

# Public Health Assessment

**Final Release**

**ORE KNOB MINE NPL SITE**

**ASHE COUNTY, NORTH CAROLINA**

**EPA FACILITY ID: NCN000409895**

**Prepared by the  
North Carolina Department of Health and Human Services**

**JULY 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**

## THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR's Cooperative Agreement Partner pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR's Cooperative Agreement Partner has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR's Cooperative Agreement Partner addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by 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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**North Carolina Department of Health and Human Services**

**Division of Public Health**

**Occupational and Environmental Epidemiology Branch**

**Under Cooperative Agreement with the  
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## Acronyms

AF	Attenuation factor
ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Centers for Disease Control and Prevention
CF	Conversion factor
cm	Centimeter
CREG	ATSDR Cancer Risk Evaluation Guide
CR	Contact rate
CV	Comparison Value
DAF	Dermal absorption efficiency
DPH	N.C. DHHS Division of Public Health
DWM	N.C. DENR Division of Waste Management
DWQ	N.C. DENR Division of Water Quality
ED	Exposure duration
EF	Exposure frequency
EMEG	ATSDR Environmental Media Evaluation Guide
EPA	U.S. Environmental Protection Agency
HG	Health Guideline value
IRi	Inhalation rate
IUR	Inhalation Unit Risk factor
Kg	Kilogram
L	Liter
LOAEL	Lowest Observed Adverse Effect Level
LTHA	EPA's Lifetime Health Advisory Level for drinking water
MCLG	EPA Maximum Contaminant Level Goal
MCL	EPA Maximum Contaminant Level
M	Meter
mg	milligram
$\mu\text{g}/\text{m}^3$	microgram per cubic meter
$\mu\text{g}$	microgram
ng	nanogram
NA	Not applicable
N.C. DENR	North Carolina Department of the Environment and Natural Resources
N.C. DHHS	North Carolina Department of Health and Human Services
NIOSH	National Institute for Occupational Safety and Health
NOAEL	No Observed Adverse Effect Level
ppm	Parts per million
ppb	Parts per billion
RfC	Reference Concentration
RfD	Reference Dose
RMEG	ATSDR Reference Dose Media Evaluation Guide
SVOC	Semi-volatile organic compound
VOC	Volatile organic compound

**\* These acronyms may or may not be used in this report**

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## Foreword

The North Carolina Department of Public Health (N.C. DPH) Medical Evaluation and Risk Assessment Unit's Health Assessment, Consultation and Education (HACE) program has prepared this Public Health Assessment in cooperation 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 the health issues related to hazardous waste. This health assessment was prepared in accordance with the methodologies and guidelines developed by ATSDR.

The purpose of this Public Health Assessment is to identify and prevent harmful health effects resulting from exposure to hazardous substances in the environment. Health assessments focus on health issues associated with specific exposures that have happened in the past, are currently occurring, or are believed to be possible in the future based on current site conditions. The HACE Program evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur in the future, reports any potential harmful effects, and then recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time this health assessment was conducted and may not be applicable if site conditions or land uses change in the future.

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## SUMMARY

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**INTRODUCTION** The N.C. Division of Public Health's (DPH) top priority is to make sure the community near the Ore Knob Mine NPL site (EPA ID: NCN000409895) has the best science information available to safeguard its health.

The N.C. DPH performed a comprehensive evaluation of available environmental analytical data associated with the Ore Knob Mine NPL site, collected from 1987 through 2008. This public health assessment evaluates potential public health hazards related to exposures to soils, sediments, surface waters and mine waste materials on the site. It also evaluates private well water, residential soils from properties near the site, surface waters, sediments, floodplain soils, and fish tissue associated with water bodies downstream of the site. Many of the samples evaluated were collected in areas expected to represent the highest potential contamination related to mining activities, and thus represent the greatest potential to result in adverse health effects associated with coming into contact with these materials.

Copper mining occurred intermittently at the Ore Knob Mine from the 1850s through 1962, with 2 main periods of activity from 1873 to 1883 and 1957 to 1962. Mining and mineral-related activities at the site included mining, concentration, roasting, smelting, and waste management. Wastes from site operations are known to have contaminated on-site surface waters and sediments with acid and heavy metals. Multiple areas of mining and processing waste material are present on the site, including a 20-acre tailings impoundment holding an estimated 720,000 cubic yards of material. The tailings impoundment is held in place by a 60 foot high, 700 foot wide earthen dam. Mining-related activities have also affected downstream surface waters, sediments, and floodplain soils as a result of surface soil and water runoff. Currently, EPA is on-site to remediate and stabilize the site to prevent further environmental damage to the surrounding areas. The physical hazards associated with the site, including stabilization of the main tailings pile dam and access to former mine shafts and adits, have been eliminated by the U.S. EPA.

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**OVERVIEW** **The N.C. DPH reached four important conclusions about the Ore Knob Mine site:**

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**CONCLUSION 1** **The N.C. DPH concludes that drinking water from private wells of some residences near the Ore Knob Mine NPL site for many years could harm people's health due to elevated concentrations of the metals manganese and cadmium. It is not known if the elevated metals are due to the former mining operations.**

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**BASIS FOR DECISION**

Manganese found in 3 residential private wells sampled once in 2007 (identified as locations OK702, OK706 and OK707) were at concentrations that indicate the potential for adverse health effects to children and adults if they drank the water over many years.

Concentrations at all 3 locations exceeded EPA's non-regulatory Lifetime Health Advisory (LTHA) level for drinking water and the estimated exposure doses exceeded EPA oral reference dose (RfD).

Cadmium was found at one location (OK702) at a concentration less than EPA's Maximum Contaminant Level ("MCL"), the regulatory value for public drinking water systems. Although the level is below EPA's MCL, the estimated dose of cadmium for a child drinking the water daily for more than one year is above ATSDR's health guideline values and indicates a potential for adverse health effects. The information currently available is not adequate to determine if these elevated metals are due to the former mining operations. These wells are located between the 1950s mine and mill and 19<sup>th</sup> century operations area of the Ore Knob Mine site.

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**NEXT STEPS**

The N.C. DPH makes the following recommendations:

- Identify if groundwater from the site is contaminated and impacting area residential private wells. Test private wells that may be impacted for metals and other associated site contaminants. Well water analyses should include the metals aluminum, arsenic, cadmium, copper, iron and manganese, as well as cyanide and sulfur species.
- Collect and analyze additional samples from the previously sampled residential private wells to better characterize the metal concentrations. If the additional manganese and cadmium analyses indicate the potential for adverse health effects, provide the residents with information on the alternatives to reduce their exposure or the potential for harmful health effects.
- Identify additional private residential wells in the area that may be affected by the site, including those of residences on the access drive to the 1950s mine and mill area, and analyze their drinking water sources for metals, cyanide and sulfide species
- Perform periodic sampling and analysis of residential private wells that may be affected by Ore Knob Mine to provide adequate characterization to identify potential health impacts associated with drinking the water.
- If concentrations of substances are found in residential private wells in the vicinity of the site at concentrations that exceed regulatory or health guidelines, and these substances can be linked to sources

emanating from the Ore Knob Mine NPL site, a clean source of drinking water should be provided. Drilling new wells or providing whole-house filter or reverse osmosis systems would be suitable means of permanently providing a clean source of drinking water.

- If elevated concentrations of substances are identified that are not associated with the mine operations that may pose health risks, inform the residents and provide them with options to reduce their exposure or potential health risks.
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**CONCLUSION 2**    **The N.C. DPH concludes that the metals copper, iron and aluminum are at concentrations in the soils from some residential lawns in the vicinity of the site that could cause adverse health effects to children ingesting (eating) the soil. It is not known if these concentrations are typical for soils in this area or if they are related to historical mining operations.**

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**BASIS FOR DECISION**

High concentrations of copper and iron were identified in the soils located at one residence (OK406, located between the east side of the 1950s mine and mill area and Little Peak Creek Road). Children accidentally ingesting (eating) these soils daily over a number of years may be subject to harmful health effects. Children playing in these yards could be exposed to copper by putting dirty hands or toys in their mouth. Some children may intentionally eat the soil, or eat the soil on unwashed items grown in the family garden.

The concentration of copper in the soils at 2 residences (OK406 and OK407, located between the southeast corner of the 1950s mine and mill area and Little Peak Creek Road) and the concentration of aluminum in soils at all 3 residences (OK406, OK407 and OK408, located between the south end of the 1950s mine and mill area and Ore Knob Road) if ingested by children in very large quantities over a short time period (1-day “pica” ingestion rates) could cause adverse health effects.

The aluminum concentrations identified for the above residential soils may be typical of area soil background concentrations and may not have been impacted by mining activities. The copper and iron residential soil concentrations are greater than those identified for the local area background. The residential soil samples may or may not represent areas of higher metal concentrations than those throughout the given property.

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**NEXT STEPS**

The N.C. DPH makes the following recommendations:

- Inform parents at these residences of the potential hazards to children accidentally ingesting the soils. To protect their children they should:
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1. Monitor their children's behavior when playing outdoors to prevent them from eating soil.
  2. Regularly wash outdoor toys.
  3. After playing outdoors have children wash their hands before they eat.
  4. Wash all homegrown garden produce before it is eaten.
  5. Seek advice from their private physician or a N.C. DPH Public Health physician if they think their child may have consumed large amounts of soil.
  6. Prevent children from playing in areas of bare soil. Children will have less direct contact with the soil if they play in areas covered by grass. Establish ground cover (grass) in areas with bare soil to decrease children's exposure.
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**CONCLUSION 3**    **N.C. DPH concludes that concentrations of copper, aluminum and zinc found in soils, sediments and mine waste materials in several areas on the Ore Knob Mine site could harm the health of children that accidentally ingest these materials while on the site for recreational activities.**

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**BASIS FOR DECISION**    High concentrations of the metal copper were found on the Ore Knob Mine site in the soils, Ore Knob Branch sediments near the main tailings impoundment, and tailings and other mine waste materials found on site. Children accessing the site occasionally over several years for recreational activities and accidentally ingesting these materials may be at risk of adverse health effects.

The concentrations of the metals copper, aluminum and zinc found in some areas of the site are at concentration high enough to harm children ingesting very large amounts of these materials in a short time period, such as 1 day.

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**NEXT STEPS**    The N.C. DPH recommends:

- All recreational visits to the Ore Knob Mine site be discouraged, especially those by children.
- Public access to the site should be restricted. Post "No Trespassing" or "hazard identification" signs around the perimeter of the site.
- Remediation (capping) of the on-site tailings piles should continue to prevent direct contact to contaminated soil or mine waste materials.
- Members of the hunting club that have been granted access to areas connected to the mine site should be told of the potential hazards to

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themselves and their children.

- Limit residential development on or near areas of the site that contain mine wastes, highly contaminated surface waters or soils, or acid mine drainage.
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**CONCLUSION 4**    **The N.C. DPH concludes that incidental ingestion of metals in off-site sediments and floodplain soils during recreational activities on waterways downstream of Ore Knob Mine is not expected to harm people’s health.**

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**BASIS FOR DECISION**    While elevated concentrations of copper, aluminum and zinc were found in sediments and floodplain soils associated with Peak Creek and South Fork New River, it is not expected that persons would come into contact with these areas with a frequency that would lead to ingestion of a sufficient amount of sediment or soil to cause harm.

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**NEXT STEPS**    The N.C. DPH recommends:

- Continue to monitor and implement efforts to control the release of contaminated media such as surface waters, sediments and soils from the site. If these environmental media show elevated concentrations of metals (above the range of what is normally expected for the area) or other contaminants that may present a health hazard, steps should be taken to inform the community that may have contact with these media.
- If releases of surface waters, sediments or soils from the site show elevated contaminant concentrations, periodically monitor the level of metals in the types of fish commonly caught and eaten by anglers downstream of the site. Inform anglers of potential hazards to themselves or their family members associated with eating these fish due to elevated metal concentrations.

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**FOR MORE INFORMATION**    If you have concerns about your health as it relates to this site you should contact your health care provider. You can also call the N.C. Division of Public Health at (919) 707-5900, or send an e-mail to [nchace@dhhs.nc.gov](mailto:nchace@dhhs.nc.gov), and ask for information on the Ore Knob Mine NPL Site Public Health Assessment.

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## PURPOSE AND HEALTH ISSUES

The Ore Knob Mine NPL (“Superfund”) site is located in Ashe County, North Carolina, 12 miles south of the Virginia state line, 15 miles east of the Tennessee border, and 8 miles east of the town of Jefferson, North Carolina (Appendix A, Figure 1). Mining for copper ore occurred intermittently from the 1850s through 1962, with the two main periods of activity from 1873 to 1883 and 1957 to 1962. Mining and mineral-related activities at the site included mining, concentration, roasting, smelting, and waste management. Wastes from site operations are known to have contaminated surface water and sediment with acid and heavy metals. The site consists of three principal areas that were directly affected by mining: the 19<sup>th</sup> century operations area, the 1950s mine and mill area, and the main tailings impoundment. Multiple areas of mining and processing waste material, as well as mining related structures, are present on the site. Waste materials present on the site include a 20-acre tailings impoundment holding an estimated 720,000 cubic yards of material held in place behind a 60 foot high, 700 foot wide earthen dam. Mining-related activities have also affected downstream surface waters, sediments, and floodplain soils as a result of surface soil and water runoff (EPA 2008). In June 2006 the N.C. Department of Environment and Natural Resources (DENR) requested the U.S. Environmental Protection Agency (EPA) to evaluate the site for a “Removal Action”, allowing EPA to remediate and stabilize the site. The N.C. Division of Land Resources had classified the tailing pile dam as having “high hazard potential” because of concerns with physical failure of the dam and the environmental impacts of the drainage emanating from the face of the dam (EPA 2008). A number of private single family homes are present along the border of the former mine areas. All use private wells as a source of drinking and household water supplies. In addition, the area is known to be used for recreational purposes including: hiking, camping, hunting, fishing, and riding off-road recreational vehicles.

The objective of this Public Health Assessment (PHA) is to determine if the site poses a health hazard to the community. Concentrations of contaminants in the soil, groundwater, surface water and air are compared to health comparison values to determine if they pose a health hazard if persons should come into contact. An important component of a PHA is the determination of a person’s possibility to come into contact with any potentially harmful substances, how that contact may occur, and for how long that contact may have occurred in the past, or may occur in the future. This information is used to determine whether past, current, or future contact with the substances may result in adverse (negative) health effects. Highly health protective methods are used throughout the PHA process so that the potential for negative health effects associated with contacting site contaminants are identified at the most sensitive (lowest) adverse health effect levels.

For the Ore Knob Mine NPL Site PHA, N.C. DPH evaluated drinking water and soil samples collected at nearby private residences; soils and surface waters collected throughout the mine site; and soil, surface water and sediment data collected off-site. The information reviewed for the PHA was taken from reports and analytical data generated by EPA and their contractors, and N.C.DENR. All available analytical data, collected from 1987 through 2008, was evaluated for this PHA.

The physical hazards associated with the site have been eliminated since April 2010 when the Public Comment Public Health Assessment was released. The EPA has stabilized the main tailings pile dam and prevented access to the mine shafts and adits.

## **BACKGROUND**

### **SITE DESCRIPTION AND HISTORY**

The Ore Knob Mine National Priorities List (NPL or “Superfund”) site is located in Ashe County, North Carolina, 12 miles south of the Virginia state line, 15 miles east of the Tennessee border, 8 miles east of the town of Jefferson, and 4.5 miles east of Laurel Springs, North Carolina (Appendix A, Figure 1). The site GPS coordinates are latitude 36.405667, longitude 81.323889, at an elevation of 3127 feet (EPA 2009a). The site was proposed for addition to the NPL list in April 2009 and listed as final in September 2009.

The NPL or Superfund is a federal program to clean-up abandoned hazardous waste sites that threaten to harm the environment or people. The program is administered through the U.S. EPA. Superfund also authorizes the Agency for Toxic Substances and Disease Registry (ATSDR), also a federal agency and part of the U.S. Department of Health and Human Services (U.S. DHHS), to assist in evaluating public health impacts associated with Superfund and other releases of harmful substances to the environment. In North Carolina, ATSDR investigations of NPL sites are conducted through a cooperative agreement program with the N.C. DPH, under the Health Assessment, Consultation and Education (“HACE”) program.

Mining for copper ore occurred intermittently from the 1850s through 1962, with the two main periods of activity from 1873 to 1883 and 1957 to 1962 (EPA 2008). Mining and mineral-related activities on the site included mining, concentration, roasting, smelting, and waste management (HRS 2009). The site consists of three main areas that were directly impacted by mining (Appendix A, Figures 2 and 3):

- the 19<sup>th</sup> century operations and smelter area
- the 1950s mine and mill area
- the main tailings impoundment area

The **19<sup>th</sup> century operations and smelter area** encompasses approximately 5 acres near the top of Ore Knob that received waste rock from mine (vertical) shafts, and an additional 5 acres to the north where ore was “roasted” (heated) to drive off sulfur and smelted (heated with charcoal) to recover copper (Appendix A, Figure 4). A partially barren area contains waste materials up to several feet deep. Acid mine drainage (AMD, see Appendix E, Glossary) reportedly discharges from 5 horizontal shafts (adits) located in a wooded area between the 19<sup>th</sup> century operations area and the tailings impoundment. AMD from 4 of the adits have been treated with buried limestone drains since the early 1990s. Drainage from this area flows northeast to a small stream that flows into the southwest corner of the main tailings impoundment, eventually forming Ore Knob Branch (EPA 2008, HRS 2009).

The **1950s mine and mill area** is a 15-acre area approximately 0.3 miles west-southwest of the 19<sup>th</sup> century operations (Appendix A, Figure 5). Ore was processed in this area from 1957 to

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1962 in preparation for separation of the mineral. Remnants of a number of old structures exist in this area, including ore bins, concrete foundations and a transformer building (Appendix A, Figure 6 and 7). A small sawmill currently operates in this area within a wooden structure (Appendix A, Figure 8). These structures likely were built on fill material made-up of waste rock from mine shaft development. Approximately 20,000 cubic yards of tailings, mostly covered by tree stumps, are located on the north end of this area. Northeast of this stump area is a 2-acre former pond where process water was stored. This pond is now described as a wetland. The headwaters of Little Peak Creek form immediately upstream (south) of the former pond. Little Peak Creek flows 2.25 miles downstream (north/northwest) to Peak Creek (EPA 2008).

The **20-acre main tailings impoundment** lies approximately 0.3 miles northeast of the 19<sup>th</sup> century operations area and contains an estimated 720,000 cubic yards of tailings primarily generated from 1957 to 1962 operations (Appendix A, Figure 9). (Tailings are fine-grain materials left over after separating, usually by grinding, the desired metal fraction from the ore.) Surface water tributaries were flowing into the impoundment forming small ponds around the perimeter and on the impoundment. Most of the surface waters flowed into a 24-inch concrete pipe that was laid beneath the tailings impoundment, running south to north, where it discharged at the base of the impoundment dam. Site visit reports indicated that the pipe become clogged at the inflow end (south end) resulting in ponding of the surface water inflow. The 60 foot high by 700 foot wide tailings impoundment dam is approximately 1000 feet north of the southern reach of the tailings impoundment (Appendix A, Figures 10 and 11). The dam appeared to be constructed of waste rock at the base. The upper portion of the dam consisted of successive lifts (layers) of tailings deposited as a slurry. Severe erosion had impacted the dam and eroded tailings had filled a settling basin at the base of the dam (north end). Water was discharging from the northern face of the dam in several places, mostly near where the pipe emerged at the base of the dam (Appendix A, Figure 12) (EPA 2008). Seeps emanating from the face of the tailings dam had extremely high concentrations of several metals (including aluminum, copper, iron, manganese, silver and zinc), acidity, sulfate, and total dissolved solids (EPA 2008b). The areas where tailings had deposited were void of vegetation, likely due to the high metals and/or sulfide concentrations and low pH.

Acid mine drainage (AMD) from the three areas mentioned above has degraded downstream receiving waters, including the entire 1.5-mile length of Ore Knob Branch, the entire 2.25-mile length of Little Peak Creek, and an estimated 2.9 miles of Peak Creek (Appendix A, Figure 2) (EPA 2008a). The long-term release of metals from the site to surface water is evidenced by bright orange stained surface water and sediments, and Ore Knob Branch, Little Peak Creek and Peak Creek being devoid of fish (HRS 2009). The site sits in the Peak Creek watershed which is a tributary to South Fork New River. The areas affected by mining and mine wastes lie in the watersheds of Little Peak Creek and Ore Knob Branch, both of which are tributaries to Peak Creek. Peak Creek flows into South Fork New River which is also degraded for some length down stream of its confluence with Peak Creek. Run-off from the site has also carried soils and solid mining materials downstream. The State of North Carolina has designated Peak Creek and Little Peak Creek as “trout waters” and South Fork New River as an “outstanding resource water”. The South Fork New River flows into New River, which was the first in the United States designated as a “National Wild and Scenic River”. New River is also designated as an “American Heritage River” and one of four rivers designated as a “State Scenic River” by North

Carolina. These waterways are classified for consumption of fish and for primary recreational activities, including swimming. In 2005, the State identified the aquatic environment of Ore Knob Branch, Little Peak Creek, and Peak Creek as “impaired” due to habitat degradation and toxic impacts associated with the AMD. The DENR has identified that South Fork New River receives significant loading of heavy metals from the Ore Knob Mine site (EPA 2008a). Peak Creek and South Fork New River are used for recreational activities including fishing and swimming. A portion of the New River State Park is located on the South Fork New River (Appendix A, Figure 10). Recreational activities in the park include camping, canoeing, picnicking and fishing (HRS 2009).

The mining operation would have used a variety of industrial materials typical of mid-20<sup>th</sup> century industrial operations. The mill would have used flotation reagents and other chemicals, possibly including cyanide for pyrite (iron sulfide, FeS<sub>2</sub>) suppression. The former machine shop and electrical shop would have used various solvents, and PCBs may have been used in transformers or other purposes (EPA 2008a).

Past analyses of site soils, solid waste materials, and surface waters and ponded waters, indicate elevated concentrations of the metals arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, selenium, silver, and zinc. Analysis of sediments collected from Little Peak Creek, Peak Creek and South Fork New River downstream of the site indicate elevated concentrations of copper (HRS 2009).

In 2000, the U.S. Army Corp of Engineers (USACE) analyzed 5 wells in the vicinity of the 1950s mill and 19th century operations areas for metals. Details on the locations sampled, the analytical methods used, and the results are not available. Reports state most metals were “well under applicable primary drinking water standards”, also noting reporting limits for some metals were greater than drinking water standards (for antimony, beryllium, and thallium). Reports also noted aluminum, iron, manganese, sulfate, and pH exceeded their respective secondary drinking water standards. It could not be determined if the elevations were due to mining impacts.

The State of North Carolina was concerned with the potential of the tailings impoundment dam to fail, resulting in “catastrophic and probable irreversible damage to one of North Carolina’s most used fisheries”, as well as the potential for the acid-generating tailings to be deposited along floodplains and in residential farmlands along the river. The State referred the site to EPA because of the complexity and costs involved with environmental restoration on the Ore Knob Mine site and downstream surface water bodies. The EPA concurred that the conditions at the Ore Knob Mine site presented a “substantial threat to the public health or welfare, and the environment”, and agreed the site met criteria for a time-critical removal action (EPA 2008b).

EPA, its contractors, and the N.C. DENR Division of Waste Management (DWM), mobilized to the site in July 2007 for a site assessment. During the site assessment, samples were collected on-site from soils, waste materials and surface waters. Site samples were collected in areas believed to represent areas of highest contamination related to the historical mining operations. Additional samples were collected in surface waters, sediments and flood-plain soils downstream of the site. Samples of private drinking water wells and soils from lawns of some near-by residences were also collected. The off-site samples were also collected in areas that were

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expected to represent the highest concentrations of contaminants that may have been influenced by the mine site. Background samples were collected from a near-by private well and residential soils to determine concentrations of substances in these sample types not impacted by the mine (EPA 2008a). In October 2008, EPA began a time-critical removal action. Planned activities included developing an access road to the main tailings impoundment area, excavation of sediment from the settling pond on the north side of the main tailings impoundment dam, determination of the stability of the dam, construction of a stream diversion channel around the tailings impoundment, and stabilization of the dam structure. Once stabilized, the main tailings impoundment will be re-contoured and covered in place with materials to provide a pH buffer and clean soil to promote re-vegetation.

The area surrounding the site includes dispersed single family residences and mixed small-scale agriculture and forestry operations. Many of the residences in the area are seasonal homes that are not occupied year-round. A local hunting club has leased an area bordering the main tailings impoundment. The region is primarily rural, with agriculture and tourism as major sources of employment. The dam is located in the Blue Ridge Mountains, a highly popular year-round vacation destination (EPA 2008b).

## **CURRENT SITE CONDITIONS**

EPA and their contractors are currently on site for a “time-critical removal action” to stabilize the imminent physical and environmental hazards and provide remediation activities identified for the 20-acre main tailings impoundment area. The site was proposed for addition to EPA’s National Priorities List (NPL, or “Superfund”) in April 2009 and final listed in September 2009. Removal activities involve the use of heavy earth-moving equipment and blasting of bed rock. Access to this area of the site is controlled by EPA and their contractors.

Run-off ponds on and around the 20-acre main tailings impoundment have been filled with tailings, covered with 3-12 inches of lime to reduce the pH, capped with 2 feet of clean soil, a thin layer of topsoil and re-vegetated (Appendix A, Figure 14). To stabilize the 20-acre main tailings impoundment dam face, the stream (Ore Knob Branch) that was piped under the impoundment and discharged at the bottom of the face of the dam has been re-routed through a 0.5-mile diversion channel on the east side perimeter of the impoundment (Appendix A, Figures 15 and 16). The sediment pond on the dam (north) end of the main tailings impoundment continues to function as intended. A “shear key” has been constructed at the base of the dam for stabilization. The shear key construction includes 30-by-30 feet of granite, followed laterally by a 30 feet high by 2 feet wide sand and gravel filter, then a second 30-by-30 feet of granite (EPA 2009b). The shear key and dam stabilization activities were completed in August 2010 (*personal communication, T. Byrd, EPA, March 4, 2011*).

The mine site is privately owned, and the owner operates a small sawmill in the 19<sup>th</sup> century operations area. This 19<sup>th</sup> century operations area is enclosed by a 7-foot chain-link fence and a lockable gate.

## DEMOGRAPHICS

Approximately 128 people live within 1-mile of the Ore Knob Mine site. The surrounding area is very rural, largely undeveloped, and sparsely populated. Approximately 1,328 people live within a 4-mile radius (HRS 2009). Further Census 2000 demographics data are provided in Appendix B.

## SITE GEOLOGY AND HYDROGEOLOGY

The Appalachian Mountains belt of the eastern United States and Canada has many deposits of massive sulfide ores that are typically a mixture of pyrite ( $\text{FeS}_2$ ), iron sulfide minerals including ( $\text{Fe}_{1-x}\text{S}$ , with  $x = 0-2$ ), and chalcopyrite ( $\text{CuFeS}_2$ ). These deposits form long, narrow belts that contain scattered bodies of massive iron sulfides. The Ore Knob complex is a group of massive sulfide deposits, with the ore containing 15% sulfur. Discarded tailings contain 12.5% sulfur and 18.7% iron. The ore body ranges in texture from fine grained massive sulfide deposits to coarse grained sulfide scattered in coarse grained silicates. The ore sheet at Ore Knob is at least 4,000 feet long.

Groundwater investigations during the EPA site assessment activities were limited to sampling six residential supply wells located in the area between the 1950s mine and mill area and the 19<sup>th</sup> century operations area. Local residents rely on groundwater for their drinking water supply. No municipal drinking water service is available in this area of the county. The extent to which contaminants in the soil, sediments and surface waters may be migrating to the groundwater is not known. The site lies within fractured bedrock terrain. It is likely that at least some of the abandoned mine shafts and adits contain contaminated water, but it is not known if these contaminated waters are able to migrate into the ground water aquifer (EPA 2008a).

## SITE VISIT

The N.C. DPH Health Assessment, Consultation and Education (HACE) team visited the Ore Knob Mine NPL site on October 23, 2009. HACE toured the site with the EPA site contractor (Environmental Restoration LLC Response Manger) and the US Coast Guard Environmental Strike Team staff. The Strike Team was providing oversight on behalf of the EPA. HACE also met with the N.C. DENR Division of Waste Management (DWM) Project Manager. The visit included walking tours of the main tailings impoundment and dam, the stream diversion channel, and upstream and downstream surface waters. HACE observed site run-off identified as iron-rich bright orange solids discharging from Ore Knob Branch to Little Peak Creek (Appendix A, Figure 17). In the same area, HACE observed floodplain soils carried downstream of the site that were devoid of vegetation (Appendix A, Figure 18). The iron discoloration (orange in color) was visible further downstream of the site, where Little Peak Creek flows into Peak Creek (Appendix A, Figure 19). HACE also walked throughout the 19<sup>th</sup> century operations and current sawmill area (Appendix A, Figures 6 – 8).

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## **DISCUSSION**

### **THE ATSDR HEALTH EFFECTS EVALUATION PROCESS**

This section provides a summary of the ATSDR health effects evaluation process. A more detailed discussion is provided in Appendix C.

The health effects evaluation process consists of two stages. The first stage involves gathering and reviewing available environmental monitoring data and evaluation of how the community may come into contact with the identified substances. The second stage involves a more in-depth evaluation to determine possible public health implications of site-specific exposure conditions.

The first stage involves a “screening analysis” to provide a consistent means to identify site contaminants to be further evaluated for potential negative health effects. The first phase of the screening analysis is the “environmental guideline comparison” which involves comparing site contaminant concentrations to water, soil, air, or food chain “comparison values”. Comparison values (CVs) are developed by ATSDR as chemical concentrations in water, soil, or air. The highest concentration of a chemical found in a particular sample type (water, soil, air) is compared to a chemical’s CV to provide a highly health-protective (“worst-case”) exposure estimate. The average concentration for chemicals found in more than one sample of a particular type may also be compared to CVs to provide an average exposure estimate. ATSDR’s comparison values are set at levels that are highly health protective, well below levels known or anticipated to result in adverse health effects. Contaminant concentrations at or below the CV may reasonably be considered safe and require no additional evaluation. When chemicals are found on a site at concentrations greater than the comparison values it does not mean that adverse health effects would be expected, but it does identify that a more in-depth evaluation is warranted.

