

Health Consultation

PUBLIC HEALTH EVALUATION OF
SOIL SAMPLING DATA IN
GREENWICH, FAIRFIELD COUNTY, CONNECTICUT

**Prepared by
The Connecticut Department of Public Health**

FEBRUARY 17, 2016

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners 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 or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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SUMMARY

INTRODUCTION

In the spring of 2014, the officials in the town of Greenwich (Town), Connecticut asked the Connecticut Department of Public Health (CT DPH) to evaluate whether soil removal in the area southwest of West Brothers Brook (the affected area) in the Greenwich High School property (school property) would protect public health. This health consultation evaluates whether soil removal in the affected area of the school property was health protective.

In July 2011, contractors found stained soils during the excavation of a utility trench on the school property. Elevated levels of polychlorinated biphenyls (PCBs) were found in soil samples. After this discovery, health assessors performed extensive soil characterization across the entire school property.

Non-native soil was present in about 16 acres of the school property beneath four of the athletic fields and an adjacent paved parking lot. This non-native soil (at depth and at the surface) was found to be contaminated with lead, chlordane, PCBs, and arsenic, although the PCB contamination was more widespread and frequently detected. However, soil in the affected area contained only elevated levels of arsenic. Therefore, this document only evaluates exposure to arsenic in soil in the affected area. Town officials are now reviewing and approving a final remedial action plan to remove contaminated soil for the remainder of the school property. Contaminated soil was removed from the affected area in the summer of 2014. At that time, CT DPH concluded that remediation of the affected area was health protective. This health consultation documents the public health evaluation that led to CT DPH's conclusion and focuses only on evaluating the health protectiveness of the remediation.

CONCLUSION

CT DPH evaluated current and future exposures to arsenic in surface soil and reached the following conclusion in the health consultation:

Conclusion

Remediation for the affected area of the school property is health protective for all users of this area. Cancer and noncancer risk estimates from exposure to arsenic in surface soil are below levels of health concern. Exposure to arsenic in surface soil in the affected area of the school property is not expected to harm the health of users.

Basis for Conclusion

Exposure to the 95% Upper Confidence Limit (UCL) arsenic concentrations in soil does not exceed a level that could harm people's health. Noncancer risk estimates from exposure to arsenic concentrations in surface soil from the affected area of the school property are well below levels of concern and cancer risk estimates are very low.

Next Steps

CT DPH recommends that the Town continue to work with CT DPH to inform teachers, students, and parents of the school of the continuing remedial efforts of the remainder of the school property. CT DPH also recommends that the Town continue to work with CT DPH to ensure that the remainder of the property is remediated in a manner that is safe and health protective.

The conclusions and recommendations in this health consultation are based on the data and information made available to the Connecticut Department of Public Health (CT DPH). This report was supported by funds from a cooperative agreement with the Agency for Toxic Substances and Disease Registry, United States Department of Health and Human Services.

BACKGROUND AND STATEMENT OF ISSUE

In the spring of 2014, officials from the town of Greenwich (Town), Connecticut asked the Connecticut Department of Public Health (CT DPH) to evaluate whether the cleanup of the area southwest of West Brothers Brook (affected area) in the Greenwich High School property (the school property) was protective of public health. The focus of this health consultation is to evaluate whether the completed cleanup was health protective. The cleanup included removing areas of soil (0–1 foot below ground surface (bgs)) with arsenic concentrations greater than 20 parts per million (ppm), replacing those areas with clean soil, and adding a fabric barrier between the clean soil and the contaminated soil.

Greenwich High School, located at 10 Hillside Road, is built on a parcel of about 54.75 acres and is owned by the Town. The school property is bounded by residential properties to the north and to the west, East Putnam Avenue to the south, and Hillside Road to the east. Residential properties are located beyond East Putnam Avenue and Hillside Road. The school property is developed with school buildings, paved parking lots, natural and artificial turf fields, and an undeveloped area (the affected area).

In July 2011, contractors found stained soils during the excavation of a utility trench on the school property. Elevated levels of polychlorinated biphenyls (PCBs) were found in soil samples. After this discovery, environmental contractors performed extensive soil characterization across the entire school property.

