Public Health Advisory

ARSENIC MINE SITE

TOWN of KENT, PUTNAM COUNTY, NEW YORK

EPA FACILITY ID: NYD982531469

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Introduction

ATSDR has determined that current and potential future exposures to arsenic in residential soil on the Arsenic Mine Site warrant the issuance of a Public Health Advisory. USEPA found that arsenic concentrations in surface soil on all ten properties of the Arsenic Mine Site greatly exceed state and federal residential soil screening values. Seven properties are occupied by children, adults, pets, and/or livestock. The remaining three unoccupied properties are accessed by property owners periodically.

In October 2018, the United States Environmental Protection Agency (USEPA) requested that the Agency for Toxic Substances and Disease Registry (ATSDR) evaluate surface soil samples collected at residential properties on the USEPA Arsenic Mine Site in Kent, Putnam County, New York, to determine if prompt action should be taken to reduce harmful exposures to arsenic-contaminated soils and mine tailings. The USEPA provided ATSDR validated residential soil data it had collected in 2017 and 2018. Concentrations of arsenic in soil collected from ten residential parcels ranged from 3.2 to 56,000 milligrams per kilogram (mg/kg). These data provided the basis for a health consultation to evaluate the public health implications of exposure to arsenic in shallow residential soils, conducted by the New York State Department of Health (NYSDOH) under a cooperative agreement with ATSDR[1] [ATSDR 2019a].

In the 2019 health consultation, the NYSDOH and ATSDR conclude that children at residential properties with the highest arsenic levels in shallow (zero to six inches below ground surface) soils on the Arsenic Mine Site can have short-term ingestion exposures to arsenic that pose an immediate and significant threat to human health, thus constituting an urgent public health hazard. If actions are not taken, these exposures could continue in the future. The NYSDOH and ATSDR also conclude that long-term ingestion and dermal exposure of children and adults to arsenic in shallow soil at residential properties on the Arsenic Mine Site pose a significant threat to human health and constitute a public health hazard. [ATSDR 2019a]

ATSDR recommends that the USEPA take short- and long-term measures as soon as feasible to quickly **dissociate** residents from exposure to arsenic in soils on the Arsenic Mine Site. In 2017 and 2018, USEPA took steps to inform property owners of their recent soil and drinking water sampling results and provided education on best practices for reducing soil arsenic exposure and maintaining their drinking water treatment systems. Additionally, USEPA has considered a removal action to reduce exposures to arsenic, such as soil cover and/or replacement, but has determined that such action would likely need to occur in stages over several years. Such an action likely would have only short-term effectiveness and would not be adequate to permanently prevent harmful exposures. Even if post-soil removal site controls were implemented, there is high potential for recontamination.

Over the longer term, USEPA should permanently remediate the source of arsenic in shallow soils at the Arsenic Mine Site. In the absence of a permanent solution, people,

[1] The interpretation, advice, and recommendations provided in this public health advisory are based on the data and information evaluated and referenced here and in the NYSDOH health consultation developed under a cooperative agreement with ATSDR [ATSDR, 2019a]. The conclusions, recommendations, and public health actions in this advisory are site-specific and are not intended as generally applicable to any other situation.

particularly children, could continue to be exposed to arsenic at levels that present an imminent and significant health threat. Until a permanent solution is in place, the USEPA should continue actions to prevent harmful exposures to arsenic in residential soils.

Background

The Arsenic Mine Site encompasses ten residential properties on and adjacent to the former Arsenic Mine located in the Town of Kent, in Putnam County, New York, near the intersection of Gipsy Trail Road and Mt. Nimham Court. The former arsenopyrite mine operated from the mid-1800s to approximately 1918. Rocks were crushed on-site to concentrate the ore. Former mine entrances and tailings piles (residual materials separated out during mining activities) exist on nearby residential properties and the Nimham Mountain Multiple Use Area (MUA). The Arsenic Mine Site includes ten residential properties, but not the Nimham Mountain MUA. There are two main mine entrances, northern and southern. The northern entrance is on private property on the Arsenic Mine Site. The southern entrance is located within the Nimham Mountain MUA. Areas of mine tailings remain at the surface in several places on both residential properties and the Nimham Mountain MUA. The area is sparsely populated, and the terrain is highly variable, with steep, forested hillsides. Occupied properties in the area generally consist of single-family residential homes. Public water is not available in the area, thus residents rely on private wells for their drinking water.

