Health Consultation

COAL FLY ASH LANDSLIDE

FORWARD TOWNSHIP, ALLEGHENY COUNTY, PENNSYLVANIA

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
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Health Consultation: A Note of Explanation

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

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

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HEALTH CONSULTATION

COAL FLY ASH LANDSLIDE

FORWARD TOWNSHIP, ALLEGHENY COUNTY, PENNSYLVANIA

Prepared by:

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Table of Contents

List of Tables and Figures

1.0 Statement of Issues

On January 25, 2005, thousands of tons of fly ash slid down a hillside and flowed into a creek and through a neighborhood located on Rostosky Ridge Road in Forward Township, Allegheny County, Pennsylvania. Approximately nine homes, a business (restaurant), and a mile of the creek were directly impacted by the landslide, which deposited large piles of fly ash in residential yards, flower beds, culverts, play areas, and around garages and houses and along the creek banks. In response, more than 1,000 tons of fly ash were removed from residential properties, roadways, culverts, and creek banks. Following the landslide, residents stated that they were ill with a variety of flu-like symptoms, including sore throat, cough, fever, nausea, fatigue, diarrhea, and headaches.

In February 2005, the Agency for Toxic Substances and Disease Registry (ATSDR) received a petition for a public health evaluation of the fly ash landslide (Petition Letter 2005). In March 2005, ATSDR conducted a preliminary review of available data, which included an evaluation of limited samples of air and fly ash. Of particular concern were the pH (potential for hydrogen), particulate matter, and arsenic levels measured in the fly ash. On the basis of this preliminary review, ATSDR classified the landslide site as a potential health hazard and made several recommendations, among which were removal of the remaining fly ash from the affected neighborhood and post-removal confirmatory sampling (ATSDR 2005a). ATSDR agreed to complete a formal written health consultation evaluating all available data following the post-removal confirmatory sampling. In this written health consultation, ATSDR focuses on determining whether exposures to fly ash, air, surface water, and surface soil in the affected neighborhood on Rostosky Ridge Road could result in harmful health effects.

2.0 Background

During the 1940s and 1950s, several thousand tons of fly ash were deposited in Forward Township near a neighborhood on Rostosky Ridge Road. Although the source of the fly ash is unknown, it is most likely a byproduct from the combustion of coal in an electric generating plant. Fly ash is made of very fine particles that are spherical in shape. Typically, the particles consist of silicon dioxide (SiO_2), aluminum oxide (Al_2O_3), and iron oxide (Fe_2O_3). Fly ash also contains metals, including arsenic (EPA 2005).

On January 25, 2005, a large portion of the fly ash slid into the channel of Perry Mills Run Creek, which flows through a neighborhood located on Rostosky Ridge Road and into the Monongahela River (Figure 1). The landslide created a fly ash water slurry that filled the creek bed and overflowed onto Rostosky Ridge Road and into the yards of nearby residences. By January 26, a half-acre lake had formed behind the dam created by the fly ash. In an immediate response action, the Pennsylvania Department of Environmental Protection (PADEP) relocated the creek channel to prevent undercutting the fly ash dam, which could have resulted in further releases of fly ash material into the neighborhood (PADEP 2006a).

During the first week after the landslide, residents used township equipment to remove some of the fly ash from driveways, walkways, parking lots, and roadways (PADEP 2006b). An uncovered dump truck transported the fly ash to a nearby ball field. The local fire department helped with wetting the streets to keep down dust levels.

Following this initial removal effort, PADEP contracted to remove the fly ash from the affected neighborhood yards, roadways, creek banks, and ball field. When feasible, the PADEP contractor removed the fly ash with a vacuum truck and small equipment such as skid-loaders, mini-excavators, and backhoes. Hand tools such as rakes, shovels, and hoes were also used to remove the fly ash. The affected areas near the creek banks and culverts were flushed with water, allowing the fly ash deposits to enter the creek water (PADEP 2005m). Confirmation of fly ash removal from the yards and creek banks by PADEP included a visual inspection without confirmatory sampling and analysis (ATSDR 2006a, PADEP 2006b, PADEP 2006c).

An environmental services company, engaged by the legal counsel representing the affected residents, performed site visits throughout the cleanup effort (NES 2005a). This environmental services company opines that the overall cleanup effort was mismanaged, ineffective, and incomplete (NES 2005a). In a recent letter to ATSDR, the legal counsel reported that fly ash is still visible on the residential properties, in the creek bed, and in the top soil (Villari, Brandes & Kline, PC. 2006). Moreover, ATSDR staff who visited the affected area during removal efforts (March 2005 and April 2005) noted visual remnants of fly ash contamination in the yards, culverts, and along the creek banks. During a March 2006 visit, ATSDR staff noted visual evidence of fly ash in the culverts and creek bed (ATSDR 2006b).

In addition, the landslide resulted in the original fly ash area having a 40 to 50 foot high steep slope of questionable stability. Because the original fly ash area’s current condition poses the likelihood that another fly ash landslide will occur, PADEP is proposing the removal and off-site disposal of the original fly ash deposit and the stabilization of the slope (PADEP 2006a).

3.0 Discussion

In this section, ATSDR addresses the question of whether exposure to fly ash contamination in the affected neighborhood on Rostosky Ridge Road could result in harmful health effects. Although the relative toxicity of a chemical is important, the human body’s response to a chemical exposure is determined by several additional factors, among which are

- the concentration (how much) of the chemical to which the person was exposed,
- the amount of time the person was exposed (how long), and
- the way the person was exposed (through breathing, eating, drinking, or direct contact with something containing the chemical).

Lifestyle factors such as occupation and personal habits have a major impact on the likelihood, magnitude, and duration of exposure. Individual characteristics such as age, sex, nutritional status, overall health, and genetic constitution affect how the human body absorbs, distributes, metabolizes, and eliminates a contaminant. A unique combination of all these factors will determine the individual's physiologic response to a chemical contaminant and any harmful health effects, if any, that the individual could experience as a result of the chemical exposure.

As an initial screen, ATSDR reviewed fly ash, air, surface water, and surface soil data to determine whether the maximum detected chemical concentrations were above each chemical's protective health-based comparison values (CVs). Health-based CVs are estimates of daily human exposure to a chemical that is not likely to result in harmful health effects over a specified duration of exposure. ATSDR CVs are developed for specific environmental media (air, water, and soil) and for specific durations of exposure (acute [≤14 days], intermediate [15–364 days], and chronic [≥365 days]).

This initial screen also identifies those chemicals with no CVs. As an additional step, ATSDR may research whether the chemicals were detected at levels typically found in the environment (i.e., their background concentrations) and whether those background levels are considered safe. In addition, many chemicals found in the environment are necessary for maintaining good health and are not considered toxic at low levels. ATSDR usually will not conduct an in-depth, site-specific chemical evaluation in these instances. However, ATSDR will conduct a site-specific evaluation for chemicals with no CVs if any possibility exists that an adverse health effect could occur for any segment of the population.

