# Health Consultation

UMETCO MINERALS CORPORATION
(a/k/a FORMER MINE SITE)

MALVERN, HOT SPRING COUNTY, ARKANSAS

EPA FACILITY ID: ARR000003632

**Prepared by the**
**Arkansas Department of Health**

DECEMBER 1, 2011

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

**Health Consultation: A Note of Explanation**

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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# SUMMARY

**INTRODUCTION**

The Umetco Minerals Corporation, a former vanadium mine site, is currently operating a wastewater treatment facility on-site as part of its reclamation process. Water from East Wilson Pond is treated and released into Wilson Creek. Wilson Creek is a small tributary to Lake Catherine. Citizens have contacted the Arkansas Department of Health (ADH) with concerns over the water quality of Wilson Creek, the effects of this creek water on public health, and the possible cancer risks associated with exposure from this water source.

**CONCLUSION**

ADH has reviewed available water data in preparing this health consultation and determined that there is currently no evidence of potential off-site human exposure to Umetco site-related contaminants through public drinking water sources. For children and adults, exposure to accidental ingestion of surface water or skin contact through recreational activities is considered the only potentially complete exposure pathway at this site. Furthermore, ADH concludes that accidentally ingesting the surface water or making dermal contact with surface water at or near the Umetco site is not currently expected to harm people's health because sample result levels of chlorides, sulfates, total dissolved solids, cadmium, chromium, and/or vanadium are below levels of public health concern. Also, there is no evidence of elevated cancer rates and/or cases associated with this site.

**BASIS FOR DECISION**

There is no exposure to contaminants related to the Umetco site when ingesting public drinking water in this county, therefore the exposure pathway is not complete. When engaged in recreational activities in surface waters near the Umetco reclamation site or nearby Lake Catherine, the amount of cadmium, chromium, or vanadium that might get into a child's or adult's body by accidentally ingesting a small amount of the surface water or by skin contact is below a level that would harm their health. Exposure dose calculations were performed, and values fell below the levels of public health concern (*i.e.*, calculated doses were lower than levels of concern and are therefore, considered an unlikely source of adverse health effects). Also, after a statistical evaluation of cancer rates in Hot Spring County and the state of Arkansas, as well as cases in areas of Garland County, it was determined that there is no significant difference between the county and state data to indicate

| | |
|---|---|
| | elevated cancer rates and/or cases near this site. |
| **NEXT STEPS** | Current data indicate no threat of contamination to public drinking water systems associated with the Umetco site and, therefore, no identifiable risk of adverse health effects from public drinking water systems near this site. There are no expected adverse health effects from exposure to the surface water near the Umetco site during recreational activities. No additional public health actions are needed concerning the surface waters related to the Umetco site. Public health education may be provided, as necessary or requested. |
| **FOR MORE INFORMATION** | If you have concerns about your health, you should contact your health care provider. You can also call the Agency for Toxic Substances and Disease Registry (ATSDR) at 1 – 800 – CDC – INFO or ADH at 501- 661-2936 and ask for information on the Umetco Minerals Corporation site. |

## Statement of Issues

The Umetco Minerals Corporation (hereafter referred to as "Umetco"), a former vanadium mine site in Hot Spring County, Arkansas is currently operating a wastewater treatment facility on-site as part of its reclamation process. Water from East Wilson Pond is treated and released into Wilson Creek. Wilson Creek is a small tributary to Lake Catherine, and is a part of the Ouachita Mountain Ecoregion system because Lake Catherine flows into the Ouachita River. Citizens have contacted the Arkansas Department of Environmental Quality (ADEQ) and the Arkansas Department of Health (ADH) with concerns over the water quality of Wilson Creek, the effects of this creek water on public health, and the possible cancer risks associated with drinking water exposure from this water source. This health consultation discusses evaluation of the environmental data from this site, as well as the review of available cancer data from Hot Spring County, specific areas of Garland County, and the state with regards to the public's interest and initial community request. Morbidity data, or disease incidence rates, were evaluated due to the citizen's inquiry.

## Background and History

The Umetco site covers approximately 375 acres located north of Highway 270 near Malvern, Arkansas. Vanadium ore mining operations were conducted from 1961 to 1964 by Union Carbide Corporation, which created the subsidiary corporation Umetco [1]. Umetco held several mining permits with ADEQ, documented from 1972 to 2000. In 2003, UMETCO met with representatives from ADEQ to discuss the reclamation plan. The goal of the plan was stated in a letter addressed to ADEQ to "eliminate treatment in East Wilson Pond by reestablishing surface drainage patterns" [2]. A National Pollutant Discharge Elimination System (NPDES) permit was granted by ADEQ in order for Umetco to operate a wastewater treatment facility in its reclamation efforts. The NPDES permit number is AR0048950.

In 2005, ADEQ performed an inspection of the Umetco Wilson Mine facility in response to a complaint. The inspection revealed the Indian Creek Pond (an on-site body of water smaller than East Wilson Pond) was discharging to Indian Springs Creek (on-site water tributary), which was a violation of the Arkansas Water and Air Pollution Control Act (Act 472 of 1949, as amended).

Further inspections during 2005 revealed a release to Indian Springs Creek resulting from pump failure, an exceedance of total dissolved solids (TDS) from the Mineral Quality Standard levels, and an alteration in the stream's color [3]. On September 19, 2007, ADEQ issued a Consent Administrative Order (CAO) to Umetco in order to set a schedule for compliance for the permitted facility and correct the treatment process as mandated by the NPDES Program [3].

To date, site surface water monitoring is conducted by ADEQ. The NPDES permitting and Regulation 2 amendment decisions between ADEQ and Umetco are pending ruling by the Arkansas Pollution Control and Ecology Commission (APC&EC).

## Discussion

Exposure to contaminants of concern (COCs) is determined by examining human exposure pathways. An exposure pathway has five parts:

1. A source of contamination (e.g., hazardous compound(s) in the water),
2. An environmental medium such as water, soil, or air that can hold or move the contamination,
3. A point at which people come in contact with a contaminated medium,
4. An exposure route, such as incidental ingestion of the surface water, and
5. A population who could come in contact with the contaminants.

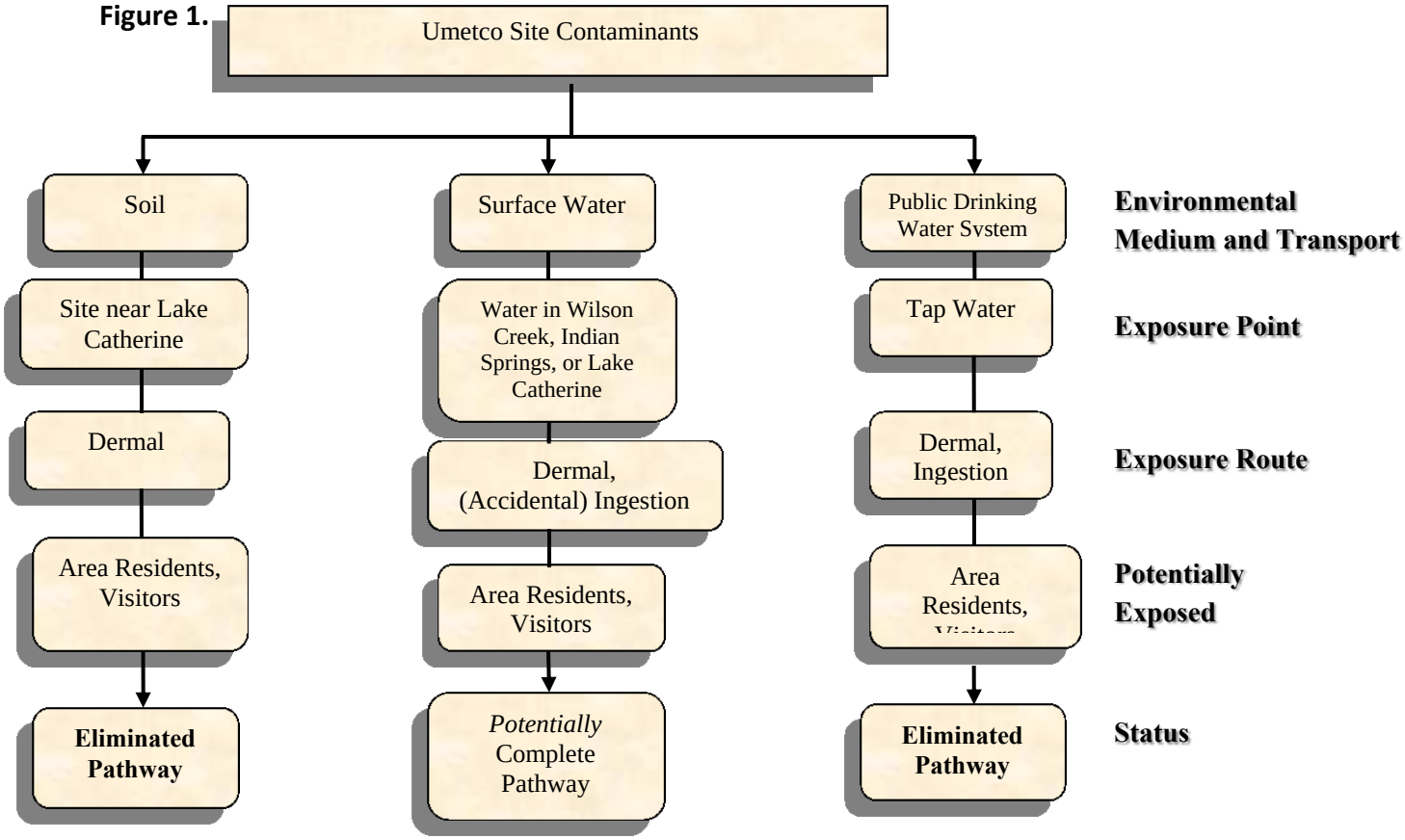
An exposure pathway is eliminated if at least one of the five parts is missing and will not occur in the future. For a completed pathway, all five parts must exist and exposure to a contaminant must have occurred, is occurring, or will occur. To evaluate the contaminants in an exposure pathway, the Agency for Toxic Substances and Disease Registry (ATSDR) Health Comparison Value (HCV) screening levels were used as comparison concentrations. HCVs are substance concentrations derived from the ATSDR Minimal Risk Levels (MRLs), which are doses below which adverse health effects are not likely to occur. Should a known contaminant concentration exceed an HCV, it does not necessarily indicate an adverse health effect may occur, rather that further analysis would be required to determine potential health risks.