In December 1987, residents at a single property living adjacent to the northern mine shaft were hospitalized with arsenic poisoning from their drinking water well [NYSDOH 1987]. Putnam County Department of Health sampling determined that the residential drinking water well was contaminated with arsenic much above state and federal drinking water standards. Soil samples collected on the residential property confirmed that the home was built upon mine tailings/mine wastes. Due to arsenic poisoning, three residents in the home required hospitalization and chelation therapy. In consultation with New York State Departments of Environmental Conservation and Health, the USEPA requested that ATSDR evaluate the health risk associated with arsenic contaminated drinking water for residents. ATSDR recommended the residents of this property be put on a permanent acceptable water supply totally disconnected from any source of arsenic [ATSDR 1988]. At that time, the USEPA installed an alternate drinking water system at the property, and both USEPA and Putman County Health Department provided health education information to the family residing at the property. Two additional private drinking water wells and one public supply well sampled by Putnam County Health Department in 1987 were found to contain arsenic at concentrations approaching or slightly above the state and federal drinking water standards. A limited drinking water sampling event was conducted by the USEPA, and the Putnam County Health Department performed routine sampling through 1992. Installation of filter systems on the drinking water wells proved to be effective in removing arsenic.

The 1987 sampling event identified a need for additional information about the potential for arsenic exposures in the area. On March 24, 1988, the Putnam County Health Department and the USEPA conducted limited soil sampling at properties near the northern mine entrance to evaluate the potential for exposures. They found high levels of arsenic in shallow soils. In May

1988, the Putnam County Health Department placed warning signs near the northern mine entrance to alert persons to the high arsenic levels in soil and tailing piles.

In 2016, arsenic contaminated sediments were found in the holding tanks of the alternate drinking water supply installed by the USEPA in 1988, which resulted in an additional site investigation. In August 2017, a USEPA contractor conducted a soil investigation of four properties. In December 2017, samples were collected at six additional properties and one previously sampled property, for a total of ten properties sampled between the two events [Weston Solutions, Inc. 2017; 2018a]. In June 2018, the USEPA collected additional soil samples from all ten properties [Weston Solutions, Inc. 2018b]. One neighboring property did not respond to USEPA outreach and was not sampled during any of the sampling events. The 2018 soil data were obtained using an X-ray fluorescence (XRF) screening tool and analyzed by a USEPA approved contract laboratory for total arsenic. However, the XRF is a screening tool and accuracy can vary based on the composition of the sample, so the NYSDOH only used the approved laboratory validated soil data to evaluate exposures and risks [ATSDR 2019a]. Concentrations of total arsenic in shallow soil samples ranged from 3.2 to 56,000 mg/kg. The mean concentrations of arsenic in shallow soil samples, by property, ranged from 34.6 to 12,734 mg/kg.

In October 2018, the USEPA collected drinking water samples (before and after water treatment systems) at the seven properties with occupied homes. These samples showed that filter systems installed and maintained by residents to remove contaminants from their drinking water continue to be effective with the exception of one property [Weston Solutions, Inc. 2018c]. The USEPA recommended that the homeowner follow the manufacturer's suggested maintenance requirements to replace the filter or install a system capable of removing contaminants. The USEPA continues to monitor drinking water on a quarterly basis. Since the October 2018 samples, two new treatment systems have been installed [personal communication, Sandra Richards, USEPA, March 2019].

Under a cooperative agreement with ATSDR, NYSDOH developed a health consultation to evaluate the potential public health implications from exposure to arsenic-contaminated residential soils based on USEPA's 2017 and 2018 soil sampling investigations. The health consultation does not evaluate other possible sources of arsenic exposure, such as inhalation of arsenic contaminated soil or dust, consumption of untreated drinking water, consumption of home raised animal products, or consumption of fruits and vegetables grown in contaminated soil. Consideration of these additional potential exposure pathways would not change the conclusions and recommendations provided in the health consultation but may likely support and strengthen them. The 2019 Arsenic Mine health consultation forms the basis for this public health advisory and is summarized below [ATSDR 2019a].

Basis for the Public Health Advisory

Table 1 summarizes the USEPA August and December 2017 and June 2018 shallow soil sample results. Concentrations of arsenic were detected in shallow soil on all ten residential properties. The concentrations ranged from 3.2 to 56,000 mg/kg.

