrogen sulfide measured in the Wedgewood community (590 ppb) caused respiratory problems.

At very high concentrations (usually only occurring in confined spaces), hydrogen sulfide can cause people to stop breathing and/or cause fluid in the lungs. This can occur even after a brief exposure.

At low concentrations, hydrogen sulfide is a respiratory irritant. Residents living near industries emitting hydrogen sulfide, such as paper mills, animal slaughter facilities, or tanneries, reported cough and/or increased visits to the hospital emergency room due to respiratory symptoms (including asthma). In general, exposure to hydrogen sulfide has not resulted in significant alterations in lung function. No alterations in lung function were observed in workers chronically exposed to 1,000 to 11,000 ppb hydrogen sulfide [ATSDR 2006; ATSDR 2014].

Some evidence, however, suggests that asthmatics are a sensitive subpopulation. Asthma symptoms may worsen in the presence of any kind of odor, including hydrogen sulfide. It is uncertain, however, whether this is a toxic effect or caused primarily by the odor.

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Although this has not been demonstrated with exposure to hydrogen sulfide, it might be reasonably anticipated due to the malodorous quality of hydrogen sulfide gas.

One controlled laboratory study of 10 adults with asthma exposed to 2,000 ppb hydrogen sulfide for 30 minutes found evidence suggesting bronchial obstruction but no statistically significant changes in lung function [Jappinen et al. 1990]. In a less controlled field study, researchers looked at children's hospital visits and hydrogen sulfide levels near a beef slaughtering facility and a leather tanning facility. They found a positive association between hospital visits for all respiratory diseases (including asthma) and an average 30-minute total reduced sulfur (hydrogen sulfide, methyl mercaptan, dimethyl sulfide, and dimethyl disulfide) concentration above 30 ppb the previous day [Campagna et al. 2004]. Although hydrogen sulfide was the primary reduced sulfur constituent, other compounds may have also caused respiratory problems.

Therefore, although high concentrations of hydrogen sulfide cause respiratory problems, it is uncertain whether the levels measured in the Wedgewood community could have caused respiratory problems, including asthma.

**Airborne Dust (Particulate Pollution)**

Landfills commonly emit dust, or particulate pollution. Because only limited data were available, FDOH could not assess whether airborne dust associated with the landfill could affect the health of the community. FDOH recommends that Escambia County measure dust levels in the future.

## Child Health Considerations

In communities faced with air, water, soil, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than adults might be for 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 adults; this means they breathe dust, soil, and vapors closer 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 system 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.

In a community setting, children are likely to be exposed to hydrogen sulfide in the same manner as adults. Very few data are available to assess if children are more sensitive to hydrogen sulfide exposure than adults [ATSDR 2006; ATSDR 2014]. Therefore, FDOH does not expect that hydrogen sulfide exposure would affect children differently than adults.

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## Limitations

Although every attempt was made to accurately assess the potential public health hazards associated with the Rolling Hills Landfill, there were limitations in the environmental data used to make this assessment. FDOH based this assessment on continuous hydrogen sulfide level data from the Wedgewood Community center between September 4, 2014 and December 31, 2014 and on discrete hydrogen sulfide measurements from several different locations between July 22, 2014 and August 27, 2014. Because hydrogen sulfide concentrations may vary greatly throughout the day and night and spatially, sampling can only be used to verify the presence or absence of hydrogen sulfide at the sampling location at the time of the measurement. Results cannot be used to determine "worst case" or "typical" exposures, as hydrogen sulfide levels are likely to vary seasonally. FDOH cannot assess the potential health effects of hydrogen sulfide exposures before the monitoring period began or exposures in areas where few or no samples were taken.

## Conclusions

FDOH reached seven conclusions about the Rolling Hills Landfill.

1. FDOH concludes that the hydrogen sulfide levels in air near the Rolling Hills Landfill between July 21 and December 31, 2014 were a public health hazard. Inhaling (breathing) the highest level of hydrogen sulfide measured near the Rolling Hills Landfill for 30 minutes could have harmed people's health. The highest level of hydrogen sulfide found in the Wedgewood community (590 parts per billion or ppb) is too close to levels known to cause headaches and nose/throat irritation (2,000 ppb) to rule out these effects.

2. FDOH concludes that the hydrogen sulfide levels in the Wedgewood community air are generally highest during the evening, night time, and early morning hours when the wind is still. Levels of hydrogen sulfide in the Wedgewood community generally decreased between July and December 2014. Hydrogen sulfide levels may, however, increase in the future with warmer temperatures, more rain, more sheetrock, reductions in landfill cover, or changes in landfill management practices.

3. FDOH cannot conclude whether breathing airborne dust (particulate matter) near the Rolling Hills Landfill could harm people's health. Airborne dust can cause breathing and heart problems, especially in the elderly, the very young, and people with asthma or heart disease. Airborne dust, however, has not been the focus of air quality monitoring near the Rolling Hills Landfill. Therefore, too little dust air monitoring data is available to evaluate the public health threat.

4. FDOH concludes that since July 2014, Wedgewood community residents have frequently been able to smell the distinct rotten egg odor of hydrogen sulfide from the Rolling Hills Landfill.

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5. FDOH concludes that that it is unclear if levels of hydrogen sulfide measured in the Wedgewood community caused eye irritation and respiratory problems.

6. FDOH concludes that the highest levels of hydrogen sulfide measured in the Wedgewood community did not likely cause heart problems, kidney problems, or cancer.

7. FDOH cannot determine the public health threat in the Wedgewood community before July 2014 or in other nearby communities. FDOH also cannot determine the health threat from pollutants other than hydrogen sulfide.

## Recommendations

FDOH recommends:

1. The landfill owners/operators manage the Rolling Hills Landfill to prevent 30-minute hydrogen sulfide levels from exceeding 70 ppb in the adjacent Wedgewood community.

