FOR IMMEDIATE RELEASE:
Wednesday, June 23, 2004

For more information, please contact:
Pam Miller, ACAT, 907-222-7714
Steve D'Esposito, Earthworks,
202-887-1872 x203

EPA CITES ALASKA, RED DOG MINE AS NATION'S BIGGEST POLLUTER

Mining Industry Tops List of Polluters, Red Dog is Biggest Source of Toxic Waste

Anchorage – Today the Environmental Protection Agency (EPA) released its 2002 Toxics Release Inventory (TRI), an annual compendium of toxic chemicals released by all industries in the United States**.** Multinational companies that mine metals and minerals—such as gold, silver and zinc—produce more toxic waste than any other industry in the country, according to the TRI data. **The Red Dog mine in the northwest Arctic is the U.S.' largest toxic polluter** (481.6 million pounds). The Greens Creek mine outside of Juneau (37.1 million pounds) ranked second in Alaska, and the Fort Knox gold mine, located 25 miles northeast of Fairbanks, ranked third (4.5 million pounds).

According to the EPA, Alaska ranked first in the nation for the largest total releases of chemicals in 2002, with 545.5 million pounds of toxics coming from the mining industry. The hardrock mining industry is the nation's largest toxic polluter: it released 1.3 billion pounds or 27% of all toxics released by U.S. industry.

This report discloses that the mining industry is Alaska's largest toxic threat. The hardrock mining industry releases toxins (lead, mercury, zinc, copper, heavy metals etc.) that poison Alaska's land, air, and water. Mine waste often leaches acidic solutions of toxic heavy metals such as arsenic, lead and cadmium into surface and ground waters. According to the EPA, 40% of the headwaters of western watersheds are polluted by mining.

Despite the large amounts of toxic releases reported, these numbers do not represent the full amount of pollution released into the environment by the mining industry. Since the mining industry was required to report its toxic releases in 1997, mining companies have successfully attempted to get out of their reporting requirements through various court cases.

"The full extent of pollution caused by the mining industry in Alaska is important for us to know, so that we can protect the people living nearby and the natural resources surrounding our mine sites," said Pam Miller, executive director of Alaska Community Action on Toxics, noting that the lead dust emissions from Red Dog had increased over the past year. "Mining corporations need to be held accountable and protect our communities and land from mining's ill effects."

"These companies are running renegade over the public's right to know what toxic waste is dumped in their communities," said Steve D'Esposito, President of Earthworks, "Mining companies are exposing communities and water supplies to contaminants like lead, mercury and arsenic, and some of them don't want anyone to know."

In 1999, Barrick Gold (the 3rd largest gold producer in the world) sued to limit the public's right to know about toxic mining pollution. In April 2003, the Court agreed with Barrick on one of its legal arguments, ruling that mining companies do not have to report toxics contained within waste rock if the toxics fall below a certain "de minimis" concentration. **Because of this court decision, this years reporting is significantly lower than last year.**

As part of the regulations that guide TRI reporting, the EPA established a reporting exemption, known as "de minimis," for minute concentrations of toxics that are deemed to constitute no threat to the environment or to public health. Including toxics within waste rock under the “de minimis” exemption violates the spirit of the exemption. Even small concentrations of toxics add up quickly when dumped in prodigious quantities. Last year’s TRI data showed the mining industry released nearly 3 billion pounds of toxic chemicals into the environment - Earthworks believes that a significant percentage represents toxic chemicals discharged in waste rock.

“The waste rock at Red Dog is not benign,” said Miller. “The native community living near Red Dog gets its food from the surrounding area and needs to know what pollutants are coming from the mine.”

The EPA has said that it plans to write a new rule clarifying reporting obligations as a result of these lawsuits. However, until then, the mining industry is doing communities affected by its toxic releases a great disservice by not reporting all the necessary information.

The TRI program was created in 1986 under the Emergency Planning and Community Right to Know Act (EPCRA) in response to the toxic gas leaks in Bhopal, India and West Virginia. The purpose of the program is to provide citizens with vital information about the existence and the characteristics of pollutants produced or released into the environment in their communities.

The billions of pounds of toxics released by today’s hardrock mines highlight the flaws inherent in the General Mining Law, which has remained virtually unchanged since it was first passed in 1872 and which contains no environmental safeguards.

TRI data can be obtained by visiting the EPA’s Toxics Release Inventory Web site at www.epa.gov/tri/. Data contained in this year’s TRI report pertain to toxic releases that occurred in 2002. For more information on the two industry lawsuits, please visit: http://www.earthworksaction.org/ewa/TRI_industry.cfm

# # #

Alaska Community Action on Toxics
505 West Northern Lights Boulevard, Suite 205
Anchorage, Alaska 99503
Phone (907) 222-7714; Fax (907) 222-7715

Media Release
For immediate release: June 9, 2004 **Contact: Pam Miller, ACAT (907) 222-7714**

NEW REPORT POINTS TO RED DOG MINE AS SOURCE OF LEAD AND OTHER TOXINS IN SUBSISTENCE FOODS:
Report Faults State for Falsely Assuring Villagers About Food Safety

Anchorage—A report released today by Alaska Community Action on Toxics (ACAT) documents that locations used by residents of Kivalina for subsistence gathering of greens and berries have higher than normal levels of lead and cadmium. The report also found evidence that Red Dog Mine, the world's largest zinc mining operation, is the source of the high levels.

The levels of metals found in the foods that Kivalina residents gather and eat are not acceptable, according to Dr. Fred Youngs, an environmental research chemist at the University of Massachusetts Lowell who conducted the analysis that led to the report. "The levels of lead and cadmium exceed safe levels in areas where people are gathering berries and greens. It is evident that those who consume these berries and vegetation may be at risk for adverse health effects," stated Dr. Youngs. "The State needs to act now to educate and protect the subsistence communities potentially affected by the mining operations."

Lead has been widely proven to affect the central nervous system and cause irreversible brain, kidney and reproductive organ damage, especially in children and pregnant women. Long-term exposure to lower levels of cadmium can result in kidney disease, lung damage, fragile bones and damage to liver and blood. As well, it can cause children to become hyperactive and reduce their verbal skills and IQ scores.

The report summarizes Dr. Youngs' analysis of two studies that examined levels of heavy metals in plants used for subsistence. The first study was done by Ecology and Environment, Inc. for the Alaska Department of Environmental Conservation (ADEC). The second was done by Exponent, a private firm contracted by Teck Cominco, the owner and operator of Red Dog Mine. The data for both studies were collected in the area of Red Dog Mine during the summer of 2001. The sampling of subsistence vegetation focused on salmonberry and sourdock. Dr. Youngs compared the levels of lead and cadmium found in the plants samples to standards set by the World Health Organization (WHO) and U.S. Food and Drug Administration (FDA) for safe levels in foods. Dr. Youngs found the levels reported in subsistence foods collected near Red Dog Mine exceeded safe levels determined by WHO and FDA.

Dr. Youngs also reviewed an evaluation of exposure of Noatak and Kivalina residents to heavy metals from Red Dog Mine completed by the Alaska Environmental Public Health Program (EPHP). EPHP concluded that the lead found in sampled vegetation did not pose a health threat to wildlife or people. This conclusion was based in great part on the results of blood tests the agency conducted of villagers in 1990, less than a year after mining operations began at Red Dog. It has not conducted any blood lead level tests of villagers since that time. Contrary to EPHP's conclusion, Dr. Youngs recommends that villagers be advised to limit the areas in which they collect berries and other edible vegetation in order to protect their health.

ACAT recommends immediate action to protect Kivalina residents from the potential health risks caused by unsafe levels of lead and cadmium in their food, including:

- The state should make new tests for blood lead levels immediately available to residents of Kivalina, Noatak and Point Hope and to the mine's employees.
- The state should conduct additional sampling of vegetation in subsistence harvest areas.
- An education program should be implemented immediately to advise all local residents to limit or completely restrict the areas in which they collect berries and other edible vegetation.
- Areas identified as containing contaminated berries or other subsistence foods should be identified by posted notices.
- Local people should be given the opportunity for meaningful involvement in the design and review of ongoing monitoring programs related to contamination by heavy metals and in public policy decisions regarding operations at Red Dog Mine.

The economy of Kivalina is based on subsistence. Since the mine began operating in 1989, villagers have noticed a serious decline in their quality of their drinking water, as well as fish kills and changes in the abundance and patterns of caribou, beluga and bearded seal migrations. On March 8, 2004, residents of Kivalina filed a lawsuit against Teck Cominco alleging nearly 4,000 violations of the federal Clean Water Act.

