HEALTH CONSULTATION

DONA ANA COUNTY METALS SURVEY

International Border Water Commission (IBWC) – Beach Area

Sunland Park, Doña Ana, New Mexico

NOVEMBER 5, 2002

Prepared by:

Office of Regional Operations – Region 6
Agency for Toxic Substances and Disease Registry

BACKGROUND AND STATEMENT OF ISSUES

The Agency for Toxic Substances and Disease Registry (ATSDR) was requested by the Environmental Protection Agency (EPA) to determine the public health significance of the lead and arsenic contamination found in three individual composite soil samples collected from a U.S. International Border Water Commission (IBWC)-beach area location. The samples were collected at the request of community members from the beach area adjacent to the Rio Grande River near the railroad bridge (off Paisano Drive). Two surface soil samples (0 to 1 inch in depth) were composited from five-point aliquots of approximately equal volume and one subsurface soil sample (0-6 inches in depth) was a grab sample. The surface soil samples contained 45 and 49 milligrams per kilogram (mg/kg) of arsenic and 240 mg/kg each of lead. The subsurface soil sample contained 50 mg/kg of arsenic and 380 mg/kg of lead.

The IBWC-beach area is a sandy, shore-line area devoid of most vegetation. Local residents use the area for recreational activities, including picnicking, water sports, and fishing. It is unlikely that residents frequent this area on a daily basis. Due to the size of the area and its limited use because of flooding events, only three samples were collected to represent the arsenic and lead distribution in the beach area. Because of the proximity to the river, distance from industrial sources, and recreation use patterns at the beach area, the soil sampling activities seemed adequate to address the public health significance of potential exposures to arsenic and lead via soil in the area.

Individuals accessing the beach are most likely to come in contact with the soils through ingestion of the soil (eating the soil), inhalation (breathing in soil as windblown dust) or by dermal (skin) contact with the soil. Primarily, individuals will be exposed to the soil contaminants through ingestion from accidental hand-to-mouth exposure. This route of exposure will be the focus of this health evaluation.

It is unlikely that inhalation or dermal exposure to the contaminants poses a significant source of exposure. Wind blown dust maybe a problem in the El Paso area. However, since the concentrations of contaminants in the soil are generally low, there would not be a significant loading of contaminants in the air. Since absorption of metals through the skin is very limited, it is not considered a significant route of exposure.

DISCUSSION

Public Health Implications

Lead

We evaluate the public health significance of lead in soil by estimating the potential impact that it may have on the blood lead levels of potentially exposed populations. For this health consultation, we considered potential exposure to adults, children, and the developing fetus (of adult females that frequent the IBWC-beach area). In general, lead in soil has the greatest impact on preschool-age children as they are more likely to play in dirt and place their hands and other contaminated objects in their mouths.

They also absorb more lead through the gastro-intestinal tract than adults and are more likely to exhibit the types of nutritional deficiencies that facilitate the absorption of lead. While lead in soil also can have an impact on adults and the developing fetus (through maternal exposure), the potential impact on these populations is low compared to the potential impact on young pre-school age children.

The Centers for Disease Control and Prevention (CDC) has determined that a blood lead level ≥10 µg/dL in children indicates excessive lead absorption and constitutes the grounds for intervention [1, 2]. While there is no clear relationship between soil lead and blood lead applicable to all sites, a number of models have been developed to estimate the potential impact that lead in soil could have on different populations [3–5]. For children, the predicted 95th percentile blood lead level associated with a soil lead concentration of 500 mg/kg is approximately 10 µg/dL. This means that except in the most extreme cases (i.e., frequent contact by children exhibiting pica behavior, or desire for unnatural foods such as dirt or ashes) children regularly exposed to soil lead levels of 500 mg/kg should have no more than a 5% probability of having blood lead levels greater than 10 µg/dL. Based on the goal of limiting the probability of exceeding a blood lead level of 10 µg/dL to no more than 5%, depending on individual exposure situations, the concentrations of lead in soil where children might have regular contact should be less than 500 mg/kg. Exceeding this value should not be taken to imply that the contaminant will cause harm but does suggest that it warrants further consideration.

