Testimony of
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Examining EPA's Unacceptable Response to Indian Tribes

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Overview
University of Arizona Programs on Environmental Health and Mining Impacts in Native Populations

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Chairman Barrasso, Vice Chairman Tester and members of the Committee. My name is Dr. Clark Lantz and I want to thank you for the opportunity to testify. I would like to acknowledge that I was assisted with preparing this testimony by Drs. Karletta Chief and Raina Maier. I am the Associate Director of the University of Arizona Superfund Research Program and Deputy Director of the Southwest Environmental Health Sciences Center, two of the programs at the University that focus on environmental issues and their effects on native populations.

The University of Arizona is uniquely situated to play a major role as an unbiased partner with American Indian communities to determine the contribution of chemical and other environmental exposures, particularly those related to metal mining, to health inequities and to support efforts to address these threats. In Part I of this document we identify and highlight the goals and accomplishments of key University of Arizona programs related to native communities and mining. Most of these programs are funded through the National Institutes of Health (NIH) by the National Institute of Environmental Health Sciences (NIEHS) and the National Cancer Institute (NCI). In Part II we describe how the existence of these programs and their established trust within native communities were essential to the University of Arizona response to the Gold King Mine spill. Part III of the document presents information on the toxicity of metals associated with the Gold King Mine spill.

PART I. KEY PROGRAMS RELATED TO NATIVE COMMUNITIES AND MINING

A. UA Southwest Environmental Health Science Center (SWEHSC)
An NIEHS Core Center of Excellence

The geographic location of the SWEHSC, with its rich Native American cultural heritage, provides unique opportunities for basic environmental health sciences research to impact the health of these populations. The focus of the Center is on supporting research related to unique exposures seen in arid and semiarid environments and how they affect indigenous populations. Within the Center the Community Outreach and Education Core (COEC) provides strong links between the research conducted within the Center and communities that maybe affected by exposures.

Under the theme of **activities with tribal entities,** the COEC continues to work with the Gila River Indian Community and the Inter Tribal Council of Arizona to develop new activities. In 2015 the SWEHSC COEC built additional collaborations with American Indian communities in close proximity to Tucson, the Tohono O'odham Nation, related to arsenic in the water, and the Pascua Yaqui Tribe, regarding high levels asthma among their children.

Major Recent Accomplishments include:

- Tribal Forum associated with the Annual Meeting of the P30 Core Centers Meeting and the outcomes associated with that meeting
- Water Summit – Arsenic in the Water of the Tohono O'odham Nation
- Publication of the Indigenous Stewards Environmental Literary Magazine and the outcomes related to its publication, a component of the "American Indian Stories of Health and the Environment" administrative supplement funding.

2015 Tribal Forum

The COEC Director continues to participate in the bi-annual Inter Tribal Council of Arizona (ITCA), Inc. Environmental Managers meetings and those of the Water Resources working group, the Air Quality working group and the Solid Waste working group led to the relationships that brought over 100 tribal representatives to the Forum. The 2015 Tribal forum was associated with the NIEHS Annual Centers Meeting and was very successful. The forum was called ***Tribal Stories of Health and the Environment:*** *A forum to share how environmental exposures affect the health of tribal people,* and was hosted by the ITCA, the Ak-Chin Indian Community and the Tohono O'odham Nation. Information, can be found at https://swehsc.pharmacy.arizona.edu/outreach/tribal-stories-health-environment-forum.

This event grew from the COEC idea of a small meeting with the tribal environmental managers to one with tribal environmental professionals from all the programs. Most of the over 125 people who attended were tribal people, people who work for tribes and attendees from NIEHS and from other P30 Core Centers who work with tribes. An NIEHS article summarizes the forum, "*Tribal forum forges new connections*" and can be found at http://www.niehs.nih.gov/news/newsletter/2015/5/spotlight-tribal/.

Arsenic Water Summit

As a result of the forum, Selso Villegas, PhD, the Director of the Water Resources Department of the Tohono O'odham Nation requested help with a meeting with community members concerning low dose chronic exposure to arsenic. The event was held in November, with attendance by Tohono O'odham (TO) community members, two members of the Tribal Council and by a number of TO Community College students. The outcome of the meeting is a request to present to subcommittees of the Council and to the Council itself. In addition, the COEC director discussed pilot project funds available from the SWEHSC for an epidemiological study.

Indigenous Stewards Magazine

In 2013 the COEC received an administrative supplement in collaboration with the COEC of the University of Washington. This project has provided new avenues of partnership with the Ha:San High School, the Tohono O'odham Community College and with Native American student associations at the University of Arizona. The output of the supplement is the inaugural issue of a literary magazine *Indigenous Stewards*, found at http://swehsc.pharmacy.arizona.edu/content/indigenous-stewards.