The Red Dog Mine is located in Northwest Alaska. Every 15 minutes around the clock, trucks carrying up to 100 tons of lead and zinc ore from the mine travel 52 miles overland to the port site on the Chukchi Sea. These transport operations generate a large amount of dust, both from the roadbed and also from ore truck surfaces. The National Park Service, the Alaska Department of Environmental Conservation and Teck Cominco undertook studies to evaluate the effects of the dust emissions on the surrounding vegetation.

"Teck Cominco should not consider this level of pollution to be just a cost of doing business in Alaska. They should be willing to be good neighbors," said Pam Miller, Executive Director of Alaska Community Action on Toxics. "Alaskans have the right to expect that operations at Red Dog do not harm nearby communities, and that the State will protect community not corporate interests."

For a full copy of the report or more information, please call Alaska Community Action of Toxics, (907)222-7714, or go to www.akaction.org. Dr. Fred Youngs of the University of Massachusetts is available for interviews at (978) 934-4859.

###

Red Dog and Subsistence

Analysis of Reports on Elevated Levels of Heavy Metals in Plants Used for Subsistence near Red Dog Mine, Alaska

ACAT
Alaska Community Action on Toxics

Contents

Acknowledgments

This report is a publication of Alaska Community Action on Toxics (ACAT), a nonprofit public interest organization whose mission is to protect human health and the environment from the toxic effects of contaminants in order to sustain the health and well-being of Alaskans, Alaska communities and the natural environment on which we depend. We believe that everyone has a right to clean air, clean water and toxic-free foods. We bring together scientific and medical experts, environmental justice and tribal leaders, organizers and activists to share information on environmental sampling, community-based environmental health surveys, GIS technology and other research tools to help Alaskans stop the production, proliferation and release of toxic chemicals that may adversely affect our health and ways of life.

This report was made possible through the generosity of True North Foundation, the Alaska Conservation Foundation and Brainerd Foundation. We are also grateful to Belvedere Foundation, Bullitt Foundation, Common Stream Inc., Mitchell Kapor Foundation, Public Welfare Foundation, Skaggs Foundation and Westwind Foundation for their support of our work and to Becca Bernard and Mike Frank, attorneys with Trustees for Alaska, Colleen Koenig, Tribal Administrator for the Village of Kivalina and Luke Cole, Director of the Center on Race, Poverty and the Environment for their advice and assistance.

A special note of thanks goes to Fred Youngs, Ph.D., occupational and environmental research chemist at the University of Massachusetts Lowell and director of the Citizens Environmental Laboratory in Boston, for his fine work in reviewing and analyzing data on the contamination of plant species in the Red Dog Mine transportation corridor. We appreciate the research, review and writing skills of Mimi Peabody, Ariel Blanc and Katherine Polan. And we are particularly indebted to Ann Rothe who, with assistance from Deanne Kloepfer, took major responsibility for drafting, editing and designing the final report.

May 2004

505 West Northern Lights Boulevard, Suite 205
Anchorage, Alaska 99503
Phone: 907-222-7714 Fax: 907-222-7715
E-mail: info@akaction.net

Executive Summary

In response to public concerns raised about possible contamination by heavy metals in Cape Krusenstern National Monument, the National Park Service (NPS) conducted a study in 2001 along the 52-mile transportation corridor that crosses the monument. The corridor connects Red Dog Mine, the world's largest zinc mining operation, to Delong Mountain port on the Chukchi Sea. At the port, lead and zinc ore is shipped to market.

The NPS research team chose to analyze levels of heavy metals in *Hylocomium splendens*, a species of moss, because moss does not take up minerals from soil and groundwater as rapidly as vascular plants. Therefore, researchers were able to delineate between concentrations of heavy metals that occur naturally in the soil and levels that result from deposition of airborne particles.

The study's findings revealed that a portion of the moss samples contained levels of lead and cadmium equivalent to levels found in some of the most polluted former Soviet bloc nations of Eastern Europe. The source of the contamination, the NPS study determined, was dust thrown from massive ore trucks that travel between the mine and the port along a haul road in the transportation corridor.

Release of the NPS study prompted two additional studies, the first by the consulting firm Ecology and Environment, Inc. (E&E) under contract to the Alaska Department of Environmental Conservation. The E&E study team collected vegetation samples — including three species of plants harvested for subsistence by local Inupiat — from a site at the port and from traditional subsistence harvest areas for the villages of Point Hope, Kivalina and Noatak, all three within an 80-mile radius of the mine.

This study found that cadmium concentrations were highest in vegetation samples collected at the port and that lead concentrations in subsistence foods collected in the Kivalina harvest areas were greater than concentrations found in samples from the Noatak and Point Hope harvest areas.

The second study was completed by Exponent, a consulting firm under contract to Teck Cominco Ltd. (Cominco), the operator of Red Dog Mine. The Exponent team studied moss and vascular plant samples collected along the haul road and at the port. The results were consistent with the NPS study, showing elevated levels of lead and cadmium in plants along the haul road.

The Exponent team also documented higher levels of lead in their salmonberry samples collected at the port and within 100 meters of the haul road than the E&E study found in salmonberry samples at Noatak and Point Hope. Similarly, the Exponent team found higher

National Park Service researchers found that vegetation sampled in the northwestern Alaska study area contained levels of lead and cadmium equivalent to levels in some of the most polluted former Soviet bloc nations of Eastern Europe.

levels of cadmium in salmonberry samples collected at two of their three port sample sites and within 100 meters of the road than were reported by the E&E team for Point Hope and Noatak.

After reviewing all three studies, the Alaska Department of Health and Social Services' Environmental Public Health Program (EPHP) concluded that the lead found in the sampled vegetation did not pose a health threat to wildlife or people because the lead occurred in a form with low bioavailability, meaning that it can not be readily absorbed by living beings. EPHP cited studies that used rats as models from which to extrapolate the health effects on humans.

Other studies, however, suggest that rats are poor models for humans in studies of the effects of lead because rodents, unlike humans, excrete lead through bile at a high rate and because of the significant anatomical and physiological differences between rodents and humans that may influence the venous uptake of lead. Studies using young swine as models have been deemed more appropriate for determining the bioavailability of heavy metals in humans because the digestive tracts of young swine are anatomically similar to those in human children.

EPHP also claimed that the low bioavailability of lead in Red Dog ore accounted for the low levels of lead in the blood of Kivalina and Noatak residents. The blood lead levels reported by EPHP were taken from tests the agency conducted in 1990, less than a year after Red Dog mine operations began in December 1989. EPHP indicated that additional testing was conducted in children from Kivalina in 1993, but was limited to 21 children, less than 20 percent of the 1990 sample size. EPHP has not conducted additional comprehensive blood lead level tests in villagers since 1990, and most notably not since mining activities expanded in 1998 and again in 2001. The agency's 2001 review concluded that "blood lead testing is not medically indicated at this time."

Fred Youngs, Ph.D., an occupational and environmental research chemist with the University of Massachusetts, conducted an independent review of the Exponent and E&E studies and the results of the EPHP investigation. He compared the levels of lead and cadmium found in the vegetation samples collected in both studies to the recommended allowances for human consumption set by the *Codex Alimentarius* Commission, a commission established by the United Nations' Food and Agriculture Organization and World Health Organization to develop food standards and guidelines to protect human health. Dr. Youngs also compared the levels of lead and cadmium found in the two studies' samples to levels reported by the U.S. Food and Drug Administration (FDA) in two raw fruits analyzed as part of FDA's ongoing Total Diet Study.

This independent review found that approximately 16 percent of the berry samples collected by E&E contained levels of lead in excess of the maximum levels (MLs) for small fruits and berries set in the *Codex Alimentarius* General Standards for

Contaminants and Toxins in Foods, and 16 percent contained levels of cadmium in excess of the draft *Codex* ML for fruits and vegetables. Approximately 30 percent of the sourdock samples collected by E&E exceeded the *Codex* ML for lead in fruits and vegetables, and 10 percent exceeded the *Codex* ML for lead in leafy vegetables.

Of the salmonberry samples collected by Exponent, approximately 29 percent contained levels of lead that exceeded the *Codex* ML for small fruits and berries, and 43 percent contained levels of cadmium in excess of the draft *Codex* ML for fruits and vegetables.

Dr. Youngs used two raw fruits — apples and strawberries — to compare the FDA study with the other two studies because wild foods (subsistence foods) are not included in the FDA study. He calculated mean values for levels of lead and cadmium in all samples from the E&E and Exponent studies and found that they equaled or exceeded mean values for strawberries and apples from the FDA Study.

Dr. Youngs' analysis also found an anomaly in the E&E data, and after investigating the anomaly, he discovered that the data revealed lead levels in salmonberries collected at Point Hope were nearly an order of magnitude higher than indicated in the E&E report.