***ADH has reviewed available water data in preparing this health consultation and determined that there is currently no evidence of potential off-site human exposure to Umetco site-related contaminants through public drinking water sources.*** ADH engineers have surveyed the public water systems for the City of Malvern, Kimzey Regional Water District, Magnet Butterfield Water, and Arkadelphia Water Works. The source of these public drinking water systems is downstream of the Lake Catherine dam in the Ouachita River area, not Lake Catherine or its associated upstream tributaries. Public water systems are monitored regularly by ADH Engineering to ensure compliance with the U.S. Environmental Protection Agency (EPA) National Primary Drinking Water Regulations. Exposures to water from Indian Springs, Wilson Pond, and Wilson Creek, located near Umetco property are not considered to be a public drinking water source pathway. Therefore, for the purposes of this public health evaluation, only an exposure to 'accidental' or 'incidental' ingestion of surface water or dermal (skin) contact will be considered as a potentially completed exposure pathway (*i.e.*, may have occurred in the past, may currently occur, or may occur in the future during recreational activities only). Because this is a public health consultation, ecological exposures and effects on aquatic habitat were not considered.

Wilson Creek and Indian Springs Creek are both small tributaries north of Lake Catherine. Lake Catherine, located in Garland and Hot Spring Counties, flows downstream into the Ouachita River. The Ouachita River extends from both Garland and Hot Spring counties in a southward flow down the state through several counties and eventually into Louisiana. See the maps in Appendix A for the location of water bodies mentioned. Map 1 depicts an aerial view of the Umetco mines in both Garland and Hot Spring counties in relation to the bodies of water mentioned. Note that the former Umetco Minerals Christy Mine near Malvern held a non-coal mining permit with ADEQ which expired in 2000. The former Christy Mine is separated from the part of Lake Catherine located in Garland County and is not part of the Wilson Mine water treatment process; it will not be evaluated as part of this health consultation. Maps 2 and 3 depict a closer view of Indian Springs, Wilson Creek, and Lake Catherine in relation to the Umetco Minerals Wilson Mine site. Note that part of the Umetco property falls near the '71901' zip code in Garland County. A citizen requested ADH to specifically evaluate this area, which is detailed in the "Evaluation of Health Outcome Data" section below.

**Figure 1** depicts the routes of human exposure from potential contamination sources near the Umetco site found in soil, surface waters, and public drinking water systems.

**Figure 1.**




As seen in Figure 1, the soil exposure pathway has been eliminated because soil sample concentrations from the Lake Catherine area are lower than health screening levels (see further explanation in text below). The public drinking water systems exposure pathway has been eliminated because it has been established that the supply source for the public drinking water systems near the Umetco site is the Ouachita River, which is downstream from Lake Catherine, and no national water criteria levels have been exceeded during regular monitoring. Therefore, drinking, cooking, and bathing with tap water from the public drinking water systems near the Umetco site and surrounding areas are considered incomplete pathways for ingestion and dermal contact. The only scenario that is a potentially complete pathway is incidental ingestion and/or dermal contact during recreational activities in Lake Catherine.

The "Update to the December 2004 Wilson Creek Minerals Water Quality Standards Evaluation" (August 2009) and the "Wilson Creek Minerals Water Quality Standards Evaluation" (October 2004) submitted by Umetco to ADEQ were both reviewed by ADH Environmental Epidemiology personnel [4]. Within the 2009 report, sulfate, chloride, and TDS have been evaluated by Umetco for site-specific conditions related to toxicity for aquatic life, not human health. In the 2009 Umetco report, for all samples analyzed, the maximum concentrations of chloride, sulfate, and TDS were 78 milligrams per liter (mg/L), 260 mg/L, and 850 mg/L, respectively. Current discharges from Umetco into Wilson Creek are consistent with attainment of water quality criteria for benthic diversity and aquatic life based on national standards. One of the challenges to support aquatic life in this region is the changes in pH levels due to sulfate or TDS; pH is routinely monitored by regulatory officials [4]. Since the issuance of the 2009 report, ADH Engineering personnel have corresponded with Umetco representatives regarding the surface water pH levels (See Appendix B).

Apart from the reports submitted by Umetco, ADEQ has collected and analyzed water samples in Indian Springs Creek, Wilson Creek, and Lake Catherine from December 2007 to April 2011 [5]. For this health consultation document, ADH reviewed a total of 21 samples collected from Indian Springs Creek, 23 samples collected from Wilson Creek, and 15 samples collected from Lake Catherine, all of which were collected by ADEQ. A summary of the most recent data from ADEQ for the maximum concentrations found for chloride, sulfate, and TDS in Indian Springs Creek, Wilson Creek, and Lake Catherine is shown in **Table 1**. In the latest ADEQ analytical laboratory report for Lake Catherine, samples collected on April 5, 2011 show the maximum concentrations of chloride, sulfate, and TDS to be 3.7 mg/L, 15.8 mg/L, and 63 mg/L, respectively [5]. These levels are lower than those detected in the March 2011 samples (from ADEQ), as well as in the 2009 samples collected from Wilson Creek, according to the "Update to the December 2004 Wilson Creek Minerals Water Quality Standards Evaluation" report submitted by Umetco [4].

**Table 1. Maximum Concentrations of Chloride, Sulfate, and TDS from 3 Water Bodies Near Umetco; Data compiled from ADEQ Laboratory Results, December 2007 – May 2011**

| Location | Chloride* (mg/L) | Date | Sulfate* (mg/L) | Date | TDS* (mg/L) | Date |
|---|---|---|---|---|---|---|
| Indian Springs | 96 | 11/11/10 | 690 | 12/7/10 & 1/5/11 | 1,230 | 11/11/10 |
| Wilson Creek | 56 | 12/6/07 | 280 | 12/6/07 | 530 | 12/6/07 |
| Lake Catherine | 122 | 3/2/11 | 169 | 3/2/11 | 313 | 3/2/11 |

*Maximum Concentration of total samples collected.
TDS = Total Dissolved Solids; ADEQ = Arkansas Department of Environmental Quality; mg/L = milligram per liter; Environmental Protection Agency (EPA) Secondary Maximum Contaminant Levels (SMCL) screening levels: chloride 250 mg/L; sulfate 250 mg/L; TDS 500 mg/L; EPA Health Reference Level (HRL): sulfate 500 mg/L

In terms of public health and human exposure, Wilson Creek is classified for: secondary contact recreation; domestic, industrial, and agricultural water supply; and seasonal Ouachita Mountain Ecoregion fishery. At the time of this report, there have been no known private water wells identified for domestic drinking water purposes by the ADH Engineering Section. To the knowledge of ADH, no known private drinking water well surveys have been conducted near the Umetco site. In the EPA document "Contaminant Candidate List Regulatory Determination Support Document for Sulfate" it suggests a Health Reference Level (HRL) of 500 milligrams per liter (mg/L) sulfate in drinking water [6]. This document also states that monitoring data indicate that sulfate is detected in the majority of drinking water supplies nationwide, but is infrequently detected above the HRL of 500 mg/L. The risk of adverse health effects to the general population is limited and acute (a short-duration laxative response), and such effects occur only at high drinking water concentrations (>500 mg/L, and in many cases >1,000 mg/L). People can develop a tolerance for high concentrations of sulfate in drinking water. Also, because of the taste of water high in sulfate (the taste threshold for sulfate is approximately 250 mg/L), people tend to decrease the amount of high-sulfate water they drink at one time, thus reducing the likelihood of acute exposure. For these reasons, it is unlikely that regulation of

sulfate would present a meaningful opportunity for health risk reduction [6]. Note that sulfate is not associated with chronic disease or cancer risks, as it is a non-carcinogen [6].

Along with HRLs, the EPA has also assigned a secondary drinking water standard for chloride, sulfate, and TDS. EPA has established National Secondary Drinking Water Regulations that set non-mandatory water quality standards for 15 contaminants. EPA does not enforce these secondary maximum contaminant levels, or SMCLs. They are established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. These contaminants are not considered to present a risk to human health at the current SMCL. The SMCL for chloride is 250 mg/L; the SMCL for sulfate is 250 mg/L; and the SMCL for TDS is 500 mg/L [7]. These SMCLs are in place to control for "nuisance" qualities like those mentioned above, but do not adversely affect the health of children and adults exposed to these types of contaminants in water [7].

In the 2004 Umetco document, Section 5.8.2 states that Wilson Creek has not been approved for or used as a public water supply. ADH Engineering monitors all public water systems of the state and confirms that Wilson Creek is not part of a public drinking water source. According to the 2004 Umetco document, Wilson Creek is also not used for agricultural or industrial water supplies [4]. Confirmation of this has been obtained from the Arkansas State Plant Board (ASPB) and ADEQ, respectively. Because the maximum concentration of sulfate in Wilson Creek in 2009 was found at 260 mg/L and has not risen above 270 mg/L since January 2011, and it is below the EPA HRL advisory of 500 mg/L, sulfates in this water should not negatively impact public health [4, 7]. Chloride and TDS are also ubiquitous in the surface water, affecting mainly the salinity or "saltiness" of the water. As with sulfates, there are no ATSDR HCVs or EPA Maximum Contaminant Levels (MCLs, derived from the EPA drinking water mandate) for chloride and TDS. In addition, neither chloride nor TDS are associated with chronic disease or cancer risks, because they are considered to be non-carcinogens.

To evaluate the public's potential health risk from exposure to incidental ingestion of, or dermal (skin) contact with surface water, data received from ADEQ and analyzed from surface water samples in Indian Creek, Wilson Creek, and Lake Catherine from December 2007 to April 2011

were examined [5]. ADH had previously conducted a review of available data in the fall of 2010. ADH Environmental Epidemiology personnel were made aware of, and given, *other* data by the ADEQ Water Division in July 2011; also, the April 2011 data were given to members of APC&E at a July 2011 meeting. Along with secondary water quality testing (*i.e.*, chloride, sulfate, and TDS), dissolved metals, including cadmium, chromium, and vanadium were also analyzed from these water samples. Out of the 63 total collection samples taken by ADEQ, the maximum concentrations reported for the COCs were evaluated separately in each water body near or on Umetco property. See **Table 2** for a summarized version of the maximum concentration of each COC analyzed. Other heavy metals were previously identified, but eliminated from this review due to the generally low levels present in the sample results.

