Health Consultation

STATE OF IDAHO

LEWISTON, NEZ PERCE COUNTY, IDAHO

EVALUATION OF BENZENE AIR CONTAMINATION IN
LEWISTON AREA, IDAHO

FEBRUARY 16, 2005

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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HEALTH CONSULTATION

STATE OF IDAHO

LEWISTON, NEZ PERCE COUNTY, IDAHO

EVALUATION OF BENZENE AIR CONTAMINATION IN LEWISTON AREA, IDAHO

Prepared by:

Idaho Department of Health and Welfare
Bureau of Community and Environmental Health
Division of Health
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Summary

What is the purpose of this health consultation?

In 2003, the Bureau of Community and Environmental Health (BCEH) conducted a health consultation, *Evaluation of Air Exposure, Potlatch Corporation Pulp and Paper Mill, Lewiston, Nez Perce County, Idaho* (BCEH 2003). The purpose was to see if a possible link exists between the Potlatch Corporation pulp and paperboard mill in Lewiston and the area's elevated cancer rates. In that health consultation, BCEH reported that the levels of chloroform and benzene in the air (both indoor and outdoor) were higher than health-based comparison values of the Agency for Toxic Substances and Disease Registry (ATSDR). Chloroform and benzene in the air were designated as contaminants of concern and should be evaluated further. However, on the basis of information from the Toxics Release Inventory of U.S. Environmental Protection Agency (EPA), ambient benzene is not related to emissions from the Potlatch mill. Therefore, ATSDR and BCEH decided to separate the evaluations of benzene and chloroform air contamination into two separate health consultations. In this health consultation, BCEH will focus on the benzene air contamination in the Lewiston area. The chloroform air contamination was evaluated in 2003 (BCEH 2003).

What is benzene?

Benzene, also known as benzol, is a flammable chemical used in manufacturing. It is a colorless liquid with a sweet odor. Benzene evaporates into air very quickly and dissolves slightly in water. Benzene found in the environment is from both human activities and natural processes. Benzene is made mostly from petroleum sources. Because of its wide use, benzene ranks in the top 20 in production volume for chemicals produced in the United States. Natural sources of benzene, which include forest fires and volcanoes, also contribute to the presence of benzene in the environment. Benzene is also a part of cigarette smoke.

How might I be exposed to benzene?

Benzene can be found outdoors, in the workplace, or in the home. Exposure of the general population to benzene is mainly through breathing air that contains benzene. People living in cities or industrial areas are generally exposed to higher levels of benzene in air than those living in rural areas. People living around hazardous waste sites, petroleum refining operations, petrochemical manufacturing sites, or gas stations may also be exposed to higher levels of benzene in air. About 50% of the nationwide exposure to benzene results from smoking tobacco or from exposure to tobacco smoke. In the Lewiston-Clarkston Valley, people could be exposed to benzene in both indoor and outdoor air. Benzene concentrations in outdoor air are lower than those in indoor air. However, in this area, there is no significant single source of benzene contamination; it comes from many sources.

How can benzene affect my health?

People who breathe benzene for long periods may experience harmful effects in the tissues that form blood cells, especially the bone marrow. These effects can disrupt normal blood production and cause a decrease in important blood components. A decrease in red blood cells can lead to anemia. Reduction in other components in the blood can cause excessive bleeding. Blood production may return to normal after exposure to benzene stops. Excessive exposure to benzene

can be harmful to the immune system, increasing the chance for infection and perhaps lowering the body's defense against cancer. Exposure to benzene may be harmful to the reproductive organs.

Brief exposure (5–10 minutes) to very high levels of benzene in air (10,000–20,000 parts per million [ppm]) can result in death. Lower levels (700–3,000 ppm) can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. In most cases, people will stop feeling these effects when they are removed from benzene exposure and begin to breathe fresh air. However, the maximum benzene exposure (29.1 parts per billion [ppb] or 0.0291 ppm) to persons in the Lewiston-Clarkston Valley is much lower than the levels shown to cause noncancer effects in these studies. BCEH and ATSDR have evaluated benzene concentrations measured in indoor and outdoor air in residential areas of the Lewiston-Clarkston Valley to determine if noncancer health effects are likely. After comparing these benzene levels to health protective levels developed by ATSDR and other studies, we determined that these exposures are unlikely to cause any noncarcinogenic adverse health effects.

The U.S. Department of Health and Human Services, the International Agency for Cancer Research, and EPA have determined that benzene is a human carcinogen. Long-term exposure to relatively high levels of benzene in the air can cause cancer of the blood-forming organs. This condition is called leukemia. Exposure to benzene has been associated with development of a particular type of leukemia called acute myeloid leukemia (AML). From benzene concentrations measured in the Lewiston area, the estimated increased cancer risk is similar to that of exposure to background benzene levels in the United States, which would be considered a low increased risk of cancer.

Could exposure to benzene contamination in the Lewiston area cause an increased rate of cancer in the community?

It is very difficult to link cancer and specific environmental exposures. The Cancer Data Registry of Idaho (CDRI) evaluated cancer incidence between 1992 and 2000 for Lewiston, Idaho, and Clarkston, Washington, and compared the rates to the remainder of the State of Idaho. Cancer incidence analysis indicates more total cancer cases (12%) than expected for the Lewiston-Clarkston Valley when compared to the rest of Idaho.

BCEH looked at the number of cancer cases in the Lewiston area, specifically leukemia cases (which could be caused by exposures to benzene). Cancer incidence analysis indicated that significantly fewer leukemia cases were observed in the Lewiston area than were expected when compared to the rest of Idaho. Consequently, it is unlikely that benzene exposure is associated with the elevated total cancer incidence.

Is there a medical test to determine whether I have been exposed to benzene?

