Health Consultation

LENOIR CAR WORKS SITE

LEAD ENVIRONMENTAL PUBLIC HEALTH INVESTIGATION

LENOIR CITY, LOUDON COUNTY, TENNESSEE

EPA FACILITY ID: TDD003384666

JANUARY 9, 2009

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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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Prepared By:

Tennessee Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Foreword

This document summarizes an environmental public health investigation performed by Environmental Epidemiology of the State of Tennessee Department of Health. Our work is conducted under a Cooperative Agreement with the federal Agency for Toxic Substances and Disease Registry. In order for the Health Department to answer an environmental public health question, several actions are performed:

Evaluate Exposure: Tennessee health assessors begin by reviewing available information about environmental conditions at a site. We interpret environmental data, review site reports, and talk with environmental officials. Usually, we do not collect our own environmental sampling data. We rely on information provided by the Tennessee Department of Environment and Conservation, U.S. Environmental Protection Agency, and other government agencies, businesses, or the general public. We work to understand how much contamination may be present, where it is located on a site, and how people might be exposed to it. We look for evidence that people may have been exposed to, are being exposed to, or in the future could be exposed to harmful substances.

Evaluate Health Effects: If people have the potential to be exposed to contamination, then health assessors take steps to determine if it could be harmful to human health. We base our health conclusions on exposure pathways, risk assessment, toxicology, cleanup actions, and the scientific literature.

Make Recommendations: Based on our conclusions, we will recommend that any potential health hazard posed by a site be reduced or eliminated. These actions will prevent possible harmful health effects. The role of Environmental Epidemiology in dealing with hazardous waste sites is to be an advisor. Often, our recommendations will be actions items for other agencies. However, if there is an urgent public health hazard, the Tennessee Department of Health can issue a public health advisory, warning people of the danger and can work with other agencies to resolve the problem.

If you have questions or comments about this report, we encourage you to contact us.

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Summary

In this health consultation, the Tennessee Department of Health, Environmental Epidemiology Program (EEP) evaluates information about contamination off-site of the Lenoir Car Works Site, Lenoir City, Tennessee. Surface soils were tested for lead at residential homes adjacent to the site. The measurements of lead in the surface soils of many yards were above the standard residential guidance value. Blood lead levels were measured in fourteen children and three pregnant women. All blood lead test results were below the threshold for intervention based on Tennessee Department of Health guidelines. Due to small number of participants living adjacent to the site participating in the blood lead sampling, the ability to interpret results of the blood lead testing was limited. No urgent health concerns were identified. The use of a model suggested that it would be prudent to remove contaminated residential soils to protect the public health.

Introduction

The Lenoir Car Works Site is located south of Lee Highway (Broadway) and north of Industrial Park Drive in Lenoir City, Loudon County, Tennessee. The, approximately 100-acre, industrial site was used from 1893 to 1985 for the manufacture of railroad cars and their components. The site housed several buildings, including iron and brass foundries. Slag and foundry sands were disposed of on the property. In 1988, the Lenoir Car Works Site was promulgated as a Tennessee Listed Hazardous Substance site. The industrial buildings have been removed. The site is now empty awaiting redevelopment.

Lead in soil was a known hazard onsite. There was public concern that lead from the site may also be off-site in the nearby community. The November 2007 *Health Consultation: Lenoir Car Works* concluded that an indeterminate health hazard existed for off-site exposure to lead because of inadequate off-site sampling.

The Tennessee Department of Environment and Conservation's (TDEC) Division of Remediation (DoR) and the EEP worked to gather the information needed to determine whether or not an off-site health hazard due to lead existed within the nearby community.

Two methods were used to gather new information. TDEC measured the amount of lead in the soils of residential yards. TDH tested the amount of lead in the blood of children and pregnant women in the community. TDEC, TDH EEP, the East Tennessee Region Health Office, and the Loudon County Health Department all worked together to plan and carry out the blood lead testing. This health consultation presents the results of the lead environmental public health investigation.

Discussion

The November 2007 *Health Consultation: Lenoir Car Works* detailed the community concerns, site history, and previous environmental investigations.