Critical blood lead levels for adults are less well established. The Occupational Safety and Health Administration (OSHA) recommends that workers whose blood lead levels exceed 40 µg/dL should have medical evaluations and workers whose blood lead levels exceed 60 µg/dL be removed from the exposure. In Texas workers, blood lead levels greater than 25 µg/dL must be reported to TDH. For adults who frequent the IBWC-beach area, we based our assessment on the same goal of limiting the probability of exceeding a blood lead level of 10 µg/dL to no more than 5 percent.

The concentrations of lead measured in soil from the IBWC-beach area were less than the 500 mg/kg screening value for children. Although it is an area where both children and adults could contact soil, based on the samples reviewed, the concentrations of lead to which people might be exposed are less than 500 mg/kg and would not pose a risk to children or adults. Any potential risks are further reduced by the fact that our exposure assumptions assume that people contact the soil every day and exposure to soil at this IBWC-beach area likely occurs less frequently. Based on these data, we would not anticipate the lead in the soil to present a public health hazard to any of the potentially exposed populations.

Chronic Exposure to Arsenic in Soil

To assess the potential health risks associated with chronic exposure to arsenic in the soil, we compared the soil concentrations to a health-based screening value specific to arsenic. This screening value represents a level in the soil that is considered safe for human contact. While exceeding this screening value does not imply that the contaminant will cause harm, it does suggest that potential exposure to the contaminant warrants further consideration.

The screening value used for arsenic in soil (24 mg/kg) is based on a child exposure scenario and EPA's reference dose (RfD) for arsenic of 0.3 µg/kg/day [6]. RfDs are based on the assumption that there is an identifiable exposure threshold (both for the individual and for populations) below which there are no observable adverse effects. Thus, the RfD is an estimate of a daily exposure to arsenic that is unlikely to cause adverse non-cancer health effects even if exposure were to occur every day for a lifetime. For arsenic, the RfD was derived by dividing the identified no observable adverse effects level (NOAEL[1]) of 0.8 µg/kg/day, obtained from human epidemiologic studies, by an uncertainty factor of three. The lowest observable adverse effects level (LOAEL[2]) associated with these epidemiologic studies was 14 µg/kg/day, where exposure to arsenic above this level resulted in hyperpigmentation of the skin, keratosis (patches of hardened skin), and possible vascular complications [6–8]. Standard assumptions for body weight (15 kg; child) and soil ingestion (200 mg per day; child) were used to calculate the screening value. Screening values calculated using child exposure scenarios also are conservative (health protective) with respect to protecting adults.

The concentrations of arsenic measured in soil from the IBWC-beach area were higher than the 24 mg/kg screening value. A 15 kg child who ate 200 mg of soil (assuming 100% absorption) from the IBWC-beach area every day would receive an estimated daily dose approximately 2 times higher than the RfD, slightly lower than the NOAEL, and 23 times lower than the LOAEL. Ingestion of less than 200 mg of soil per day or an exposure frequency less than seven days per week would result in exposures below the RfD. A 70 kg adult who ate 100 mg of soil (assuming 100% absorption) from the IBWC-beach area every day would receive an estimated dose approximately 4 times lower than the RfD, 11 times lower than the NOAEL, and 200 times lower than the LOAEL. Based on these estimates of exposure it is not likely that children or adults exposed to soil from this IBWC-beach area would experience adverse non-cancer health effects.

Acute Exposure to Arsenic in Soil (Pica Behavior)

Soil pica behavior (ingestion of more than 1.0 gram soil per day) may occur in a portion of children throughout the year. EPA has reported that less than 1% of children exhibit pica behavior [9]. Additionally, children less than 3 years old are most likely to exhibit this behavior.