Several tests can show if you have been exposed to benzene. Some of these tests may be available at your doctor's office. All of these tests are limited in what they can tell you. One test can measure benzene in your breath, but it must be administered shortly after exposure. It is not, however, very helpful for detecting very low levels of benzene in your body. Benzene can also be measured in your blood. Because benzene disappears rapidly from the blood, such measurements may be accurate only for recent exposures. The amount of phenol in urine has also

been used to check for benzene exposure in workers. This test is useful only when you are exposed to benzene in air at levels of 10 ppm or greater. The maximum benzene concentration measured in the Lewiston area was 29.1 ppb or 0.0291 ppm, so this test would not be able to detect benzene exposure. This test must also be conducted shortly after exposure. It is not a reliable indicator of how much benzene you have been exposed to, because phenol from other sources, such as diet and the environment, is also present in urine. Measurement of muconic acid or S-phenyl-N-acetyl cysteine (PhAC) in urine is a more sensitive and reliable indicator of benzene exposure.

The measurement of benzene in blood or of metabolites in urine cannot be used to determine whether you will experience harmful health effects.

What are the major recommendations of this health consultation and the public health action plan?

Recommendations:

- Because indoor air benzene concentrations are higher than outdoor concentrations, residents should maintain good ventilation in homes to minimize benzene accumulation.
- People also should limit their cigarette smoking inside the house, because tobacco smoke is a significant benzene source.
- Cancer surveillance in the community should continue.

Public health action plan:

- BCEH will conduct health education in the community to explain the findings of our evaluation of chloroform and benzene exposures in the Lewiston-Clarkson area, assist residents in understanding and mitigating exposure to air contaminants, and provide information about how to reduce cancer risk.
- BCEH and CDRI will periodically monitor the incidence of cancer in the area.

Where do I get more information?

If you have questions or comments on this document, please contact Lijun Jin, Ph.D., BCEH, at 208-334-5682 or jinl@idhw.state.id.us.

Purpose

This health consultation was conducted by the Bureau of Community and Environmental Health (BCEH), Division of Health, Idaho Department of Health and Welfare, in cooperation with the Cancer Data Registry of Idaho (CDRI). It was conducted as part of BCEH's cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

In 2003, BCEH conducted a health consultation to see if a possible link exists between the Potlatch Corporation pulp and paperboard mill (Potlatch) and the elevated cancer rates. The results were published in *Evaluation of Air Exposure, Potlatch Corporation Pulp and Paper Mill, Lewiston, Nez Perce County, Idaho* (BCEH 2003). In that health consultation, BCEH reported that the levels of chloroform and benzene in the air were higher than ATSDR's health-based comparison values.

The primary source of airborne chloroform in the Lewiston area has been emissions from the bleaching process and wastewater treatment system at Potlatch. However, ambient benzene is not related to emissions from Potlatch, according to the Toxics Release Inventory of the U.S. Environmental Protection Agency (EPA). Therefore, ATSDR and BCEH decided to separate the evaluations of benzene and chloroform air contamination into two separate health consultations. In this health consultation, BCEH focuses on the benzene air contamination in the Lewiston area. The chloroform air contamination was evaluated in 2003 (BCEH 2003).

Background and Statement of Issue

Lewiston, Idaho, is located at the confluence of the Snake and Clearwater Rivers, at an elevation of 738 feet above sea level (Appendix A, Figure 1). Located approximately 465 river miles from the Pacific Ocean, Lewiston is the furthest inland seaport on the West Coast. Through the Columbia and Snake Rivers waterway and three port districts, the community serves as an economic hub for the inland Northwest and a portal to the Pacific Rim. The Lewiston-Clarkston Valley is rather narrow, with a range of hills to the north sloping abruptly from about 2,000 feet above the valley floor. The valley's low elevation provides temperate conditions.

Lewiston serves as a regional market center for a trade area of approximately 140,000 people. The Lewiston-Clarkston metro area population is a little more than 50,000. That area includes the city of Lewiston, portions of Nez Perce County in Idaho, the cities of Clarkston and Asotin in Washington, and portions of Asotin County in Washington. The major employers (and numbers of people employed) in the Lewiston-Clarkston Valley are Potlatch (1,900), St. Joseph Regional Medical Center (913), Lewiston School District (709), ATK (formerly Blount) (700), Regence BlueShield of Idaho (600), and Lewis-Clark State College (405). The average household income is $36,606. In March 2004, the unemployment rate was 3.5% (Lewis-Clark Valley Information Fact Books from http://www.lewis-clarkvalley.com).

In the 2003 health consultation, BCEH identified that the average concentrations of benzene in indoor and outdoor air were higher than cancer risk evaluation guides (CREG) (BCEH 2003). However, on the basis of the EPA's Toxics Release Inventory, ambient benzene is not linked to emissions from Potlatch. Therefore, benzene contamination in the air was not evaluated in that health consultation (BCEH 2003).

Benzene is commonly found in the environment. The main sources of benzene in the environment are industrial processes. Benzene levels in the air can increase through:

- emissions from burning coal and oil,
- leaks from benzene waste and storage operations,
- exhaust from motor vehicles, and
- evaporation from gasoline service stations.

Tobacco contains high levels of benzene and tobacco smoke is another important source of benzene in air. Most people are exposed to a small amount of benzene each day, mainly in the air they breathe.

Measured levels of benzene in outdoor air in the United States have ranged from 0.02 to 34 parts per billion parts (ppb) (1 ppb is 1,000 times less than 1 part per million [ppm]). The national background level of benzene in indoor air is 5 $\mu g/m^3$ (or 1.57 ppb) (Appendix B, Table B-1). People living in cities or industrial areas are generally exposed to higher levels of benzene in air than those living in rural areas. Benzene levels in the home are usually higher than outdoor levels. People living around hazardous waste sites, petroleum refining operations, petrochemical manufacturing sites, or gas stations may be exposed to higher levels of benzene in air. In the Lewiston-Clarkston Valley, there is no significant single source of benzene contamination; it comes from many sources.

Discussion

Assessment Methodology

BCEH generally follows a two-step methodology to evaluate public health issues related to air pollution. First, BCEH obtains representative environmental monitoring data for the site of concern and compiles a comprehensive list of site-related contaminants. Second, BCEH uses health-based comparison values to screen out those contaminants that do not have a realistic possibility of causing adverse health effects. For contaminants that exceed health-based comparison values, BCEH reviews recent scientific studies to determine whether the level of environmental contamination and exposure indicates a public health hazard.