There are several ways for lead to have migrated off-site during operations of the Lenoir Car Works. Iron and brass foundries operated on the site. Dusts from these operations could have been blown by the wind into the nearby community. In addition to dusts, a large amount of foundry sands were created, were sometimes mined for slag metals, and were buried on-site. It is possible that foundry sands could have been buried or used as fill materials in the nearby area. Also, as the site was in use for nearly a century, the site boundary likely changed over the years. It is possible that an area of use or waste disposal extended beyond the current site boundary. An area such as this could easily have been forgotten and now have homes or other buildings constructed over the lead waste.

To respond to community concerns about possible off-site lead contamination, surface soil samples were collected. These samples were collected from nearby residential areas where people live and children play to determine if there are any off-site health hazards. Blood lead testing targeted the sensitive populations of young children and pregnant women.

Environmental Sampling

Lead is a naturally occurring element that is normally found in soil. The natural lead content of soils ranges from <10 to about 30 milligrams per kilogram (mg/kg) (ATSDR 2007). In Tennessee, the naturally-occurring background concentration is 45 mg/kg (Kopp 2001). Another evaluation of background lead concentrations in Tennessee had a range from non-detect to 70 mg/kg (Dragun and Chekiri 2005). However, the widespread use of certain products (such as leaded gasoline and lead-based paint) and the emissions from certain industrial operations (such as smelters) has resulted in higher levels of lead in some areas (ATSDR 2007).

TDEC performed shallow off-site surface soil sampling in late 2007. Soil samples were collected from 0 to 2 inches depth in residential yards and a publically accessible playground in the area near the former Lenoir Car Works. Shallow surface soils were first screened using an X-ray fluorescence (XRF) device to determine areas to test.

If the XRF showed elevated amounts of lead in surface soils, then shallow surface soils were collected for analysis. Soil samples were taken from 5 places in each yard and mixed together making one composite sample to be analyzed by the laboratory. One of these five places was from a *high activity area* in each yard. Samples were collected at least 8 feet from the precipitation “drip-line” of the house. For the playground samples, individual samples were collected without mixing. A total of 49 residential and publicly accessible playground surface soil samples were collected. Samples were analyzed by US EPA method SW-846 6010 and the results are compiled in Table 1.

TABLE 1: Concentration ranges of lead in milligrams per kilogram measured in off-site surface soils from a public playground and residential yards near the Lenoir Car Works Site (TDEC 2007).

Location	Lead measurements (mg/kg)	Maximum TN soils background range (mg/kg)	EPA guidance value (mg/kg)
off-site playground soils	37 – 85	45 - 70	400
off-site residential soils	38 – 1,490		

***Notes*:**
TN = Tennessee
mg/kg = milligrams per kilogram

The EPA has an established guidance value of 400 milligrams of lead per kilogram of soil (mg/kg) in residential areas. Amounts of lead in soils below 400 mg/kg generally do not pose any increased risk to health.

Seven soil samples were analyzed from the playground area on the west side of the site. Lead in the surface soils ranged from 37 to 85 mg/kg with an average value of 53 mg/kg. This range is well below the 400 mg/kg guidance value. A typical maximum background amount of lead in Tennessee soils is 45 mg/kg. It appears that the playground has not been impacted by lead contamination.

Residential yards had lead in surface soil measurements ranging from 38 to 1,490 mg/kg with an average of 402 mg/kg (TDEC 2007). Only about 5 of the 42 homes adjacent to the Lenoir Car Works Site were within typical background values. Most of the samples showed elevated amounts of lead in surface soils. There were 21 residential samples at or above 400 mg/kg. Clearly, there is lead contamination that extends off-site into the adjacent neighborhood. Specifically, elevated amounts of lead in surface soils were identified along the south side of Lee Highway (Broadway) and the east side of Halls Ferry Road.

Lead Toxicity

Lead, at high concentrations in a person's body, has been found to primarily affect the peripheral and central nervous systems, renal function, blood cells, and the metabolism of vitamin D and calcium. Lead can also cause hypertension, reproductive toxicity, and developmental effects. The nervous system is the most sensitive target of lead exposure. Fetuses and young children are especially vulnerable to the neurologic effects of lead because their brains and nervous systems are still developing and the blood-brain barrier is incomplete. Children exposed to high levels of lead can have increased incidences of lasting neurologic and behavioral damage. It is often impossible to determine these effects through clinical examination. Children suffer other neurologic effects at much

lower exposure levels than adults. There is a large body of evidence that associates decrement in intelligence quotient (IQ) performance and other neuropsychological defects with lead exposure (ATSDR 2007).