Table 1. Summary of arsenic in residential property shallow soils

Property/ Occupied	Number of Samples	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Mean Concentration (mg/kg)	95% UCL (mg/kg)[b]
1 / Yes	13	19.7	49,300	10,690	48,071
2 / Yes	9	10.3	6,050	873	4,247
3 / No	8	26.6	56,000	12,734	25,406
4 / No	5	19.6	20,600	4,142	NC
5 / Yes	7	24.3	181	79	NC
6 / Yes[a]	10	3.2	687	193	512
7 / No	6	22	317	116	NC
8 / Yes	7	9	99.5	35	NC
9 / Yes	8	66.5	1,520	298	1,398
10 / Yes	7	3.6	841	199	NC

Data Source: Arsenic Mine Site Health Consultation [ATSDR 2019]
mg/kg = milligrams of arsenic per kilogram of soil; NC = Not calculated; UCL = Upper Confidence Limit
[a]The residents, including a young child, reside at the property *part-time*, thus reducing their potential for long-term exposure.
[b]95% UCL was calculated for properties with eight or more samples.

The method for assessing the presence of a health hazard in a community is to determine whether a completed exposure pathway connects a contaminant source to a receptor population, and whether exposures to that contamination are sufficiently high to be of health concern. As described in the 2019 health consultation, an exposure pathway was and is complete for ingestion of, and dermal contact with, the shallow soil containing arsenic for seven occupied properties [ATSDR 2019a]. The exposure pathway is potentially completed for the remaining three vacant residential properties. Exposed persons may include children and adults residing on or accessing any of the ten Arsenic Mine Site properties.

For specific details of exposure pathway determination, screening of the data, and the non-cancer and cancer evaluation for residential soil exposures, please refer to the accompanying health consultation [ATSDR 2019a]. A summary of the major findings are included in this advisory.

Public Health Implications of Completed and Potential Exposure Pathways

The maximum arsenic concentrations in shallow soil on all properties exceed the ATSDR child chronic environmental media evaluation guide (16 mg/kg), as well as the New York State Residential Soil Clean Up Objective (16 mg/kg) for arsenic in soil [ATSDR 2019b; NYSDEC/NYSDOH 2006]. The exceedance of these values prompted further evaluation of arsenic.

ATSDR and NYSDOH evaluated the risk for acute pica and non-pica[2] exposures and chronic non-cancer health effects for seven age ranges by comparing the estimated arsenic exposures from soil to ATSDR's acute minimal risk level (MRL) of 0.005 mg/kg/day and chronic MRL (0.0003 mg/kg/day), respectively [ATSDR 2007]. The ATSDR chronic MRL is the same value as the USEPA chronic reference dose (RfD) [USEPA 1991]. Consistently, the 1 to 2-year-old child is estimated to receive the highest dose of arsenic; therefore, this age group is the focus of the evaluation.

When an MRL or RfD is exceeded, the estimated exposure dose is compared with the dose known to cause health effects to determine the margin of exposure (MOE). The higher the MOE, the greater the difference—and margin of protection—between the estimated soil exposure and the human effect level. An MOE equal to one means that the estimated soil exposure is the same as the human effect level. An MOE less than one means that the estimated exposure in soil is higher than the exposure that has caused health effects. An MOE of more than 1 means that the estimated exposure in soil is lower than the exposure that has caused health effects. For example, if the margin of exposure is 10, this means that the exposure is 10 times below levels that cause harmful, non-cancerous effects.

ATSDR and NYSDOH estimated lifetime cancer risks by multiplying the estimated arsenic exposure by the USEPA arsenic cancer potency factor [USEPA 1995]. The cancer potency factor[3] is a numerical estimate of the carcinogenic strength (potency) of a contaminant.

Non-cancer Health Effects – Incidental Ingestion and/or Dermal Absorption of Contaminated Residential Shallow Soil

Short-Term Exposure

For each property, ATSDR and NYSDOH evaluated the health risks associated with a one-time episode in which a 1 to 2-year-old child is assumed to ingest both an unusually large amount of soil (5 grams, representing pica behavior) or the daily amount of soil specified in

[2] Pica is defined by behavior that involves eating and ingesting non-food substances, such as soil.

[3] EPA defines cancer slope factor (CSF) as "An upper bound, approximating a 95% confidence limit, on the increased cancer risk from a lifetime oral exposure to an agent. This estimate, usually expressed in units of proportion (of a population) affected per mg/kg-day, is generally reserved for use in the low-dose region of the dose-response relationship, that is, for exposures corresponding to risks less than 1 in 100." See also https://www.epa.gov/fera/risk-assessment-carcinogenic-effects.

ATSDR's reasonable maximum exposure (RME) scenario (200 milligrams per day). In each scenario, the soil concentration used to estimate the exposure dose is assumed to be the highest level of arsenic found in shallow soil samples at the property. The arsenic exposure doses in these short-term scenarios (estimated using current ATSDR guidance [ATSDR 2018]) are compared to the ATSDR acute MRL for arsenic of 0.005 mg/kg/day [ATSDR 2007]. The acute MRL is based on swelling (edema) of the face, and gastrointestinal and upper respiratory symptoms in people exposed to arsenic-contaminated soy sauce for 2-3 weeks, with a short-term observed effect level of 0.05 mg/kg/day [ATSDR 2007].