Some of the CVs and health guidelines used by ATSDR scientists include ATSDR's cancer risk evaluation guides (CREGs), environmental media evaluation guides (EMEGs), and minimal risk levels (MRLs). If an ATSDR CV is not available for a particular chemical, ATSDR will screen environmental data with CVs developed by other sources such as the Environmental Protection Agency (EPA). These CVs and health guidelines, as well as all other health-based screening criteria, represent conservative levels of safety, not thresholds of toxicity. Although concentrations at or below a CV may reasonably be considered safe, concentrations above a CV will not necessarily be harmful. To ensure that even the most sensitive populations, such as children and the elderly, are protected, CVs are intentionally designed to be much lower, usually by two or three orders of magnitude, than the corresponding no-observed-adverse-effect-levels (NOAELs) or lowest-observed-adverse-effect-levels (LOAELs) on which the CVs were based. Most NOAELs and LOAELs are established in laboratory animals; relatively few are derived from epidemiologic (chiefly occupational) studies. All ATSDR health-based CVs are non-enforceable and are used for screening purposes only.

ATSDR selects chemicals for further consideration if their maximum concentrations exceed those of a CV. When a chemical exceeds its CV, ATSDR begins a process that includes several steps. The first step in understanding the public health significance of exceeding the CV of a chemical is to review and understand the basis for that chemical's guideline. Two key steps in this analysis of the guideline involve (1) comparing site-specific exposure doses to observed effect levels reported in critical studies and (2) carefully considering study parameters in the context of site exposures (ATSDR 2005b). The following text describes ATSDR's analysis of the fly ash landslide site.

3.1 Environmental Data Evaluation

Following the January 2005 fly ash landslide, only limited sampling occurred (See Section 3.3, "Data Quality," for information on the quality of all data reviewed in this health consultation.). Fly ash samples were collected from residential yards and creek banks, air samples were collected from one residential yard, and a few creek water samples were collected from downstream and upstream locations. Following the removal of the initial bulk fly ash in January and February 2005 and the removal of residual fly ash in April and May 2005, an environmental services company engaged by legal counsel representing the affected residents collected confirmatory surface soil samples from residential yards and analyzed the samples for arsenic. In this section, ATSDR also discusses the interior samples that were collected from residential homes and analyzed for arsenic.

Following the landslide, residents living in the affected neighborhood and visitors to the neighborhood were exposed to fly ash contamination on the ground, in the air, in the homes, and along the creek. Residents and visitors are still being exposed to remnants of fly ash contamination that remain in the yards and culverts and on creek banks. In the following sections, ATSDR evaluates exposure routes (dermal contact, inhalation, and ingestion) and the site-specific environmental data with respect to available health guidelines and available data on levels known to cause harmful health effects in animals and humans.

3.1.1 Fly Ash

Fly ash material was deposited throughout a neighborhood located on Rostosky Ridge Road following a fly ash landslide. Adults who participated in activities such as shoveling and removing the fly ash from yards, driveways, and walkways were in direct contact with the fly ash. Adults and children who engaged in activities such as playing, gardening, and walking in the affected neighborhood were also exposed to the fly ash.

On January 26, 2005, a citizen's group collected a residential fly ash sample and had it analyzed at a state accredited laboratory (GLA Laboratories 2005a). On January 27, 2005, PADEP collected four fly ash samples from the affected neighborhood (PADEP 2005c, PADEP 2005d, PADEP 2005e, PADEP 2005f). On February 9, 2005, PADEP collected another four fly ash samples (PADEP 2005g, PADEP 2005h, PADEP 2005i, PADEP 2005j). Table 1 contains the analysis results for these fly ash samples.

On March 28, 2005, six samples were collected from fly ash deposits near the creek channel and were analyzed only for arsenic and pH (ACHD 2005). The arsenic levels ranged from 174 milligrams per kilogram (mg/kg) to 206 mg/kg and the pH levels ranged from 8.81 to 9.27.

ATSDR does not have CVs for fly ash material. Instead, ATSDR screened the fly ash data using available health-based CVs for soil exposures. Most chemicals at the landslide site were detected at levels below both the ATSDR soil CVs for child and adult exposures and the EPA Region III soil CVs for residential exposure. As stated previously, chemical concentrations at or below a CV may reasonably be considered safe. Of note, ATSDR does not have soil CVs for calcium, iron, magnesium, potassium, and sodium because these chemicals have low toxicity and are essential elements for maintaining good health.

All arsenic levels exceed ATSDR’s acute EMEG. In the following text, ATSDR discusses the public health implications of exposure to arsenic as well as exposure to elevated pH levels in the fly ash.

Table 1: Fly Ash Sampling Data

Chemical	PADEP Sample Concentration Range (mg/kg)	Citizen's Group Sample Concentration (mg/kg)
Aluminum	17,251 – 29,478	15,000
Antimony	ND – 3.35	ND
Arsenic	143 – 268	170
Barium	234 – 580	--
Beryllium	ND – 2.65	1.1
Cadmium	0.886 – 1.47	1.9
Calcium	1,518 – 24,706	--
Chromium	35.1 – 58.5	33
Cobalt	13.9 – 27.2	--
Copper	20.2 – 32	7.5
Iron	21,546 – 85,240	28,000
Lead	13 – 20.5	23
Magnesium	1,773 – 3,339	--
Manganese	142 – 756	--
Mercury	ND – 0.157	0.219
Nickel	25.5 – 54.5	16
Potassium	1,518 – 2,654	--
Selenium	ND – 5.8	ND
Silicon	--	734
Silver	ND – 6.62	ND
Sodium	351 – 852	--
Thallium	2.2 – 3.09	1.7
Vanadium	79.8 – 117	--
Zinc	29.1 – 79.7	43
pH	8.54 – 9.86	9.56

mg/kg milligrams/kilogram
ND not detected
PADEP Pennsylvania Department of Environmental Protection
-- not reported

Arsenic

Arsenic occurs naturally in soil and minerals. People normally take in small amounts of arsenic in air, water, soil, and food. Of these, food is usually the most common source of arsenic for people (ATSDR 2005c). Fly ash from coal-fired power plants and incinerators often contains arsenic.

Current understanding of arsenic's toxicology suggests that at low-level exposures, arsenic compounds are detoxified—that is, changed into less harmful forms—and then excreted in the urine. At higher-level exposures, however, the body may not have the ability to detoxify the increased amount of arsenic. When this overload happens, blood levels of arsenic increase and adverse health effects may occur. Arsenic, like some other chemicals, does not seem to cause adverse health effects until a certain amount, or threshold, of the chemical has entered the body. Once the threshold, also known as the minimal effective dose, is reached, and the body is no longer able to detoxify arsenic compounds, adverse health effects may result. (ATSDR 2005c).

The primary exposure route of concern for arsenic in fly ash is ingestion (oral exposure). This ingestion could occur by the inadvertent consumption of fly ash on hands or food items, mouthing of objects, or intentional ingestion (pica behavior[1]). Arsenic contact with skin is not expected to cause harm because arsenic is not readily absorbed through the skin (ATSDR 2005c). Although fly ash can be inhaled, one study in the scientific literature reported that approximately 90% of the arsenic-containing particles in airborne coal fly ash from a coal-fired power plant were ≥3.5 microns in size (ATSDR 2005c). The petition letter to ATSDR reported that the fly ash was tested for particle size and that the ash contained a significant portion of fine particles (22% were below 10 microns) (Petition Letter 2005). Airborne exposures to arsenic and particulate matter are discussed in the "Air" section of this document (see Section 3.1.2).