2. Escambia County continue around-the-clock hydrogen sulfide air monitoring in the Wedgewood community. If odor problems arise in other nearby communities, FDOH recommends testing there also.

3. FDOH recommends that while the Rolling Hills Landfill is in operation, Escambia County monitor particulate matter air pollution. FDOH recommends the County test for airborne dust (inhalable course particulates) between 2.5 and 10 micrometers in diameter ($PM_{10}$).

# Public Health Action Plan

FDOH, with the FDOH-Escambia County and Escambia County officials, will conduct an open house to explain the findings of this health consultation.

FDOH will solicit public comment on this draft report and will address any comments and health concerns in the final report.

FDOH will consider review of new data when requested.

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## Report Preparation

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# Appendices

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# Appendix A: Tables

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**Table 1: Hydrogen Sulfide Daytime Test Locations (Discrete Monitoring)**

| Test Location | Number of Samples | Number of Days Tested | Maximum Hydrogen Sulfide Concentration (ppb) |
|---|---|---|---|
| Anita Avenue (at Vivian Drive) | 58 | 19 | 10 |
| Blossom Trail (at Field Lane) | 15 | 5 | 7 |
| 6802 Cornelius Lane | 15 | 5 | 7 |
| Longleaf C&D Facility (East Fence Line) | 3 | 1 | 5 |
| Longleaf C&D Facility (East Gate) | 15 | 5 | 6 |
| Longleaf C&D Facility (South Fence Line) | 4 | 1 | 7 |
| Longleaf C&D Facility (Southeast Corner) | 4 | 1 | 7 |
| Longleaf C&D Facility (Southwest Corner) | 4 | 1 | 8 |
| Longleaf C&D Facility (West Fence Line) | 5 | 1 | 8 |
| Longleaf C&D Facility (West Gate) | 18 | 5 | 230 |
| Longleaf C&D Facility (West Northwest Fence Line) | 4 | 1 | 7 |
| Marcus Point Grande Apartments (Creek Crossing) | 45 | 15 | 8 |
| Marcus Point Grande Apartments (Lightpost 12) | 36 | 12 | 8 |
| Marcus Point Grande Apartments (Lightpost 15) | 55 | 19 | 8 |
| 3183 Marcus Pointe Boulevard | 15 | 5 | 8 |
| Marie K Young Community Center (Exit) | 1 | 1 | 9 |
| Marie K Young Community Center (Front Door) | 48 | 16 | 25 |
| Marie K Young Community Center (Indoors) | 51 | 17 | 9 |
| Marie K Young Community Center (Parking Lot) | 65 | 21 | 10 |
| Marie K Young Community Center (Picnic Pavillion) | 66 | 22 | 10 |

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**Table 1. Hydrogen Sulfide Daytime Test Locations (Discrete Monitoring) (continued)**

| Test Location | Number of Samples | Number of Days Tested | Maximum Hydrogen Sulfide Concentration (ppb) |
|---|---|---|---|
| Marie K Young Community Center (Playground) | 48 | 16 | 9 |
| 6861 Melanie Drive | 1 | 1 | <3 |
| 7005 Melanie Drive | 1 | 1 | <3 |
| 901 W. Pinestead Road | 1 | 1 | <3 |
| Rolling Hills at Blossom Trail | 60 | 20 | 11 |
| Rolling Hills C&D Facility Northeast Corner Fenceline | 80 | 21 | 35 |
| Rolling Hills C&D Facility Northeast Fenceline | 96 | 24 | 340 |
| Rolling Hills C&D Facility Northwest Fenceline | 48 | 16 | 10 |
| 6760 Rolling Hills Road | 47 | 15 | 11 |
| 6791 Rolling Hills Road | 1 | 1 | <3 |
| 6964 Rolling Hills Road | 30 | 10 | 37 |
| 6971 Rolling Hills Road | 1 | 1 | <3 |
| Rolling Hills Road at Hampton Road | 6 | 2 | 17 |
| Rolling Hills Road at Bud Johnson Road | 48 | 12 | 24 |
| 6791 Vivian Drive | 1 | 1 | 3 |
| 6801 Vivian Drive | 1 | 1 | 5 |
| 6811 Vivian Drive | 1 | 1 | 4 |
| 6841/6852 Vivian Drive | 1 | 1 | 6 |
| 6851/6861 Vivian Drive | 1 | 1 | 5 |
| 6871/6881 Vivian Drive | 1 | 1 | 4 |
| 6404 Wagner Road | 1 | 1 | <3 |
| 6406 Wagner Road | 3 | 3 | 8 |
| 6408 Wagner Road | 6 | 6 | 7 |
| 6410 Wagner Road | 6 | 6 | 8 |
| 6412 Wagner Road | 6 | 6 | 12 |
| 6414 Wagner Road | 6 | 6 | 9 |
| 6416 Wagner Road | 6 | 6 | 6 |
| 6418 Wagner Road | 5 | 5 | 5 |

C&D = construction and demolition; ppb = parts per billion
Data source: (Escambia County, unpublished data, 2014)

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**Table 2. Summary of Continuous, Stationary Hydrogen Sulfide Test Data During Testing Between September 4, 2014 to December 31, 2014: Wedgewood Community Center**

| Total Number of Hydrogen Sulfide Measurements* | Testing Duration (hours) | 50th Percentile Concentration (ppb) | 90th Percentile Concentration (ppb) | Maximum Concentration (ppb) |
|---|---|---|---|---|
| 5,618 | 2,837.5 | 2** | 8 | 590 |

**ppb** = parts per billion

*Measurements were taken every 30 minutes; the total number of measurements taken is slightly fewer than twice the sample duration in hours because measurements at 12:30 a.m. were occasionally missing.
**The detection limit of the Jerome 631X is 3 ppb; although the instrument reports levels below the detection limit, they are less accurate than those at or above the detection limit.