Short-Term Exposure from Pica Behavior

A single ingestion of a large amount of soil (5 grams) containing the maximum arsenic soil level found at each property by a 1 to 2-year-old pica child is estimated to result in exposures that exceed the ATSDR acute MRL of 0.005 mg/kg/day at all ten properties (indicated by hazard quotient greater than 1, Table 2). The estimated pica behavior doses range from 0.03 to 13 mg/kg/day. For three properties (properties 1, 3, and 4), the estimated exposure exceeds the short-term observed effect level (0.05 mg/kg/day [ATSDR 2007]) more than 100-fold. The estimated doses at five other properties (properties 2, 6, 7, 9, and 10) also exceeded the short-term observed effect level, but to a lesser degree. Possible health effects resulting from these pica exposures might be nausea, vomiting, headaches, stomach cramps, diarrhea, fatigue, chills, sore throat, and nasal discharge. These effects are usually temporary provided exposure to arsenic is stopped. However, exposures, particularly between 1 and 13 mg/kg/day—expected from a pica child scenario—could lead to serious, and potentially deadly health effects because they approach or exceed exposures that are reported to cause death [ATSDR 2007].

Short-Term Exposure from Non-Pica Behavior

Using the RME soil ingestion rate (200 milligrams/episode) for a 1 to 2-year-old child, the estimated exposure at seven properties exceeds the ATSDR acute MRL (hazard quotient greater than 1, Table 2). The estimated arsenic exposure from soil exceeds the short-term observed effect level on properties 1, 2, 3, and 4 (MOE less than 1, Table 2). For properties 6, 9, and 10, the short-term arsenic exposure from soil in the RME scenario exceeds ATSDR's acute MRL and results in a margin of exposure which is indicative of inadequate protection against short-term non-cancer health effects.

Based on both pica and non-pica acute exposure scenarios for young children, exposure to arsenic in soil on these residential properties shown in Table 2 constitutes a significantly elevated risk for the short-term non-cancer arsenic health effects previously described.

Table 2. Non-cancer hazard quotients for short-term exposure to arsenic in shallow soil for a 1 to 2- year-old child on residential properties on the Arsenic Mine Site

Property	Arsenic Soil Conc.[a] (mg/kg)	Estimated Pica Behavior Exposure[b] (mg/kg/day)	Estimated RME Exposure[b] (mg/kg/day)	Short-Term HQ[c] Pica	Short-Term HQ[c] RME	Short-Term MOE[d] Pica	Short-Term MOE[d] RME
1	49,300	13	0.52	2,595	104	< 1	< 1
2	6,050	1.6	0.064	318	13	< 1	< 1
3	56,000	15	0.59	2,947	118	< 1	< 1
4	20,600	5.4	0.22	1,084	43	< 1	< 1
5	181	0.048	0.0019	9.5	0.38	1.0	26
6	687	0.18	0.0072	36	1.4	< 1	6.9
7	317	0.083	0.0033	17	0.7	< 1	15
8	100	0.026	0.0011	5.2	0.2	1.9	47
9	1,520	0.4	0.016	80	3.2	< 1	3.1
10	841	0.22	0.0089	44	1.7	< 1	5.7

Data source: Arsenic Mine Site Health Consultation [ATSDR 2019]

HQ = hazard quotient; mg/kg = milligrams of arsenic per kilogram of soil; mg/kg/day = milligram of arsenic per kilogram of body weight per day; MOE = margin of exposure; RME = reasonable maximum exposure

[a] The highest arsenic concentration in soil on each property is used as the exposure point concentration to evaluate short-term exposure risks.

[b] Exposure estimates are for 1 to 2-year-old child weighing 11.4 kilograms who ingests 5,000 milligrams (pica) or 200 milligrams (RME) of soil per episode [ATSDR 2019a].

[c] The hazard quotient is calculated by dividing the estimated contaminant exposure by the ATSDR acute arsenic MRL of 0.005 mg/kg/day [ATSDR 2007].

[d] The margin of exposure is calculated by dividing the short-term human observed effect level for arsenic (0.05 mg/kg/day [ATSDR 2007]) by the estimated arsenic exposure from soil. A margin of exposure less than 1 means the estimated exposure is higher than the short-term human arsenic exposure reported to have caused health effects. On the other hand if MOE is 10, this means that the exposure is 10 times below levels that cause harmful, non-cancerous effects.