Data collected in the NPS, E&E and Exponent studies strongly indicate that vegetation in the region of Red Dog Mine, including plant species harvested for subsistence by local residents, contains elevated levels of lead and cadmium. Evidence points to mine operations as the source of observed elevated levels of heavy metals. In an effort to reduce the release of heavy metal contaminants in the transportation corridor, Cominco replaced its truck fleet in 2001 with side-dumping vehicles that have hydraulically sealed cargo covers. However, more must be done to control pollution sources and prevent contamination.

Additional vegetation sampling is needed — in previously sampled areas and in areas that have not been sampled, especially places where people gather berries and plants for subsistence. This will provide more knowledge of where contamination exists. It will also contribute information needed for strategies to limit further contamination and protect human health and the environment.

The state should make new tests for blood lead levels immediately available to residents of Kivalina, Noatak and Point Hope and to the mine's employees. EPHP's recommendation that "residents of Kivalina, Noatak and Point Hope should continue to eat their traditional foods without restriction" seems ill-advised at best, given the lack of recent data on blood lead levels for the villagers.

Local and state health officials should conduct a health education program to make local residents aware of the findings of the studies performed to date, of the need for further testing of plants and, in the interim, of the need to limit or restrict the areas in which they collect subsistence foods.

The state should make new tests for blood lead levels immediately available to residents of Kivalina, Noatak and Point Hope and to Red Dog Mine employees.

Villagers must be given the opportunity for active, meaningful involvement in monitoring programs related to contamination by heavy metals and in public policy decisions regarding operations at Red Dog Mine.

Villagers must be given the opportunity for active and meaningful involvement in the design and review of ongoing monitoring programs related to contamination by heavy metals and in public policy decisions regarding operations at Red Dog Mine.

I. Background

Red Dog Mine, the world's largest producer of zinc, is located in northwestern Alaska on the western edge of the Brooks Range between Noatak National Preserve to the east and Cape Krusenstern National Monument to the west (see map next page). The mine is approximately 55 miles inland from Chukchi Sea.

Teck Cominco Ltd. (Cominco), a Canadian mining company based in Vancouver, British Columbia, operates the mine. Red Dog ore deposits lie within a 120-$mile^2$ block of land owned by the Northwest Alaska Native Association (NANA), a Native for-profit corporation created pursuant to the 1973 Alaska Native Claims Settlement Act. In 1982, Cominco entered into an agreement with NANA to develop the ore deposit at Red Dog.[1] Mine development began in 1986 and construction was completed in 1989, the same year that operations and production began.[2]

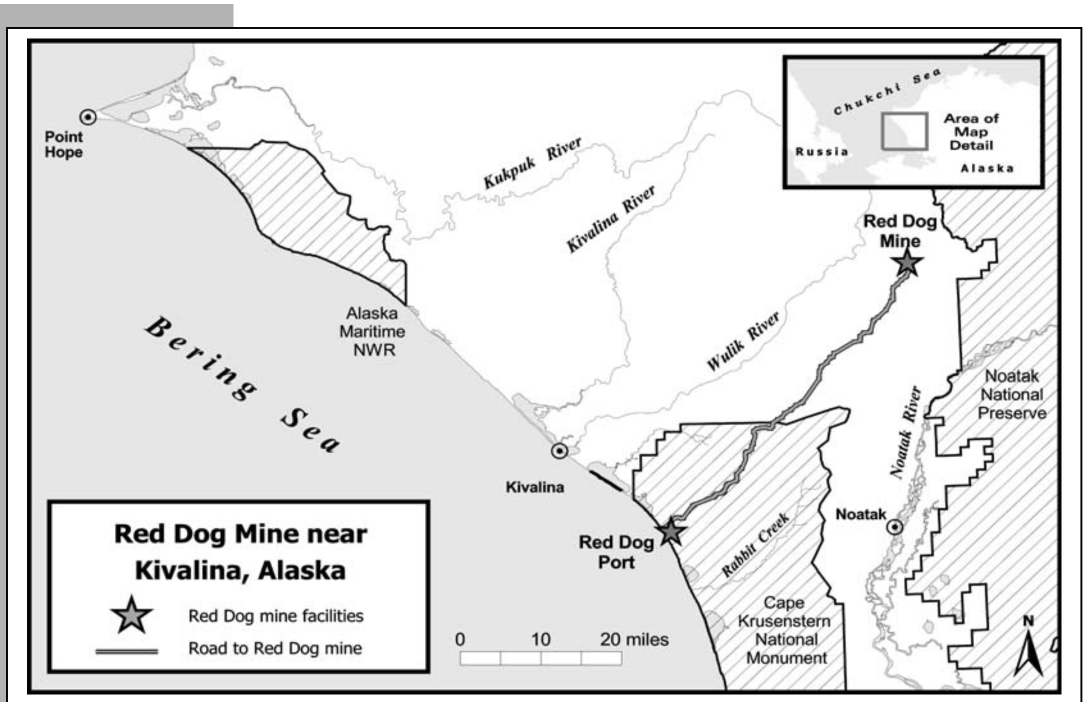
In 1985, Congress granted NANA a 100-year easement for a transportation corridor that bisects the northern portion of Cape Krusenstern National Monument and includes land for a port site inside monument boundaries. The grant exempted the corridor from review under provisions of Title XI of the Alaska National Interest Lands Conservation Act, which require an environmental impact assessment and full public review of proposed transportation and utility corridors across federal lands protected under the Act.[3]

Within the transportation corridor, the State of Alaska financed the construction of a 30-foot wide, 52-mile long all-weather haul road extending from the mine west to the Chukchi Sea, where a shallow-water dock, offshore ore loading facility, fuel distribution and storage systems and other port facilities were built.

Collectively, the corridor and port are known as the DeLong Mountain Regional Transportation System, which is managed by the Alaska Industrial Development and Export Authority (AIDEA).[4] Cominco entered into a contract with AIDEA for a priority, non-exclusive right for use of the system until 2040 to transport ore concentrates over the haul road, store ore concentrates in buildings at the port and load concentrates onto ore ships.[5]

The mine itself encompasses a number of ore bodies that total more than 160 million tons of reserves and resources. The deposit is 15.9 percent zinc and 4.4 percent lead and contains nearly 2.9 ounces of silver per ton.[6] The ore lies close to the surface in a relatively flat area, making open pit mining the method of choice for extraction.[7] After ore is removed from the pit, the rock is crushed. Zinc and lead concentrates, the mine's primary products, are separated in a milling process that utilizes a range of chemicals, including 60-

The transportation corridor, including the heavily traveled haul road and port, is traditionally used by local residents for the gathering of subsistence foods.



70 grams of cyanide per ton of ore. Red Dog produces nearly 20,000 tons of ore concentrates and waste each day.[8] Trucks weighing 100 tons each when loaded leave the mine site every 15 minutes around the clock, taking ore along the 52-mile haul road to DeLong Mountain port, where the ore is stored in two quarter-mile-long buildings that can hold 1.1 million tons of ore concentrates until the product can be shipped.[9] (The port is accessible to ore ships for only about 100 ice-free days per year.[10]) The water at the port is so shallow that the concentrates must be loaded onto small barges for transport to large ore ships anchored approximately three miles offshore.[11]

The nearly continuous heavy traffic along the haul road generates a significant amount of dust from the roadbed and from loss of loaded concentrates as the trucks move up and down the road.[12] To minimize the loss of concentrate and reduce dust emissions, Cominco replaced its older trucks with their open-top containers on tandem tractor-trailers in 2001. The new trucks have hydraulically sealed cargo covers and a side-dumping feature.[13] Cominco also installed washing stations for the trucks at both the mine and the port, but freezing weather conditions soon proved them useless.

Cominco states it is developing other strategies to prevent contamination, [14] but serious concerns have been raised about the release of heavy metals, specifically lead and cadmium, from industrial activities at the mine and from ore truck traffic dust along the haul road and at the port. The transportation corridor, including the haul road and port site, is an area traditionally used by local residents for the gathering of subsistence foods, including berries and plants.

II. Mine Wastes and the Toxics Release Inventory

Under provisions of the federal Emergency Planning and Community Right-to-Know Act of 1986 (Community Right-to-Know Act), industries that manufacture, process or otherwise use toxic substances are required to report each year the locations and quantities of toxic substances released during their operations to the U.S. Environmental Protection Agency (EPA) and the state government in the state(s) where they operate.[15]

The term “release” means any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping or disposing into the environment of any hazardous chemical, extremely hazardous substance or toxic chemical.[16]

Pursuant to the Community Right-to-Know Act, the EPA maintains a list of the substances and quantities of each that industries must report. The Act grants EPA the authority to expand the list of substances, as well as expand the list of industries that must report, and requires the agency to maintain and annually update a database of the release reports it receives.[17] EPA’s Toxics Release Inventory (TRI) is the annual compilation of nearly 650 chemicals and chemical categories released by various industries in the United States.