For this health consultation, ATSDR derived exposure doses for adults and children using a range of fly ash ingestion values. Exposure doses help determine the extent to which ingesting fly ash might be associated with harmful health effects. ATSDR then compared the doses to its arsenic acute MRL, the estimate of daily human exposure to arsenic levels that is not likely to be associated with any appreciable risk of non-cancer health effects over a specified duration of exposure.

Estimating an exposure dose requires identifying how much, how often, and how long a person may come in contact with some concentration of the contaminant in a specific medium (air, water, soil). The equation and assumptions used to estimate exposure doses from ingesting fly ash follow.

Exhibit 1: Exposure Dose Equation for Ingestion

$$D = \frac{C \times IR \times EF \times CF}{BW}$$

where,

D	=	exposure dose in milligrams per kilogram per day (mg/kg/day)
C	=	chemical concentration in milligrams per kilogram (mg/kg)
IR	=	intake rate in milligrams per day (mg/day)
EF	=	exposure factor (unitless)
CF	=	conversion factor, 1×10^{-6} kilograms/milligram (kg/mg)
BW	=	body weight in kilograms (kg)

In the absence of complete exposure-specific information, ATSDR applied several conservative exposure assumptions to define site-specific arsenic exposures as accurately as possible. Specifically, ATSDR estimated arsenic exposure doses using the following assumptions and default intake rates for exposure through ingestion:

[1] Pica behavior refers to the intentional ingestion of non-food items. Groups that are at an increased risk for pica behavior are children aged 1–3 years old.

- The maximum detected concentration of arsenic (268 mg/kg) was assumed to be representative of arsenic levels in fly ash. Of note, almost all arsenic concentrations were greater than 200 mg/kg in fly ash.
- Fly ash intake rates for an adult were assumed to be 100 mg/day and 2,000 mg/day for a contact-intense activity such as shoveling fly ash.
- Fly ash intake rates for a child were assumed to be 200 mg/day and 5,000 mg/day for a child exhibiting pica behavior.
- The exposure factor was assumed to be 1, representing daily exposure to arsenic for several months (late January through May 2005 when removal actions were ongoing).
- The body weight of an adult was assumed to be 70 kg and a child was assumed to be 16 kg.
- The bioavailability of arsenic was assumed to be 100%—that is, all of the arsenic in fly ash that a person ingests is assumed to enter the bloodstream.

ATSDR, on the basis of these conservative assumptions, derived estimated exposure doses. The estimated doses are listed in Table 2.

Table 2: Estimated Doses of Arsenic Contaminated-Fly Ash

Population	Soil Intake (mg/day)	Estimated Dose (mg/kg/day)
Adults	100	0.0004
	2,000	0.008
Children	200	0.003
	5,000	0.08

mg milligram
kg kilogram

ATSDR reviewed the scientific literature on arsenic to evaluate whether non-cancer adverse health effects would be likely to occur at the estimated doses. ATSDR developed a provisional acute oral MRL for arsenic of 0.005 mg/kg/day. This MRL is based on several transient (i.e., temporary) effects that could occur from acute exposures (≤14 days). Acute exposure to arsenic can cause irritation to the stomach and intestines, with symptoms such as pain, nausea, vomiting, and diarrhea. When an estimated acute dose of arsenic is below 0.005 mg/kg/day, these non-cancerous harmful effects are unlikely. It should be noted that the acute MRL is 10 times below the levels that are known to cause these harmful effects. In addition, the acute MRL is based on studies of people being exposed to arsenic dissolved in water instead of arsenic in fly ash—a fact that might influence how much arsenic can be absorbed. Based on ATSDR’s conservative assumptions, the estimated doses for adults who were not engaged in contact-intense activities and for children who do not exhibit pica behavior are currently below the ATSDR acute MRL. Therefore, these populations are unlikely to have experienced acute non-cancerous harmful effects due to past arsenic exposures.

The estimated doses, however, do exceed the ATSDR acute MRL for adults who engaged in contact-intense activities such as shoveling fly ash and for children who exhibited pica behavior. ATSDR considers it plausible that adults could have experienced transient adverse harmful effects from exposure to arsenic during past contact-intense activities. ATSDR also considers it plausible that sensitive populations, such as children who eat non-food items, could also have received doses that caused temporary harmful effects. The exposure conditions changed, however, with the removal of the majority of fly ash from the affected neighborhood. Current ingestion exposures to arsenic are discussed in the surface soil section of this health consultation (see Section 3.1.4).

pH

The initials pH stand for "Potential of Hydrogen." The pH scale, which ranges from 0 to 14, measures how acidic or basic (alkaline) a substance is. A pH of 7 is neutral, a pH less than 7 is acidic, and a pH greater than 7 is alkaline. Each whole pH value below 7 is ten times more acidic than the next higher value. For example, a pH of 4 is ten times more acidic than a pH of 5 and 100 times (10 times 10) more acidic than a pH of 6. The same holds true for pH values above 7, each of which is ten times more alkaline than the next lower whole value. For example, a pH of 9 is ten times more alkaline than a pH of 8 and 100 times (10 times 10) more alkaline than a pH of 7. A substance with a pH that is either too high or too low can have irritant effects.

The fly ash samples contained levels of pH in the alkaline range (8.54–9.86). Dermal contact, inhalation, and ingestion of fly ash with these pH levels, combined with exposure to other dermal and respiratory irritants in the fly ash, could have resulted in acute, short-term irritant effects at the time of the landslide and during the clean-up efforts. Now, as a result of most of the fly ash having been removed from the affected neighborhood, current pH levels are most likely not of public health concern. ATSDR cannot make, however, conclusive statements about current exposures because confirmatory data on pH levels are not available.

3.1.2 Air

Residents living in the affected neighborhood and visitors to the neighborhood were exposed to fly ash in the air following the fly ash landslide, particularly during cleanup efforts. Residents were not informed that the use of personal protective equipment (PPE) such as dust masks would have helped reduce the inhalation of the fine fly ash particles. Therefore, residents, without wearing PPE, moved fly ash from their yards to the street. Inhalation of small fly ash particles may continue if remnants of the fly ash contamination still present in the yards, culverts, and creek banks become airborne during periods of little or no precipitation.

The Allegheny County Health Department (ACHD) conducted limited ambient (outdoor) air sampling at one residence located on Rostosky Ridge Road. The monitoring schedule called for 24-hour average air samples to be collected at this location once every three days and analyzed for arsenic. ACHD collected the first sample on February 12, 2005, and the last on August 23, 2005. From February 12–21, 2005, these air samples were also analyzed for copper, chromium, lead, and zinc. In addition, ACDH monitored particulate matter less than 10 microns in diameter (PM_{10}) at this residence once every 6 days from March 29–April 28, 2005, and from June 3–27, 2005. Of note, PADEP completed fly ash removal efforts in May 2005.