Long-Term Exposure

The estimated long-term exposure dose to the arsenic in residential shallow soil exceeded the ATSDR chronic MRL and USEPA arsenic RfD (0.0003 mg/kg/day [USEPA 1991; ATSDR 2007]) for all ten properties. Because the exposure exceeds the chronic MRL and RfD (hazard quotient greater than 1, Table 3), the NYSDOH evaluated the MOE for long-term health effects.

The arsenic reference dose is based on skin darkening (hyperpigmentation) and localized overgrowth of skin (keratosis) in humans exposed to high levels of arsenic in their drinking water over long periods of time [USEPA 1991]. The estimated long-term exposure to arsenic in soil on four properties is greater than the arsenic exposure level that caused hyperpigmentation in humans (MOE less than 1; properties 1, 2, 3, and 4; Table 3). This observed effect level (0.014 mg/kg/day [USEPA 1991]) is exceeded by 27-fold on Property 1, 14-fold on Property 3, 11-fold on Property 4, and 2-fold on Property 2. Long-term exposure to arsenic in soil on these properties poses a significantly elevated risk for non-cancer health effects, such as hyperpigmentation and keratosis, as well as other adverse health effects [USEPA 1991; ATSDR 2007].

For the other properties, the margin of exposure ranges from about 2 to 51 (Table 3). On Property 9, the soil exposure is about equal to the human observed effect level (margin of exposure of 1.3). This means that exposure to arsenic in soil on these properties reduces the margin of protection (as indicated by the small margins of exposure), and the difference between the arsenic exposure from soil and the arsenic observed effect level in humans indicates inadequate protection against non-cancer health effects. Long-term exposure to soil arsenic at these residential properties constitutes a significantly elevated risk for long-term non-cancer health effects.

Table 3. Non-cancer hazard quotients for long-term exposure to arsenic in soil for an infant on residential properties on the Arsenic Mine Site

Property	Arsenic Soil Concentration (mg/kg)[a]	Estimated Exposure (mg/kg/day)[b]	Long-Term HQ[c]	Long-Term MOE[d]
1	48,071	0.38	1,269	< 1
2	4,247	0.034	112	< 1
3	25,406	0.20	671	< 1
4	20,600 (maximum)	0.16	544	< 1
	4,142 (mean)	0.033	109	< 1
5	181 (maximum)	0.0014	4.7	10
	79 (mean)	0.0006	2	22
6	512	0.0041	14	3.5
7	317 (maximum)	0.0025	8	6
	116 (mean)	0.00091	3	15
8	100 (maximum)	0.00078	2.6	18
	35 (mean)	0.00027	0.9	51
9	1,398	0.011	37	1.3
10	841 (maximum)	0.0066	22	2.1
	199 (mean)	0.0016	5	9

Data source: Arsenic Mine Site Health Consultation [ATSDR 2019]

HQ = hazard quotient; mg/kg = milligrams of arsenic per kilogram of soil; mg/kg/day = milligram arsenic per kilogram body weight per day; MOE = margin of exposure; RME = reasonable maximum exposure

[a] For properties having 8 or more shallow soil samples, the arsenic exposure concentration is the 95% UCL of the mean. For properties having less than 8 shallow soil samples, both the maximum and average arsenic concentrations are used as exposure point concentrations and denoted in the table.

[b] Exposure estimates are for an infant, for whom the soil ingestion rate and body weight yield the largest contaminant dose among the seven life stages evaluated [ATSDR 2019a]. Contaminant exposure is assumed to occur via soil ingestion and dermal exposure.

[c] The hazard quotient is calculated by dividing the estimated contaminant exposure by the USEPA arsenic reference dose for oral exposure of 0.0003 mg/kg/day [USEPA 1991]. The USEPA RfD and ATSDR MRL [2007] are the same value (0.0003 mg/kg/day). The highest hazard quotient, calculated using ATSDR's reasonable maximum exposure parameters for infants [ATSDR 2019a].

[d] The margin of exposure is calculated by dividing the human observed effect level for arsenic (0.014 mg/kg/day [USEPA 1991]) by the estimated arsenic exposure from soil. A margin of exposure less than 1 means the estimated exposure is higher than the human arsenic exposure reported to have caused health effects, on the other hand if MOE is 10, this means that the exposure is 10 times below levels that cause harmful, non-cancerous effects.

Cancer Health Effects-Incidental Ingestion and/or Dermal Absorption of Contaminated Shallow Soil

Based on convincing evidence from scientific studies of people exposed to high levels of arsenic in drinking water, ingestion of arsenic increases the risk for skin, lung, and bladder cancer [ATSDR 2007; NRC 2001; NTP 2016]. The USEPA and US Department of Health and Human Services classify arsenic as a known human carcinogen [USEPA 1991; NTP 2016].