In 1997, EPA expanded the list of industries that must report releases of toxic substances to include the coal and metal mining industries.[18] Effective January 1, 1998, for the first time since mining operations began at Red Dog, Cominco was required to report toxic substances released in the course of operations at the mine. EPA’s decision to require reports of mining industry releases for inclusion in the TRI prompted the National Mining Association (NMA) to file a lawsuit in 1998, challenging EPA’s authority to extend TRI reporting requirements to the mining industry, EPA’s interpretation of TRI reporting requirements to include toxic chemicals placed in containment units at mines and the agency’s interpretation that mining companies were required to report toxics produced from the extraction and beneficiation[19] of metal ores. In relation to the latter point, the lawsuit claimed that the toxics contained in the ores were naturally occurring and had not been “manufactured” as defined in the Community Right-to-Know Act.[20]

In January 2001, the federal District Court presiding over the NMA case issued an order and opinion and then a revised order in March 2001 that upheld EPA’s authority to extend TRI reporting requirements to the mining industry and EPA’s determination that mining facilities must report their releases to land, including into landfills and onsite containment areas. The Court also determined that extraction and beneficiation of undisturbed

Effective January 1, 1998, for the first time since mining began at Red Dog, Cominco was required to report toxic substances released during operations at the mine.

Mine Wastes and the Toxics Release Inventory

ores does not fit the Community Right-to-Know Act's definition of "manufacturing." But the Court made clear in its revised order that its decision did not set aside EPA's determination that mining facilities must report any toxic chemicals generated during extraction and beneficiation that are not present in naturally occurring undisturbed ores (for example, the creation of sulfates from sulfides as a result of the unearthing and processing of metal ores).[21]

TRI reports for Red Dog Mine include toxic releases to land, water and air from waste rock and tailings solids, metal loads from water sources in tailings impoundments, water treatment plant sludge, emissions from power generators and incinerators, fugitive dust emissions, and discharges from sewage treatment facilities. By far, most releases are from waste rock and tailings solids.[22]

In 1998, its first year of reporting, Red Dog Mine's releases totaled nearly 250 million pounds of toxics, the fifth highest total of all metal mines in the nation.[23] The inclusion of the mining industry in the TRI for 2000 pushed Alaska from forty-seventh to fourth place in state rankings for highest total toxic releases. Red Dog Mine's releases accounted for 83 percent of the total releases of toxic substances within Alaska's boundaries.[24] The 2000 TRI shows Red Dog Mine released nearly 445 million pounds of toxics, including 308 million pounds of zinc compounds, 123 million pounds of lead compounds and 2 million pounds of cadmium compounds.

In 2001, Alaska again ranked fourth in the nation for the amount of toxic substance releases that occurred within its borders. More than 522 million pounds of toxic chemicals were released as a result of industrial operations in the state.[25] Of that total, Red Dog Mine was responsible for 432 million pounds, or approximately 83 percent.

In addition, the mine surpassed all other Alaskan mining operations and industries in the total of persistent bioaccumulative toxins reported,[26] releasing more than 128 million pounds of lead compounds and 2.2 million pounds of cadmium compounds.

Table 1 details the releases from Red Dog Mine as reported in EPA's TRI for 2001 and 2002. An onsite release is one that occurs at the reporting facility, while an off-site release refers to a transfer of toxic substances away from the site for disposal. [27]

TRI data clearly show that enormous amounts of toxic substances are generated in the course of mining activities at Red Dog Mine. It is the potential environmental and human health impacts of these releases that have, in turn, generated concern among residents in the region, as well as among federal land managers and state resource agency personnel.

Potential impacts on village drinking water supplies and regional air quality are prominent issues. So are the potential impacts of dust from transportation of ore and other mining activities — the problems that are the focus of this report.

Table 1. Toxic releases (in pounds) from Red Dog Mine, reporting years 2000 and 2001

Total Air Emissions

	2000	2001
Lead	8,290	8,303
Zinc	32,850	32,063
Cadmium	229	225
PBT[a]		9,379
All Chemicals	521,973	524,146

Total Land Releases

	2000	2001
Lead	123,000,000	128,298,825
Zinc	308,000,000	290,902,426
Cadmium	2,080,000	2,214,951
PBT[a]		128,298,825
All Chemicals	444,800,000	431,487,880

Total Water Discharge

	2000	2001
Lead	13	8
Zinc	330	488
Cadmium	12	15
PBT[a]		8
All Chemicals	555	819

Total On-and-Off Site Releases

	2000	2001
Lead	123,008,303	128,307,136
Zinc	308,000,000	290,902,426
Cadmium	2,080,000	2,214,951
PBT[a]		128,308,212
All Chemicals	445,322,528	432,012,845

[a] PBT = Persistent Bioaccumulative and Toxic Chemicals. At Red Dog Mine, these include lead releases. There are no PBT data for 2000.

Since reporting began, data show that Red Dog Mine consistently accounts for the overwhelming majority of toxic chemicals released by *all* industrial operations in Alaska.

III. Living in the Shadow of an Industrial Complex

Red Dog Mine's location (see Figure 1) places it squarely between Noatak National Preserve to the east and Cape Krusenstern National Monument to the west, both units of the America's National Park System and both of which are protected under provisions of the 1980 Alaska National Interest Lands Conservation Act. The road connecting the mine to its port on the Chukchi Sea cuts directly across the northern portion of Cape Krusenstern monument, and the port is located within the monument's boundaries.

The purposes for which the 560,000-acre monument was established include preservation of evidence of prehistoric and historic Native cultures, protection of habitat for marine mammals and populations of fish, birds and other wildlife, and protection of the viability of subsistence resources.[28]

Just about 8 miles east of the mine is Noatak National Preserve, encompassing one of the largest wilderness ecosystems in the National Parks System. The 6.4 million-acre preserve was established to protect the integrity of the Noatak River watershed and "assure the continuation of geological and biological processes unimpaired by adverse human activity," to protect habitat for, and populations of, fish and wildlife, and to protect archaeological resources.[29]

Three Inupiaq Eskimo villages lie within the region that encompasses Red Dog Mine. Nearly all of the residents of two of the villages, Noatak and Kivalina, are shareholders of NANA, the corporate partner of Cominco in the operation of the mine,[30] and a number of villagers are employed as workers at the mine. By virtue of their proximity to the mine and the fact that the economies of their villages are principally based on subsistence, the residents of the three villages also comprise the population most at risk from the potential human health effects of the mine's toxic releases.

The village of Noatak is located on the Noatak River about 45 miles south of the mine and just west of Noatak National Preserve. It was established in the 1800s as a fishing and hunting camp, and because of the abundance of fish and wildlife resources in the region, this village of 428 became a permanent settlement.[31] Red Dog Mine employs many of the village's residents, but subsistence activities are still the central focus of the village's economy and culture.[32] Many of the families living in Noatak travel to fish camps during the summer. Salmon, whitefish, caribou, moose and waterfowl are the primary animal species harvested for subsistence.

Kivalina is 50 miles southwest of Red Dog Mine at the end of an 8-mile long barrier island between the Chukchi Sea and the mouth of the Wulik River. The village

Three Inupiaq Eskimo villages — Noatak, Kivalina and Point Hope — are located in the region that encompasses Red Dog Mine and its operations.

Living in the Shadow of an Industrial Complex

has long been a stopping place for seasonal travel between arctic coastal areas and Kotzebue Sound. (In 1847, a Russian Navy officer's report identified it as "Kivualinagmut."[33]) The economy of this village of 377 people is based primarily on subsistence activities, although Red Dog Mine employs some of its residents.[34] In addition to bowhead and beluga whales, Kivalina residents use seals, walrus, salmon, whitefish, caribou, berries and greens for subsistence. Two of the village's main hunting trails follow the Wulik and Kivalina Rivers.[35] Given the village's proximity to Red Dog Mine and the fact that the village's water supply and many of the species on which villagers rely for subsistence are found within the watershed of the mine and near the DeLong Mountain port, the residents of Kivalina are arguably among the people in the region most at risk from the potential environmental impacts of toxic releases from the mine. Consequently, they have for many years expressed concerns about potential impacts of mining activities on village air and water quality and on resources they harvest for subsistence.[36]

The village of Point Hope is located approximately 80 miles west northwest of Red Dog Mine near the tip of Point Hope, which juts out into the Chukchi Sea and forms the western-most extension of the Northwest Alaska coast. This peninsula is one of the oldest continuously occupied Inupiaq areas in Alaska. Settlements have existed there for at least 2,500 years.[37] The Tikeraqmiut Inupiat of Point Hope depend on marine fish and wildlife species for subsistence. They have been able to retain strong cultural traditions, after more than a century of outside influences, because of the abundance of marine resources in the waters around the peninsula.[38]

There is easy access to marine mammals along the peninsula, with ice conditions that allow boats to be launched into open leads early in spring for the hunting of migrating whales. Historically, inhabitants of the peninsula ranged over an extensive area, south to the Kivalina River and far inland. The current 757 residents of Point Hope use seals, bowhead whales, beluga whales, caribou, polar bears, birds, fish and berries for subsistence.[39]

The impacts of mining activities on the region's water quality are perhaps of greatest concern to local residents. The drinking water supply for the village of Kivalina is drawn from the Wulik River via a 3-mile surface transmission line and is then treated and stored in tanks from which villagers draw water to haul to their homes.[40] Red Dog Mine is located in the watershed of the Wulik River, and Red Dog Creek, which flows through the mine site, is a tributary of the Wulik.

