Health Consultation

Evaluation of Potential Health Effects from Air Toxics

LEWISTON AIR TOXICS MONITORING 2006-2007

NEZ PERCE COUNTY, IDAHO

FEBRUARY 18, 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.

You May Contact ATSDR TOLL FREE at
1-800-CDC-INFO
or
Visit our Home Page at: http://www.atsdr.cdc.gov

HEALTH CONSULTATION

Evaluation of Potential Health Effects from Air Toxics

LEWISTON AIR TOXICS MONITORING 2006-2007

NEZ PERCE COUNTY, IDAHO

Prepared By:

The Idaho Division of Health
Bureau of Community and Environmental Health
and
The Agency for Toxic Substances and Disease Registry
Division of Regional Operations

Foreword

The State of Idaho, Idaho Division of Health (IDOH), Bureau of Community and Environmental Health (BCEH) jointly prepared this public health consultation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to environmental contaminants. This health consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The health consultation is an approach used by ATSDR and IDOH to respond to requests from concerned residents for health information on hazardous substances in the environment. The health consultation process evaluates sampling data collected from a sites impacted by environmental contamination, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health.

Statement of Issues

In early 2008, the Nez Perce Tribe's Environmental Restoration and Waste Management Division (ERWM), Air Quality Program, contacted the Bureau of Community and Environmental Health (BCEH), Idaho Division of Health, to review data from its most recent air toxics monitoring project in the Lewiston, ID area. Monitoring was conducted for a one-year period starting in May 2006 and finishing in April 2007.

Background and Site Description

Lewiston, Idaho, is located at the confluence of the Snake and Clearwater Rivers, at an elevation of 738 feet above sea level. Located approximately 465 river miles from the Pacific Ocean, Lewiston is the furthest inland seaport on the West Coast. Through the Columbia River and Snake River waterways 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 to the valley floor. The valley's low elevation provides temperate conditions. The combined population of Lewiston and Clarkston area is 38,630 according to U.S. Census 2006 estimates.

The major employers (and numbers of people employed) in the Lewiston-Clarkston Valley are Clearwater Paper Corporation, formerly known as Potlatch Corporation, (1,700), St. Joseph Regional Medical Center (968), Regence Blue Shield of Idaho (739), ATK (700), Lewiston School District (693), and Lewis-Clark State College (423). The average household income is $36,606 as of 2007 (Lewis-Clark Valley Information Fact Books from http://www.lewis-clarkvalley.com).

Air quality can become poor in the Lewiston area and surrounding towns due to the steep canyon topography that contributes to inversions, and due to the large kraft pulp and paper mill operated by the Clearwater Paper Corporation in Lewiston. The Clearwater Paper Corporation facility is the largest single source of air pollution in the valley according to the Environmental Protection Agency's Toxic Release Inventory (http://www.epa.gov/triexplorer/facility.htm). In 2006, the facility released over 700,000 pounds of toxics into the air. This number includes over 25,000 pounds of formaldehyde and over 106,000 pounds of acetaldehyde. There are approximately 15,312 residents and 6,594 households within a 3-mile radius of the facility.

The emissions from the Clearwater Paper Corporation complex commonly adversely affect air quality (haze, odor) in the cities of Lewiston, Idaho and Clarkston, Washington. Depending upon conditions, the outlying towns of Lapwai, Lenore, and Orofino on the Nez Perce Reservation in Idaho and Asotin in Washington can also be affected. A map of the region is shown in Figure 1.

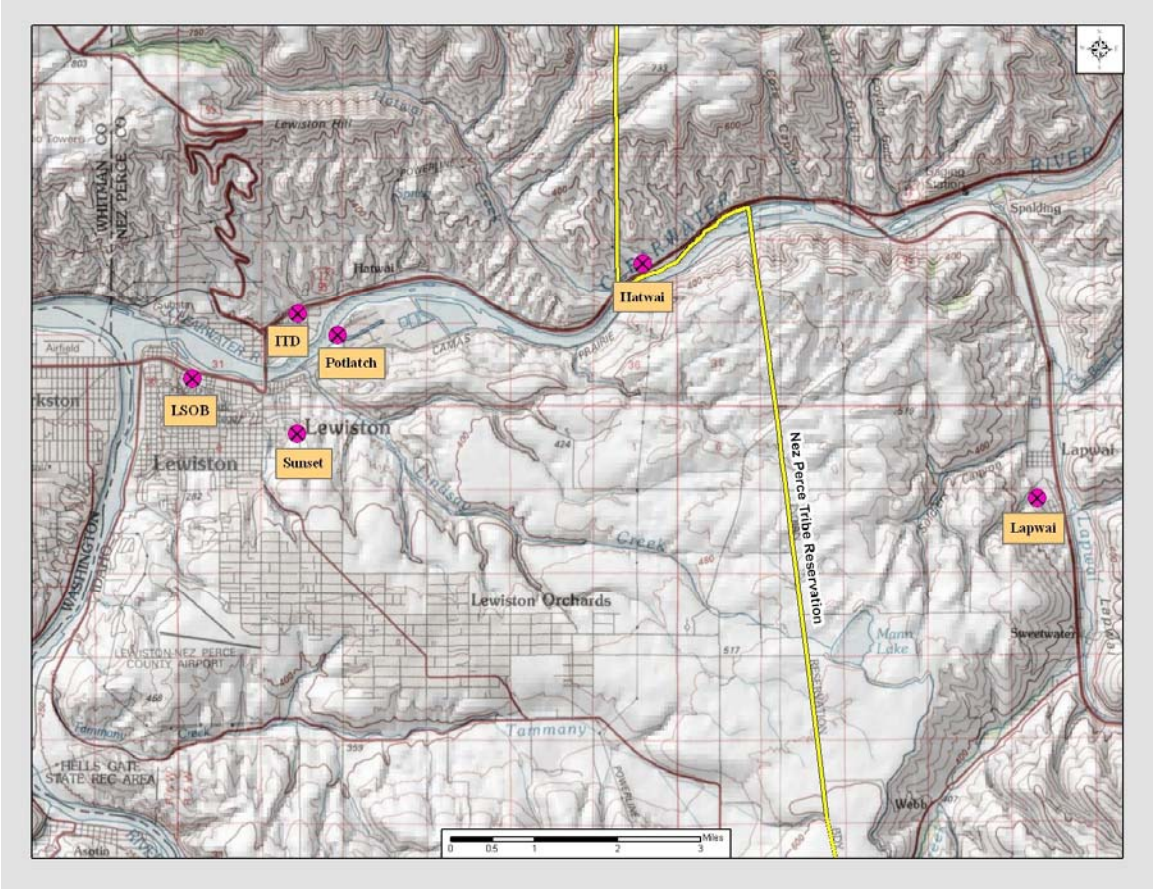

Figure 1: Map showing the region affected, the Clearwater Paper (formerly Potlatch) Corporation, and the 5 monitoring sites indicated by crossed circles.