The second stage of the process is the “health guideline comparison” and involves looking more closely at site-specific exposure conditions, estimating exposure doses, and comparing the exposure dose estimate to dose-based health-effect comparison values. Contaminants exceeding CVs are selected for a more in-depth site-specific analysis to evaluate the likelihood of possible harmful health effects by comparing an estimated exposure dose against ATSDR health guidelines. An exposure dose is an estimate of the amount of a substance a person may come into contact with in the environment during a specific time period, expressed relative to body weight. Health guideline values represent daily human exposure levels to a substance that is likely to be without appreciable risk of adverse health effects during a specified exposure duration. Important factors in determining exposure dose estimates include the concentration of the chemical, the duration of exposure, the frequency of the exposure, the route of exposure, and the health status of those exposed. To determine exposure dose when site-specific information is not available, DPH uses standard assumptions about typical body weights, ingestion or inhalation rates, and duration of exposure. Highly health protective site-specific dose estimates are

developed for both children and adults. These values are then compared to ATSDR health guideline values.

To determine if adverse (negative) health effects are indicated for the developed site-specific doses for children and adults, these values are compared to data collected in animal and human health effect studies for the chemicals of concern. The health study data is generally taken from ATSDR or EPA references that summarize animal and human studies that have undergone extensive validation review. Comparisons are made on the basis of the exposure route (ingestion/eating, inhalation/breathing, or dermal/skin contact) and the length of the exposure. Preference is given to human study data and chemical doses or concentrations where no adverse health effects were observed. If human data or no-adverse-effect data is not available, animal data or the lowest chemical dose where adverse health effects were observed, may be used.

There are limitations inherent to the public health assessment process. These include the availability of analytical data collected for a site, the type and quantity of health effect information, and the risk estimation process itself. To overcome some of these limitations, highly health protective (i.e., reasonable or anticipated “worst-case”) exposure assumptions are used to evaluate site data and interpret the potential for adverse health effects. ATSDR comparison values (CVs) and other health guideline values incorporate large margins-of-safety to protect groups of the exposed population that may be particularly sensitive, such as children, the elderly, or persons with impaired immune response. Large margins-of-safety are also employed when comparing exposure dose to health effect data. The objective of the assumptions, interpretations and recommendations in this public health assessment is to provide a realistic, reasonable, site-specific, scientifically valid assessment of the potential for adverse health effects to known or suspected populations.

## **REVIEW OF SITE ENVIRONMENTAL DATA**

N.C. DPH reviewed all available analytical data generated by N.C. DENR and EPA. Data sets evaluated for this Public Health Assessment include:

- On-site and off-site surface waters and sediments collected in 1987, 1990, 1991, 1992, 1994, 1996 and 2006 by N.C. DENR
- Ore Knob Branch sediment collected in 1990 by N.C. DENR
- On-site and off-site surface waters, sediments and floodplain soils collected in 2007 and 2008 by EPA
- On-site soils, tailings, slag, ore bin solids, other mine process material and waste rock collected in 2007 by EPA
- Private well waters and residential (lawn) soils collected in 2007 by EPA
- Fish tissue samples collected by N.C. DENR downstream of the site in South Fork New River in 1998, 2005 and 2008, and in the New River in 2008

A table at the end of this section summarizes the sample sets discussed below.

Samples collected and analyzed by EPA and their contractors used EPA-approved protocols (EPA 2008a). No documentation was available regarding the surface water and sediment data

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collected and analyzed by N.C. DENR. Sampling locations were selected by EPA to indicate the highest concentrations of substances, if present, in those areas that would be associated with contamination from the former mining operations.

All samples collected on-site and off-site were analyzed for a variety of metals. Some soils and other solid materials were also analyzed for organic contaminants including PCBs (polychlorinated biphenyls) as Aroclors, SVOCs (semi-volatile organic compounds), VOCs (volatile organic compounds), and PAHs (polynuclear aromatic hydrocarbons). The PCBs, VOCs, SVOCs and PAHs are EPA-standardized analytical methods used to identify and quantify groups of organic compounds commonly seen at hazardous waste sites. Selection of organic contaminant analyses for a particular sample set was based on the known or suspected historical operations that took place in that area. Some samples were also analyzed for additional inorganic compounds including sulfur species and cyanide. The following discussions of analytical data will focus only on substances detected in a particular sample set and those that exceed ATSDR-defined comparison values (CVs). The average chemical concentration was used for samples collected in duplicate. Comparison values were not available for 4 of the metals detected in most of the samples (calcium, magnesium, potassium and sodium). These metals are essential nutrients and are not typically harmful under most environmental exposure scenarios (ATSDR 2005). Detections of these metals are noted in the sample set discussions and the summary tables. ATSDR also does not provide CVs or health guideline comparison values for iron. N.C.DPH used EPA's risk-based Regional Screening Levels (RSLs) to assess the iron environmental and exposure data (EPA RSL).

***Residential Private Drinking Water Wells:*** In July 2007, EPA contractors collected water from 6 private wells located near the Ore Knob Mine site (see Appendix A, Figure 20 for locations). Five of the wells were located between the 19<sup>th</sup> century operations and the former mill site, and one was southeast of the 19<sup>th</sup> century operations area (OK703). One sample was collected in duplicate (OK702). A background well sample was collected approximately 1.5 miles southwest of the site off of NC Highway 88 (OK701). The background well sample provides information on the native groundwater make-up without influences related to historical Ore Knob Mine activities that may have impacted the wells near the site. The private well samples were analyzed for metals, sulfates, VOCs and SVOCs. Seventeen of the 24 metals analyzed were detected in one or more of the 6 private well waters. Sulfates were detected in all 6 samples. No VOCs or SVOCs were detected. The data is summarized in Appendix C, Table 2. Many of the homes in the area around the mine site are seasonal homes and are not occupied year round. Some of these residents were not available to provide access to their private well waters when EPA was in the area collecting private well samples.

***Residential Soils:*** Surface soils (taken from 0 to 6 inches below the surface) were collected by EPA contractors in July 2007 from 3 residential properties near the east and south side of the 1950s mine and mill area (locations OK406, OK407 and OK408, see Appendix A, Figure 5). Samples were collected in areas of the residential properties that would be expected to be the most impacted by contaminants moving down stream from the mine site. Seventeen metals were detected in one or more of the 3 sample locations. A single SVOC compound was detected in sample OK406 (benzaldehyde). No VOCs or PCBs were detected in sample OK408, the only sample analyzed for VOCs or PCBs (EPA 2008a).

***Ore Knob Mine Site Soils:*** Thirteen soils were collected in the 1950s mine and mill area, and 9 were collected in the 19<sup>th</sup> century operations historic smelter area. The depth of the samples ranged from 0 to 4 inches below ground surface (bgs) to 0 to 12 inches bgs. Soils from both areas were analyzed for metals, PCBs and SVOCs. The soils from the 1950s mine and mill area were also analyzed for VOCs. Twenty metals and 13 SVOCs were detected in the soils from each of these 2 areas.

***Waste Rock, Slag, Ore Bin and Processed Materials:*** Thirteen samples of waste rock, slag, ore bin waste and processed materials wastes located throughout the site generated during historical mining and ore recovery operations were sampled by EPA in July 2007. These materials were analyzed for metals, PCBs and SVOCs. Twenty-three metals and 11 SVOCs (all PAHs) were detected in the waste material samples.

***Tailings Piles:*** Nine total samples were collected from 0 to 18 inches below ground surface (bgs) from tailings piles located in 2 areas of the site. Seven were from the main 20-acre tailings pile and the remaining 2 were from material eroded from the 1950s mine and mill site tailings pile. All the samples were analyzed for metals. One sample from the 1950s mine and mill area was analyzed for PCBs, and both samples collected from this area were analyzed for SVOCs. There were no PCBs or SVOCs detected. Twenty metals were detected in the 9 samples.

***Ponded Waters and Seeps Associated with the Main Tailings Impoundment:*** Twenty two samples were collected by EPA and DENR between 1990 and 2008 to characterize the water collecting on and around the 20-acre main tailings impoundment and water seeping from the dam face. The samples were analyzed for metals, with 23 different metals detected.

***On-site and Downstream Surface Waters, Sediments and Floodplain Soils:*** The four surface water bodies impacted by the site were evaluated separately. From 1987 through 2008, surface water samples were collected 9 different times from Ore Knob Branch and its on-site tributaries downstream of the main tailings impoundment. The metals analyzed varied with the sampling events. Seventeen different metals were detected in the Ore Knob Branch waters.

A total of 9 sediment and floodplain soil samples were collected from Ore Knob Branch in 1990 and 2007. All 9 samples were analyzed for metals. The 8 samples collected in 2007 were also analyzed for PCBs and SVOCs. Twenty-two different metals and 4 organic compounds were detected.

A total of 10 surface water samples were collected from Little Peak Creek and its tributaries during 7 sampling events between 1990 and 2007. All samples were analyzed for metals and the 2007 samples were also analyzed for PCBs, VOCs, and SVOCs. Sixteen metals were detected over that period. No organic compounds were detected.

Eight sediment and floodplain soils were collected from Little Peak Creek and its tributaries in 2007. Eighteen metals and 2 SVOCs (*o*-cresol and benzaldehyde) were detected.

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Forty-six water samples were collected from Peak Creek in 10 sampling events between 1987 and 2008, with fourteen different metals were detected. All samples were analyzed for metals, with the suite of metals analyzed varying with the sampling event. Fourteen metals were detected.

Nine Peak Creek sediments and floodplain soil samples were collected in 2007 and analyzed for metals, PCBs and SVOCs. Twenty-one metals and 3 SVOCs were detected in the sediments and soils.

Five surface water samples were collected in the South Fork New River in 2007, 630 feet downstream of the confluence with Peak Creek. The 5 water samples were collected in a transect across the channel. The water samples were analyzed for metals and SVOCs. Fourteen different metals were detected. No SVOCs were detected in the water samples.

Six sediment samples were collected in 2007 in the South Fork New River and analyzed for metals, PCBs and SVOCs. A 3 sample transect across the channel was collected 630 feet downstream of the confluence with Peak Creek, 2 samples were collected at 1,550 feet downstream of Peak Creek, and single sample was collected at 1,930 feet downstream of Peak Creek. Twenty different metals were detected in the 6 samples. No PCBs or SVOCs were detected in any of the South Fork New River sediments.

***Fish Tissue Samples:*** N.C. DENR collected fish on the South Fork New River less than 1.5 miles downstream of its confluence with Peak Creek in 1998, 2005 and 2008, collecting a total of 25 fish during the 3 sampling events. An additional 18 fish were collected in the New River near Sparta NC, 32 miles downstream of Peak Creek in 2008. Fish collected were those the N.C. Wildlife Resources Commission (WRC) identified as commonly consumed by recreational anglers in the area and were not species being stocked in the area. Fish species sampled included: rock bass, smallmouth bass, white sucker, rainbow trout, brown trout, redbreast sunfish, northern hog sucker and brown trout. The fish tissue samples were analyzed for the metals mercury, arsenic, cadmium, total chromium, copper, nickel, lead and zinc. Mercury, copper and zinc were detected in all fish. Selenium was also analyzed and detected in all fish collected in 2008.

***Other Biota:*** No data is available for other biota (plants and animals) that live on or near the site. It is not known if they may accumulate the metals identified as elevated in the site surface waters, sediments and soils and ultimately serve as a source of exposure to persons that consume them.

**Summary of Environmental Samples Collected for the Ore Knob Mine NPL Site**

Sample Type	Year Collected	Number Samples	Analyses	Appendix C Tables <sup>1</sup>
Residential private drinking water well samples near the site	2007	6	Metals, sulfates, VOCs, SVOCs	2 – 4
Residential soil samples near the site	2007	3	Metals, VOCs, SVOCs, PCBs	5, 6, 11, 12
Ore Knob Mine site: 1950s mine & mill area soils 19 <sup>th</sup> century operations soils Waste rock, slag, ore bin materials	2007	13	Metals, SVOCs, PCBs for all, plus VOCs in 1950s mine & mill area	7 - 12 10 - 12 13 – 16
Ore Knob Mine site: Tailings piles	2007	9	Metals, SVOCs, PCBs	17, 18
Ore Knob Mine site ponded waters & seeps around main tailings pile	1990 - 2008	22	Metals	19, 20
Ore Knob Branch surface water	1987 – 2008	9	Metals	21, 22
Ore Knob Branch sediments	1990, 2007	9	Metals, PCBs, SVOCs	23 – 26
Little Peak Creek surface water	1990 – 2007	10	Metals, 2007: Metals, SVOCs, VOCs & PCBs	27, 28
Little Peak Creek sediments	2007	8	Metals, SVOCs	29 – 31
Peak Creek surface water	1987 – 2007	46	Metals	32, 33
Peak Creek sediments	2007	9	Metals, SVOCs, PCBs	34 – 37
South Fork New River surface water	2007	5	Metals, SVOCs	38
South Fork New River sediments		6	Metals, SVOCs, PCBs	39, 40
Fish tissue from South Fork New River	1998, 2005, 2008	25	Metals	
Fish tissue from New River	2008	18	Metals	

<sup>1</sup> Tables summarize sample analyte detections and site-specific estimated exposure doses.

**EXPOSURE PATHWAY ANALYSIS**

An exposure to a chemical and the possibility of adverse health effects requires persons come into contact with the chemical through:

- ingestion (eating the chemical),
- inhalation (breathing the chemical), or
- absorbing the chemical through the skin (dermal absorption)

Having contact with a chemical does not necessarily result in adverse (harmful) health effects. A chemical’s ability to result in adverse health effects is influenced by a number of factors in the exposure situation, including:

- how much of the chemical a person is exposed to (the dose)
- how long a time period a person is exposed to the chemical (the duration)
- how often the person is exposed (the frequency)
- the amount and type of damage the chemical can cause in the body (the toxicity of the chemical)

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To result in adverse health effects, the chemical must be present at concentrations high enough and for long enough to cause harm. Exposures at concentrations or time periods less than these levels do not cause adverse health effects. Knowing or estimating the frequency with which people have contact with hazardous substances is essential to assessing the public health importance of these contaminants.

Responses of persons to potentially harmful substances may vary with the individual or particular groups of individuals, such as children, the elderly, or persons with weakened immune responses, or other chronic health issues. These susceptible populations may have different or enhanced responses as compared to most persons exposed at the same concentration to a particular chemical in the environment. Reasons for these differences may include:

- genetic makeup
- age
- health status
- nutritional status
- exposure to other toxic substances (like cigarette smoke or alcohol).

These factors may limit that persons' ability to detoxify or eliminate the harmful chemicals from their body, or may increase the effects of damage to their organs or physiological systems. Child-specific exposure situations and susceptibilities are also considered in DPH health evaluations.

The exposure pathway (how people may come into contact with substances contaminating their environment) is evaluated to determine if people have come into contact with site contaminants, or if they may in the future. A completed exposure pathway is one that contains the following elements:

- a **source** of chemical of concern (contamination), such as a hazardous waste site or contaminated industrial site,
- movement (**transport**) of the contaminant through **environmental media** such as air, water, or soil,
- a **point of exposure** where people come in contact with a contaminated medium, such as drinking water, soil in a garden, or in the air,
- a **route of exposure**, or how people come into contact with the chemical, such as drinking contaminated well water, eating contaminated soil on homegrown vegetables, or inhaling contaminated air, and
- a receptor **population** of persons that can come into contact with the contaminants

The elements of an exposure pathway may change over time, so the time frame of potential exposure (contact) is also considered. Exposures may have happened in the past, may be taking place at the present time, or may occur in the future. A **completed pathway** is one in which all five pathway components exist in the selected time frame (the past, present, or future). If one of the five elements is not present, but could be at some point, the exposure is considered a **potential exposure pathway**. The length of the exposure period, the concentration of the

contaminants at the time of exposure, and the route of exposure (skin contact, ingestion, and inhalation), are all critical elements considered in defining a particular exposure event. If one of the five elements is not present and will not occur in the future it is considered an **eliminated exposure pathway**.

### SUMMARY OF ENVIRONMENTAL EXPOSURE POTENTIAL AT THE SITE

The population of concern for the Ore Knob Mine site is those persons living in the immediate vicinity of the site that may be impacted by mining waste or impacted soil, surface water, sediment, or groundwater moving off the site. Persons that may visit the site with or without permission (“trespassers”) are also of concern. These would be persons using the site for recreational purposes, such as the hunting club members that have been given permission to use the area for hunting, and persons hiking, camping, or riding recreational vehicles. Exposure pathways identified for the Ore Knob Mine NPL site and the status of those pathways are summarized below.

#### Summary of Ore Knob Mine NPL site exposure pathways and pathway status.

Source	Environmental Transport and media	Exposure point	Exposure Route	Exposed population	Time Frame	Pathway status
Surface soil	Contaminated surface soil	Soil	Eating, Breathing	People living near or visiting the site	Past Current Future	Complete for on-site, Potential for some off-site residences
Ground-water	Contaminated groundwater	Private wells	Drinking	People living near the site on private wells	Past Current Future	Complete for residential exposures
Surface water and Sediment	Contaminated surface water and sediment	Ponded waters on-site and local streams	Drinking	Local residents and recreational users on and off-site	Past Current Future	Complete for recreational users
Mine Waste Materials	Contaminated water, soil and air	Waste soils, rocks	Eating, Breathing	People living near or visiting the site	Past Current Future	Complete for recreational users
Fish	Contaminated surface water and sediment	Fish	Eating	Persons fishing downstream of site	Past Current Future	Complete for recreational anglers

### SITE-SPECIFIC EXPOSURE CONDITIONS USED FOR THE HEALTH EVALUATIONS

Long-term daily exposures were considered for children and adults living on or near the Ore Knob Mine property (residential private wells and soils). Thirty-year exposure periods were used to estimate the maximum length of residence at one location for drinking water and soil exposures.

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Recreational exposure scenarios were developed to estimate how persons that may hunt, hike, camp or use recreational vehicles on the site may be exposed. An additional set of exposure parameters were used to estimate the accidental drinking of water (“incidental ingestion”) by children during swimming or wading in the surface waters on and around the site. Tables 42 and 43 (Appendix C) list the exposure calculation parameters that were used to estimate child and adult recreational exposures. The parameters selected for these exposure estimates (amount consumed, frequency of exposure, years or exposure) were all selected to be health protective by maximizing the selected values to represent the potential for persons to be in contact with the environmental contamination that may exist on the site. The soil ingestion rates used reflect values twice the typical rates used for incidental ingestion of soil. These values were selected to provide a health protective estimate of additional exposure that may be incurred by occasional recreational site visitors, including those accessing the site in recreational vehicles, and during camping, hiking or hunting activities. The 400 mg/day ingestion rate used for child recreational exposure estimates also represents the upper percentile values determined by EPA; the 200 mg/day adult value is 4 times the mean rate (EPA 1997).

Acute exposures of young children based on pica behavior were also evaluated for those substances detected on residential properties for which ATSDR has developed pica exposure comparison values. Pica is an eating disorder associated with consumption of large amounts of non-nutritive substances such as soil. ATSDR recommends evaluating acute exposures for pica-behavior based on the consumption of large amounts of soil (5000 mg per day) (ATSDR 2005). This very high rate of pica soil intake is generally observed in young children (2-3 years of age). Children this age would not be expected to visit the site frequently, thus pica behavior is not likely occurring frequently under most circumstances. EPA does not consider child pica-type exposure situations when performing their evaluation of a site. DPH used 5000 mg ingestion of soil to evaluate a one-day child pica exposure, in addition to the 400 mg daily incidental ingestion indicated above for recreational exposures.

PAH compounds detected in site samples were evaluated for cancer effects by adjusting the concentrations of the individual PAH compounds to the benzo(a)pyrene-equivalent concentration using toxicity equivalency factors (TEFs) developed by EPA or Nisbet and LaGoy (TEF 2002). A theoretical additional cancer risk was calculated for the sum of the TEF-adjusted concentrations. The evaluation of PAH compound data is discussed in more detail in Appendix D.

## **EVALUATION OF POTENTIAL PUBLIC HEALTH ISSUES**

The substances detected in environmental samples collected at the site at concentrations greater than comparison values are discussed below. The tables in Appendix C summarize the data for the detected substances, lists comparison values used for data screening, and identify site-specific exposure estimates. Table 44 in Appendix C summarizes the health study effect levels used for final evaluation of the potential for site contaminants to cause adverse health effects. All available site data generated from 1987 through 2008 were considered as a single data set since site conditions have not changed to any extent between the time mining activities ended and the EPA began remediation and stabilization activities.

**Residential Private Drinking Water Wells:** Four metals (cadmium, cobalt, manganese and nickel) detected in the July 2007 residential private drinking water well samples were present at concentrations greater than ATSDR comparison values (CVs). Appendix C, Table 2 summarizes the substances detected and lists comparison values used for ingestion exposures. Table 3 lists well water exposure dose estimates and health guideline values. Cadmium, cobalt and nickel were not detected in the background well water sample (at reporting limits of 0.1, 0.1 and 0.5 micrograms per liter,  $\mu\text{g/L}$ , respectively). All 4 metals, including the highest concentration of manganese (17,800  $\mu\text{g/L}$ ), were detected in well OK702. Manganese was the only metal detected at a concentration greater than the CV in more than one location (also detected at OK706 and OK707). All manganese detections were more than twice the background well sample concentration (92.5 J  $\mu\text{g/L}$ ). (A “J” notation indicates that the reported analytical concentration is an “estimated” value.) Both child and adult exposure dose estimates for manganese at all 3 locations were greater than the health guideline comparison value (MRL) and the lowest dose at which adverse health effects were observed (LOAEL) in health effect studies, indicating the potential for adverse health effects with long-term ingestion of these well waters. EPA lists 50  $\mu\text{g/L}$  as the secondary drinking water guideline for manganese. EPA’s secondary drinking water guidelines are non-regulatory guidelines for substances in public water systems that may cause negative odor or taste effects, or discoloration of the skin or teeth. The drinking waters from well locations OK702, OK703, OK706 and OK707 were all greater than the EPA secondary drinking water value. Sulfate was detected in all 6 private well samples. ATSDR does not provide CVs for sulfate. EPA provides a secondary drinking water guideline of 250,000  $\mu\text{g/L}$  for sulfates. The samples collected from OK702 and OK706 wells exceed EPA’s guideline value. Sample collection locations are identified in Appendix A, Figure 20.

Exposure dose estimates for drinking (ingesting) well water containing cobalt and nickel at the concentrations observed in the 2007 private well samples were less than ATSDR health guideline (“HG”) values and thus do not indicate the potential for adverse health effects.

The cadmium concentration in well OK702 was greater than the ATSDR chronic CV for children (1  $\mu\text{g/L}$  chronic EMEG), but less than the EPA “maximum contaminant level” (MCL) value. EPA’s MCL values are regulatory limits set for public water systems as a maximum permissible concentration of a contaminant in drinking water. MCLs are based on health data, but also consider the economic and technical feasibility of achieving a desired treatment level. ATSDR considers only health issues when deriving their comparison values, thus ATSDR CVs may be lower than the MCL values. The cadmium exposure dose estimated for children was greater than the ATSDR health guideline. In addition, cadmium is identified as a “probable” (by EPA) or “known” (by IARC) human carcinogen by the inhalation route, although there is conflicting information on whether it can cause cancer in humans by oral (ingestion) exposure (ATSDR 2008 FAQ Cd). Exposure dose estimates and health guideline values used for the health effect evaluations for the well waters are listed in Appendix C, Table 3.

Arsenic was not detected in the private well samples, but the reporting limit (1.5  $\mu\text{g/L}$ ) was greater than the cancer-effect health guideline screening value (CREG). Therefore, arsenic was evaluated for cancer effects at the minimum reporting limit which exceeds the ATSDR cancer comparison value (0.02  $\mu\text{g/L}$  CREG value). The minimum reporting limit is less than the MCL (10  $\mu\text{g/L}$ ). Estimates of the number of increased cancers at the reporting limit indicate a “low”

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level of additional cancers (less than 1 additional cancer per 10,000 persons exposed) would be anticipated. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that would be expected to occur in the exposed population, but gives a theoretical excess cancer risk expressed as the proportion of a population that may be affected by a carcinogen during the predicted period of exposure. In this instance, the number of predicted cancers would be less, because the reporting limit represents a concentration greater than the maximum concentration in the well water. Exposure dose and increased cancer risk estimates for arsenic are listed in Appendix C, Table 4.

**Residential Soil Samples:** The metals aluminum, copper, and iron were the only detected compounds exceeding ATSDR comparison values. Aluminum exceeded comparison values in all 3 residential soils (locations OK406, OK407 and OK408), copper in two locations (OK406 and OK407), and iron at one location (OK406). The detected metals data is summarized in Appendix C, Table 5. The locations of the residential soil samples collections are noted in Appendix A, Figure 5.

The exposure dose estimate for children using a residential exposure scenario for the highest iron concentration (60,000 J mg/kg) exceeds the screening value (the EPA reference dose or RfD). Residential exposure dose estimates calculated from site soil concentrations were compared to EPA's oral reference dose (0.70 mg/kg-d RfD<sub>oral</sub>). The exposure dose estimates for children exposed at the concentration of copper and iron observed at the OK406 location (1800 and 60,000 mg/kg, respectively) also indicate the potential for adverse health effects for long term exposures to children. Adverse health effects are also indicated for children for pica ingestion rates for the aluminum concentrations observed at OK408, both at the maximum and the average concentration. Because the RfD represents a daily dose considered safe for a lifetime of exposure this conclusion is very health-protective. The residential soil samples were collected in areas of each property that would potentially be most influenced by contaminant moving down stream from the mine and represents the point of highest anticipated exposure, such as along a stream bank. The detected metal concentrations may or may not represent an average concentration throughout the property, or the areas where children may be most likely playing.

EPA collected 6 background soils samples on the site in 2007, 3 each in the 1950s mine and mill and the 19<sup>th</sup> century operations areas. The samples were collected in areas that appeared to not have been impacted by mining operations. DPH considers concentrations less than twice the average background concentration of a substance to be indicative of "native" concentrations, or within the concentration range that would be anticipated for soils in the Ore Knob Mine area without influence of mining operations. All 3 residential soil aluminum concentrations were within the range expected for the area background. This would indicate that the potential health hazard that may be associated with pica ingestion of aluminum in the soils is the same for the native background soils in the area. Background soil concentrations for select substances analyzed on the site are listed in Appendix C, Table 41. Exposure dose estimates and health guideline values are listed in Appendix C, Table 6.

**Ore Knob Mine Site Soils:** Four metals detected in the 1950s mine and mill area soils were at concentrations greater than comparison values (aluminum, arsenic, cobalt and copper). Only copper at a single location in the 19<sup>th</sup> century operations area exceeded comparison value. One

SVOC (benzo(a)pyrene, a PAH) exceeded comparison values in each area. The detected substances in both areas and comparison values are summarized in Appendix C, Tables 7 through 10.

Estimates of the recreational exposure dose for persons in contact with soils in these areas indicates the potential for adverse health effects only to children associated with copper ingestion in the 1950s mine and mill area. Adverse health effects are indicated for children exposed at the highest soil copper concentrations (9,600 mg/kg), using the health protective recreational exposure scenario parameters (36 days per year for 6 years). Adverse health effects are not indicated for children exposed at less than 15 days per year. Exposure dose estimates and health guidelines values for metals are listed in Appendix C, Table 11.

The additional cancer risk associated with recreational exposure to PAHs in soils in the 1950s mine and mill and 19<sup>th</sup> century operations areas both indicate “no increased” risk (or, less than 1 additional cancer for every 1 million persons exposed). No adverse health effects are indicated for recreational exposures to the PAH compounds in the site soils. Cancer risk estimates for PAHs in soils are listed in Appendix C, Table 12. Pica exposure scenarios for children were considered unlikely for site soils and were not included in the evaluation.

**Waste Rock, Slag, Ore Bin and Processed Materials:** Four metals (aluminum, cadmium, copper and manganese) were detected in the waste materials at concentrations greater than comparison values (Appendix C, Table 13). Copper exceeded the comparison value in 9 of 13 waste samples, not unexpected for a former copper mine. The other metals exceeded comparison values in a single sample. Benzo(a)pyrene was the only PAH compound that exceeded a comparison value (Appendix C, Table 14). The exposures estimates for these materials were based on the recreational exposure parameters developed for this site (Appendix C, Table 42).

The exposure dose estimates for children were greater than health guideline comparison values (MRLs) for the maximum and average copper concentrations. The estimated maximum copper dose for children (0.049 mg/kg-d) is slightly above the “no observed adverse effect level” (NOAEL) for a daily exposure over a 2 month period (0.042 mg/kg-d). The “lowest observed adverse effect level” (LOAEL) from the same study is (0.091 mg/kg-d). The potential for adverse health effects to children are indicated for the recreational exposure scenario (36 days per year on the site, for 6 years). Decreases in the frequency of visits to the site, or the amount of waste material (accidentally) ingested by children while on the site would reduce their exposure and the likelihood of adverse health effects for copper. Further exposure reductions would be expected by the likely limited ability to absorb the copper from the waste materials when ingested. ATSDR states in their *Toxicological Profile for Copper* (ATSDR 2004 Cu) that in studies, healthy humans absorb 24% to 60% of ingested copper (presumably from food or water). Copper binds tightly to soils. Copper associated with the waste slag and ore is likely tightly bound to the solid substrate and not appreciably available for absorption in the gastrointestinal tract. It is likely that absorption from ingested mine waste materials, such as ore, slag or rock, would be much less. The decreased ability to absorb the copper from any accidentally ingested mine waste materials would reduce the ultimate exposure and the likelihood of adverse health effects. Recreational exposure dose estimates for the other 3 metals were less than health

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guideline comparison values. Exposure dose estimates and health guideline comparison values for the metals are listed in Appendix C, Table 15.

The theoretical additional cancer risk for recreational exposures to the PAHs detected in the waste materials indicated no increased cancer risk (less than 1 additional cancer in 1 million persons). Exposure doses and increased cancer risk estimates for the combined PAHs are in Appendix C, Table 16.

**Tailings Piles:** Copper was detected at concentrations greater than the soil ingestion comparison value in 6 tailings samples. Recreational exposure dose estimates were calculated with the highest and average copper concentration observed in the samples (6,000 J and 1,800 mg/kg). The dose estimate for children (0.015 mg/kg-d, Appendix C, Table 18) using the highest copper concentration was greater than the health guideline value (MRL). While the estimated children's maximum dose (0.015 mg/kg-d) is less than the 0.042 mg/kg-d NOAEL (the highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals), the potential for adverse health effects to sensitive individuals for the recreational exposure scenario can not be ruled out. The recreational exposure estimates for children are based on contact with the tailings for 36 days per year for 6 years. If the exposures are reduced to 24 days per year for children, the exposure dose is reduced to less than the health guideline comparison value, indicating that adverse health effects would not be expected. In addition, in the past there was limited ability to come into direct contact with the tailings. Currently, site remediation and stabilization activities include burying and capping the tailings, pH stabilization and re-vegetation. This activity will eliminate the potential for future direct contact with the tailings.