The estimated increased lifetime cancer risk posed by long term-exposure to arsenic in shallow soil on the residential properties ranged from 4 in 100,000 to 6 in 100 (Table 4). All ten properties have estimated lifetime cancer risk levels that typically trigger measures to reduce exposure (i.e., 1 in 10,000 or higher). For six properties the estimated lifetime cancer risk is 1 in 1,000 or higher, which is unusually high for environmental exposures. USEPA's generally acceptable risk for environmental exposures ranges from 1 in 10,000 to 1 in 1,000,000 as discussed in the National Contingency Plan (NCP), 40 CFR 300.430.

Overall, the arsenic on the residential properties poses a significantly elevated risk for cancer health effects. ATSDR's and NYSDOH's concern about the significance of the estimated cancer risk is increased by evidence from studies of people and animals that suggests the very young may be more sensitive to the carcinogenic effects of arsenic than adults [Ahlborn et al. 2009; Marshall et al. 2007; Smith et al. 2006; Tokar et al. 2011; Waalkes et al. 2003, 2006, 2007, 2009].

Table 4. Estimated lifetime cancer risk for long-term exposure to arsenic in shallow soil on residential properties on the Arsenic Mine Site

Property	Arsenic Soil Concentration (mg/kg)[a]	Estimated Lifetime Cancer Risk[b]
1	48,071	6 in 100
2	4,247	5 in 1,000
3	25,406	3 in 100
4	20,600 (maximum)	3 in 100
	4,142 (mean)	5 in 1,000
5	181 (maximum)	2 in 10,000
	79 (mean)	1 in 10,000
6	512	6 in 10,000
7	317 (maximum)	4 in 10,000
	116 (mean)	1 in 10,000
8	100 (maximum)	1 in 10,000
	35 (mean)	4 in 100,000
9	1,398	2 in 1,000
10	841 (maximum)	1 in 1,000
	199 (mean)	2 in 10,000

Data Source: Arsenic Mine Site Health Consultation [ATSDR 2019]
mg/kg = milligrams of arsenic per kilogram of soil

[a] For properties having 8 or more shallow soil samples, the arsenic exposure concentration is the 95% UCL of the mean. For properties having less than 8 shallow soil samples, both the maximum and average arsenic concentrations are used as exposure point concentrations, as denoted in the table.

[b] The lifetime estimated cancer risk is calculated by multiplying the estimated arsenic exposure from soil for each of seven age groups by the USEPA cancer potency factor for arsenic [USEPA 1995]. The cancer risks for each age group are then added to obtain an estimate of the lifetime cancer risk for 33 years of exposure to arsenic in soil at each property. Cancer risks estimates at higher exposures have additional uncertainty because the assumed shape of the dose-response curve used to derive the cancer potency factor may no longer hold. See the health consultation for additional details [ATSDR 2019a].

Conclusions

ATSDR has determined that current and potential future exposures to arsenic in residential soil on the Arsenic Mine Site warrant the issuance of a Public Health Advisory. In a 2019 health consultation, ATSDR and NYSDOH concluded that children at residential properties on the Arsenic Mine Site with the highest arsenic levels in shallow soils can have short-term ingestion exposures to arsenic that pose an immediate and significant threat to human health, constituting an urgent public health hazard. People can be exposed to harmful levels of arsenic by incidental ingestion of and/or dermal contact with contaminated soil. The observed concentrations of arsenic at the ten residential properties pose an urgent public health hazard.

This conclusion is based on the following five points:

1. Short-term exposure to arsenic in residential soil could result in adverse health effects. For all ten residential properties, a single ingestion of a large amount of soil (i.e., 5 grams) containing the maximum arsenic soil level found at each property, by a 1 to 2-year old child exhibiting pica behavior, results in an arsenic dose that either exceeds or approaches the arsenic exposure level which causes short-term health effects.

2. On seven properties a single ingestion of a smaller amount of soil (i.e., 200 milligrams) containing the maximum arsenic level results in an arsenic dose that either exceeds or approaches short-term arsenic exposure level which causes health-effects.

3. Long-term ingestion and dermal exposures of children and adults to arsenic in shallow soil at the Arsenic Mine Site residential properties pose a significant threat to human health and constitute a public health hazard. Long-term exposure to arsenic in residential soil could result in adverse cancer and non-cancer health effects. For all ten residential properties, long-term arsenic exposure in soil results in an estimated lifetime cancer risk of over 1 in 10,000. For six of the residential properties, the estimated cancer risk is over 1 in 1,000, which is unusually high for environmental exposures. Regarding non-cancer health risks, long-term exposure to arsenic in soil at all properties results in an arsenic dose that either exceeds or approaches the long-term arsenic exposure levels which cause health effects.