Data source: (Escambia County, unpublished data, 2014)

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**Table 3. Hydrogen Sulfide Gas Concentrations Exceeding 70 ppb During Continuous Testing Between September 4 and December 31, 2014: Wedgewood Community Center**

| Test Date/Time | Hydrogen Sulfide Concentration (ppb) | Test Date/Time | Hydrogen Sulfide Concentration (ppb) |
|---|---|---|---|
| 9/9/2014 3:31 a.m. | 110 | 10/11/2014 2:30 a.m. | 230 |
| 9/15/2014 7:01 p.m. | 110 | 10/11/2014 3:00 a.m. | 77 |
| 9/16/2014 1:30 a.m. | 160 | 10/11/2014 8:31 p.m. | 109 |
| 9/16/2014 3:31 p.m. | 80 | 10/11/2014 11:30 p.m. | 120 |
| 9/18/2014 12:31 a.m. | 140 | 10/14/2014 11:30 p.m. | 130 |
| 9/18/2014 1:00 a.m. | 130 | 10/15/2014 12:00 a.m. | 112 |
| 9/18/2014 1:30 a.m. | 72 | 10/15/2014 5:30 a.m. | 260 |
| 9/18/2014 7:01 p.m. | 95 | 10/15/2014 6:00 a.m. | 230 |
| 9/21/2014 7:01 p.m. | 83 | 10/15/2014 7:30 a.m. | 250 |
| 9/22/2014 2:00 a.m. | 220 | 10/16/2014 8:31 p.m. | 104 |
| 10/3/2014 3:31 a.m. | 140 | 10/18/2014 4:30 a.m. | 590* |
| 10/3/2014 5:00 a.m. | 92 | 10/18/2014 5:00 a.m. | 290 |
| 10/5/2014 7:00 p.m. | 230 | 10/18/2014 5:30 a.m. | 76 |
| 10/5/2014 7:30 p.m. | 102 | 10/26/2014 2:01 a.m. | 120 |
| 10/5/2014 8:30 p.m. | 95 | 10/26/2014 3:31 a.m. | 94 |
| 10/6/2014 6:31 p.m. | 76 | 11/9/2014 4:01 a.m. | 84 |
| 10/6/2014 7:00 p.m. | 97 | 11/11/2014 11:01 p.m. | 108 |
| 10/6/2014 7:30 p.m. | 75 | 11/26/2014 7:01 p.m. | 89 |
| 10/7/2014 7:31 p.m. | 73 | 11/26/2014 7:30 p.m. | 230 |
| 10/9/2014 8:31 p.m. | 77 | 11/26/2014 8:00 p.m. | 119 |
| 10/9/2014 10:30 p.m. | 79 | 11/26/2014 8:30 p.m. | 96 |
| 10/10/2014 11:00 p.m. | 120 | 12/2/2014 6:01 p.m. | 99 |
| 10/10/2014 11:30 p.m. | 110 | 12/25/2014 6:00 p.m. | 140 |
| 10/11/2014 2:00 a.m. | 99 | 12/25/2014 6:30 p.m. | 95 |

**ppb** = parts per billion
*Maximum concentration measured
Data source: (Escambia County, unpublished data, 2014)

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**Table 4. Complete Human Exposure Pathways at the Rolling Hills Landfill Site**

| PATHWAY NAME | COMPLETE EXPOSURE PATHWAY ELEMENTS | | | | | TIME |
|---|---|---|---|---|---|---|
| | SOURCE | ENVIRONMENTAL MEDIA | POINT OF EXPOSURE | ROUTE OF EXPOSURE | EXPOSED POPULATION | |
| Hydrogen Sulfide Inhalation | Rolling Hills Landfill | Air | Wedgewood Community Center and other neighborhoods near the landfill | Inhalation | Nearby residents and users of community center | Past, present, and future |

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# Appendix B: Figures

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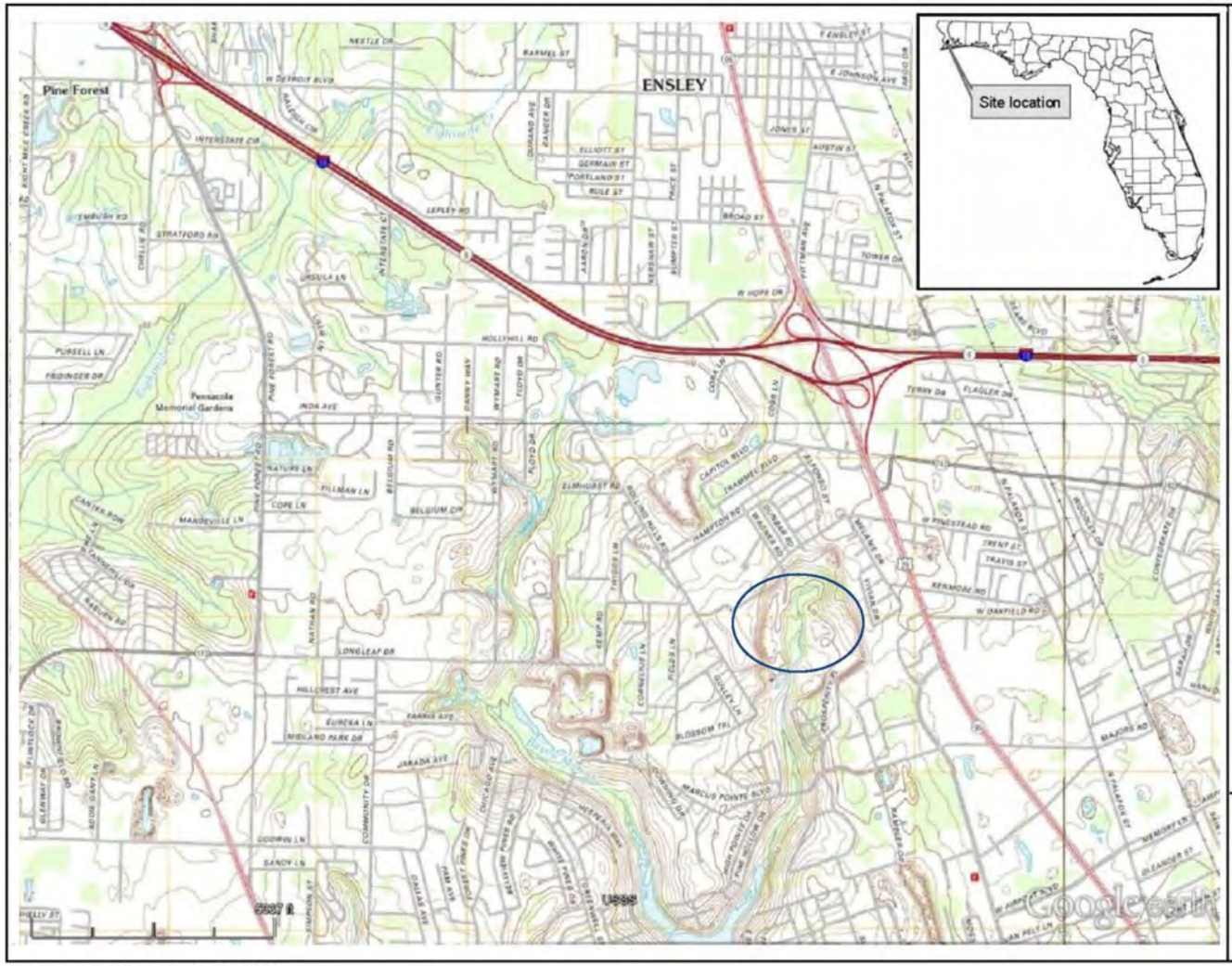