**Table 2. Maximum Concentrations of Cadmium, Chromium, and Vanadium from 3 Water Bodies Near Umetco; Data compiled from ADEQ Laboratory Results, December 2007 – May 2011**

| Location | Cadmium* (μg/L) | Date | Chromium* (μg/L) | Date | Vanadium* (μg/L) | Date |
|---|---|---|---|---|---|---|
| Indian Springs | 0.4 | 1/8/09 | 0.5 | 4/5/09 | n/a | n/a |
| Wilson Creek | 0.7 | 11/23/09 | < 0.5 | 5/12/11 | n/a | n/a |
| Lake Catherine | < 1.0 | 4/5/11 | < 1.0 | 4/5/11 | **180** | 4/5/11 |

*Maximum Concentration of total samples collected.
ADEQ = Arkansas Department of Environmental Quality; μg/L = micrograms per liter; n/a = not applicable; Lowest Health Screening Values for Comparison: 1.0 μg/L Cadmium, 100 μg/L Chromium, 100 μg/L Vanadium

For Indian Springs Creek data (collected between December 2007 to April 2011), the maximum concentration reported for cadmium was 0.4 micrograms per liter (μg/L); the maximum concentration reported for chromium was 0.5 μg/L; and vanadium was not reported [5]. For Wilson Creek data (collected between December 2007 to April 2011), the maximum concentration reported for cadmium was 0.7 μg/L; the maximum concentration reported for chromium was less than 0.5 μg/L; and vanadium was not reported [5]. For Lake Catherine samples (collected January, March, and April of 2011), the maximum concentration reported for

cadmium was less than 1.0 μg/L; the maximum concentration reported for chromium was less than 1.0 μg/L; and the maximum concentration reported for vanadium was 180 μg/L [5]. These concentrations reported fall below the ATSDR HCV for cadmium and chromium. For cadmium, the HCV is 1.0 μg/L (for a child) and 4.0 μg/L (for an adult). Cadmium has a MCL, derived from the U.S. EPA, of 5 μg/L. Chromium has no HCV, and the MCL value is 100 μg/L. For vanadium, the HCV is 100 μg/L (for a child) and 400 μg/L (for an adult); vanadium has no MCL value. Since the maximum reported concentration of vanadium was 180 μg/L, which exceeded the ATSDR childhood HCV, further analysis using the incidental ingestion exposure pathway or dermal pathway was considered for both a child and adult. Note that while both cadmium and chromium are considered carcinogens [based on findings from EPA, the International Agency for Research on Cancer (IARC), and the National Toxicology Program (NTP)], vanadium is not classified as a carcinogen.

Using the maximum concentration of 180 μg/L vanadium in water, a specific amount of water at 0.05 fluid ounces ingested per day for up to one year was used in the accidental ingestion scenario for both children and adults to account for any recreational setting in Lake Catherine or its tributaries. A body weight used for a child was 16 kilograms (kg), and a body weight used for an adult was 70 kg. When using the exposure dose equation for water ingestion, an exposure dose of 1.66E-05 (*or* 0.0000166) milligrams per kilograms per day (mg/kg/day) was calculated for a child scenario, and an exposure dose of 3.80E-06 (*or* 0.0000038) mg/kg/day was calculated for an adult scenario. This falls below the ATSDR intermediate oral Minimal Risk Level (MRL) value of 0.01 mg/kg/day.

Likewise, to determine the exposure dose for both children and adults making dermal contact with surface water (*i.e.*, swimming, wading, fishing), a specific exposure time of 1.5 hours per day for 90 days per year for up to 10 years was used. A body weight used for a child was 16 kg, and a body weight used for an adult was 70 kg. When using the exposure dose equation for dermal contact, an exposure dose of 1.5E-04 (*or* 0.00015) mg/kg/day was calculated for a child scenario, and an exposure dose of 7.5E-05 (*or* 0.000075) mg/kg/day was calculated for an adult

scenario (see Appendix C for equation calculations). This falls below the ATSDR intermediate oral MRL value of 0.01 mg/kg/day.

A MRL is an ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. The intermediate duration exposure represents contact with a substance that occurs for more than 14 days and less than a year [compared with acute exposure (less than 14 days) and chronic exposure (over a year)]. There is no acute or chronic MRL for vanadium. Therefore, since the exposure doses calculated at this maximum concentration of vanadium (180 μg/L) for a child and adult are below the intermediate MRL for both accidental ingestion and dermal contact, there is no likelihood that a person spending recreational time in the Lake Catherine waters tested would experience harmful health effects. The maximum concentration of vanadium was used to represent a "worst-case" scenario, and all other samples collected were detected at concentration levels lower than 180 ug/L. See Appendix C for further explanation of the equations and calculations used.

A small data set (4 samples) of surface soil was collected from permitted outfall areas near Lake Catherine by ADEQ on March 2, 2011. These areas sampled are likely the most contaminated soil spots since they are near the mine outfall areas, and they are not considered part of the state park area for recreation, hiking, or camping, so people would not have as much soil contact in these areas. The maximum concentrations of each of the COCs in the soil data were: 1.67 milligrams per kilogram (mg/kg) cadmium; 56.5 mg/kg chromium; 476.0 mg/kg vanadium. None of these maximum concentrations exceeded ATSDR HCVs (HCVs: 5 – 70 mg/kg for cadmium; none for chromium, however hexavalent chromium is 50 – 700 mg/kg; and 500 – 7,000 mg/kg for vanadium). Should anyone be exposed through dermal (skin) contact to the surface soil during recreational activities, it is not anticipated to cause adverse health effects based on the concentrations reported, since all concentrations were below HCVs (see Figure 1).

## Health Outcome Data

Because citizens expressed concern over cancer in the area near the Umetco property, the available cancer incidence rates in Hot Spring County were compared to those in the state of

Arkansas. In addition, an examination of health outcome data was undertaken and is discussed further in this section.

***Contaminants of Concern***

In this assessment, data from the Arkansas Central Cancer Registry (ACCR) were evaluated to compare general and specific cancers in Hot Spring County and areas of Garland County to those in Arkansas. The ACCR is a population-based registry designed to collect, analyze, research, and disseminate quality cancer data to help describe the burden of cancer, so evidence-based cancer prevention and control programs can be implemented to reduce cancer incidence and mortality in Arkansas. In this investigation, the overall cancer age-adjusted incidence rate was reported, as well as six other specific cancers: (1) bones and joints, (2) digestive system, (3) kidney and renal pelvis, (4) lung and bronchus, (5) lymphoma, and (6) stomach. These specific cancers were chosen based on target organs typically affected by COCs connected with this site, namely cadmium, chromium, and vanadium. Although vanadium is a COC at this site, it was not directly considered as part of the cancer incidence analysis because the Department of Health and Human Services (DHHS) and the IARC have not classified vanadium for carcinogenicity [8]. Furthermore, based on incomplete information from human and animal studies, the EPA has determined that vanadium is not classifiable as to its human carcinogenicity [8].

ATSDR's Toxicological Profiles for the compounds previously identified at the Umetco site were used to classify the health relevance for each COC. The carcinogenic properties and their probable impact on designated target organs for cadmium and chromium were considered when choosing the specific cancer types to evaluate.

Cadmium exposure may occur through ingestion of contaminated food and drinking water, inhalation of particulates from ambient air or tobacco smoke, or ingestion of contaminated soil or dust. For nonsmokers, food is the major source of cadmium exposure, and inhalation of cigarette smoke is the major source of cadmium exposure for smokers. Cadmium is introduced to the food chain through agricultural soils, which may contain naturally occurring cadmium or cadmium found in phosphate fertilizer applications. Long-term exposure to low levels of cadmium in air, food, or water leads to a buildup of cadmium in the kidneys and possible kidney disease. Other possible long-term effects are lung damage and fragile bones. DHHS has

determined that cadmium and cadmium compounds are known human carcinogens, and research shows cadmium primarily targets the lungs in term of cancer [9].
Chromium can be found in air, soil, and water after release from the manufacture, use, and disposal of chromium-containing products, and during the manufacturing process. It is also a component of cigarette smoke. Chromium is a naturally occurring element found in rocks, animals, plants, and soil. It can exist in several different forms. DHHS, IARC, and the EPA have determined that chromium (VI) compounds are known human carcinogens. Studies involving chromium have shown evidence of oral, gastrointestinal, and lung cancers in humans and animals [10].

Of the identified COCs in this health consultation, only cadmium and chromium have documented studies of chemical mixture interaction in animal research. An *in vitro* animal study investigated potential interactions of cadmium and chromium (VI) with regard to kidney function. It was determined that renal damage was greater from a combined treatment of cadmium and chromium (VI) than it was from each contaminant treated separately [11]. Kidney (renal) cancers are further discussed below.

Health outcome data identify certain health conditions that occur in populations. These data can provide information on the general health of communities living near a hazardous waste site. They also can provide information on patterns of specified health conditions. Some examples of health outcome databases are tumor registries and vital records (or statistics). Information from local hospitals and other health care providers can also be used to investigate patterns of disease in a specific population. When a complete exposure pathway or community concern exists, ADH reviews appropriate and available health outcome data.

The ADH ACCR maintains the cancer morbidity (the rate of newly diagnosed cancers in a population) information. Using this information, a crude cancer rate for a county can be estimated, but should not be construed as an accurate estimate of cancer risk. Crude rates are specific to a population and can only be used in populations with similar distributions of age, gender, race, socioeconomic level, geographic distribution, or any other variable that might affect the magnitude of the crude rate. Adjusted rates allow better comparisons between

populations without influence of confounding factors, such as those previously listed. The crude rates reported for the state and county area can be used for general evaluation with the understanding that no adjustments exist for confounders in the population. To more accurately depict the conditions near this site, age-specific and age-adjusted analyses were performed, and no significant difference between Hot Spring County and state incidence exists.