4. Neither the health consultation [ATSDR 2019a] nor this advisory evaluate other possible sources of arsenic exposure, such as inhalation of arsenic contaminated soil or dust, consumption of untreated drinking water, home raised animal products, or fruits and vegetables grown in contaminated soil. Consideration of these additional potential exposure pathways would not change the conclusions and recommendations provided in this advisory, but may likely support and strengthen them.

5. For decades, health risks at this site have been difficult to manage. Short-term remedies (e.g., cistern, water filters) have been implemented to address drinking water concerns; however, the soil remains contaminated with arsenic at levels that may cause serious health effects. As long as shallow soils remain contaminated with elevated levels of arsenic, children and adults will continue to be at risk of exposure to levels of arsenic posing an immediate and significant threat to human health. The amount of exposure to arsenic and consequent health risk depend, in part, on the degree to which residents access the contaminated properties and the activities they conduct there. These risks are considerable for all residents and for persons using the Arsenic Mine Site properties. If no permanent remedy is undertaken to address arsenic contamination of the Arsenic Mine Site, this risk can potentially affect all future residents and persons, particularly children, accessing the ten Arsenic Mine Site properties.

Recommendations and Proposed Actions

ATSDR recommends that the USEPA take immediate short- and long-term measures to **dissociate** persons, especially children, from exposure to arsenic in shallow soils at the Arsenic Mine Site. USEPA took steps to inform property owners of their soil arsenic results, investigate residential drinking water sources for potential arsenic contamination, and provide information to residents on best practices for avoiding exposures to arsenic in soil and drinking water. Additionally, USEPA should continue to investigate the potential impact on residential drinking water sources from arsenic releases related to historic mining activities at the Arsenic Mine Site and take appropriate actions to prevent harmful arsenic exposures.

Over the longer term, USEPA should permanently remediate the source of arsenic in shallow soils at the Arsenic Mine Site. Until completion of a permanent solution, all residents and persons accessing the Arsenic Mine Site properties may continue to be exposed to arsenic at levels that present an imminent and significant health threat. The USEPA should continue taking actions to prevent harmful exposures to arsenic in residential soils and other possible routes of exposure, such as consumption of contaminated drinking water.

Until a long-term remedial action can be put in place, ATSDR recommends that people take practical measures to reduce exposure to arsenic in soil:

- People, especially children, should minimize direct and repeated contact with bare soils.
- Maintain a grass or mulch cover wherever possible to help reduce direct contact with the soil.
- Wipe shoes on doormat or remove shoes before entering the home. Apply general good housekeeping practices by periodically damp mopping floors, vacuuming (using a HEPA filter if available), and cleaning furniture to help reduce exposure to outdoor soil that might be tracked indoors. Avoid the use of brooms.
- Avoid unnecessary digging in the dirt.
- Children and adults should wash hands after outdoor activities to help reduce the potential for exposure.
- Wash children's toys regularly.
- Refrain from landscaping activities that increase exposure to soil and create bare areas of soil.
- Refrain from eating food or smoking when working in the yard.
- Refrain from consumption of home raised fruits, vegetables, and animal products. If residents choose to garden, they grow crops in raised bed gardens and containers with clean soil imported from a non-contaminated area or bagged soil bought commercially instead of the existing soil. Residents should wear gloves when gardening and dispose or wash gloves thoroughly after each use.
- Regularly wash pets that may go outdoors and contact the soil.
- Properly maintain water treatment systems in accordance with the manufacturer's specification.

Additional public health actions are planned by ATSDR:

1. Immediately, ATSDR will coordinate with the NYSDOH, NYSDEC, Putnam County Health Department, USEPA, and the Town of Kent to provide health education to residents whose properties are affected by arsenic contamination on how to reduce arsenic exposure. Activities may include public meetings, public availability sessions, preparation of factsheets, and information sessions and mailings for local physicians to assist them in addressing their patients' concerns.

2. ATSDR will advise area health care providers, particularly pediatricians and family care practitioners, of this report's findings. ATSDR will make available materials related to arsenic exposure and health effects.

3. The ATSDR and NYSDOH will continue to coordinate with the USEPA, NYSDEC, and Putnam County Health Department to implement the recommendations contained in the accompanying health consultation [ATSDR 2019a].

4. The NYSDOH and ATSDR will review additional USEPA-collected data (e.g., drinking water, other contaminants of concern in soil), evaluate the public health implications of additional sampling results, and recommend public health actions as needed.