**FIGURE 1:**
**LOCATION MAP**
**ROLLING HILLS LANDFILL**

Image source:[Google Earth 2014]

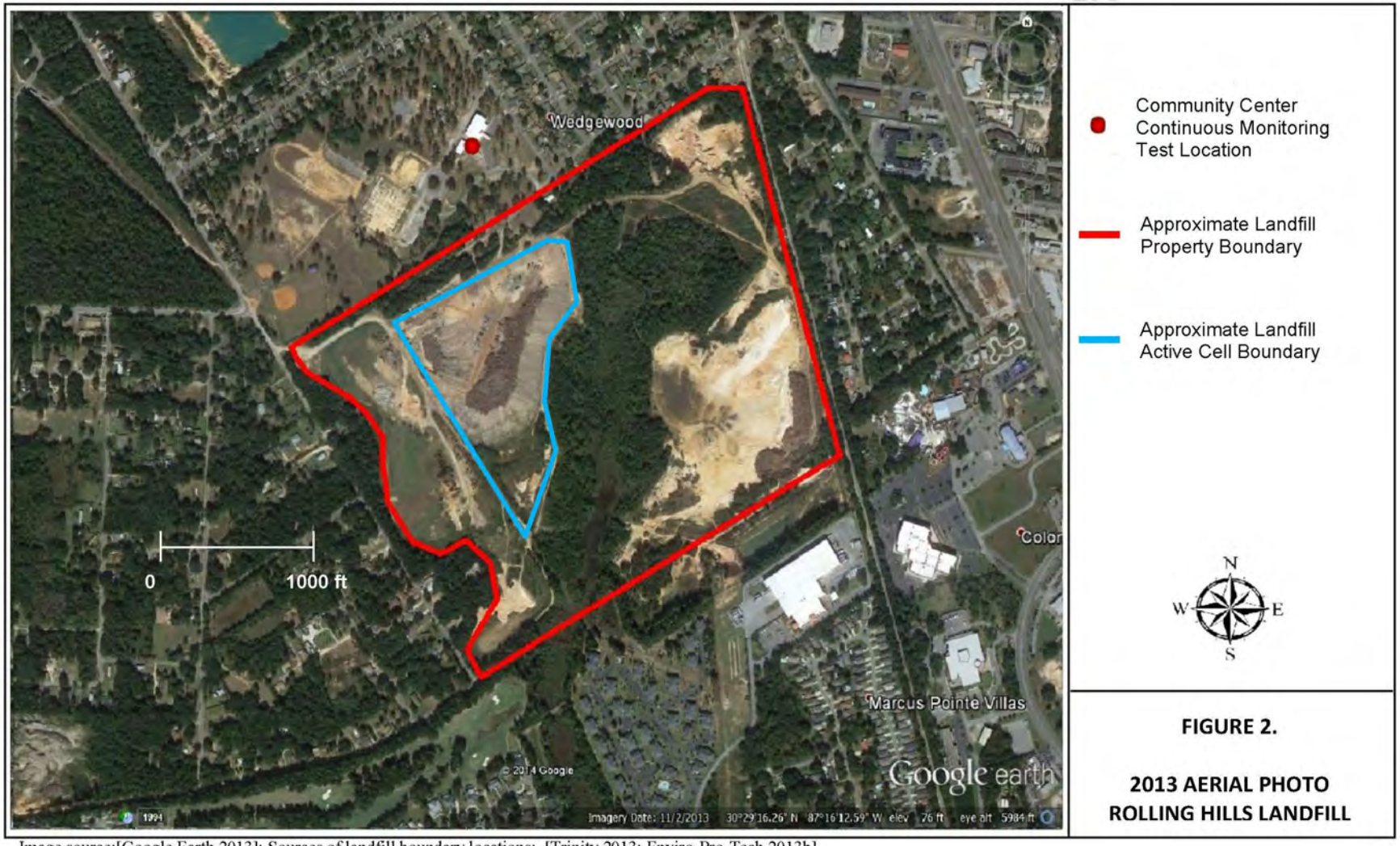
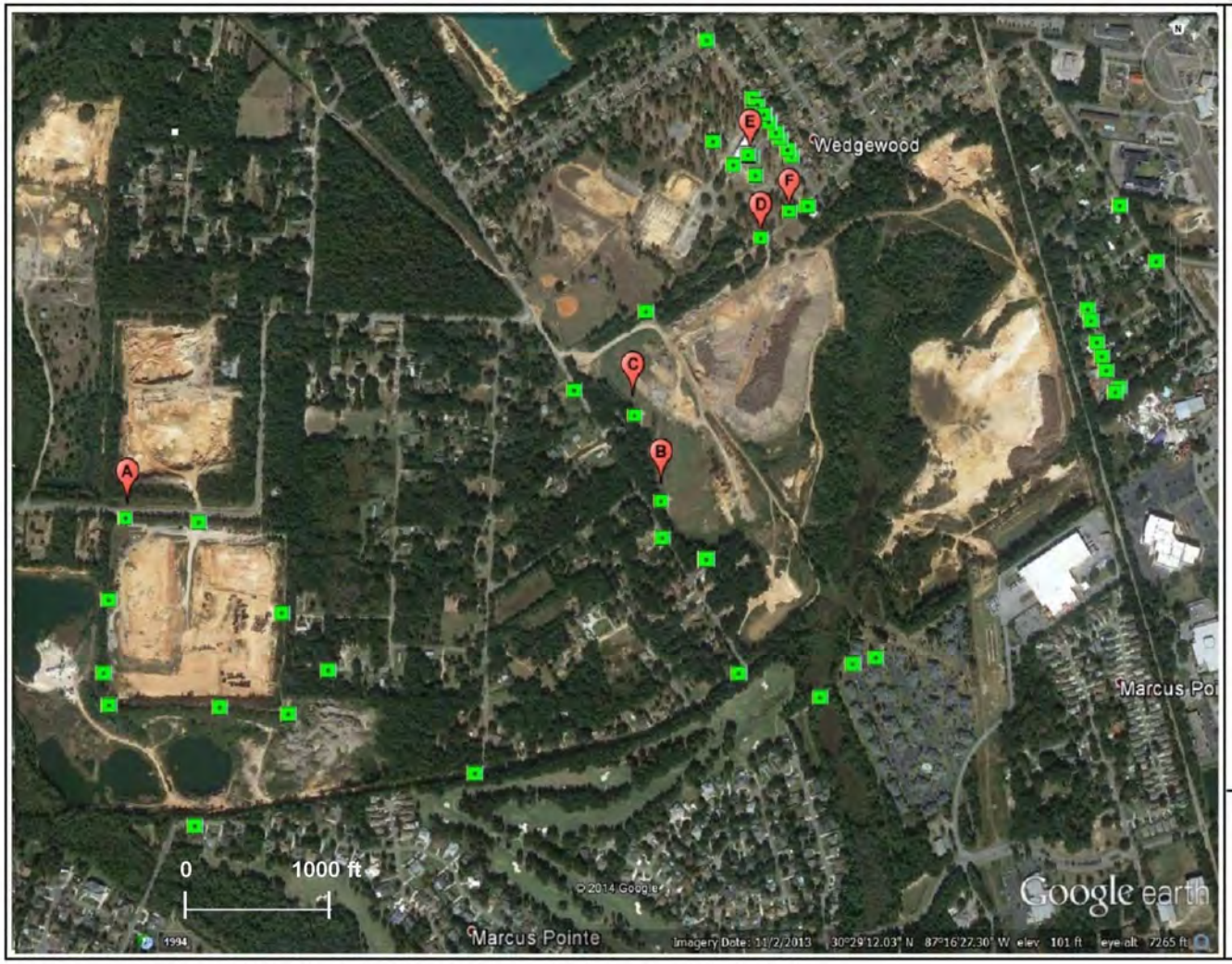



**FIGURE 2.**

**2013 AERIAL PHOTO**
**ROLLING HILLS LANDFILL**

Image source:[Google Earth 2013]; Sources of landfill boundary locations: [Trinity 2013; Enviro-Pro-Tech 2013b]




Discrete Daytime Test Location

A Longleaf Landfill (West Gate)

B Rolling Hills Road at Bud Johnson Road

C 6964 Rolling Hills Road

D Rolling Hills Landfill Northeast Fenceline

E Community Center Front Door

F Rolling Hills Landfill Northeast Corner Fenceline

N
W E
S

**FIGURE 3.**

**DISCRETE DAYTIME TEST LOCATIONS**

Image source:[Google Earth 2013]; Sample location source: (Escambia County, unpublished data, 2014)