Previous studies have evaluated contaminants in the air near Lewiston. The first of these studies was completed in 1990 and focused on chloroform concentrations around Potlatch (EPA 1991). Maximum downwind concentrations ranged from 2 to 8 parts per billion (ppb). A major modernization at the Potlatch plant that reduced the use of chlorine dioxide was completed in 1992 and thereafter chloroform concentrations declined greatly.

A comprehensive year-long study was conducted from July 1994 through June 1995 (IDEQ 1995). This study included sampling for chloroform, benzene, toluene, ethylbenzene, and xylene on a once-in-every-six-days schedule at 13 sites plus a background site. A review of these data by BCEH found that only chloroform and benzene were at levels above their respective health-based risk comparison values (CVs).

A review by the Idaho Cancer Data Registry (ICDR) of cancer incidence in the zip codes that included Lewiston and Clarkston from 1992-2000 found that the incidence of some specific cancers, such as colon and lung, were significantly higher than the remainder of Idaho (ICDR 2003). Soon thereafter, separate public health consultations were prepared by BCEH for chloroform and benzene. The health consultation (HC) for chloroform

determined that chloroform concentrations released by the Potlatch plant after 1992 were unlikely to result in an appreciable increased risk of cancer in the exposed population. The HC for benzene, which was not associated with emissions from Potlatch, found that both short-term and long-term non-cancer health effects are unlikely. The report also determined that outdoor benzene concentrations were unlikely to result in an appreciable increased risk of cancer in the exposed population.

While the past studies of air pollution in the Lewiston area found that only chloroform and benzene were elevated above levels of health concern, there were many contaminants that were not monitored due to inadequate funding and analytical capacity. In this latest round of sampling, a total of 27 primary and secondary volatile organic compounds (VOCs) and 11 metals were sampled. This report focuses on those 27 VOCs and 11 metals.

Methods

See Figure 1 for a map showing Lewiston and nearby areas, the Clearwater Paper Corporation facility (formerly Potlatch, as labeled on the map), and the monitoring sites. The monitoring sites were selected to provide a variety of land use types and spatial scales. The 5 sites were:

- Idaho Transportation Department (ITD) – Proximal to the Clearwater Paper Corporation industrial source.
- Hatwai – On the Nez Perce Reservation, upriver (East) from the source on Highway 12/95 near the Clearwater River Casino.
- Lewiston State Office Building (LSOB) – Representative of the 'downtown' central Lewiston urban area with commercial and residential mix.
- Sunset Park TEOM site – Residential site in southeast Lewiston near the Clearwater Paper Corporation industrial source.
- Lapwai – On the Nez Perce Reservation, designated as the background site

Duplicate samples were taken at the Hatwai and ITD sites. The detection limit for all compounds measured was well below the CV for each contaminant. Thus, non-detect readings were rare; therefore, non-detects were ignored rather than assigned a zero value or some other surrogate value. By not including surrogate values for non-detects in the calculation of the mean values, the means are greater and represent a more conservative estimate of risk.

Air was sampled once every 6 days from May 1, 2006 through April 30, 2007 at the five locations. The VOCs that were sampled and analyzed are listed in Table 1.

Table 1. VOCs Sampled

Benzene	1,4-Dichlorobenzene
1,3-Butadiene	Chloroethane
Carbon Tetrachloride	Chloroethene
Chloroform	Chloromethane
Dichloromethane	1,1,1-Trichloroethane
Tetrachloroethylene	Hexane
Trichloroethylene	Toluene
1,2-Dichloropropane	Ethylbenzene
Vinyl Chloride	M,P-Xylene
Trichlorofluoromethane	O-Xylene
Dichlorodifluoromethane	Styrene
Chlorobenzene	Acetaldehyde
1,2-Dichlorobenzene	Formaldehyde
1,3-Dichlorobenzene	

Sampling was also conducted for the metallic compounds listed below in Table 2.

Table 2. Metallic Compounds Sampled

Arsenic Compounds	Nickel Compounds
Beryllium Compounds	Aluminum Compounds
Cadmium Compounds	Iron Compounds
Chromium Compounds (Total)	Copper Compounds
Lead Compounds	Zinc Compounds
Manganese Compounds	

Results

In order to evaluate public health concerns related to air contamination in the Lewiston area, BCEH followed a two-step methodology. First, BCEH obtained and standardized the units for air quality data for the area. Second, BCEH used health-based CVs to screen out those contaminants that are unlikely to cause adverse health effects. For the remaining contaminants that exceeded their health-based CVs, BCEH made further determinations to evaluate whether the level of environmental contamination and exposure indicated an elevated public health risk. CVs reflect an estimated contaminant concentration level for which an exposure at or below that level is *not expected* to cause adverse health effects.

*Comparison values **are not** thresholds for adverse health effects*. That is, CVs do not represent a level at which a person exposed to a contaminant level above the CV will likely suffer health consequences. This is because CVs are typically set at levels many times lower than the levels at which health effects were observed in experimental animal or human epidemiologic studies. CVs are deemed protective because they include safety or uncertainty factors that account for more sensitive populations, such as young children.

Again, if the concentration of a chemical is less than its CV, it is unlikely that exposure would result in adverse health effects, and further evaluation of exposures to that chemical is not necessary. If the concentration of a chemical exceeds a CV, adverse health effects from exposure are not automatically expected, but potential exposures to that chemical from the site should be further evaluated.

Table 3 shows the highest mean or average level monitored of each of the contaminants. The mean was chosen as a representative statistic because there were no extreme outliers (very high or very low readings) during the sampling period. The highest mean was derived by taking each monitoring station and calculating the mean level for each contaminant over the sampling year. These yearly mean levels were then compared to each other and the highest mean for each contaminant was selected to compare with its CV. This is a conservative approach that likely overestimates chronic exposure. Also, the most conservative CV available was selected for each contaminant.