Additional information about lead and its affects on health can be found in the Appendix at the end of this document. Just coming into contact with lead will not cause harm. There are many factors to consider when evaluating exposure to lead.

Introduction to Chemical Exposure

To determine whether persons have been, are, or are likely to be exposed to chemicals, EEP evaluates mechanisms that could lead to human exposure. An exposure pathway contains five parts:

- a source of contamination,
- contaminant transport through an environmental medium,
- a point of exposure,
- a route of human exposure, and
- a receptor population.

An exposure pathway is considered complete if there is evidence that all five of these elements are, have been, or will be present at the site. The pathway is considered either a potential or an incomplete exposure pathway if there is no evidence that at least one of the five elements listed has been, is, or will be present at the site.

When a chemical is released from an area such as an industrial plant or from a container such as a drum, it enters the environment. A chemical release does not, however, always lead to human exposure. Persons can be exposed to a chemical when contact is made by breathing, eating, drinking, or otherwise touching the chemical.

Furthermore, physical contact alone with a potentially harmful chemical in the environment by itself does not necessarily mean that a person will develop adverse health effects. A chemical's ability to affect public health is also controlled by a number of other factors, including:

- the amount of the chemical that a person is exposed to (dose)
- the length of time that a person is exposed to the chemical (duration)
- the number of times a person is exposed to the chemical (frequency)
- the person's age and health status
- the person's diet and nutritional habits.

A person's potential exposure pathway for lead is by swallowing it after hand-to-mouth behavior (incidental ingestion exposure), breathing dust (inhalation exposure) or getting it on their skin (dermal exposure). For lead in surface soil incidental ingestion is the primary exposure pathway for children and adults. The environmental soil testing results, as shown in Table 1, indicated that there are elevated concentrations of lead in soil of properties adjacent to the site. People living near the site could be exposed if they

ingested contaminated soil. Children with unique behaviors, such as pica (dirt eating), would be at greatest risk from lead exposure (ATSDR 2007).

Whether or not the elevated lead concentrations are harmful can only be estimated. One way to estimate is using a mathematical model. Another way is to measure the amount of lead in people's bodies.

Blood Lead Testing

Because surface soil in some residential yards was above the EPA guidance value of 400 mg/kg, blood lead testing was offered to the community. Free blood lead testing was offered for children, aged 6 months to 10 years, and pregnant women. This environmental health investigation was performed by the East Tennessee Regional Health Office and the Loudon County Health Department.

The outreach to inform the community of the blood lead testing was extensive. Regional Health Office personnel went door-to-door in the community surrounding the site handing out flyers, explaining the free blood testing, and encouraging participation. Many lead fact sheets, in both English and Spanish, were distributed while going door-to-door. Additional notices were posted in local stores and churches. Pastors of local churches were informed so they could encourage members of their congregations to participate. The Mayor's Office of Lenoir City and other civic officials also helped publicize the event. The local newspaper and local radio stations were instrumental in announcing the event to the community.

Blood tests were done as part of two community blood lead screening outreach events scheduled for Thursday, April 24, and on Tuesday, April 29, 2008. The community outreach was performed at the War Memorial Building, secured through the cooperation of civic officials. The War Memorial Building was a neutral site within walking distance of the affected neighborhood. Even though those residents living near the Lenoir Car Works Site were targeted, free blood tests were performed for any interested child or pregnant woman during the two events. Of course, parents had to give permission for their child to have their blood lead tested.

Procedures before the blood draw included collecting address and other information upon entering the facility, answering fifteen questions pertaining to health and lifestyle choices, and being led to the actual blood draw station. Additional information was gathered from the individual at the station after which blood was drawn by one of the local or regional public health department nurses. Upon finishing the blood collection, the individual was provided cookies and juice. Participants were also provided take-home information about nutrition, healthier living, protecting children from exposure to lead, and other general health topics.

First Day of Blood Lead Testing

A total of 10 women and children had their blood drawn for lead analysis the first day of the outreach effort on Thursday, April 24. Volunteers from the Loudon County Health Department, Lenoir City/Loudon County EMS, other community agencies, and civic officials were on hand offering assistance as needed. Secondary public health messages of maintaining a healthy lifestyle and protecting children were promoted at the event. TDH EEP representatives observed the set-up and community interest. The 10 blood samples from the first day were submitted for testing at the end of the day.