ATSDR notes that these air data do not necessarily represent measurements collected during peak exposure periods, such as during the time that residents were shoveling and removing fly ash from their yards or during the time that fly ash was disturbed during PADEP removal activities. ATSDR also notes that airborne fly ash particles and low levels of some chemicals in the air may exacerbate respiratory symptoms in sensitive individuals (EPA 2006b, EPA 2006c). The term “sensitive individuals,” for the purpose of this health consultation, refers to those individuals with pre-existing respiratory conditions that lead to any kind of compromised lung function, including asthma, emphysema, influenza, and chronic bronchitis. The term also refers to those with allergic reactions to certain chemicals. Sensitive individuals with allergic reactions do not exhibit the same relatively predictable dose-response behaviors that non-allergic individuals do. Other factors may also affect respiratory health. For example, cold air and warm humid air can aggravate respiratory ailments in sensitive individuals (EPA 2000, EPA 2004).

ATSDR reviewed the detected levels of arsenic, copper, chromium, lead, particulate matter, and zinc in outdoor air, but ATSDR does not have air CVs for copper, lead, and zinc. However, ACHD detected these three metals in the air well below levels considered safe for worker exposure. Levels that are considered safe for worker exposure may not be protective of sensitive individuals such as children, the elderly, and individuals with compromised health. ATSDR notes that ACHD detected these metals at levels typically found in rural areas of the United States (ATSDR 2004, ATSDR 2005d, ATSDR 2005e). Although the copper, lead, and zinc levels detected in the four air samples collected from the one residential yard may not represent peak exposure periods, for this health consultation, ATSDR assumed that the levels are representative of everyday, typical chronic exposure conditions. As such, ATSDR does not consider the levels of copper, lead, and zinc in the air to be harmful.

The detected levels of arsenic and chromium exceeded their respective ATSDR CREGs. In the following text, ATSDR discusses the arsenic, chromium, and particulate matter levels that ACHD detected in the air samples collected from the front yard of one residence on Rostosky Ridge Road.

Arsenic

Because arsenic occurs naturally in soil and minerals, people normally take in small amounts in air, water, soil, and food. Mean levels in ambient air in the U.S. have been reported to range from less than 0.001 to 0.003 micrograms per cubic meter (μg/m^3) in remote areas and from 0.02 to 0.03 μg/m^3 in urban areas (ATSDR 2005c). One study in the scientific literature reported that approximately 90% of the arsenic-containing particles in airborne coal fly ash from a coal-fired power plant were ≥3.5 microns in size (ATSDR 2005c). The petition letter reported that the fly ash was tested for particle size and that it contained a significant portion of fine particles (22% were below 10 microns) (Petition Letter 2005).

ACHD detected arsenic in all but two air samples. All detections exceeded the arsenic CREG of 0.0002 μg/m^3 for continuous lifetime exposure to arsenic in ambient air. ATSDR has no non-cancer CVs for arsenic in air. The maximum concentration (0.022 μg/m^3) was detected on April 19, 2005, during a period with no precipitation. Setting the two samples that did not detect arsenic at the detection limit, the average arsenic concentration was 0.0032 μg/m^3, and the median was 0.002 μg/m^3. The average and median arsenic levels are not elevated compared with mean arsenic levels in ambient air in remote areas of the U.S. (0.001–0.003 μg/m^3). Although the maximum concentration is elevated when compared with remote areas, it is not elevated when compared with mean levels reported in urban areas (0.02–0.03 μg/m^3).

The lowest reported human inhalation cancer effect level (CEL) is 50 µg/m^3 for lung cancer in workers at a copper smelter who were exposed to inorganic arsenic in air for 3 months to 30 years (ATSDR 2005c). The concentrations of arsenic detected in the outdoor air samples are well below all human inhalation NOAELs, LOAELs and CELs reported for inorganic arsenic in ATSDR's 2000 Toxicological Profile. On the basis of the available air data from this one residential yard, ATSDR considers that the arsenic levels detected in outdoor air are not likely to result in harmful health effects.

Chromium (Total)

Chromium is present in the environment in several different forms. The most common forms are chromium(0), chromium(III), and chromium(VI). No taste or odor is associated with chromium compounds. Chromium(III) is an essential nutrient, but Chromium(VI) and chromium(0) are usually produced by industrial processes. Breathing in high levels of chromium(VI), such as those in a compound known as chromic acid or chromium(VI) trioxide, can cause irritation to the nose, and long-term exposure to chromium(VI) has been associated with lung cancer in workers (ATSDR 2000).

In February 2005, ACHD collected and analyzed four air samples for total chromium. The chromium levels ranged from 0.0026 µg/m^3 to 0.0048 µg/m^3. Typical U.S. atmospheric levels of total chromium are <0.010 µg/m^3 in rural areas and 0.01 to 0.03 µg/m^3 in urban areas. (ATSDR 2000).

Chromium(VI) has been detected in fly ash from coal-fired power plants (ATSDR 2000). As a conservative measure, ATSDR assumed the total chromium detected in the outdoor air was 100% chromium(VI). There are three non-cancer CVs for chromium(VI) in air. ATSDR's only non-cancer CV for chromium(VI) in air is an intermediate EMEG of 1 µg/m^3. The maximum concentration of total chromium detected (0.0048 µg/m^3) is less than this EMEG. Furthermore, the maximum chromium level is below the EPA reference concentration (RfC) for chromium(VI) of 0.008 µg/m^3 as chromic acid mist or dissolved aerosol and below the EPA RfC of 0.1 µg/m^3 for particulate chromium(VI). As stated previously, chemical concentrations at or below a CV may reasonably be considered safe.

All four detections of total chromium exceeded the ATSDR CREG of 0.00008 µg/m^3 for chromium(VI). Long-term exposure of workers to chromium(VI) at levels above 40 µg/m^3 has been associated with lung cancer. This level is much higher than the levels found in the air samples collected in the residential yard near the landslide site (ATSDR 2000). Breathing in small amounts of chromium(VI) for short or long periods does not cause harmful health effects in most people (ATSDR 2000). Assuming the levels detected in the four air samples collected from the one residential yard are representative of chronic exposure conditions, chromium levels in the air are not likely to result in harmful health effects.

Particulate Matter

Over the past 20 years, numerous investigators have researched the public health implications of inhalation exposures to particulate matter. Prior to 1987, EPA enforced health-based standards that regulated ambient air concentrations of total suspended particulates (TSP). By 1987, a growing amount of research had shown that the particles of greatest health concern were actually particulate matter less than 10 microns in diameter (PM_{10}), which at that time were shown to be capable of penetrating into sensitive regions of the respiratory tract. Consequently, in 1987, EPA took action to monitor and regulate ambient levels of PM_{10}.