The non-cancer CV and the cancer CV for each compound except for lead and nickel were taken from the most recent resources available at the time of publication. One resource combines CVs derived by the Environmental Protection Agency (EPA), the California Environmental Protection Agency (CalEPA), and the World Health Organization. The CV values from these agencies were compiled by EPA Regions 3, 6 and 9 and are available solely from Region 3's website. This reference and the table of values are available at: http://www.epa.gov/reg3hwmd/risk/human/index.htm and was last updated on September 12, 2008. The other resource is the Agency for Toxic Substances and Disease Registry (ATSDR) Environmental Media Evaluation Guide (EMEG) and Cancer Risk Evaluation Guide (CREG) values. ATSDR values were considered first. For most compounds, the EMEG or CREG was the most protective CV and was used to screen contaminants for risk. A few contaminants were not covered by the new Region 3 or ATSDR resources. The chronic CV for lead used here is the new EPA National Ambient Air Quality Standard for lead. For aluminum, iron, copper and zinc, older Region 3 EPA Risk-Based Concentrations (RBCs) were the only chronic inhalation CVs available and are noted in the table below. Tables showing the contaminants *at each individual monitoring site* that were above a CV are presented in Appendix A.

Table 3: All Monitors—Highest Mean[1] Concentrations[2] and Comparison Values[2]

Compound	Highest Mean[2]	Chronic CV[2]	Exceeds Non-Cancer CV?	Cancer CV[2]	Exceeds Cancer CV?
Benzene	1.98	30.0[6]	No	0.10[6]	**Yes**
1,3-Butadiene	0.32	2.0[6]	No	0.03[6]	**Yes**
Carbon tetrachloride	0.63	200[6]	No	0.01[6]	**Yes**
Chloroform	0.22	100[6]	No	0.04[6]	**Yes**
Dichloromethane/Methylene Chloride	0.74	1100[6]	No	3.0[6]	No
Tetrachloroethylene	0.33	280	No	0.41	No
Trichloroethylene	0.66	No CV	No CV	1.2	No
1,2-Dichloropropane	0.01	4.0[6]	No	0.24	No
Vinylchloride	0.003	100	No	0.10[6]	No
Acetaldehyde	3.86	9.0[6]	No	0.5[6]	**Yes**
Formaldehyde	6.19	10.0[6]	No	0.08[6]	**Yes**
Trichlorofluoromethane	1.79	730	No	No CV	NA
Dichloro Difluoromethane	3.66	210	No	No CV	NA
Chlorobenzene	1.12	52.0	No	No CV	NA
1,2-Dichlorobenzene	0.27	210	No	No CV	NA
1,3-Dichlorobenzene	0.22	52.0[3]	No	No CV	NA
1,4-Dichlorobenzene	0.369	100[6]	No	0.22	**Yes**
Chloroethane/Ethyl Chloride	0.323	10000	No	No CV	NA
Chloroethene/Vinyl Chloride	0.006	100[6]	No	0.10[6]	No
Chloromethane	1.28	94.0	No	1.4	No
1,1,1-Trichloroethane	0.11	5200	No	No CV	NA
Hexane	0.90	730.0	No	No CV	NA
Toluene	3.11	300[6]	No	No CV	NA
Ethylbenzene	0.56	1000[6]	No	0.97	No
m,p-Xylene	1.95	200[6]	No	No CV	NA
o-Xylene	0.69	200[6]	No	No CV	NA
Styrene	0.17	300[6]	No	No CV	NA
Arsenic	0.00051	0.031	No	0.00057	No
Beryllium	0.000046	0.020[6]	No	0.0004[6]	No
Cadmium	0.000099	No CV	No CV	0.0006[6]	No
Chromium	0.0009	No CV	No CV	0.0002[4]	**Yes**
Lead	0.004	0.15[5]	No	No CV	NA
Manganese	0.0158	0.04[6]	No	No CV	NA
Nickel	0.0012	0.09[6]	No	No CV	NA
Aluminum	0.00049	3.7[7]	No	No CV	NA
Iron	0.00076	1100[7]	No CV	No CV	NA
Copper	0.039	150[7]	No CV	No CV	NA
Zinc	0.076	1100[7]	No CV	No CV	NA

[1]The highest mean for each contaminant is the highest mean of all the monitoring stations.
[2]All values are in μg/m^3.
[3]This is the non-cancer CV for 1,2-dichlorobenzene. No inhalation NOAEL exists for 1,3-dichlorobenzene.
[4]This is the cancer CV for a 1:6 ratio of Chromium VI:Chromium III
[5]EPA NAAQS Value
[6]ATSDR EMEG or CREG Chronic Exposure Value
[7](Old) Region 3 EPA Risk-Based Concentration (RBC)

Comparisons with Chronic CVs
As Table 3 reflects, there were no contaminants that were above a chronic (non-cancer) CV. The chronic CVs are generally used for continuous or near continuous inhalation exposures that occur for a year or more. Chronic CVs typically have safety factors built in so that the margin of safety is large and people exposed to levels at or below the chronic CV are not likely to experience any adverse health effects when daily exposure occurs for many years. A contaminant without a chronic CV requires further evaluation to determine if the level found poses a health risk. This additional evaluation is discussed below.

Comparisons with Cancer CVs
Seven VOCs (benzene, 1,3-butadiene, carbon tetrachloride, chloroform, acetaldehyde, formaldehyde and 1,4-dichlorobenzene) were detected at concentrations above their cancer CV. Benzene, 1, 3-butadiene, carbon tetrachloride, acetaldehyde, and formaldehyde were detected above their cancer CVs at all 5 sampling sites. The compound 1,4-dichlorobenzene was detected above its cancer CV at 3 of the 5 sites. Formaldehyde was found at levels greater than 19 times its cancer CV at all five sites.

No metals were detected above a CV except for chromium compounds which exceeded the cancer CV at all sampling locations. However, the cancer CV listed in the table is assuming a ratio of 1 to 6 of chromium VI to chromium III. Chromium VI is a highly toxic form of chromium and is not very common compared to the less toxic chromium III. Only total chromium was measured in this study. Generally, the level of chromium VI in the air is a small percentage of the total chromium. Using the cancer CV for total chromium, the highest average measured was more than 4 times greater than the CV. Assuming that *all* chromium found is chromium VI, the highest average would be 28 times greater than the CV: this is even more unlikely.

Exposure Pathways
To determine whether people are, were, or could be exposed in the future to the contaminants sampled and analyzed in this study, the environmental and human components that lead to exposure were evaluated. Exposure is said to exist if the five elements of an exposure pathway exist, have existed, or may exist in the future. An exposure pathway is composed of: 1) a source of contamination; 2) a movement of the contamination through air, water, and/or soil; 3) human activity where the contamination exists; 4) human contact with contaminant through touching, breathing, swallowing and/or drinking; and, 5) a population that can potentially be exposed. If all five elements are present, an exposure pathway is said to exist.