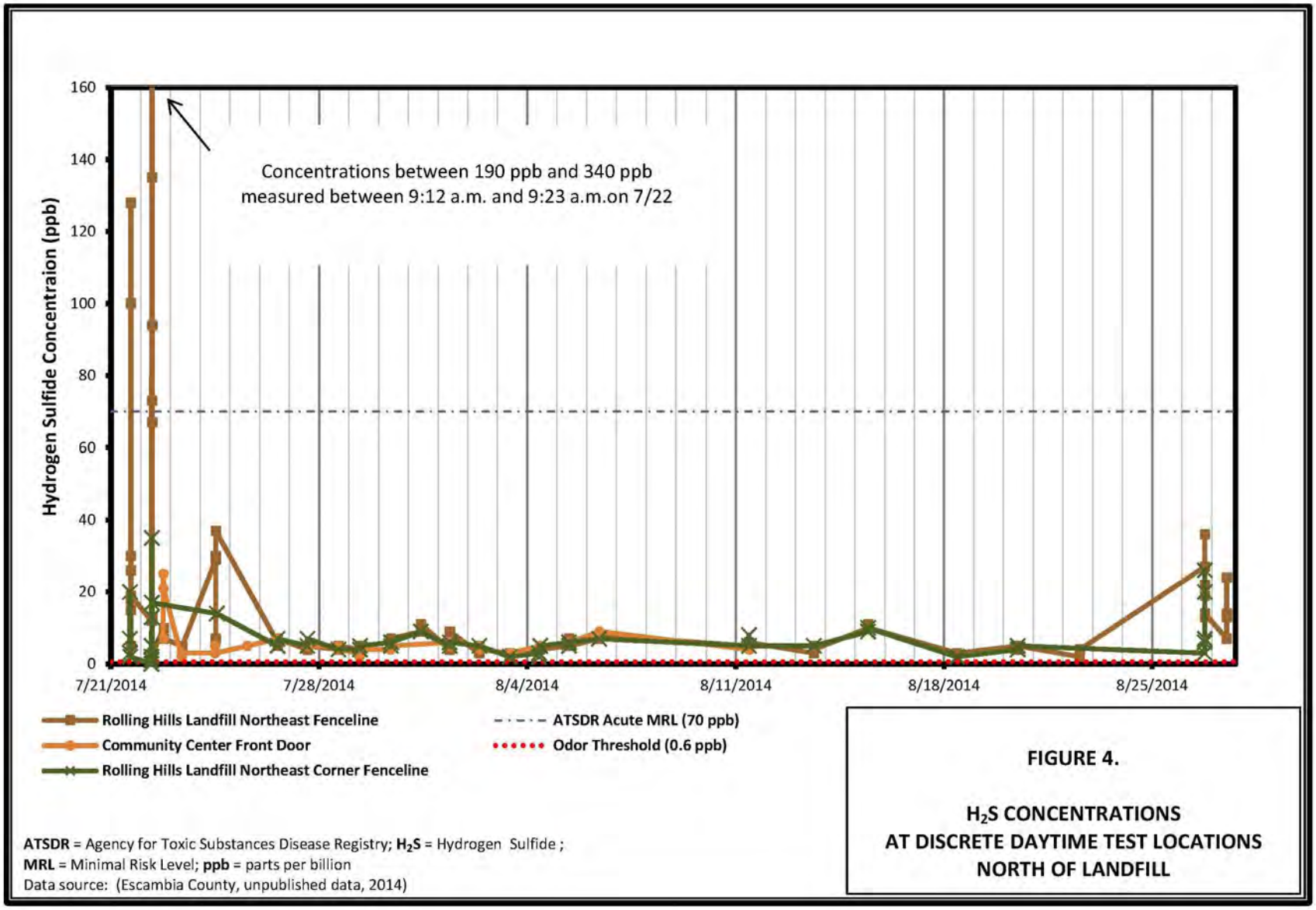
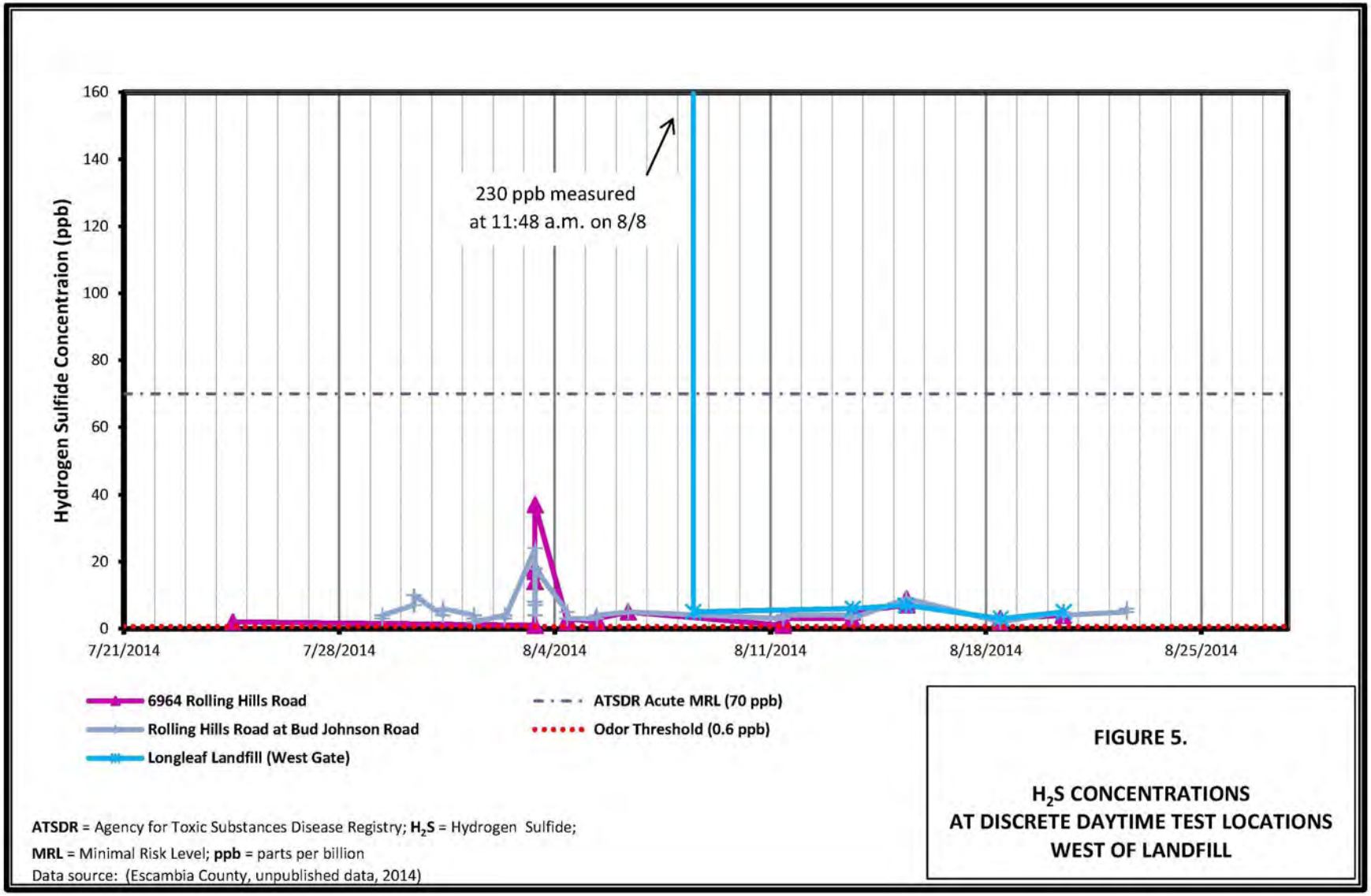