Since 1987, scores of additional epidemiologic studies have been published on the health effects of particulate matter. These studies generally suggest that harmful health effects in sensitive populations have been associated with exposure to fine particles (particulate matter less than 2.5 microns in diameter [$PM_{2.5}$]) that can penetrate into the lungs more deeply than PM_{10}. Currently, study results show that fine particles are more likely to contribute to harmful health effects than are coarse particles (EPA 2002).

Eleven samples were measured for PM_{10} in outdoor air. Because samples were not necessarily collected during fly ash removal activities, results may not represent peak exposure levels. The maximum PM_{10} 24-hour average air concentration was 36.4 µg/m^3, which is below EPA's PM_{10} 24-hour average National Ambient Air Quality Standard (NAAQS)[2] of 150 µg/m^3. We cannot know what levels of $PM_{2.5}$ were associated with measured PM_{10} levels. However, even assuming all of the particulate matter was less than 2.5 microns, the measured levels are also below EPA's $PM_{2.5}$ 24-hour average NAAQS of 65 µg/m^3. The limited air data suggests exposures to PM_{10} levels are not likely to be harmful to human health.

However, past exposures to fine particulate matter immediately following the landslide and during removal activities may have been at levels of health concern. Many epidemiologic studies have found consistent associations between exposure and harmful health effects for short-term, or acute, exposures (usually measured in days) to fine particulate matter (EPA 2002). Acute exposures to fine particulate matter may also aggravate pre-existing respiratory conditions in sensitive individuals. Although measured PM_{10} levels from the one residential yard were below NAAQS values, the air measurements were not necessarily collected during peak exposure periods when residents were shoveling and removing fly ash from their yards. ATSDR considers it plausible that fine particles in the fly ash may have acted as a respiratory irritant in exposed adults and children during that time.

3.1.3 Surface Water

Perry Mills Run Creek flows through a neighborhood located on Rostosky Ridge Road and into the Monongahela River. Adults and children in the neighborhood frequently are in direct contact with creek water during activities such as wading and playing. Following the landslide, residents reported that the creek water was black.

Because the creek has steep slopes, PADEP reported that the majority of the fly ash was contained in the creek channel and washed out into the Monongahela River shortly after the landslide (PADEP 2006c). Of note, the Monongahela River serves as a drinking water source down river from the landslide area. ATSDR understands that downstream, Monongahela River water authorities were notified of the fly ash landslide so they could take action if necessary. ATSDR was informed that arsenic was not detected in a downstream water authorities' samples (PADEP 2006b). Therefore, ATSDR is focusing this health consultation only on Perry Mills Run Creek.

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[2] On its Web site, EPA defines its Primary NAAQS as "levels of air quality which the Administrator judges are necessary, with an adequate margin of safety, to protect the public health," and its Secondary NAAQS as "levels of air quality which the Administrator judges necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant" (EPA 2001).

On January 27, 2005, PADEP collected a creek water sample downstream of the landslide and reported that this downstream creek water sample appeared dark in color (PADEP 2005a). On January 28, 2005, PADEP collected a creek water sample approximately 200 yards upstream from the landslide and reported that this upstream creek water sample appeared clear in color (PADEP 2005b). On February 3, 2005, a citizen's group collected a downstream water sample from the creek and sent it to a state accredited laboratory for analysis (GLA Laboratories 2005b). On February 17, 2005, PADEP collected one downstream and one upstream sample, both of which appeared clear in color (PADEP 2005k, PADEP 2005l).

Most chemical concentrations were much higher in the downstream samples collected on January 27 and February 3, 2005, than they were in the upstream samples. On the basis of these results, ATSDR determined the landslide adversely affected the creek water. Table 3 provides the results of the creek water analyses.

Table 3: Creek Water Sampling Data

Chemical	January 27 Downstream Sample Concentration (µg/L)	February 3 Downstream Sample Concentration (µg/L)	February 17 Downstream Sample Concentration (µg/L)	January 28 Upstream Sample Concentration (µg/L)	February 17 Upstream Sample Concentration (µg/L)
Aluminum	195,000	--	1,240	ND	451
Antimony	ND	6.4	ND	ND	ND
Arsenic	1,877	1,300	9.6	ND	ND
Barium	3,080	--	84	73	70
Beryllium	ND	18	ND	ND	ND
Cadmium	60	ND	ND	ND	ND
Calcium	209,000	--	70,700	70,300	70,700
Chromium	239	290	ND	ND	ND
Chromium(VI)	6.79	--	1.13	ND	ND
Copper	183	160	ND	ND	ND
Iron	112,000	--	1,080	164	484
Lead	152	190	10.4	ND	1.1
Magnesium	39,500	--	23,100	18,100	17,900
Manganese	1,200	--	39	ND	16
Mercury	0.87	3.4	ND	ND	ND
Nickel	209	210	ND	ND	ND
Potassium	24,300	--	2,370	1,400	1,410
Selenium	22.6	ND	ND	ND	ND
Sodium	32,200	--	36,200	11,100	12,000
Thallium	16.2	20	ND	ND	ND
Vanadium	594	--	ND	ND	ND
Zinc	335	500	ND	ND	ND
pH	8.36	8.1	8.24	8.0	8.18

ND not detected
µg/L micrograms per liter
-- not reported

ATSDR does not have CVs for non-potable surface water. Instead, ATSDR screened the creek water data using available health-based CVs for drinking water exposures. On the basis of the January 27 and February 3, 2005, creek water data, arsenic levels (1,877 micrograms per liter [µg/L] and 1,300 µg/L) in the downstream samples significantly exceeded ATSDR's chronic EMEGs for child exposure (3 µg/L) and adult exposure (10 µg/L) as well as EPA's maximum contaminant level (10 µg/L). In addition, aluminum, antimony, barium, beryllium, cadmium, chromium, iron, lead, manganese, mercury, nickel, thallium and vanadium levels exceeded ATSDR and/or EPA drinking water CVs. The measured pH levels were within EPA's secondary drinking water regulations (6.5–8.5)[3]. Chromium(VI), copper, selenium, and zinc did not exceed ATSDR and EPA drinking water CVs. Of note, ATSDR does not have drinking water CVs for calcium, magnesium, potassium, and sodium because varying levels of these chemicals are necessary for maintaining good health.

Following the fly ash landslide, many chemical concentrations from the downstream samples collected on January 27 and February 3, 2005, exceeded health-based drinking water CVs. However, these CVs are based on individuals ingesting 2 liters of water every day for life. Following the landslide, residents would not have been drinking water from the creek, and because the creek water was dark with fly ash, children would not have been likely to play or wade in the water. Therefore, ATSDR assumes that residents had little or no exposure to the chemical levels detected in downstream creek water samples immediately following the landslide.

Based on the downstream sampling results from February 17, 2005, which was about three weeks after the landslide event, and on the upstream results, creek water chemical concentrations are not at levels of health concern for adults and children who wade and play in the creek water.

Of note, during a recent March 2006 site visit, ATSDR staff noted fly ash in culverts and in the creek bed. Current ingestion exposures to arsenic levels in culverts and near the creek channel are discussed in the surface soil section of this health consultation (see Section 3.1.4).