Second Day of Blood Lead Testing

On April 29, a total of 21 women and children had their blood drawn for lead analysis. Again the blood collection and education went as planned. Problems were encountered with the sample transport procedure allowing the samples to not be maintained at the proper temperature. Therefore. the decision was made to discard these blood samples. The individuals whose blood was lost were contacted to see if they would agree to having their blood drawn a second time. All persons agreed to have their blood drawn again. However, when the retesting was done on June 3, 2008, only 7 out of the 21 people returned.

Blood Lead Sampling Results

Overall, the blood lead of 17 individuals was measured. The participants included 14 children, aged 3 to 16, and 3 women, aged 23 to 41. Children aged 6 months to 10 years were targeted for blood lead measurement. If the tested child had siblings older than 10 and the parents requested, the older child was also tested. Of the 17 people who had blood lead testing, 14 participants (12 children and 2 adults) lived in Lenoir City. One child participant listed their residence as Knoxville. Another child participant lived in Etowah, and one adult participant was from Loudon. Only one person who actually lived adjacent to the Lenoir Car Works Site was tested.

Table 2 shows the age, gender, race, and blood lead measurement result for the 14 children who participated in this lead environmental health investigation.

TABLE 2: Concentration of lead in blood of child participants (µg/dL).

Age	Gender	Race	Result
7	M	W	3
3	M	W	2
10	F	W	2
3	M	W	2
16	M	W	2

TABLE 2: Concentration of lead in blood of child participants (µg/dL).

Age	Gender	Race	Result
4	M	W	2
8	F	W	6
11	M	W	1
14	F	W	1
4	M	W	1
5	F	W	1
8	M	W	1
3	M	W	1
3	F	W	2

Notes:
µg/dL = micrograms per deciliter
Age reported in years
Gender Codes: M = Male, F = Female
Race Codes: W = White, B = Black, O = Other

All blood lead measurements were well below 10 micrograms of lead per deciliter of blood (µg/dL) recommended for follow-up.

Table 3 shows the age, race, and blood lead measurements of the three pregnant women who participated. Again, all results were below the recommended 10 µg/dL Tennessee Department of Health guideline for follow-up.

TABLE 3: Concentration of lead in the blood of pregnant women participants (µg/dL).

Age	Gender	Race	Result
41	F	B	2
27	F	W	2
23	F	W	2

Notes:
µg/dL = micrograms per deciliter
ge reported in years
Gender Codes: M = Male, F = Female
Race Codes: W = White, B = Black, O = Other

Unfortunately, only one of the participants in the lead environmental health investigation listed their residential address from one of the locations adjacent to the Site where surface

soil samples were collected. The surface soil lead concentration in the yard was about 400 mg/kg. The blood lead level of the child from this address was 1 µg/dL.

Several participants listed their addresses as being within the downtown area of Lenoir City and, therefore, generally near the site. Because of the many years of operation and the lack of erosion controls for the site, emissions containing lead could have been deposited in other areas near the site. All blood lead measurements of these participants were appropriately low.

No one participated in the blood draw from those addresses where TDEC collected shallow surface soil samples that had lead concentrations above the EPA soil screening level. Therefore, blood lead levels could not be directly correlated to lead concentrations in residential yards.

Based on the blood lead data, no one in the community who participated in the lead environmental health investigation had elevated blood lead results. All participants were informed of their blood lead concentrations in letters sent out by the East Tennessee Regional Health Office.

Unfortunately, it was impossible to interpret the blood lead levels as related to soil concentration. Therefore, there is an indeterminate public health hazard from off-site shallow soils in residential yards adjacent to the site.

Limitation

This lead environmental public health investigation aimed to gather blood lead information for the community members who live closest to the Lenoir Car Works Site. Those people living near the site were targeted for participation. Blood lead testing was offered freely to all children and pregnant women. After a mishap with the handling of some of the blood samples, several test results that would have represented people living close to the site were lost. In the end, only the test result for one person who actually lived near the site was available. This limitation made it impossible to make an evidence-based conclusion about whether off-site lead in residential surface soil has impacted the blood lead levels of persons living close to the site.