Health-based comparison values used in this report are contaminant concentrations below which current public health literature suggests people's health will not be affected. These comparison values are conservative, or cautious, because they include safety factors that account for the most sensitive populations. Typically, BCEH concludes the levels of contamination are unlikely to result in any adverse health effects if a contaminant is never found at levels greater than its comparison value. If, however, a contaminant is found at levels greater than its comparison value, BCEH designates the chemical as a contaminant of concern and examines potential human exposures in greater detail. Because comparison values are based on conservative assumptions, the presence of concentrations greater than comparison values does not necessarily suggest that adverse health effects will occur among exposed populations. Using comparison values provides a way to prioritize the contaminants at a site for further evaluation.

Environmental Contamination

Idaho Department of Environmental Quality (IDEQ) conducted an air-monitoring program in the Lewiston and Clarkston area from July 1, 1994 through June 27, 1995. The goal of the program was to assess the annual average exposure of the general public in the area to selected compounds, including benzene; toluene; ethylbenzene; meta-, para-, and ortho-xylene; and chloroform. Ambient air samples (24-hour average) were collected at one background location and 13 locations throughout the Lewiston-Clarkston valley every 6 days during the study (Figure 2). The background site was selected outside of the study area to establish a baseline for concentrations observed in the area. The maximum observed 24-hour average benzene concentration was 14.7 ppb. The annual average of benzene for all sites within the valley (excluding background) was 0.97 ppb, and the background benzene concentration was 0.19 ppb (IDEQ 1995). The valley average was significantly higher than the background.

Indoor air samples were collected between February 14 and March 10, 1995, from selected residences in areas corresponding to most of the outdoor monitoring sites. One of the outdoor monitoring sites and the background site did not have associated indoor air samples. Indoor air samples were collected at 12 sites every 6 days during the study. The maximum benzene concentration in the indoor air was 29.1 ppb, while the indoor air average concentration for benzene was 2.54 ppb. In most cases, the indoor concentrations exceeded the corresponding outdoor concentrations, which is typical given other indoor sources of chemicals. These include combustion sources such as gas, wood, and tobacco products. They also include deteriorated, wet, or damp carpet; cabinetry or furniture made of certain pressed wood products; and other building materials and furnishings. Additional sources range from products for household cleaning and maintenance to central heating and cooling systems.

Contaminant of Concern

Concentrations of chemicals in indoor and outdoor air were compared to health-based air comparison values developed by ATSDR to decide whether any of the chemicals need further evaluation. Health-based comparison values are derived using chemical toxicity information and assume daily human exposure to contaminants. For noncancer toxicity, BCEH typically uses environmental media evaluation guides (EMEGs), minimal risk levels (MRLs), or the EPA's references concentrations (RfCs). MRLs and RfCs are estimates of daily human exposure to a contaminant that is unlikely to cause adverse noncancer health effects over a lifetime.

CREGs are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million (10^{-6}) persons exposed during their lifetime (70 years). If the concentration of a chemical is less than its comparison value, it is unlikely that exposure would result in adverse health effects, and further evaluation of exposures to that chemical is not warranted. If the concentration of a chemical exceeds a comparison value, adverse health effects from exposure are not necessarily expected, but potential exposures to that chemical from the site should be evaluated. Benzene concentrations in ambient and indoor air and air comparison values for benzene are summarized in Appendix B.

Benzene concentrations in both outdoor and indoor air were higher than its comparison values. Therefore, benzene is further evaluated in the following section.

Exposure Pathway

Inhalation is the dominant route of human exposure to benzene. A completed air exposure pathway for benzene in the Lewiston area existed in the past, currently exists, and will exist in the future.

Public Health Implications

Noncancer Health Effects

Most of the benzene levels found in the study area were below ATSDR's intermediate MRL (4 ppb) for less serious neurological effects of benzene, as derived from a study of mice (Sun et al., 1992). The maximum concentrations of benzene in outdoor air (14.7 ppb) (Appendix B, Table B-2) and in indoor air (29.1 ppb) (Appendix B, Table B-3) are about 30 to 60 times below the less serious neurological effects seen by Sun et al. None of the benzene levels measured in the Lewiston-Clarkson area exceeded ATSDR's acute MRL (50 ppb). The average benzene levels in outdoor air (0.97 ppb) and in indoor air (2.54 ppb) were similar to the national background level of benzene (5 $\mu g/m^3$ or 1.57 ppb) (Appendix B, Table B-1). BCEH and ATSDR compared the benzene levels found in indoor and outdoor air in the Lewiston area to ATSDR's MRL and findings in the study by Sun et al. On the basis of those comparisons, BCEH and ATSDR have determined that short-term or long-term adverse noncancer health effects are unlikely.

Cancer Risk

The U.S. Department of Health and Human Services, the International Agency for Cancer Research, and EPA have determined that benzene is a human carcinogen. Long-term exposure to relatively high levels of benzene in the air can cause cancer of the blood-forming organs. This condition is called leukemia. Studies of workers have consistently linked benzene exposures with a particular type of leukemia called acute myeloid leukemia (AML). Studies also have shown that benzene can cause cancer in animals (ATSDR 1997). The primary endpoint of concern for benzene air exposure is leukemia, specifically, AML, the only form of cancer that is consistently associated with high levels of occupational exposures to benzene.

Cancer risk is estimated by multiplying the air contaminant concentration by the unit risk (Appendix C). Cancer risk estimates do not provide definitive answers about whether or not a person will get cancer; rather, they are measures of chance (probability). Cancer is a common illness, with many different forms that result from a variety of causes; not all are fatal. Approximately one quarter to one third of people living in the United States will develop cancer at some point in their lives.

<u>Outdoor Air</u>

The national background level of benzene in outdoor air is 5 $\mu g/m^3$ (or 1.57 ppb) (Appendix B, Table B-1). On the basis of this value, the estimated cancer risk is about four excess cancer cases for 100,000 persons exposed over a lifetime (70 years).