B. Center for Indigenous Environmental Health Research (CIEHR)

An NIEHS and USEPA Center of Excellence on Environmental Health Disparities

The P50 Center for Indigenous Environmental Health Research (CIEHR) newly established and funded in late 2015, was initiated to partner with American Indian and Alaska Native (AI/AN) communities to build capacity to determine the contribution of chemical and other environmental exposures to health inequities and support efforts to address these threats. AI/AN communities suffer from increased mortality attributable to cancer (stomach, gallbladder, liver and kidney), respiratory disease, diabetes, and liver disease, among other conditions. Chemically contaminated traditional foods, water, air, and household environments, as well as social determinants of health, contribute to these health disparities and stand out as modifiable factors for AI/AN communities. Effective and sustainable environmental health disparities research and mitigation require a community-based participatory research (CBPR) approach, engaging the strengths of AI/AN communities and providing data and context to inform policy decisions. Nascent research on resilience in AI/AN and other peoples identifies traditional community structure and social relationships, cultural identity and practices, and experience with past adversity as protective, offering innovative directions for AI/AN health research and intervention.

C. The Partnership for Native American Cancer Prevention (NACP)

An NCI Partnership to Advance Cancer Health Equity

The Partnership for Native American Cancer Prevention (NACP) is a collaborative Minority Institution/Cancer Center Partnership (MI/CCP) between the University of Arizona Cancer Center, Northern Arizona University and the NIH National Cancer Institute. The mission is to alleviate the unequal burden of cancer among Native Americans of the Southwest through research, training and community outreach programs in collaboration with the communities they serve.

The Program is designed to facilitate the entry of Native Americans into biomedical research and healthcare professions while engaging communities in research and training relevant to their needs. Research projects include laboratory, field-based and community-based participatory research. All programs involving communities originate in those communities and are developed and implemented in partnership with NACP students and faculty.

The goals of the NACP are:

1) Continue to increase the competitive stance of cancer research and training at Northern Arizona University by adding new cancer researchers and by continuing strong faculty development programs for all junior faculty.
2) Develop programs that facilitate the successful transition of Native American students into the universities and that enhance the retention and graduation of Native American undergraduates in biomedical sciences.
3) Develop sustainable community education programs and research for cancer prevention that meet the unique needs of the Hopi Tribe and the Navajo and Tohono O'odham Nations.

D. University of Arizona Superfund Research Program (UASRP)

An NIEHS multi-investigator interdisciplinary research program

The University of Arizona Superfund Research Program (UA SRP) addresses the current knowledge gap in our understanding of mine waste systems in relation to human and environmental health, a current and growing problem. The research goals of the UA SRP are two-fold, first to develop exposure assessment tools that can be used to evaluate the risk for communities that neighbor mine waste or smelter sites. A second goal is to develop and evaluate the effectiveness of new cleanup technologies for mining waste. Along with these goals, the UA SRP has a mission to work to mitigate the human impacts of exposure to mining waste through effective communication of its research and by serving as a State and national resource for human and environmental health issues associated with mining.

Within the UASRP the **Community Engagement Core** (CEC) applies research outcomes from the UA SRP to empower underrepresented populations to address health and environmental challenges related to our mining legacy. This is done through a combination of community-engaged research and training and capacity building focused on Arizona Tribal Nations and Hispanic communities.

The purpose of the CEC is to deliver science-based information to engage affected community stakeholders so they can become active players in understanding and making informed decisions on health issues related to mining. In this way, they become active players in understanding and dealing with the environmental health issues they face. Active participation allows citizens to help create and drive the research process, problem solving, solution development, and political dialogue. The exchange between the UA SRP and communities is multi-directional so as to influence both the research agenda and the engagement experiences that are implemented. For instance, community members not only interact with CEC personnel regarding community engaged-research, but also, opportunities are made available for them to discuss current UA SRP research as well as how this research can respond to local concerns.

Mining Modules

The UA SRP has partnered with Arizona tribal colleges to design and pilot educational modules on mining processes and on the sociocultural and environmental impacts of mining to supplement existing science, technology, engineering, and mathematics (STEM) curricula, with the goal of supporting the Native American STEM pipeline to four-year institutions. The first module, *Copper Mining*, is available on-line: http://www.superfund.pharmacy.arizona.edu/learning-modules/tribal-modules
Five additional modules will be made available as they are completed.

Community Informational Pamphlets

The UA SRP has developed a series of eleven tri-fold information sheets to date which are designed to provide a basic introduction to environmental issues for community members neighboring contaminated sites as well the general public. The materials are available online or in English and Spanish. Examples include: *What are Mine Tailings?, What is Arsenic*?, *Lead and Our Health*, and *What is Hazardous Waste?*.

E. Lowell Institute for Mineral Resources (IMR)

A State and industry supported Institute

The IMR (www.imr.arizona.edu) is the largest interdisciplinary center for mineral resources research in the US and one of the largest in the world. The purpose of the IMR is to create the “new face of mining” by fusing intellectual disciplines, engaging communities, being responsive to stakeholders, conducting use-inspired research, being entrepreneurial, having permeable boundaries, and being engaged globally. The IMR is unique in the world in the success of this transdisciplinary approach.