To determine whether a cancer rate could have been higher just by chance, a confidence interval (CI) is calculated for the rate. The CI has a minimum (lower) value and a maximum (higher) value. Analysts commonly use a 95% CI, meaning that the true age-adjusted point estimate is within the range between the lower and higher value calculations with 95% certainty. If the county's 95% CI range does not fall within the state's 95% CI values, then the difference between the county rate and state rate is statistically significant. A statistically significant difference between the county and state age-adjusted rates means more cases than expected were diagnosed, and the result may not have happened by chance. Although the calculated values can tell investigators the statistical significance of cancer rates, the 95% CI alone cannot determine the factors that may have caused the values to be significant.

ACCR data rely on accurate reporting from area hospitals and physicians. Even if a resident receives treatment outside the area of residence, the data are collected because of data-sharing agreements with other registries. However, review of cancer morbidity data does *not* indicate exposure *route* or exposure *duration*.

Reporting to the ACCR began in 1996. During the first year of reporting, only facilities with 100-plus beds were required to report their data. However, beginning in 1997, all hospitals and clinics regardless of bed capacity were required to report these data. Therefore, cancer data reported from the time period 1997 – 2008 were combined and analyzed. Cancer incidence by primary organ type for Hot Spring County, as well as statewide, from 1997 to 2008 can be found in **Table 3**.

**Table 3. Case Counts and Age-adjusted Cancer Incidence Rates for Hot Spring County and Arkansas, 1997 - 2008**

| | Arkansas Overall | | | Hot Spring County | | | |
|---|---|---|---|---|---|---|---|
| **Cancer Type** | **Cases** | **Age-Adjusted Rate(a)** | **95% Confidence Interval** | **Cases** | **Age-Adjusted Rate(a)** | **95% Confidence Interval** | **Percent Difference(b)** |
| **All Cancers** | | | | | | | |
| 1997 - 2008 | 168,738 | 473.9 | (471.7 - 476.2) | 2,004 | 460.3 | (440.2 - 481.1) | 3% |
| **Bones & Joints** | | | | | | | |
| 1997 - 2008 | 262 | 0.8 | (0.7 - 0.9) | ~ | 1.1(c) | (0.3 - 3.0) (c) | 38% (c) |
| **Digestive System** | | | | | | | |
| 1997 - 2008 | 29,681 | 82.9 | (82.0 - 83.8) | 342 | 77.8 | (69.7 - 86.6) | 6% |
| **Kidney & Renal Pelvis** | | | | | | | |
| 1997 - 2008 | 4,995 | 14.1 | (13.7 - 14.5) | 61 | 14.6 | (11.1 - 18.9) | 4% |
| **Lung & Bronchus** | | | | | | | |
| 1997 - 2008 | 29,417 | 81.4 | (80.5 - 82.3) | 406 | 90.8 | (82.2 - 100.2) | 1% |
| **Lymphoma** | | | | | | | |
| 1997 - 2008 | 7,207 | 20.5 | (20.0 - 21.0) | 92 | 21.8 | (17.5 - 26.9) | 6% |
| **Stomach** | | | | | | | |
| 1997 - 2008 | 2,233 | 6.2 | (6.0 - 6.5) | 21 | 4.8 | (2.9 - 7.5) | 23% |

**Source: Arkansas Central Cancer Registry, 2011**

(a) All rates are per 100,000. Rates are age-adjusted to the 2000 U.S. Standard Million Population.

(b) Denotes the percent difference between the county rate compared to the state rate.

(c) Counts < 10 are too few to calculate stable age-adjusted rates.

~ Counts are suppressed if fewer than 5 cases were reported.

Includes *in situ* and invasive cancers.

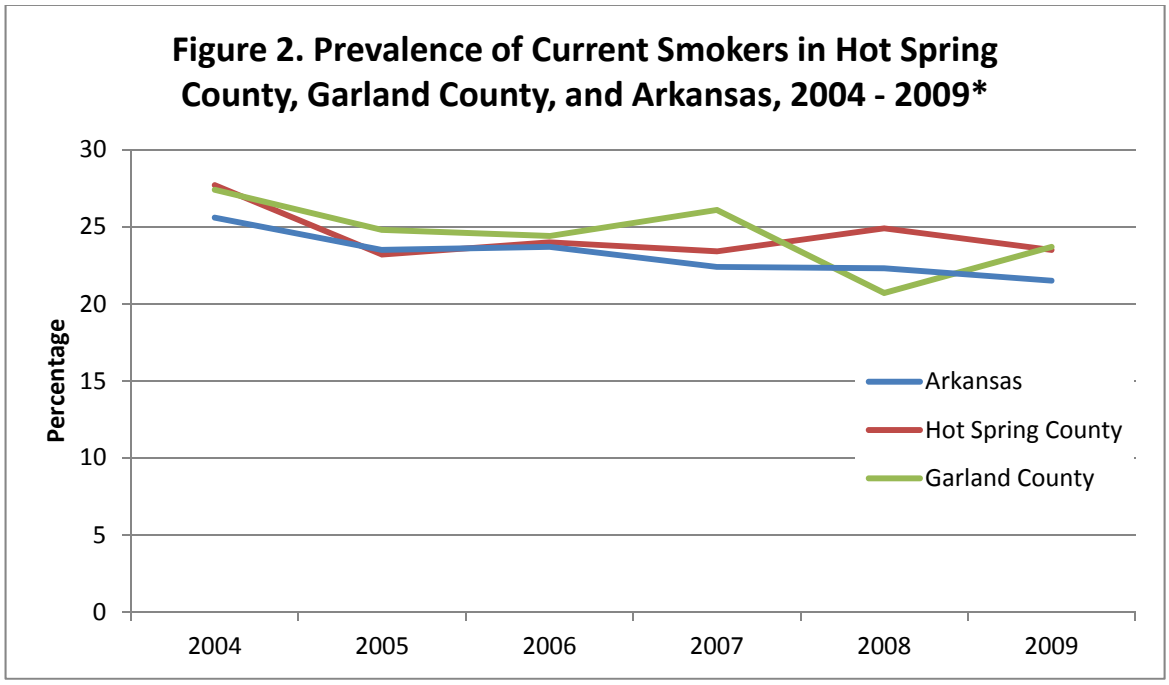
Based on the analysis using the data from the ACCR, when comparing statewide age-adjusted cancer incidence rates to the cancer rates in Hot Spring County, there were no significant elevated risks for all cancers combined; bone and joint cancer; digestive cancer; cancer of the kidney; lung and bronchus cancer; lymphoma; or stomach cancer. For all cancers combined, the Hot Spring County rate was 3% lower than the state rate for years 1997 – 2008 (See Table 3).

Additionally, within the '72104' zip code which represents the city of Malvern in Hot Spring County, there were 1,540 cancer cases diagnosed during 1997 – 2008. Of those, less than 1% of the total cases were diagnosed among children aged 0 – 19 years. According to the American Cancer Society, childhood cancers are rare and represent less than 1% of new cancers diagnosed annually [12]. Arkansas has maintained lower incidence and mortality trends of childhood cancers than the United States over time. The most common types of cancer diagnosed among children in Arkansas aged 0 – 14 years are leukemia, brain and other central nervous system cancers, and cancer of the thymus. The most common cancers diagnosed among adolescents in Arkansas aged 15 – 19 years are leukemia, brain and central nervous system cancers, and cancers of the bone. The childhood cancers (aged 0 -19 years) diagnosed in the city of Malvern from 1997 – 2008, using zip code '72104', are similar to the childhood cancers diagnosed in the state: brain and central nervous system, Hodgkin's lymphoma, leukemia, and bone.

The zip code '71901' within Hot Springs, Garland County was also examined using the ACCR since an advocate/concerned citizen contacted ADH with specific health concerns within the neighborhoods associated with this zip code. (This zip code also includes the Stratcor, Inc. property, which is another known vanadium mining site.) Statistics showed there are over 100 cancer cases diagnosed per year for the '71901' zip code, and the cases by year do not show any significant elevation or variation. The three types of cancer most frequently diagnosed in this area were lung and bronchial cancer, prostate cancer, and breast cancer, which are expected given the population age and gender within this zip code. Note that lung and bronchial cancer is mostly associated with cigarette smoking, and prostate cancer and breast cancer are not associated with the COCs examined at or near the Umetco site.

Also within the '71901' zip code, there were 1,998 cancer cases diagnosed during 1997 – 2008. Of those, less than 1% of the total cases were diagnosed among children aged 0 – 19 years. The childhood cancers (aged 0 -19 years) diagnosed using the '71901' Garland County zip code from 1997 – 2008 are also similar to the childhood cancer trends in the state: leukemia, brain, and thymus.

Since the causes of cancer are multi-factorial in origin and the risk of developing cancer depends on an individual's past and current health status, genetic make-up, and/or lifestyle choices, tobacco use in these geographic areas was examined. Tobacco use increases the risk of cancers of the lung and bronchus, kidney and renal pelvis, stomach, and other digestive cancers [13]. These cancers account for approximately 40% of the cancers examined in Hot Spring County (See Table 3) and 38% of the cancers examined in Garland County. **Figure 2** shows the prevalence of current smokers in Hot Spring County, Garland County and the state overall from 2004 – 2009. Overall, smoking rates in the state and in Hot Spring and Garland counties have decreased. During the past six years, the rates of smoking among those living in Garland County have remained higher than the overall smoking rates in the state, with the exception of one year (2008). Hot Spring County had smoking rates similar to that of the state with an increasing trend over the last three years (See Figure 2).




Source: 2004-2009 Arkansas and county-level Behavioral Risk Factor Surveillance System (BRFSS) Survey Results: http://www.healthy.arkansas.gov/programsServices/healthStatistics/Brfss/Pages/default.aspx

Factors such as the higher prevalence of smoking in Hot Spring and Garland Counties, coupled with small population sizes and the lack of historical information relative to each individual cancer case, are limitations that almost always exist in determining cancer sources.