On the basis of outdoor benzene concentrations in the Lewiston area in 1994 and 1995 (Appendix B, Table B-2), the estimated cancer risk is about two excess cancer cases for 100,000 persons exposed over a lifetime (70 years). This risk is slightly lower than the risk to the general

population in the United States and would be considered a low increased risk of cancer. Therefore, benzene concentrations in the outdoor air are unlikely to result in an appreciable increased risk of cancer in the exposed population.

Indoor Air

The national background level of benzene in indoor air is 5 $\mu g/m^3$ (or 1.57 ppb) (Appendix B, Table B-1). Using this value, the estimated cancer risk is about four excess cancer cases for 100,000 persons exposed over a lifetime (70 years).

Calculating from the indoor air concentrations of benzene in the Lewiston area in 1995 (Appendix B, Table B-3), the estimated cancer risk is about six excess cancer cases for 100,000 persons exposed over a lifetime (70 years). This risk is slightly above the risk to the general population in the United States. However, the risk of getting cancer is still low. Therefore, benzene concentrations in the indoor air are unlikely to result in an appreciable increased risk of cancer in the exposed population.

ATSDR Child Health Considerations

Children differ from adults in their physiology (e.g., respiratory rates relative to body weight), pharmacokinetics (i.e., distribution, absorption, metabolism, and excretion of chemicals), and pharmacodynamics (i.e., susceptibility of an organ to the exposure). Therefore, it is always important to address chemical exposures of these sensitive populations. Fetuses, infants, and children are more vulnerable to the toxic effects of chemicals for the following reasons:

1) children are more likely to play outdoors and bring food into contaminated areas;
2) children are closer to the ground (shorter), resulting in a greater likelihood to breathe dust, soil, and heavy vapors laying on the ground;
3) children weigh less, resulting in higher doses of chemical exposure per body weight; and
4) children's developing body systems can sustain permanent damage if toxic exposures occur during critical growth stages.

As discussed earlier, exposure to benzene levels in the Lewiston area is unlikely to result in any adverse noncarcinogenic public health effects in adults or children. The main concern is an increased risk of cancer in the exposed population. However, because cancer risk is based on a lifetime exposure, it is the same for both adults and children. This risk is not significantly different from the national background risk.

Health Outcome Data Evaluation

Data Review

The health outcome data evaluation for the Lewiston area is based on an analysis of available cancer data from CDRI. CDRI is an Idaho Hospital Association program that contracts with Idaho Department of Health and Welfare to provide a statewide cancer surveillance system. The population-based cancer registry collects incidence and survival data on all cancer patients who reside or are treated for cancer in Idaho. Through collaborative efforts with Idaho's neighboring states, CDRI is able to obtain cancer cases of Idaho residents diagnosed or treated for cancer in adjacent states. CDRI has been in operation since 1969 and the registry became population-based

in 1971. Each Idaho hospital, outpatient surgery center, and pathology laboratory is responsible for reporting cancer diagnoses and treatments within 6 months after services are provided. CDRI has a 99.6% case completeness rate and a 98.6% accuracy rate according to the North American Association of Central Cancer Registries (www.naaccr.org). For residents of Clarkston, Washington, information on cancer incidence was obtained from the Washington State Cancer Registry.

The period selected for each evaluation of the cancer incidence data was 1992–2000. This is the most recent data available for ZIP code analysis. Cancer incidence was reviewed for this health consultation instead of cancer mortality because cancer death rates are affected by how advanced the cancer was at the time of diagnosis, access to health care, and other factors not related to exposure. Cancer rates were compared to the remainder of the State of Idaho.

Data Analysis

Cancer incidence was calculated for ZIP codes 83501 and 99403, which correspond to Lewiston and Clarkston. Cancer incidence was calculated by comparing the observed number of cancer cases to the expected number of cases (also known as a standardized incidence ratio). The expected number of cancer cases was calculated by multiplying cancer rates for the remainder of Idaho and the population of the combined ZIP codes. Cancer rates for the remainder of Idaho were calculated by dividing the observed cases by the person-years for the remainder of Idaho. Person-years were estimated by summing population estimates for the ZIP codes over the time period of the study.

To help interpret the difference between observed and expected cancer cases, we calculate the "statistical significance" of the difference. "Statistical significance" for this health consultation means that there is less than a 5% chance that an observed difference is due to random chance alone ($p<0.05$). In other words, if a difference is found to be statistically significant, then this difference probably results from some set of factors that influence the rate of the disease (cancer). These factors could be environmental factors, lifestyle factors, or hereditary factors. In the health consultation, only statistically significant differences are discussed.

Cancer is not a single disease. It is a group of more than 200 different diseases (such as lung cancer, bladder cancer, etc.). Because cancer is, unfortunately, a common disease (one in two men, or one in three women will develop cancer in the lifetime), every community will experience a certain number of cancers. Different types of cancer have different causes and are likely to be linked to different risk factors. Therefore, BCEH selected the specific cancer types—cancer of the blood-forming organs, such as leukemia and acute myeloid leukemia—that, according to scientific studies, plausibly could result from benzene exposure.

Results of Cancer Incidence Analysis

Overall, cancer incidence in the combined ZIP code area was statistically significantly different from that in the rest of Idaho. Statistically more cases were observed (2,628) than expected (2,342), which is about 12% more cases than occurred in the rest of the state (Appendix D, Table D-1).

For the cancers that might be associated with benzene, significantly fewer male and fewer total leukemia cancers were observed than in the rest of Idaho (Appendix D, Table D-1). There is no significant difference between the observed female leukemia cancers, total/male/female acute myeloid leukemia cancers, and expected cases for the remainder of the state (Appendix D, Table D-1). Therefore, according to this analysis, it is unlikely that the benzene contamination in the Lewiston area resulted in any increased cancer incidence.

All the cancers with significantly more observed cases than expected were discussed in the health consultation, *Evaluation of Air Exposure, Potlatch Corporation Pulp and Paper Mill, Lewiston, Nez Perce County, Idaho* (BCEH 2003). That health consultation concluded that it was not possible to determine if past exposure to site-related chloroform was associated with the increased cancer incidence.