Non-native material was present in about 16 acres of the school property beneath four of the athletic fields and an adjacent paved parking lot. This non-native soil at depth and at the surface) was found to be contaminated with lead, chlordane, PCBs, and arsenic, although the PCB contamination was more widespread and frequently detected (the soil in the affected area of the school property only had arsenic contamination. (AECOMM 2013).

Town public health officials are in the process of negotiating approval for a remedial action plan for the remainder of the school property but have asked CT DPH to evaluate whether the remediation of the affected area of the school property was health protective. The affected area was remediated separately in the summer of 2014. At that time, CT DPH concluded that the planned remediation was health protective. After this determination, remediation was performed. This health consultation documents the public health evaluation that led CT DPH to conclude that the remediation of the affected area of the school property was health protective for high school students and teachers. It focuses only on evaluating the health protectiveness of the remediation for the affected area.

Site Visit

In September 2011, the CT DPH and the Connecticut Department of Energy and Environmental Protection (CT DEEP) conducted a site visit to observe the accessibility of the contaminated soil in the affected area of the school property and meet with Town staff to discuss health concerns from exposure to the contaminants in soil in the affected area and steps to prevent exposure. Accessors observed that all of the areas where surface soil was contaminated were fenced to prevent access and therefore exposure. The affected area was largely vegetated with trees and bushes and a wetland area but a few picnic tables and a walking path were present. This area was completely fenced until the area was remediated in the summer of 2014 (See map Appendix A).

Demographics

Approximately 2678 students attend Greenwich High School. About 73% of those students are Caucasian, 15% are Hispanic, 7% are Asian or Pacific Islander, 3% are African American, and 1% are two or more races. The school has 401 faculty members and administrators (NCES 2012).

Environmental Contamination and Health Comparison Values

Soil Data

In June 2013 (before remediation) and summer 2014 (post remediation), a contractor for the Town took 30 soil samples at 0–3 inches below ground surface (bgs) in the affected area of the school property (Table 1) and analyzed them for a full range of contaminants. Arsenic concentrations ranged from 1.77 (below the Residential Direct Exposure Criteria in Soil (CT DEC)¹ and the ATSDR chronic child Environmental Media Evaluation Guide [EMEG])² to 18.2 parts per million (ppm) (almost twice the CT DEC of 10 ppm) (CT RSRs 2013).

Five out of 30 soil samples exceed the CT DEC (AECOMM 2015). Some of those samples were taken before the remediation took place (in unexcavated areas where arsenic levels did not exceed 20 ppm) and some were taken post sampling in excavated areas (where arsenic levels exceeded 20 ppm). **Therefore, Table 1 shows what is currently in the surface soil after remediation.**

¹ The CT DEC is a health-based level developed to be protective of children and adults with frequent, long-term exposure to contaminants in soil (CT RSRs 2013).

² Agency for Toxic Substances and Disease Registry (ATSDR) chronic child EMEGs (Environmental Media Evaluation Guide) are estimated contaminant concentrations that are not expected to result in adverse noncarcinogenic health effects based on ATSDR evaluation. EMEGs are based on ATSDR MRLs (an estimate of daily human exposure to a substance (in milligrams per kilogram per day [mg/kg/day] for oral exposures and parts per billion [ppb] or micrograms per cubic meter [$\mu\text{g}/\text{m}^3$] for inhalation exposures) that is likely to be without noncarcinogenic health effects during a specified duration of exposure based on ATSDR evaluations and conservative assumptions about exposure, such as intake rate, exposure frequency and duration, and body weight (ATSDR 2007).

The United States (US) Environmental Protection Agency's (EPA) ProUCL software was used to calculate the 95% Upper Confidence Level (95% UCL) of the arithmetic mean of the surface soil sample results in Table 1 which is 8 ppm (and below both the CT DEC and the ATSDR chronic child EMEG). **However, the maximum arsenic concentration in surface soil (18 ppm) exceeds both the CT DEC and the ATSDR chronic child EMEG.**

Table 1. Summary of Surface Soil Results from the Southeast Corner of the Athletic Fields of Greenwich High School, Greenwich, Connecticut, June 2013 and Summer 2014.