## Community Health Concerns

ADH is aware of the health concerns within the community surrounding the Umetco site. Following a specific request, the ADH Chronic Disease Epidemiology Section personnel along with Environmental Epidemiology personnel, called the citizen to inform them of these health outcome data findings on November 23, 2010. Environmental data review findings were also shared with the citizen during this call. Advocates presented their case during a House and Senate Interim Committee Meeting on Public Health, Welfare, and Labor of the Arkansas General Assembly that ADH personnel also attended on July 21, 2011. Health outcome data findings were explained by ADH personnel at this meeting. Should other concerned citizens or organizational groups direct complaints to ADH, a copy of this health outcome data consultation will be provided to them, along with further assistance addressing specific public health issues.

## Child Health Considerations

In communities faced with environmental contamination, the many physical differences between children and adults may require special emphasis. Children could be at greater risk from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Additionally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Therefore, adults need as much information as possible to make informed decisions regarding their children's health.

During this health consultation evaluation of the Umetco site surface water data, the individual child exposure was examined due to the factors listed above. Scenarios of a child accidentally ingesting a small amount of some surface water during recreational activities (such as swimming) within Lake Catherine near the Umetco property were examined. It was determined that a child accidentally ingesting no more than 0.05 fluid ounces a day, every day, for no more than one year is not expected to experience adverse health effects. Dermal exposure (via swimming, wading, fishing) was also reviewed for a child and found to not exceed levels of health concern for a child exposed to surface waters in Lake Catherine for 1.5 hours per day for 90 days per year for up to 10 years.

## Conclusions

***ADH concludes that COCs in the surface water at or near the Umetco site are not expected to harm people's health***.

Based upon information reviewed, there is a potentially complete exposure pathway from incidental (*i.e.* accidental) ingestion of and/or skin contact with contaminants found in surface water (i.e. Lake Catherine) near the Umetco site.

After review of the maximum concentration levels of chloride, sulfate, and TDS in surface water on or near the Umetco site, it was determined that levels of these contaminants are unlikely to cause adverse health effects in people. After review of the maximum concentration levels of cadmium, chromium, and vanadium found in the surface water at or near the Umetco site, it was determined that the exposure dose values for both a child and an adult exposed to contaminated surface water through accidental ingestion or dermal contact were below the HCV or MRL values, and therefore regarded as unlikely to cause adverse health effects at the concentrations evaluated.

A statistical evaluation of cancer data in Hot Spring County, parts of Garland County, and the state of Arkansas, revealed no significant differences to indicate elevated cancer rates and/or cases when comparing health outcome data. Factors that may add to the limitations of the health outcome data include unknown contributions such as a resident's amount of cigarette smoke or

tobacco exposure, years of residency within Hot Spring County (or zip code areas '72104' or '71901'), and past occupations or hobbies involving chemicals or toxic substances. Since cancer is a multifaceted condition, each person's individual exposures, along with lifestyle and genetic components, can contribute to potential adverse health effects and carcinogenic risks.

## Recommendations

There are no identified public health hazards associated with the Umetco site, and ADH has no recommendations at this time. ADH will continue to educate the public, address citizen requests, and evaluate future environmental data provided by ADEQ or other sources in regards to the Umetco site, as necessary or requested.

## Public Health Action Plan

The purpose of the Public Health Action Plan (PHAP) is to ensure that this health consultation not only identifies any public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The PHAP implemented by ADH with regards to the Umetco site is as follows:

***Completed Actions***

- ADH Engineering Section was in communication with Umetco representatives and FTN Associates concerning the water treatment system in place at Umetco; March – May 2010 (See Appendix C for complete ADH Engineering timeline of events).

- Dr. Joe Bates, ADH Deputy State Public Health Officer; Dr. Nate Smith, ADH Deputy Director for Public Health Programs and State Epidemiologist; Robert Hart, ADH Engineering Section Director; and Terry Paul, ADH Environmental Health Branch Chief, conducted a site visit on Umetco property and the surrounding area; October 2010.

- ADH Environmental Epidemiology Section reviewed Umetco reports and documentation submitted to ADEQ at the request of ADH Engineering Section and citizen concerns; October 2010.

- ADH Environmental Epidemiology Section received from ADEQ and ADH Engineering a private citizen's request for a review of the cancer rates in the area surrounding Umetco; November 2010.

- ADH Environmental Epidemiology Section consulted ADH Chronic Disease and Cancer Registry Section to find cancer rates for Hot Spring County and Arkansas; ADH personnel from Cancer Registry and Environmental Epidemiology contacted the concerned citizen by phone and email correspondence. Multiple correspondences were made with the citizen to explain the cancer rate findings for Hot Spring County and the state; November 2010.

***Future Activities***

- ADH will continue to work with state and federal officials regarding this site. Should new information or environmental data become available from ADEQ or Umetco, ADH will review for public health evaluation.

- ADH will continue to monitor the state and county cancer statistics.

- ADH will continue to educate the public and address citizen request in regards to the Umetco site, as needed and/or requested.

# REPORT PREPARATION

This Health Consultation for the Umetco Minerals Corporation Site was prepared by the Arkansas Department of Health (ADH) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner. ATSDR has reviewed this document and concurs with its findings based on the information presented. ATSDR's approval of this document has been captured in an electronic database, and the approving agency reviewers are listed below.

**Authors**

**Health Assessor**

Ashley Whitlow, M.S.
Arkansas Department of Health
4815 West Markham, Mail Slot 32
Little Rock, AR 72205

**Cancer Registry**

Abby Holt, MPH
Arkansas Department of Health
4815 West Markham, Mail Slot 32
Little Rock, AR 72205

**State Designated Reviewer**

Lori Simmons, M.S.
Arkansas Department of Health
4815 West Markham, Mail Slot 32
Little Rock, AR 72205

**Independent Reviewers**

Shirley Louie, M.S., CIH

Applied Epidemiology Branch Chief & Deputy State Epidemiologist, ADH

Jeff Stone, P.E.

Chief Engineer, Director of Engineering, ADH

**ATSDR Reviewers**

Jeff Kellam, M.S.

Technical Project Officer

Division of Health Assessment and Consultation (DHAC)

Wendy Wattigney, MStat

Division of Health Assessment and Consultation (DHAC)

Alan Yarbrough

Cooperative Agreement Team Lead

ATSDR/DHAC/CAPEB

Rick Gillig

Cooperative Agreement and Program Evaluation Branch Chief

ATSDR/DHAC

Lynn Wilder, ATSDR/DHAC

Assistant Director for Science

William Cibulas, ATSDR/DHAC

Division Director, DHAC

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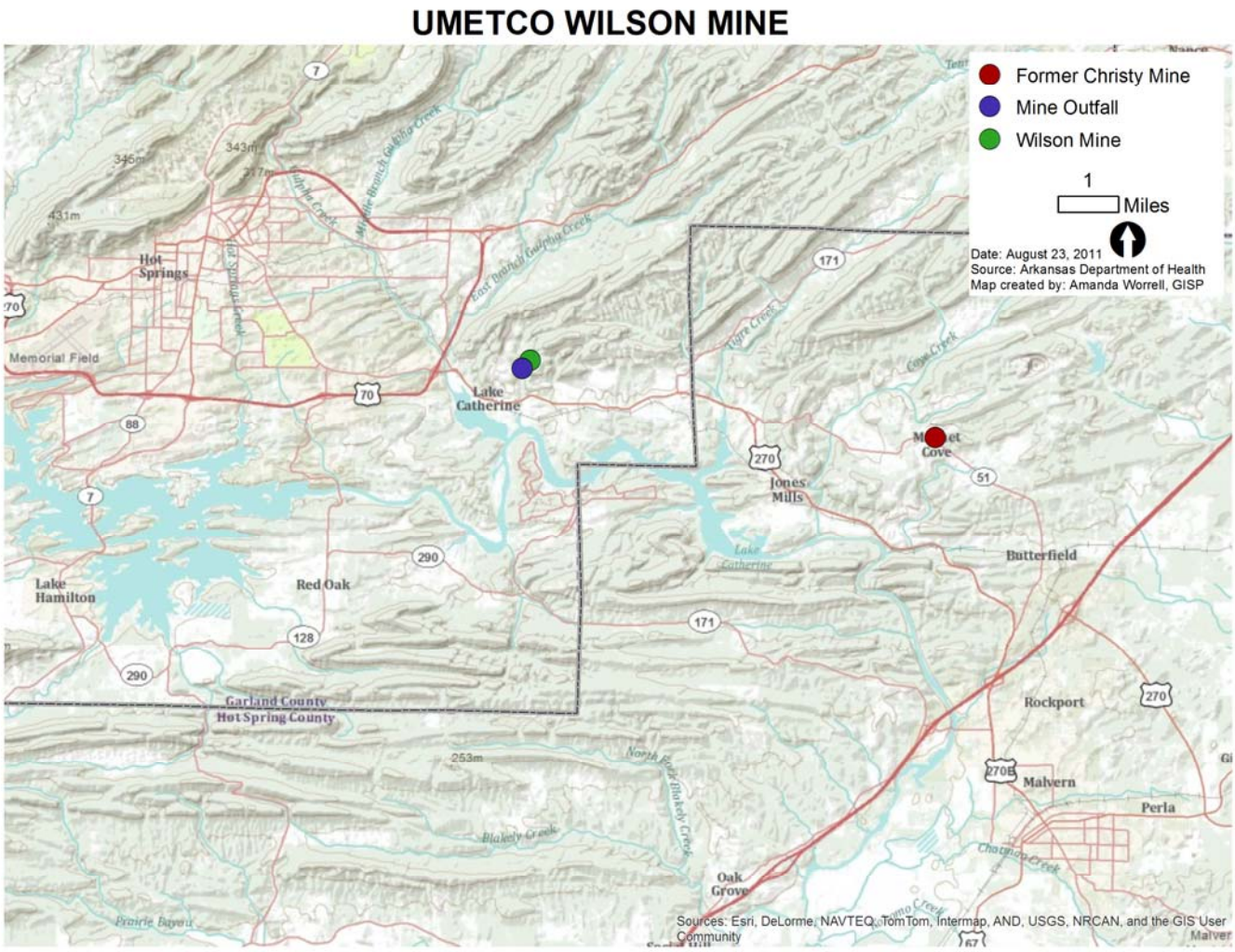
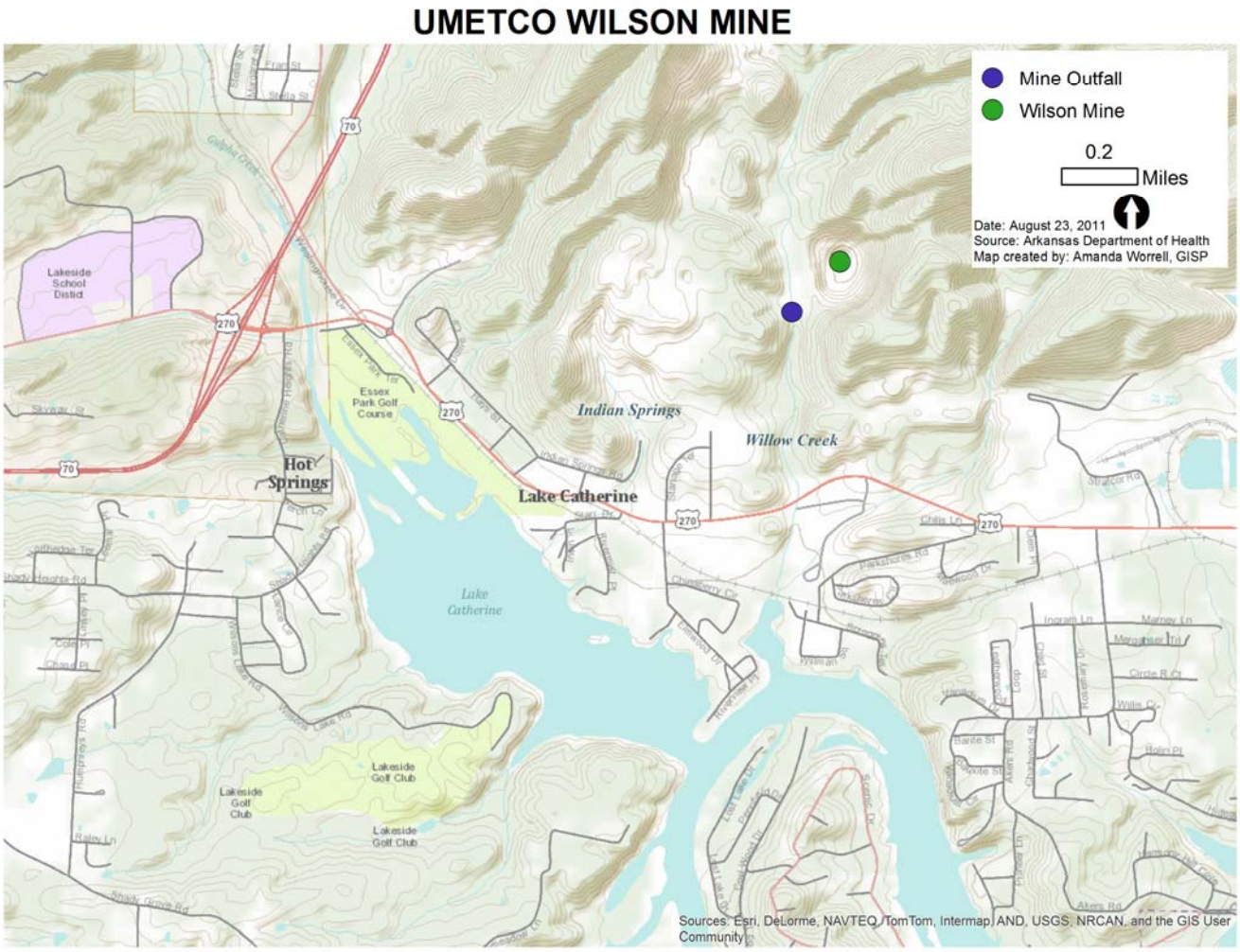
## Appendix A: Umetco Site Maps