3.1.4 Surface Soil

Residents living in the affected neighborhood and visitors to the neighborhood are exposed to chemicals in the soil during such activities as gardening, playing, and walking. ATSDR's preliminary health consultation on the landslide site recommended confirmatory sampling following the fly ash removal efforts (ATSDR 2005a). An environmental services company engaged by the legal counsel representing the affected residents conducted limited confirmatory surface soil sampling (NES 2005b).

On May 18, 2005, this environmental services company collected 17 surface soil samples from locations throughout the affected neighborhood following PADEP's April and May 2005 fly ash removal efforts. Samples were collected from areas that showed visual evidence of the presence of fly ash including a playground, residential driveways, culverts, and the creek channel (NES 2005b). Of note, no background samples were collected from areas not affected by the fly ash

[3] EPA's secondary drinking water regulations are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply (EPA 2006a).

landslide. The samples were only analyzed for arsenic. The arsenic levels ranged from 20.8 mg/kg to 82.8 mg/kg.

For arsenic in soil, the primary exposure route of concern is ingestion (oral exposure). Ingestion of soil could occur by the inadvertent consumption of soil on hands or food items, mouthing of objects, or intentional ingestion (pica behavior).

ATSDR derived soil exposure doses using the equation from Exhibit 1. In the absence of complete exposure-specific information, ATSDR applied several conservative exposure assumptions to define current site-specific arsenic exposures as accurately as possible. Specifically, ATSDR estimated arsenic exposure doses using the following assumptions and default intake rates for exposure via ingestion:

- The maximum detected concentration of arsenic (82.8 mg/kg) was assumed to be representative of arsenic levels in surface soil.
- Soil intake rates for an adult were assumed to be 100 mg/day.
- Soil intake rates for a child were assumed to be 200 mg/day and 5,000 mg/day for a child exhibiting pica behavior.
- The exposure factor was assumed to be 1, representing daily exposure to arsenic over a lifetime.
- The body weight of an adult was assumed to be 70 kg and a child was assumed to be 16 kg .
- The bioavailability of arsenic was assumed to be 100%—that is, all of the arsenic in soil that a person ingested was assumed to enter the bloodstream.

ATSDR derived exposure doses based on these conservative assumptions. The estimated doses are listed in Table 4.

Table 4: Estimated Doses of Arsenic in Soil

Population	Soil Intake (mg/day)	Estimated Dose (mg/kg/day)
Adults	100	0.0001
Children	200	0.001
	5,000	0.03

mg milligram
kg kilogram

As stated previously, ATSDR developed a provisional acute oral MRL for arsenic of 0.005 mg/kg/day based on transient effects such as irritation of the stomach and intestines with symptoms such as pain, nausea, vomiting, and diarrhea. Based on ATSDR's conservative assumptions, the estimated doses for adults and for children who do not exhibit pica behavior are currently below the ATSDR acute MRL. Therefore, acute non-cancerous harmful effects are unlikely for these populations.

However, estimated doses for children exhibiting pica behavior exceed the ATSDR acute MRL. Surface soil samples, which were collected from areas that showed visual evidence of the presence of fly ash, showed arsenic at 57.6 mg/kg in a playground near a swing set. Sensitive populations, such as children who eat non-food items like soil, could receive doses that might cause temporary harmful effects. Groups that are at an increased risk for pica behavior are children aged 1–3 years old. Although aware that children live in the area, ATSDR does not know whether these children are young or whether they exhibit pica behavior. If young children live or visit the affected neighborhood, ATSDR suggests that concerned parents monitor their children's behavior while they are playing outdoors to ensure that their children are not eating excessive amounts of soil.

In addition to the acute MRL, ATSDR developed a chronic oral MRL for arsenic of 0.0003 mg/kg/day. Exposure doses in this health consultation were estimated using the maximum detected concentration, which is a conservative assumption for chronic exposures. Results from this health consultation show that the estimated arsenic dose for adults does not exceed the chronic oral MRL, but the estimated dose for children does exceed it. ATSDR's chronic oral MRL is based on one of the most common and characteristic effects of arsenic ingestion—a pattern of skin changes that include hyperpigmentation and hyperkeratosis. These dermal effects have been noted in a majority of human studies that involved daily, long-term ingestion of elevated arsenic levels in drinking water. Collectively, these studies indicate that the threshold dose for hyperpigmentation and hyperkeratosis is approximately 0.01 mg/kg/day (ATSDR 2005c).

The estimated dose for children not exhibiting pica behavior is below the arsenic threshold dose. Therefore, harmful health effects are unlikely to occur. However, the estimated dose for children exhibiting pica behavior is slightly above the threshold dose. The harmful health effects observed in the studies on arsenic ingestion, however, involved daily, long-term ingestion of elevated arsenic levels in drinking water. Ingestion of large amounts of soil with elevated arsenic levels during gardening and playing activities would most likely not occur on a daily basis over many years. Because daily ingestion of large amounts of soil, unlike ingestion of water, is not expected to be a chronic (long-term) exposure, ATSDR considers it unlikely that soil exposures will result in hyperpigmentation and hyperkeratosis in children who exhibit pica behavior. However, as a prudent measure, ATSDR suggests that concerned parents monitor their children's behavior while the children are playing outdoors to ensure that they are not eating excessive amounts of soil.

Arsenic is classified as a human carcinogen. Several epidemiological studies conducted in other countries, including Taiwan and Chile, have reported that chronic ingestion of water that contains arsenic at several hundred parts per billion can increase the risk of cancer in the skin, liver, bladder, kidneys, prostate, and lungs (ATSDR 2005c). However, as stated previously, chronic exposure through ingestion of soil is not expected, and no significant increase in cancer risk is expected.

3.1.5 Interior Dust

Following the landslide, fly ash could have been brought into vehicles and homes on the feet of family members and pets. In fact, during a February 2005 site visit, ATSDR staff witnessed fly ash dust and indoor tracking of dirt into homes and cars in the affected neighborhood. Suspended fly ash particles in outdoor air could have entered a home through indoor-outdoor air exchange.

A young child playing on a home's floor will have the maximum opportunity for ingestion, inhalation, and dermal exposure to dust.

An environmental services company engaged by legal counsel representing the affected residents conducted an interior home sampling investigation (NES 2005b). In February, March, and April 2005, interior dust wipe samples from the surface of carpets, countertops, tables, windowsills, fans, furnace filters, and vacuum cleaner bags were collected by residents and sent for arsenic analysis. Arsenic was detected in some of the samples. Follow-up sampling in July 2005 also detected arsenic in dust wipe samples (NES 2005b).

Detections of arsenic in dust wipe samples are an indication that arsenic was, at some point, distributed throughout the home and was accessible to the occupants. Residents can take several actions to protect themselves and their families from further arsenic exposures. Figure 2 contains a pictorial that shows ways to protect family members from contaminants in the soil by keeping dirt and dust from getting into the home and into the body.

3.2 Biological Data Evaluation

To evaluate exposure in humans, arsenic can be measured in urine, hair, nails or blood. Each matrix has its limitations and advantages. To understand human exposure, each method must be used judiciously and applied appropriately to the environmental problem.