The IMR bridges basic and applied research across all areas of science, technology, health, social science, law, policy, business, and leadership and works with leaders to adopt new ideas, policies, and technologies. Key thematic challenges include water, energy, healthy and safe communities, improving our knowledge of the global mineral resource inventory, improving environmental stewardship, obtaining social license to operate, informing law and policy, educating the next generation, and engaging our communities.

Personnel from the IMR have been active in briefing the staffs for all Arizona federal representatives and Senators, state legislators, and local city and county council and supervisors on issues related to mining.

F. The Center for Environmentally Sustainable Mining (CESM)

A State and industry supported Center

The mission of CESM is to develop educational, specialized professional training, and research initiatives that address environmental issues related to mining activities in arid and semi-arid urban environments. Examples include development of novel technologies to: minimize water use and suppress dust generation in mining operations; allow green engineering for environmentally responsible new mine development; create sustainable mine tailings caps; prevent and treat acid rock drainage; allow long-term assessment of environmental impacts; assess short- and long-term health risks from contaminated water and air in urban environments near mining operations.

A major accomplishment of the CESM is the formation of an Industry-Academic Cooperative for the reclamation of mine wastes. The purpose of the Cooperative is to bring mining companies together with academia to develop improved reclamation technology for mining waste. All members of the Cooperative agree to share results.

PART II: UNIVERSITY OF ARIZONA RESPONSE TO GOLD KING MINE SPILL

Communicating information

The Gold King Mine spill contaminated waterways running through Navajo Nation communities. The spill occurred on August 5, 2015 from the Gold King Mine in Silverton, CO. Acid mine drainage (AMD) from the mine traveled to Cement creek, a tributary of the Animas River, eventually adding three million gallons of AMD into the waterways of the Colorado River Basin. Tribal community members along the impacted rivers and streams began voicing their concerns about the safety of the contaminated water for personal use as well as for livestock, wildlife, and crops. The Friday after the spill, it was suggested that based on all the questions being received from Navajo Nation Speaker of the Navajo Council Lorenzo Bates and from Navajo and Yuma farmers, that an unbiased information sheet should be developed as quickly as possible. Because of the foundation and trust established by the UA Programs listed above, UA SRP personnel were contacted to help with this project. They produced and published an on-line Gold King Mine spill fact sheet following analysis of data released by the US Environmental Protection Agency (US EPA) in the week following the spill.

http://www.superfund.pharmacy.arizona.edu/sites/default/files/u43/gold_king_mine_spill.pdf.

The fact sheet was posted on the UA SRP website and was distributed by email and through Jeannie Benally (UA extension agent) who distributed hard copies at the farmers meetings. In addition, Perry Charley (Research Manager at Dine' College) used it in his presentations about the spill. The document continues to be updated and the current version is posted on the UA SRP website at the url provided above. The fact sheet has also been condensed into a two page brochure for ease of distribution. (The 2 page information sheets are attached).

In addition to the fact sheet, over the next couple of months, UA SRP personnel were engaged in diverse translation and outreach efforts. These included media interviews (see media outlet list below), student educational opportunities, a community "teach-in" regarding spill consequences held in Shiprock, AZ, and three community "listening" sessions held in Shiprock, Aneth, and Upper Fruitland, AZ. Topics covered included the extent of the contamination and potential for impact to the environment, in particular water quality; and the significance of the spill to Navajo livelihoods and cultural beliefs.

Media interview outlets included:

- Arizona Week, a newsmagazine produced by Arizona Public Media
- Native America Calling, a live call-in program which can be heard on over public, community, and tribal radio stations and the internet
- Arizona Daily Star
- Arizona Farm Bureau

Finally on March 29, 2016, UA SRP personnel hosted four members of the Navajo Nation to participate in a panel to discuss "Navajo Perspectives on the Gold King Mine Spill." Panel members included: Chili Yazzie (Shiprock Chapter President), Perry Charley (Diné College Scientist), Jani Ingram (NAU Chemistry Professor), and Mae-Gilene Begay (Navajo Community Health Representatives Director). The purpose of this visit was to promote meaningful interaction between the Navajo community and the UA community.

Independent Assessment of Spill Outcomes

University of Arizona researchers felt it was important to not only provide information related to the spill but to also be involved as an independent source in evaluation of the outcomes of the spill. To this end researchers submitted a grant to NIEHS entitled: "*Tó Łítso, The Water Is Yellow: Investigating Short Term Exposure And Risk Perception Of Navajo Communities To The Gold King Mine Toxic Spill*". The grant was funded for two years, beginning March 1, 2016, through a rapid funding mechanism that can be used for time sensitive research needs such as the Gold King spill. Realizing the importance of beginning the studies as quickly as possible, UA SRP and SWEHSC both provided preliminary funds so that the project could actually begin in late 2015. The application was strengthened by the involvement and support of the Navajo Nation. This included a letter of support from President Begay and VP Nez, the Division directors including Navajo EPA Dr. Benn, and approval by the Navajo Nation Human Subjects Review Board as of Jan 2016. The application also had a supporting resolution from the Dine' Medicine Men's Association.