For several years, villagers expressed concerns to Cominco that discharges from the mine were polluting the village's drinking water and impacting fish populations on which villagers depend for subsistence, but they received little or no response from the company.[41] On March 8, 2004, villagers filed a lawsuit against Cominco, asserting nearly 4,000 violations of permits issued under the federal Clean Water Act.

EPA issued two wastewater discharge permits, one for the mine and one for the port, pursuant to Section 401 of the Clean Water Act. The mine's permit allows Cominco to discharge approximately 2.4 *billion* gallons of effluent into the middle fork of Red Dog Creek every year. The permit also sets maximum daily limits for the levels of total dissolved solids, heavy metals and other toxins contained in the effluent. The villagers' citizen lawsuit alleged that between August 1998 and May 2003, Cominco committed 2,322 violations of the provisions of the wastewater permit for the mine, including exceeding the discharge levels for total dissolved solids (in some instances by more than 1500 percent), cyanide and cadmium.[42]

The wastewater permit for the port lets Cominco discharge drainage water from the ore storage buildings directly into the Chukchi Sea or onto the tundra near the port. As with the mine permit, maximum daily limits are set in the port's wastewater permit for levels of heavy metals allowed in the discharges. The lawsuit stated that Cominco violated the provisions of the port permit 1,654 times between May 1999 and May 2003, including the unpermitted discharging of untreated water to the tundra, exceeding the levels of total suspended solids in discharges to the Chukchi Sea and failing to contain a pipeline spill.[43]

Kivalina residents felt compelled to take action to protect resources on which they depend for their lives and livelihoods because of what they determined was a clear lack of action on the part of state and federal agencies charged with protecting their interests.[44] Neither EPA nor the Alaska Department of Environmental Conservation has taken action to enforce the provisions of the mine and port permits. Instead, EPA issued "Compliance Orders by Consent" to Cominco, which extended the deadlines for the company to comply with the permit provisions and relaxed the limits for certain discharge parameters. The agency subsequently modified the Consent Orders to extend the deadlines over an even longer period of time.[45] Even with the relaxation of permit conditions represented by these Consent Orders, Kivalina residents documented in their lawsuit that Cominco committed 64 violations of the mine Consent Orders and 53 violations of the port Consent Order. The lawsuit was pending before the federal District Court in Anchorage, Alaska, as of this writing.

Meanwhile, Kivalina's residents and other residents in the region face another pollution problem arising from Red Dog Mine operations — contamination from dust laden with lead, cadmium and other heavy metals that is generated by the nearly constant movement of ore trucks on the haul road, by loading and unloading of ore trucks and barges at the port and by other mining activities. The area in question includes sites where villagers have traditionally harvested berries, other vegetation, caribou and other animals for subsistence.

On March 8, 2004, villagers from Kivalina filed a lawsuit against Cominco, asserting nearly 4,000 violations of the federal Clean Water Act resulting from operations at Red Dog Mine.

IV. Effects of Lead and Cadmium on Human Health

The concerns of residents regarding the potential effects on human health from pollution generated by mining operations at Red Dog are far from frivolous. A wealth of research indicates that the health effects of at least two of the heavy metals — lead and cadmium —are significant.

Historically, lead has been and continues to be mined for a variety of uses. It was added to gasoline until the mid-1980s and is still used in the manufacture of batteries, industrial paints, ammunitions, aviation parts, medical instruments and computer equipment.[46] Lead particles can come from these products, before and after their disposal, and from mining industry operations. After lead particles are liberated, they easily travel through the atmosphere, settle and readily stick to soil particles.[47] Over time and especially in areas of constant lead-related activity, lead levels can build up in soil, plants and animals. Lead has no characteristic taste or smell, so humans can unknowingly breathe in, eat and drink lead particles.

Once ingested, lead can affect almost every organ of the body. Although it is usually excreted from the body within a couple of weeks after ingestion, continuous exposure can result in accumulation.[48] Lead is typically stored in the bones and teeth. However, it can be liberated throughout the human life cycle and become mobile in the blood.

The kidneys, reproductive organs and neurological systems of the body are particularly sensitive to lead, which can also affect the central nervous system, cause irreversible brain damage and impair the blood-forming system, causing anemia.[49]

People of all ages are susceptible to lead toxicity, but children and developing fetuses are especially vulnerable because they tend to be at a higher risk of exposure and because harmful effects appear at lower blood lead levels.[50] Before 1979, scientists believed blood lead levels of less than 25 micrograms per deciliter (*u*g/dl) did not cause human health problems. Since then, both the Centers for Disease Control (CDC) and the World Health Organization (WHO) agreed that anything above 10 *u*g/dl constituted a "level of concern."[51] As a result, the acceptable blood lead level for children was lowered to ≤10 *u*g/dl, while the acceptable blood lead level for adults remains at ≤25 *u*g/dl.

At the time the change was made, few definitive studies of the effects of blood lead levels below 10 *u*g/dl in children had been completed. The CDC and WHO established the 10 *u*g/dl maximum while simultaneously recognizng that no actual threshold of lead-associated effects may exist.[52] Recent studies indicate that there is no acceptable blood lead concentration thresholds, particularly for children, and that lead-associated impairments may

People of all ages are susceptible to lead toxicity, but children and developing fetuses are especially vulnerable because they tend to be at a higher risk of exposure and because harmful effects appear at lower blood lead levels.

Effects of Lead and Cadmium on Human Health

be both persistent and irreversible.[53] The studies showed that in children with blood lead levels at and above 10 ug/dl, IQ scores dropped 4.6 points for each 10 ug/dl lead increase.[54] An average 7.4-point decrease in IQ scores was observed in children with blood lead levels ranging up to 10 ug/dl.[55] This implies that significant impairment may occur in children at blood lead levels less than 10 ug/dl and suggests that, for children at least, there may not be a "safe" exposure level.

Cadmium is often found in association with other heavy metals in the earth's crust, and is released during ore extraction and processing. Once cadmium particles are released, they can drift long distances in the atmosphere; upon settling, they bind strongly to the soil.[56] Plants, animals and fish readily take up cadmium from their environment. Cadmium bioaccumulates (builds up) in tissues and to high levels from years of constant low exposure.[57] People are exposed through breathing in cadmium particles or by eating and drinking substances contaminated with cadmium.

Cadmium causes many short- and long-term detrimental health effects. Acute exposure can result in nausea, vomiting, diarrhea, muscle cramps, excess salivation, sensory disturbances, liver injury, convulsions, shock, renal failure and even death.[58] Long-term exposure to lower levels can cause kidney disease, lung damage, fragile bones and damage to the liver and blood.[59] In addition, preliminary studies indicate that children exposed to cadmium can become hyperactive and have reduced verbal skills and IQ scores.[60]

Preliminary studies indicate that children exposed to cadmium can become hyperactive and have reduced verbal skills and IQ scores.

V. Studies Examine the Impacts of Fugitive Dust from Red Dog Operations

The environmental toxicity of lead and cadmium was the primary reason for concerns about the possible release of heavy metals in airborne dust particles generated by mining activities at Red Dog. Three studies that examined the extent of contamination from dust generated by traffic along the haul road and operations at the port are summarized below.

National Park Service Study

In 2000, the National Park Service (NPS) initiated a study of vegetation in the transportation corridor and port. NPS researchers collected the moss *Hylocomium splendens* and soil samples along six transects in the corridor between the mine and the port. The moss was selected as the sample plant species because it does not take up minerals from soil and groundwater as rapidly as vascular plants; thus, the NPS team was able to distinguish between heavy metals concentrations that occur naturally in the soil and levels that are the result of the deposition of airborne particles.[61]

Keeping in mind that the prevailing winds in the region blow from the south, the researchers drew their transect lines perpendicular to the road, with three on the north side and three on the south side. Samples were collected along the transect lines at sites that ranged from 3-1,600 meters from the road.