**Map 1.** Map Depicting Garland and Hot Spring Counties in Relation to Umetco Mine Sites*

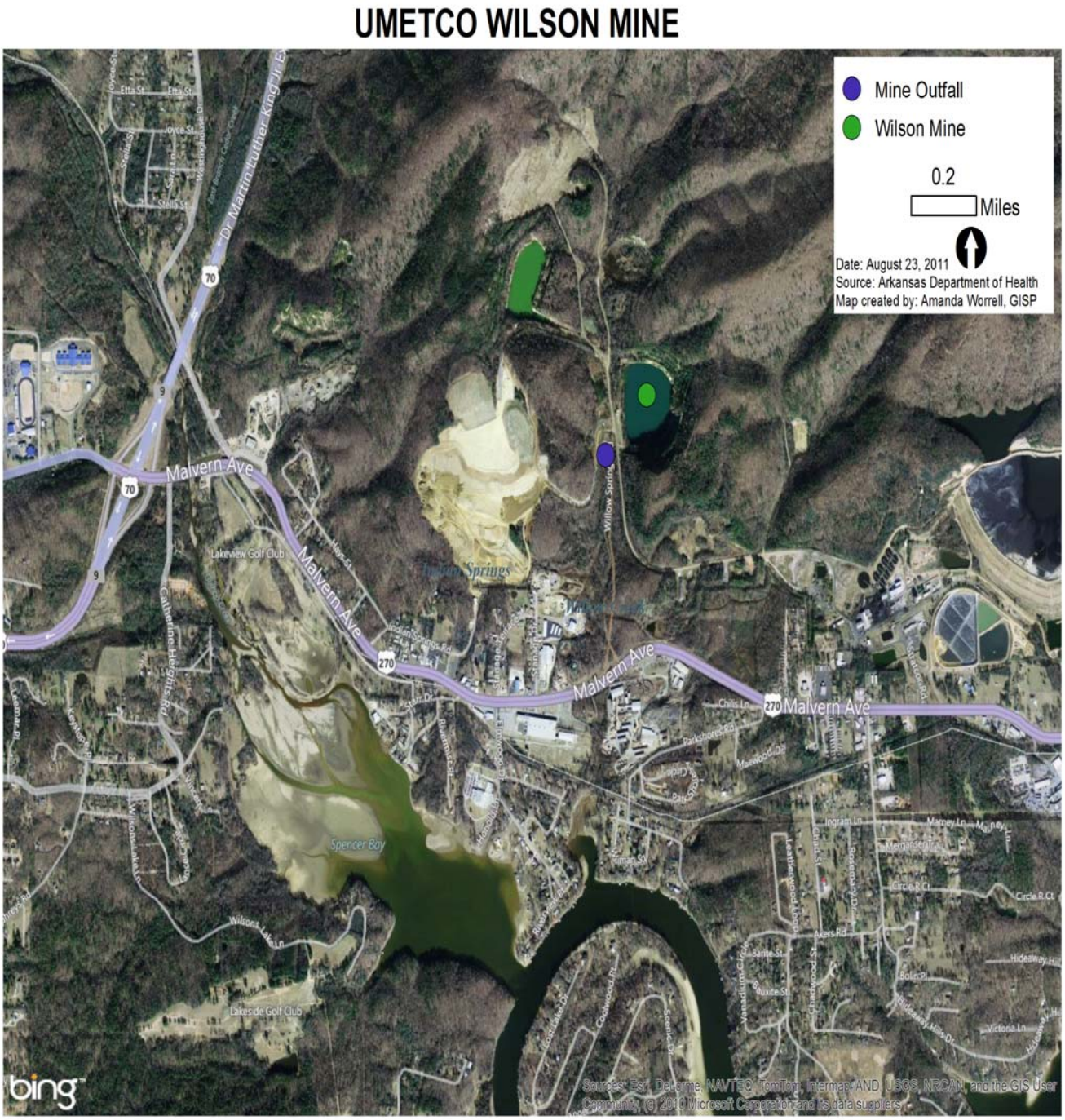



* Maps provided by: Amanda Worrell, GIS Coordinator, Office of Health Communications and Marketing**;** Arkansas Department of Health

**Map 2**. Map Depicting Indian Springs Creek and Wilson Creek



**Map 3.** Map of Indian Springs Creek and Wilson Creek near the Umetco Water Treatment Facility



## Appendix B: ADH Engineering Section Evaluation, Umetco Timeline

- In a letter dated March 18, 2010, Jim Malcom of FTN Associates notified the ADH of the proposal to change the water quality criteria for Wilson Creek. The proposed changes would affect chlorides, sulfates, and total dissolved solids. The purpose of the letter was to solicit comments from the ADH as part of the rulemaking process required by the Arkansas Department of Environmental Quality.

- In a letter dated March 30, 2010 to FTN, Jeff Stone of the ADH indicated that the ADH had concerns and did not support the proposed water quality criteria and use changes based upon concern for drinking water supply intakes located downstream on the Ouachita River. Public water supply intakes on the river are maintained by the Kimzey, Malvern, and Arkadelphia water systems.

- At the request of Jim Malcom of FTN, a meeting was held on April 16, 2010 at the ADH concerning our comments. Present at that meeting were Jim Malcom of FTN, Al Eckert of Quattlebaum, Grooms, Tull, & Burrow, PLLC, and Charles McGrew, Robert Hart, and Jeff Stone of the ADH. During that meeting, existing conditions at the site were more fully explained and following that meeting, the ADH was provided by FTN with a previously prepared report concerning these issues titled “Wilson Creek Minerals, Water Quality Standards Evaluation”.

- Between March 30 and May 5, 2010, there were several telephone and email communications between Jim Malcom and ADH staff attempting to clarify what was being proposed by FTN and UMETCO, and how it compared with similar water quality standard changes that had been submitted to the ADH in the past for other sites in the state.

- In a letter dated May 5, 2010, and e-mailed to the ADH that morning, Lucius Boudreaux of UMETCO Minerals Corporation committed in writing that the facility would continue to treat the discharge for pH adjustment, and in the future would continue to utilize a “continuous” type of discharge operation and not utilize “batch” discharges.

- In a letter dated May 5, 2010 to FTN, Jeff Stone of the ADH withdrew the ADH's previously stated concerns and in doing so cited the information provided in the Water Quality Standards Evaluation report as well as the commitment by UMTECO to maintain pH adjustment treatment and a continuous type discharge.

- Subsequent communications with Jim Malcom of FTN led to a tour of the UMETCO site on October 19, 2010 by the ADH’s Joe Bates, MD; Nate Smith, MD; Terry Paul; and Robert Hart.