The research is a partnership between UA and Navajo Nation. Samples are collected by the community who are guided to the points by farmers for their areas of concern. UA investigators have been quick to respond to the questions by the community and have taken careful steps to seek the community's input in approvals and research design. All results will be reported first and belong to the community. Navajo Nation President Russell Begaye and Vice President Jonathan Nez delivered samples to the University of Arizona. Vice President Nez spent a day touring University labs and discussing issues of the spill with investigators.

***"Tó Łítso, The Water Is Yellow"* grant summary**

On August 5, 2015, 3 million gallons of acid mine drainage was accidently released from the Gold King Mine spill, eventually reaching the San Juan River - the lifeblood of the Navajo Nation. Many Native American communities have subsistence livelihoods and strong cultural practices and spiritual beliefs that are deeply connected to the natural environment. As a result, environmental contamination from catastrophic mine spills severely impacts indigenous people to the core of their spiritual and physical livelihoods and there is potential for unique exposure pathways and greater health risks. Further complicating the situation is the lack of empirical short and long-term exposure data following mine spills, necessary for scientists to address these concerns. Building on established partnerships with the Navajo Nation, this project aims to measure the short- term exposure to lead and arsenic and evaluate the risk perceptions of Navajo communities dependent on the San Juan River in order to understand the potential long-term health risks from the Gold King Mine spill and develop mitigation strategies. Exposure and health effects of lead and arsenic are widely studied and clear guidelines for human biomonitoring levels are established such that individuals with high risks can be identified and treated before adverse health effects occur. The first aim is to determine levels of exposures in three Navajo Chapters downstream of spill within 9 months of the spill and prior to the growing season. The second aim is to assess temporal and spatial changes in sediment, agricultural soil, river and well water in the three Navajo Chapters within 12 months of the spill. The third aim is to determine the association between Navajo community members' perception of health risks and measured health risks from the Gold King Mine spill within the 9-month period after the spill. This application is time-sensitive because it is essential to obtain baseline short-term exposure measurements prior to spring runoff which is likely to re-mobilize river sediment and prior to the start of the Navajo growing season. Additionally, risk perception is most elevated, dynamic, and diverse shortly after an incident and recall bias should be minimized. The unpredictable timing of a mine spill of this magnitude increases the importance of a timely response for the collection of samples to evaluate potential harm to human health from environmental exposures. The results of this investigation will be used in the future to develop a community-based intervention, designed to a) prevent potentially harmful exposures based on actual measured risk, and/or b) communicate the actual long-term risks from the Gold King mine spill, effectively. While this specific incident may have been one of the largest acid mine spills in recent history, the Department of Interior has estimated more than 500,000 abandoned mines throughout the United States, and the potential for ongoing acid mine leaks or large-scale spills to impact many communities and eco-systems is high. Empirical data collected from this study could also be used to improve risk assessment and communication in the unfortunate event of future mine spill disasters affecting other communities.

PART III: TOXICITY OF METALS ASSOCIATED WITH THE GOLD KING SPILL

Based on the total estimated levels of metals released from the spill (see Understanding the Gold King Mine Spill pamphlet) and the relative toxicity of the metals, in our opinion, the following metals seem to be the most problematic in terms of health risk. These include in order of importance lead, arsenic, mercury, cadmium, manganese, copper and zinc.

Overview of metal toxicity

Lead is known to cause neurological deficits. Long-term lead exposure of adults can result in decreased performance in some tests that measure functions of the nervous system. It may also cause weakness in fingers, wrists, or ankles. Children are particularly sensitive to lead exposures resulting in decreased mental abilities, and learning difficulties. Current EPA standards are lead in drinking water is 0.015 milligrams per liter.

Arsenic has been associated with a wide range of chronic diseases. Long-term exposure to arsenic may cause cancers of the skin, bladder and lungs. The International Agency for Research on Cancer (IARC) has classified arsenic and arsenic compounds as carcinogenic to humans, and has also stated that arsenic in drinking-water is carcinogenic to humans. Other adverse health effects that may be associated with long-term ingestion of inorganic arsenic include developmental effects, neurotoxicity, diabetes and cardiovascular disease. Children appear to be particularly sensitive, especially at high doses. Exposures during *in utero* and postnatal development lead to increased mortality, decreased lung function and increased incidence of pulmonary infections in adults. Some of these changes are evident as early as 6 years of age following chronic *in utero* and postnatal exposures. Arsenic can be accumulated in some plants and foods including rice, lettuce, radishes, broccoli, Brussels sprouts, kale, and cabbage. The current EPA standard for arsenic in municipal drinking water systems is 0.010 milligrams per liter.

