

Health Consultation

Recommendations for Off-site Sampling

LENOIR CAR WORKS

LENOIR CITY, LOUDON COUNTY, TENNESSEE

EPA FACILITY ID: TDD003384666

NOVEMBER 9, 2007

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

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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 could 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 will 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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Or call us during business hours at: (615) 741-7247 or toll-free (800) 404-3006.

Background and Statement of Issue

The Tennessee Department of Environment and Conservation (TDEC) Division of Remediation (DoR) contacted Tennessee Department of Health (TDH) Environmental Epidemiology (EEP) after they received a comment from a concerned citizen regarding off-site contamination in their neighborhood near the former Lenoir Car Works site. The citizen expressed concern that pollution, through flooding or airborne means, may have migrated off-site and into their neighborhood. They requested that TDEC evaluate the environmental impact of the Lenoir Car Works site on the people who live nearby.

TDEC DoR was unsure whether sufficient data had been collected off-site to fully respond to the citizen's concern. TDEC asked EEP to evaluate previous off-site sampling to determine whether the off-site sampling was adequate, and, if not, to assist with guidance on additional sampling appropriate to evaluate potential community health concerns. Therefore, the purpose of this health consultation is to assist TDEC DoR with evaluating potential health concerns in the vicinity of former Lenoir Car Works site.

Following a site visit in April 2007, EEP was concerned with easy site access. EEP sent a letter to TDEC suggesting that the site may be a potential human health hazard for trespassers. This health consultation will also include an evaluation of environmental health risk to site trespassers.

Figures 1 and 2 show the former Lenoir Car Works property that is located south of Lee Highway and north of Industrial Park Drive in Lenoir City, Tennessee. The approximately 100-acre property was home to industrial activities that began in 1893 with the Bass Foundry and Machine Shops. In 1904, Lenoir Car Works was chartered. The Lenoir Car Works operated from 1907 through 1985 for manufacture of rail cars and their components. Multiple buildings were utilized for this purpose, including ferrous (iron) and nonferrous (brass) foundries. Freight car journal bearings were manufactured at the facility by reprocessing scrap journal bearings. As part of the operation, slag and foundry sands were disposed on the property and, during part of the operational history, non-ferrous slag was sold for recycling. Foundry sands and slag deposited on-site were reportedly mined for slag in the 1940s and again in 1983. Foundry sands were sifted to remove metal slag. Slag was loaded on rail cars and was transported off-site for reuse. Sifted foundry sands remain on-site.

The large chimney on the property was associated with the complex. Although, a September 16, 1971 Air Pollution Field Inspection verified that there was no smoke stack for the brass smelting furnaces, the emissions exited out the windows. A battery of 4 or 5 melting furnaces melted 17,000 pounds of bronze in an eight-hour day. There was also a lead melting vat that was vented to the atmosphere. Air Pollution Field Inspection reports and files also referenced an old baghouse, a dust collector (in operation since 1940s), and possibly several other items that may have accumulated dust (DoR 2007).

The Lenoir Car Works business dissolved in 1986. As of this report, Southern Regional Industrial Railway Inc. is the current owner of record for the for Lenoir Car Works property. The Lenoir Car Works site was promulgated as a Tennessee Listed Hazardous Substance site in 1988. Since that time, several site investigations of the former Lenoir Car Works facility were performed. Investigations evaluated areas of foundry sand, areas of slag disposal, an aboveground storage tank area, and a possible transformer pad. Diesel range organics were measured in soils in the vicinity of the aboveground storage tank. PCBs were not detected in the transformer pad area. A number of drums were evaluated and removed from the site. Five monitoring wells were also installed on the property. One of these monitoring wells contained low levels of naphthalene and several other constituents consistent with petroleum. During the site characterization process, it was apparent that lead and arsenic in some of the foundry sand and slag were the chemicals of concern for the site. Air Pollution Control records indicate that asbestos containing building materials were abated during different projects from June 1, 1999, to March 31, 2002 (DoR 2007).