Analysis of the samples revealed a gradient of heavy metal deposition, with the highest levels occurring closest to the road and decreasing levels occurring with increasing distances from the road.[62] Specifically, the team found lead levels as high as 430 milligram/kilogram (mg/kg) dry weight of moss samples collected three meters from the road and cadmium levels as high as 12 mg/kg dry weight in the samples collected at this distance.[63]

In their report, the researchers concluded that concentrations of lead and cadmium in the moss samples they collected even at 1,000 and 1,600 meters from the road "…exceed medians (and in most cases maxima) from all 28 countries in the Nordic moss monitoring program, including many of the most polluted countries in Central and Eastern Europe, and all areas of western Russia." [64]

After the release of the NPS report, two additional studies were undertaken in the summer of 2001. The first was done by the consulting firm Ecology and Environment, Inc. (E&E) under contract to the Alaska Department of Environmental Conservation (ADEC). The second was completed by the consulting firm Exponent under contract to Cominco.

In both studies, researchers collected samples of vascular plants, including plants used for

The National Park Service study found heavy metal deposition was highest near the haul road, with decreasing levels occurring as distance from the road increased.

Studies Examine the Impacts of Fugitive Dust from Red Dog Operations

subsistence. And both studies were expanded to include samples collected beyond the haul road.

E&E Study

ADEC commissioned the E&E study upon the request of villagers in northwestern Alaska to investigate the subsistence foods harvested in areas potentially affected by dust from activities along the haul road and at the port.[65] The E&E study team chose three species of plants used for subsistence to analyze for heavy metals content: sourdock (*Rumex arcticus*), salmon-berry (*Rubus chamaemorus*) and blackberry (*Empetrum nigrum*).[66]

The team selected four sites from which to collect samples: an area immediately south of the port next to the port's tank farm (the "Terminal" site); an area that included lands north and south of the port, which are traditional subsistence harvest sites for villagers from Kivalina (the "Port Site"); an area northwest and upriver from the village of Noatak, which is used for subsistence; and a subsistence harvest area west of the village of Point Hope,[67] included at the request of Point Hope residents.[68]

The Noatak site was chosen for statistical control purposes; that is, a site at which heavy metals levels were expected to reflect levels in natural conditions not impacted by mining activities at Red Dog. However, E&E researchers subsequently abandoned use of the Noatak site as a control because the differences in geological con-ditions and plant community composition between the coastal regions near the port and the inland riverine area of Noatak precluded a valid comparison.[69]

E&E researchers noted that their study was not designed to determine whether dust from port and haul road operations was affecting and accumulating in nearby subsistence foods. Rather, the goal was to determine the similarities and differences in metal concentrations among sampled data sets collected at and near the port, at Noatak and at Point Hope.[70] Because no control data set was available for comparison, the data collected in the study were not compared to background levels; that is, levels found in areas not impacted by Red Dog mining activities. Comparisons were made only among the data collected at each sample site.[71]

At the onset of the study, the state's Environmental Public Health Program was asked to include the study results in its investigation of the risks to human health from the consump-tion of subsistence foods poten-tially contaminated by mining activities at Red Dog (see next chapter).[72]

The results of the E&E study showed that the greatest con-centration of cadmium in all subsistence food samples was in salmonberries at the Terminal sample site. The greatest concen-trations of lead and zinc were found in the sour dock samples collected at the Port sample site, which included the traditional subsistence harvest areas of the residents of Kivalina. And lead concentrations in all subsistence foods sampled at the Port Site were greater than concentrations found in samples from Noatak and Point Hope.[73] The study also revealed that washing the vegetation samples in the field appeared to have no effect on the concentrations of metals. The research team surmised that a more thorough washing process might have been more effective, but indicated that a simple rinse of subsistence foods would not lower exposure of subsistence users to heavy metals.[74]

Exponent Study

The Exponent research team, contracted by Cominco, collected vegetation samples from sites near the mine, along the haul road and at the port. Berry samples were gathered at varying distances along transect lines perpendicular to the haul road from locations not sampled in the National Park Service study and from four locations close to port facilities near E&E's "Terminal" sample site.[75]

The team chose four species of plants to analyze for heavy metals content: *Hylocomium splendens,* the same moss sampled in the NPS study; the lichen *Peltigera aphthosa*; diamond-leaf willow (*Salix pulchra)*; and salmonberry. The moss was selected because it has been used in long-term atmospheric deposition monitoring programs, and therefore its inclusion allows comparisons of results with the NPS study. The lichen, willow and berry species were selected because they are part of the diet of resident and migratory wildlife in the region.[76] The samples were submitted unwashed for analysis of a range of metals, including aluminum, arsenic, cadmium, calcium, lead, magnesium and zinc.

The results of the Exponent study showed a similar pattern to the findings of the NPS study: the highest levels of metals were found in samples collected closest to the road and port, and decreasing levels occurred with increasing distances from the road and port. This supported the conclusion that the source of the metals contaminants was likely mine traffic and activity at the port. Lead and cadmium concentrations in moss collected along the haul road and at the port were higher than background levels recorded for northern Alaska.[77]

The Exponent team did not compare levels of heavy metals found in moss samples collected closer than 300 meters from the haul road to levels found in Europe, claiming that it was inappropriate to do so since the European study did not include samples closer than 300 meters from any road.[78] In making this judgment, the Exponent team apparently failed to appreciate that the haul road and its impacts on the surrounding area were the *focus* of the NPS study, and it was therefore entirely appropriate to make comparisons of all samples collected to the results of the European study. The Exponent team also noted that dust was shaken from the moss samples prior to analysis in the European study but not from samples collected in the NPS and Exponent studies, concluding that metals concentrations reported in the European study were likely lower than would have been found in undusted samples.[79]

In comparing levels of heavy metals they found in salmonberries to levels found in the

Studies Examine the Impacts of Fugitive Dust from Red Dog Operations

The study by Ecology and Environment, Inc. revealed that washing the vegetation samples in the field appeared to have no effect on the concentrations of metals.

Studies Examine the Impacts of Fugitive Dust from Red Dog Operations

E&E study, the Exponent research team asserted that the E&E study team had selected Noatak and Point Hope as control or reference sites,[80] making heavy metal levels in samples collected at these sites normal background or reference levels.

This assertion was contrary to the E&E report (see above). Nonetheless, the Exponent team reported that lead levels in all the salmonberry samples they collected at the port exceeded levels the E&E study found in salmonberry samples at Noatak and Point Hope. And the E&E cadmium levels in salmonberry samples collected at two of their three port sample sites exceeded levels reported by the E&E team for Point Hope and Noatak.

Lead concentrations found in all salmonberry samples collected on the haul road exceeded levels for Point Hope and Noatak, and cadmium levels in salmonberry samples collected within 100 meters of the road were greater than levels for Noatak and Point Hope.[81]

VI. State Environmental Public Health Investigation

After the release of the NPS study, the Alaska Department of Health and Social Services' Environmental Public Health Program (EPHP) initiated an investigation to determine if mining operations at Red Dog Mine were exposing local residents to risks from heavy metal contaminants.[82] EPHP reviewed the data from the NPS, E&E and Exponent studies and compared levels of heavy metals found in salmonberry samples in the E&E and Exponent studies to levels found in berries collected in 1998 in the Yukon and Northwest Territories as part of the Arctic Monitoring and Assessment Programme (AMAP).[83]

EPHP reviewed Cominco data regarding blood lead levels of mine workers and heavy metals in water samples the company collected from the Wulik River and Kivalina's village water tanks. The agency also examined data gathered by the Alaska Department of Fish and Game on levels of heavy metals in the tissues of caribou and fish.[84]

In addition to the data review, EPHP evaluated whether "exposure pathways" existed that would cause residents to be exposed to heavy metal contaminants from Red Dog mining activities. EPHP's definition of exposure pathway included the following elements: (1) a source of contaminants, (2) an environmental medium such as air or water that contains or moves contamination, (3) a point such as a river where people contact contaminated media, (4) an exposure route such as eating contaminated berries or drinking contaminated water and (5) people who come in contact with the contaminants. An exposure pathway is not complete if any one or more of these elements is missing.[85]

EPHP concluded that the levels of heavy metals in the drinking water of the village of Kivalina were low and did not pose a health threat, that the heavy metals levels found in fish from the Red Dog mine area and surrounding watershed were low and did not pose a public health threat, that heavy metals levels in caribou tissue samples were low and did not constitute a public health threat and that levels of heavy metals found in berries sampled from the area were low and did not constitute a public health threat.[86]

Most significantly, EPHP asserted that the form of lead found in the ore at Red Dog had a low bioavailability, meaning it occurs in a form not easily absorbed by living organisms. This assertion was based on studies where rats were used to examine absorption rates of lead from Skagway, Alaska, and Red Dog Mine.