**Ponded Waters and Seeps Associated with the Main Tailings Impoundment:** Ten metals were detected at concentrations greater than comparison values (Appendix C, Table 19). None of the recreational exposure dose estimates for children accidentally consuming these waters exceeded health guideline values, indicating that adverse health effects are not predicted for incidental ingestion. The exposure dose estimates and health guideline values used for the metals evaluation are listed in Appendix C, Table 20.

***On-site and Downstream Surface Waters, Sediments and Floodplain Soils:***

***Ore Knob Branch*** - Concentrations of 8 metals (aluminum, cadmium, chromium, cobalt, copper, iron, manganese, and zinc) detected in surface waters of Ore Knob Branch and its tributaries from 1987 through 2008 were greater than comparison values and were evaluated for incidental ingestion by children (Appendix C, Table 21). Exposure dose estimates for all 8 metals were less than health guideline comparison values and indicate that adverse health effects would not be expected for children playing in Ore Knob Branch and its tributaries (Appendix C, Table 22).

Copper was the only metal detected in the Ore Knob Branch sediments or floodplain soils at a concentration greater than the comparison value (Appendix C, Table 23). Copper exceeded comparison values in 6 of 9 samples (average concentration = 980 mg/kg). The exposure dose estimate for children participating in recreational activities using the highest detected copper concentration (4,200 J mg/kg) was equal to the health guideline value (MRL) (Appendix C, Table 24). Although the exposure dose estimate for children was less than the 0.042 mg/kg-d

NOAEL, negative health impacts may be indicated for sensitive individuals coming into contact with the sediments at the frequency used for the recreational exposure estimates. If the frequency of contact is reduced to 32 days or less per year, then negative health impacts are not indicated. The high copper concentration was observed in the sample collected from Ore Knob Branch just before it flows into the north end of the main tailings impoundment, a location where children are not expected to visit. All other copper concentrations for the sediments and floodplain soils were much less than the high concentration and negative health impacts associated with recreational exposures are not expected.

Four PAH compounds were detected in a single Ore Knob Branch sediment sample collected above the main tailings impoundment (Appendix C, Table 25). Cancer risk estimates for the concentration of the combined PAH compounds indicated no increased cancer risk for recreational exposures (less than 1 additional cancer per 1 million exposed persons) (Appendix C, Table 26).

*Little Peak Creek* – Manganese was detected in 2 samples of Little Peak Creek water at concentrations greater than comparison values. All other metals were at concentrations less than comparison values (Appendix C, Table 27). Dose estimates for manganese incidental ingestion exposures for children were less than health guideline values, indicating that negative health effects to children associated with recreational contact would not be expected (Appendix C, Table 28).

Copper was detected at concentrations greater than comparison values in 2 Little Peak Creek sediment and floodplain soil samples (Appendix C, Table 29), at locations above and just below the former freshwater pond (locations OK025 and OK426, Appendix A, Figure 5). All other detected metal concentrations were less than comparison values. Dose estimates for recreational exposures to the soils did not indicate the potential for negative health impacts associated with copper in the Little Peak Creek soils (Appendix C, Table 30). Neither of the detected SVOCs (*o*-cresol and benzaldehyde) was at concentrations greater than the comparison values.

*Peak Creek* - Copper was detected (330 µg/L) at a concentration greater than the comparison value in a single sample of Peak Creek surface water collected in 1987 just below the confluence with Ore Knob Branch (Appendix C, Table 32). The copper dose estimate for recreational exposures to children at this concentration did not indicate the potential for adverse health effects (Appendix C, Table 33).

Four metals (arsenic, cobalt, copper and iron) were detected at concentrations greater than the comparison values in Peak Creek sediments and floodplain soils (Appendix C, Table 34). Copper was the only metal to exceed the comparison value in more than 1 location, at 3 locations collected in a transverse across the channel, 60 feet below the confluence with Ore Knob Branch. The dose estimates for arsenic and cobalt for recreational exposures did not indicate the potential for adverse health effects. The iron recreational exposure dose estimate for children at the highest detected sediment and soil concentration (940,000 J mg/kg) was greater than the EPA reference dose (RfD). (ATSDR does not provide comparison values for iron.) This iron detection was from the same location as the elevated copper detections, just below the confluence with Ore Knob Branch. Although the dose estimate indicates the potential for

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negative health effects to children associated with long-term ingestion of the Peak Creek sediment with the highest iron concentration, the sample is from a location that would be of limited access due to the size of the creek at this location. The recreational exposure dose estimates for the maximum and average copper detections in the Peak Creek sediments indicate the potential adverse health effects to both children and adults with long-term exposures, but the reference dose used for comparison assumes daily exposure over a life time, an exposure scenario not likely for the sediments. The dose estimates for children are also greater than the NOAEL (the highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals). Again, as with the sediment iron, the elevated copper sediment detections are from an area where there is limited potential to come into contact with the sediment. Negative health impacts associated with long-term recreational exposures to metals observed in Peak Creek sediments and floodplain soils would not be anticipated because of the limited exposure possibilities. The recreational exposure estimates and health guideline screening values are provided in Appendix C, Table 35.

The 3 SVOCs were detected in a single sample of the Peak Creek floodplain soil at the confluence with the South Fork New River. None were detected at concentrations greater than the selected comparison values (Appendix C, Table 36). Two of the 3 detected SVOCs were PAHs. No increased cancer risk was indicated for their benzo(a)pyrene adjusted concentrations (less than 1 additional cancer in 1 million persons exposed) (Appendix C, Table 37). No negative health effects are expected for recreational exposures to the SVOCs in the floodplain soil.

*South Fork New River* - None of the metals detected in South Fork New River surface water samples were detected at concentrations exceeding comparison values (Appendix C, Table 38). Copper was the only metal detected in the sediments or floodplain soils at a concentration greater than the comparison value. The copper detection (570 mg/kg) was from the sediment sample collected the furthest downstream (1,930 ft below the confluence with Peak Creek) (Appendix C, Table 39). Recreational exposure dose estimates for the copper detection were less than health guideline comparison values (Appendix C, Table 40), indicating that negative health effects are not anticipated for long-term recreational exposures.

***Fish Tissue:*** Metals data for fish tissue samples collected in 1998, 2005 and 2008 in South Fork New River less than 1.5 miles downstream of its confluence with Peak Creek and the New River 32 miles downstream of Peak Creek were unremarkable, although data review was limited by the unavailability of upstream data for comparison (personal communication with NCDENR DWQ, Dec. 18, 2009). One of 2 rock bass (0.49 mg/kg mercury) samples collected in 1998 (average rock bass concentration = 0.36 mg/kg mercury) in the South Fork New River exceeded the N.C. DPH action level for mercury (0.4 mg/kg). The mercury concentration for all other samples was less than the action level. All selenium concentrations were less than the DPH action level of 10 mg/kg. The fish tissue data indicates the fish are not taking up elevated concentrations of these metals from the environment as compared to fish collected from other nearby areas. The fish tissue data does not indicate a potential for adverse health effects associated with eating fish caught at these locations. The fish sample collection locations are noted on Appendix A, Figure 21.

## HEALTH EFFECTS OF SELECTED SUBSTANCES

**Aluminum** - Animal studies show that the nervous system is a sensitive target of aluminum toxicity. Obvious signs of damage were not seen in animals after high oral doses of aluminum. However, the animals did not perform as well in tests that measured the strength of their grip or how much they moved around. Persons that store large amounts of aluminum in their bodies (as may occur with kidney disease) sometimes develop bone or brain diseases. It is not certain this is caused by the aluminum storage. Some studies show that people exposed to high levels of aluminum may develop Alzheimer's disease, but other studies have not found this to be true. It is not known for certain whether aluminum causes Alzheimer's disease. It is not known if aluminum will affect reproduction in people. Aluminum does not appear to affect fertility in animals. Children with kidney problems who were given aluminum in their medical treatments developed bone diseases. It does not appear that children are more sensitive to aluminum than adults. Birth defects have not been seen in animals exposed to high amounts of aluminum. It is not known if aluminum will cause birth defects in people. Aluminum in large amounts has been shown to be harmful to unborn and developing animals by delaying skeletal and neurological development. Aluminum is found in breast milk, but only a small amount enters the infant's body through breastfeeding. The carcinogenicity of aluminum to humans has not been classified, but it has not been shown to cause cancer in animals (ATSDR 2008 FAQ Al). Aluminum is poorly absorbed in humans following oral (<1%) exposure. Aluminum does not bioaccumulate in plants (TOX 2008).

**Cadmium** - Long-term exposure to lower levels of cadmium in air, food, or water leads to a buildup of cadmium in the kidneys and possible kidney disease. Fragile bones may result from long-term exposures. Eating food or drinking water with very high levels severely irritates the stomach, leading to vomiting and diarrhea. The health effects in children are expected to be similar to the effects seen in adults (kidney, lung, and bone damage depending on the route of exposure). A few studies in animals indicate that younger animals absorb more cadmium than adults. Animal studies indicate that the young are more susceptible than adults to a loss of bone and decreased bone strength from exposure to cadmium. It is not known if cadmium causes birth defects in people. The babies of animals exposed to high levels of cadmium during pregnancy had changes in behavior and learning ability. There is also some information from animal studies that high enough exposures to cadmium before birth can reduce body weights and affect the skeleton in the developing young. Cadmium is a known human carcinogen (ATSDR 2008 FAQ Cd). Reports of the ability of cadmium to cause cancer in animals following oral exposure are conflicting; with a negative cancer response reported in multiple studies in rats and mice (IRIS 2009), while a positive cancer response has been reported for animals in other references (TOX 2008). EPA states there are no positive studies of cadmium causing cancer after oral exposure (IRIS 2009). Humans absorb 5 to 10% of ingested cadmium. Animals accumulate cadmium in the liver and kidney. Plants readily accumulate cadmium from the soil (TOX 2008). Neither EPA nor ATSDR provide values to estimate cancer risk for oral exposures.

**Copper** - Copper is an essential nutrient. People need small amounts of copper in their diets to maintain their health, but high levels can harm health. Ingesting high levels of copper can cause nausea, vomiting, and diarrhea. Very high doses of copper can cause damage to the liver and

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kidneys, and can even cause death. Children exposed to high levels of copper experience the same types of effects as adults. It is not known if children are more sensitive to the adverse effects of copper at lower doses. Although not confirmed in human studies, animal studies suggest that young children may have more severe effects than adults to copper. There are a very small percentage of infants and children who are unusually sensitive to copper. It is not known if copper causes birth defects or other developmental effects in humans at high levels. Studies in animals suggest that high levels of copper may cause a decrease in fetal growth. It is not known if exposure to copper causes cancer in humans and the carcinogenicity of copper to humans has not been classified (ATSDR 2004 FAQ Cu). Humans absorb 55 to 75% of ingested copper (TOX 2008).

***Manganese*** - Manganese is an essential nutrient required for many metabolic and cellular functions (TOX 2008). Eating a small amount of it each day is important to stay healthy. The most common health problems in workers who inhaled high levels of manganese involve the nervous system. These health effects include behavioral changes and other nervous system effects, which include movements that may become slow and clumsy. This combination of symptoms when sufficiently severe is referred to as “manganism”. Other less severe nervous system effects such as slowed hand movements have been observed in some workers exposed to lower concentrations in the work place. Nervous system and reproductive effects have been observed in animals after high oral doses of manganese (ATSDR 2008 FAQ Mn). Nervous system damage has been reported following ingestion of water contaminated with manganese between 1,800 to 14,000 µg/L (TOX 2008). Studies in children have suggested that extremely high levels of manganese exposure may produce undesirable effects on brain development, including changes in behavior and decreases in the ability to learn and remember. It is not known if these changes were due to manganese alone, or if they were temporary or permanent. It is not known if children are more sensitive than adults to the effects of high levels of manganese. Studies of manganese workers have not found increases in birth defects or low birth weight in their offspring. No birth defects were observed in animals exposed to manganese. It is not known if exposure to manganese causes cancer in humans and the carcinogenicity of manganese to humans has not been classified (ATSDR 2008 FAQ Mn). Humans absorb 1 to 5% of ingested manganese (TOX 2008).

***Zinc*** - Zinc is an essential element in our diet required for many metabolic processes. Too little zinc can cause health problems, but too much zinc is also harmful. Harmful effects generally begin at levels 10-15 times higher than the amount needed for good health. Large doses taken by mouth even for a short time can cause stomach cramps, nausea, and vomiting. Taken longer, it can cause anemia and decrease the levels of good cholesterol. It is not known if high levels of zinc affect reproduction in humans. Rats that were fed large amounts of zinc became infertile. It is not known if exposure to zinc causes cancer in humans and the carcinogenicity of zinc to humans has not been classified (ATSDR 2005 FAQ Zn). There are indications that ingesting too little zinc may be associated with an increased risk of developing some types of cancer in humans (TOX 2008). Twenty to 30% of ingested zinc is absorbed (TOX 2008).

***Iron*** - Iron is an essential nutrient. Our bodies need some iron for proper bodily functions and to maintain our health. But taking in too much iron, either through eating, drinking or breathing the dust or fumes can cause harm. Eating large amounts of iron in a short period, or lower amounts

over long periods, may result in gastrointestinal symptoms including abdominal pain, diarrhea and vomiting and ultimately damage to the heart, pancreas, liver and kidneys. The immune system may also be damaged with long-term eating of a large excess of iron, reducing the body's ability to fight off infections. The build-up of excess iron in the body may lead to atherosclerosis, although this association is still being studied. Some studies also suggest the brain may be affected by too much iron, resulting in neurodegenerative disorders. Individuals with the liver disease hemochromatosis, which is characterized by excessive retention of iron in the liver, are at risk from iron ingestion (TOX 2008, Hayes 2008).

## **HEALTH OUTCOME DATA**

In addition to studying exposure and chemical-specific toxicity data as part of the public health assessment process, N.C. DPH also considers health outcome data, such as mortality and morbidity data. The following criteria are evaluated when determining if a study of health outcome data is reasonable: (1) presence of a completed human exposure pathway, (2) high enough concentrations of contaminants to result in measureable adverse health effects, (3) sufficient numbers of exposed people in the pathway for effects to be measured, and (4) a health outcome database where disease rates for the population of concern can be identified.

No health outcome data has been collected for the Ore Knob Mine NPL site.

## **COMMUNITY HEALTH CONCERNS**

The primary concerns associated with the Ore Knob Mine site include potential groundwater impacts for persons living in close proximity to the site and using private drinking water wells and the physical hazard associated with the main tailings impoundment. In addition, surface water impacts caused by acid mine drainage and surface water run-off impacted by mining waste materials on the site could impact persons living and recreating in the vicinity of the site. In the past, prior to the main tailings pile being capped by clean soils and re-vegetated, persons exposed to airborne dust could have experienced upper respiratory irritation associated with inhalation of the fine tailings materials, especially during periods of extended dry weather. N.C. DENR noted experiencing this phenomenon during their visits to the site.

A number of physical hazards also exist at the site. These include the mine shafts and adits, the remaining former mine equipment and structures, the earthen dam structure of the main tailings impoundment and the construction and remediation activities on-going on the site. Controlling access to the site will reduce or eliminate these potential hazards. A fence (6 or more feet high) is in place around portions of the 1950s mine and mill area.

County health officials and EPA site personnel both indicated that the community has not expressed particular concern with the site and current activities. This may be related to the community's familiarity with the historical presence of the mine, or lack of knowledge of the potential site issues. In November 2009, EPA staff held a public availability meeting in the community. Sixteen persons from the community attended the meeting. The main concern expressed to the EPA staff were concerns with potential negative impacts to the groundwater and private drinking water wells in the area.

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## **CHILD HEALTH CONSIDERATIONS**

The ATSDR recognizes there are unique exposure risks concerning children that do not apply to adults. Children are at a greater risk than are adults to certain kinds of exposures to hazardous substances. Because they play outdoors and because they often carry food into contaminated areas, children are more likely to be exposed to contaminants in the environment. Children are shorter than adults and as a result, they are more likely to breathe more dust, soil, and heavy vapors that accumulate near the ground. They are also smaller, resulting in higher doses of chemical exposure per body weight compared to adults. If toxic exposures occur during critical growth stages, the developing body systems of children can sustain permanent damage. Probably most important, however, is that children depend on adults for risk identification and risk management, housing, and access to medical care. Thus, adults should be aware of public health risks in their community, so they can guide their children accordingly. Child-specific exposure situations and health effects are taken into account in N.C. DPH health effect evaluations.

In addition to residential exposures and site-specific recreational exposures, soil pica exposures to young children were considered in this Public Health Assessment. Pica exposures are acute exposures taking place over a short period of time (1-day) applying to young children (0-6 years of age). ATSDR recommends evaluating pica behavior using consumption of a large amount of soil (5,000 mg/day) (ATSDR 2005). Non-pica recreational soil exposures of 400 mg/day were also used in this study to represent the upper percentile soil ingestion rate determined by EPA (EPA 1997). The 400 mg/day value is twice the rate generally applied by ATSDR and N.C. DPH for incidental soil ingestion by children.

Concentrations of the metals copper and iron in soils collected from the lawn of the residence identified as OK406 near the Ore Knob Mine site indicates the potential to cause adverse health effects to children unintentionally ingesting (eating) the soil over many years. The copper and iron residential soil concentrations are greater than those identified for the local area background. The information currently available is not adequate to determine if these concentrations are typical for soils in this area or if they are related to the former mining operations.

Exposure estimates for pica behavior in children indicated the potential for adverse health effects associated with copper and aluminum intake in the sampled residential soils. In addition, the potential for adverse health effects are indicated for pica behavior for children exposed to site soils and waste materials, and sediment and floodplain soils for copper, aluminum and zinc. The ultimate occurrence of adverse health effects related to these exposures maybe reduced by the likelihood that young children would be on the site for recreational activities and the lack of access to some of these media, such as the sediments in the larger downstream water bodies and the tailing wastes.

In addition to the potential chemical hazards associated with this site, children may be especially drawn to want to play on or near the potential physical hazards areas of the site. Limiting access to the site and educating the local community of the potential physical hazards are warranted.

## **PUBLIC COMMENT PERIOD**

The *Ore Knob Mine NPL Site Public Health Assessment* was released as a draft on April 14, 2010. Copies were made available to members of the local community, Ashe County N.C. officials, the N.C. DENR, and the U.S. EPA. The PHA was made available on the N.C. DPH HACE program and ATSDR web sites. Copies were also provided to the Ashe County Public Library in West Jefferson and the Ashe County Court House in Jefferson, NC. A press release notice of the release of the draft PHA and comment period was distributed to local media. A 60-day public comment period was provided from April 14, 2010 through June 14, 2010. During the comment period N.C. DPH collected submitted comments. Comments were received from a single member of the community. Those comments and N.C. DPH's response to those comments are provided in Appendix F.

## **CONCLUSIONS**

N.C. DPH evaluated all the available environmental data for Ore Knob Mine which included water, soil and waste materials. Surface water and sediment samples collected on the site, as well as those collected downstream from the site, were also evaluated. Samples of private drinking water wells and soils collected from the lawns of nearby residences were also evaluated. The time period of environmental samples evaluated include 1987 through 2008. Many of the samples, both on-site and off-site, were collected to characterize areas thought to represent the greatest potential impact (contamination) due to historical mining operations. These samples may not be representative of the typical concentrations of the detected substances throughout the area. As such, the health impacts indicated would likely represent the greatest potential for adverse health effects anticipated from contact with the discussed media.

N.C. DPH concluded:

- Concentrations of the metals cadmium and manganese in some of the private drinking water well samples collected from residences located near the Ore Knob Mine site may cause adverse health effects to persons drinking the water over many years. Cadmium at well location OK702 was at a concentration high enough to indicate the potential for adverse health effects to children. The manganese concentration at locations OK702, OK706 and OK707 indicate the potential to cause health effects to children and adults. The information currently available is not adequate to determine if these elevated metals are due to the former mining operations.
- Concentrations of the metals copper and iron in soils collected from the lawn of the residence identified as OK406 near the Ore Knob Mine site indicates the potential to cause adverse health effects to children unintentionally ingesting (eating) the soil over many years through normal activities of children living at these locations. The information currently available is not adequate to determine if these concentrations are typical for soils in this area or if they are related to the former mining operations.
- Concentrations of the metals copper and aluminum in the soils collected from lawns of residences near the Ore Knob Mine site may cause adverse health effects to children exhibiting "pica" behavior. Pica behavior is characterized by the ingestion of very large quantities of soil in a short period of time (such as 1 day). The concentrations of copper at

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residential locations OK406 and OK407, and aluminum at all 3 residential soil sampling locations (OK406, OK407 and OK408) were at concentrations that indicate the potential for adverse health effects with pica ingestion rates. The aluminum concentrations observed in the residential soils were all within the range expected for area soils not impacted by the mine site. The copper and iron residential soil concentrations are greater than those identified for the local area background.

- The concentrations of the metals aluminum, copper and zinc found in soils, waste materials, tailings and sediments found on-site were at concentrations high enough to potentially cause adverse health effects to children exhibiting pica behavior. However, it is not likely that children of the age that exhibit pica behavior (2-3 years of age) would be expected to frequent the site.
- The concentration of copper found in multiple areas on-site were at concentrations high enough to cause adverse health effects to children accidentally ingesting large amounts of these environmental media while participating in frequent recreational activities (such as camping or hiking) in these areas over many years. On-site media that exhibited elevated copper concentrations at these levels include some soils, Ore Knob Branch sediments near the main tailing impoundment, the tailings and other waste materials. Future exposures to the tailings will be eliminated by covering the main tailings impoundment with clean soil and re-vegetation. Most of the main tailing pile was covered by the end of 2009.
- The concentrations of the metals aluminum, copper and zinc found in floodplain soils and sediments associated with downstream water bodies as far as the South Fork New River were found at concentrations high enough to potentially cause adverse health effects to children exhibiting pica behavior and ingesting the soils and sediments. It is not likely that young children (2-3 years of age) that generally exhibit pica behavior are likely to frequently have access to these areas.
- Copper concentrations off-site in Peak Creek sediments just below the confluence with Ore Knob Branch were at concentrations high enough to cause adverse health effects to children and adults accidentally ingesting the sediments while participating in frequent recreational activities in these areas over many years. Sediment iron concentrations in this same area were also high enough to potentially cause adverse health effects to children exposed in frequent recreational activities in these areas over many years.

## **RECOMMENDATIONS**

The N.C. DPH makes the following recommendations:

- Determine if groundwater from the site is contaminated by site waste materials and impacting private wells in the area. Test private wells that may be impacted for metals and other associated site contaminants (such as cyanide and sulfur species).
- Re-test the private wells with the elevated manganese and cadmium. State or local health agencies should inform residents at locations where the private wells contain elevated concentrations of the metals manganese and cadmium of the potential for adverse health effects associated with long-term drinking of the well water. Assist them in identifying the alternatives to reduce their exposure or the potential for negative health impacts.

- Testing is recommended of the wells for the 2 mobile homes located on the access road to the 1950s mine and mill area.
- If concentrations of substances related to the mine are found in residential private wells in the vicinity of the site exceed regulatory or health guidelines, a clean source of drinking water should be provided. Drilling new wells or providing whole-house filter or reverse osmosis systems would be suitable means of permanently providing a clean source of drinking water.
- If elevated concentrations of substances not associated with the mine operations are identified in private wells that may pose health risks inform the residents and provide them with options to reduce their exposure or potential health risks.
- Test waters supplied by any new wells placed in the area for the metals aluminum, arsenic, cadmium, copper, iron and manganese.
- Inform parents of children that may be living at residences where elevated levels of copper, aluminum and iron were found in the lawn soils of the potential hazards and inform them of steps they can take to reduce the potential for their children's exposure.
  - Monitor their play to prevent soil ingestion
  - Regularly wash outdoor toys
  - Have children wash their hands before eating after playing outdoors
  - Wash home grown produce before it is eaten
  - Limit children from playing in areas of bare soil. Use ground covers such as grass or mulch to limit direct contact with soil in areas where children play.
  - Seek medical attention from your family physician or consult with N.C. DPH physicians if you are concerned that your children have ingested large quantities of soil or had daily contact with contaminated soil.
- Control access to all areas of the site to reduce potential health hazards associated with high levels of metals-contaminated media and physical hazards associated with the site. Post warning signs addressing these hazards at locations where persons may gain access to the site.
- Identify site-specific activities that persons maybe involved in (such as hiking, camping, fishing, or riding recreational vehicles) that could result in exposures to site media. This information is important to effectively communicate the potential hazards associated with these activities. Inform parents of the specific hazards to children.
- Inform members of the hunting club that have been given access to nearby areas of the potential hazards associated with environmental materials on the site, and particularly those to children because they may have higher levels of exposure and be more susceptible to harm than adults.
- Inform the site owner, the hunting club members that have been given access to areas bordering the site, and the local residents of the potential physical and health hazards (particularly those to children) associated with the site.

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## PUBLIC HEALTH ACTION PLAN

The purpose of the Public Health Action Plan (PHAP) is to ensure that this Public Health Assessment provides a plan of action designed to mitigate or prevent potential adverse health effects.

### A. Public Health Actions Completed

- N.C. DPH has evaluated site information, environmental media analytical data, and health effects information to determine the potential for the health of the local community to be adversely impacted by substances identified on the Ore Knob Mine NPL site.
- A draft copy of N.C. DPH's Public Health Assessment (PHA) was made available to U.S. EPA and N.C. DENR. DPH reviewed the comments and made the appropriate modifications to the document which were reflected in the PHA *Public Comment Release* draft version published April 14, 2010.
- The PHA *Public Comment Release* draft was published on April 14, 2010. Copies of the draft PHA were available electronically from HACE and ATSDR web sites. Hard copies were made available to the public at the site document repositories located in the community (the Ashe County Public Library, 148 Library Road, West Jefferson and the Ashe County Court House, 150 Government Bldg., Suite 2500, Jefferson) and at the Ashe County Health Department. Print copies were available upon request from ATSDR.
- A 60-day period beginning with the publication of the PHA *Public Comment Release* draft was provided to gather comments from the community and County, State and Federal agencies on the content and findings of the draft PHA. Contact information was provided to submit the comments to N.C. DPH or ATSDR.
- N.C. DPH made contact with the Ashe County Health Department and Environmental Health Department to inform them of the concerns with the elevated manganese and cadmium in the residential private wells.
- HACE staff attended EPA site status update meetings held for the community on April 20 and November 4, 2010. HACE was present to provide an overview of the findings of the PHA and respond to the community's questions and concerns.
- An Ore Knob Mine NPL Site PHA summary factsheet was prepared by HACE and be made available to the public and government agencies on April 14, 2010. The factsheet is available on the HACE website and at the Ashe County Health Department. Fact sheet updates will be prepared as activity on the site continues or additional documents are prepared by HACE for this site.
- N.C. DPH staff has worked with local residents in response to well water samples collected by EPA since April 2010 to explain health implications of the data, recommend follow-up and assist EPA in providing in-home water treatment alternatives. Well water testing and interfacing with the impacted community continues.

- The Final publication version of the PHA is available on the HACE and ATSDR websites. Hard copies will be available at the site document repositories in the community (the Ashe County Public Library, 148 Library Road, West Jefferson and the Ashe County Court House, 150 Government Bldg., Suite 2500, Jefferson) and at the Ashe County Health Department. Print copies may also be requested from ATSDR.
- N.C. DPH has provided contact information to agencies, organizations, and the public desiring additional inquiries about the site or the PHA.

B. Public Health Actions Planned

- N.C. DPH will monitor the implementation of the recommendations made in this PHA to protect public health.
- N.C. DPH will continue to monitor health and environmental data generated by Federal, State, or County agencies, or other groups, relevant to this site or potentially affected areas near the site.
- N.C. DPH will develop Health Consultations addressing private well water analytical data and other samples collected from residences in the community surrounding the former mine since April 2010. These documents will be made available to the community and agencies as were the PHAs.
- N.C. DPH will continue to work directly with impacted community members to make sure they understand the potential health implications, answer their health questions, provide health monitoring guidance, and assist with obtaining appropriate water treatment systems to protect their health.
- N.C. DPH will continue to assist the County, State or Federal agencies as needed to protect the health of the community around the former mine.

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## CONTACT INFORMATION

Contact information for additional inquiries regarding the Ore Knob Mine NPL Site Public Health Assessment, or to contact N.C. DPH Public Health physicians:

Web links:

N.C. DPH HACE: <http://www.epi.state.nc.us/epi/oe/hace/reports.html>

ATSDR access to the Ore Knob Mine NPL Site Public Health Assessment:

<http://www.atsdr.cdc.gov/HAC/PHA/index.asp>

HACE e-mail address: [nchace@dhhs.nc.gov](mailto:nchace@dhhs.nc.gov)

HACE telephone number: (919) 707-5900

HACE fax number: (919) 870-4807

HACE USPS mailing address:

Health Assessment, Education and Consultation Program  
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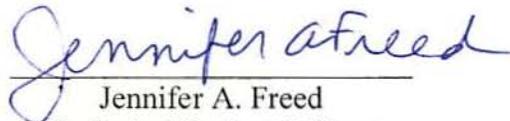
### **ATSDR Technical Project Officer:**

Jennifer Freed, MPH, REHS/RS  
Agency for Toxic Substances and Disease Registry (ATSDR)  
Division of Health Assessment and Consultation (DHAC)

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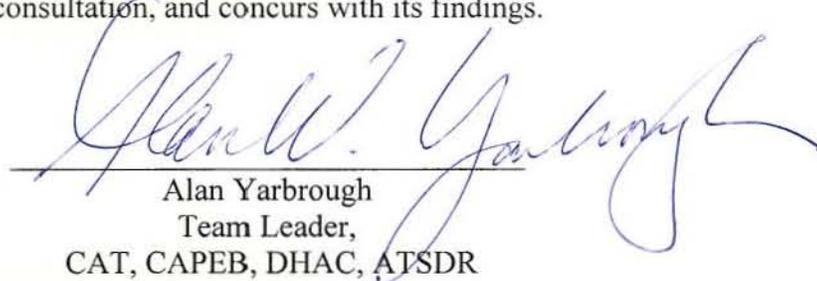
## CERTIFICATION

This Public Health Assessment for the Ore Knob Mine NPL Site (EPA ID: NCN000409895) was prepared by the North Carolina Division of Public Health (N.C. DHHS) under a cooperative agreement with the Federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consult and update was initiated. Editorial review was completed by the cooperative agreement partner.