Contaminant	Concentration Range (ppm*)	95% Upper Confidence Level (ppm)	Number of Exceedances of Comparison Value/Number of Samples Taken	Comparison Value (ppm)	Comparison Value Source
Arsenic	1.77-18.2	8	5/30	10	CT DEC [@]
				15	EMEG [^]

*ppm or parts per million

[@] CT RDEC = Residential Direct Exposure Criteria in Soil (CT Remediation Standard Regulations (RSRs, 2013).

[^] EMEG=ATSDR Chronic Child Environmental Media Evaluation Guide (ATSDR 2007).

DISCUSSION

Exposure Pathway Analysis

To determine if people are exposed to contaminants in soil in the affected area of the school property, CT DPH evaluated the environmental data and considered how people might come into contact with contaminants in soil. The possible pathways of exposure are dermal and ingestion. In other words, to be exposed to contaminants in soil, one must come into contact with the soil by touching it or by ingesting it accidentally. An exposure pathway consists of five elements (ATSDR 2005):

1. A source of contamination
2. Transport through an environmental medium
3. A point of exposure
4. A route of human exposure
5. A receptor population.

ATSDR categorizes an exposure pathway as either completed, potential, or eliminated. In a completed pathway, all five elements exist and indicate that exposure to a contaminant has occurred in the past, is occurring, or will occur in the future. In a potential exposure pathway, at least one of the five elements has not been confirmed, but it might exist. Exposure to a contaminant might have occurred in the past, might be occurring, or might occur in the future. An exposure pathway can be eliminated if at least one of the five elements is missing and will never be present (ATSDR 2005).

Current and Future Conditions

The affected area of the school property is generally a wooded, heavily vegetated area with a few park benches and a wetland area. Visitors (high school students, teachers, parents or anyone visiting the fields) to the athletic fields would use this area for passive recreation (walking, picnicking). Visitors could be exposed by dermal (touching the surface soil) or by ingestion. No current or future plans exist for digging in this area. Therefore, exposure to soil at depth is not a complete exposure pathway.

Much of the soil is covered by vegetation or grass so direct contact is reduced further.

Inhalation exposure to arsenic in soil is not evaluated because such exposure is minimal. This is largely because the soil is mostly covered by grass, and no mechanical disturbances of the soil occur (like lawn mowing in that area). In addition, activities occurring in this area (walking, picnicking) are not intense enough to make soil airborne.

Because the focus of this document is to evaluate whether the soil remediation in the affected area of the school property is health protective, CT DPH only evaluated current and future exposures to arsenic in soil.

Public Health Implications for Adults and Children

When determining the public health implications of exposure to hazardous contaminants, CT DPH considers how people might come into contact with contaminants and compares contaminant concentrations with health protective comparison values. When contaminant levels are below health-based comparison values, health impacts from exposure to those levels are unlikely. Contaminant levels exceeding comparison values do not necessarily indicate that health impacts are likely but instead warrant further evaluation. In this health consultation, CT DPH used the CT DEC's as health protective screening values. These values are health-based levels developed to be protective of children and adults with frequent, long-term exposure to contaminants in soil. CT DPH only evaluated complete exposure pathways where contaminants in surface soil exceeded the CT DEC's or ATSDR Child EMEG's. ATSDR provides toxicology information on arsenic in its fact sheet found here: <http://www.atsdr.cdc.gov/toxfaqs/tfacts2.pdf>.

Table 1 indicates that arsenic was detected in soil at levels above the CT DEC's in the affected area of the school property. Current and future exposure to soil is a complete exposure pathway. Teachers and high school students have the most exposure to the affected area, so they were selected as receptor groups for exposure evaluation. CT DPH assumed that contact with soil occurred twice a week, 6 months per year, for 25 years for teachers and 4 years for high school aged students. Body weights are assumed to be 80 kg for teachers and 62.6 kg for high school aged students (ATSDR 2014).

CT DPH did not evaluate current or future noncancer risk and lifetime cancer risk from dermal exposure to arsenic in soil because it is very minimal compared with noncancer and cancer risk from ingestion exposure.

Noncancer Effects

High School Student

Using the ATSDR Dose Calculator (ATSDR 2014) the 95% UCL concentration of 8 ppm as the exposure level, the average daily dose (ADD) from ingestion is $1.8\text{E-}6\text{mg/kg/day}^3$.