In its report, EPHP stated that because levels were low in all sources of contaminants examined, that because the agency determined the lead in the ore at Red Dog had a low bioavailability and that because public access to

State Environmental Public Health Investigation

Red Dog Mine, the haul road and the port was limited, "There are no identified exposure pathways from Red Dog Mine to the residents of Noatak and Kivalina. Exposure monitoring by blood level testing is not medically warranted at this time."[87]

The agency ended its report with a recommendation that "residents of Kivalina and Noatak should continue unrestricted harvest and consumption of subsistence resources in the area."[88]

> Alaska's state Environmental Public Health Program reviewed the data from studies completed for Cominco and the Alaska Department of Environmental Conservation and, despite the evidence of elevated levels of toxic chemicals in traditional subsistence areas, declared that "residents of Kivalina and Noatak should continue unrestricted harvest and consumption of subsistence resources in the area."

VII. Independent Analysis

Reviews of the EPHP report revealed a number of insufficiencies and inconsistencies in the data presented and the assumptions made, casting doubt on some of the agency's conclusions. This prompted Alaska Community Action on Toxics (ACAT) to sponsor an independent review of the E&E and Exponent studies and an independent evaluation of the conclusions of the EPHP investigation. ACAT asked Fred Youngs, Ph.D., an occupational and environmental research chemist at the University of Massachusetts Lowell, to conduct the analysis. His findings are summarized below and presented in more detail in the Appendix.

For purposes of comparing data from the two studies in his analysis, Dr. Youngs referred to samples collected from E&E's "Port Site" sample area (the area that includes Kivalina's subsistence harvest sites) as "Kivalina" samples and samples collected from E&E's "Terminal" sample area and Exponent's "port site" sample area as "Port" samples. Dr. Youngs determined that the vegetation samples collected in both the E&E and Exponent studies had higher than normal levels of lead and cadmium. He reached this conclusion after comparing the results of both studies to standards and guidelines set by the United Nations' *Codex Alimentarius* Commission for maximum acceptable levels of heavy metals in foods and to data collected by the U.S. Food and Drug Administration in an ongoing study of contaminants in the U.S. food supply.

Dr. Youngs' analysis also found an anomaly in the E&E data, and after investigating the anomaly, he discovered the data revealed lead levels in salmonberries collected at Point Hope were nearly an order of magnitude higher than indicated in the E&E report (see Appendix).

Guidelines of the *Codex Alimentarius* Commission

The *Codex Alimentarius* Commission was established by the United Nations' Food and Agriculture Organization and World Health Organization to develop food standards and guidelines to protect human health. The Commission has produced a comprehensive set, and to date the only set, of standards and guidelines for acceptable levels of heavy metals in fruits and vegetables. These are published in the *Codex Alimentarius*, a compilation of the Commission's approved food standards and guidelines.

Acceptable levels of contaminants and toxins in foods are expressed as maximum levels (MLs) in the *Codex*. The *Codex* ML for lead is 0.2 mg/kg for small fruits and berries, 0.1 mg/kg for fruits and vegetables and 0.3 mg/kg for leafy vegetables. The Commission has drafted a set of MLs for cadmium that are scheduled to be reviewed and approved by Commission members later this year. The draft *Codex* ML for cadmium is 0.05 mg/kg for vegetables and 0.2 mg/kg for leafy vegetables.[89]

Thirteen (15.9 percent) of the 82 berry samples collected in the E&E study equaled or exceeded the maximum levels for lead and cadmium set in the *Codex Alimentarius*. All of the E&E berry samples that exceeded *Codex* MLs for lead and cadmium were from the Terminal site (identified in Youngs' report as the "Port" site) and the Point Hope site. Twenty nine percent of the salmonberry samples collected in the Exponent study equaled or exceeded the *Codex* ML for lead, and 28 percent exceeded the draft *Codex* ML for cadmium.

Twelve (30 percent) of the sourdock samples collected in the E&E study equaled or exceeded the *Codex* ML for lead in fruits and vegetables, and four samples (10 percent) equaled or exceeded the *Codex* ML for lead in leafy vegetables. Two (28 percent) of Exponent's samples equaled or exceeded the draft maximum level for cadmium.

FDA's Total Diet Study

As part of its ongoing Total Diet Study, the U.S. Food and Drug Administration (FDA) collects food samples four times a year from supermarkets and grocery stores in four geographic areas of the United States for analysis of various contaminants and nutrients. The study was initiated in 1960s, and the agency updated its food sample list and study protocol in 1991.

Subsistence foods are not included in the Total Diet Study. So to compare results from the E&E and Exponent studies to FDA information on levels of lead and cadmium, Dr. Youngs used data from the Total Diet Study collected after 1991 for two raw fruits, strawberries and apples.

Mean values for lead and cadmium levels in all subsistence food samples collected in both the E&E and Exponent studies equaled or exceeded mean values for lead and cadmium levels found in strawberries and apples in the FDA study. The lowest mean value for lead levels in salmonberries was found in berries collected at Noatak and was approximately equal to the FDA mean value for lead levels in strawberries and apples. The lowest mean value for cadmium levels in salmonberries was found in the Kivalina subsistence harvest areas, and it was approximately 1.4 times higher than the FDA mean value for cadmium levels in strawberries.

Critique of EPHP Report

In its work, EPHP used a data set compiled by M. Gamberg for the Arctic Monitoring and Assessment Programme that included the results of an analysis of 88 berry samples collected in the Yukon and Northwest Territories. In comparing the E&E data to the Gamberg data, EPHP assumed that the Gamberg data set represented naturally occurring levels of heavy metal contaminants in an Arctic environment, apparently failing to recognize the extensive level of open pit gold and diamond mining that exists in northwestern Canada and without considering the likelihood that some of the samples in the Gamberg data base had been collected in areas with active mines.

But even if the Gamberg data were representative of normal background levels, an examination of the data for salmonberries in both the E&E and Exponent studies reveals that, with the exception of the E&E samples collected at Noatak, mean lead levels in all the samples from both studies were higher than the Gamberg mean. And mean cadmium levels in all samples, except for the Exponent sample taken on the haul road transect at 100 meters, were greater than the Gamberg mean. Still, EPHP concluded that the "concentrations of heavy metals detected in the salmonberries [were] consistent with typical background levels and do not pose a public health concern." [90]

EPHP also assumed that because the levels of heavy metals concentrations in washed and unwashed vegetation samples collected in the E&E study were similar, "little atmospheric deposition has occurred on the salmonberries." This assumption ignores the conclusion of the E&E study team that "…rinsing the samples was most likely ineffective in reducing concentrations of metals or washing away any metal-laden dust that may have settled on subsistence foods."[91]

Bioavailability of Lead In Red Dog Ore

Perhaps the most significant factor EPHP considered in reaching its conclusions was its own determination that the lead found in the Red Dog ore body is in a form that not easily absorbed in living tissue. To support this conclusion, EPHP cited studies conducted by the National Institute of Environmental Health Sciences' National Toxicology Program (NTP) on the bioavailability of lead found in lead ore concentrate from mining operations near Skagway, Alaska, and from Red Dog Mine.

The NTP's Skagway study was published in 1993. When EPHP conducted its 2001 investigation of the potential public health threats posed by Red Dog Mine, the NTP study on Red Dog ore had not yet been reviewed. However, NTP provided a copy of its contractor's report to EPHP, and the agency determined that the results were directly comparable to the Skagway study. EPHP's report stated that the lead samples analyzed from Red Dog and Skagway had similar compositions; that is, both ore bodies were high in lead sulfide or galena, which, the studies showed, is more insoluble and has a lower bioavailability than lead acetate or lead oxide.

EPHP then concluded that lead released into the environment from Red Dog mining operations posed little health risk to local residents. The agency cited as proof its own 1990 blood studies of Kivalina and Noatak residents,[92] which showed low blood lead levels among the villagers tested. However, at the time of the testing the Red Dog Mine had been in operation for less than a year. EPHP indicated that additional testing was conducted to determine blood lead levels in children in Kivalina in 1993, but that testing was limited to 21 children, less than 20 percent of

Independent Analysis

Independent analysis of the results from the state commissioned study and the study sponsored by Cominco showed that many of the samples collected equaled or exceeded the *Codex* acceptable levels for lead and cadmium.

Independent Analysis

the 1990 sample size. EPHP has not conducted additional comprehensive blood lead level tests for villagers in the region since 1990, most notably not even after mining activities were expanded in 1998 and again in 2001.

A review of the Skagway lead ore study cited by EPHP reveals that the researchers fed male rats lead sulfide, lead oxide, lead acetate and the Skagway ore concen-trate.[93] Researchers found that the blood lead levels of rats fed the lead sulfide and Skagway ore were eight times lower than the levels found in rats fed lead acetate or lead oxide.