Jennifer A. Freed  
Technical Project Officer  
Division of Health Assessment and Consultation (DHAC)  
ATSDR

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



Alan Yarbrough  
Team Leader,  
CAT, CAPEB, DHAC, ATSDR

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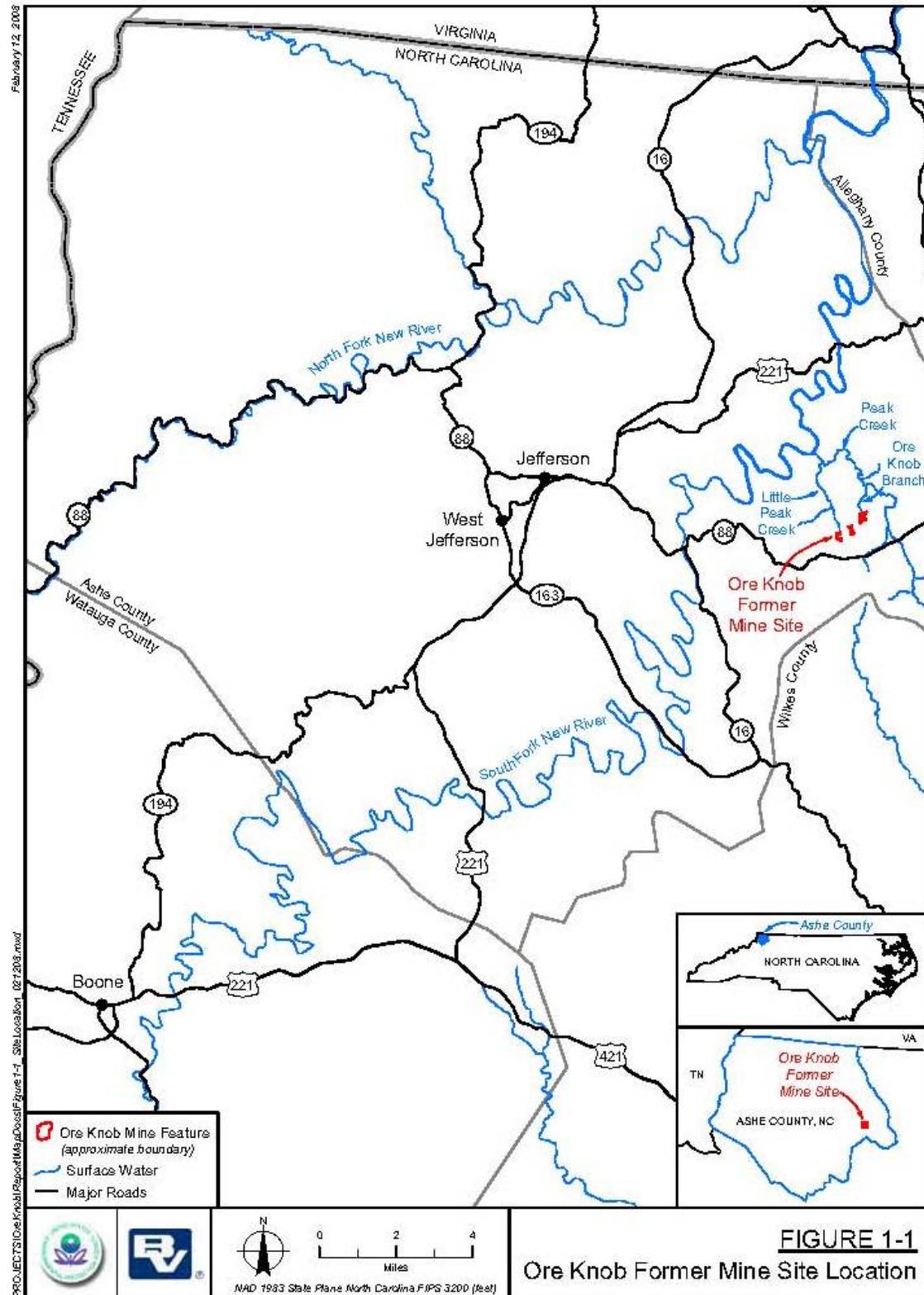
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## **Appendix A**

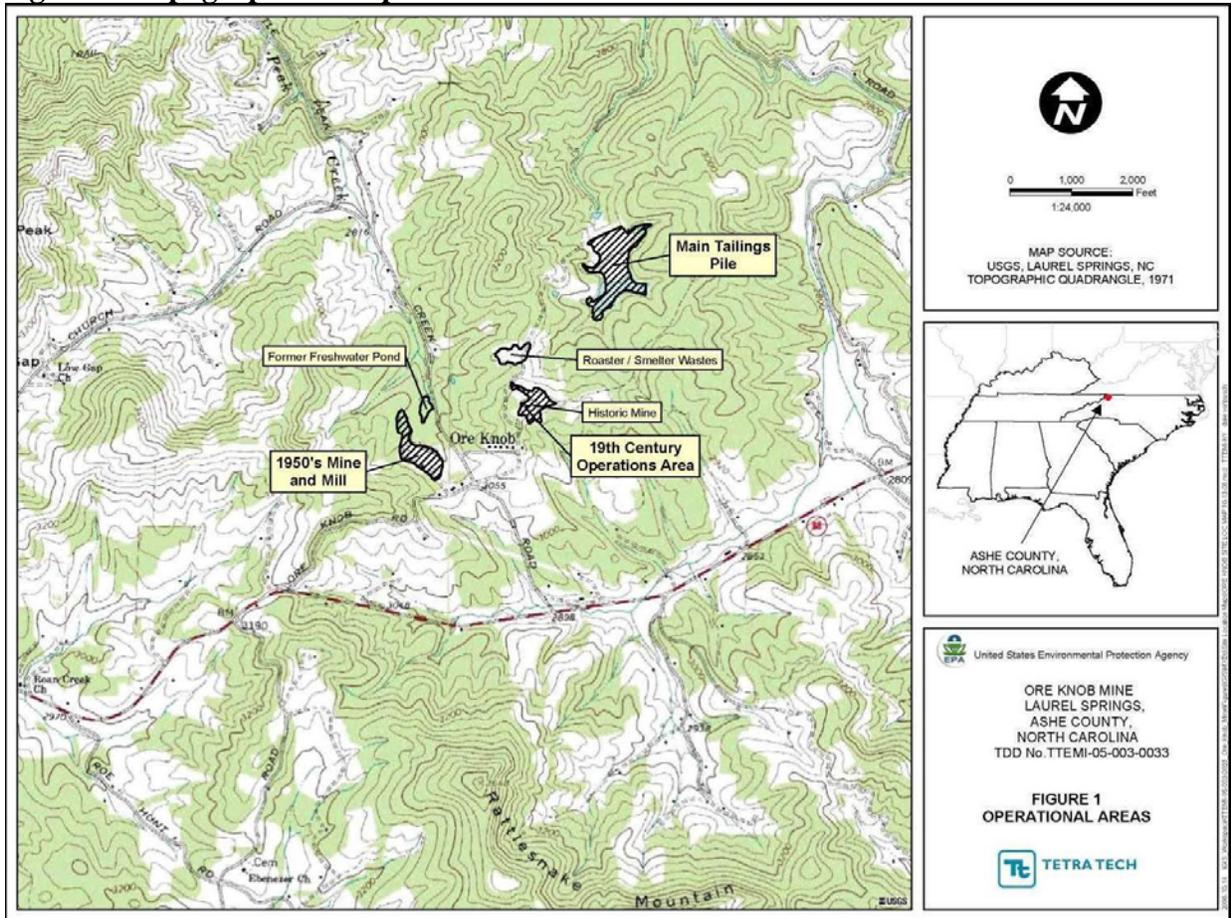
### **Figures**

**Figure 1. Location of the Ore Knob Mine NPL site, Ashe County, NC and regional downstream surface waters.**

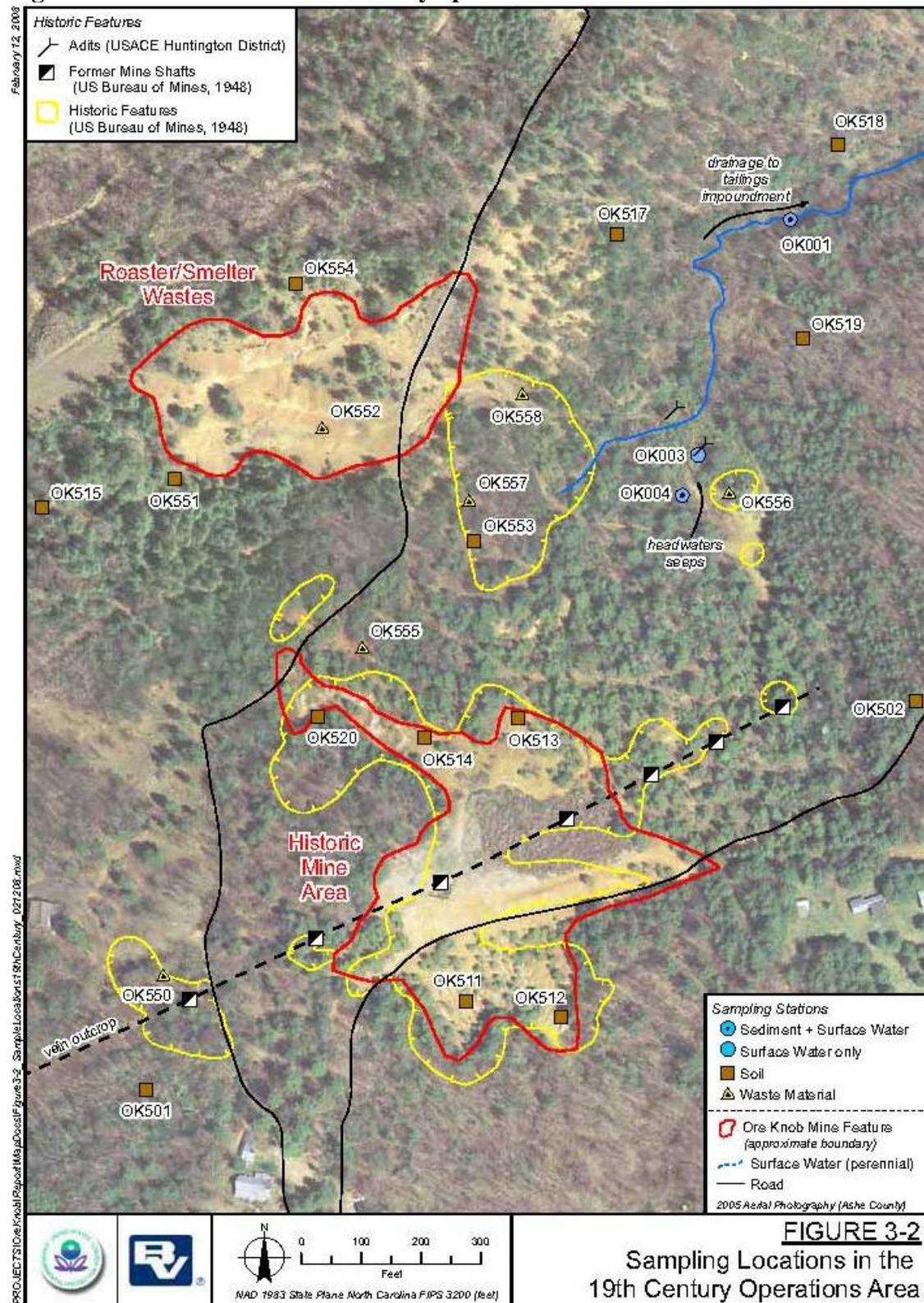




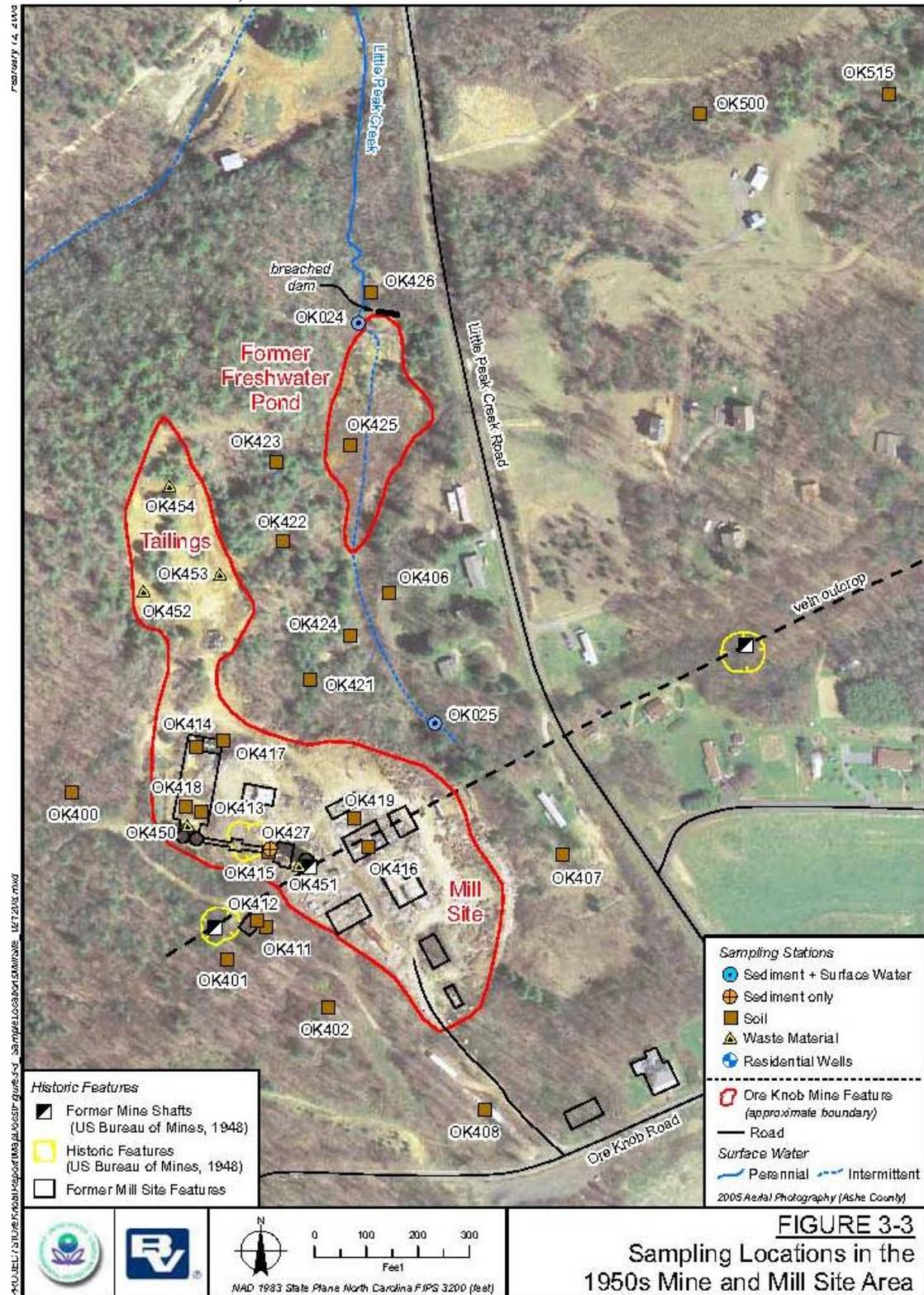
**Figure 3. Topographical map of the Ore Knob Mine NPL site source areas.**



**Figure 4. Ore Knob Mine 19<sup>th</sup> century operations area.**



**Figure 5. 1950s mine and mill area, Ore Knob Mine site. The residential soil sample locations are OK406, OK407 and OK408.**



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**Figure 6. Ore Knob Mine NPL site, October 2009. Ore bin remnants in 19<sup>th</sup> century operations area.**



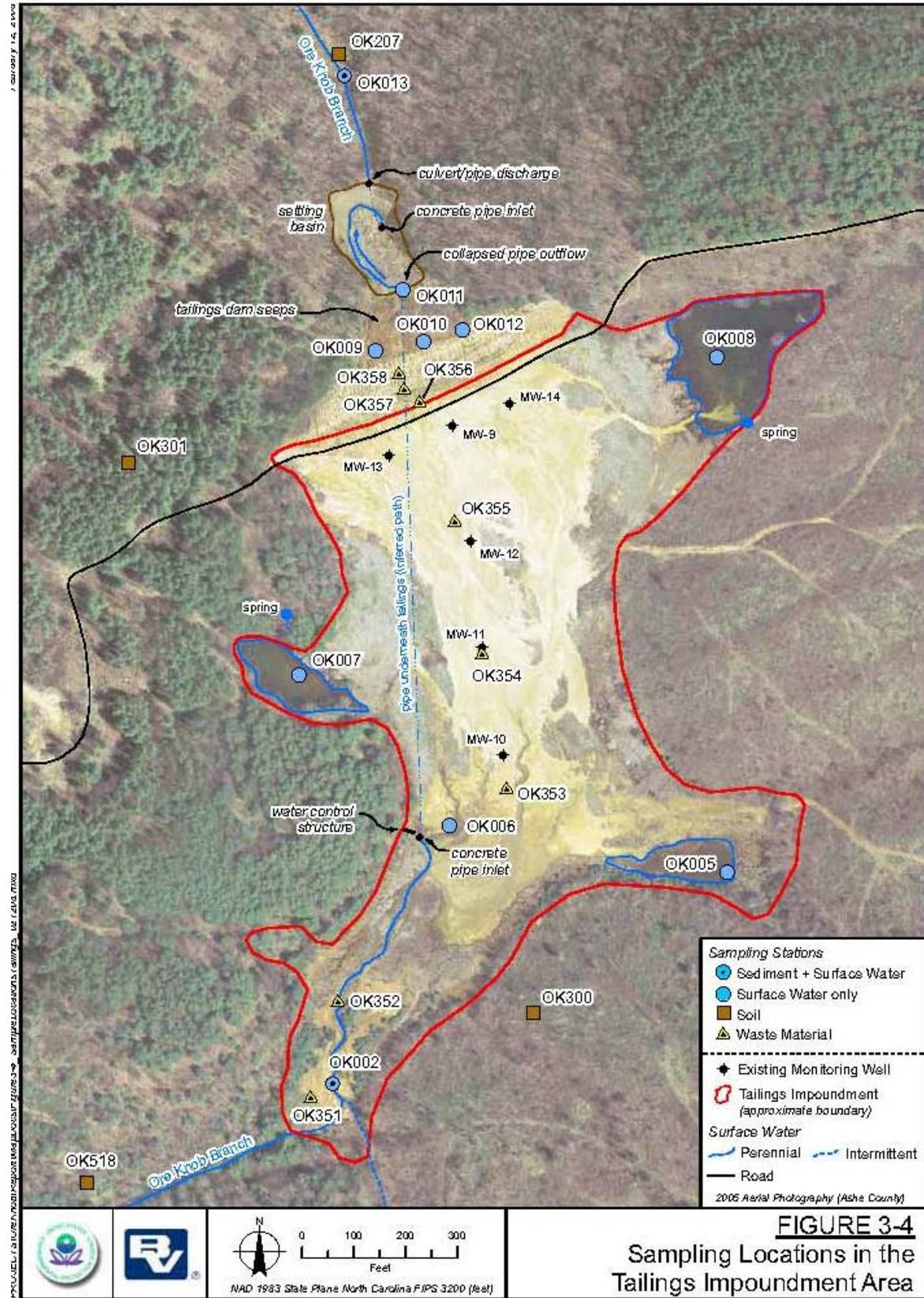
**Figure 7. Ore Knob Mine NPL site, October 2009. Structure remnants in 19<sup>th</sup> century operations area.**



**Figure 8. Ore Knob Mine NPL site, October 2009. Sawmill operating in 19<sup>th</sup> century operations area.**



Figure 9. Ore Knob Mine NPL site tailings impoundment area.



**Figure 10. Ore Knob Mine NPL site. Facing south toward tailings impoundment. EPA photo, October 2008. Photo taken before site remediation.**



**Figure 11. Ore Knob Mine NPL site, October 2009. Tailings impoundment dam, from west side, facing east. Photo taken before dam stabilization.**

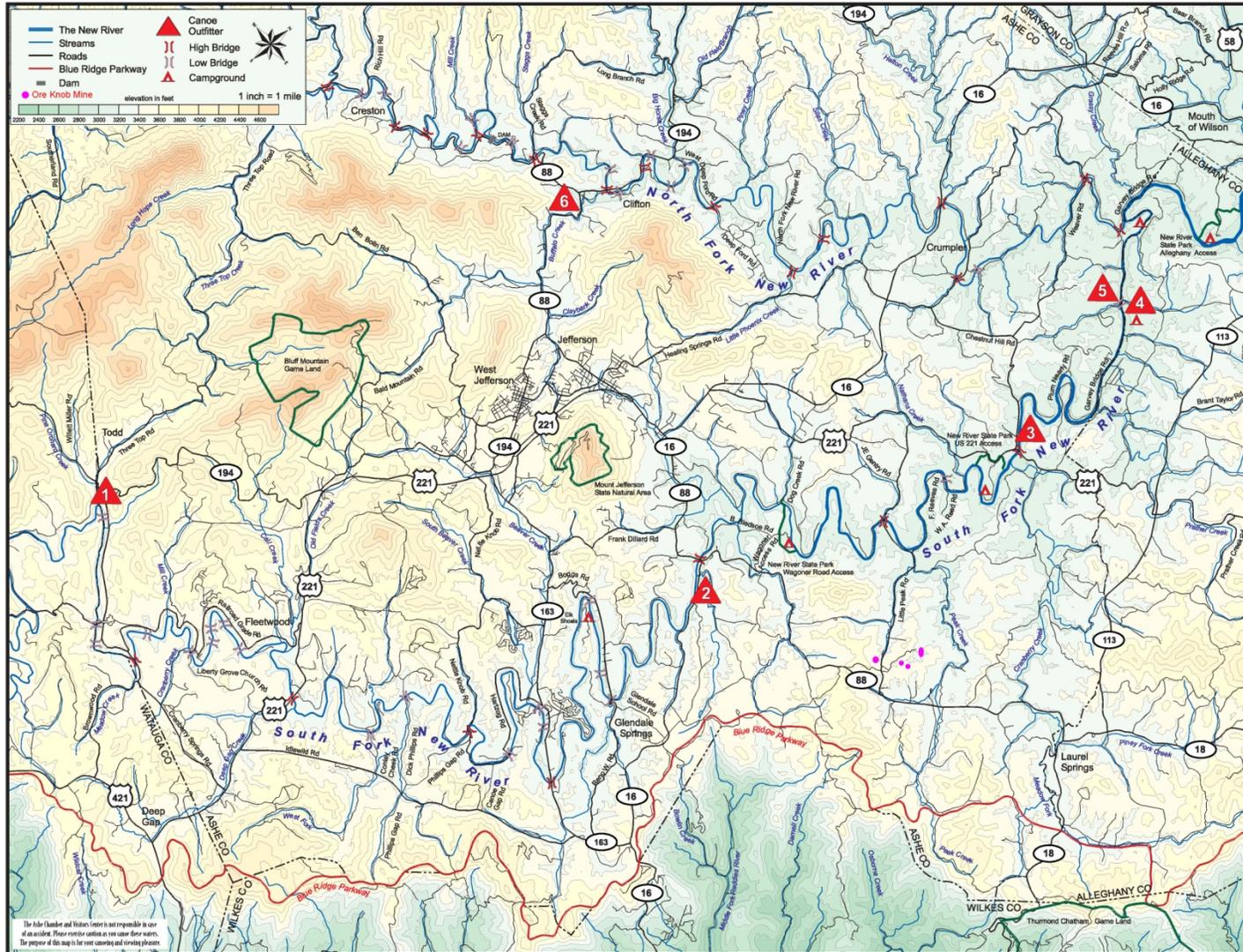


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**Figure 12. Ore Knob Mine NPL site, October 2009. Water discharging from face of tailings impoundment dam around area of 24-inch pipe carrying surface water under the impoundment and discharging at the base of the dam. Photo taken before re-routing of the surface water around the tailings pile and dam stabilization.**



Figure 13. Location of New River State Park in relation to the Ore Knob Mine site. Ore Knob Mine areas represented by pink markers.



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**Figure 14. Ore Knob Mine NPL site, October 2009. View of capped and re-vegetated surface water pond on perimeter of 20-acre main tailings impoundment.**



**Figure 15. Ore Knob Mine NPL site, October 2009. View of channel under construction re-routing stream around outside northwest perimeter of 20-acre main tailings impoundment.**



**Figure 16. Ore Knob Mine NPL site, October 2009. View of channel under construction re-routing stream around outside southwest perimeter of 20-acre main tailings impoundment.**



**Figure 17. Confluence of Ore Knob Branch and Little Peak Creek downstream of the Ore Knob Mine NPL site. Note bright orange color of iron-rich site run-off in Ore Knob Branch (background) entering Little Peak Creek (flowing laterally in the fore ground). HACE October 2009.**



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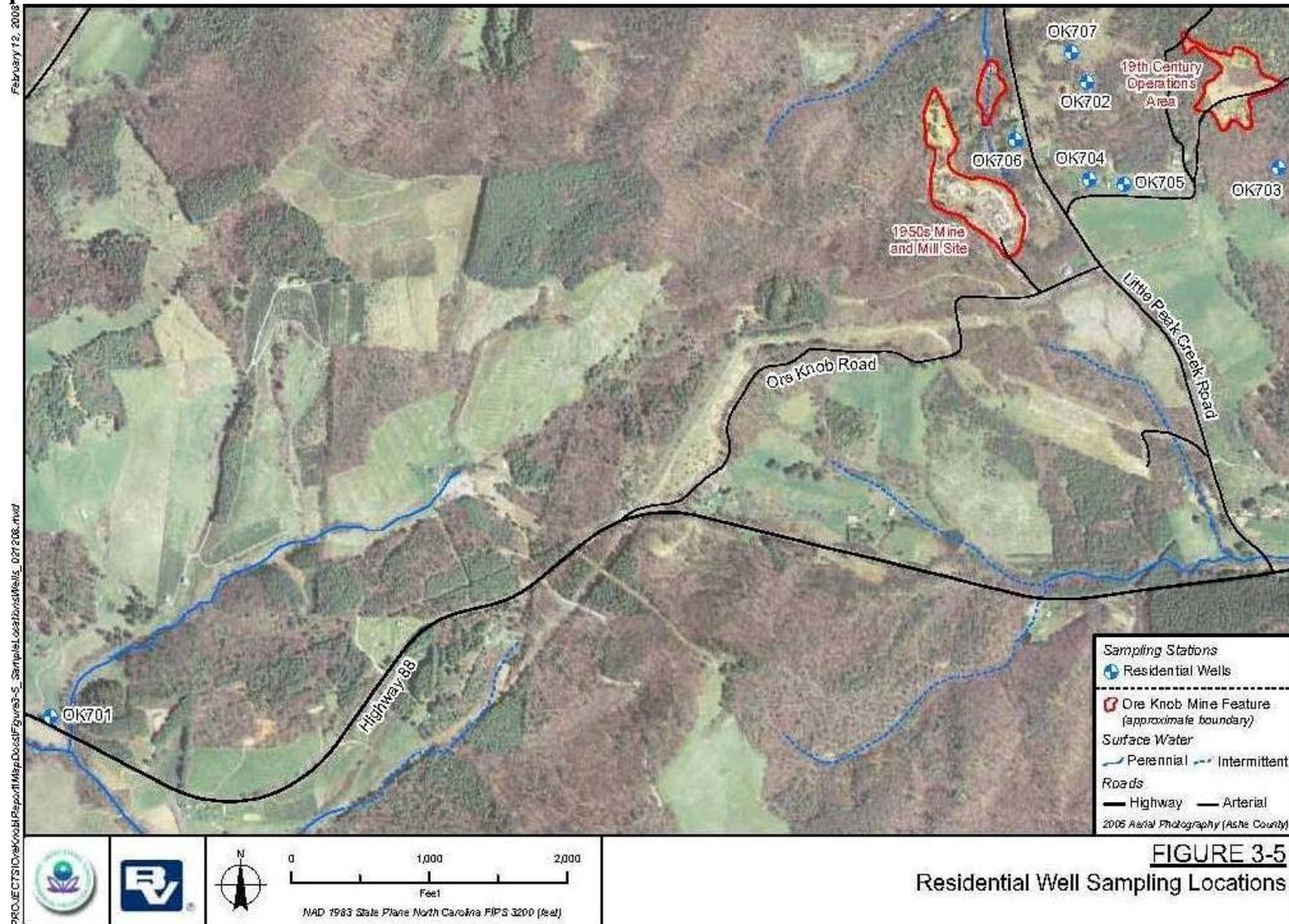
**Figure 18. Apparent floodplain soils carried downstream of the Ore Knob Mine NPL site. Observed near the confluence of Ore Knob Branch and Little Peak Creek. HACE October 2009.**