Based on the exposure pathway analysis and environmental data, it was determined that an inhalation exposure pathway exists for residents of Lewiston, Lapwai and surrounding areas. This means it is likely that residents are currently exposed to the contaminants listed in Table 3 through breathing the ambient air.

Discussion

Acute and Chronic Risks

By comparing the highest mean levels of each contaminant to its acute and chronic CV value it was found that exposure is not likely to result in any acute or chronic adverse non-cancer health effects. Most of the highest mean values were many times below their chronic CV value, and even further below their acute CV value. Also, no individual 24 hour sample at any of the locations exceeded any of the acute CV values. The only two contaminants that were close to their chronic CVs were acetaldehyde and formaldehyde. The highest mean for acetaldehyde was 3.86 $\mu g/m^3$ and its chronic CV is 9.4 $\mu g/m^3$ or 2.4 greater than the highest mean. The highest mean for formaldehyde was 6.19 $\mu g/m^3$ and the CV is 10.0 $\mu g/m^3$ or 1.6 times greater than the highest mean.

Cancer Risks

Cancer exposure scenarios generally assume a 30 year exposure to the suspected carcinogen. By looking at the levels of contaminants and comparing those levels to risk-based cancer CVs it is possible to determine a theoretical risk for populations exposed to the current levels of contaminants for the next 30 years.

The measured average (mean) and median level of a contaminant can be used to calculate how much *extra (excess) risk* of cancer a group of people might have from being exposed to this contaminant in the air for 30 years. The mean is considered to be the most representative value for these data, though it should be noted that the mean is influenced by high individual maximum values. The median could have been chosen at the best measure, but it was decided to use the mean since high levels appeared to occur for days at a time, and outliers (individual extreme values) did not occur.

The health endpoint considered for all these compounds is increased risk of cancer at specific sites (endpoints) in the body. The most sensitive site is used as the endpoint. For cancer endpoints, the cancer CV is set at the concentration at which it is believed one in a million excess cancers could potentially be attributed to the exposure.

The CVs for cancer risk do not establish a level at which people exposed above the CV are expected to get cancer. Cancer CVs allow health assessors to determine an estimate of the number of unexpected (extra/excess) cancers that might be caused if a group of people were exposed to contaminant levels above the CV every day, 24 hours a day, for an entire 30 year residence time.

The extra cancer calculations are shown in Appendix B. As shown in Table 3, the highest yearly mean (average) value at a single monitoring site is used in these calculations. The highest yearly mean was derived by taking each monitoring station's data and calculating the mean level for each contaminant. These yearly mean levels were then compared to each other and the highest mean for each contaminant was selected to compare with its CV. It must be noted that using the highest mean value to calculate the extra cancer risk is a conservative approach and will likely overestimate the extra cancer risk since not everyone will be exposed to the highest value for 24 hours a day for 30 years.

To determine extra cancer risk the following formula was used:

Extra Cancer Risk = C x IUR

C = concentration of the contaminant
IUR = Inhalation Unit Risk (EPA)

When reviewing the extra cancer risk, it is important to know that the methods used to derive the Inhalation Unit Risk values result in upper bound estimates of extra cancers, that is, the true risk is not likely to exceed this value and may be much lower.

- The cancer risk level for this continual exposure to benzene is 15.41 extra cancers per one million people exposed or 1.5 extra cancers in 100,000 people when calculated using EPA's Inhalation Unit Risk method. The most sensitive cancer endpoint considered is leukemia.
- The cancer risk level for this continual exposure to 1,3-butadiene is 9.48 extra cancers per one million people exposed when calculated using EPA's Inhalation Unit Risk method. The most sensitive cancer endpoint considered is leukemia.
- The cancer risk level for this continual exposure to carbon tetrachloride is 9.48 extra cancers per one million people exposed when calculated using EPA's Inhalation Unit Risk method. The cancer endpoint considered is liver cancer.
- The cancer risk level for this continual exposure to chloroform is 5.08 extra cancers per one million people exposed when calculated using EPA's Inhalation Unit Risk method. The cancer endpoint considered is both liver and kidney cancers.
- The cancer risk level for this continual exposure to acetaldehyde is 8.49 extra cancers per one million people exposed when calculated using EPA's Inhalation Unit Risk method. The cancer endpoint considered is upper respiratory tract cancer.
- The cancer risk level for this continual exposure to formaldehyde is 80.5 extra cancers per one million people exposed or 8 extra cancers in 100,000 people when calculated using EPA's Inhalation Unit Risk method. The cancer endpoint considered is upper respiratory tract cancer.
- The cancer risk level for this continual exposure to 1,4-dichlorobenzene is 4.06 extra cancers per one million people exposed when calculated using EPA's Inhalation Unit Risk method. The cancer endpoint considered is liver cancer.
- The cancer risk level for this continual exposure to total chromium is 10.8 extra cancers per one million people exposed when calculated using EPA's Inhalation Unit Risk method. The cancer endpoint considered is lung cancer. The cancer risk level assuming all chromium was chromium VI is 75.6 extra cancers per one million people exposed: however, it is extremely unlikely that all chromium present in air was chromium VI. Therefore, this theoretical risk calculation is likely to be an overestimate of the extra cancer risk.

The Inhalation Unit Risk is the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 $\mu g/m^3$ in air. This means that, for example, it is possible that for every million people there could be 80.5 extra (unexpected) cases of cancer in people exposed to formaldehyde under these

circumstances. These extra cases might be attributable to formaldehyde exposure. Formaldehyde was clearly the highest extra risk of all contaminants measured. It is important to note that cancer risk estimates do not provide definitive answers about whether or not a person will get cancer; rather, they are measures of chance (probability).

At first glance, it may seem intuitive to add up the cancer risks for all the contaminants to arrive at a single risk number. However, this is only valid for cancers that occur at the same site in the body. The cancer endpoints listed above for each contaminant are for a specific site in the body. Thus we may add together the following:

- Benzene + 1,3-butadiene = *24.9 extra leukemias* (cancers) in 1 million or 2.5 extra cancers per 100,000
- Carbon tetrachloride + chloroform + 1,4-dichlorobenzene = *18.6 extra liver cancers* in 1 million or 1.9 extra cancers per 100,000
- Acetaldehyde + formaldehyde = *89.0 extra upper respiratory tract cancers* in 1 million or 9 extra cancers per 100,000

Thus, the site at greatest risk for developing cancers from 30-year exposure to ambient air in the region is the upper respiratory tract; however, this risk is still considered to be low. Risk was also very slightly elevated for lung and kidney due to total chromium and chloroform individually, as noted above.