ACHD provided the "Results of the Health Investigation Following Fly Ash Contamination in Forward Township" report and the data sheets of urine measurements for ATSDR review (ACHD 2005). Urine laboratory analysis was conducted by LabCorp. Laboratory methodology for the analysis of blood, hair, nails, and urine was not available for review.

Blood Arsenic

Measurement of arsenic in blood is not a reliable indicator of chronic exposure to low levels of arsenic because it is cleared from the blood within a few hours, so a blood test for arsenic reflects only very recent exposure (hours). Blood arsenic levels are also difficult to interpret because the relationship between levels of exposure and levels of blood concentrations is not well established. Blood arsenic levels are generally not considered a reliable method of monitoring humans for arsenic exposure (ATSDR 2005c).

According to the ACHD report, an independent physician performed blood arsenic testing on one resident (ACHD 2005), but no blood arsenic was detected (ACHD 2005). ATSDR did not review the actual data report or laboratory methodology. Because blood arsenic levels only indicate very recent exposure (hours), this lack of detection is not unusual. If ongoing arsenic exposure is a concern, urine arsenic measurements would be indicated.

Hair Arsenic

Arsenic has a high affinity for sulfhydryl groups, which means that arsenic is attracted to sulphur, and it therefore tends to accumulate in keratin rich tissue such as hair and nails (NRC 1999). Hair arsenic levels are affected by external contamination such as from air, dust, and hair products, which cannot be distinguished from internally deposited arsenic in the hair shaft. Currently, no standardized method is available to ensure accurate and reliable test results among laboratories that analyze hair samples. Considerable inter- and intra-laboratory variability exists, as well as inconsistency in washing methods, sample preparation, analytical methods, results, interpretation, and definitions of reference ranges (Harkins and Susten 2003). Therefore, hair analysis may not be useful in a population in which external arsenic sources from the local environment may be significant sources of exposure.

ACHD did not receive hair samples from local residents. Therefore, no information is available to assess arsenic exposure through this matrix. In addition, hair analysis may not have been a useful matrix in this community because of the external contamination in the local environment.

Nail Arsenic

Human nail clippings have been used in epidemiological studies to understand arsenic exposure because they can potentially reflect exposure over the past 6–12 months. (Slotnick and Nriagu 2006). Fingernails grow at a rate of about 0.1 millimeter per day (mm/day), and toenails grow at 1/2 to 1/3 the rate of fingernails (Fleckman 1997). Although growth rates can vary among individuals, fingernails may take about 6 months to grow out fully and toenails may take about 12–18 months (Slotnick and Nriagu 2006). As with hair analysis samples, nail samples are also affected by external contamination but less so than hair. No standardization for the analytical method is available and standardized testing may not be feasible (Slotnick and Nriagu 2006). Therefore, good quality control measures are necessary to ensure validity and consistency in laboratory testing methods. To minimize external contamination and maximize exposure time assessment, toenail samples are recommended for testing instead of fingernail samples (Garland 1993). Samples of all 10 toenails from an individual are preferred when performing an integrated measure of exposure. Various sources have reported normal ranges for nail arsenic concentrations. These normal ranges are quite variable and range from 0.02 to 2.90 parts per million (ppm) (Agahian et al. 1990, Liebscher and Smith 1968).

In April and May 2005, seven participants (3–51 years of age) provided nail samples to ACHD for arsenic analysis. The samples were either fingernails or toenails but were not both as requested. The ACHD report does not mention if samples of all 10 nails were provided for analysis. The number of nails provided per sample may have impacted results. No information about laboratory methods of analysis was available in the ACHD report.

No arsenic was detected in three nail samples. All nail arsenic levels were below or equal to 0.15 ppm, the highest concentration detected among the seven samples. The mean arsenic concentration was 0.06 ppm. None of the arsenic nail concentrations exceeded published references ranges. Despite incomplete nail sampling information, these arsenic nail concentrations do not indicate unusual exposure to arsenic. However, as stated previously, fingernails take about 6 months to grow out and toenails take about 12–18 months. The fly ash landslide occurred during the last week of January 2005, and the nail sampling occurred approximately 3 to 4 months later (April and May 2005). The nail samples most likely did not reflect the peak exposure period. Therefore, the concerns posed by community members about arsenic exposure cannot be addressed on the basis of the results of the nail samples collected during April and May 2005 because of the timing of the collection.

Urine Arsenic

Urine arsenic is the most reliable method for measuring arsenic exposure, particularly exposures that occurred within a few days of the specimen collection. To control for differences in urine output and dilution, urine creatinine is measured. Although a 24-hour urine collection is considered an optimal sample because of fluctuations in excretion rates, most exposure studies have used a first morning void or a random sample because of the ease of collection. Under steady state exposure conditions[4], as would be assumed for most residents of this community, random or spot urine results have correlated well with 24-hour results. Testing for speciated urinary arsenic is preferable to testing for total urinary arsenic because the speciated forms can distinguish between exposure to inorganic arsenic and its metabolites and exposure to the relatively non-toxic forms of organic arsenic commonly found in seafood (Kallman 1990). Because urine arsenic measurements reflect only very recent exposure (within a few days), this measurement provides only a small window for assessment of arsenic exposure.

Inorganic arsenic is considered more toxic than organic arsenic, which is often found in seafood and shellfish. Other foods can also contain some amounts of arsenic. Consumption of seafood a few days before urine arsenic testing can elevate the total urine arsenic concentration many fold. Inorganic urinary arsenic levels in unexposed individuals are normally <10 µg/L (less than 10 micrograms per liter). Total arsenic levels below 50 µg/L are expected for individuals without occupational or dietary exposures (NRC 1999).

The ACHD conducted two rounds of arsenic urine sampling in March and April 2005. According to the ACHD report, none of the urine samples exceeded 50 µg/L for total arsenic, and no inorganic arsenic was found.

A February 2006 letter to ATSDR stated, "It is of significant concern to the residents that the Department of Health's urine tests of March and April 2005 showed that arsenic was not detected at all" (Villari, Brandes & Kline, PC. 2006). The laboratory detection limit for inorganic arsenic was 10 µg/L. Lower levels of inorganic arsenic, if present, were not found because the laboratory detection limit was 10 µg/L. Because inorganic arsenic levels in an unexposed person are normally less than 10 µg/L, the laboratory detection limit would still be capable of identifying unusual inorganic arsenic exposure in an individual.

Based on the available sampling data, results show that the participants were not exposed to unusual arsenic concentrations a few days (2–3 days) prior to their urine collection. However, these urinary results do not represent peak exposure levels such as those that occurred during the initial efforts by residents to remove fly ash from their yards. Therefore, despite the reported urine levels, the concerns posed by community members about arsenic exposure cannot be addressed on the basis of the results of the urine samples collected during April and May 2005 because of the timing of the collection.

3.3 Data Quality

In preparing this health consultation, ATSDR relied on information provided in the referenced documents. The analyses, conclusions, and recommendations in this health consultation are valid only if the referenced documents are complete and reliable.