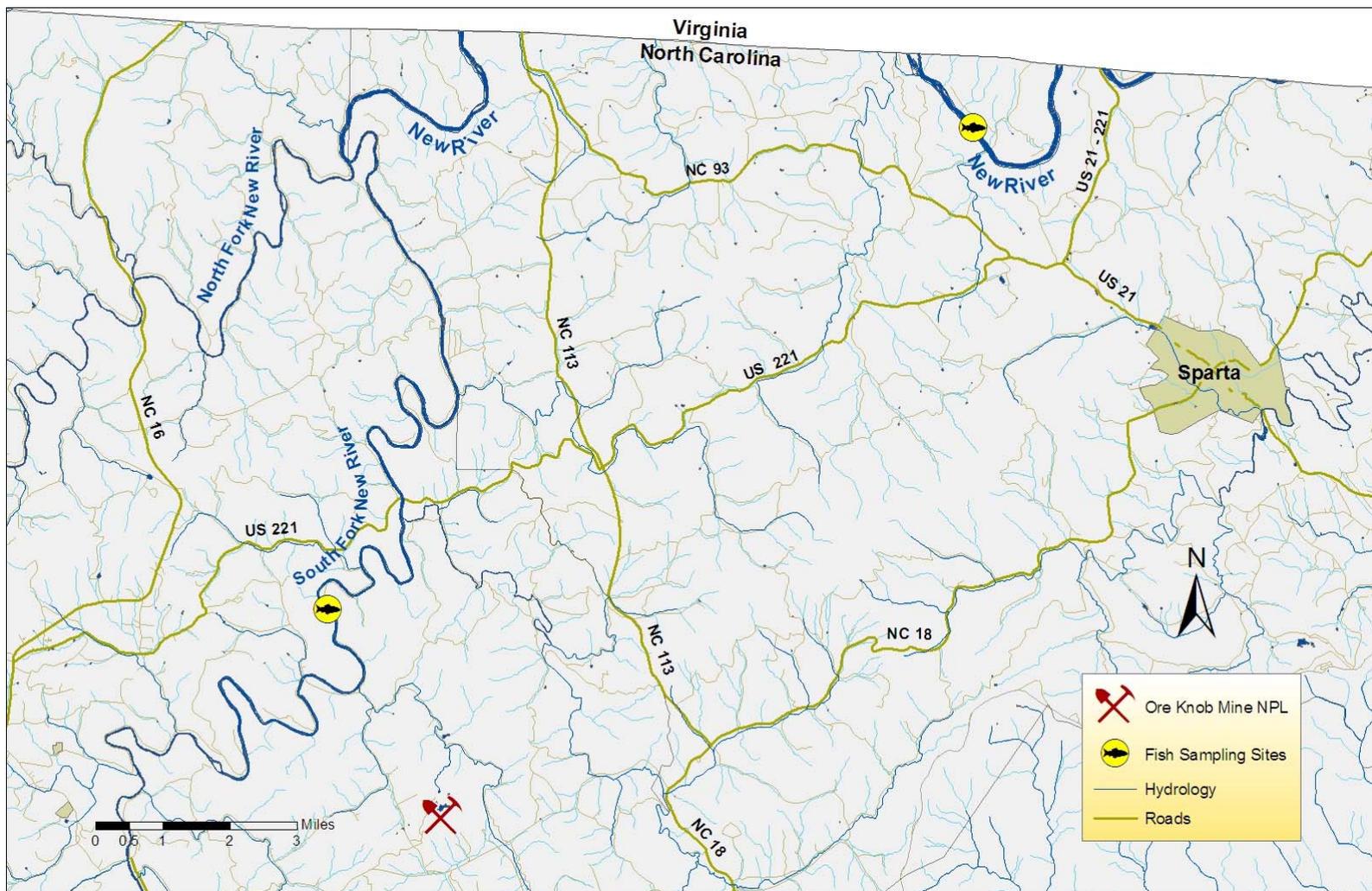
**Figure 19. Iron (orange) discoloration downstream of the Ore Knob Mine NPL site in the Little Peak Creek immediately upstream of the confluence with Peak Creek. HACE October 2009.**



**Figure 20. Location of residential private drinking water well samples collected in July 2007. Location OK701 is the background private well water location.**



**Figure 21. N.C. DENR/Div. of Water Quality fish collection locations downstream of the Ore Knob Mine NPL site. The location on South fork New River is approximately 1.5 miles downstream of the Peak Creek. The location on the New River is 32 miles downstream of Peak Creek.**



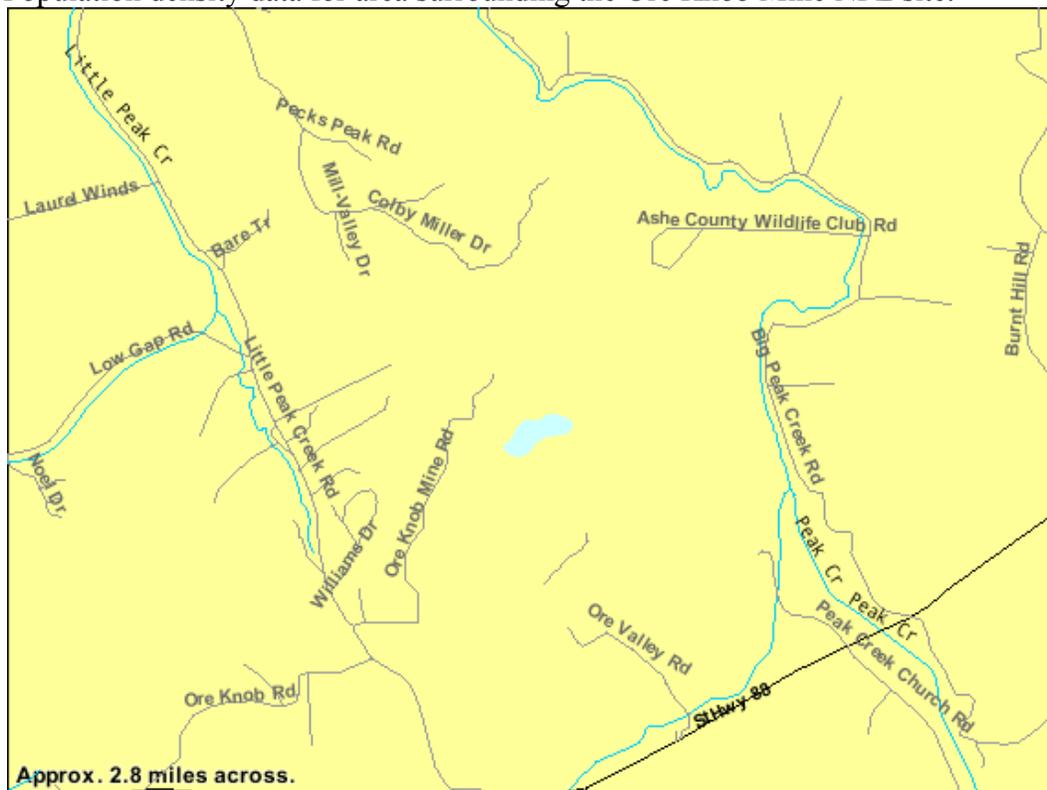
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**Appendix B**  
**Demographics Data**

According to Census 2000 figures, Ashe County has a population of 24,384. The majority of the population in the county is White (97%), with 1% African-American and 2% Hispanic. The educational attainment of the population is lower than the state and the country with 69% having a high school diploma or higher compared to 77% in the state and 80% in the country. In addition, 14% of the population has less than a 9<sup>th</sup> grade education, almost twice the percentage for the state and the country (8%).

It is estimated that there are 13,268 housing units in the county of which 10,411 are occupied (79%). Of the occupied housing units, 1,983 are occupied by renters (19%). The population density within 3 miles of the Ore Knob Mine Site is approximately 35 persons per square mile (DPH 2009).

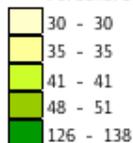
Population density data for area surrounding the Ore Knob Mine NPL site.



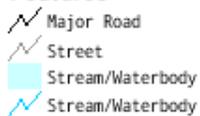
Legend

**Data Classes**

Persons/Sq Mile



**Features**



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**Ashe County, NC - Demographics (Census 2000 figures)**

	<b>Ashe County</b>	<b>North Carolina</b>	<b>U.S.</b>
Total population	24,384	8,049,313	281,421,906
Percent Minority			
Ethnicity			
White	97%	72%	75%
African-American	1%	22%	12%
Hispanics	2%	5%	13%
Asians	<1%	1%	4%
American Indians	<1%	1%	1%
Poverty Level	14%	12%	12%
High school diploma or higher	69%	77%	80%
Less than 9 <sup>th</sup> grade	14%	8%	8%

**Reference:**

*EnviroMapper*. U.S.EPA. <http://www.epa.gov/emefdata/em4ef.home>

## **Appendix C**

### **Tables**

**Table 2. Data summary and screening value analysis for substances detected in private drinking water well samples collected near the Ore Knob Mine NPL site in July 2007. Table continued on next page.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (µg/L)	Comparison Values (CV), (µg/L)	Type of CV
Aluminum	6	5	0	5.6 – 179	10,000 child 40,000 adult	Chronic EMEG
Arsenic <sup>1</sup>	6	0	0	<1.5	0.02	CREG
					10	MCL
Barium	6	6	0	11.3 – 39.8	2,000 child 7,000 adult	Chronic EMEG
Beryllium	6	4	0	0.26 – 0.42	20 child 40 adult	Chronic EMEG
					4	MCL
Cadmium	6	4	1	0.63 – 2.5	1 child 4 adult	Chronic EMEG
					5	MCL, MCLG
Calcium	6	6	----	5,080 – 159,000	No CVs	----
Chromium <sup>2</sup>	6	1	0	1.5	10 child 40 adult	Chronic EMEG <sup>2</sup>
					100	MCL
Cobalt	6	5	1	0.18 - 136	100 child 400 adult	Intermediate EMEG
Copper	6	6	0	1.6 – 41.8	100 child 400 adult	Intermediate EMEG
Iron	6	6	0	35.1 – 14,800	26,000	EPA tap water
Lead	6	3	0	0.55 – 9.9	15	EPA MCL AL
Magnesium	6	6	----	1,270 – 126,500	No CVs	----

**Table 2, continued. Data summary and screening value analysis for substances detected in private drinking water well samples collected near the Ore Knob Mine NPL site in July 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (µg/L)	Comparison Values (CV), (µg/L)	Type of CV
Manganese	6	6	3	2.1 – 17,750	500 child 2,000 adult	RMEG
					300 50	EPA LTHA EPA 2 <sup>nd</sup> DW <sup>3</sup>
Nickel	6	6	1	0.84 – 113	200 child 700 adult	RMEG
					100	EPA LTHA
Potassium	6	6	----	1,340 – 5,660	No CVs	----
Sodium	6	6	----	2,450 – 9,580	No CVs	----
Sulfate, Total	6	6	----	11,500 J – 472,000 J	No CVs	----
					250,000	EPA 2 <sup>nd</sup> DW <sup>3</sup>
Zinc	6	6	0	14.6 – 838	3,000 child 10,000 adult	Chronic EMEG
					2,000	EPA LTHA

Notes: <sup>1</sup> Retained for Health Evaluation because reporting limit is greater than CREG comparison value Arsenic should not be retained – value is background  
<sup>2</sup> CV given is for hexavalent chromium, the more toxic soluble form  
<sup>3</sup> EPA secondary drinking water regulation. Non-enforceable guideline for compounds that may cause taste, odor, or appearance effects in drinking water.  
CV = Comparison value (ATSDR established screening values)  
AL = Action Level  
J = estimated analytical value  
DW = drinking water  
EPA = U.S. Environmental Protection Agency  
RMEG = Reference Dose Media Evaluation Guide  
EMEG = Environmental Media Evaluation Guide  
CREG = Cancer Risk Evaluation Guide  
LTHA = Lifetime Health Advisory for Drinking Water (EPA)  
µg/L = micrograms per liter, parts per billion (ppb)  
MCL = Maximum Contaminant Level for drinking water, EPA regulatory value  
MCLG = Maximum Contaminant Level goal for drinking water, EPA non-regulatory value  
EPA tap water = U.S. Environmental Protection Agency Superfund health screening values for tap water

**Table 3. Site-specific exposure dose estimates and health guideline comparison values for residential private drinking water well samples collected near the Ore Knob Mine NPL site in July 2007.**

Contaminant	Calculated Maximum Exposure Dose (mg/kg-d)	Calculated Mean Exposure Dose (mg/kg-d)	Health Guideline / Type <sup>1</sup> (non-cancer) (mg/kg-d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult) ?
Cadmium	0.00016 child 7.1e-05 adult	----	0.0001	child YES adult NO
Manganese at OK702 (17,800 µg/L)	1.1 child 0.51 adult	----	0.050 EPA RfD 0.14 IRIS RfD	child YES adult YES
Manganese at OK706 (6,370 µg/L)	0.40 child 0.18 adult	----		child YES adult YES
Manganese at OK707 (1,900 µg/L)	0.12 child 0.054 adult	----		child YES adult YES
Cobalt	0.0085 child 0.0039 adult	----	0.010	child NO adult NO
Nickel	0.0071 child 0.0032 adult	----	0.02	child NO adult NO

Notes: <sup>1</sup> Listed health guideline is an ATSDR chronic exposure (1 to 14 days) MRL, unless specified otherwise  
mg/kg-d = milligrams per kilogram per day  
MRL = Minimum Risk Level  
non-CA = non-cancer  
µg/L = micrograms per liter, or parts per billion (ppb)  
RfD = Reference Dose  
IRIS = Integrated Risk Information System, EPA database of health information for environmental chemicals  
HG = Health Guideline  
Non-CA = non-cancer

**Table 4. Site-specific exposure dose estimates and increased cancer risk for residential private drinking water well samples collected near the Ore Knob Mine NPL site in July 2007. Estimates represent maximum values based on the arsenic analytical reporting limit.**

<b>Contaminant</b>	<b>Calculated Maximum Exposure Dose (mg/kg-d)</b>	<b>Cancer Slope Factor (CSF) (mg/kg-d)</b>	<b>Calculated Theoretical Increased Cancer Risk (in 10,000 exposed persons)</b>	<b>Equal to 1 Increased Cancer in a Population of -</b>
Arsenic	9.4e-05 child 4.3e-05 adult	1.5	Less than 1	15,500

Note: mg/kg-d = milligrams per kilogram per day

**Table 5. Data summary and screening value analysis for substances detected in soil samples collected from lawns of residences near the Ore Knob Mine NPL site in July 2007. Table continued on the next page.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Aluminum	3	3	3	10,000 J - 19,000	50,000 child 700,000 adult	Chronic EMEG
					2,000 child	Pica Intermediate
Arsenic	3	1	0	2 J	20 child 200 adult	Chronic EMEG
					20	CREG
Barium	3	3	0	71 J – 110	10,000 child 100,000 adult	Chronic EMEG
					400 child	Pica Intermediate
Beryllium	3	1	0	0.78	100 child 1,000 adult	Chronic EMEG
Calcium	3	3	----	410 J – 2,600 J	No CVs	----
Chromium	3	3	0	17 J – 27	80,000 child 1,000,000 adult	RMEG
Cobalt	3	3	0	7.7 J – 19 J	500 child 7,000 adult	Intermediate EMEG
Copper	3	3	2	17 J – 1,800 J	500 child 7,000 adult	Intermediate EMEG
					20 pica child	Pica, acute, Intermediate
Iron	3	3	1	19,000 J – 60,000 J	55,000	EPA residential
Lead	3	3	0	12 J – 15 J	400	EPA residential
Magnesium	3	3	----	2,700 J – 2,900 J	No CVs	----

**Table 5, continued. Data summary and screening value analysis for substances detected in soil samples collected from lawns of residences near the Ore Knob Mine NPL site in July 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Manganese	3	3	0	250 J – 1,200 J	3,000 child 40,000 adult	RMEG
Mercury	3	1	0	0.48	23	EPA residential
Nickel	3	2	0	9.8 J – 10 J	1,000 child 10,000 adult	RMEG
Potassium	3	3	----	1,900 J – 4,000	No CVs	----
Vanadium	3	3	0	29 J – 47	200 child 2,000 adult	Intermediate EMEG
Zinc	3	3	0	48 J – 170 J	20,000 child 200,000 adult	Chronic EMEG
					600 child	Pica intermediate
Benzaldehyde	3	1	0	27 J	5,000,000 child 70,000,000 adult	RMEG

Notes: CV = Comparison value (ATSDR established screening values)  
 mg/kg = milligrams per kilogram, or parts per million (ppm)  
 AL = Action Level  
 J = estimated analytical value  
 RMEG = Reference Dose Media Evaluation Guide  
 EMEG = Environmental Media Evaluation Guide  
 CREG = Cancer Risk Evaluation Guide  
 LTHA = Lifetime Health Advisory for Drinking Water (EPA)  
 MCL = Maximum Contaminant Level for drinking water, EPA regulatory value  
 MCLG = Maximum Contaminant Level goal for drinking water, EPA non-regulatory value  
 EPA Residential = U.S. Environmental Protection Agency Superfund health screening value for residential sites

**Table 6. Site-specific exposure dose estimates and health guideline comparisons for residential soil samples collected near the Ore Knob Mine NPL site in July 2007.**

Contaminant	Calculated Maximum Exposure Dose (mg/kg-d)	Calculated Mean Exposure Dose (mg/kg-d)	Health Guideline / Type (non-cancer) (mg/kg-d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult) ?	Does Calculated Geometric Mean Exposure Dose Exceed non-CA HG (child/adult) ?
Copper at OK406 (1,800 mg/kg)	0.022 child 0.0026 adult 0.56 pica child	----	0.01 ATSDR Intermediate <sup>1</sup> MRL	child YES adult NO pica child YES	----
Copper at OK407 (170 mg/kg)	0.0021 child 0.00024 adult 0.053 pica child	----		child No adult NO pica child YES	----
Iron at OK406	0.75 child 0.086 adult	----	0.70 EPA residential oral RfD	child YES adult NO	----
Aluminum	0.24 child 0.027 adult 5.9 pica child	0.18 child 0.020 adult 4.4 pica child	1.0 ATSDR Chronic <sup>2</sup> MRL	child NO adult NO pica child YES	child NO adult NO pica child YES

Notes: <sup>1</sup> An intermediate exposure is 15 to 364 days

<sup>2</sup> A chronic exposure is 365 days or longer

mg/kg-d = milligrams per kilogram per day

mg/kg = milligrams per kilogram, or parts per million (ppm)

MRL = Minimum Risk Level

non-CA = non-cancer

HG = ATSDR published Health Guideline value

mg/kg = milligrams per kilogram, or parts per million (ppm)

EPA Residential oral RfD = U.S. Environmental Protection Agency Superfund health-based oral reference dose value for residential sites

**Table 7. Data summary and screening value analysis for substances detected in soils collected in the 1950s mine and mill area. Samples collected in 2007. Table continued on the next page.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Aluminum	13	13	13	3,800 – 16,000 J	50,000 child 700,000 adult	Intermediate EMEG
					2,000 child	Pica Intermediate EMEG
Arsenic	8	6	2	0.54 J – 150 J	20 child 200 adult	RMEG
					20	CREG
Barium	13	13	0	41 J – 260	10,000 child 100,000 adult	Chronic EMEG
					400 child	Pica Intermediate
Beryllium	12	6	0	0.25 J – 0.8	100 child 1,000 adult	RMEG
Cadmium	12	4	0	0.76 J – 10.2	30 child 400 adult	Intermediate EMEG
Calcium	13	12	0	150 J – 27,000 J	No CVs	----
Chromium <sup>1</sup>	13	13	0	9.9 – 120	80,000 child 1,000,000 adult	RMEG
Cobalt	13	10	1	4.7 J – 500	500 child 7,000 adult	Intermediate EMEG
Copper	13	13	6	19 J – 9,600 J	500 child 7,000 adult	Intermediate EMEG
					20 pica child	Pica, acute, Intermediate

**Table 7, continued. Data summary and screening value analysis for substances detected in soils collected in the 1950s mine and mill area. Samples collected in 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Cyanide	10	1	0	1.7	1000 child 10,000 adult	RMEG
Iron	13	13	0	14,000 J – 370,000 J	720,000	EPA Industrial
Lead	13	13	0	3.4 J – 49 J	400	EPA residential
Magnesium	13	13	0	570 J – 5,300 J	No CVs	----
Manganese	13	13	0	51 – 810	3,000 child 40,000 adult	RMEG
Mercury	13	9	0	0.12 – 0.28	23	EPA residential
Nickel	13	10	0	5.4 J – 41 J	1,000 child 10,000 adult	RMEG
Potassium	13	13	0	670 J – 9,600	No CVs	----
Selenium	11	6	0	2.4 J – 71 J	300 child 4,000 adult	RMEG
Silver	9	2	0	1.4 – 4.1	300 child 4,000 adult	RMEG
Sodium	13	2	0	400 J – 940 J	No CVs	----
Zinc	13	13	0	22 J – 2,700 J	20,000 child 200,000 adult	Chronic EMEG
					600 child	Pica intermediate

Notes:

<sup>1</sup> as Hexavalent chromium

CV = Comparison value (ATSDR screening values)

mg/kg = milligrams per kilogram, or parts per million (ppm)

J = estimated analytical value

RMEG = Reference Dose Media Evaluation Guide

EMEG = Environmental Media Evaluation Guide

CREG = Cancer Risk Evaluation Guide

EPA Industrial = U.S. Environmental Protection Agency

Superfund health screening value for industrial sites

EPA Residential = U.S. Environmental Protection Agency

Superfund health screening value for residential sites

**Table 8. Data summary and screening value analysis for metals detected in soils collected in the 19<sup>th</sup> century operations area. Samples collected in 2007. Table continued on the next page.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Aluminum	9	9	9	12,000 J – 35,000	50,000 child 700,000 adult	Intermediate EMEG
					2,000 child	Pica Intermediate EMEG
Arsenic	9	8	0	1.2 J – 20 J	20 child 200 adult	RMEG
					20	CREG
Barium	9	9	0	26 J – 140 J	10,000 child 100,000 adult	Chronic EMEG
					400 child	Pica Intermediate
Beryllium	9	3	0	0.65 – 0.85	100 child 1,000 adult	RMEG
Cadmium	9	1	0	0.52 J	30 child 400 adult	Intermediate EMEG
Calcium	9	7	0	110 J – 950 J	No CVs	----
Chromium <sup>1</sup>	9	9	0	16 J – 42	80,000 child 1,000,000 adult	RMEG
Cobalt	9	8	0	5.7 - 20	500 child 7,000 adult	Intermediate EMEG
Copper	9	9	1	33 J – 680 J	500 child 7,000 adult	Intermediate EMEG
					20 pica child	Pica, acute, Intermediate

**Table 8, continued. Data summary and screening value analysis for metals detected in soils collected in the 19<sup>th</sup> century operations area. Samples collected in 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Iron	9	9	0	28,000 J – 110,000	720,000	EPA Industrial
Lead	9	9	0	8.2 J – 37 J	400	EPA residential
Magnesium	9	9	0	1,600 J – 4,600 J	No CVs	----
Manganese	9	9	0	110 J - 480	3,000 child 40,000 adult	RMEG
Mercury	9	2	0	0.15 – 0.76	23	EPA residential
Nickel	9	9	0	5 J – 19 J	1,000 child 10,000 adult	RMEG
Potassium	9	9	0	1,200 J – 5,100 J	No CVs	----
Selenium	7	1	0	9.4 J	300 child 4,000 adult	RMEG
Silver	9	2	0	0.13 J – 0.36 J	300 child 4,000 adult	RMEG
Vanadium	9	9	0	25 - 52	200 child 2,000 adult	Intermediate EMEG
Zinc	9	9	0	32 J – 180 J	20,000 child 200,000 adult	Chronic EMEG
					600 child	Pica intermediate

Notes:

<sup>1</sup> as Hexavalent chromium

CV = Comparison value (ATSDR established screening values)

mg/kg = milligrams per kilogram, or parts per million (ppm)

J = estimated analytical value

RMEG = Reference Dose Media Evaluation Guide

EMEG = Environmental Media Evaluation Guide

CREG = Cancer Risk Evaluation Guide

EPA Industrial = U.S. EPA Superfund health screening value for industrial sites

EPA Residential = U.S. Environmental Protection Agency Superfund health screening value for residential sites

**Table 9. Data summary and screening value analysis for organic compounds detected in the 1950s mine and mill area soil samples. Samples collected in 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (µg/kg)	Comparison Values (CV), (µg/kg)	Type of CV
2-Methylnaphthalene	13	2	0	26 J – 570 J	200,000 child 3,000,000 adult	RMEG
Benzaldehyde	13	3	0	44 J – 580 J	5,000,000 child 70,000,000 adult	RMEG
Benzo(a)anthracene	13	3	0	46 J – 180 J	2,100	EPA Industrial
Benzo(b)fluoranthene	13	6	0	31 J – 310 J	2,100	EPA Industrial
Benzo(g,h,i)perylene	13	4	0	27 J – 180 J	No CVs	----
Benzo(k)fluoranthene	13	5	0	26 J – 260 J	2,100	EPA Industrial
Benzo(a)pyrene	13	4	1	29 J – 260	100	CREG
Bis(2-ethylhexyl)-phthalate	13	2	0	42 J – 370	120,000	EPA Industrial
Carbazole	13	1	0	34 J	86,000	EPA Industrial
Chrysene	13	2	0	51 J – 230	210,000	EPA Industrial
Dibenzo(a,h)-anthracene	13	1	0	45 J	210	EPA Industrial
Fluoranthene	13	3	0	72 J – 390	20,000,000 child 300,000,000 adult	Intermediate EMEG
Indeno(1,2,3-cd)-pyrene	13	3	0	28 J – 190 J	2,100	EPA Industrial

Notes: CV = Comparison value (ATSDR established screening values)  
µg/kg = micrograms per kilogram, or parts per billion (ppb)  
J = estimated analytical value  
RMEG = Reference Dose Media Evaluation Guide  
EMEG = Environmental Media Evaluation Guide  
CREG = Cancer Risk Evaluation Guide  
EPA = U.S. Environmental Protection Agency  
EPA Industrial = U.S. Environmental Protection Agency Superfund health screening value for industrial sites

**Table 10. Data summary and screening value analysis for organic compounds detected in the 19<sup>th</sup> century operations area soil samples. Samples collected in 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (µg/kg)	Comparison Values (CV), (µg/kg)	Type of CV
Acenaphthylene	9	1	0	33 J	No CVs	----
Benzaldehyde	9	2	0	32 J – 150 J	5,000,000 child 70,000,000 adult	RMEG
Benzo(a)anthracene	9	2	0	53 J - 150 J	2,100	EPA Industrial
Benzo(b)fluoranthene	9	2	0	120 J – 190 J	2,100	EPA Industrial
Benzo(g,h,i)perylene	9	2		110 J – 140 J	No CVs	----
Benzo(k)fluoranthene	9	2	0	110 J – 200 J	2,100	EPA Industrial
Benzo(a)pyrene	9	2	1	87 J – 200 J	100	CREG
Chrysene	9	2	0	75 J – 150 J	210,000	EPA Industrial
Dibenzo(a,h)-anthracene	9	1	0	31 J	210	EPA Industrial
Fluoranthene	9	2	0	110 J – 160 J	20,000,000 child 300,000,000 adult	Intermediate EMEG
Indeno(1,2,3-cd)-pyrene	9	2	0	99 J – 130 J	2,100	EPA Industrial
Phenanthrene	9	1		54 J	No CVs	----
Pyrene	9	2	0	90 J – 130 J	2,000,000 child 20,000,000 adult	RMEG

Notes: CV = Comparison value (ATSDR established screening values)  
µg/kg = micrograms per kilogram, or parts per billion (ppb)  
J = estimated analytical value  
RMEG = Reference Dose Media Evaluation Guide  
EMEG = Environmental Media Evaluation Guide  
CREG = Cancer Risk Evaluation Guide  
EPA Industrial = U.S. Environmental Protection Agency Superfund health screening value for industrial sites

**Table 11. Site-specific exposure dose estimates and health guideline comparison for the child and adult recreational exposure scenarios for soil samples collected from the 1950s mine and mill and 19<sup>th</sup> century operations areas. Samples collected in 2007.**

Contaminant	Calculated Maximum Exposure Dose <sup>1</sup> (mg/kg-d)	Calculated Mean Exposure Dose <sup>1</sup> (mg/kg-d)	Health Guideline / Type (non-cancer) (mg/kg-d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult) ?	Does Calculated Geometric Mean Exposure Dose Exceed non-CA HG (child/adult) ?
<b>1950s Mine and Mill area</b>					
Arsenic	0.00037 child 0.000042 adult	0.00021 child 0.000024 adult	0.005 ATSDR Acute <sup>2</sup> MRL	child NO adult NO	child NO adult NO
Cobalt	0.0012 child 0.00014 adult	----	0.01 ATSDR Intermediate <sup>3</sup> MRL	child NO adult NO	----
Copper	0.024 child 0.0027 adult	0.0096 child 0.0011 adult	0.01 ATSDR Intermediate <sup>3</sup> MRL	child YES adult NO	child NO adult NO
<b>19<sup>th</sup> Century Operations area</b>					
Copper, Historic Smelter area	0.0017 child 0.00019 adult	----	0.01 ATSDR Intermediate <sup>3</sup> MRL	child NO adult NO	----

Notes: <sup>1</sup> Child trespasser: 400 mg/d IR; 36 d/yr exposure frequency; 6 yr exposure period; Adult trespasser: 200 mg/d IR; 36 d/yr exposure frequency; 30 yr exposure period

<sup>2</sup> An acute exposure is 1 to 14 days

<sup>3</sup> An intermediate exposure is 15 to 364 days

mg/kg-d = milligrams per kilogram per day

MRL = Minimum Risk Level

non-CA = non-cancer

HG = ATSDR published Health Guideline value

**Table 12. Site-specific recreational exposure dose estimates and health guideline comparison for the child and adult recreational exposure scenarios for soil samples collected from the 1950s mine and mill and 19<sup>th</sup> century operations areas. Samples collected in 2007.**

Contaminant	Calculated Maximum Exposure Dose <sup>1</sup> (mg/kg-d)	Cancer Slope Factor (CSF) (mg/kg-d)	Calculated Theoretical Increased Cancer Risk (in 1,000,000 exposed persons)	Equals 1 Increased Cancer in a Population of -
<b>1950s Mine and Mill Area</b>				
Total PAHs as Benzo(a)pyrene equivalent	9.4e-07 child 1.1e-7 adult	7.3	Less than 1	1,200,000
<b>19<sup>th</sup> Century Operations area</b>				
Total PAHs as Benzo(a)pyrene equivalent	7.0e-7 child 8.0e-8 adult	7.3	Less than 1	1,700,000

Notes: <sup>1</sup> Child trespasser: 400 mg/d IR; 36 d/yr exposure frequency; 6 yr exposure period; Adult trespasser: 200 mg/d IR; 36 d/yr exposure frequency; 30 yr exposure period  
mg/kg-d = milligrams per kilogram per day

**Table 13. Data summary and screening value analysis for metals detected in waste rock, slag, ore bin and processed materials collected in 2007. Table continued on the next page.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Aluminum	12	12	1	1,300 – 82,000	50,000 child 700,000 adult	Intermediate EMEG
					2,000 child	Pica Intermediate
Antimony	7	1	0	7.4 J	20 child 300 adult	RMEG
Arsenic	11	2	0	3.2 J – 4 J	20 child 200 adult	RMEG
					20	CREG
Barium	13	13	0	58 – 375	10,000 child 100,000 adult	Chronic EMEG
					400 child	Pica Intermediate
Beryllium	12	6	0	0.11 J – 1.9	100 child 1,000 adult	RMEG
Cadmium	13	6	1	1.5 – 7	30 child 400 adult	Intermediate EMEG
Calcium	12	11	0	120 – 61,000	No CVs	----
Chromium <sup>1</sup>	13	13	0	5.4 – 77	80,000 child 1,000,000 adult	RMEG
Cobalt	13	12	0	7.5 J – 390	500 child 7,000 adult	Intermediate EMEG
Copper	13	13	9	170 J – 20,000	500 child 7,000 adult	Intermediate EMEG
					20 pica child	Pica, acute, Intermediate