Cancer is a common illness, with many different forms that result from a variety of causes; not all are fatal. According to the American Cancer Society, nearly half of all men and one-third of all women in the U.S. population will develop cancer at some point in their lives. Since cancer is very common and the highest risk estimate for the estimated exposure is 9 excess cancers per 100,000 people exposed, *BCEH believes that there is no apparent health risk for those living in the Lewiston area.* In other words, it is possible that some excess cases of upper respiratory tract cancer may be attributable to exposure to aldehydes in the Lewiston area, but it is likely impossible to distinguish these potential excess cases from background levels of cancer in the area. In particular, exposure appears to be greatest in the urban areas of Lewiston. This emphasizes that regions and municipalities should always strive to attain ambient air quality below CVs .

Uncertainties

As with most ambient air monitoring, the data reviewed in this health consultation were collected at single fixed-position monitoring stations and, thus, only reflect air quality at a specific location. It is possible that other parts of the valley that have not been sampled could have higher or lower concentrations of air contaminants than those reported here. Also, since the air was only monitored one day in every six, there is always the possibility that some of the maximum air contaminant levels were not captured and that could possibly change the mean values used in the risk analysis.

While it is possible to introduce bias by ignoring the non-detects, the detection limit for all compounds measured was well below the CV for each contaminant. Thus, non-detect readings were rare and there is no reason to believe that non-detects would influence the derived mean concentration of any compound.

Another uncertainty is that the sampler with the most compounds detected at high concentrations was LSOB, which is mounted on a multi-story building rooftop. In contrast, most of the other samplers in the study were at breathing height on the ground level. The only other rooftop monitor was the ITD site, where the sampler was on the roof of a single-story building. People are more likely to be exposed near the ground than at rooftop height, particularly in a town like Lewiston that does not have high-rise residential housing or high-rise office buildings. It is possible that the concentrations at street level at the LSOB site and at the ITD site could be higher or lower than what was detected on the roof.

The total chromium CV assumes a 1 to 6 ratio of Chromium VI to Chromium III, which is a high proportion of the more toxic Chromium VI. It is rare for this ratio to exist in the environment, thus actual risk from chromium exposure is likely lower than predicted here. The comparison to the chromium VI CV is shown for reference only. Chromium VI is not found by itself in ambient air.

The carcinogenic potential of many chemicals is characterized by a threshold level below which no effect occurs. Such a threshold has been estimated for both formaldehyde and acetaldehyde. These thresholds are based on mathematical modeling of animal study data and, to be conservative, have been estimated to err on the side of caution. The cancer CV for these two compounds may therefore slightly overestimate the hazard present and this estimated threshold may be somewhat higher.

Formaldehyde and Acetaldehyde Background Levels. When comparing the levels of formaldehyde and acetaldehyde with those measured in similar size towns in the Pacific Northwest, Lewiston had higher levels of both. The formaldehyde level in Lewiston was approximately double that of La Grande, Oregon and triple that of Longview, Washington. The acetaldehyde level in Lewiston was approximately double that of La Grande and Longview (EPA AQS 2007; SW Clean Air Agency 2007).

According to the most recent manuscript on the subject of ambient background levels in North America (McCarthy et al. 2006), the formaldehyde and acetaldehyde levels in the Lewiston area are comparable to levels that are found in urban areas, but much higher than what is found in rural areas across North America. In a 10-city pilot study of urban areas, the *median* formaldehyde concentration was 2.55 $\mu g/m^3$, compared to a median of 2.96 $\mu g/m^3$ at the LSOB monitor. The *median* acetaldehyde concentration was 1.62 $\mu g/m^3$ in the same study, compared to a median of 2.04 $\mu g/m^3$ at the LSOB monitor. This study (McCarthy et al. 2006) does not list mean levels for urban areas due to outliers in the data. It does list mean levels for remote areas. In remote areas, the mean formaldehyde concentration was 0.2 $\mu g/m^3$, and the mean acetaldehyde concentration was 0.16 $\mu g/m^3$. Clearly, all monitors in the current Lewiston area study regularly exceed these remote background levels, but are similar to levels found in cities across the U.S. Levels of formaldehyde and acetaldehyde were lower at the Lapwai site on the Nez Perce Reservation than in Lewiston, but not by a significant amount. Table 4 includes the contaminants found to be above their respective cancer CV and urban background levels.

Table 4. Urban Background Levels of Contaminants Above Their Cancer CVs

Contaminant	Urban Median[1] Background Level ($\mu g/m^3$)	Lewiston Sampling Median[1,2] Values ($\mu g/m^3$)	Difference (%)
Benzene	1.09	1.58	**144%**
1,3-Butadiene	NF[2]	0.188	
Carbon tetrachloride	0.62	0.65	**105%**
Chloroform	0.14	0.29	**207%**
Acetaldehyde	1.62	2.04	**126%**
Formaldehyde	2.55	2.96	**116%**
1,4-Dichlorobenzene	NF[3]	0.19	
Chromium	NF[3]	0.0007	

[1]Only median values were available in the literature on urban background values
[2]Lewiston median indicates highest detected median at either LSOB, ITD or SUNSET
[3]NF=not found; a review of the scientific literature did not turn up an urban background level

ATSDR Child Health Concerns

ATSDR and BCEH recognize that children may be more sensitive to contaminant exposures than adults. This sensitivity is a result of several factors: 1) children may have greater exposures to environmental toxicants than adults because, pound for pound of body weight, children drink more water, eat more food, and breathe more air than adults; 2) children play outdoors close to the ground, increasing their exposure to toxicants in dust, soil, water, and air; 3) children have a tendency to put their hands in their mouths while playing, thereby exposing them to potentially contaminated soil particles at higher rates than adults (also, some children ingest non-food items, such as soil, a behavior known as "pica"); 4) children are shorter than adults, meaning that they can breathe dust, soil, and any vapors close to the ground; and 5) children grow and develop rapidly; they can sustain permanent damage if toxic exposures occur during critical growth stages.

As discussed earlier, exposure to the measured contaminants in ambient air is unlikely to result in any adverse non-carcinogenic public health effects to children or adults. The main concern is an increased risk of cancer in the exposed population. Since cancer risk is based on a 30-year exposure, the risk is considered the same for both adults and children.