The nervous system is very sensitive to all forms of mercury. Methylmercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Very young children are more sensitive to mercury than adults. Mercury in the mother's body passes to the fetus and may accumulate there. Methylmercury builds up in the tissues of fish. Larger and older fish tend to have the highest levels of mercury. The EPA has set a limit of 0.002 milligrams per liter in drinking water. The Food and Drug Administration (FDA) has set a maximum permissible level of 1 milligram per kilogram of seafood.

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. Other long-term effects are lung damage and fragile bones. The health effects in children are expected to be similar. Animal studies indicate that younger animals may be more sensitive. Fish, plants, and animals take up cadmium from the environment. You can be exposed by eating foods containing cadmium; low levels are found in all foods (highest levels are found in shellfish, liver, and kidney meats) or by drinking contaminated water. No long term adverse effects are expected with a lifetime exposure to 0.005 milligrams per liter.

Manganese is also known to cause neurological deficits. While most data on manganese is from inhaled occupational exposures, limited evidence suggests that high manganese intake from drinking water may be associated with neurological symptoms similar to those of Parkinson's disease. In addition, limited evidence also indicates children exposed to high levels of manganese had significantly lower scores on tests of intelligence. A life time exposure to 0.3 milligrams per liter is not expected to cause any adverse effects. The current EPA standard for manganese in drinking water is 0.05 milligrams per liter. This is a secondary standard dealing mostly with taste, clarity and other nontoxic properties.

Copper and zinc are both essential nutrients but high levels may also cause toxicity. Very high doses of copper can cause damage to your liver and kidneys, and can even cause death. We do not know if these effects would occur at the same dose level in children and adults. Studies in animals suggest that young children may have more severe effects than adults, but we don't know if this would also be true in humans. For zinc, harmful effects generally begin at levels 10-15 times higher than the amount needed for good health. Large doses taken chronically by mouth can cause anemia and decrease the levels of good cholesterol. It is not known whether children are more susceptible. EPA recommended levels of copper and zinc in water should not exceed 1 milligram per liter and 5 milligrams per liter for copper and zinc, respectively. These also are secondary standards. Please note that these recommended limits are at least 100 times higher than those for lead, arsenic mercury and cadmium, demonstrating that they are relatively less toxic. However, they are mentioned here because of the high levels of zinc and copper released during the spill.

Summary of toxicity of each metal

Additional information about the toxicity of these metals is given in the more detailed sections below and can also be found on the Agency for Toxic Substances and Disease Registry (ATSDR) ToxFAQs websites.

Lead

How can lead affect my health?

The effects of lead are the same whether it enters the body through breathing or swallowing. Lead can affect almost every organ and system in your body. The main target for lead toxicity is the nervous system, both in adults and children. Long-term exposure of adults can result in decreased performance in some tests that measure functions of the nervous system. It may also cause weakness in fingers, wrists, or ankles. Lead exposure also causes small increases in blood pressure, particularly in middle-aged and older people and can cause anemia. Exposure to high lead levels can severely damage the brain and kidneys in adults or children and ultimately cause death. In pregnant women, high-levels of exposure to lead may cause miscarriage. High-level exposure in men can damage the organs responsible for sperm production. There is no conclusive proof that lead causes cancer.

How can lead affect children?

Small children can be exposed by eating lead-based paint chips, chewing on objects painted with lead-based paint or swallowing house dust or soil that contains lead.

Children are more vulnerable to lead poisoning than adults. A child who swallows large amounts of lead may develop blood anemia, severe stomachache, muscle weakness, and brain damage. If a child swallows smaller amounts of lead, much less severe effects on blood and brain function may occur. Even at much lower levels of exposure, lead can affect a child's mental and physical growth.

Exposure to lead is more dangerous for young and unborn children. Unborn children can be exposed to lead through their mothers. Harmful effects include premature births, smaller babies, decreased mental ability in the infant, learning difficulties, and reduced growth in young children. These effects are more common if the mother or baby was exposed to high levels of lead. Some of these effects may persist beyond childhood.

What happens to lead when it enters the environment?

Once lead falls onto soil, it usually sticks to soil particles. Movement of lead from soil into groundwater will depend on the type of lead compound and the characteristics of the soil.

Has the federal government made recommendations to protect human health?

The Centers for Disease Control and Prevention (CDC) recommends that states test children at ages 1 and 2 years. Children should be tested at ages 3–6 years if they have never been tested for lead, if they receive services from public assistance programs for the poor such as Medicaid or the Supplemental Food Program for Women, Infants, and Children, if they live in a building or frequently visit a house built before 1950; if they visit a home (house or apartment) built before 1978 that has been recently remodeled; and/or if they have a brother, sister, or playmate who has had lead poisoning. CDC has updated its recommendations on children's blood lead levels. Experts now use an upper reference level value of 97.5% of the population distribution for children's blood lead. In

2012-2015, the value to identify children with blood lead levels that are much higher than most children have is 5 micrograms per deciliter. EPA limits lead in drinking water to 0.015 milligrams per liter.