**Table 13, continued. Data summary and screening value analysis for metals detected in waste rock, slag, ore bin and processed materials collected in 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Iron	13	13	0	21,000 J – 270,000 J	720,000	EPA Industrial
Lead	13	13	0	11 J – 250 J	400	EPA residential
Magnesium	12	12	0	170 J – 11,000 J	No CVs	----
Manganese	12	12	1	73 – 7,100	3,000 child 40,000 adult	RMEG
Mercury	13	10	0	0.15 – 0.5	23	EPA residential
Nickel	13	8	0	4.2 J – 30 J	1,000 child 10,000 adult	RMEG
Potassium	12	12	0	980 – 10,000 J	No CVs	----
Selenium	13	10	0	3.7 J – 38	300 child 4,000 adult	RMEG
Silver	13	11	0	2.8 – 9.6 J	300 child 4,000 adult	RMEG
Sodium	12	8	0	310 J – 15,000	No CVs	----
Thallium	10	2	0	4.1 – 8.6	No CVs	----
Vanadium	13	13	0	18 – 130	200 child 2,000 adult	Intermediate EMEG
Zinc	12	12	0	47 J – 3,900 J	20,000 child 200,000 adult	Chronic EMEG
					600 child	Pica intermediate

Notes: <sup>1</sup> as Hexavalent chromium  
 CV = Comparison value (ATSDR established screening values)  
 mg/kg = milligrams per kilogram, or parts per million (ppm)  
 J = estimated analytical value  
 RMEG = Reference Dose Media Evaluation Guide  
 EMEG = Environmental Media Evaluation Guide

CREG = Cancer Risk Evaluation Guide  
 EPA Residential = U.S. Environmental Protection Agency Superfund health screening value for residential sites  
 EPA Industrial = U.S. Environmental Protection Agency Superfund health screening value for industrial sites

**Table 14. Data summary and screening value analysis for organic compounds detected in waste rock, slag, ore bin and processed materials. Samples collected in 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (µg/kg)	Comparison Values (CV), (µg/kg)	Type of CV
Anthracene	9	1	0	30 J	500,000,000 child 1,000,000,000 adult	Intermediate EMEG
Benzo(a)anthracene	9	4	0	38 J – 130 J	2,100	EPA Industrial
Benzo(b)fluoranthene	9	4	0	26 J – 130 J	2,100	EPA Industrial
Benzo(g,h,i)perylene	9	3	0	26 J – 64 J	No CVs	----
Benzo(k)fluoranthene	9	4	0	30 J – 130 J	2,100	EPA Industrial
Benzo(a)pyrene	9	3	1	41 J – 110 J	100	CREG
Chrysene	9	3	0	37J – 120 J	210,000	EPA Industrial
Fluoranthene	9	4	0	57 J – 250	20,000,000 child 300,000,000 adult	Intermediate EMEG
Indeno(1,2,3-cd)-pyrene	9	3	0	30 J – 86 J	2,100	EPA Industrial
Phenanthrene	9	2	0	58 J – 150 J	No CVs	----
Pyrene	9	3	0	53 J – 83 J	2,000,000 child 20,000,000 adult	RMEG

Notes: CV = Comparison value (ATSDR established screening values)  
µg/kg = micrograms per kilogram, or parts per billion (ppb)  
J = estimated analytical value  
RMEG = Reference Dose Media Evaluation Guide  
EMEG = Environmental Media Evaluation Guide  
CREG = Cancer Risk Evaluation Guide  
EPA Industrial = U.S. Environmental Protection Agency Superfund health screening value for industrial sites

**Table 15. Site-specific recreational exposure dose estimates and health guideline comparison for ingestion of metals detected in waste rock, slag, ore bin and processed materials collected in 2007.**

Contaminant	Calculated Maximum Exposure Dose <sup>1</sup> (mg/kg-d)	Calculated Mean Exposure Dose (mg/kg-d)	Health Guideline / Type (non-cancer) (mg/kg-d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult) ?	Does Calculated Geometric Mean Exposure Dose Exceed non-CA HG (child/adult) ?
Aluminum	0.020 child 0.023 adult	----	1.0 ATSDR Chronic <sup>2</sup> MRL	child NO adult NO	----
Cadmium	1.7e-05 child 2.0e-06 adult	----	0.0005 ATSDR Intermediate <sup>3</sup> MRL	child NO adult NO	----
Manganese	0.018 child 0.0020 adult	----	0.05 EPA chronic oral RfD	child NO adult NO	----
Copper	0.049 child 0.00056 adult	0.018 child 0.0021 adult	0.01 ATSDR Intermediate <sup>3</sup> MRL	child YES adult NO	child YES adult NO

Notes: <sup>1</sup> Child trespasser: 400 mg/d IR; 36 d/yr exposure frequency; 6 yr exposure period; Adult trespasser: 200 mg/d IR; 36 d/yr exposure frequency; 30 yr exposure period

<sup>2</sup> A chronic exposure is 365 days or longer

<sup>3</sup> An intermediate exposure is 15 to 364 days

mg/kg-d = milligrams per kilogram per day

MRL = Minimum Risk Level

non-CA = non-cancer

HG = ATSDR published Health Guideline value

EPA chronic oral RfD = U.S. Environmental Protection Agency Superfund health-based chronic oral reference dose value

**Table 16. Site-specific recreational exposure dose estimates and health guideline comparison for the child and adult trespasser exposure scenarios for waste rock, slag, ore bin and processed materials. Samples collected in 2007.**

Contaminant	Calculated Maximum Exposure Dose <sup>1</sup> (mg/kg-d)	Cancer Slope Factor (CSF) (mg/kg-d)	Calculated Theoretical Increased Cancer Risk (in 1,000,000 exposed persons)	Equals 1 Increased Cancer in a Population of -
Total PAHs as Benzo(a)pyrene equivalent	3.6e-07 child 4.2e-08 adult	7.3	Less than 1	3,300,000

Notes: <sup>1</sup> Child trespasser: 400 mg/d IR; 36 d/yr exposure frequency; 6 yr exposure period; Adult trespasser: 200 mg/d IR; 36 d/yr exposure frequency; 30 yr exposure period  
 mg/kg-d = milligrams per kilogram per day  
 PAH = polynuclear aromatic hydrocarbons

**Table 17. Data summary and screening value analysis for metals detected in main 20-acre tailings pile samples collected in 2007. Table continued on the next page.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Aluminum	9	9	0	780 – 6300	50,000 child 700,000 adult	Intermediate EMEG
					2,000 child	Pica Intermediate
Arsenic	8	8	0	2.2 J – 16 J	20 child 200 adult	RMEG
					20	CREG
Barium	9	9	0	70 – 240 J	10,000 child 100,000 adult	Chronic EMEG
					400 child	Pica Intermediate
Cadmium	7	4	0	0.81 J – 13	30 child 400 adult	Intermediate EMEG
Calcium	8	8	0	170 J – 32,000 J	No CVs	----
Chromium	9	9	0	5.2 – 79 J	80,000 child 1,000,000 adult	RMEG
Cobalt	9	8	0	8.9 – 230	500 child 7,000 adult	Intermediate EMEG
Copper	9	9	6	56 J – 6,000 J	500 child 7,000 adult	Intermediate EMEG
					20 pica child	Pica, acute, Intermediate
Iron	9	9	0	55,000 – 180,000	720,000	EPA Industrial
Lead	9	9	0	6.3 J – 23 J	400	EPA residential
Magnesium	9	9	0	180 J – 3,500 J	No CVs	----

**Table 17, continued. Data summary and screening value analysis for metals detected in main 20-acre tailings pile samples collected in 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Manganese	9	9	0	68 – 280 J	3,000 child 40,000 adult	RMEG
Mercury	9	9	0	0.13 – 0.71	23	EPA residential
Nickel	9	5	0	5.5 J – 26 J	1,000 child 10,000 adult	RMEG
Potassium	9	9	0	2,800 – 8,200	No CVs	----
Selenium	9	9	0	13 J – 87 J	300 child 4,000 adult	RMEG
Silver	9	8	0	1 J - 2.8	300 child 4,000 adult	RMEG
Sodium	9	4	0	330 J – 1,200	No CVs	----
Vanadium	9	9	0	12 J – 170 J	200 child 2,000 adult	Intermediate EMEG
Zinc	9	9	0	45 J – 1,500 J	20,000 child 200,000 adult	Chronic EMEG
					600 child	Pica intermediate

Notes: CV = Comparison value (ATSDR established screening values)  
 mg/kg = milligrams per kilogram, or parts per million (ppm)  
 J = estimated analytical value  
 RMEG = Reference Dose Media Evaluation Guide  
 EMEG = Environmental Media Evaluation Guide  
 CREG = Cancer Risk Evaluation Guide  
 EPA Industrial = U.S. Environmental Protection Agency Superfund health screening value for industrial sites  
 EPA Residential = U.S. Environmental Protection Agency Superfund health screening value for residential sites

**Table 18. Site-specific exposure dose estimates and health guideline comparison for the child and adult recreational exposure scenarios for the tailings pile samples. Samples collected in 2007.**

Contaminant	Calculated Maximum Exposure Dose (mg/kg-d)	Calculated Mean Exposure Dose (mg/kg-d)	Health Guideline / Type (non-cancer) (mg/kg-d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult) ?	Does Calculated Geometric Mean Exposure Dose Exceed non-CA HG (child/adult) ?
Copper	0.015 child 0.0017 adult	0.0044 child 0.00051 adult	0.01 ATSDR Intermediate <sup>2</sup> MRL	child YES adult NO	child NO adult NO

Notes: <sup>1</sup> Child trespasser: 400 mg/d IR; 36 d/yr exposure frequency; 6 yr exposure period; Adult trespasser: 200 mg/d IR; 36 d/yr exposure frequency; 30 yr exposure period

<sup>2</sup> An intermediate exposure is 15 to 364 days

mg/kg-d = milligrams per kilogram per day

MRL = Minimum Risk Level

non-CA = non-cancer

HG = ATSDR published Health Guideline value

**Table 19. Data summary and screening value analysis for substances detected in ponded and seep surface waters associated with the main tailings impoundment. Samples collected from 1990 through 2008. Table continued on the next page.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (µg/L)	Comparison Values (CV), (µg/L)	Type of CV
Aluminum	17	17	3	142 – 110,000	10,000 child 40,000 adult	Intermediate EMEG
Arsenic	14	2	1	2 - 4.5	3 child 10 adult	RMEG
					10	MCL
Barium	16	13	0	12.5 – 140	2,000 child 7,000 adult	Chronic EMEG
Beryllium	7	5	0	0.19 – 2.3	20 child 70 adult	RMEG
					4	MCL, MCLG
Cadmium	21	16	3	0.22 – 31	5 child 20 adult	Intermediate EMEG
					5	MCL, MCLG
Calcium	19	19	----	2,000 – 463,000 J	No CVs	----
Chromium <sup>1</sup>	19	7	3	3.3 – 120	50 child 200 adult	Intermediate EMEG <sup>1</sup>
					100	MCL, MCLG
Cobalt	7	7	3	1.3 J – 743	100 child 400 adult	Intermediate EMEG
Copper	21	21	14	3 J – 9,200	100 child 400 adult	Intermediate EMEG
Iron	19	19	12	720 – 4,090,000	26,000	EPA tap water
Lead	13	1	0	1.7 J	15	EPA MCL AL
Magnesium	20	20	----	481 – 130,000	No CVs	----
Manganese	20	20	16	37.3 J – 25,900	500 child 2,000 adult	RMEG
					300	EPA LTHA

**Table 19, continued. Data summary and screening value analysis for substances detected in ponded and seep surface waters associated with the main tailings impoundment. Samples collected from 1990 through 2008.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (µg/L)	Comparison Values (CV), (µg/L)	Type of CV
Mercury	10	3	0	0.031 – 0.083 (dissolved)	11	EPA Tap Water
Molybdenum	7	2	0	0.17 – 0.62	50 child 200 adult	RMEG
					40	EPA LTHA
Nickel	18	17	0	0.53 J – 180	200 child 700 adult	RMEG
					100	EPA LTHA
Potassium	13	13	----	1,400 – 46,300	No CVs	----
Selenium	12	5	0	2.8 (dissolved) - 12	50 child 100 adult	RMEG
					50	MCL, MCLG, LTHA
Silver	7	3	0	1.4 – 4.9	50 child 200 adult	RMEG
					100	EPA LTHA
Sodium	13	13	----	770 – 8,490	No CVs	----
Thallium	7	1	0	0.6	2 0.5 0.5	MCL MCLG EPA LTHA
Vanadium	7	3	1	7.4 – 36.4 (dissolved)	30 child 100 adult	Intermediate EMEG
Zinc	21	21	3	6.9 J – 4,900	3,000 child 10,000 adult	Chronic EMEG
					2,000	EPA LTHA

Notes: <sup>1</sup> as Hexavalent chromium  
 CV = Comparison value (ATSDR established screening values)  
 AL = Action Level  
 J = estimated analytical value  
 DW = drinking water  
 EPA = U.S. Environmental Protection Agency  
 RMEG = Reference Dose Media Evaluation Guide  
 EMEG = Environmental Media Evaluation Guide

CREG = Cancer Risk Evaluation Guide  
 LTHA = Lifetime Health Advisory for Drinking Water (EPA)  
 µg/L = micrograms per liter, parts per billion (ppb)  
 MCL = Maximum Contaminant Level for drinking water, EPA regulatory value  
 MCLG = Maximum Contaminant Level goal for drinking water, EPA non-regulatory value  
 EPA tap water = U.S. Environmental Protection Agency Superfund health screening values for tap water

**Table 20. Site-specific exposure dose estimates and health guideline comparison values for incidental ingestion recreational exposures of seep and ponded surface waters near the main tailings impoundment. Samples collected from 1990 through 2008.**

Contaminant	Calculated Maximum Exposure Dose <sup>1</sup> (mg/kg-d)	Calculated Mean Exposure Dose <sup>1</sup> (mg/kg-d)	Health Guideline / Type <sup>2</sup> (non-cancer) (mg/kg-d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult) ?	Does Calculated Geometric Mean Exposure Dose Exceed non-CA HG (child/adult) ?
Aluminum	0.011 child	0.050 child	1	child NO	child NO
Arsenic	4.6e-07 child	----	0.005 ATSDR Intermediate <sup>3</sup> MRL	child NO	----
Cadmium	3.2e-06 child	2.4e-06 child	0.0005 ATSDR Intermediate <sup>3</sup> MRL	child NO	----
Chromium	1.2e-05 child	1.0e-05 child	0.001 as 6Cr	child NO	child NO
Cobalt	7.6e-05 child	4.4e-05 child	0.01 ATSDR Intermediate <sup>3</sup> MRL	child NO	child NO
Copper	9.4e-04 child	2.1e-04 child	0.01 ATSDR Intermediate <sup>3</sup> MRL	child NO	child NO
Iron	0.42 child	0.078 child	0.70 EPA chronic oral RfD	child NO	----
Manganese	0.0027 child	5.6e-04 child	0.05 EPA chronic oral RfD	child NO	child NO
Vanadium	3.7e-06 child	----	0.003 ATSDR Intermediate <sup>3</sup> MRL	child NO	----
Zinc	5.0e-04 child	4.6e-04 child	0.3	child NO	child NO

Notes: <sup>1</sup> Child trespasser: 400 mg/d IR; 36 d/yr exposure frequency; 6 yr exposure period; Adult trespasser: 200 mg/d IR; 36 d/yr exposure frequency; 30 yr exposure period

<sup>2</sup> Listed health guideline is an ATSDR chronic exposure (1 to 14 days) MRL, unless specified otherwise

<sup>3</sup> An intermediate exposure is 15 to 364 days

mg/kg-d = milligrams per kilogram per day

MRL = Minimum Risk Level

non-CA = non-cancer

HG = ATSDR published Health Guideline value

EPA chronic oral RfD = U.S. Environmental Protection Agency Superfund health-based chronic oral reference dose value

6Cr = Hexavalent chromium

**Table 21. Data summary and screening value analysis for substances detected in Ore Knob Branch and its tributaries surface water samples. Samples collected from 1987 through 2008. Table continued on the next page.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (µg/L)	Comparison Values (CV), (µg/L)	Type of CV
Aluminum	23	21	1	590 – 17,000	10,000 child 40,000 adult	Intermediate EMEG
Barium	5	5	0	15.5 – 35.9 J	2,000 child 7,000 adult	Chronic EMEG
Beryllium	5	5	0	0.67 – 1.1	20 child 40 adult	Chronic EMEG
					4	MCL
Cadmium	28	12	2	0.94 – 5.5	5 child 20 adult	Intermediate EMEG
					5	MCL, MCLG
Calcium	17	17	----	39,000 – 130,000	No CVs	----
Chromium <sup>1</sup>	22	5	1	4.5 - 51	50 child 200 adult	Intermediate EMEG <sup>1</sup>
					100	MCL
Cobalt	3	3	1	63.4 – 124	100 child 400 adult	Intermediate EMEG
Copper	26	26	23	170 – 1,600	100 child 400 adult	Intermediate EMEG
Iron	19	19	19	49,000 – 840,000	26,000	EPA RSL tap water
Lead	24	4	0	0.5 J – 13	15	EPA MCL AL
Magnesium	23	23	----	6,400 – 180,000	No CVs	----

**Table 21, continued. Data summary and screening value analysis for substances detected in Ore Knob Branch and Tributaries surface water samples. Samples collected from 1987 through 2008.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (µg/L)	Comparison Values (CV), (µg/L)	Type of CV
Manganese	22	22	22	1,180 – 22,000	500 child 2,000 adult	RMEG
					300	EPA LTHA
Molybdenum	5	1	0	0.21B	50 child 200 adult	RMEG
					40	EPA LTHA
Nickel	26	21	0	11.9 - 130	200 child 700 adult	RMEG
					100	EPA LTHA
Potassium	4	4	----	5,700 – 17,000	No CVs	----
Selenium	3	3	0	5	50 child 100 adult	RMEG
					50	MCL, MCLG, LTHA
Silver	3	3	0	5	50 child 200 adult	RMEG
					100	LTHA
Sodium	4	4	----	1,800 – 3,330	No CVs	----
Thallium	3	1	0	0.3	2 0.5 0.5	MCL MCLG LTHA
Zinc	30	25	3	4,100 – 10,000	3,000 child 10,000 adult	Chronic EMEG
					2,000	EPA LTHA

Notes:

<sup>1</sup> as Hexavalent chromium  
CV = Comparison value (ATSDR established screening values)  
AL = Action Level  
J = estimated analytical value  
DW = drinking water  
EPA = U.S. Environmental Protection Agency  
RMEG = Reference Dose Media Evaluation Guide  
EMEG = Environmental Media Evaluation Guide

CREG = Cancer Risk Evaluation Guide  
LTHA = Lifetime Health Advisory for Drinking Water (EPA)  
µg/L = micrograms per liter, parts per billion (ppb)  
MCL = Maximum Contaminant Level for drinking water, EPA regulatory value  
MCLG = Maximum Contaminant Level goal for drinking water, EPA non-regulatory value  
EPA tap water = U.S. Environmental Protection Agency Superfund health screening values for tap water  
RSL = Regional Screening Level

**Table 22. Site-specific exposure dose estimates and health guideline comparison for incidental ingestion during recreational activities of surface waters collected in Ore Knob Branch. Samples collected from 1987 through 2008.**

Contaminant	Calculated Maximum Exposure Dose <sup>1</sup> (mg/kg-d)	Calculated Mean Exposure Dose (mg/kg-d)	Health Guideline / Type <sup>2</sup> (non-cancer) (mg/kg-d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult) ?	Does Calculated Geometric Mean Exposure Dose Exceed non-CA HG (child/adult) ?
Aluminum	0.0018 child	----	1	child NO	----
Cadmium	5.6e-07 child	5.6e-07 child	0.0001	child NO	----
Chromium	5.2e-06 child	----	0.001 as 6Cr	child NO	----
Cobalt	1.3e-05 child	----	0.01 ATSDR Intermediate <sup>3</sup> MRL	child NO	----
Copper	1.6e-04 child	5.6e-05 child	0.01 ATSDR Intermediate <sup>3</sup> MRL	child NO	child NO
Iron	0.086 child	0.19 child	0.7 EPA oral RfD	child NO	child NO
Manganese	0.0023 child	4.4e-04 child	0.05 EPA oral RfD	child NO	child NO
Zinc	0.0010 child	7.6e-4 child	0.03	child NO	child NO

Notes: <sup>1</sup> Child trespasser: 400 mg/d IR; 36 d/yr exposure frequency; 6 yr exposure period; Adult trespasser: 200 mg/d IR; 36 d/yr exposure frequency; 30 yr exposure period

<sup>2</sup> Listed health guideline is an ATSDR chronic exposure (1 to 14 days) MRL, unless specified otherwise

<sup>3</sup> An intermediate exposure is 15 to 364 days

mg/kg-d = milligrams per kilogram per day

MRL = minimum risk level

non-CA = non-cancer

HG = ATSDR published Health Guideline value

EPA oral RfD = U.S. Environmental Protection Agency Superfund health-based oral reference dose value

**Table 23. Data summary and screening value analysis for metals detected in Ore Knob Branch sediment and floodplain soil. Table continued on the next page. Samples collected in 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Aluminum	9	9	0	1,900 J – 4,900 J	50,000 child 700,000 adult	Intermediate EMEG
					2,000 child	Pica Intermediate
Arsenic	8	7	0	1.6 J – 3.8 J	20 child 200 adult	RMEG
					20	CREG
Barium	8	8	0	59 J – 220	10,000 child 100,000 adult	Chronic EMEG
					400 child	Pica Intermediate
Beryllium	8	6	0	0.074 J – 2.2	100 child 1,000 adult	RMEG
Cadmium	9	5	0	0.7 – 6.7	30 child 400 adult	Intermediate EMEG
Calcium	8	8	0	180 J – 3,100 J	No CVs	----
Chromium <sup>1</sup>	9	9	0	2.4 – 44	80,000 child 1,000,000 adult	RMEG
Cobalt	8	8	0	2.1 J – 140	500 child 7,000 adult	Intermediate EMEG
Copper	9	9	6	93 – 4,200 J	500 child 7,000 adult	Intermediate EMEG
					20 pica child	Pica, acute, Intermediate
Iron	8	8	0	51,000 – 550,000	720,000	EPA Industrial

**Table 23, continued. Data summary and screening value analysis for metals detected in Ore Knob Branch sediment and floodplain soil. Samples collected in 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Lead	9	9	0	4.6 – 24 J	400	EPA residential
Magnesium	9	9	0	540 J – 6,200 J	No CVs	----
Manganese	9	9	0	17 – 820	3,000 child 40,000 adult	RMEG
Mercury	8	8	0	0.16 – 0.29	23	EPA residential
Nickel	9	2	0	17 J – 19 J	1,000 child 10,000 adult	RMEG
Potassium	8	8	0	1,600 J – 10,000	No CVs	----
Selenium	8	6	0	12 J – 20 J	300 child 4,000 adult	RMEG
Silver	9	7	0	0.62 J – 1.6 J	300 child 4,000 adult	RMEG
Sodium	8	1	0	600 J	No CVs	----
Thallium	6	1	0	4.4	No CVs	----
Vanadium	8	8	0	22 J – 73	200 child 2,000 adult	Intermediate EMEG
Zinc	9	9	0	27 J – 1,000 J	20,000 child 200,000 adult	Chronic EMEG
					600 child	Pica intermediate

Notes: <sup>1</sup> as hexavalent chromium  
 CV = Comparison value (ATSDR established screening values)  
 mg/kg = milligrams per kilogram, or parts per million (ppm)  
 J = estimated analytical value  
 RMEG = Reference Dose Media Evaluation Guide  
 EMEG = Environmental Media Evaluation Guide  
 CREG = Cancer Risk Evaluation Guide  
 EPA Industrial = U.S. Environmental Protection Agency Superfund health screening value for industrial sites  
 EPA Residential = U.S. Environmental Protection Agency Superfund health screening value for residential sites

**Table 24. Site-specific exposure dose estimates and health guideline comparison for child and adult recreational exposure scenarios for Ore Knob Branch sediments and floodplain soils. Samples collected in 2007.**

Contaminant	Calculated Maximum Exposure Dose (mg/kg-d) <sup>1</sup>	Calculated Mean Exposure Dose (mg/kg-d)	Health Guideline / Type (non-cancer) (mg/kg-d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult) ?	Does Calculated Geometric Mean Exposure Dose Exceed non-CA HG (child/adult) ?
Copper	0.010 child 0.0012 adult	0.0024 child 0.00027 adult	0.01 ATSDR Intermediate <sup>2</sup> MRL	child YES adult NO	child NO adult NO

Notes: <sup>1</sup> Child trespasser: 400 mg/d IR; 36 d/yr exposure frequency; 6 yr exposure period; Adult trespasser: 200 mg/d IR; 36 d/yr exposure frequency; 30 yr exposure period

<sup>2</sup> An intermediate exposure is 15 to 364 days

mg/kg-d = milligrams per kilogram per day

MRL = minimum risk level

non-CA = non-cancer

HG = ATSDR published Health Guideline value

EPA chronic oral RfD = U.S. Environmental Protection Agency Superfund health-based chronic oral reference dose value

**Table 25. Data summary and screening value analysis for organic compounds detected in Ore Knob Branch sediments and floodplain soils. Samples collected in 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (µg/kg)	Comparison Values (CV), (µg/kg)	Type of CV
Benzo(a)anthracene	8	1	0	45 J	2,100	EPA Industrial
Benzo(b)fluoranthene	8	1	0	37 J	2,100	EPA Industrial
Benzo(k)fluoranthene	8	1	0	42 J	2,100	EPA Industrial
Fluoranthene	8	1	0	83 J	20,000,000 child 300,000,000 adult	Intermediate EMEG

Notes: CV = Comparison value (ATSDR established screening values)

µg/kg = micrograms per kilogram, or parts per billion (ppb)

J = estimated analytical value

EMEG = Environmental Media Evaluation Guide

EPA Industrial = U.S. Environmental Protection Agency Superfund health screening value for industrial sites

**Table 26. Site-specific exposure dose estimates and health guideline comparison for the child and adult trespasser exposure scenarios for Ore Knob Branch sediments and floodplain soils. Samples collected in 2007.**

<b>Contaminant</b>	<b>Calculated Maximum Exposure Dose <sup>1</sup> (mg/kg-d)</b>	<b>Cancer Slope Factor (CSF) (mg/kg-d)</b>	<b>Calculated Theoretical Increased Cancer Risk (in 1,000,000 exposed persons)</b>	<b>Equals 1 Increased Cancer in a Population of -</b>
Total PAHs as Benzo(a)pyrene equivalent	2.2e-08 child 2.4e-09 adult	7.3	Less than 1	57,000,000

Notes: <sup>1</sup> Child trespasser: 400 mg/d IR; 36 d/yr exposure frequency; 6 yr exposure period; Adult trespasser: 200 mg/d IR; 36 d/yr exposure frequency; 30 yr exposure period  
 mg/kg-d = milligrams per kilogram per day  
 PAH = polynuclear aromatic hydrocarbons

**Table 27. Data summary and screening value analysis for substances detected in Little Peak Creek and its tributaries surface water samples. Samples collected from 1990 through 2007. Table continued on the next page.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (µg/L)	Comparison Values (CV), (µg/L)	Type of CV
Aluminum	10	10	0	284 J – 3590 J	10,000 child 40,000 adult	Intermediate EMEG
Barium	4	4	0	22.8 – 34	2,000 child 7,000 adult	Chronic EMEG
Beryllium	4	2	0	0.37 – 1.2	20 child 40 adult	Chronic EMEG
					4	MCL
Cadmium	10	2	0	0.3 – 0.91	5 child 20 adult	Intermediate EMEG
					5	MCL, MCLG
Calcium	10	10	0	2,210 – 33,700	No CVs	----
Chromium	10	1	0	1.9	50 child 200 adult	Intermediate EMEG <sup>1</sup>
					100	MCL
Cobalt	4	4	0	0.52 J – 77.5 J	100 child 400 adult	Intermediate EMEG
Copper	10	10	0	1.7 J – 81.3 J	100 child 400 adult	Intermediate EMEG
Iron	10	10	0	120 – 4,890	26,000	EPA tap water
Lead	10	2	0	0.6 – 0.59 J	15	EPA MCL AL

**Table 27, continued. Data summary and screening value analysis for substances detected in Little Peak Creek and its tributaries surface water samples. Samples collected from 1990 through 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (µg/L)	Comparison Values (CV), (µg/L)	Type of CV
Magnesium	10	10	0	799 – 7,560	No CVs	----
Manganese	10	10	2	1,320 – 3,570	500 child 2,000 adult	RMEG
					300	EPA LTHA
Nickel	10	7	0	2.2 J – 14 J	200 child 700 adult	RMEG
					100	EPA LTHA
Potassium	4	4	0	1,210 – 3,910	No CVs	----
Sodium	4	4	0	1,950 – 4,570	No CVs	----
Zinc	10	10	0	4.5 J - 139 J	3,000 child 10,000 adult	Chronic EMEG
					2,000	EPA LTHA

Notes: <sup>1</sup> as Hexavalent chromium  
 CV = Comparison value (ATSDR established screening values)  
 AL = Action Level  
 J = estimated analytical value  
 DW = drinking water  
 EPA = U.S. Environmental Protection Agency  
 RMEG = Reference Dose Media Evaluation Guide  
 EMEG = Environmental Media Evaluation Guide  
 CREG = Cancer Risk Evaluation Guide  
 LTHA = Lifetime Health Advisory for Drinking Water (EPA)  
 µg/L = micrograms per liter, parts per billion (ppb)  
 MCL = Maximum Contaminant Level for drinking water, EPA regulatory value  
 MCLG = Maximum Contaminant Level goal for drinking water, EPA non-regulatory value  
 EPA tap water = U.S. Environmental Protection Agency Superfund health screening values for tap water

**Table 28. Site-specific exposure dose estimates and health guideline comparison for incidental ingestion during recreational activities of surface waters collected in Little Peak Creek. Samples collected from 1990 through 2007.**