Conclusions

Since cancer is very common and the highest risk estimate for the estimated exposure is 9 excess cancers per 100,000 people exposed, *BCEH believes that there is no apparent health risk for those living in the Lewiston area.* It is possible that some excess cases of upper respiratory tract cancer may be attributable to exposure to aldehydes in the Lewiston area, but it is likely impossible to distinguish these potential excess cases from background levels of cancer in the area. In particular, exposure appears to be greatest in

the urban areas of Lewiston. This emphasizes that regions and municipalities should always strive to attain ambient air quality below CVs. Levels of formaldehyde and acetaldehyde within Lewiston city limits were comparable to that found in a recent survey of 10 urban areas across North America. Levels of formaldehyde and acetaldehyde were lower at the Lapwai site on the Nez Perce Reservation than in Lewiston, but not by a significant amount.

Recommendations

BCEH recommends that the Nez Perce Tribe ERWM Air Quality Program and IDEQ continue air monitoring in Lewiston and surrounding areas. A seasonal monitoring approach that captures daily 24-hour readings during inversions should be attempted since contaminant concentrations may be the highest during these periods.

BCEH recommends that BCEH work with the Nez Perce Tribe ERWM Air Quality Program and IDEQ to address air pollution in Lewiston and surrounding areas through educational activities.

BCEH recommends that BCEH work with the Nez Perce Tribe ERWM Air Quality Program and IDEQ to identify the sources of contaminants and work to reduce levels below CVs.

BCEH recommends that the Idaho Cancer Data Registry review the current cancer incidence data for the Lewiston area and report its findings to BCEH.

Public Health Action Plan

BCEH will continue to work with the Nez Perce Tribe ERWM Air Quality Program and IDEQ to assess health effects from exposure to ambient air in Lewiston and surrounding areas on an as-needed basis.

Appendix A

Monitoring Sites and the Maximum and Mean Levels of Contaminants that Exceeded Cancer CV

Table A1: LAPWAI

Compound	Maximum	Mean	Cancer CV	Exceeds Cancer CV?
Benzene	4.038	1.656	0.31	**Yes**
1,3-Butadiene	0.261	0.099	0.081	**Yes**
Carbon tetrachloride	0.878	0.615	0.160	**Yes**
Acetaldehyde	14.380	2.850	1.100	**Yes**
Formaldehyde	17.046	3.739*	0.190	**Yes**
1,4-Dichlorobenzene	6.547	0.317	0.22	**Yes**
Chromium compounds	0.011	0.0007	0.0002**	**Yes**

All values are in $\mu g/m^3$

Note that CV values are for chronic exposure scenarios and cannot be directly compared to maximums.

*Denotes mean/median value is more than 10x the CV

**Note that this is the cancer CV for a 1:6 ratio of Chromium VI:Chromium III

Table A2: HATWAI1

Compound	Maximum	Mean	Cancer CV	Exceeds Cancer CV?
Benzene	1.218	1.140	0.31	**Yes**
1,3-Butadiene	0.421	0.104	0.081	**Yes**
Carbon tetrachloride	0.840	0.572	0.160	**Yes**
Chloroform	0.713	0.130	0.110	**Yes**
Acetaldehyde	16.457	2.879	1.100	**Yes**
Formaldehyde	15.924	4.011*	0.190	**Yes**
Chromium compounds	0.004	0.0005	0.0002**	**Yes**

All values are in $\mu g/m^3$

Note that CV values are for chronic exposure and cannot be directly compared to maximums.

*Denotes mean/median value is more than 10x the CV

**Note that this is the cancer CV for a 1:6 ratio of Chromium VI:Chromium III

Table A3: ITD1				
Compound	**Maximum**	**Mean**	**Cancer CV**	**Exceeds Cancer CV?**
Benzene	6.226	1.513	0.31	**Yes**
1,3-Butadiene	0.692	0.152	0.081	**Yes**
Carbon tetrachloride	0.878	0.602	0.160	**Yes**
Chloroform	0.979	0.325	0.110	**Yes**
Acetaldehyde	17.928	3.707	1.100	**Yes**
Formaldehyde	21.000	5.341*	0.190	**Yes**
Chromium compounds	0.005	0.0009	0.0002**	**Yes**

All values are in $\mu g/m^3$

Note that CV values are for chronic exposure and cannot be directly compared to maximums.

*Denotes mean/median value is more than 10x the CV

**Note that this is the cancer CV for a 1:6 ratio of Chromium VI:Chromium III

Table A4: ITD2				
Compound	**Maximum**	**Mean**	**Cancer CV**	**Exceeds Cancer CV?**
Benzene	4.748	1.679	0.31	**Yes**
1,3-Butadiene	0.584	0.139	0.081	**Yes**
Carbon tetrachloride	0.895	0.601	0.160	**Yes**
Chloroform	0.853	0.314	0.110	**Yes**
Acetaldehyde	20.052	3.619	1.100	**Yes**
Formaldehyde	25.601	5.150*	0.190	**Yes**
1,4-Dichlorobenzene	0.861	0.222	0.22	**Yes**

All values are in $\mu g/m^3$

Note that CV values are for chronic exposure and cannot be directly compared to maximums.

*Denotes mean/median value is more than 10x the CV

Table A5: SUNSET				
Compound	**Maximum**	**Mean**	**Cancer CV**	**Exceeds Cancer CV?**
Benzene	6.627	1.439	0.31	**Yes**
1,3-Butadiene	0.337	0.118	0.081	**Yes**
Carbon tetrachloride	0.840	0.587	0.160	**Yes**
Chloroform	0.798	0.205	0.110	**Yes**
Acetaldehyde	13.589	3.580	1.100	**Yes**
Formaldehyde	20.418	6.195*	0.190	**Yes**
Chromium compounds	0.002	0.0004	0.0002**	**Yes**
All values are in $\mu g/m^3$ Note that CV values are for chronic exposure and cannot be directly compared to maximums. *Denotes mean/median value is more than 10x the CV **Note that this is the cancer CV for a 1:6 ratio of Chromium VI:Chromium III				

Table A6: LSOB				
Compound	**Maximum**	**Mean**	**Cancer CV**	**Exceeds Cancer CV?**
Benzene	5.508	1.976	0.31	**Yes**
1,3-Butadiene	5.169	0.316	0.081	**Yes**
Carbon tetrachloride	0.907	0.632	0.160	**Yes**
Chloroform	0.511	0.221	0.110	**Yes**
Acetaldehyde	18.233	3.860	1.100	**Yes**
Formaldehyde	21.838	5.798*	0.190	**Yes**
1,4-Dichlorobenzene	4.178	0.369	0.22	**Yes**
Chromium compounds	0.003	0.0006	0.0002**	**Yes**
All values are in $\mu g/m^3$ Note that CV values are for chronic exposure and cannot be directly compared to maximums. *Denotes mean/median value is more than 10x the CV **Note that this is the cancer CV for a 1:6 ratio of Chromium VI:Chromium III				