It is reported that both iron and brass foundries operated at the former Lenoir Car Works site. Foundry sands were known to have different characteristics. Slags with several different colors are also found on the property indicating the different slags could contain different compositions of metals. Slag and foundry sand is present over a large portion of the site. It was estimated that approximately 180,000 cubic yards of foundry sand with slag remain on the property (DoR 2007).

As of this report, hazardous substances remaining on the site include lead and arsenic associated with slag and foundry sand. The contaminants are at concentrations of concern for either a future residential or industrial use scenario. Results from monitoring wells installed on the property did not indicate elevated levels of lead or arsenic in groundwater. Soil samples collected under the foundry sand generally contained concentrations of lead and arsenic consistent with background concentrations (Kopp 2001). Therefore, lead and arsenic are not believed to have migrated to groundwater.

As of this report, the former Lenoir Car Works property is not being used and has not been used since it was closed in 1985. All buildings associated with the former Lenoir Car Works have been razed. Foundations and rubble remain on site. Many of the former rail lines have been removed and old railroad ties are mixed with piles of brush and other material. Some of the brush piles on site have slag and foundry sand mixed in.

As of this report, clean up is anticipated in the near future. The intended future use of the property is for commercial/industrial redevelopment. The future use of this property was discussed at a public availability session for the site and received local media attention. Concerned citizens contacted TDEC regarding health concerns and possible off-site contamination.

There are homes adjacent to the site as shown in Figure 3. Swing sets and lawn chairs are present in backyards that are next to the train tracks. Children were observed playing in their yards and walking near the site entrance.

As of this report, there is a fence on the northwestern portion of the property between the former Lenoir Car Works and the active rail line. Several holes in the fence were recently repaired. A new gate was also installed on the entrance closest to the homes. There is a gate on the second entrance by the recycling center adjacent to the southwestern end of the property. Much of the property is not currently fenced and could be passable by trespassers.

Discussion

Introduction to chemical exposure

To determine whether persons are, have been, or are likely to be exposed to chemicals, Environmental Epidemiology of the Tennessee Department of Health evaluates mechanisms that could lead to human exposure. An exposure pathway contains five parts:

1. a source of contamination,
2. contaminant transport through an environmental medium,
3. a point of exposure,
4. a route of human exposure, and
5. 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, or if there is a lower probability of exposure.

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.

Health comparison values that can be used as screening values have been derived by ATSDR and EPA. The health comparison values are screening values. If the concentrations found in soil are less than the comparison values, we can be reasonably

certain that no adverse health effects will occur in people who are exposed. Health comparison values should not be used for more than screening purposes. They are not intended to be used as clean up levels.

A person’s potential exposure pathway for arsenic or lead is by swallowing it after hand-to-mouth behavior (ingestion exposure), breathing dust (inhalation exposure) or getting it on their skin (dermal exposure). People could be exposed if they came into contact with contaminated soil.

Potential for off-site exposure

The wind direction at this site is unpredictable as there are frequent wind inversions in the region. Chemicals historically dispersed into the air may have blown in any direction. On-site dust could have moved off-site. It is possible that dust may have deposited in residential areas near the site. Many houses are located just north of the site. There are two apartment buildings adjacent to the site. There is also a playground nearby.

Potential for on-site exposure

During the site visit, EEP observed that bricks, railroad ties, and other materials had been removed from the site. Other signs of trespassing included empty bottles and food wrappers on the site. The site has been cleared of vegetation. For frequent trespassers, exposure routes are complete for incidental ingestion of soil and inhalation of dusts.

Environmental sampling

The contamination on-site of the former Lenoir Car Works has been well characterized (DoR 2007 and URS 2005) through adequate sampling. Table 1 shows the range of concentrations of lead and arsenic found in soil samples on-site of the former Lenoir Car Works and health comparison values (ATSDR 2004, URS 2005, DoR 2007, and EPA 2002). The contamination is not distributed uniformly; some accessible areas have the highest concentrations, while other areas have background levels of lead and arsenic.