Conclusions

1. Using ATSDR's public health hazard categories (Appendix E) and available data, BCEH considers the benzene levels in the Lewiston area to be *no apparent public health hazard*. Benzene concentrations measured in indoor and outdoor air in residential areas are unlikely to cause any adverse noncarcinogenic public health effects or an appreciable increased risk of cancer in the exposed population.

2. Health outcome data analysis indicates dramatically more total cancer cases (12%) than expected for this area, as compared to the remainder of Idaho. However, it is unlikely that benzene exposure is associated with the elevated total cancer incidence, because significantly fewer leukemia cases (which could be caused by benzene) were observed than expected when compared to the rest of the state.

Recommendations

1. Because indoor air benzene concentrations are higher than outdoor concentrations, residents should maintain good ventilation in the home to minimize benzene accumulation.

2. People also should limit their cigarette smoking inside the house, because tobacco smoke is a significant benzene source. People who are interested in quitting smoking can call toll free at 1-800-QUITNOW.

3. Cancer surveillance in the community should continue.

Public Health Action Plan

1. BCEH will conduct health education in the community to explain the findings of our evaluation of chloroform and benzene exposures in the Lewiston-Clarkson area, assist residents in understanding and mitigating exposure to air contaminants, and provide information about how to reduce cancer risk.

2. BCEH and CDRI will periodically monitor cancer incidence.

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Certification

The Idaho Bureau of Community and Environmental Health prepared this Health Consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time this Health Consultation was initiated.

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Senior Health Scientist, SPAB, DHAC

The Superfund Program and Assessment Branch (SPAB), Division of Health Assessment and Consultation (DHAC), ATSDR has reviewed this health consultation and concurs with its findings.

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Team Leader, CAT, SPAB, DHAC, ATSDR