**FIGURE 4.**

**$H_2S$ CONCENTRATIONS AT DISCRETE DAYTIME TEST LOCATIONS NORTH OF LANDFILL**

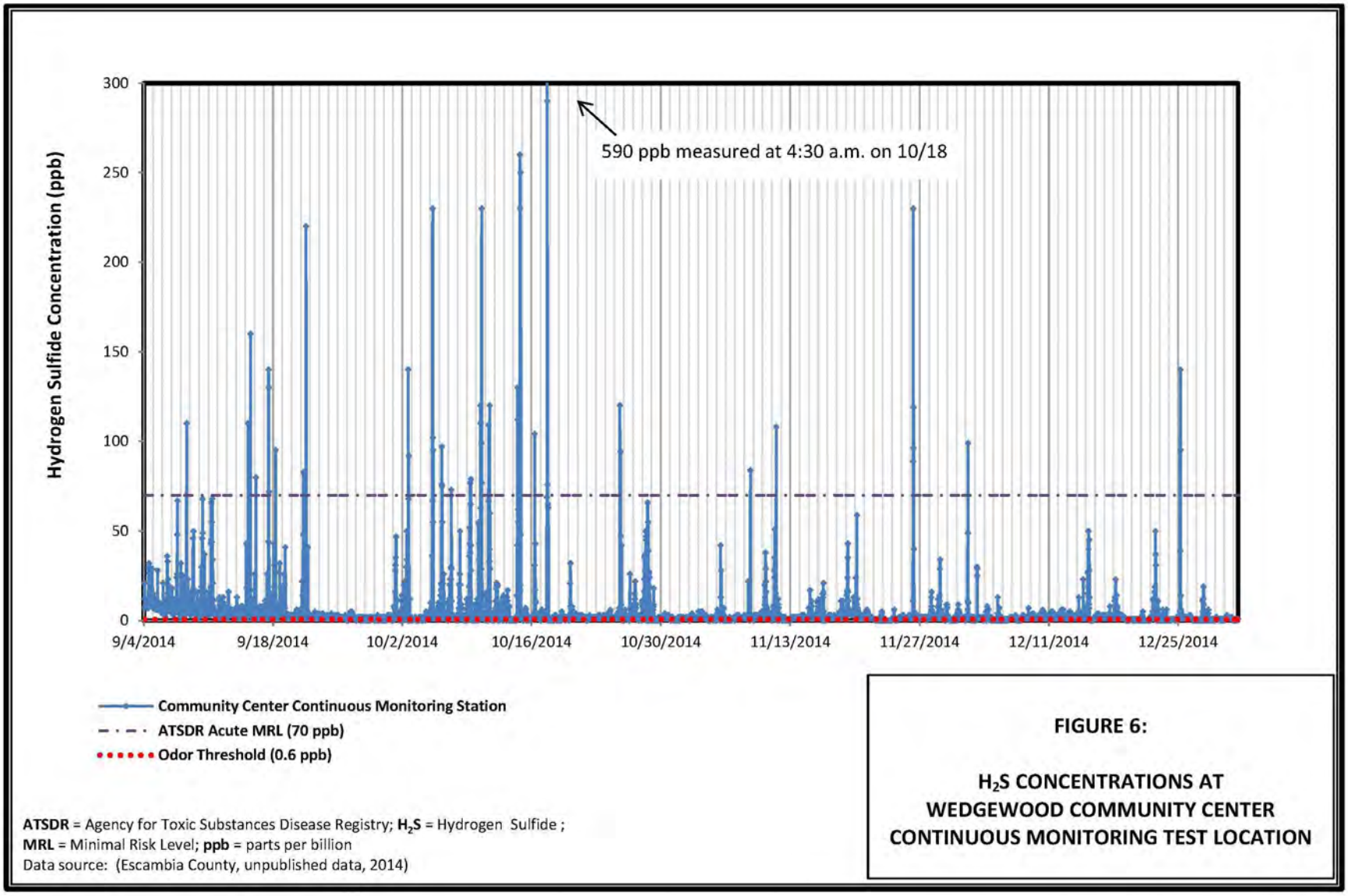
**ATSDR** = Agency for Toxic Substances Disease Registry; **$H_2S$** = Hydrogen Sulfide ;
**MRL** = Minimal Risk Level; **ppb** = parts per billion
Data source: (Escambia County, unpublished data, 2014)




**ATSDR** = Agency for Toxic Substances Disease Registry; **$H_2S$** = Hydrogen Sulfide;
**MRL** = Minimal Risk Level; **ppb** = parts per billion
Data source: (Escambia County, unpublished data, 2014)

**FIGURE 5.**

**$H_2S$ CONCENTRATIONS AT DISCRETE DAYTIME TEST LOCATIONS WEST OF LANDFILL**




**ATSDR** = Agency for Toxic Substances Disease Registry; **$H_2S$** = Hydrogen Sulfide ;
**MRL** = Minimal Risk Level; **ppb** = parts per billion
Data source: (Escambia County, unpublished data, 2014)