Appendix B

Benzene Risk Calculation

Benzene: using highest measured 1 year average concentration at a single site (LSOB)

Lifetime

30-year Risk Using Unit Risk

Inhalation Unit Risk = 7.8×10^{-6} $(\mu g/m^3)^{-1}$

Risk = Concentration ($\mu g/m^3$) x Unit Risk $(\mu g/m^3)^{-1}$ = $1.976 \times (7.8 \times 10^{-6})$ $= 15.41 \times 10^{-6}$

15.41 in 1 million excess cancer risk

Cancer Risk Comparison Levels = **1×10^{-6}**

1,3 Butadiene Risk Calculation

1,3-Butadiene: using highest measured 1 year average concentration at a single site (LSOB)

Lifetime

30-year Risk Using Unit Risk

Inhalation Unit Risk = 3.0×10^{-5} $(\mu g/m^3)^{-1}$

Risk = Concentration ($\mu g/m^3$) x Unit Risk $(\mu g/m^3)^{-1} = 0.316 \times (3 \times 10^{-5}) = 9.48 \times 10^{-6}$

9.48 in 1 million excess cancer risk

Cancer Risk Comparison Levels = **1×10^{-6}**

Carbon Tetrachloride Risk Calculation

Carbon Tetrachloride: using highest measured 1 year average concentration at a single site (LSOB)

Lifetime

30-year Risk Using Unit Risk

Inhalation Unit Risk = 1.5 x 10-^{5} $(\mu g/m^3)^{-1}$

Risk = Concentration ($\mu g/m^3$) x Unit Risk $(\mu g/m^3)^{-1} = 0.632 \times (1.5 \times 10^{-5})$ $= 9.48 \times 10^{-6}$

9.48 in 1 million excess cancer risk

Cancer Risk Comparison Levels = **1×10^{-6}**

Chloroform Risk Calculation

Chloroform: using highest measured 1 year average concentration at a single site (LSOB)

Lifetime

30-year Risk Using Unit Risk

Inhalation Unit Risk = 2.3 x 10-^{5} ($\mu g/m^{3\ -1}$

Risk = Concentration ($\mu g/m^3$) x Unit Risk ($\mu g/m^3$)$^{-1}$ = 0.221 x (2.3 x 10^{-5})

= 5.08 x 10^{-6}

5.08 in 1 million excess cancer risk

Cancer Risk Comparison Levels = **1 x 10^{-6}**

Acetaldehyde Risk Calculation

Acetaldehyde: using highest measured 1 year average concentration at a single site (LSOB)

Lifetime

30-year Risk Using Unit Risk

Inhalation Unit Risk = 2.2 x 10^{-6} ($\mu g/m^3$)$^{-1}$

Risk = Concentration ($\mu g/m^3$) x Unit Risk ($\mu g/m^3$)$^{-1}$ = 3.86 x (2.2 x 10^{-6})

= 8.49 x 10^{-6}

8.49 in 1 million excess cancer risk

Cancer Risk Comparison Levels = **1 x 10^{-6}**

Formaldehyde Risk Calculation

Formaldehyde: using highest measured 1 year average concentration at a single site (SUNSET)

Lifetime

30-year Risk Using Unit Risk

Inhalation Unit Risk = 1.3 x 10^{-5} ($\mu g/m^3$)$^{-1}$

Risk = Concentration ($\mu g/m^3$) x Unit Risk ($\mu g/m^3$)$^{-1}$ = 6.195 x (1.3 x 10^{-5})

= 80.5 x 10^{-6}

80.5 in 1 million excess cancer risk

Cancer Risk Comparison Levels = **1 x 10^{-6}**

1, 4-Dichlorobenzene Risk Calculation

1, 4-Dichlorobenzene: using highest measured 1 year average concentration at a single site (LSOB)

Lifetime

30-year Risk Using Unit Risk
Inhalation Unit Risk = 1.1×10^{-5} $(\mu g/m^3)^{-1}$
Risk = Concentration ($\mu g/m^3$) x Unit Risk $(\mu g/m^3)^{-1}$ = $0.369 \times (1.1 \times 10^{-5})$
$= 4.06 \times 10^{-6}$

4.06 in 1 million excess cancer risk

Cancer Risk Comparison Levels = **1×10^{-6}**

Chromium Risk Calculation

A. Chromium (total): using highest measured 1 year average total Cr concentration at a single site (ITD1)

Lifetime

30-year Risk Using Unit Risk
Inhalation Unit Risk = 1.2×10^{-2} $(\mu g/m^3)^{-1}$
Risk = Concentration ($\mu g/m^3$) x Unit Risk $(\mu g/m^3)^{-1}$ = $0.0009 \times (1.2 \times 10^{-2})$
$= 10.8 \times 10^{-6}$

10.8 in 1 million excess cancer risk

B. Chromium (Cr +6): using highest measured 1 year average total Cr concentration at a single site (ITD1)

Lifetime

30-year Risk Using Unit Risk
Inhalation Unit Risk = 8.4×10^{-2} $(\mu g/m^3)^{-1}$
Risk = Concentration ($\mu g/m^3$) x Unit Risk $(\mu g/m^3)^{-1}$ = $0.0009 \times (8.4 \times 10^{-2})$
$= 75.6 \times 10^{-6}$

75.6 in 1 million excess cancer risk

Cancer Risk Comparison Levels = **1×10^{-6}**

Authors of Report

Kai Elgethun PhD, MPH
State Public Health Toxicologist
Health Assessor
Idaho Division of Health
Bureau of Community and Environmental Health

Jim Vannoy, MPH
Program Manager
Idaho Division of Health
Bureau of Community and Environmental Health

Reviewers of Report

Gregory Ulirsch, MS, PhD
Technical Project Officer
Agency for Toxic Substances and Disease Registry

Cameron Stephenson, MPH
Health Educator
Idaho Division of Health
Bureau of Community and Environmental Health

Kara Stevens
Section Manager
Idaho Division of Health
Bureau of Community and Environmental Health

Elke Shaw-Tulloch, MHS
Bureau Chief
Idaho Division of Health
Bureau of Community and Environmental Health

Richard Kauffman, MS
Senior Regional Representative, Region 10
Division of Regional Operations
Agency for Toxic Substances and Disease Registry

References

ATSDR. Health Consultation: Evaluation of Air Exposure:
Potlatch Corporation Pulp and Paper Mill, Lewiston, Idaho
EPA Facility ID: IDD009061375. Lewiston, Nez Perce County, Idaho, August 2003

ATSDR. Health Consultation: Evaluation of Benzene Air Contamination in Lewiston Area, Idaho. Lewiston, Nez Perce County, Idaho, February 16, 2005.