Based on the level of arsenic (<50 mg/kg) found in soils from the IBWC-beach area, adverse health effects are not expected in children exhibiting pica behavior. For example, a 15 kg child exhibiting pica behavior would need to consume 5,000 mg (5 grams) soil/day at an arsenic soil concentration of 150 mg/kg to exceed the acute LOAEL of 0.05 mg/kg/day (assuming 100% absorption of arsenic from ingested soil). Accordingly, a 15 kg child would need to eat 15,000 mg of soil (about 2.5 teaspoons) at 50 mg/kg to exceed the acute LOAEL.

Cancer Effects of Arsenic

[1]The highest dose at which adverse effects were not observed.

[2]The lowest dose at which adverse effects were observed.

EPA classifies arsenic as a known human carcinogen based on evidence from human data. An increase in lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer (non-malignant) were observed in populations consuming water high in inorganic arsenic [6]. The comparison value for arsenic of 0.5 mg/kg is based on EPA's cancer slope factor for skin cancer and an estimated excess lifetime cancer risk of one excess cancer in one million people exposed for 70 years. Arsenic was detected in all three samples at concentrations above the carcinogenic comparison value; however, naturally occurring levels of arsenic typically found in the environment also exceed the comparison value. As such, people who regularly, e.g. 7 days a week for one year, ingest soil from some of these areas could have a theoretical excess lifetime risk for developing cancer. Qualitatively, depending on specific exposure scenarios, we estimate that the risk of developing cancer from chronic ingestion of soil from the IBWC-beach area could range from an insignificant increased lifetime risk to a low increased lifetime risk for developing cancer. However, the most likely cancer risk associated with the length of time that people access this beach does not increase their lifetime cancer risk.

ATSDR's Child Health Initiative

We recognize that the unique vulnerabilities of children demand special attention. Windows of vulnerability (critical periods) exist during development, particularly during early gestation, but also throughout pregnancy, infancy, childhood and adolescence --- periods when toxicants may permanently impair or alter structure and function [6]. Unique childhood vulnerabilities may be present because, at birth, many organs and body systems (including the lungs and the immune, endocrine, reproductive, and nervous systems) have not achieved structural or functional maturity. These organ systems continue to develop throughout childhood and adolescence. Children may exhibit differences in absorption, metabolism, storage, and excretion of toxicants, resulting in higher biologically effective doses to target tissues. Depending on the affected media, they also may be more exposed than adults because of behavior patterns specific to children. In an effort to account for children's unique vulnerabilities, and in accordance with ATSDR's Child Health Initiative [7] and EPA's National Agenda to Protect Children's Health from Environmental Threats [8], we used the potential exposure of children as a guide in assessing the potential public health implications of the contaminants.

If parents are concerned about their children's health as it relates to exposure from soils in the IBWC-beach area, they can have their children's blood tested for lead. The Texas Department of Health Childhood Lead Poisoning Prevention Program recommends that all children have their blood tested for lead at ages one and two.

CONCLUSIONS

1. The concentrations of lead and arsenic in soil from the IBWC-beach area to which people might be exposed are generally low. Thus, it is not expected that people frequenting the IBWC-beach area would experience adverse health effects associated with the reported levels of arsenic and lead found in soil. Based on the available information we have concluded that the levels of lead and arsenic found in the soil do not pose a public health hazard to any of the potentially exposed populations.

PUBLIC HEALTH ACTION PLAN

Actions Recommended

1. None at this time.

REFERENCES

1. Centers for Disease Control. Preventing lead poisoning in young children. US Department of Health and Human Services; October 1991.

2. Agency for Toxic Substances and Disease Registry. The nature and extent of lead poisoning in children in the United States: a report to Congress. Atlanta: US Department of Health and Human Services; 1988.

3. US Environmental Protection Agency (USEPA). Memorandum from Mark Maddaloni, chair technical review workgroup adult lead subgroup to Pat Van Leeuwen, region 5 superfund program use of the technical review workgroup Interim Adult Lead Methodology in Risk Assessment, April 1999.