Conclusions

1. Lead concentrations in surface soils measured in 42 off-site residential yards near the Lenoir Car Works Site, Lenoir City, Loudon County, Tennessee, ranged from 38 to 1,490 mg/kg. Lead in soil at 21 of the properties was measured to be about or greater than the 400 mg/kg EPA residential lead in soil guidance value.

2. Blood lead test results from 14 children and 3 pregnant women ranged from 1 to 6 ug/dL, well below the typical 10 µg/dL health guideline.

3. Only one participant lived adjacent to the Lenoir Car Works Site in Loudon County.

4. Because of limitations with participation in this lead environmental public health investigation, no evidence-based data was generated to enable conclusions to be made about the relationship between blood lead levels and surface soil lead levels.

5. Based on the results of the surface soil sampling conducted by TDEC in 42 off-site residential yards a Public Health Hazard exists due to elevated lead in the off-site residential soils.

Recommendations

1. The residential properties with elevated amounts of lead in surface soils should be evaluated by TDEC/EPA for cleanup.

2. Continue to keep trespassers from accessing the site by keeping the perimeter fence maintained and secure.

3. Post signs informing the public that the site is contaminated and that the site may pose a serious health threat.

Public Health Action Plan

1. Environmental Epidemiology will provide this public health document to the appropriate environmental regulatory agencies, public health agencies, the participants, local community, civic officials, and other interested parties.

2. Environmental Epidemiology will continue to work with TDEC and will be available to review the results of any additional work related to public health or comment on any proposed work plan for TDEC.

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Figures

FIGURE 1. Map of 100-acre former Lenoir Car Works Site and surrounding area.
Source: Google Earth, 2008