ATSDR. Toxicological profile for 1,3 butadiene. Atlanta: US Department of Health and Human Services, 1993.

ATSDR. Toxicological profile for formaldehyde. Atlanta: US Department of Health and Human Services, July 1999.

ATSDR. Toxicological profile for carbon tetrachloride (update). Atlanta: US Department of Health and Human Services, August 2005.

ATSDR. Toxicological profile for dichlorobenzenes (update). Atlanta: US Department of Health and Human Services, August 2006.

ATSDR. Toxicological profile for benzene (update). Atlanta: US Department of Health and Human Services, August 2007.

ATSDR. Toxicological profile for chloroform (update). Atlanta: US Department of Health and Human Services, September 2007.

ATSDR. Health Consultation: Evaluation of Air Contaminants in the Treasure Valley Area Ada and Canyon Counties, Idaho. 2006 (a.k.a. NNU Air Study').

ATSDR. TopHat Exposure Dose Calculator software. Atlanta: US Department of Health and Human Services, Updated June 20, 2006.

ATSDR. Public Health Assessment Guidance Manual. Atlanta: US Department of Health and Human Services, revised January, 2005. Available online: http://www.atsdr.cdc.gov/HAC/PHAManual/index.html, accessed November 13, 2008.

American Conference of Governmental Industrial Hygienists Threshold Limit Values. ACGIH Worldwide, Cincinnati, Ohio. 2006.

Idaho Cancer Data Registry (ICDR). Cancer incidence 1992-2000, comparison between Lewiston, ID and Clarkston, WA zip codes and the remainder of the State of Idaho. 2003.

McCarthy MC, Hafner HR and SA Montzka. Background concentrations of 18 air toxics for North America. J. Air & Waste Manage. Assoc. 56:3-11 (2006).

Southwest (WA) Clean Air Agency. Final Report: Longview Air Toxics Monitoring Project. March 2007. Available online: http://www.swcleanair.org/pdf/LongviewToxicsReport.pdf, accessed November 19 2008.

U.S. EPA. Exposure Factors Handbook. EPA/600/P-95/002Fa. August 1997.

U.S. EPA Region 6 Preliminary Remediation Goals: Human Health Medium-Specific Screening Levels. Available online: http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm, accessed November 13 2008.

U.S. EPA Region 9 Preliminary Remediation Goals. Available online: http://www.epa.gov/region09/waste/sfund/prg/faq.htm, accessed November 13 2008.

U.S. EPA Region 10. Memorandum: Recommendations for Human Health Risk-based Chemical Screening and Related Issues at EPA Region 10 CERCLA and RCRA Sites. April 17, 2007.

U.S. EPA Region 3 Risk-Based Concentration Table. Available online: http://www.epa.gov/reg3hwmd/risk/human/index.htm, updated September 12 2008, accessed September 23 2008.

Certification

This health consultation, Lewiston Air Toxics Monitoring 2006-2007: Evaluation of Potential Health Effects from Air Toxics, was prepared by the Idaho Division of Health (IDOH) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodologies and procedures existing at the time the health consultation was initiated. Editorial review was completed by the Cooperative Agreement partner.

Greg Ulirsch, PhD
Technical Project Officer, DHAC
Division of Health Assessment and Consultation
Agency for Toxic Substances & Disease Registry

Alan W. Yarbrough, M.S.
Team Lead, DHAC, CAPEB
Division of Health Assessment and Consultation
Agency for Toxic Substances & Disease Registry

Glossary

Acute - Occurring over a short time.

Agency for Toxic Substances and Disease Registry (ATSDR) - The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.

Airshed - A part of the atmosphere that behaves in a coherent way with respect to the dispersion of contaminants.

Cancer Slope Factor - A number assigned to a cancer causing chemical that is used to estimate its ability to cause cancer in humans.

Carcinogen - A substance that causes cancer.

Chronic - Occurring over a long time (more than 1 year).

Comparison value (CV) - Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Contaminant - A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Cancer Risk Evaluation Guide (CREG) - A concentration in air, water, or soil (or other environmental media), that is derived from EPA's cancer slope factor and carcinogenic risk of 10E-6 for oral exposure. It is the concentration that would be expected to cause no more than one excess cancer in a million persons exposed over a lifetime.

Dose - The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An “exposure dose” is how much of a substance is encountered in the environment. An “absorbed dose” is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Environmental Media Evaluation Guide (EMEG) - A concentration in air, soil, or water (or other environmental media), that is derived from ATSDR's MRL, and below which adverse non-cancer health effects are not expected to occur. Separate EMEGs can be derived to account for acute, intermediate, or chronic exposure durations.

Exposure - Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [**acute**], of intermediate duration [**intermediate**], or long-term [**chronic**].

Hazardous substance - Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.

IDEQ - The Idaho Department of Environmental Quality.

Indeterminate public health hazard - The category used in ATSDR's health consultation documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Inhalation rate - The amount of an environmental medium which could be inhaled typically on a daily basis. Units for inhalation rate are typically in cubic meters per day.

Inhalation unit risk - The upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 ug/m 3 in air.

Intermediate - Occurring over a time more than 14 days and less than one year.

Lowest Observed Adverse Effect Level (LOAEL) - The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Media - Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.

Minimal Risk Level (MRL) - An **MRL** is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects.

No apparent public health hazard - A category used in ATSDR's health consultation reports for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No Observed Adverse Effect Level (NOAEL) - The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard - A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

Oral Reference Dose (RfD) - An amount of chemical ingested into the body (i.e., dose) below which health effects are not expected. RfDs are published by EPA.

Organic - Compounds composed of carbon, including materials such as solvents, oils, and pesticides which are not easily dissolved in water.

Plume - A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Public Health Hazard - A category used in ATSDR's health consultation reports for sites that pose a risk to health because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances that could result in harmful health effects.

Remedial investigation - The process of determining the type and extent of hazardous substance contamination at a site.

Route of exposure - The way people come into contact with a hazardous substance. Three routes of exposure are breathing [**inhalation**], eating or drinking [**ingestion**], or contact with the skin [**dermal contact**].