TABLE 1: Concentration ranges of lead and arsenic (ppm or mg/kg) measured in soils on-site at Lenoir Car Works based on several thorough sampling reports.		
	Lead (Pb)	Arsenic (As)
Lenoir Car Works site	10.3 – 55,600	0.41 – 241
ATSDR RMEG ¹		20 Child 200 Adult
EPA Region 9 PRG ² for industrial soil	750	1.6
EPA Region 9 PRG ² for residential soil	400	
¹ = ATSDR Reference Dose Media Evaluation Guide ² = EPA Region 9 Preliminary Remediation Goal		

Incomplete data exists for off-site contamination. A November 2001 investigation *Off-Site Sampling Investigation Results* did not provide adequate information as properties were purposefully chosen or other properties were excluded for undetermined reasons (CPF 2002). Later, the Loudon County Economic Development Agency hired an environmental consulting firm to do limited, off-site sampling of city easements. This project did not include sampling residential properties (S&ME 2006). The off-site data for Lenoir Car Works that is available is provided in Table 2. Environmental Epidemiology feels that this data is too limited to draw health-based conclusions.

TABLE 2: Concentration ranges of lead and arsenic (ppm or mg/kg) measured in soils off-site of Lenoir Car Works based on two limited sampling reports.		
	Lead (Pb)	Arsenic (As)
Off-site Sampling Investigation Results 2001 (CPF 2002)	14 - 220	4.4 - 13
Summary of off-site Sampling Results 2006 (S&ME)	36- 360	1.4 - 10
ATSDR RMEG ¹		20 Child 200 Adult
EPA Region 9 PRG ² for industrial exposures	750	1.6
EPA Region 9 PRG ² for residential exposures	400	
¹ = ATSDR Reference Dose Media Evaluation Guide ² = EPA Region 9 Preliminary Remediation Goal		

For many chemicals, EPA Region 9 has established health guidance values called preliminary remedial goals (PRGs), which are tools for evaluating contaminated sites (EPA9 2002). PRGs are risk-based calculations designed as screening levels and are one method often used to set worker health protective criteria when job site and land use alterations are being considered. Tables 1 & 2 show the EPA Region 9 industrial soil PRG and the residential soil PRG for lead. ATSDR has established health comparison values called reference dose media evaluation guides (RMEGs) that can be used as a screening tool. Tables 1 & 2 show the ATSDR RMEG value for arsenic (ATSDR 2004).

The available on-site data shows that some concentrations of lead and arsenic are above health screening values. In areas of the site where the highest concentrations of chemicals are present, there could be a health hazard to trespassers who frequent the site. The off-site sampling data that was available for review is too limited to make comparisons to screening values such as the PRG and RMEG. Additional environmental sampling data should be collected from nearby residential areas that are representative of where people live and children play to determine if there are any off-site health hazards.

Toxicology of chemicals of concern

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 1999).

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 1999).

Arsenic

A naturally occurring element, arsenic is widely distributed in the Earth's crust. In Tennessee, the upper limit for background concentrations is 10 ppm (Kopp 2001). Kopp 2001 was partially based on TDEC DoR data. TDEC DoR has demonstrated through more recent evaluations that, in some areas, background arsenic concentrations in

Tennessee are greater than 10 mg/kg. TDEC DoR allows site-specific background concentration determination in areas where elevated arsenic background concentrations are anticipated (Andy Binford, personal communication). Elemental arsenic sometimes occurs naturally. More often, arsenic is found with other elements forming inorganic compounds. Arsenic can change chemical form, but is never destroyed. Inorganic arsenic occurs naturally in minerals and ores of copper and lead. That is the kind of arsenic found on this site. Most of these arsenic compounds are white or colorless powders. Most are reported to have no smell or taste. People likely cannot tell if there is arsenic in the air (or dust) they are breathing.