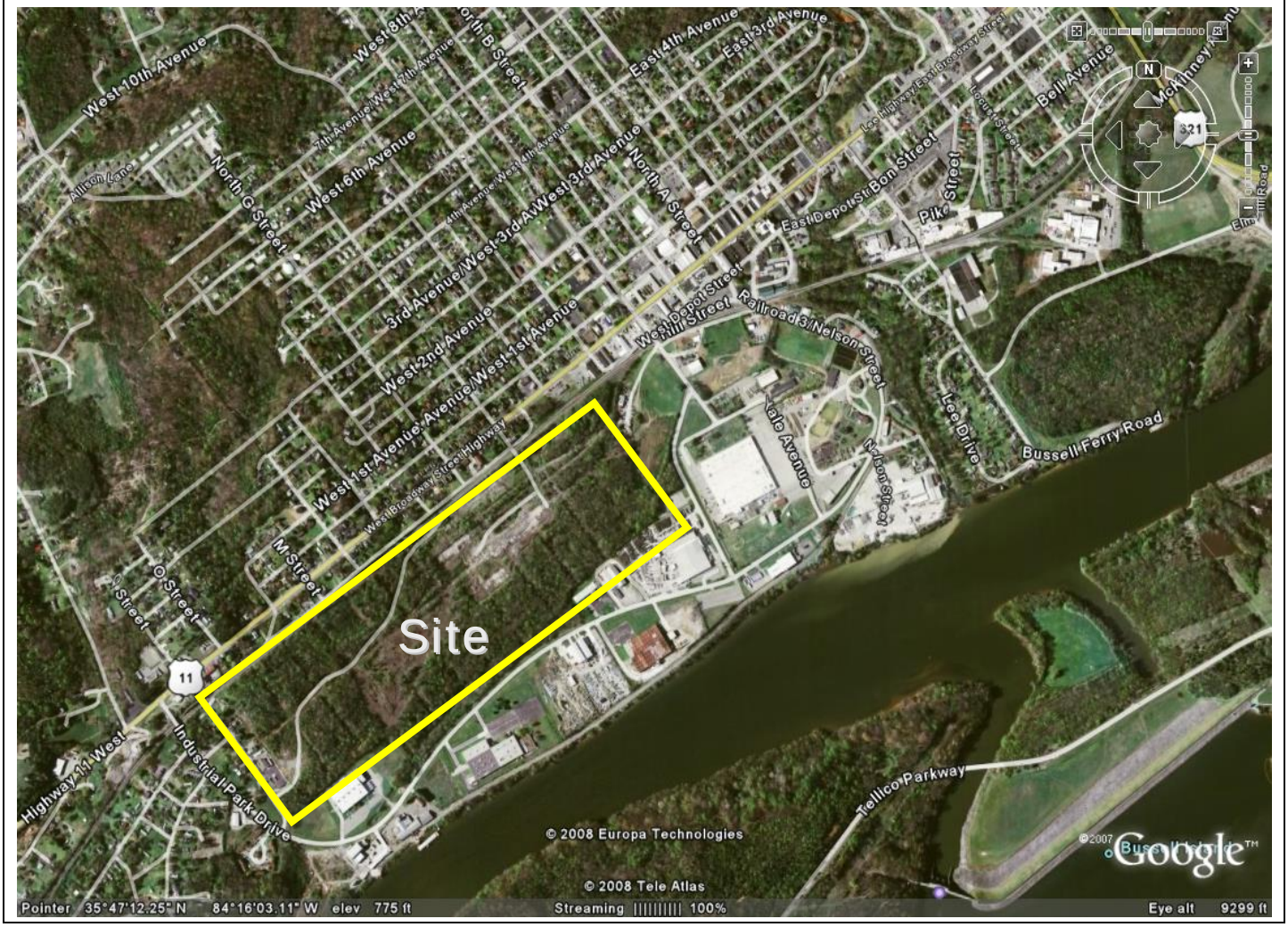

FIGURE 2. Photo of some residential properties adjacent to the Lenoir Car Works Site. Photo taken near a site entrance to show the close proximity to the residential yards. Source: David.M. Borowski, Tennessee Department of Health

FIGURE 3. Photographs of the War Memorial Building in Lenoir City set up for the public outreach event when free blood lead screening was offered to the community. The privacy curtains for the blood draws and a health education display are featured.
Source: Bonnie Bashor, Tennessee Department of Health

Appendix

Information about Lead

Lead is a naturally occurring chemical element that is normally found in soil. In Tennessee, the upper limit for background concentrations is 45 ppm (Kopp 2001). However, the widespread use of certain products (such as leaded gasoline and lead-based paint) and the emissions from certain industrial operations (such as smelters) has resulted in higher levels of lead in some areas (ATSDR 2007).

Lead primarily affects the peripheral and central nervous systems, renal function, blood cells, and the metabolism of vitamin D and calcium. Lead can also cause hypertension, reproductive toxicity, and developmental effects. The nervous system is the most sensitive target of lead exposure. Fetuses and young children are especially vulnerable to the neurologic effects of lead because their brains and nervous systems are still developing and the blood-brain barrier is incomplete. There may be no lower threshold for some of the adverse neurologic effects of lead in children; some of these effects have been documented at exposure levels once thought to cause no harmful effects (<10 µg/dL) (CDC 1997a). Because otherwise asymptomatic individuals may experience neurologic effects from lead exposure, clinicians should have a high index of suspicion for lead exposure, especially in the case of children.

There is a wide range of neurologic effects associated with lead exposure, some of which may likely be irreversible. Some of the neurologic effects of lead in children may persist into adulthood. One study, for example, correlated lead exposure with lower class standing (classroom performance); greater absenteeism; more reading disabilities; and deficits in vocabulary, fine motor skills, reaction time, and hand-eye coordination in young adults more than 10 years after childhood exposure (Needleman et al. 1990).

In adults, lead can cause health problems such as high blood pressure, kidney damage, nerve disorders, memory and concentration problems, difficulties during pregnancy, digestive problems, and pain in the muscles and joints. The National Toxicology Program report has listed lead as a potential carcinogen. Because of chemical similarities to calcium, lead can be stored in bone for many years. Even after exposure to environmental lead has been reduced, lead stored in bone can be released back into the blood where it can have harmful effects. Normally this release occurs relatively slowly. However, certain conditions, such as pregnancy, lactation, menopause, and hyperthyroidism can cause more rapid release of the lead, which could lead to a significant rise in blood lead level (ATSDR 2007).

Certification

This Health Consultation: Lenoir Car Works, Lead Environmental Health Investigation, Lenoir City, Loudon County, Tennessee, was prepared by the Tennessee Department of Health Environmental Epidemiology under a Cooperative Agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was prepared in accordance with the approved methodology and procedures that existed at the time the health consultation was begun. Editorial review was conducted by the Cooperative Agreement Partner.

Technical Project Officer, CAT, CAPEB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

Team Leader, CAT, CAPEB, DHAC, ATSDR