Arsenic

How can arsenic affect my health?
The first symptoms of long-term exposure to high levels of inorganic arsenic (e.g. through drinking-water and food) are usually observed in the skin, and include pigmentation changes, skin lesions and hard patches on the palms and soles of the feet (hyperkeratosis). These occur after a minimum exposure of approximately five years and may be a precursor to skin cancer.

In addition to skin cancer, long-term exposure to arsenic may also cause cancers of the bladder and lungs. The International Agency for Research on Cancer (IARC) has classified arsenic and arsenic compounds as carcinogenic to humans, both through inhalation and through ingestion. Other adverse health effects that may be associated with long-term ingestion of inorganic arsenic include developmental effects, neurotoxicity, diabetes and cardiovascular disease.

How can arsenic affect children?
Children appear to be particularly sensitive, especially at high doses. Exposures during *in utero* and postnatal development led to increased mortality, decreased lung function and increased incidence of pulmonary infections in adults. Some of these changes are evident as early as 6 years of age following chronic *in utero* and postnatal exposures.

What happens to arsenic when it enters the environment?
Arsenic occurs naturally in soil and minerals and may enter the air, water, and land from wind-blown dust and may get into water from runoff and leaching. Arsenic can be accumulated in some plants including rice, lettuce, radishes, broccoli, Brussels sprouts, kale, and cabbage.

Has the federal government made recommendations to protect human health?
US EPA standard for arsenic in municipal water systems is 0.010 milligrams per liter.

Mercury

How can mercury affect my health?
The nervous system is very sensitive to all forms of mercury. Methylmercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems. Methylmercury and mercuric chloride are possible human carcinogen.

How does mercury affect children?

Very young children are more sensitive to mercury than adults. Mercury in the mother's body passes to the fetus and may accumulate there. It can also pass to a nursing infant through breast milk. Mercury's harmful effects that may be passed from the mother to the fetus include brain damage, mental retardation, incoordination, blindness, seizures, and inability to speak. Children poisoned by mercury may develop problems of their nervous and digestive systems, and kidney damage.

What happens to mercury when it enters the environment?

Inorganic mercury (metallic mercury and inorganic mercury compounds) enters the air from mining ore deposits, burning coal and waste, and from manufacturing plants. It enters the water or soil from natural deposits, disposal of wastes, and volcanic activity. Methylmercury may be formed in water and soil by small organisms called bacteria. Methylmercury builds up in the tissues of fish. Larger and older fish tend to have the highest levels of mercury.

Has the federal government made recommendations to protect human health?

The EPA has set a limit of 0.002 milligrams per liter of mercury in drinking water. The Food and Drug Administration (FDA) has set a maximum permissible level of 1 milligram per kilogram in seafood.

Cadmium

How can cadmium affect my health?

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. Other long-term effects are lung damage and fragile bones. Eating food or drinking water with very high levels severely irritates the stomach, leading to vomiting and diarrhea. Cadmium is classified as a human carcinogen.

How can cadmium affect children?

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 also indicate that the young are more susceptible than adults to a loss of bone and decreased bone strength from exposure to cadmium.

What happens to cadmium when it enters the environment?

Cadmium enters soil, water, and air from mining, industry, and burning coal and household wastes. Some forms of cadmium dissolve in water. Fish, plants, and animals take up cadmium from the environment.

Has the federal government made recommendations to protect human health?

The EPA has determined that lifetime exposure to 0.005 milligrams per liter is not expected to cause any adverse effects. The FDA has determined that the cadmium concentration in bottled drinking water should not exceed 0.005 milligrams per liter.

Manganese

How can manganese affect my health?
Manganese is an essential nutrient, and eating a small amount of it each day is important to stay healthy. Limited evidence suggests that high manganese intakes from drinking water may be associated with neurological symptoms similar to those of Parkinson's disease. A study of older adults in Greece found a high prevalence of neurological symptoms in those exposed to water manganese levels of 1.8 to 2.3 milligrams per liter, while a study in Germany found no evidence of increased neurological symptoms in people drinking water with manganese levels ranging from 0.3 to 2.2 milligrams per liter compared to those drinking water containing less than 0.05 milligrams per liter. Manganese in drinking water may be more bioavailable than manganese in food. However, none of the studies measured dietary manganese, so total manganese intake in these cases is unknown. Manganese is not classified as a human carcinogen

How can manganese affect children?
Recent studies have shown that children exposed to high levels of manganese through drinking water experience cognitive and behavioral deficits. For instance, a cross-sectional study in 142 10-year old children, who were exposed to a mean manganese water concentration of 0.8 milligrams per liter, found that children exposed to higher manganese levels had significantly lower scores on three tests of intellectual function. Another study associated high levels of manganese in tap water with hyperactive behavioral disorders in children. These and other recent reports have raised concern over the neurobehavioral effects of manganese exposure in children.