Although ATSDR staff did not review quality assurance/quality control (QA/QC) information with regard to the collection of environmental data such as laboratory procedures and data reporting and whether measures were followed in chains-of-custody, all samples were analyzed by certified laboratories. Therefore, ATSDR considers these environmental data adequate for public health evaluation purposes.

[4] Steady state conditions exist when the chemical level in an environmental medium exhibits only negligible change over a long period.

Quality control and quality assurance for the biological data was not available for ATSDR review. Therefore, chains-of-custody, laboratory procedures, and data reporting information were not available for review, although all urine arsenic samples were analyzed by an accredited laboratory. As such, ATSDR considers this biological data adequate for public health evaluation purposes.

Because no standardization for the analytical method is available for nail analysis, ATSDR cannot comment on the quality of the QA/QC for the nail arsenic data.

4.0 Community Concerns

In the petition letter, residents reported a variety of flu-like symptoms, including sore throat, cough, fever, nausea, fatigue, diarrhea, and headaches (Petition Letter 2005). On March 1, 2005, ACHD administered a questionnaire to residents in the impacted area (ACHD 2005). The questionnaire was administered (1) to investigate the potential for exposure to fly ash in the neighborhood, (2) to investigate the potential for other exposures through daily activities such as cigarette smoking, eating fish, or cleaning a coal-burning stove, and (3) to compile the list of symptoms residents' experienced the first month after the fly ash landslide.

ACHD reported that 15 adults and 6 children responded to the questionnaire. At the time the questionnaire was administered, 82% of the respondents indicated that fly ash was still in their yards. All six children reported nausea. Four children reported symptoms of fever, vomiting, and headache. Six adults reported symptoms of fever, difficulty breathing, chills, and nausea.

Overall, ATSDR considers that the self-reported health symptoms by residents are suggestive of past exposures to fly ash that contained elevated levels of arsenic and high pH. Please refer to Section 3.0, which contains detailed discussions on plausible harmful health effects from this exposure.

In addition to health concerns, residents have also expressed concerns about the stability of the original fly ash area, the potential for landslides in the future, and the stability and safety of Riverhill Road for school buses. The January 2005 fly ash landslide resulted in the original fly ash area having a steep slope of questionable stability. The original fly ash area's condition poses the likelihood that another fly ash landslide could occur and result in future releases of fly ash into the Rostosky Ridge Road neighborhood (PADEP 2006a). In May 2006, residents sent ATSDR photographs that show Riverhill Road is collapsing and closed to traffic. PADEP is addressing these issues at this time.

5.0 Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults need to be emphasized. Children could be at greater risk than 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, and thus they breathe dust, soil, and vapors closer to the ground. A child's lower body weight and higher air intake rate results in a greater dose of hazardous substances 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, medical care, and risk identification. Thus, adults need as much information as possible to make informed decisions about their children's health. Therefore, in this health consultation, ATSDR's has particularly focused on the evaluation of children's exposure to arsenic and to other irritants in the fly ash and on the potential health effects associated with these exposures. Children with pica behavior are a particular concern. Please refer to Section 3.0, which contains detailed discussions on children's exposures.

6.0 Conclusions

Following the January 2005 fly ash landslide, residents living in the affected neighborhood and visitors to the neighborhood were exposed to fly ash contamination on the ground, in the air, in the homes, and along the creek banks. Exposures were highest during the fly ash removal efforts. ATSDR considers that residents'self-reported health symptoms are suggestive of exposure to high pH fly ash that contained elevated levels of arsenic. Children, particularly those who eat non-food items (pica behavior); adults engaged in contact-intense activities such as shoveling fly ash; and sensitive populations such as those with compromised lung function (ex., asthma), were more likely to experience temporary harmful health effects.

Residents and visitors are currently being exposed to remnants of fly ash contamination that remain in the yards and culverts and along creek banks. PADEP did not collect confirmatory surface soil data from the affected neighborhood following the fly ash removal actions, nor did it collect any background surface soil data. ATSDR understands that with the removal of the majority of fly ash from the affected neighborhood, exposure conditions changed.

Analysis of the limited soil samples collected by an environmental services company indicates that arsenic levels in the surface soil (20.8–82.8 mg/kg) are not of health concern for adults and most children. However, in areas with visible remnants of fly ash contamination, arsenic levels in surface soil are of health concern for preschool children who exhibit pica behavior or have episodes of high exposure. If these children eat large amounts of soil, they could be exposed to arsenic at levels that may cause temporary harmful health effects.

Limited outdoor air data indicate that the reported chemical levels are not likely to result in harmful health effects.

On the basis of the limited creek water data collected about three weeks after the landslide, chemical concentrations are not at levels of health concern for adults and children who wade or play in the creek water.

Results of the analysis of the urinary arsenic levels measured indicate that the participants were not exposed to high levels of arsenic 2 to 3 days prior to their urine collection. However, the urinary sampling time does not represent the time of peak exposure levels.

None of the arsenic concentrations in toenails or fingernails exceeded the published reference ranges. However, because of the length of time required for nail growth, the results from the nail samples did not reflect peak exposure times at the site.

Overall, the biological testing was conducted to address community concerns about arsenic exposures following the landslide event. However, the timing of the biological testing does not allow these community concerns to be addressed.

The landslide resulted in the original fly ash area having a steep slope of questionable stability. This poses the likelihood that another fly ash landslide could occur and result in future exposures of public health concern in this neighborhood. PADEP is addressing the issue at this time.

7.0 Recommendations

1. Residents should be made aware of prudent public health measures they can take to reduce exposures and to protect themselves, their families, and visitors.
2. Visible fly ash contamination should be removed from yards, culverts, and creek beds in the affected neighborhood to reduce the potential for future exposures to the fly ash.
3. Post-confirmatory sampling of surface soil (0–1 inch) in neighborhood yards, culverts, and creek banks should be conducted after fly ash removal efforts are completed to ensure that arsenic levels are not of health concern.
4. Background surface soil samples (0–1 inch) should be collected from an area not affected by the fly ash landslide to determine the naturally-occurring arsenic levels in the soil in this area.
5. The original fly ash area should be remediated to prevent future fly ash landslides into the creek and neighborhood.

8.0 Public Health Action Plan

The purpose of the public health action plan (PHAP) is to ensure that this evaluation not only identifies potential and ongoing public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects that result from exposure to hazardous substances in the environment. Following are listed the public health actions that are completed, ongoing, and planned.

Completed Actions

From January through May 2005 following the fly ash landslide, residents and PADEP intermittently removed large piles of fly ash from residential yards, flower beds, play areas, culverts, and creek banks.

Ongoing Actions

PADEP has initiated the removal and off-site disposal of the original fly ash area and the stabilization of the remaining slope.

Planned Actions

ATSDR will mail this health consultation to residents in the affected neighborhood to ensure that they are made aware of prudent public health measures they can take to reduce exposure.

ATSDR will mail this health consultation to the appropriate personnel at PADEP, ACHD, and EPA to ensure that they are made aware of ATSDR's recommendations to remove the visible fly ash and to conduct post-confirmatory sampling in the affected neighborhood.

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