Appendix A

Maps and Sampling Locations

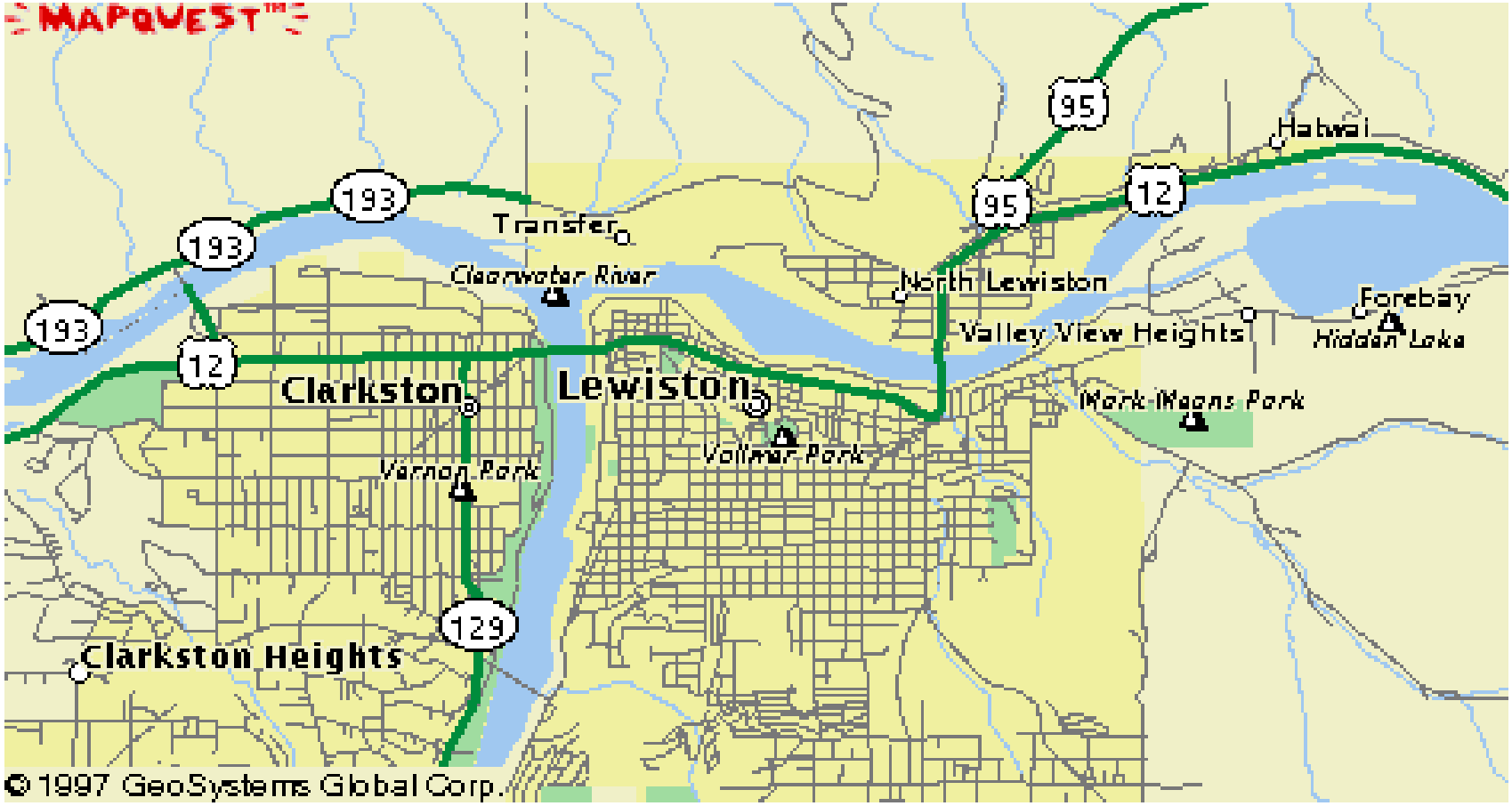

Figure 1. Map of Lewiston Area, Idaho

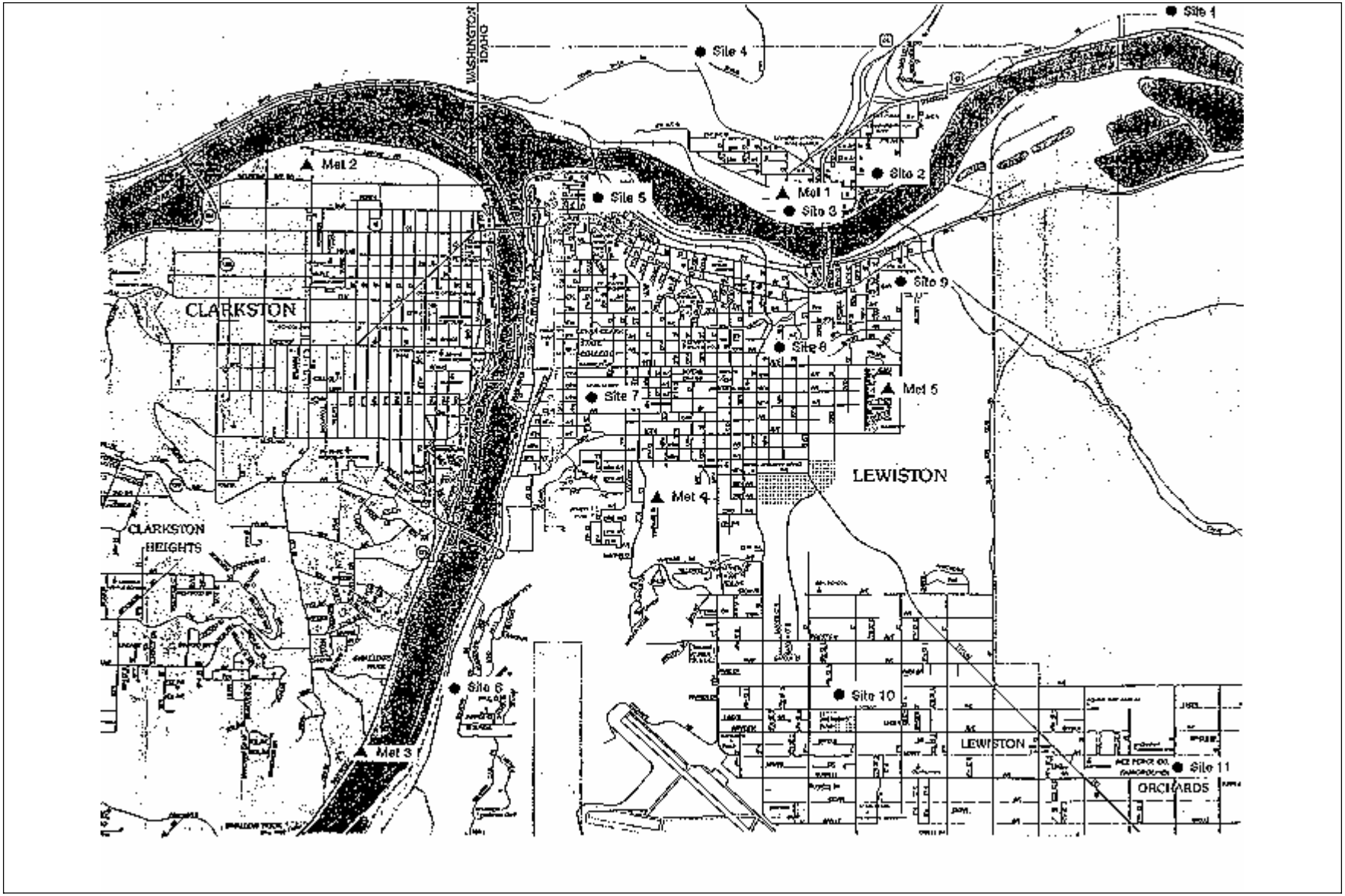

Figure 2. 1994–1994 Sites for VOC Sampling and Meteorological Monitoring in Lewiston, Idaho
(Picture adapted from EPA 1995)

Site Descriptions for Figure 2

Site 1: Hatwai and 42nd
Site 2: 2611 4th Street
Site 3: End of 1st Street at river
Site 4: Spiral Highway (0.25 miles from Down River Road)
Site 5: 505 C Street
Site 6: Elks Lodge (Country Club Drive)
Site 7: 4th Street and 14th Avenue (Cemetery)
Site 8: Whitman Elementary (19th Street)
Site 9: 29th Street and 5th Avenue
Site 10: McGhee Elementary (Warner Avenue)
Site 11: Midway between Airway and Burrell (Fairgrounds)
Site 12: Scenic overlook on I-95
Site 13: Outside of Uniontown
Site W-1: Clarkston: 10th and Chestnut Street

Appendix B

Contaminant of Concern Selection

Table B-1. Air Comparison Values (ppb) and National Background Levels (μg/m^3) for Benzene

Chemical	Noncancer		Cancer			National Background Level (μg/m^3)	
	CVs (ppb)	Source	CVs (μg/m^3)	Source	Unit Risk (μg/m^3)$^{-1}$	Outdoor Air	Indoor Air
Benzene	4 50	i-MRL a-MRL	0.1	CREG	0.0000078	5	5

National background level = "Typical" value from EPA 1998
CVs = comparison values
ppb = parts per billion
i-MRL = intermediate minimal risk level
a-MRL = acute minimal risk level
CREG = cancer risk evaluation guide

Table B-2. Minimum, Maximum, and Average Concentrations of Benzene in Ambient Air, 1994–1995*

Chemical	Minimum	Maximum	Average	Minimum	Maximum	Average
	(ppb)			(μg/m^3)		
Benzene	ND	**14.7**	0.97	ND	**46.96**	**3.10**

* 930 24-hour samples (including duplicates) taken during 61 tests from 12 locations; 66 background samples.
ND: Non-detect

Table B-3 Indoor Air Sampling Summary, 1995*

Chemical	Minimum	Maximum	Average	Minimum	Maximum	Average
	(ppb)			(μg/m^3)		
Benzene	0.16	**29.1**	2.54	**0.51**	**93.0**	**8.11**

* 71 samples (including duplicates) taken during five tests from 12 locations (site 4 and 13 does not have associated indoor samples).