# Appendix C: Variables Used in Exposure Dose and Theoretical Risk Calculation Scenarios

**Exposure Dose Equation for Accidental Ingestion**

**ED = (C x IR x EF x CF) / BW**

ED = Exposure Dose (milligrams per kilogram per day, mg/kg/day)
C = Contaminant Concentration (micrograms per liter, μg/L)
IR = Intake Rate of Contaminated Water per Day (fluid ounces per day, fl.oz./day)
EF = Exposure Factor (unitless)
CF = Conversion Factor (1E-03)
BW = Body Weight (kilograms, kg)

Child Scenario Variables:
C = 180 μg/L vanadium
IR = 0.05 fl.oz./day
EF = 1; CF = 1E-03
BW = 16 kg

Adult Scenario Variables:
C = 180 μg/L vanadium
IR = 0.05 fl.oz./day
EF = 1; CF = 1E-03
BW = 70 kg

## Appendix C: *Continued*

**Exposure Dose Equation for Dermal (Skin) Contact**

**ED = (C x P x SA x ET x CF) / BW**

ED = Exposure Dose (milligrams per kilogram per day, mg/kg/day)
C = Contaminant Concentration (micrograms per liter, μg/L)
P = Permeability Coefficient (1.00E-03 centimeters per hour, cm/hr)
SA = Exposed Body Surface Area (cubic centimeters, $cm^2$)
ET = Exposure Time (unitless)
CF = Conversion Factor (1E-06, unitless)
BW = Body Weight (kilograms, kg)

Child Scenario Variables:
C = 180 μg/L vanadium
SA = 8.75E03 (whole body)
ET = 30 min/day; 1 hour/day; 90 days/year; 10 years
BW = 16 kg

Adult Scenario Variables:
C = 180 μg/L vanadium
SA = 1.94E04 (whole body)
ET = 30 min/day; 1 hour/day; 90 days/year; 10 years
BW = 70 kg

## Appendix D: ATSDR Cancer Fact Sheet

# Cancer Fact Sheet

## Overview

Cancer is not a single disease. It is a group of more than 200 different diseases. Cancer can be generally described as an uncontrolled growth and spread of abnormal cells in the body. Cells are basic units of life. All organisms are composed of one or more cells. Normally, cells divide to produce more cells only when the body needs them.

Sometimes cells keep dividing and thus creating more cells even when they are not needed. When this happens, a mass of tissue forms. This mass of extra tissue is called a tumor. Tumors are found in all kinds of tissue, and can be benign or malignant.

### Tumors

### Benign

Benign tumors are not cancer. They usually can be removed and, in most cases, they do not come back. Most important, cells from benign tumors do not spread to other parts of the body. Cells from benign tumors stay together and often they are surrounded by a containing membrane. Benign tumors are not usually a threat to life.

### Examples of Benign Tumors

- Papilloma - A projecting mass on the skin (for example, a wart)
- Adenoma - A tumor that grows in and around the glands
- Lipoma - A tumor in fatty tissue
- Osteoma - A tumor originating in the bones
- Myoma - A tumor of muscle tissue
- Angioma - A tumor usually composed of small blood or lymph vessels (for example, a birthmark)
- Nevus - A small skin tumor of one variety of tissues (for example, a mole).

### Malignant

Malignant tumors are cancer. Cancer cells can invade and damage tissues and organs near the tumor. Cancer cells also can break away from a malignant tumor and enter the

lymphatic system or the bloodstream, which is how cancer can spread to other parts of the body. The characteristic feature of cancer is the cell's ability to grow rapidly, uncontrollably, and independently from the tissue where it started. The spread of cancer to other sites or organs in the body through the blood stream or lymphatic system is called metastasis.

Malignant tumors generally can be classified in two categories.

- Carcinomas. These cancers originate in the epithelium. The epithelium is the lining cells of an organ. Carcinomas are the most common type of cancer. Common sites of carcinomas are the skin, mouth, lung, breast, stomach, colon and uterus.
- Sarcomas. Sarcomas are cancers of connective and supportive tissue (soft tissues) of all kinds. Sarcomas can be found anywhere in the body, and they often form secondary growths in the lungs.

**Characteristics of Benign and Malignant Tumors**

| Characteristic | Benign | Malignant |
|---|---|---|
| Differentiation | Tumor cells resemble the original mature cells | Tumor cells might not resemble the original mature cells |
| Growth Rate | Slow; might stop or regress | Rapid, autonomous; usually does not stop or regress |
| Type of Growth | Expand and displace | Invade, destroy, and replace |
| Metastasis | No | Yes |
| Health Effect | Usually does not cause death | May cause death if not diagnosed and treated |

**Some Causes of Cancer**

Different types of cancer have different causes and are likely to depend on many factors. Some cancers are more common than others, and chances for survival vary among different types. Most cancers do not have known causes from a chemical, environmental, genetic, immunologic, or viral origin. Cancers also can arise spontaneously from causes that are thus far unexplained.

The causes of cancer are very complex, involving both the cell and factors in the environment. Much progress has been made in identifying possible causes of cancer, including:

**Chemicals and other substances.** Being exposed to substances such as certain chemicals, metals, or pesticides can increase the risk of cancer. Any chemical that is

known to cause cancer is called a carcinogen. Asbestos, nickel, cadmium, uranium, radon, vinyl chloride, benzidene, and benzene are examples of well-known carcinogens. These may act alone or along with another carcinogen, such as cigarette smoke, to increase the risk of cancer. For example, inhaling asbestos fibers increases the risk of lung diseases, including cancer, and the cancer risk is especially high for asbestos workers who smoke.

**Tobacco.** The most common carcinogens in our society are those present in cigarette smoke. Tobacco smoke is known to contain at least 60 carcinogens and 6 developmental toxicants. In addition to being responsible for 80 to 90 percent of lung cancers, cigarette smoking is also associated with cancers of the mouth, pharynx, larynx, esophagus, pancreas, kidney, and bladder.
Avoiding tobacco products is one way to decrease a person's risk of cancer.

**Ionizing radiation.** Certain types of radiation, such as x-rays, rays from radioactive substances, and ultraviolet rays from exposure to the sun, can produce damage to the DNA of cells, which might lead to cancer.

**Heredity.** Certain types of cancer occur more frequently in some families than in others, indicating some inherited predisposition to the development of cancer. Even in these cases, however, environment plays a part in the development of cancer.

### How Cancer Develops

Cancer can develop in people of all ages, but it is more common in people over 60 years old. One of every three people will develop cancer at some point in their lives. Because people are living longer, the risk of developing cancer is increasing.

The development of cancer is a long process that usually starts with genetic changes in the cells, and continues in the growth of these cells over time. The time from genetic change to development of cancer is called the latency period. The latency period can be as long as 30 years or more. This means that some cancers diagnosed today may be due to genetic changes that occurred in the cells a long time ago.

Theoretically, the body develops cancer cells continuously, but the immune system recognizes them as foreign cells and destroys them. The body's ability to protect itself from cancer can be impaired by some drugs and viral infections.

### Symptoms of Cancer

Everyone should be familiar with certain signs that may indicate early cancer. It is important to report them immediately, before the condition spreads. It is unfortunate that early stages of cancer are typically painless; because they are painless, diagnosis and treatment are often delayed.

Early symptoms can include

- unaccountable weight loss

- unusual bleeding or discharge
- persistent indigestion
- the presence of white patches inside the mouth or white spots on the tongue

**Detection of Cancer**

Early detection and prompt treatment are directly responsible for increased survival rates.

Tools for cancer detection include

- Self-exams
- Biopsy (the removal of living tissue for the purpose of microscopic examination of cells)
- Ultrasound (the use of reflected high-frequency sound waves to differentiate various kinds of tissue)
- Computed tomography (CT) (the use of x-rays to produce a cross-sectional picture of body parts)
- Magnetic resonance imaging (MRI) (the use of magnetic fields and radio waves to show changes in soft tissues without the use of x-rays).

**Health Promotion Tips**

- Reduce or avoid exposure to known or suspected carcinogens or cancer-promoting agents, including cigarettes and sun exposure.
- Eat a balanced diet that includes vegetables, fresh fruit, whole grains, and adequate amounts of fiber.
- Reduce the amount of fat and preservatives in the diet, including smoked and salt-cured meats.
- Participate in regular exercise.
- Obtain adequate, consistent periods of rest (at least 6 to 8 hours per night).
- Eliminate or reduce stress and enhance the ability to effectively cope with stress.
- Go to annual health check-ups.
- Enjoy consistent periods of relaxation and leisure.
- Learn to practice self-examination (breast and testicular).
- Seek immediate medical care if cancer is suspected.

**Risk Factors for Cancer**

Because cancer is not a single disease, it does not have a single cause. Many causes or risk factors can contribute to a person's chance of getting cancer. Risk factors are different with each type of cancer. It is important to remember that 1 in 3 people will develop a cancer during their lifetime.

Risk factors can include such things as age, race, sex, genetic factors, diet, and exposure to chemicals, radiation, and tobacco.

Genetics play a large role for many cancers, such as breast and colon cancer. This means that a family's health history can be a risk factor for some types of cancers.

**Lifestyle Factors**
Personal choices we make about the way we live our lives can increase our chance of developing cancer. These choices are called lifestyle factors, and they include smoking, heavy drinking, and eating foods that have excess calories, high fat, and low fiber. Other factors that increase risk are related to sexual contact and sunlight exposure.

**Tobacco**
Thirty percent of all cancers are attributed to smoking or chewing tobacco. Cigarette smoking is also associated with cancers of the mouth, pharynx, larynx, esophagus, pancreas, kidney, and bladder.

**Diet**
Researchers found that different types of food you eat affect your risk of developing cancer. Approximately 30% of cancers are related to diet.

**Infectious Agents**
Some viruses have the ability to transform cells into cancer. Examples include (a) human papilloma virus (HPV) and cervical cancer, and (b) Epstein-Barr virus and lymphoma.

**Occupational Exposure**
Occupational exposure includes high-risk occupations such as uranium miners, asbestos factory workers, certain chemical plant workers, and workers in nuclear power plants.