5. ATSDR will respond to requests involving the Arsenic Mine Site as necessary.

References

Ahlborn GJ, Nelson GM, Grindstaff RD, et al. 2009. Impact of life stage and duration of exposure on arsenic-induced proliferative lesions and neoplasia in C3H mice. Toxicology. 262(2): 106-113.

[ATSDR] Agency for Toxic Substances and Disease Registry. 1988. Health Consultation, Berns Family Arsenic Poisoning, Kent, Putnam County, New York. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2007. Toxicological Profile for Arsenic. Atlanta: US Department of Health and Human Services; August.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2018. Exposure Dose Guidance for Soil and Sediment Ingestion. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, September 25, 2018.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2019a. Health Consultation, Arsenic Mine, Evaluation of Shallow Residential Soils. Town of Kent, Putnam County, New York. EPA Facility ID: NYD982531469. New York State Department of Health under a cooperative agreement with ATSDR. Atlanta: US Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2019b. Soil Comparison Values. Atlanta, GA. [accessed 2019 Feb 22].

Marshall G, Ferreccio C, Yuan Y, et al. 2007. Fifty-year study of lung and bladder cancer mortality in Chile related to arsenic in drinking water. J Natl Cancer Inst. 99: 920-928.

[NRC] National Research Council. 2001. Arsenic in Drinking Water; 2001 Update. Washington, DC: National Academy Press.

[NTP] National Toxicology Program. 2016. 14th Report on Carcinogens. Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service. [accessed 2018 Nov 23]. Available at: https://ntp.niehs.nih.gov/pubhealth/roc/index-1.html.

[NYSDEC/NYSDOH] New York State Department of Environmental Conservation/New York State Department of Health. 2006. New York State Brownfield Cleanup Program. Development of Soil Cleanup Objectives. Technical Support Document. [accessed 2018 November 26] Available at: http://www.dec.ny.gov/chemical/34189.html.

[NYSDOH] New York State Department of Health. 1987. Memorandum: Review and Update on Arsenic in Well Water. Kelly Brix to Bonnie Farone. December 16, 1987.

Smith AH, Marshall G, Yuan Y, et al. 2006. Increased mortality from lung cancer and bronchiectasis in young adults after exposure to arsenic *in utero* and in early childhood. Environ Health Perspect. 114: 1293-6.

Tokar EJ, Diwan BA, Ward JM, et al. 2011. Carcinogenic effects of "whole-life" exposure to inorganic arsenic in CD1 mice. Toxicol Sci. 119: 73-83.

[USEPA] United States Environmental Protection Agency. 1991. Integrated Risk Information System. Arsenic, Inorganic (CASRN 7440-38-2). National Center for Environmental Assessment, Office of Research and Development [accessed 2018 Nov 23].

[USEPA] United States Environmental Protection Agency. 1995. Integrated Risk Information System. Arsenic, Inorganic (CASRN 7440-38-2). National Center for Environmental Assessment, Office of Research and Development [accessed 2018 Nov 23].

Waalkes MP, Ward JM, Liu, J, and Diwan BA. 2003. Transplacental carcinogenicity of inorganic arsenic in the drinking water: Induction of hepatic, ovarian, pulmonary and adrenal tumors in mice. Toxicol Appl Pharmacol. 86:7–17.

Waalkes MP, Liu J, Ward JM, et al. 2006. Urogenital carcinogenesis in female CD1 mice induced by in utero arsenic exposure is exacerbated by postnatal diethylstilbestrol treatment. Cancer Res. 66:1337–1345.

Waalkes MP, Liu J, and Diwan BA. 2007. Transplacental arsenic carcinogenesis in mice. Toxicol Appl Pharmacol. 222: 271-280.

Waalkes MP, Liu J, Germolec DR, et al. 2009. Arsenic exposure in utero exacerbates skin cancer response in adulthood with contemporaneous distortion of tumor stem cell dynamics. Cancer Res. 68: 8278-8285.

Weston Solutions, Inc. 2017. Removal Assessment Sampling Report, Phase I, Arsenic Mines Site, Kent, Putnam County, NY. November 2017.

Weston Solutions, Inc. 2018a. Removal Assessment Sampling Report, Phase II, Arsenic Mines Site, Kent, Putnam County, NY. March 2018.

Weston Solutions, Inc. 2018b. Removal Assessment Sampling Report, Phase III, Arsenic Mines Site, Kent, Putnam County, NY. September 2018.

Weston Solutions, Inc. 2018c. Removal Assessment Sampling Report, Phase IV, Arsenic Mines Site, Kent, Putnam County, NY. December 2018.