Appendix C

Cancer Risk Calculations

$$Risk = C_{ug/m^3} \times UR$$

$$C_{ug/m^3} = C_{ppb} \times \frac{MW(g/mole)}{24.45}$$

Where,

Risk = Cancer risk (unitless)
$C_{\mu g/m^3}$ = Contaminant concentration in the air ($\mu g/m^3$)
UR = Unit risk ($(\mu g/m^3)^{-1}$)
C_{ppb} = Contaminant concentration in the air (parts per billion)
MW = Molecular weight (g/mole)

Appendix D

Cancer Incidence Evaluation 1992–2000

Table D-1. Cancer Incidence 1992–2000, Comparison Between Lewiston, Idaho, and Clarkston, Washington, ZIP Codes (83501 and 99403) and the Remainder of State of Idaho

		ZIP Codes 83501& 99403						Remainder of Idaho		
Cancer Site/Type	Sex	Observed Cases	Person Years	Crude Rate (1)	AAI Rate (1,2)	Expected Cases (3)	P-Value (4)	Observed Cases	Person Years	Crude Rate (1)
All sites combined	Total	2,628	451,772	581.71	457.53	2,341.9	0.000 >>	41,178	10,099,656	407.72
All sites combined	Male	1,453	218,079	666.27	517.49	1,220.5	0.000 >>	21,887	5,035,288	434.67
All sites combined	Female	1,175	233,694	502.80	399.12	1,121.4	0.114	19,291	5,064,368	380.92
Bladder	Total	125	451,772	27.67	21.09	115.9	0.423	1,976	10,099,656	19.57
Bladder	Male	97	218,079	44.48	33.52	89.3	0.442	1,554	5,035,288	30.86
Bladder	Female	28	233,694	11.98	8.76	26.6	0.841	422	5,064,368	8.33
Brain	Total	43	451,772	9.52	8.43	34.5	0.183	684	10,099,656	6.77
Brain	Male	31	218,079	14.22	12.62	19.4	0.018 >>	397	5,035,288	7.88
Brain	Female	12	233,694	5.13	4.48	15.2	0.505	287	5,064,368	5.67
Breast	Total	356	451,772	78.80	62.21	353.4	0.905	6,237	10,099,656	61.75
Breast	Male	2	218,079	0.92	0.72	2.1	1.000	39	5,035,288	0.77
Breast	Female	354	233,694	151.48	123.33	351.3	0.899	6,198	5,064,368	122.38
Cervix	Female	18	233,694	7.70	7.02	19.7	0.813	389	5,064,368	7.68
Colon	Total	240	451,772	53.12	39.24	184.6	0.000 >>	3,049	10,099,656	30.19
Colon	Male	116	218,079	53.19	40.14	85.9	0.002 >>	1,497	5,035,288	29.73
Colon	Female	124	233,694	53.06	38.49	98.7	0.016 >>	1,552	5,064,368	30.65
Endometrium	Female	69	233,694	29.53	23.68	65.3	0.679	1,135	5,064,368	22.41
Esophagus	Total	21	451,772	4.65	3.66	21.5	1.000	378	10,099,656	3.74
Esophagus	Male	15	218,079	6.88	5.39	16.4	0.854	297	5,035,288	5.90
Esophagus	Female	6	233,694	2.57	1.89	5.1	0.793	81	5,064,368	1.60
Hodgkin's Lymphoma	Total	12	451,772	2.66	2.49	13.0	0.916	273	10,099,656	2.70
Hodgkin's Lymphoma	Male	8	218,079	3.67	3.43	6.9	0.787	150	5,035,288	2.98
Hodgkin's Lymphoma	Female	4	233,694	1.71	1.59	6.1	0.544	123	5,064,368	2.43
Kidney and Renal Pelvis	Total	62	451,772	13.72	11.06	53.8	0.292	969	10,099,656	9.59
Kidney and Renal Pelvis	Male	28	218,079	12.84	10.36	31.7	0.588	590	5,035,288	11.72
Kidney and Renal Pelvis	Female	34	233,694	14.55	11.51	22.1	0.022 >>	379	5,064,368	7.48
Larynx	Total	21	451,772	4.65	3.77	18.0	0.537	326	10,099,656	3.23
Larynx	Male	14	218,079	6.42	5.05	14.9	0.959	270	5,035,288	5.36
Larynx	Female	7	233,694	3.00	2.48	3.1	0.080	56	5,064,368	1.11
Leukemia	Total	45	451,772	9.96	8.07	66.1	0.008 <<	1,196	10,099,656	11.84
Leukemia	Male	24	218,079	11.01	8.87	37.8	0.022 <<	704	5,035,288	13.98
Leukemia	Female	21	233,694	8.99	7.23	28.2	0.198	492	5,064,368	9.71
Leukemia - Acute Myeloid	Total	17	451,772	3.76	2.95	16.7	1.000	293	10,099,656	2.90
Leukemia - Acute Myeloid	Male	8	218,079	3.67	2.84	10.1	0.636	181	5,035,288	3.59
Leukemia - Acute Myeloid	Female	9	233,694	3.85	3.02	6.6	0.441	112	5,064,368	2.21
Liver	Total	13	451,772	2.88	2.21	15.3	0.671	263	10,099,656	2.60
Liver	Male	9	218,079	4.13	3.24	8.9	1.000	161	5,035,288	3.20
Liver	Female	4	233,694	1.71	1.25	6.4	0.465	102	5,064,368	2.01
Lung and Bronchus	Total	384	451,772	85.00	65.34	304.2	0.000 >>	5,228	10,099,656	51.76
Lung and Bronchus	Male	238	218,079	109.13	83.43	176.1	0.000 >>	3,109	5,035,288	61.74
Lung and Bronchus	Female	146	233,694	62.47	47.69	128.1	0.129	2,119	5,064,368	41.84
Melanoma of the Skin	Total	81	451,772	17.93	15.24	88.1	0.488	1,674	10,099,656	16.57
Melanoma of the Skin	Male	48	218,079	22.01	18.36	48.7	0.997	938	5,035,288	18.63
Melanoma of the Skin	Female	33	233,694	14.12	12.17	39.4	0.348	736	5,064,368	14.53
Multiple Myeloma	Total	34	451,772	7.53	5.73	27.1	0.224	461	10,099,656	4.56
Multiple Myeloma	Male	14	218,079	6.42	4.90	14.6	1.000	258	5,035,288	5.12
Multiple Myeloma	Female	20	233,694	8.56	6.43	12.5	0.060	203	5,064,368	4.01
Non-Hodgkin's Lymphoma	Total	95	451,772	21.03	16.70	94.6	0.996	1,680	10,099,656	16.63
Non-Hodgkin's Lymphoma	Male	45	218,079	20.63	16.60	47.7	0.765	886	5,035,288	17.60
Non-Hodgkin's Lymphoma	Female	50	233,694	21.40	16.71	46.9	0.690	794	5,064,368	15.68
Oral Cavity and Pharynx	Total	65	451,772	14.39	11.63	59.8	0.533	1,080	10,099,656	10.69
Oral Cavity and Pharynx	Male	42	218,079	19.26	15.40	42.1	1.000	777	5,035,288	15.43
Oral Cavity and Pharynx	Female	23	233,694	9.84	7.77	17.7	0.258	303	5,064,368	5.98
Ovary	Female	47	233,694	20.11	16.51	47.6	1.000	847	5,064,368	16.72
Pancreas	Total	50	451,772	11.07	8.26	51.9	0.865	866	10,099,656	8.57
Pancreas	Male	32	218,079	14.67	11.31	24.3	0.155	433	5,035,288	8.60
Pancreas	Female	18	233,694	7.70	5.59	27.6	0.072	433	5,064,368	8.55
Prostate	Male	510	218,079	233.86	177.10	393.8	0.000 >>	6,885	5,035,288	136.73
Rectum & Rectosigmoid	Total	91	451,772	20.14	15.42	72.9	0.045 >>	1,248	10,099,656	12.36
Rectum & Rectosigmoid	Male	54	218,079	24.76	18.87	41.8	0.080	736	5,035,288	14.62
Rectum & Rectosigmoid	Female	37	233,694	15.83	12.03	31.1	0.332	512	5,064,368	10.11
Stomach	Total	35	451,772	7.75	5.91	32.1	0.650	547	10,099,656	5.42
Stomach	Male	19	218,079	8.71	6.61	19.6	1.000	344	5,035,288	6.83
Stomach	Female	16	233,694	6.85	5.16	12.4	0.376	203	5,064,368	4.01
Testis	Male	14	218,079	6.42	6.38	13.3	0.926	306	5,035,288	6.08
Thyroid	Total	25	451,772	5.53	5.07	30.2	0.393	619	10,099,656	6.13
Thyroid	Male	4	218,079	1.83	1.65	7.3	0.293	152	5,035,288	3.02
Thyroid	Female	21	233,694	8.99	8.45	22.9	0.791	467	5,064,368	9.22