<b>Contaminant</b>	<b>Calculated Maximum Exposure Dose <sup>1</sup> (mg/kg-d)</b>	<b>Calculated Mean Exposure Dose <sup>1</sup> (mg/kg-d)</b>	<b>Health Guideline / Type (non-cancer) (mg/kg-d)</b>	<b>Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult) ?</b>
Manganese	3.7e-04 child	2.5e-04 child	0.05 EPA oral RfD	child NO

Notes: <sup>1</sup> Child trespasser: 400 mg/d IR; 36 d/yr exposure frequency; 6 yr exposure period  
<sup>1</sup> Adult trespasser: 200 mg/d IR; 36 d/yr exposure frequency; 30 yr exposure period  
 mg/kg-d = milligrams per kilogram per day  
 MRL = Minimum Risk Level  
 non-CA = non-cancer  
 HG = ATSDR published Health Guideline value  
 EPA oral RfD = U.S. Environmental Protection Agency Superfund health-based oral reference dose value

**Table 29. Data summary and screening value analysis for metals detected in Little Peak Creek sediments and floodplain soils. Samples collected in 2007. Table continued on the next page.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Aluminum	8	8	0	2,500 J – 18,000	50,000 child 700,000 adult	Intermediate EMEG
					2,000 child	Pica Intermediate
Arsenic	8	2	0	1.1 J – 1.5 J	20 child 200 adult	RMEG
					20	CREG
Barium	8	8	0	20 J – 120 J	10,000 child 100,000 adult	Chronic EMEG
					400 child	Pica Intermediate
Beryllium	8	2	0	0.75 – 0.9	100 child 1,000 adult	RMEG
Calcium	8	8	0	120 J – 610 J	No CVs	----
Chromium	8	8	0	12 J - 46	80,000 child 1,000,000 adult	RMEG
Cobalt	8	6	0	2.8 J - 15	500 child 7,000 adult	Intermediate EMEG
Copper	8	8	2	5.7 J – 900 J	500 child 7,000 adult	Intermediate EMEG
					20 pica child	Pica, acute, Intermediate
Iron	8	8	0	12,000 – 43,000	720,000	EPA RSL Industrial

**Table 29, continued. Data summary and screening value analysis for metals detected in Little Peak Creek sediments and floodplain soils. Samples collected in 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Lead	8	8	0	3.1 J – 10 J	400	EPA residential
Magnesium	8	8	0	750 J – 3,700 J	No CVs	----
Manganese	8	8	0	120 - 470	3,000 child 40,000 adult	RMEG
Nickel	8	4	0	5.4 J – 14 J	1,000 child 10,000 adult	RMEG
Potassium	8	8	0	600 J – 3,500 J	No CVs	----
Selenium	6	1	0	19 J	300 child 4,000 adult	RMEG
Silver	5	1	0	0.93 J	300 child 4,000 adult	RMEG
Vanadium	8	8	0	13 J – 70 J	200 child 2,000 adult	Intermediate EMEG
Zinc	8	8	0	18 J – 81 J	20,000 child 200,000 adult	Chronic EMEG
					600 child	Pica Intermediate

Notes: CV = Comparison value (ATSDR established screening values)  
mg/kg = milligrams per kilogram, or parts per million (ppm)  
J = estimated analytical value  
RMEG = Reference Dose Media Evaluation Guide  
EMEG = Environmental Media Evaluation Guide  
CREG = Cancer Risk Evaluation Guide  
EPA Residential = U.S. Environmental Protection Agency Superfund health screening value for residential sites  
RSL = Regional Screening Level

**Table 30. Site-specific recreational exposure dose estimates and health guideline comparison values for Little Peak Creek sediments and floodplain soils. Samples collected in 2007.**

Contaminant	Calculated Maximum Exposure Dose (mg/kg-d) <sup>1</sup>	Calculated Mean Exposure Dose (mg/kg-d)	Health Guideline / Type (non-cancer) (mg/kg-d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult) ?	Does Calculated Geometric Mean Exposure Dose Exceed non-CA HG (child/adult) ?
Copper	0.0022 child 0.00025 adult	0.0018 child 0.00021 adult	0.01 ATSDR Intermediate <sup>2</sup> MRL	child NO adult NO	child NO adult NO

Notes: <sup>1</sup> Child trespasser: 400 mg/d IR; 36 d/yr exposure frequency; 6 yr exposure period; Adult trespasser: 200 mg/d IR; 36 d/yr exposure frequency; 30 yr exposure period  
<sup>2</sup> An intermediate exposure is 15 to 364 days  
 mg/kg-d = milligrams per kilogram per day  
 MRL = minimum risk level  
 non-CA = non-cancer  
 HG = ATSDR published Health Guideline value

**Table 31. Data summary and screening value analysis for organic compounds detected in Little Peak Creek sediments and floodplain soils. Samples collected in 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (µg/kg)	Comparison Values (CV), (µg/kg)	Type of CV
<i>o</i> -Cresol	8	1	0	45 J	3,000 child 40,000 adult	RMEG
					100	Pica Intermediate
Benzaldehyde	8	1	0	100 J	5,000 child 70,000 adult	RMEG

Notes: CV = Comparison value (ATSDR established screening values)  
 µg/kg = micrograms per kilogram, or parts per billion (ppb)  
 J = estimated analytical value  
 RMEG = Reference Dose Media Evaluation Guide

**Table 32. Data summary and screening value analysis for substances detected in Peak Creek and its tributaries surface water samples. Samples collected from 1987 through 2008.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (µg/L)	Comparison Values (CV), (µg/L)	Type of CV
Aluminum	43	40	0	93 - 633	10,000 child 40,000 adult	Intermediate EMEG
Barium	11	10	0	11.7 – 24	2,000 child 7,000 adult	Chronic EMEG
Cadmium	46	10	0	0.11 – 0.94 J	5 child 20 adult	Intermediate EMEG
					5	MCL, MCLG
Calcium	45	45	0	500 – 9,270	No CVs	----
Chromium <sup>1</sup>	36	8	0	1.3 – 1.7	50 child 200 adult	Intermediate EMEG <sup>1</sup>
					100	MCL
Cobalt	7	7	0	0.58 J – 8.5 J	100 child 400 adult	Intermediate EMEG
Copper	46	42	1	0.56 J – 330	100 child 400 adult	Intermediate EMEG
Iron	45	45	0	72 – 12,900	26,000	EPA tap water
Magnesium	45	45	0	730 – 16,000	No CVs	----
Manganese	45	45	0	8.1 – 226 J	500 child 2,000 adult	RMEG
					300	EPA LTHA
Nickel	44	16	0	0.58 J – 10	200 child 700 adult	RMEG
					100	EPA LTHA
Potassium	9	9	0	1000 – 1900	No CVs	----
Sodium	9	9	0	2,110 – 2,690	No CVs	----
Zinc	46	39	0	3.2 J – 850	3,000 child 10,000 adult	Chronic EMEG
					2,000	EPA LTHA

Notes:

<sup>1</sup> as Hexavalent chromium

CV = Comparison value (ATSDR established screening values)

AL = Action Level

J = estimated analytical value

DW = drinking water

EPA = U.S. Environmental Protection Agency

RMEG = Reference Dose Media Evaluation Guide

EMEG = Environmental Media Evaluation Guide

CREG = Cancer Risk Evaluation Guide

LTHA = Lifetime Health Advisory for Drinking Water

µg/L = micrograms per liter, parts per billion (ppb)

MCL = Maximum Contaminant Level for drinking water, EPA regulatory value

MCLG = Maximum Contaminant Level goal for drinking water, EPA non-regulatory value

EPA tap water = U.S. Environmental Protection Agency

Superfund health screening values for tap water

**Table 33. Site-specific recreational exposure dose estimates and health guideline comparison values for surface waters collected in Peak Creek. Samples collected from 1987 through 2008.**

Contaminant	Calculated Maximum Exposure Dose (mg/kg-d) <sup>1</sup>	Calculated Mean Exposure Dose (mg/kg-d)	Health Guideline / Type (non-cancer) (mg/kg-d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult) ?	Does Calculated Geometric Mean Exposure Dose Exceed non-CA HG (child/adult) ?
Copper	3.4e-05 child	----	0.01 ATSDR Intermediate <sup>2</sup> MRL	child NO	----

Notes: <sup>1</sup> Child trespasser: 400 mg/d IR; 36 d/yr exposure frequency; 6 yr exposure period; Adult trespasser: 200 mg/d IR; 36 d/yr exposure frequency; 30 yr exposure period

<sup>2</sup> An intermediate exposure is 15 to 364 days

mg/kg-d = milligrams per kilogram per day

MRL = minimum risk level

non-CA = non-cancer

HG = ATSDR published Health Guideline value

**Table 34. Data summary and screening value analysis for metals detected in Peak Creek sediments and floodplain soils. Samples collected in 2007. Table continued on the next page.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Aluminum	9	9	0	2,900 – 13,000	50,000 child 700,000 adult	Intermediate EMEG
					2,000 child	Pica Intermediate
Arsenic	8	4	1	0.67 J – 67 J	20 child 200 adult	RMEG
					20	CREG
Barium	9	9	0	19 J - 220	10,000 child 100,000 adult	Chronic EMEG
					400 child	Pica Intermediate
Beryllium	9	2	0	0.27 J – 0.65	100 child 1,000 adult	RMEG
Cadmium	9	1	0	15	30 child 400 adult	Intermediate EMEG
Calcium	9	7	0	210 J – 10,000 J	No CVs	----
Chromium <sup>1</sup>	9	9	0	11 - 390	80,000 child 1,000,000 adult	RMEG <sup>1</sup>
Cobalt	9	8	1	3.7 J – 500	500 child 7,000 adult	Intermediate EMEG
Copper	9	9	3	5.7 J – 99,000 J	500 child 7,000 adult	Intermediate EMEG
					20 pica child	Pica, acute, Intermediate

**Table 34, continued. Data summary and screening value analysis for metals detected in Peak Creek sediments and floodplain soils. Samples collected in 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Iron	9	9	1	6,400 J – 940,000 J	720,000	EPA Industrial
Lead	9	9	0	1.7 J – 370 J	400	EPA residential
Magnesium	9	9	0	480 J – 4,400 J	No CVs	----
Manganese	9	9	0	94 J - 770	3,000 child 40,000 adult	RMEG
Mercury	9	1	0	1.2	23	EPA residential
Nickel	9	7	0	6 J – 350 J	1,000 child 10,000 adult	RMEG
Potassium	9	9	0	310 J – 14,000 J	No CVs	----
Selenium	4	3	0	7 - 260	300 child 4,000 adult	RMEG
Silver	9	3	0	1.7 - 23	300 child 4,000 adult	RMEG
Sodium	9	2	0	320 J – 1,200 J	No CVs	----
Vanadium	9	9	0	12 - 88	200 child 2,000 adult	Intermediate EMEG
Zinc	9	9	0	14 J – 6,900 J	20,000 child 200,000 adult	Chronic EMEG
					600 child	Pica intermediate

Notes: <sup>1</sup> as Hexavalent chromium  
 CV = Comparison value (ATSDR established screening values)  
 mg/kg = milligrams per kilogram, or parts per million (ppm)  
 J = estimated analytical value  
 RMEG = Reference Dose Media Evaluation Guide  
 EMEG = Environmental Media Evaluation Guide  
 CREG = Cancer Risk Evaluation Guide  
 EPA Residential = U.S. Environmental Protection Agency Superfund health screening value for residential sites  
 EPA Industrial = U.S. Environmental Protection Agency Superfund health screening value for industrial sites

**Table 35. Site-specific recreational exposure dose estimates and health guideline comparison values for metals in Peak Creek sediments and floodplain soils. Samples collected in 2007.**

Contaminant	Calculated Maximum Exposure Dose <sup>1</sup> (mg/kg-d)	Calculated Mean Exposure Dose <sup>1</sup> (mg/kg-d)	Health Guideline / Type (non-cancer) (mg/kg-d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult) ?	Does Calculated Geometric Mean Exposure Dose Exceed non-CA HG (child/adult) ?
Arsenic	0.00016 child 1.9e-05 adult	----	0.005 ATSDR Acute <sup>2</sup> MRL	child NO adult NO	----
Cobalt	0.0012 child 0.00014 adult	----	0.01 ATSDR Intermediate <sup>3</sup> MRL	child NO adult NO	----
Copper	0.24 child 0.028 adult	0.13 child 0.015 adult	0.01 ATSDR Intermediate <sup>3</sup> MRL	child YES adult YES	child YES adult YES
Iron	2.3 child 0.26 adult	----	0.70 EPA oral RfD	child YES adult NO	----

Notes: <sup>1</sup> Child trespasser: 400 mg/d IR; 36 d/yr exposure frequency; 6 yr exposure period; Adult trespasser: 200 mg/d IR; 36 d/yr exposure frequency; 30 yr exposure period

<sup>2</sup> An acute exposure is 1 to 14 days

<sup>3</sup> An intermediate exposure is 15 to 364 days

mg/kg-d = milligrams per kilogram per day

MRL = minimum risk level

non-CA = non-cancer

HG = ATSDR published Health Guideline value

EPA oral RfD = U.S. Environmental Protection Agency Superfund health-based oral reference dose value

**Table 36. Data summary and screening value analysis for organic compounds detected in Peak Creek sediments and floodplain soils. Samples collected in 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (µg/kg)	Comparison Values (CV), (µg/kg)	Type of CV
Benzaldehyde	9	1	0	180 J	5,000,000 child 70,000,000 adult	RMEG
Benzo(b)fluoranthene	9	1	0	22 J	2,100	EPA Industrial
Benzo(k)fluoranthene	9	1	0	22 J	2,100	EPA Industrial

Notes: CV = Comparison value (ATSDR established screening values)

µg/kg = micrograms per kilogram, or parts per billion (ppb)

J = estimated analytical value

RMEG = Reference Dose Media Evaluation Guide

EPA Industrial = U.S. Environmental Protection Agency Superfund health screening value for industrial sites

**Table 37. Site-specific recreational exposure dose estimates and health guideline comparison values for PAHs detected in Peak Creek sediments and floodplain soils. Samples collected in 2007.**

<b>Contaminant</b>	<b>Calculated Maximum Exposure Dose <sup>1</sup> (mg/kg-d)</b>	<b>Cancer Slope Factor (CSF) (mg/kg-d)</b>	<b>Calculated Theoretical Increased Cancer Risk (in 1,000,000 exposed persons)</b>	<b>Equals 1 Increased Cancer in a Population of -</b>
Total PAHs as Benzo(a)pyrene equivalent	6.0e-09 child 6.8e-10 adult	7.3	Less than 1	200,000,000

Notes: <sup>1</sup> Child trespasser: 400 mg/d IR; 36 d/yr exposure frequency; 6 yr exposure period;  
 Adult trespasser: 200 mg/d IR; 36 d/yr exposure frequency; 30 yr exposure period  
 mg/kg-d = milligrams per kilogram per day  
 PAH = polynuclear aromatic hydrocarbons

**Table 38. Data summary and screening value analysis for metals detected in South Fork New River surface water samples collected 630 feet downstream of Peak Creek. Samples collected in 2007. Table continued on the next page.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (µg/L)	Comparison Values (CV), (µg/L)	Type of CV
Aluminum	5	5	0	175 – 298	10,000 child 40,000 adult	Intermediate EMEG
Barium	5	5	0	11.6 - 12.6	2,000 child 7,000 adult	Chronic EMEG
Calcium	5	5	0	4,510 – 5,220	No CVs	----
Chromium <sup>1</sup>	5	4	0	1.4 – 1.6	50 child 200 adult	Intermediate EMEG <sup>1</sup>
					100	MCL
Cobalt	5	5	0	0.28 J – 1.2 J	100 child 400 adult	Intermediate EMEG
Copper	5	5	0	1.5 J – 3.6 J	100 child 400 adult	Intermediate EMEG
Iron	5	5	0	492 – 766	26,000	EPA tap water
Magnesium	5	5	0	1,830 – 2,120	No CVs	----
Manganese	5	5	0	20.7 J - 54.2 J	500 child 2,000 adult	RMEG
					300	EPA LTHA
Molybdenum	5	3	0	0.11 – 0.15	50 child 200 adult	RMEG
					40	EPA LTHA
Nickel	5	5	0	0.63 J – 3.1 J	200 child 700 adult	RMEG
					100	EPA LTHA

**Table 38, continued. Data summary and screening value analysis for metals detected in South Fork New River surface water samples collected 630 feet downstream of Peak Creek. Sample collection in 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (µg/L)	Comparison Values (CV), (µg/L)	Type of CV
Potassium	5	5	0	1,230 – 1,390	No CVs	----
Sodium	5	5	0	5,075 J – 5,860 J	No CVs	----
Zinc	5	5	0	2.4 J – 22.3 J	3,000 child 10,000 adult	Chronic EMEG
					2,000	EPA LTHA

Notes: <sup>1</sup> as Hexavalent chromium  
 CV = Comparison value (ATSDR established screening values)  
 AL = Action Level  
 J = estimated analytical value  
 DW = drinking water  
 EPA = U.S. Environmental Protection Agency  
 RMEG = Reference Dose Media Evaluation Guide  
 EMEG = Environmental Media Evaluation Guide  
 CREG = Cancer Risk Evaluation Guide  
 LTHA = Lifetime Health Advisory for Drinking Water (EPA)  
 µg/L = micrograms per liter, parts per billion (ppb)  
 MCL = Maximum Contaminant Level for drinking water, EPA regulatory value  
 MCLG = Maximum Contaminant Level goal for drinking water, EPA non-regulatory value  
 EPA tap water = U.S. Environmental Protection Agency Superfund health screening values for tap water

**Table 39. Data summary and screening value analysis for metals detected in South Fork New River sediments and floodplain soils. Samples collected in 2007. Table continued on the next page.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Aluminum	6	8	0	2,500 J – 19,000	50,000 child 700,000 adult	Intermediate EMEG
					2,000 child	Pica Intermediate
Arsenic	6	2	0	1.4 J – 1.9 J	20 child 200 adult	RMEG
					20	CREG
Barium	6	6	0	8.5 J - 150	10,000 child 100,000 adult	Chronic EMEG
					400 child	Pica Intermediate
Beryllium	6	1	0	0.9	100 child 1,000 adult	RMEG
Calcium	6	6	0	180 – 1,500 J	No CVs	----
Chromium <sup>1</sup>	6	6	0	4 J - 32	80,000 child 1,000,000 adult	RMEG
Cobalt	6	4	0	3.4J - 16	500 child 7,000 adult	Intermediate EMEG
Copper	6	6	1	4J – 570 J	500 child 7,000 adult	Intermediate EMEG
					20 pica child	Pica, acute, Intermediate
Iron	6	6	0	5,400 J – 130,000 J	720,000	EPA RSL Industrial
Lead	6	6	0	0.76 J – 16 J	400	EPA RSL residential

**Table 39, continued. Data summary and screening value analysis for metals detected in South Fork New River sediments and floodplain soils. Samples collected in 2007.**

Contaminant	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV), (mg/kg)	Type of CV
Magnesium	6	6	0	200 J – 4,800 J	No CVs	----
Manganese	6	6	0	82 J – 470 J	3,000 child 40,000 adult	RMEG
Mercury	6	1	0	0.29	310	EPA Industrial
Nickel	6	3	0	3.6 J – 19 J	1,000 child 10,000 adult	RMEG
Potassium	6	6	0	110 J – 6,600	No CVs	----
Selenium	6	2	0	0.89 J – 11 J	300 child 4,000 adult	RMEG
Silver	6	1	0	1.3 J	300 child 4,000 adult	RMEG
Sodium	6	1	0	320 J	No CVs	----
Vanadium	6	6	0	6.2 J - 52	200 child 2,000 adult	Intermediate EMEG
Zinc	6	6	0	10 J – 81 J	20,000 child 200,000 adult	Chronic EMEG
					600 child	Pica intermediate

Notes: <sup>1</sup> as Hexavalent chromium  
 CV = Comparison value (ATSDR established screening values)  
 mg/kg = milligrams per kilogram, or parts per million (ppm)  
 J = estimated analytical value  
 RMEG = Reference Dose Media Evaluation Guide  
 EMEG = Environmental Media Evaluation Guide  
 CREG = Cancer Risk Evaluation Guide  
 EPA Industrial = U.S. Environmental Protection Agency Superfund health screening value for industrial sites  
 RSL = Regional Screening Level

**Table 40. Site-specific recreational exposure dose estimates and health guideline comparison values for South Fork New River sediments and floodplain soils. Samples collected in 2007.**

Contaminant	Calculated Maximum Exposure Dose <sup>1</sup> (mg/kg-d)	Health Guideline / Type (non-cancer) (mg/kg-d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult) ?
Copper	0.0014 child 0.00016 adult	0.01 ATSDR Intermediate <sup>2</sup> MRL	child NO adult NO

Notes: <sup>1</sup> Child trespasser: 400 mg/d IR; 36 d/yr exposure frequency; 6 yr exposure period;  
Adult trespasser: 200 mg/d IR; 36 d/yr exposure frequency; 30 yr exposure period

<sup>2</sup> An intermediate exposure is 15 to 364 days

mg/kg-d = milligrams per kilogram per day

MRL = minimum risk level

non-CA = non-cancer

HG = ATSDR published Health Guideline value

**Table 41. Local soil background concentrations for metals detected in soils from the Ore Knob Mine site. Samples collected in 2007.**

Substance	Concentration (mg/kg)
Aluminum	13,000
Copper	38
Iron	29,000
Zinc	48

Notes: mg/kg = milligrams per kilogram, or parts per million (ppm)

**Table 42. Exposure estimation parameters used for recreational exposures to soils, sediments and waste materials.**

Exposure Calculation Parameter	Child	Adult
Soil ingestion rate (IR), mg/d	400	200
Number of days per year exposed, days	36	36
Number of years exposed, years	6	30
Body weight (BW), kg	16	70

Notes: mg/d = milligrams per day  
kg = kilograms

**Table 43. Exposure estimation parameters used for incidental ingestion of surface waters by children while swimming or wading.**

Exposure Calculation Parameter	Value
Number of times per week	1
Number of times per year	12
Number of hours per each activity	1
Number of years	6
Volume of water accidentally ingested, mls	50
Body weight (BW), kg	16

Notes: mls = milliliters  
kg = kilograms

**Table 44. ATSDR health effects study data values used for evaluation of site-specific exposure dose estimates for determination of the potential for adverse health effects.**

Contaminant of Concern	Health Effect Dose (mg/kg-d)	Notes	Reference
Cadmium	0.0003	Oral, chronic, human - NOAEL, female, renal effects	ATSDR 2008 Cd
	0.0021	NOAEL, life-time exposure, renal effects	
	0.0078	NOAEL, Greater than 25 year lifetime exposure, hematological/musculoskeletal/renal effects	
Manganese	0.0048	Oral, chronic, human - NOAEL, 50 yr exposure in drinking water, neurological effects	ATSDR 2008 Mn
	0.059	LOAEL, 50 yr exposure in drinking water, mild neurological effects	
	0.06	LOAEL, male, 5 yr exposure in drinking water, affecting general, verbal and visual memory and learning skills; inattentiveness; lack of focus	
	0.26	LOAEL, ≤1 yr exposure in drinking water, increased fatality among children <1 yr of age	
Aluminum	0.6	[No human data] NOAEL – Rat, 2.5 yr exposure in drinking water, respiratory, cardiac, hepatic, renal & BW effects	ATSDR 2008 Al
	1.2	Mouse, lifetime exposure in water, respiratory, cardiac, hepatic, renal & BW effects	
	100	LOAEL, female mouse, 2-yr exposure in food, BW effects, decreased limb strength, decreased thermal sensitivity	
Copper	0.042	Oral, intermediate, human – NOAEL, daily x 2 months in drinking water, gastrointestinal effects	ATSDR 2004 Cu
	0.091	LOAEL, daily x 2 months in drinking water, gastrointestinal effects	
	0.14	NOAEL, 12 weeks, gastrointestinal effects	

Notes: mg/kg-d = milligrams per kilogram per day  
 NOAEL = No observed adverse effect level  
 LOAEL = Lowest observed adverse effect level  
 yr = year  
 BW = body weight

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**Appendix D**  
**The ATSDR Health Effects Evaluation Process**

## THE ATSDR HEALTH EFFECTS EVALUATION PROCESS

The ATSDR health effects evaluation process consists of two steps: a screening analysis, and at some sites, based on the results of the screening analysis and community health concerns, a more in-depth analysis to determine possible public health implications of site-specific exposure estimates.

In evaluating data, ATSDR uses comparison values (CVs) to determine which chemicals to examine more closely. CVs are the contaminant concentrations found in a specific medium (soil, water, or air) and are used to select contaminants for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard amount of air, water and soil that someone may inhale or ingest each day.

The two step screening analysis process provides a consistent means to identify site contaminants that need to be evaluated more closely through the use of “comparison values” (CVs). The first step of the screening analysis is the “environmental guideline comparison” which involves comparing site contaminant concentrations to medium-specific comparison values derived by ATSDR from standard exposure default values. The second step is the “health guideline comparison” and involves looking more closely at site-specific exposure conditions, estimating exposure doses, and comparing them to dose-based health-effect comparison values.

As health-based thresholds, CVs are set at a concentration below which no known or anticipated adverse human health effects are expected to occur. CVs are not thresholds of toxicity and do not predict adverse health effects. CVs serve only as guidelines to provide an initial screen of human exposure to substances. Contaminant concentrations at or below the relevant CV may reasonably be considered safe, but it does not automatically follow that any environmental concentration that exceeds a CV would be expected to produce adverse health effects. Different CVs are developed for cancer and non-cancer health effects. Non-cancer levels are based on validated toxicological studies for a chemical, with appropriate safety factors included, and the assumption that small children (22 pounds) and adults are exposed every day. Cancer levels are the media concentrations at which there could be a one additional cancer in a one million person population (one in a million excess cancer risk for an adult) eating contaminated soil or drinking contaminated water every day for 70 years. For chemicals for which both cancer and non-cancer CVs exist, the lower level is used to be protective. Exceeding a CV does not mean that health effects will occur, just that more evaluation is needed.

After completing a screening analysis, site contaminants are divided into two categories. Those not exceeding CVs usually require no further analysis, and those exceeding CVs are selected for a more in-depth analysis to evaluate the likelihood of possible harmful effects.

The North Carolina Department of Public Health (N.C. DPH) uses the following screening values for public health assessments:

1. **Environmental Media Evaluation Guide (EMEG):** EMEGs are estimated contaminant concentrations in water, soil or air to which humans may be exposed over specified time periods and are not expected to result in adverse non-cancer health effects. EMEGs are based on ATSDR “minimum risk levels” (MRLs) and conservative (highly health protective)

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assumptions about exposure, such as intake rate, exposure frequency and duration, and body weight.

2. **Reference Dose Media Evaluation Guides (RMEGs):** RMEGs represent concentrations of substances in water and soil to which humans may be exposed over specified time periods without experiencing non-cancer adverse health effects. The RMEG is derived from the U.S. Environmental Protection Agency's (EPA's) oral reference dose (RfD).
3. **Cancer Risk Evaluation Guide (CREG):** CREGs are estimated media-specific contaminant concentrations that would be expected to cause no more than one additional excess cancer in one million persons exposed over a 70-year lifetime. CREGs are calculated from EPA's cancer slope factors (CSFs) or inhalation unit risk (IUR) values.
4. **Maximum Contaminant Levels (MCL):** A Federal Maximum Contaminant Level (MCL) is the regulatory limit set by EPA that establishes the maximum permissible level of a contaminant in water that is deliverable to the user of a public water system. MCLs are based on health data, also taking into account economic and technical feasibility to achieve that level. (ATSDR 2005a)
5. **EPA Regional Screening Levels (RSL):** "Regional Screening Levels for Chemical Contaminants at Superfund Sites" are tables of risk-based screening levels, calculated using the latest toxicity values, default exposure assumptions and physical and chemical properties. The Regional Screening table was developed with input from EPA Regions III, VI, and IX in an effort to improve consistency and incorporate updated guidance. ([http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/index.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm))

Contaminant concentrations exceeding the appropriate CVs are further evaluated against ATSDR health guidelines. N.C. DPH also retains for further assessment contaminants that are known or suspected to be cancer-causing agents. To determine exposure dose, N.C. DHHS uses standard assumptions about body weight, ingestion or inhalation rates, and duration of exposure. Important factors in determining the potential for adverse health effects also include the concentration of the chemical, the duration of exposure, the route of exposure, and the health status of those exposed. Site contaminant concentrations and site-specific exposure conditions are used to make conservative estimates of site-specific exposure doses for children and adults that are compared to ATSDR health guidelines (HGs), generally expressed as Minimal Risk Levels (MRLs). An exposure dose (generally expressed as milligrams of chemical per kilogram of body weight per day or "mg/kg-day") is an estimate of how much of a substance a person may come into contact based on their actions and habits. Exposure dose calculations are based on the following assumptions as outlined by the ATSDR (ATSDR 2005a):

- Children between the ages of 1 and 6 ingest an average of 1 liter of water per day
- Children weigh an average of 15 kilograms
- Infants weigh an average of 10 kilograms
- Adults ingest an average of 2 liters of water per day
- Adults weigh an average of 70 kilograms

### **Ingestion of contaminants present in drinking water**

Exposure doses for ingestion of contaminants present in groundwater are calculated using the maximum and average detected concentrations of contaminants in milligrams per liter (mg/kg [mg/kg = ppm]). The following equation is used to estimate the exposure doses resulting from ingestion of contaminated groundwater:

$$ED_w = \frac{C \times IR \times AF \times EF}{BW}$$

Where:

- ED<sub>w</sub> = exposure dose water (mg/kg-day)
- C = contaminant concentration (mg/kg)
- IR = intake rate of contaminated medium (liters/day)
- AF = bioavailability factor (unitless)
- EF = exposure factor
- BW = body weight (kilograms)

### **Ingestion of contaminants present in soil**

Exposure doses for ingestion of contaminants present in soil are calculated using the maximum and average detected concentrations of contaminants in milligrams per kilogram (mg/kg [mg/kg = ppm]). The following equation is used to estimate the exposure doses resulting from ingestion of contaminated soil:

$$ED_s = \frac{C \times IR \times AF \times EF}{BW}$$

Where:

- ED<sub>s</sub> = exposure dose soil (mg/kg-day)
- C = contaminant concentration (mg/kg)
- IR = intake rate of contaminated medium (kilograms/day)
- EF = exposure factor (unitless)
- BW = body weight (kilograms)
- AF = bioavailability factor

The exposure factor is an expression of how often and how long a person may contact a substance in the environment. The exposure factor is calculated with the following general equation:

$$EF = \frac{F \times ED}{AT}$$

Where:

- F = frequency of exposure (days/year)
- ED = exposure duration (years)
- AT = averaging time (ED x 365 days/year)

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### **Inhalation (breathing) of contaminants present in air**

Inhalation is an important pathway for human exposure to contaminants that exist as atmospheric gases or are adsorbed to airborne particles or fibers. Exposure doses for breathing contaminants in air were calculated using the maximum or average detected concentrations in milligrams per cubic meter ( $\text{mg}/\text{m}^3$ ) or parts per billion by volume (ppbv). The following equation is used to estimate the exposure doses resulting from inhalation of contaminated air.

$$D = (C \times IR \times EF) / BW$$

Where:

D	=	exposure dose ( $\text{mg}/\text{kg}\text{-day}$ )
C	=	contaminant concentration ( $\text{mg}/\text{m}^3$ )
IR	=	intake rate ( $\text{m}^3/\text{day}$ )
EF	=	exposure factor (unitless)
BW	=	body weight (kg)

Health guidelines represent daily human exposure to a substance that is likely to be without appreciable risk of adverse health effects during the specified exposure duration. The potential for adverse health effects exists under the representative exposure conditions if the estimated site-specific exposure doses exceed the health guidelines and they are retained for further evaluation. A MRL is an estimate of daily human exposure to a substance (in milligrams per kilogram per day [ $\text{mg}/\text{kg}\text{-day}$ ] for oral exposures) that is likely to be without non-cancer health effects during a specified duration of exposure. Exposures are based on the assumption a person is exposed to the maximum concentration of the contaminant with a daily occurrence.