The ADD from the 95% UCL concentration is well below ATSDR's Minimum Risk Level (MRL) for chronic oral exposure (ATSDR 2007) and the US EPA's reference dose (RfD), which are both 0.0003 mg/kg/day (IRIS 1993). MRLs and RfDs are estimates of daily exposure to humans that are likely to be without harmful noncancer effects. Because the ADD does not exceed the MRL and RfD, noncancer health effects from current or future exposure to arsenic in soil at the affected area of the school property are unlikely.

High School Teacher

Using the 95% UCL concentrations of 8 ppm as the exposure level, the daily dose from ingestion is $7.1\text{ E-}7\text{ mg/kg/day}$. Because the ADD does not exceed the MRL and RfD, noncancer health effects from current or future exposure to arsenic in soil at the affected area of the school property are unlikely.

Cancer Effects

CT DPH also estimated lifetime cancer risks from exposure to arsenic for teachers and high school students who are exposed to arsenic in soil in the affected area.

For estimating cancer risk, the US EPA typically provides a potency factor for an environmental contaminant, such as arsenic. This potency factor (known as a slope factor or unit risk factor) is an upper-bound estimate of theoretical cancer risk for the general population for a lifetime of exposure to account for the possibility that potency may vary between the individuals.

High School Student

Using the 95% UCL concentration and the US EPA's oral cancer slope factor, exposure to soil in the affected area of the school property by a high school student for 4 years, suggests a *de minimus* (extremely low) risk of $1.4\text{ E-}7^4$.

³ Average daily dose (ADD) for noncancer effects from ingestion=(Exposure concentration*Ingestion rate *Exposure frequency* 0.000001)/Body weight.

For this teenager exposure scenario, $\text{ADD} = (8\text{mg/kg} * 100\text{ mg/day} * (0.1424\text{ (52days/365days)})) * 0.000001(\text{kg/mg})^{-1} / 62.6\text{kgs}$ (ATSDR 2014)

⁴ Lifetime Cancer Risk from ingestion=(ADD*Cancer Slope Factor*Age-Specific # of years)/Attenuating Factor (cancer)

For this teenage exposure scenario, Lifetime Cancer Risk from ingestion= $(1.8\text{E-}6\text{mg/kg/day} * 1.5\text{ mg/kg/day})^{-1} * 4\text{ years} / 78\text{years}$

Teacher

Using the 95% UCL concentration and the US EPA's oral cancer slope factor, exposure to soil in the affected area of the school property by a teacher for 25 years, suggests a *de minimus* risk of $3.4\text{E-}7$.

CONCLUSION

Noncancer risk estimates from exposure to arsenic concentrations in surface soil from the affected area of the school property are well below levels of concern and cancer risk estimates are very low. Exposure to arsenic in surface soil in the affected area is not expected to harm the health of students or teachers at the high school; therefore remediation of the affected area is health protective for all users.

RECOMMENDATIONS

1. CT DPH recommends keeping a layer of grass or mulch over the soil where appropriate to prevent soil erosion.
2. CT DPH recommends against digging greater than 1 foot below ground surface in any areas on the property. If digging must occur (e.g., installation of a fence), soil may need to be managed properly to prevent exposure (e.g., workers handling soil should use proper protective equipment and use dust control measures).
3. CT DPH recommends that the Town continue to work with CT DPH to inform teachers, students, and parents of the school of the continuing remedial efforts of the remainder of the athletic fields and to ensure that exposure from contamination in the soil (from the remainder of the athletic fields) is prevented or reduced.

REFERENCES

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REPORT PREPARATION

This health consultation for the Greenwich High School site was prepared by the Connecticut Department of Public Health under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). The consultation complies with the approval agency methods, policies, and procedures existing at the date of the publication. ATSDR has reviewed this document and concurs with its findings based on the information presented.

Author

Sharee Major Rusnak, MSPH, ScD
Epidemiologist
Environmental and Occupational Health Assessment Program
Connecticut Department of Public Health

Technical Project Officer

Laura Frazier
ATSDR
Division of Community Health Investigations

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LCDR Donna K. Chaney, MBAHCM
U.S. Public Health Service
4770 Buford Highway N.E. MS-F59
Atlanta, GA 30341-3717
(W) 770.488.0713
(F) 770.488.1542