4. Agency for Toxic Substances and Disease Registry (ATSDR). Analysis paper: Impact of lead-contaminated soil on public health. US Department of Health and Human Services; May 1992.

5. Society for Environmental Geochemistry and Health. 1993. Lead in soil, recommended guidelines. Science Reviews.

6. US Environmental Protection Agency. 2000. Strategy for research on environmental risks to children. Washington, DC: US Environmental Protection Agency, Office of Research and Development. EPA/600/R-00/068, Section 1.2.

7. Agency for Toxic Substances and Disease Registry (ATSDR). Child health initiative. Atlanta: US Department of Health and Human Services; 1995.

8. US Environmental Protection Agency. The children's environmental health yearbook; 1998.

9. US Environmental Protection Agency. Exposure Factors Handbook (EFH). Washington (DC): US Environmental Protection Agency; National Center for Environmental Assessment. February 1999. EPA 600-C-99-001.

PREPARERS OF THE REPORT

Karl V. Markiewicz, Ph.D.
Senior Toxicologist
Agency for Toxic Substances & Disease Registry

Concurrence by: Tina Forrester by JLL
Tina Forrester, Ph.D.
Deputy Director
Office of Regional Operations
Agency for Toxic Substances & Disease Registry

ATSDR REGIONAL REPRESENTATIVE

Jennifer Lyke
Regional Representative
ATSDR - Region 6

George Pettigrew, PE
Senior Regional representative
ATSDR - Region 6

Uncertainties

General Uncertainties

In preparing this report, we relied on the information provided and assumed adequate quality assurance/quality control (QA/QC) procedures were followed with regard to data collection, chain-of-custody, laboratory procedures, and data reporting. The analysis and conclusions in this report are valid only if the referenced information is valid and complete.

In order for exposure to the contaminants to occur through ingestion, the soil must be physically available. The screening values that we used in this consultation assume that the soil is available and that physical barriers such as grass are not present. The presence of the grass would further reduce the likelihood for exposure. Individual behavior patterns also are important in assessing risk. The amount of soil that a person eats, how often they eat the soil, and the average concentration of the contaminant in the soil that they eat all are important factors in determining potential public health implications. For this consultation we assumed that people eat soil from the IBWC-beach area every day and that their total daily consumption of soil and dust comes from the IBWC-beach area. In most instances these assumptions overestimate the potential exposures.

Specific Uncertainties

There is considerable controversy with respect to assessing potential risks associated with exposure to arsenic. Both the RfD and the CSF are based on human ecological studies that have recognized uncertainties with respect to the assignation of exposure. Such studies find it difficult to avoid errors in assigning people to specific exposure groups. The studies upon which the RfD and the CSF are based also involved exposure to arsenic in drinking water. The ability of the body to absorb arsenic in water is likely higher than the ability of the body to absorb arsenic in soil. In our analysis we assumed that the arsenic in the soil was 100% absorbed. The assumption that the applied or ingested dose (the amount available for absorption) is the same as the internal dose (the amount that has been absorbed) is conservative and to some unknown extent overestimates the risk. We also did not consider the kinetics of arsenic in the body in our risk estimates. The RfD and the CSF are based on daily exposures over a lifetime. Since the half-life (the time it takes ½ of the absorbed arsenic to be excreted) is short (40-60 hours), the risk estimates for exposures that occur less frequently than every day also may result in an overestimate of the risks.

With specific respect to the cancer risk estimates, the mechanisms through which arsenic causes cancer are not known; however, arsenic is not believed to act directly with DNA. Since the studies used to derive the CSF are based on exposure doses much higher than those likely to be encountered at this site, it is questionable whether it is appropriate to assume linearity for the dose-response assessment for arsenic at low doses. The actual dose-response curve at low doses may be sublinear which would mean that the risk estimates in this consultation overestimate the actual risks.

APPENDIX