Notes

1. Rates are expressed as the number of cases per 100,000 persons per year (person-years).
2. Compare these age and sex-adjusted incidence (AAI) rates to the crude rates for the rest of Idaho.
3. Expected cases are based upon age and sex-specific rates for the rest of Idaho.
4. P-values compare observed and expected cases, are two-tailed, and are based upon the Poisson probability distribution.

"<<" denotes significantly fewer cases observed than expected, ">>" denotes significantly more cases observed than expected (p=.05).

Statistical Notes

- Rates derived from 10 or fewer cases (numerator) should be interpreted with caution.
- Rates shown for ZIP code analyzes are not comparable to those in state or county analyses due to population estimation procedures.

Appendix E

ATSDR Interim Public Health Hazard Categories

Table E-1. Interim Public Health Hazard Categories

CATEGORY/DEFINITION	DATA SUFFICIENCY	CRITERIA
Urgent Public Health Hazard This category is used for sites where short-term exposures (<1year) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.	This determination represents a professional judgment that is based on critical data, which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* indicated that site-specific conditions or likely exposures have had, are having, or are likely to have in the future, an adverse effect on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the pre of serious physical or safety hazards.
Public Health Hazard This category is used for sites that pose a public health hazard due to the existence of long-term exposure (>1year) to hazardous substance or conditions that could result in adverse health effects.	This determination represents a professional judgment that is based on critical data, which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* suggests that, under site-specific conditions of exposure, long-term exposures to site-specific contaminants (including radionuclides) have had, are having, or are likely to have in the future, an adverse effect on human health that requires one of more public health interventions. Such site-specific exposures may include the presence of serious physical or safety hazards.
Indeterminate Public Health Hazard This category is used for sites in which "critical" data are insufficient with regard to extent of exposure and/or toxicological properties at estimated exposure levels.	This determination represents a professional judgment that critical data are missing and ATSDR has judged the data are insufficient to support a decision. This does not necessarily imply all data are incomplete; but that some additional data are required to support a decision.	The health assessor much determine, using professional judgment, the "criticality" of such data and the likelihood that the data can be obtained and will be obtained in a timely manner. Where some data are available, even limited data, the health assessor is encouraged to the extent possible to select other hazard categories and to support their decision with clear narrative that explains the limits of the data and the rationale for the decision.
No Apparent Public Health Hazard This category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.	This determination represents a professional judgment that is based on critical data, which ATSDR considers sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* indicates that, under site-specific conditions of exposure, exposures, exposure to site-specific contaminants in the past, present, or future are not likely to result in any adverse impact on human health.
No Public Health Hazard This category is used for sites that, because of the absence of exposure, do NOT pose a public health hazard.	Sufficient evidence indicates that no human exposures to contaminated media have occurred, none are now occurring, and none are likely to occur in the future.	

* Such as environmental and demographic data; health outcome data; community health concerns information; toxicological, medical, and epidemiological data; monitoring and management plan