Inorganic arsenic has been recognized as a human poison since ancient times, and large oral doses (above 60,000 ppb in food or water) can result in death. If you swallow lower levels of inorganic arsenic (ranging from about 300 to 30,000 ppb in food or water), you may experience irritation of your stomach and intestines, with symptoms such as stomachache, nausea, vomiting, and diarrhea. Other effects you might experience from swallowing inorganic arsenic include decreased production of red and white blood cells, which may cause fatigue, abnormal heart rhythm, blood-vessel damage resulting in bruising, and impaired nerve function causing a "pins and needles" sensation in your hands and feet (ATSDR 1999). Swallowing arsenic has also been reported to increase the risk of cancer in the liver, bladder, kidneys, prostate, and lungs. The Department of Health and Human Services (DHHS) has determined that inorganic arsenic is known to be a human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans. EPA also has classified inorganic arsenic as a known human carcinogen.

Perhaps the single-most characteristic effect of long-term oral exposure to inorganic arsenic is a pattern of skin changes. These include a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso, and are often associated with changes in the blood vessels of the skin. A small number of the corns may ultimately develop into skin cancer. If you have direct skin contact with inorganic arsenic compounds, your skin may become irritated, with some redness and swelling. However, it does not appear that skin contact is likely to lead to any serious internal effects.

If you breathe high levels of inorganic arsenic, then you are likely to experience a sore throat and irritated lungs. You may also develop some of the skin effects mentioned above. The exposure level that produces these effects is uncertain, but it is probably above 100 micrograms of arsenic per cubic meter ($\mu\text{g}/\text{m}^3$) for a brief exposure. Longer exposure at lower concentrations can lead to skin effects, and also to circulatory and peripheral nervous disorders. There are some data suggesting that inhalation of inorganic arsenic may also interfere with normal fetal development, although this is not certain. An important concern is the ability of inhaled inorganic arsenic to increase the risk of lung cancer. This has been seen mostly in workers exposed to arsenic at smelters, mines, and chemical factories, but also in residents living near smelters and arsenical chemical factories. People who live near waste sites with arsenic may have an increased risk of lung cancer as well (ATSDR 1999).

Despite all of the adverse health effects associated with inorganic arsenic exposure, there is some evidence that the small amounts of arsenic in the normal diet (10-50 ppb) may be beneficial to your health. For example, animals fed a diet with unusually low concentrations of arsenic did not gain weight normally.

Child Health Considerations

The many physical differences between children and adults demand special emphasis. Children could be at greater risk than adults from certain kinds of exposure to hazardous substances. Children often play in the dirt and put their hands in their mouths and sometimes intentionally eat dirt, ingestion of contaminated soil may be a more important source of exposure for children than for adults. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. Children are shorter than adults; this means they breathe dust and vapors close to the ground. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, nourishment, medical care, and risk identification.

In children, acute exposure to very high levels of lead may produce encephalopathy and its attendant signs (e.g., hyperirritability, ataxia, convulsions, stupor, and coma or death). The blood lead levels (BLLs) associated with encephalopathy in children vary from study to study, but BLLs of 70-80 µg/dL or greater appear to indicate a serious risk (ATSDR 1999). Even without encephalopathy symptoms, these levels are associated with increased incidences of lasting neurologic and behavioral damage (ATSDR 1999). The developing nervous system of a child can be affected adversely at BLLs of less than 10 µg/dL. It is often impossible to determine these effects through clinical examination. Children suffer other neurologic effects at much lower exposure levels. There is a large body of evidence that associates decrement in intelligence quotient (IQ) performance and other neuropsychologic defects with lead exposure. Some studies have found, for example, that for every 10 µg/dL increase in BLL, children's IQ dropped by four to seven points (Yule et al. 1981; Schroeder et al. 1985; Fulton et al. 1987; Landsdown et al. 1986; Hawk et al. 1986; Winneke et al. 1990). There is also evidence that the probability of ADHD and hearing impairment in children increases with increasing BLLs, and that lead exposure may disrupt balance and impair peripheral nerve function (ATSDR 1999). These effects may begin at low, more widespread BLLs (at or below 10 µg/dL in some cases), and it may not be possible to detect them on clinical examination.