Generally, site-specific exposure doses that do not exceed screening values are dropped from further assessment. Exposure doses that exceed MRLs, or are known or suspected cancer-causing agents, are carried through to the health-effects evaluation. The health-effects evaluation includes an in-depth analysis examining and interpreting reliable substance-specific health effects data (toxicological, epidemiologic, medical, and health outcome data) related to dose-response relationships for the substance and pathways of interest. The magnitude of the public health issue may be estimated by comparing the estimated exposures to “no observed” (NOAELs) and “lowest observed” (LOAELs) adverse effect levels in animals and in humans, when available.

ATSDR’s toxicological profiles serve as the primary source of the health-effects data. Other sources of toxicological data include EPA’s Integrated Risk Information System (IRIS) database, International Agency for Research on Cancer (IARC) Monographs, and the National Toxicology Program (NTP). Standard toxicology textbooks and peer-reviewed scientific journals of environmental toxicology or environmental health can also be consulted.

### **Polynuclear Aromatic Hydrocarbons (PAHs)**

ATSDR does not provide individual comparison values (CVs) for the group of structurally related multi-carbon ring compounds known as polynuclear aromatic hydrocarbons or PAHs (PAHs may also be called “polycyclic aromatic hydrocarbons”). ATSDR does provide a CREG for the PAH compound benzo(a)pyrene (BaP). BaP is the most studied of the individual chemicals of the PAH group, and is thought to be the most toxic. To evaluate potential adverse health effects associated with incidental ingestion of soil PAH concentrations, the concentrations of individual detected PAH compounds are converted to an equivalent BaP concentration and summed to provide a “BaP-equivalent” concentration for all detected PAHs. BaP-equivalent exposure dose are calculated by multiplying the concentration of individual detected PAH compounds by their “toxicity equivalency factor” (TEF), a value that relates the relative toxicity of the individual PAH compounds to the toxicity of BaP. Below is a table of TEF values used by N.C. DPH to calculate BaP-equivalent concentrations. An estimated soil ingestion BaP-equivalent exposure dose is calculated using soil exposure rates. Estimated numbers of increased cancers for the combined PAH exposure is calculated by multiplying the CREG value by the BaP-equivalent exposure dose.

$$PAH_{BaP-eq} = PAH_{conc} \times TEF$$

$$Combined\ Cancer\ Risk_{PAHs} = \sum PAH_{adj} \times CSF$$

Where:

$PAH_{BaP-eq}$	= Benzo(a)pyrene equivalent TEF adjusted PAH compound concentration, mg/kg
$PAH_{conc}$	= concentration of PAH compound, mg/kg
TEF	= Toxicity Equivalency Factor for PAH compound, unitless
Combined Cancer Risk <sub>PAHs</sub>	= Summed cancer risk of all detected PAH compounds
$\sum PAH_{adj}$	= summed TEF-adjusted concentrations of all detected PAH compounds, mg/kg
CSF	= Cancer Slope Factor, mg/kg-d

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### PAH Toxicity Equivalency Factors (“TEFs”)

PAH compounds	TEF value
acenaphthene	0.001
acenaphthylene	0.001
anthracene	0.01
benzo(a)anthracene	0.1
benzo(a)pyrene	1.00
benzo(b,k)fluoranthene	na
benzo(g,h,i)perylene	0.01
benzo(b)fluoranthene	0.1
benzo(k)fluoranthene	0.01
chrysene	0.001
dibenzo(a,h)anthracene	1.00
fluoranthene	0.001
fluorene	0.001
indeno(1,2,3-cd)pyrene	0.1
2-methylnaphthalene	0.001
naphthalene	0.001
phenanthrene	0.001
pyrene	0.001

Source: *Toxicity equivalency factors for PAH and their applicability in shellfish pollution monitoring studies*. J Environ Monit, 2002, 4, 383-388  
na = not available

### Cancer Health Effect Evaluations

Theoretical increased numbers of cancers are calculated for known or suspected cancer-causing contaminants using the estimated site-specific exposure dose and cancer slope factor (CSF) provided in ATSDR health guideline documents. This theoretical calculation is based on the assumption that there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in the exposed population, but estimates a theoretical excess cancer risk expressed as the proportion of a population that may be affected by a carcinogen during a lifetime or other selected period of exposure. For example, an estimated cancer risk of  $1 \times 10^{-4}$  predicts the probability of one additional cancer over the background number of cancers in a population of 10,000. Qualitative assessment of the predicted increased numbers of cancers is also used and represents terminology suggested by ATSDR and N.C. DPH.

The theoretical cancer risk calculation is:

$$\text{Theoretical Cancer Risk} = \text{Dose} \times \text{CSF}$$

or

$$\text{Theoretical Cancer Risk} = \text{Air Concentration} \times \text{IUR}$$

Where:

Theoretical Cancer Risk	= Expression of the cancer risk (unitless)
Dose	= Site-specific cancer dose (mg/kg-d)
Air Concentration	= Site-specific air concentration ( $\mu\text{g}/\text{m}^3$ )
CSF	= Cancer Slope Factor ( $[\text{mg}/\text{kg}\cdot\text{d}]^{-1}$ )
IUR	= Inhalation Unit Risk ( $[\mu\text{g}/\text{m}^3]^{-1}$ )

The N.C. Central Cancer Registry states:

*“Although much has been learned about cancer over the past couple of decades, there is still much that is not known about the causes of cancer. What we do know is that cancer is not one disease, but a group of diseases that behave similarly. We know that different types of cancers are caused by different things. For example, cigarette smoking has been implicated in causing lung cancer, some chemical exposures are associated with leukemia, and prolonged exposure to sunlight causes some types of skin cancer. Genetic research has shown that defects in certain genes result in a much higher likelihood that a person will get cancer. What is not known is how genetic factors and exposures to cancer causing agents interact.*

*Many people do not realize how common cancers are. It is estimated that one out of every two men and one out of every three women will develop a cancer of some type during his or her lifetime. As a result, it is common to find what appear to be cancer cases clustering in neighborhoods over a period of years. This will occur in any neighborhood. As people age, their chance of getting cancer increases, and so as we look at a community, it is common to see increasing numbers of cancer cases as the people in the community age.*

*Cancers are diseases that develop over many years. As a result, it is difficult to know when any specific cancer began to develop, and consequently, what the specific factor was which caused the cancer. Because people in our society move several times during their lives, the evaluation of clusters of cancer cases is quite challenging. One can never be certain that a specific cancer was caused by something in the community in which the person currently resides. When we investigate clusters of cancer cases, we look for several things that are clues to likely associations with exposures in the community. These are:*

- 1. Groups of cases of all the same type of cancer (such as brain cancer or leukemia). Because different types of cancer are caused by different things, cases of many different types of cancer do not constitute a cluster of cases.*
- 2. Groups of cases among children, or ones with an unusual age distribution.*

3. *Cases diagnosed during a relatively short time interval. Cases diagnosed over a span of years do not constitute a cluster of cases unless there is consistency in the type of cancer.*
4. *Clusters of rare cancers. Because lung, breast, colon, and prostate cancers are so common, it is very difficult to find any association between them and exposures in a community.”*

N.C. DPH evaluates cancer health effects in terms of possible increased cancer risk. In North Carolina, approximately 30% of women and 50% of men (about 40% combined), will be diagnosed with cancer in their life-time from a variety of causes. This is referred to as the “background cancer risk”. The term “excess cancer risk” represents the risk on top of the background cancer risk. A “one-in-a-million” excess cancer risk (1/1,000,000 or  $10^{-6}$  cancer risk) means that if 1,000,000 people are exposed to the cancer-causing substance at a certain level every day of their life-time (considered 70 years), then one cancer above the background number of cancers may develop in those 1 million people. In numerical terms, the background number of cancers expected in 1 million people over their life-time is 400,000. If they are all exposed to the cancer-causing substance daily throughout their life-time, then 400,001 people may get cancer, instead of the expected 400,000. The expression of the estimated cancer risk is not a prediction that cancer will occur, it represents the upper bound estimate of the probability of additional cancers, and merely suggests that there is a possibility. The actual risk may be much lower, or even no risk. For specific exposure situations N.C. DPH may use exposure periods of less than a life-time to provide a more realistic estimation of the risks that are known or predicted to have occurred for a particular area. If information on the specifics of the exposure situations at a particular site is not known, then N.C. DPH will always use health protective values to estimate the maximum level of risk that we believe to be realistic.

**Estimates of Increased Number of Cancers Qualitative Assessment Categories Utilized by N.C. DPH**

Estimated Number of Increased Cancers <sup>a</sup>	Qualitative Increased Risk Term
< 1/1,000,000	No Increase
< 1/100,000	Very Low
< 1/10,000	Low
< 1/1,000	Moderate
< 1/100	High
Greater than 1/100	Very High

<sup>a</sup> As number of increased cancers above typical background numbers of cancers in the stated population size. “<1/1,000,000” = less than one additional cancer in a population of 1 million persons.

**Limitations of the Health Evaluation Process**

Uncertainties are inherent in the public health assessment process. These uncertainties fall into the following categories: 1) the imprecision of the risk assessment process, 2) the incompleteness

of the information collected and used in the assessment, and 3) the differences in opinion as to the implications of the information. These uncertainties are addressed in public health assessments by using worst-case assumptions when estimating or interpreting health risks. The health assessment calculations and screening values also incorporate safety margins. The assumptions, interpretations, and recommendations made throughout this public health assessment err in the direction of protecting public health.

### **Assessment of Chemical Interactions**

To evaluate the risk for noncancerous effects in a mixture, ATSDR's guidance manual (*Guidance Manual for the Assessment of Joint Toxic Action of Chemical Mixtures*, 2004) prescribes the calculation of a hazard quotient (HQ) for each chemical. The HQ is calculated using the following formula:

$$\text{HQ} = \text{estimated dose} \div \text{applicable health guideline}$$

Generally, whenever the HQ for a chemical exceeds 1, concern for the potential hazard of the chemical increases. Individual chemicals that have HQs less than 0.1 are considered unlikely to pose a health hazard from interactions and are eliminated from further evaluation. If all of the chemicals have HQs less than 0.1, harmful health effects are unlikely, and no further assessment of the mixture is necessary. If two or more chemicals have HQs greater than 0.1, then these chemicals are to be evaluated further as outlined below.

Since the HQ is greater than 1 for both adults and children the hazard index (HI) will be calculated. The HQ for each chemical then is used to determine the (HI) for the mixture of chemicals. An HI is the sum of the HQs and is calculated as follows:

$$\text{HI} = \text{HQ}_1 + \text{HQ}_2 + \text{HQ}_3 + \dots + \text{HQ}_n$$

The HI is used as a screening tool to indicate whether further evaluation is needed. If the HI is less than 1.0, significant additive or toxic interactions are highly unlikely, so no further evaluation is necessary. If the HI is greater than 1.0, then further evaluation is necessary, as described below.

For chemical mixtures with an HI greater than 1.0, the estimated doses of the individual chemicals are compared with their NOAELs or comparable values. If the dose of one or more of the individual chemicals is within one order of magnitude of its respective NOAEL (0.1 x NOAEL), then potential exists for additive or interactive effects. Under such circumstances, an in-depth mixtures evaluation should proceed as described in ATSDR's *Guidance Manual for the Assessment of Joint Action of Chemical Mixtures*.

If the estimated doses of the individual chemicals are less than 1/10 of their respective NOAELs, then significant additive or interactive effects are unlikely, and no further evaluation is necessary.

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**Reference:**

(Andelman 1990). *Total Exposure of Volatile Organic Compounds in Potable Water*. In: Significance and Treatment of Volatile Organic Compounds in Water Supplies, Chapter 20. Lewis Publishers, Chelsea, MI.

**Appendix E**  
**ATSDR Glossary**

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## ATSDR Glossary

### **Absorption**

The process of taking in. For a person or animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

### **Acid mine drainage (AMD)**

AMD is highly acidic water flowing out of metal or coal mines or areas with high mineral content. The pH of AMD can be as low as 1. AMD is formed when water comes into contact with sulfide-containing metal ores (such as the mineral pyrite, FeS<sub>2</sub>) and air, resulting in the formation of sulfuric acid and dissolved iron. Orange or red sediments can be formed when the iron precipitates out of the water. The acid can dissolve other metals and metalloids in the surrounding rock and carry them to surface waters where the dissolved metals or low pH can harm fish and other aquatic organisms, or to ground water that may be used as a drinking water source and potentially impacting people's health.

### **Acute**

Occurring over a short time [compare with chronic].

### **Acute exposure**

Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

### **Additive effect**

A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with antagonistic effect and synergistic effect].

### **Adverse health effect**

A change in body functions or cell structure that might lead to disease or health problems.

### **Aerobic**

Requiring oxygen [compare with anaerobic].

### **Ambient**

Surrounding (for example, *ambient* air).

### **Anaerobic**

Requiring the absence of oxygen [compare with aerobic].

### **Analyte**

A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

### **Antagonistic effect**

A biologic response to exposure to multiple substances that is less than would be expected if the known effects of the individual substances were added together [compare with additive effect and synergistic effect].

**Background level**

An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

**Biodegradation**

Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

**Biologic indicators of exposure study**

A study that uses (a) biomedical testing or (b) the measurement of a substance [an analyte], its metabolite, or another marker of exposure in human body fluids or tissues to confirm human exposure to a hazardous substance [also see exposure investigation].

**Biologic monitoring**

Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

**Biologic uptake**

The transfer of substances from the environment to plants, animals, and humans.

**Biomedical testing**

Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

**Biota**

Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

**Body burden**

The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

**Cancer**

Any one of a group of diseases that occurs when cells in the body become abnormal and grow or multiply out of control.

**Cancer risk**

A theoretical risk of for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

**Carcinogen**

A substance that causes cancer.

**Case study**

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A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

**CAS registry number**

A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.

**Central nervous system**

The part of the nervous system that consists of the brain and the spinal cord.

**CERCLA** [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]

**Chronic**

Occurring over a long time (more than 1 year) [compare with acute].

**Chronic exposure**

Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure].

**Cluster investigation**

A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.

**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.

**Completed exposure pathway** [see exposure pathway].

**Comprehensive Environmental Response,**

Compensation, and Liability Act of 1980 (CERCLA) CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances.

**Concentration**

The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

**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.

**Delayed health effect**

A disease or injury that happens as a result of exposures that might have occurred in the past.

**Dermal**

Referring to the skin. For example, dermal absorption means passing through the skin.

**Dermal contact**

Contact with (touching) the skin [see route of exposure].

**Detection limit**

The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

**Disease prevention**

Measures used to prevent a disease or reduce its severity.

**Disease registry**

A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

**Dose (for chemicals that are not radioactive)**

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.

**Dose-response relationship**

The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

**Environmental media**

Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

**Environmental media and transport mechanism**

Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur.

**EPA**

United States Environmental Protection Agency.

**Epidemiology**

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The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

### **Exposure**

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

### **Exposure assessment**

The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

### **Exposure-dose reconstruction**

A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

### **Exposure investigation**

The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

### **Exposure pathway**

The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

### **Geographic information system (GIS)**

A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

### **Groundwater**

Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

### **Hazard**

A source of potential harm from past, current, or future exposures.

### **Hazardous Substance Release and Health Effects Database (HazDat)**

The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

### **Hazardous waste**

Potentially harmful substances that have been released or discarded into the environment.

### **Health consultation**

A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with public health assessment].

### **Health education**

Programs designed with a community to help it know about health risks and how to reduce these risks.

### **Health investigation**

The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to estimate the possible association between the occurrence and exposure to hazardous substances.

### **Health promotion**

The process of enabling people to increase control over, and to improve, their health.

### **Health statistics review**

The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

### **Indeterminate public health hazard**

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

### **Incidence**

The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].

### **Ingestion**

The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

### **Inhalation**

The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

### **Intermediate duration exposure**

Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

### **Lowest-observed-adverse-effect level (LOAEL)**

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The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

**Maximum Contaminant Level (MCL)**

The highest level of a contaminant that EPA allows in drinking water. MCLs ensure that drinking water does not pose either a short-term or long-term health risk. EPA sets MCLs at levels that are economically and technologically feasible. Some states set MCLs which are more strict than EPA's.

**Medical monitoring**

A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

**Metabolism**

The conversion or breakdown of a substance from one form to another by a living organism.

**Metabolite**

Any product of metabolism.

**mg/kg**

Milligram per kilogram.

**Migration**

Moving from one location to another.

**Minimal risk level (MRL)**

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. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].

**Morbidity**

State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

**Mortality**

Death. Usually the cause (a specific disease, condition, or injury) is stated.

**Mutagen**

A substance that causes mutations (genetic damage).

**Mutation**

A change (damage) to the DNA, genes, or chromosomes of living organisms.

**National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)**

EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

**No apparent public health hazard**

A category used in ATSDR's public health assessments 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.

**NPL** [see National Priorities List for Uncontrolled Hazardous Waste Sites]

**Physiologically based pharmacokinetic model (PBPK model)**

A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

**Pica**

A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.

**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.

**Point of exposure**

The place where someone can come into contact with a substance present in the environment [see exposure pathway].

**Population**

A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

**Potentially responsible party (PRP)**

A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

**ppb**

Parts per billion.

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**ppm**

Parts per million.

**Prevention**

Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

**Public comment period**

An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

**Public availability session**

An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

**Public health action**

A list of steps to protect public health.

**Public health advisory**

A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

**Public health assessment (PHA)**

An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

**Public health hazard**

A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

**Public health hazard categories**

Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

**Public health statement**

The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

**Public meeting**

A public forum with community members for communication about a site.

**RCRA** [See Resource Conservation and Recovery Act (1976, 1984)]

**Receptor population**

People who could come into contact with hazardous substances [see exposure pathway].

**Reference dose (RfD)**

An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

**Remedial Investigation**

The CERCLA process of determining the type and extent of hazardous material contamination at a site.

**Resource Conservation and Recovery Act (1976, 1984) (RCRA)**

This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

**RfD See reference dose**

**Risk**

The probability that something will cause injury or harm.

**Risk reduction**

Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

**Risk communication**

The exchange of information to increase understanding of health risks.

**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].

**Safety factor** [see uncertainty factor]

**SARA** [see Superfund Amendments and Reauthorization Act]

**Sample**

A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

**Sample size**

The number of units chosen from a population or environment.

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**Solvent**

A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

**Source of contamination**

The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

**Special populations**

People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

**Statistics**

A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

**Substance**

A chemical.

**Superfund Amendments and Reauthorization Act (SARA)**

In 1986, SARA amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

**Surface water**

Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

**Survey**

A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].

**Synergistic effect**

A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see additive effect and antagonistic effect].

**Teratogen**

A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

**Toxic agent**

Chemical or physical (for example, radiation, heat, cold, microwaves) agents which, under certain circumstances of exposure, can cause harmful effects to living organisms.

### **Toxicological profile**

An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

### **Toxicology**

The study of the harmful effects of substances on humans or animals.

### **Tumor**

An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

### **Uncertainty factor**

Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

### **Urgent public health hazard**

A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

### **Volatile organic compounds (VOCs)**

Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

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**Appendix F**  
**Response to Public Comments**

## Response to Public Comments

The *Ore Knob Mine NPL Site Public Health Assessment* was released as a draft on April 14, 2010. Copies were made available to members of the local community, Ashe County N.C. officials, the N.C. DENR, and the U.S. EPA. The PHA was made available on the N.C. DPH HACE program and ATSDR web sites. Copies were also provided to the Ashe County Public Library in West Jefferson and the Ashe County Court House in Jefferson, NC. A press release notice of the release of the draft PHA and comment period was distributed to local media. A 60-day public comment period was provided from April 14, 2010 through June 14, 2010. During the comment period N.C. DPH collected submitted comments. Comments were received from a single member of the community. Those comments and N.C. DPH's response to those comments follow.

1. Comment – *“On page 29 of the Ore knob Mine Public Health Assessment Initial /Public Comment Release under the heading Community Health Concerns, It states County health officials and EPA site personnel both indicated that the community has not expressed particular concern with the site and current activities. In July of 2007, when I observed EPA testing wells in the area I asked them to test my well. I was very concerned. We were given our test results in an EPA public meeting and were given the impression that our water was safe to drink. We were given the impression that clean up was going fine and that our drinking water would not be affected by the clean up at the site. Please do not let our trust be taken for a lack of concern. Please do not let the lack of representation and support from Ashe County Officials let you draw the conclusion that there is lack of concern on the part of our community because this is not the case.”*

N.C. DPH Response - N.C. DPH recognizes that the community's concern is closely linked with their knowledge of the potential health hazards associated with the site. The community's concerns have been expressed in 2 public meetings since the release of the draft Public Health Assessment in April 2010. N.C. DPH attended both meetings to hear the community's concerns, to hear of the EPA's plans for follow-up of our recommendations, and to answer the community's questions. N.C. DPH will continue to monitor analytical data for residential wells and soils, to provide an independent review of the potential health hazards associated with this data. N.C. DPH will work directly with the community and EPA to communicate with the affected community any health hazards we believe are present. N.C. DPH will also provide guidance or assistance to persons that may be impacted, or will assist Ashe County staff or other local agencies that are working directly with the community.

2. Comment - *“The EPA has informed our community through letters left on door knobs of our homes and if we are home we have spoken with the person leaving the letter. Maybe they should also consider announcing public meetings through our local newspapers and local radio station to help ensure that all efforts are being made to inform our community. Maybe county officials (health department, county commissioners) could be notified of future public meetings so they could attend. We feel that the letters given out by the EPA to date are not adequate to show folks the true situation. I am providing my neighbors in affected in the area of concern a copy of the Ore Knob Mine Public Health Assessment Initial/Public Comment Release. I feel that the EPA and other agencies involved should provide residences affected all reports so that we can be informed of the situation.”*

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N.C. DPH Response - N.C. DPH has passed the comments regarding EPA's activities along to EPA and N.C. DENR staff associated with the site. N.C. DPH has communicated with Ashe County Health Department/Environmental Health Department to keep them informed of recent activities associated with the mine site, including well water sampling and all public meetings. A press release was issued by N.C. DPH on April 27<sup>th</sup> about the availability of this document and the public comment period. Copies of the document and a summary sheet were provided to the Ashe County Public Library and the Ashe County Court House.

3. Comment - *“We have major concerns about the short and long term effects of drinking our water may have on our twelve year old son. We worry about him playing outside from what we gather from your assessment. ... Is it safe?”*

N.C. DPH Response - N.C. DPH provides guidance in this document on pages 3 and 32 to reduce children's exposure to the elevated metal concentrations found in some residential soil samples. Reducing children's exposures through these measures should prevent any potential harm. These measures include: not playing in bare soil, washing hands before eating, washing home-grown produce before it is eaten, periodically washing off outdoor toys, and preventing dust accumulation indoors. EPA has identified that residential soils discussed in the PHA were collected from areas that would be expected to have the highest concentrations of metals, such as along creek beds. As a result, the residential soil data is not likely representative of the average concentrations of metals in someone's yard. Residents may wish to have their soil tested to better define average metal levels. N.C. DPH can assist with reviewing this data to determine if health issues are indicated.

Since the initial public comment release of this document, EPA conducted additional testing of the private well waters to better define the concentrations of metals to which residents may have been exposed. In addition, it has also been learned that some of the private wells tested in 2007 had treatment systems, but it was only the un-treated water that was sampled. Many residents had filtration systems that were effective at reducing the amounts of contaminants in their water below levels of health concern. In the follow-up private well testing conducted by EPA homes that did not have water treatment systems, or the systems were ineffective at removing the contaminants, were provided with alternative water or filtration systems. EPA is continuing to monitor the quality of the drinking water in the area and provide bottled water until contaminants reach and remain below levels of health concern, or a treatment system is provided. N.C. DPH will continue to monitor the additional drinking water analytical data as it becomes available and assist residents with identifying what steps may be necessary to reduce their exposures to elevated metals.

4. Comment – *“On page 10 of the Ore Knob Mine Public Health Assessment Initial/Comment Release under the heading Background it states in 2000, the U.S. Army Corp of Engineers analyzed 5 wells in the vicinity of the 1950's mill and 19<sup>th</sup> century operations areas for metals. Details on the locations sampled, the analytical methods used, and the results are not available. Reports state most metals were **“well under applicable primary drinking water standards”**, also noting reporting limits for some metals were greater than drinking water standards (for antimony, beryllium, and thallium). Reports also noted aluminum, iron, manganese, sulfate, and pH exceeded their respective secondary drinking water standards. It could not be determined if the elevations were due to mining impacts. The unavailability of*

*these results should be unacceptable. We should know where the 5 wells tested in 2000 are located and the results of those tests. We need to know the methods used to test these wells. We feel this information needs to be released to the public. This information is vital to the community. I believe the ball was dropped in 2000 and in 2007. Government officials have known of the water quality for many years, but have failed to react to their own results, and have not made the public aware of these findings.”*

N.C. DPH Response - EPA has recently been able to locate the data generated by the US Army Corp of Engineers in 2000. N.C. DPH has requested a copy of the data for review.

5. Comment – *“In 2007, the EPA conducted water samples on 6 wells. 3 of the 6 sampled showed high metals. I believe this is associated with the mine. It took almost three years to address the issue. Please do not let the current water tests take three years to be evaluated. Our health and peace of mind are counting on this issue to be resolved as quickly and accurately as possible. We believe that studies have taken far too long. Results need to come forth in the very near future, including a solution to the problem. Human life should be the most important consideration. We do not want to be part of a health study to see how high exposure to metals through drinking water and environment affect our health.”*

N.C. DPH Response – Once the data review error was identified, EPA immediately informed the community and collected additional residential private well and soil samples. These new samples will better define the exposure of local residents to elevated metals in their soil and well water. This data will be provided to N.C. DPH as soon as it is available. N.C. DPH is working with the EPA and the residents to explain their exposures. N.C. DPH is also investigating potential health effects if metals are elevated.

The recent well samples included well water samples collected before and after any in-home treatment systems. The original well water samples identified in the PHA were taken before the water treatment systems and were not representative of what people were drinking. If the in-home water treatment systems reduce the concentration of metals in the water people were drinking the potential for negative health effects may be lower than that identified in the PHA. The before and after treatment water samples can also be used to identify water treatment systems that are effective in reducing metal concentrations to safe levels. EPA is assisting residents that have elevated metal concentrations in their well water to add or upgrade their water treatment systems to reduce metals concentrations to safe levels. N.C. DPH will request that waters continue to be tested after treatment systems are added or modified to be certain that they are effective. It is critical to note that continued effective reduction of metals concentrations to safe levels by the treatment system may require on-going system maintenance. Likely the EPA will provide this maintenance for a defined period, but at some point it may become the responsibility of the homeowner, if an effective long-term alternative water supply has not been provided at the time.

6. Comments –
- a. *We believe the fastest and safest solution would [be] to remove residences that are affected through a buyout.*
  - b. *Ashe County should consider denying any new residential building permits in the affected area until it is proven that drinking water and soil is deemed safe in this area*

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*to protect people from unnecessary risk. If we had known then, what we do now we would have never in a million years built a home here. If the EPA is able to provide filtration for our drinking water are they going to see that it is maintained and working properly on a regular schedule, will they also provide the necessary chemicals to treat water? Will they replace a filtration system as needed? If EPA is able to get a new source of drinking water for us are they going to monitor it and see that it is maintained?*

c. *If our soil is contaminated how long will it take to clean up?*

N.C. DPH Response - These are important issues that are outside of N.C. DPH control. We will share these concerns with EPA, N.C. DENR and the Ashe County Health Department and other County officials.

7. Comment – *“What are we going to do if we find our health has been compromised? What steps do we need to take if our health has been compromised?”*

N.C. DPH Response - N.C. DPH has contacted residents that were drinking well water with concentrations of metals that may have caused negative health impacts. N.C. DPH will work directly with residents to answer their questions about their health concerns. N.C. DPH Physicians will also provide information to residents or their personal physicians to identify what health issues may result from their exposures. They can be reached at telephone number (919) 707-5900.

8. Comment – *“This whole process has taken too long. It appears that various government agencies have studied Ore Knob Mine and its effects on the environment and drinking water for many years. It seems like with all the data that has been studied to date that a solution to the problem could have been found. The water contamination in this area has been a major hardship for the people who are affected. We have health concerns, property values concerns, should we let our children play outside, etc., we are hoping that the government doesn’t drag this out for a prolonged period of time. We do thank the EPA for providing drinking water.... For once may the United States Government spend money wisely and remove the residences that have been affected by contamination from the Ore Knob mine.”*

N.C. DPH Response - N.C. DPH involvement began in March 2009 when the site was proposed to the NPL (“Superfund” list) and our focus is public health issues. Unfortunately, the mine predates most building and environmental regulations. N.C. DPH is working with the EPA, NC N.C. DENR and the County to respond to the potential health issues associated with the elevated metal concentrations found in some private well waters and soils