**Reproductive Factors**
The reproductive factors category refers mostly to women's risk factors. For example, the risk of breast cancer goes up if a woman does not have children before the age of 30. Sexually transmitted diseases also increase the risk of cervical cancer.

**Sedentary Lifestyle**
Not moving around much during the day may increase the risk of cancer. The body's own defenses work better when you exercise and maintain an ideal weight. Moderate exercise such as walking or climbing a flight of stairs can help.

**Alcohol/Drugs**
Alcohol contributes to the risk of developing cancer. People who drink too much or abuse drugs may not eat well or take care of themselves, which will increase their overall risk of cancer.

**Pollution**
Although people think environmental pollution is a major cause of cancer, in fact few cancers have been found to be caused by pollution, but research is still ongoing. The cause of many cancers is not known. Other factors that interact to increase the risk of cancer are age, hormonal balance, response to stress, and status of the immune system.

**Risk and Protective Factors in the Development of Cancer**

| Protective Factors | | | | Risk Factors | | | |
|---|---|---|---|---|---|---|---|
| Type of Cancer | Vegetables | Fruits | Physical Activity | Alcohol | Obesity | Tobacco Use | Environmental Exposure |
| Lung | GL | SL | ML | MR | | HR | SR |
| Colon/Rectum | GL | | GL | SR | MR | MR | |
| Breast | SL | SL | ML | SR | SR | | |
| Prostate | ML | | | | | | MR |
| Stomach | GL | GL | | | | | MR |
| Oral/Pharynx | GL | GL | | MR | | HR | MR |
| Kidney | ML | | | | SR | MR | |
| Ovary | ML | ML | | | | | |
| Pancreas | SL | SL | | | | HR | |
| Liver | ML | | | HR | | | MR |
| Cervix | ML | ML | | | | HR | |
| Bladder | SL | SL | | | | HR | SR |
| Esophagus | GL | GL | | HR | | HR | MR |
| Larynx | SL | SL | | HR | | HR | MR |
| Thyroid | ML | ML | | | | | SR |
| Uterus | ML | ML | | | HR | | |
| Gallbladder | | | | | MR | | |
| Nasopharynx | | | | | | SR | MR |

GL = Greatly lowers your risk
SL = Somewhat lowers your risk
ML = Might lower your risk
SR = Somewhat raises your risk
MR = Might raise your risk
HR = Highly raises your risk

Adapted from: Westcott S. A Journey Into Cancer's Causes. Anchorage (AK): Alaska Native Health Board; 1999. p. 11.

## Cancer and Children

It can be especially difficult to understand and accept when a child develops cancer. The most common cancers in children are leukemia, brain tumors, and lymphomas. Nearly 1 in 450 children will be diagnosed with cancer before the age of 15.

Many pediatric cancers occur very early in life and many parents want to know why. The cause of most childhood cancers is not known, although some of these cancers are the result of genetic predisposition (cancer runs in the family). Radiation exposure also contributes to certain types of childhood cancers. Other factors that have been implicated in childhood cancers include infectious diseases, prenatal conditions, environmental pollutants, electromagnetic fields, and use of medications.

Unlike most cancers of adults, childhood cancers are not significantly related to lifestyle risk factors such as tobacco or alcohol use, poor diet, or not enough physical activity. Many organ systems in children are undergoing rapid growth and development in the first years of life. These systems are especially vulnerable to injury during these periods of development.

The types of cancer that occur in children vary greatly from those seen in adults.

## Most Common Cancers in Children and Adults

| Children | Adults |
|---|---|
| Leukemias: acute lymphocytic (lymphoblastic) | Lung |
| Brain and Other nervous system tumor: neuroblastoma | Breast (carcinoma) |
| Lymph-node cancers (lymphomas) | Colorectal |
| Bone (osteosarcoma) | Prostate |
| Soft-tissue sarcomas: rhabdomyosarcoma | Skin (melanoma) |
| Kidney: Wilms tumor | |
| Eye: retinoblastoma | |
| Adrenal gland (adrenocortical carcinoma) | |

This information on children and cancer was compiled from "Childhood Cancer-General Statement", published by the American Cancer Society.

**Acute lymphocytic leukemia** (ALL) is the most common childhood malignancy. ALL accounts for almost one-third of all childhood cancers.

**Brain and spinal cord** cancers are the second most common cancers in children. Most brain cancers of children involve the cerebellum or brain stem. Adults are more likely to develop cancers in different parts of the brain -- usually the cerebral hemispheres. Spinal cord tumors are less common than brain tumors in both children and adults.

**Bone cancer is uncommon.** The incidence of primary bone cancer (cancer starting in bones) is highest in children and adolescents. Cancer that spreads to the bones is more common than primary bone cancer in all age groups. Osteosarcoma is the most common type of primary bone cancer in children and young adults. Ewing sarcoma is a less common primary bone cancer that occurs mostly in children and adolescents.

**Detecting Cancer in Children**
Cancers in children are often difficult to recognize. Parents should take their children to regular medical checkups and should be alert to any unusual signs or symptoms that persist. It is important to report unusual signs or symptoms to a health care provider.

Unusual signs or symptoms include

- unusual mass or swelling
- unexplained paleness
- loss of energy
- sudden tendency to bruise
- persistent, localized pain or limping
- prolonged, unexplained fever or illness
- frequent headaches, often with vomiting
- sudden eye or vision changes
- excessive, rapid weight loss.

**What About Chemicals in the Environment?**

"All substances are poisons: there is none which is not a poison. The right dose differentiates a poison and a remedy."

Environmental pollutants are only one of the many connections between cancer and our lives. Not all contaminants are deadly or even cause disease.

The amount of a contaminant a person is exposed to
plus the length of time that person is exposed
plus how many times that person is exposed

plus how the person was exposed
equals whether a person will experience negative health effects from an exposure.

Exposures to some chemicals in the environment, at home, and at work may contribute to an individual's risk of developing cancer. Toxic substances such as benzene, asbestos, vinyl chloride, and arsenic can increase the risk of cancer in those exposed to them. The International Agency for Research on Cancer (IARC) classified these substances as known human carcinogens because studies showed a link in humans between exposure to these substances and cancer.
Some chemicals have been shown to cause cancer in animals, but there is not enough evidence to show that these chemicals also cause cancer in humans. These chemicals are classified by IARC as possibly or probably carcinogenic to humans. Chloroform, DDT, formaldehyde, and polychlorinated biphenyls are examples of such chemicals.

Most of what we know about chemicals and cancer in humans comes from scientists' observation of workers. The most significant exposures to cancer-causing chemicals have occurred in workplaces where large amounts of toxic chemicals have been used regularly.

The amount of toxic chemicals found in food, air, and drinking water are typically much lower than those in the work environment. Therefore, cancer risk from environmental exposures is thought to be lower compared to the risk in occupational settings. In fact, the cancer risk from environmental exposures is often difficult to measure.

**Environmental Toxicants**

Environmental toxicants are classified by the National Toxicology Program as (a) known human carcinogens and (b) reasonably anticipated to be (suspected) human carcinogens to differentiate the level of evidence available to support the carcinogenicity of a probable toxicant. Carcinogens include a wide diversity of synthetic and naturally occurring substances, including hormones, immunosuppressants, organic and inorganic chemicals, and cytotoxins.

It is difficult to study populations living near a hazardous waste site and determine if their cancers are associated with exposures. A major difficulty for those studying these populations is not knowing the exact level of individual exposure to a carcinogenic agent. Waste sites often contain more than one chemical, which makes it difficult to associate health outcomes to a single exposure. Often other variables must be accounted for before making any associations of the disease outcome to a given exposure from the site.

Because of the long latency period of cancer development and the type of behavioral risk factors associated with cancers (such as tobacco use, alcohol consumption, and diet), it is difficult to collect information about environmental exposures that occurred years ago.

**A List of Known and Suspected Human Carcinogenic Agents by Organ**

| Human Carcinogenic Agent | | |
|---|---|---|
| **Organ** | **Known** | **Suspected** |
| Lung | Arsenic<br>Asbestos<br>Benzo(a)pyrene<br>bis(Chloromethyl)ether<br>Chromium<br>Nickel subsulfide<br>Zinc chromate<br>Tobacco smoking<br>Mustard gas<br>Uranium | Acrylonitrile<br>Beryllium<br>Cadmium<br>1,2-Dibromo-3-chloropropane<br>Polyclic aromatic hydrocarbons (PAHs) |
| Kidney | Coke oven emissions<br>Zinc chromate | Tetrachloroethylene |
| Bladder | Benzidine<br>Tetrachloroethylene<br>Cyclophosphamide<br>4-Aminodiphenyl<br>Tobacco smoking<br>Chloraphazine | Tetrachloroethylene |
| Stomach | Zinc chromate | Ethylene oxide |
| Skin | Arsenic<br>Benzo(a)pyrene<br>Overexposure to the sun | PAHs<br>Tetrachloroethylene |
| Liver | Vinyl chloride<br>Aflatoxin<br>Alcoholic drinks | |
| Mouth, pharynx, larynx, esophagus | Alcoholic drinks<br>Tobacco smoking<br>Tobacco chewing (mouth only)<br>Mustard gas (larynx) | |
| Prostate | Cadmium | |

Source: Lybarger JA, Spengler RF, DeRosa CT, editors. Priority health conditions: an integrated strategy to evaluate the relationship between illness and exposure to hazardous substances. Atlanta: Agency for Toxic Substances and Disease Registry; 1993. p. 61.

For more information about Cancer:

Contact your Health Care Provider
Your local American Cancer Society Chapter
or visit the following sites on the Internet:

http://www.cancer.gov/

http://www.yourdiseaserisk.wustl.edu/hccpquiz.pl?lang=english&func=home&page=cancer_index

http://www.cdc.gov/cancer/

http://www.acor.org

http://www.pbs.org/wgbh/nova/cancer

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Childhood Cancers; (2001); Pediatric Oncology Resource Center,
www.acor.org.diseases/ped-onc/diseases/diseases.html

NCI Fact Sheet: National Cancer Institute Research on Causes of Cancers in Children; (1999);
www.oncolink.upenn.edu/pdq_html

Cancer Information Service; www.fhcrc.org/cipr/pnwcis

For more information,
contact ATSDR's toll-free information line:
(888) 42-ATSDR. . .(888) 422-8737