In the US, the EPA recommends 0.05 milligrams per liter as the maximum allowable manganese concentration in drinking water. This is a secondary standard based on color and taste. Life time exposures to 0.3 milligrams per liter is not expected to cause any adverse effects.

Copper

How can copper affect my health?
Everyone must absorb small amounts of copper every day because copper is essential for good health. High levels of copper can be harmful. Breathing high levels of copper can cause irritation of your nose and throat. Ingesting high levels of copper can cause nausea, vomiting, and diarrhea. Very-high doses of copper can cause damage to your liver and kidneys, and can even cause death. Copper is not classified as a human carcinogen.

How can copper affect children?
Exposure to high levels of copper will result in the same type of effects in children and adults. We do not know if these effects would occur at the same dose level in children

and adults. Studies in animals suggest that the young children may have more severe effects than adults, but we don't know if this would also be true in humans. There is a very small percentage of infants and children who are unusually sensitive to copper.

We do not know if copper can cause birth defects or other developmental effects in humans. Studies in animals suggest that high levels of copper may cause a decrease in fetal growth.

What happens to copper when it enters the environment?
Copper is released into the environment by mining, farming, and manufacturing operations and through waste water releases into rivers and lakes. Copper is also released from natural sources, like volcanoes, windblown dusts, decaying vegetation, and forest fires. Copper released into the environment usually attaches to particles made of organic matter, clay, soil, or sand. Copper does not break down in the environment. Copper compounds can break down and release free copper into the air, water, and foods.

Has the federal government made recommendations to protect human health?
The EPA requires that levels of copper in drinking water be less than 1 milligram of copper per one liter of drinking water based on taste and staining.

Zinc

How can zinc affect my health?
Zinc is an essential element in our diet. Too little zinc can cause 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 your good cholesterol. We do not know if high levels of zinc affect reproduction in humans. Rats that were fed large amounts of zinc became infertile. Putting low levels of zinc acetate and zinc chloride on the skin of rabbits, guinea pigs, and mice caused skin irritation. Skin irritation will probably occur in people. Zinc is not classified as a carcinogen.

How can zinc affect children?
Zinc is essential for proper growth and development of young children. It is likely that children exposed to very high levels of zinc will have similar effects as adults. We do not know whether children are more susceptible to the effects of excessive intake of zinc than the adults.

We do not know if excess zinc can cause developmental effects in humans. Animal studies have found decreased weight in the offspring of animals that ingested very high amounts of zinc.

What happens to zinc when it enters the environment?
Some is released into the environment by natural processes, but most comes from

human activities like mining, steel production, coal burning, and burning of waste. Depending on the type of soil, some zinc compounds can move into the groundwater and into lakes, streams, and rivers. Most of the zinc in soil stays bound to soil particles and does not dissolve in water. It builds up in fish and other organisms, but it does not build up in plants.

Has the federal government made recommendations to protect human health?
The EPA recommends that drinking water should contain no more than 5 milligrams per liter of water because of taste.

Gold King Mine Spill two page information sheet

Gold King Mine Spill Community Sheet

IN GENERAL:

- Short-term the Gold King Mine spill was quickly diluted and metals settled in the river sediment.
- Long-term health and environmental impacts of the Gold King Mine spill are not well understood.
- Currently different agencies and universities are trying to understand what are the overall impacts.

	The Bottom Line Answer
Why was the water yellow after the spill?	When rocks made up of minerals and metals found in deep mine tunnels come into contact with water and air this combination creates acid mine drainage. This rock-acid mixture causes the metals in the rocks to seep out into the water. The Gold King Mine spill turned a yellow orange color because there was iron present. When acid mine drainage from the **spill came into contact with fresh river water** it made the mixture less acidic and **caused the iron to settle out**.
How will the spill affect people's health?	**Not enough information has been gathered** to determine what the health impacts are or will be for people living near waterways affected by the Gold King Mine spill. Tribal, federal, state, and local agencies as well as universities are currently studying the potential short- and long-term effects by collecting water, soil, and animal samples. At this point, drinking water sources have been determined to be safe to drink by federal and state authorities.
How are crops or gardens affected by the spill?	Soon after the Gold King Mine spill, irrigation intakes at the Animas and San Juan Rivers were turned off. Because this happened quickly, agencies suggested that crops were not impacted. Many local farmers lost their crops due to a lack of water during the hottest time of the year. The possible long-term impacts of the spill on local crops are not known. It is **generally recommended** that farmers or gardeners growing crops **call the extension office for specific advice**. At this time, irrigation intakes have been flushed and reopened for use.
Can the spill affect livestock?	In August 2015, the Colorado Department of Agriculture and the Utah Department of Agriculture and Food **lifted warnings on the use of water** from the San Juan River for livestock. However, **there have not been enough studies conducted** to say with certainty that livestock was not impacted soon after the spill. Cattle ranchers in areas where the Gold King Mine spill occurred should double check with veterinarians or extension personnel regarding potential impacts.