Children are exposed to arsenic in many of the same ways that adults are. Since arsenic is found in the soil, water, food, and air, children may take in arsenic in the air they breathe, the water they drink, and the food they eat. In areas of the United States where natural levels of arsenic in the soil and water are high, or in areas in and around contaminated waste sites, exposure of children to arsenic through ingestion of soil and water may be significant. Although most of the exposure pathways for children are the

same as those for adults, children may be at a higher risk of exposure because of normal hand-to-mouth activity (ATSDR 1999).

Children who are exposed to arsenic may have many of the same effects as adults, including irritation of the stomach and intestines, blood vessel damage, skin changes, and reduced nerve function. All health effects observed in adults are of potential concern in children. There is also some evidence that suggests that long-term exposure to arsenic in children may result in lower IQ scores. We do not know if absorption of arsenic from the gut in children differs from adults. There is some information suggesting that children may be less efficient at converting inorganic arsenic to the less harmful organic forms. For this reason, children may be more susceptible to health effects from inorganic arsenic than adults.

There is some evidence that inhaled or ingested arsenic can injure pregnant women or their unborn babies, although the studies are not definitive. Studies in animals show that large doses of arsenic that cause illness in pregnant females can also cause low birth weight, fetal malformations, and even fetal death. Arsenic can cross the placenta and has been found in fetal tissues. Arsenic is found at low levels in breast milk (ATSDR 1999).

Conclusion

Off-site environmental sampling near the Lenoir Car Works site is inadequate to characterize the concentrations of lead and arsenic in the nearby neighborhood. Therefore, an indeterminate health hazard exists for off-site exposure to contamination that may have migrated off-site from the former Lenoir Car Works.

Recommendations

1. Measure concentrations of lead and arsenic in soil of nearby residential yards along the northwest border of the Lenoir Car Works site. TDEC DoR will be responsible for ensuring that environmental samples are collected and analyzed.
2. Measure concentrations of lead and arsenic in soil of the neighborhood park along the southwest border of the site. TDEC DoR will be responsible ensuring environmental samples are collected and analyzed.
3. Continue with plans for remediation of the site.

Public Health Action Plan

1. Environmental Epidemiology (EEP) will provide this public health document to the appropriate environmental regulatory agencies.
2. Environmental Epidemiology is currently working with DoR on an off-site sampling plan to be implemented in fall 2007.
3. Environmental Epidemiology (EEP) will review the results of the additional off-site sampling for lead and arsenic in residential soil near the Lenoir Car Works that will be performed as recommended.

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Figures

FIGURE 1. Map of 100-acre Former Lenoir Car Works and surrounding area.

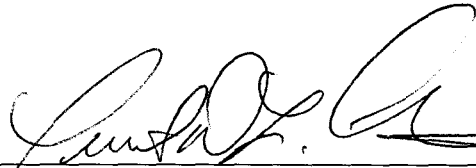


FIGURE 3. Photo of residential properties adjacent to the Former Lenoir Car Works.



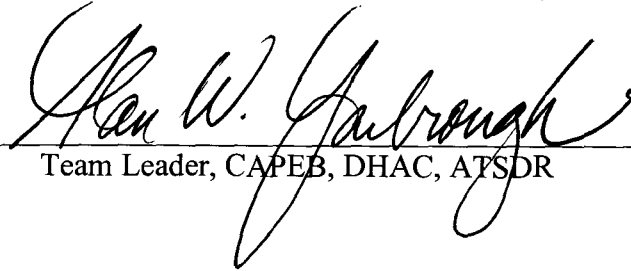
Certification

This Technical Health Consultation: Lenoir Car Works, 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 completed by the Cooperative Agreement Partner.



Technical Project Officer, CAPEB, DHAC, ATSDR

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



Team Leader, CAPEB, DHAC, ATSDR