**FIGURE 6:**

**$H_2S$ CONCENTRATIONS AT WEDGEWOOD COMMUNITY CENTER CONTINUOUS MONITORING TEST LOCATION**

# Appendix C: Jerome® 631 X Specifications

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## 8. JEROME® 631-X TECHNICAL SPECIFICATIONS

| | |
|---|---|
| Range | 0.003ppm (3ppb) to 50ppm $H_2S$ in four graduated ranges |
| Sensitivity | 0.003ppm $H_2S$ |
| Precision | 5% relative standard deviation |
| Accuracy | Range 0: ± 0.003ppm at 0.050ppm $H_2S$<br>Range 1: ± 0.03ppm at 0.50ppm $H_2S$<br>Range 2: ± 0.3ppm at 5.0ppm $H_2S$<br>Range 3: ± 2ppm at 25ppm $H_2S$ |
| Response time-sample mode | |
| 10 to 50 ppm (Range 3) | 13 seconds |
| 1.0 to 10.0 ppm (Range 2) | 16 seconds |
| 0.10 to 1.00 ppm (Range 1) | 25 seconds |
| 0.001 to 0.100 ppm (Range 0) | 30 seconds |
| Response time-survey mode | |
| 10 to 50 ppm (Range 3) | 3 seconds |
| 1.0 to 9.9 ppm (Range 2) | 6 seconds |
| 0.10 to 0.99 ppm (Range 1) | 15 seconds |
| 0.001 to 0.099 ppm (Range 0) | 20 seconds |
| Flow rate | 150 ± 10ml/min (0.15 ± .01 liters/min) |
| Power requirements | 100-120 V~, 50/60 Hz, 1 A or 220-240 V~, 50/60 Hz, 1 A |
| Fuse | F1A 250V, 5mm X 20mm |
| Internal battery pack | Rechargeable Nickel Cadmium |
| Operating environment | 0° to 40 °C, non-condensing, non-explosive |
| Case construction | Aluminum alloy |
| Dimensions – standard model | 33 cm L x 15 cm W x 10 cm H (13" L x 6" W x 4" H) |
| Dimensions – XE model | 35 cm L x 18 cm W x 18 cm H (14" L x 7" W x 7" H) |
| Weight – standard model | 3.18 kilos (7 pounds) |
| Weight – XE model | 3.5 kilos (8 pounds) |
| Digital meter display | Liquid crystal display (LCD) |
| Certification | CE mark on 220-240 V~, 631-XE model only. |



Source: [Arizona Instrument 2014]

# Appendix D: Photographs

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Photo 1. View of Rolling Hills Landfill from Wedgewood Community Center


Photo 2. Continuous Hydrogen Sulfide Monitoring Equipment at the Community Center

# Glossary

**Acute**
Occurring over a short time [compare with **chronic**].

**Acute exposure**
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with **intermediate duration exposure** and **chronic exposure**].

**Adverse health effect**
A change in body function or cell structure that might lead to disease or health problems.

**Cancer**
Any one of a group of diseases that occurs when cells in the body become abnormal and grow or multiply out of control.

**Chronic**
Occurring over a long time (more than 1 year) [compare with **acute**].

**Chronic exposure**
Contact with a substance that occurs over a long time (more than 1 year) [compare with **acute exposure** and **intermediate duration exposure**].

**Completed exposure pathway** [see **exposure pathway**].

**Concentration**
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

**Contaminant**
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

**Detection limit**
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

**Environmental media**
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

**Environmental media and transport mechanism**
Environmental media include water, air, soil, and **biota** (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The **environmental media and transport mechanism** is the second part of an **exposure pathway**.

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**EPA**
United States Environmental Protection Agency.

**Exposure**
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [**acute exposure**], of intermediate duration, or long-term [**chronic exposure**].

**Exposure pathway**
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a **source of contamination** (such as an abandoned business); an **environmental media and transport mechanism** (such as movement through groundwater); a **point of exposure** (such as a private well); a **route of exposure** (eating, drinking, breathing, or touching), and a **receptor population** (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a **completed exposure pathway**.

**Hazardous waste**
Potentially harmful substances that have been released or discarded into the environment.

**Health consultation**
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical.

**Inhalation**
The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**].

**Intermediate duration exposure**
Contact with a substance that occurs for more than 14 days and less than a year [compare with **acute exposure** and **chronic exposure**].

**Lowest-observed-adverse-effect level (LOAEL)**
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

**Minimal risk level (MRL)**
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral)

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over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see **reference dose**].

**No-observed-adverse-effect level (NOAEL)**
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

**Point of exposure**
The place where someone can come into contact with a substance present in the environment [see **exposure pathway**].

**Population**
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

**ppb**
Parts per billion.

**ppm**
Parts per million.

**Public health action**
A list of steps to protect public health.

**Public health advisory**
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

**Public health statement**
The first chapter of an ATSDR **toxicological profile**. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

**Public meeting**
A public forum with community members for communication about a site.

**Receptor population**
People who could come into contact with hazardous substances [see **exposure pathway**].

**Registry**
A systematic collection of information on persons exposed to a specific substance or having specific diseases.

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**Risk**
The probability that something will cause injury or harm.

**Route of exposure**
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [**inhalation**], eating or drinking [**ingestion**], or contact with the skin [**dermal contact**].

**Safety factor [**see **uncertainty factor]**

**Sample**
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

**Special populations**
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

**Stakeholder**
A person, group, or community who has an interest in activities at a hazardous waste site.

**Substance**
A chemical.

**Toxicological profile**
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

**Toxicology**
The study of the harmful effects of substances on humans or animals.

**Tumor**
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

**Uncertainty factor**
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-

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observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a **safety factor**].

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