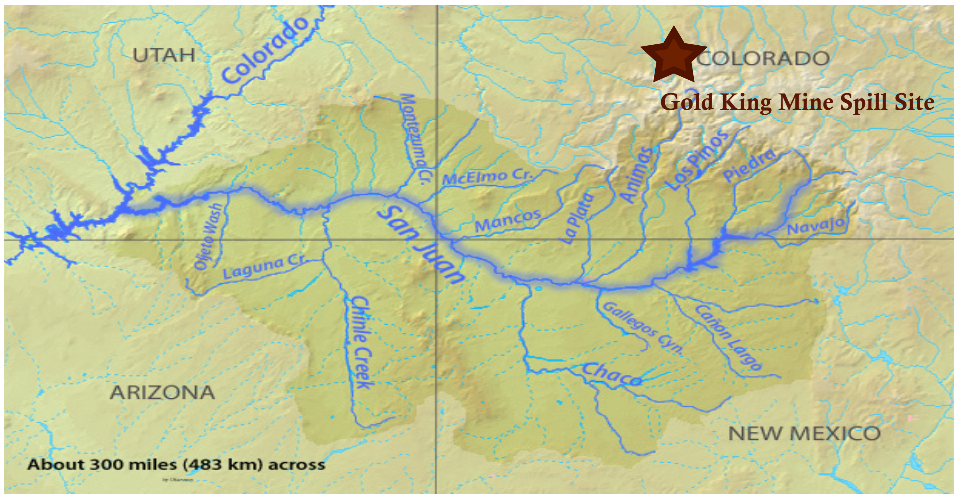
This is a community summary of the information complied for the "Understanding the Gold King Mine Spill" document available at:

NIEHS Superfund Research Center
The University of Arizona

http://superfund.pharmacy.arizona.edu/sites/default/files/u43/gold_king_mine_spill.pdf

What happened at the Gold King Mine on August 5, 2015?

On August 5, 2015, when the U.S. Environmental Protection Agency was investigating the old, abandoned Gold King Mine in Silverton, Colorado, digging machines loosened a soil plug that caused mine water under pressure to gush out and eventually travel to Cement Creek, a tributary of the Animas River. It is estimated that three million gallons or nine football fields with one foot deep of mine water spilled out. This mine water contained acid, salts, and toxic metals such as lead and arsenic. The Gold King Mine spill took place in the Colorado River Basin.



What was done and is being done to control the Gold King Mine spill?

Stopping or pumping the Gold King Mine spill was not possible because the Animas River is flows fast. The water in the river diluted the initial acid mine drainage as it flowed downstream. The U.S. Environmental Protection Agency and other federal, state, and tribal agencies worked to redirect additional acid mine drainage away from waterways. This acid mine drainage is being treated in a series of man-made ponds that both decrease the acidity using lime and remove metals from the water. Since February 2016, the Bonita Peak Mining District (where the Gold King Mine is located) is being considered for the Superfund National Priority List that would apply more federal monies to monitor and treat contamination.

I would like to talk to someone about the Gold King Mine spill and…

Drinking Water - Janick Artiola, Soil, Water and Environmental Science, (520) 621-3516

Human Health - Clark Lantz, Cellular Biology and Anatomy, (520) 626-6716

Crop/Garden - Mónica Ramírez-Andreotta, Soil, Water and Environmental Science, (520) 621-0091

Community Organizing - Janene Yazzie, Sixth World Solutions, (928) 245-1352

Livestock - Gerald Moore, Navajo Nation Extension Agent, (928) 871-7686

NIEHS Gold King Mine Exposure Project - Karletta Chief, Soil, Water and Environmental Science (520) 222-9801

Who are involved in studying the impacts of the Gold King Mine spill?

There are various tribal, federal, state, and local agencies as well as universities studying the impacts of the Gold King Mine spill. The following is a list of the major groups involved:

Tribal Agencies

Navajo Nation, Navajo Environmental Protection Agency, Southern Ute Indian Tribe Water Quality Program

Federal Agencies

U.S. Environmental Protection Agency, U.S. Geological Survey, U.S. Agency for Toxic Substances and Disease Registry, Bureau of Indian Affairs

State Agencies

AZ Department of Environmental Quality, NM Environmental Department, CO Fish and Wildlife Conservation Office, CO Department of Public Health and the Environment

Universities

University of Arizona, Northern Arizona University, Rice University, University of New Mexico, University of Colorado Boulder, New Mexico State University, New Mexico Institute of Mining and Technology

As a community member, it is important to ask questions! Researchers involved in these studies should follow up with you and your community about the results and what they mean. Information is important for everyone impacted by environmental contamination. You and others can use results from these studies to make informed decisions.