But the authors stated that while the lead sulfide and Skagway ore doses resulted in lower blood lead levels, lead from these sources was bioavailable and accumulated, generally in proportion to dose, in bone and kidney tissue.[94] The authors also found that the possibility of prolonged exposure to low levels of less soluble forms of lead such as lead sulfide, which result in the accumulation of lead in bone and kidney tissues to toxic levels, has yet to be investigated.

The NTP studies on Skagway and Red Dog ore concentrates, as well as many other lead-sulfide toxicity studies, used rats as models for predicting potential human health effects. Other recent studies indicate that rats are poor models for the human digestive tract, primarily because rodents, unlike humans, excrete lead through bile at a very high rate and because of significant anatomical and physiological differences between rodents and humans that could influence the venous uptake of lead.[95]

The results of studies using young swine as models for humans (the digestive tracts of young swine are similar to those in human children) indicate that blood absorption rates for lead sulfide were lower than those of lead acetate by a factor of less than two, rather than lower by a factor of eight as was the case in the Skagway study on rats.[96]

Given the conflicting evidence on bioavailability of lead sulfide, it would seem imprudent at best to make determinations about the bioavailability of lead from Red Dog ore concentrate.

Moreover, it makes little sense to base such determinations on the unpublished 1993 NTP study, which used ore concentrate that may not be representative of the current ore concentrate being transported up and down the haul road.[97]

In his review of the EPHP investigation report, Dr. Youngs concluded that "the true bioavailability of the lead from Red Dog Mine is at best unclear and may be significantly higher than previously estimated."

VIII. Conclusions and Recommendations

Information to date indicates that levels of lead and cadmium found in vegetation in the vicinity of Red Dog Mine, along the haul road connecting the mine to DeLong Mountain port and at the port are higher than naturally occurring levels. Data also indicate that operations associated with the mine are the source of the observed elevated metal levels.

But there is conflicting evidence, as well as a clear lack of evidence, to make a definitive judgment about the risk that mining activities at Red Dog Mine pose to residents living in the region and to the wild foods on which they depend for subsistence. A number of steps should be taken to better understand and limit this risk:

1. The state should make new tests for blood lead levels immediately available to residents of Kivalina, Noatak and Point Hope.

2. The state and Cominco should immediately inform residents of Kivalina, Noatak and Point Hope of the results of studies performed to date and of the detrimental effects that lead and cadmium have on human health.

3. The state should advise villagers to limit harvest of subsistence foods in areas — along the haul road and in the Kivalina subsistence harvest sites near the port — where lead and cadmium levels in sampled subsistence plants were found to be higher than normal.

4. The state should examine data from Point Hope to determine if the high levels of lead are naturally occurring or if contaminants from mining operations are being carried through the air

5. The state should take samples of the ore concentrate currently being transported on the haul road to determine its composition and conduct new studies — using young swine, not rats, for models — on the bioavailability of the ore concentrate.

6. The state should conduct additional sampling of vegetation in areas that were previously sampled to develop a more comprehensive database for evaluations of heavy metals levels in subsistence foods.

7. Sampling should be extended to other subsistence harvest areas identified by local residents.

8. The state should establish an ongoing monitoring program that includes sampling of plants and the tissues of fish and wildlife that are used for subsistence as well as sampling of drinking water.

Conclusions and Recommendations

9. All environmental and health assessments conducted by the state and Cominco should be peer-reviewed by independent scientists, including academic scientists and local experts with traditional knowledge.

10. Cominco should aggressively pursue all means to control fugitive dust emissions from activities at the mine, along the haul road and at the port.

11. Cominco and the state should develop a mechanism for providing meaningful public input into decisions regarding operations at Red Dog Mine. The objective is to give the people most directly impacted by mining operations an opportunity to be involved in decisions regarding those operations. At a minimum, local residents should be engaged in the design of monitoring programs and the review of the results of those programs. As well, local residents should be given ample opportunity to review mining permits and permit compliance and proposed plans for the expansion of and changes in ongoing mining operations.

> A number of actions can be taken to better understand and limit the risks that Red Dog mining operations pose to people in the region and to the wild foods on which they depend for subsistence. Among those actions, and contrary to the advice of the Alaska Environmental Public Health Program, the state should advise villagers to limit harvest of subsistence foods in areas where lead and cadmium levels in sampled subsistence plants were found to be higher than normal.

End Notes

[1] Teck Cominco Limited. 2003. Red Dog Mine, Alaska, USA <http://www.teckcomnco.com/operations/reddog>
[2] Ibid.
[3] 43 UCS Section 1629.
[4] Alaska Industrial Development and Export Authority. 2004. Project Fact Sheet: Delong Mountain Regional Transportation System (DMTS).
[5] Ibid.
[6] Northwest Alaska Native Association, Cominco. 1998. Shared Values, Common Goals, Exceptional Results: The Red Dog Mine Story. Kotzebue, AK.
[7] Ibid.
[8] Werniuk, J. 2001. Red Dog Mine: Cominco's Alaska triumph. *Canadian Mining Journal* April. [Hereinafter, Werniuk 2001]
[9] Ford, J., and L. Hasslebach. 2001. Heavy Metals in Mosses and Soils on Six Transects along the Red Dog Mine Haul Road, Alaska. Western Arctic National Parklands, National Park Service, Alaska Region. [Hereinafter, Ford and Hasslebach 2001]
[10] Werniuk 2001.
[11] Ibid.
[12] Ford and Hasslebach 2001.
[13] Ecology & Environment, Inc. 2002. Wild Foods Investigation Public Review Draft Report Northwest Alaska. Prepared for Alaska Department of Environmental Conservation. [Hereinafter E&E 2002]
[14] Ibid.
[15] 42 USC Sec. 11023.
[16] 42 USC Sec. 11049.
[17] 42 USC Sec. 11023.
[18] 62 FR 23834 May 1, 1997. 40 CFR Part 372. Addition of Facilities in Certain Industry Sectors; Revised Interpretation of Otherwise Use; Toxic Release Inventory Reporting; Community Right-to-Know; Final Rule.
[19] 40 CFR 372.3. Definitions. "Beneficiation means the preparation of ores to regulate the size (including crushing and grinding) of the product, to remove unwanted constituents, or to improve the quality, purity or grade of a desired product."
[20] U.S. Environmental Protection Agency. 2002. Summary of EPCRA Section 313 Reporting Requirements and The National Mining Association (NMA) Lawsuit. Washington, DC.
[21] U.S. Environmental Protection Agency. 2001. June 14, 2001 letter to J. Daniel Berry, Esq. from Elaine G. Stanley, Director, Office of Information Analysis and Access, U.S. Environmental Protection Agency. Washington, DC.
[22] Cominco. 1999. Nature's Gift to the People: Land, Air, Water. Cominco's Promise to the People: To Protect Those Gifts. Kotzebue, AK.
[23] U.S. Environmental Protection Agency. 2002. TRI Releases in 1998 for Top 25 Metal Mining Facilities. <http://www.epa.gov/tri/tri98/press/metal_table_fac.pdf>
[24] U.S. Environmental Protection Agency. 2002. 2000 Toxics Release Inventory ALASKA <http://www.epa.gov/tri>
[25] U.S. Environmental Protection Agency. 2003. 2001 Toxics Release Inventory ALASKA <http://www.epa.gov/tri>
[26] Ibid.
[27] 40 CFR 372.85
[28] 16 USC Sec. 410hh(3).
[29] 16 USC Sec. 410hh(8)(a).
[30] Northwest Alaska Native Association. 2003. This is NANA. The Villages. <http://www.nana.com/villages.htm>
[31] Tanadgusix (TDX) Foundation. 2003. BeringSea.com: A Communities and Fisheries Website <http://www.beringsea.com/communities> [Hereinafter Tanadgusix 2003]
[32] Maniilaq Association. 2003. Northwest Alaska: Noatak <http://www.maniilaq.org/noatak.html>
[33] Ibid.
[34] Maniilaq Association. 2003. Northwest Alaska: Kivalina <http://www.maniilaq.org/kivalina.html> [Hereinafter Maniilaq, Kivalina 2003]
[35] Tanadgusix 2003.
[36] Dobyn, P. 2003. Pollution? Village group claims mine is fouling primary water, food source. *Anchorage Daily News* September 20. [Hereinafter Dobyn 2003]

[37] Tanadgusix 2003.
[38] Ibid.
[39] Ibid.
[40] Tanadgusix 2003.
[41] Dobyn 2003.
[42] Complaint for Injunctive and Declaratory Relief and Civil Penalties, Kivalina Relocation Planning Committee v. Teck Cominco Alaska Inc., No. Ao2-231 CV (D-Alaska filed March 8, 2004.)
[43] Ibid.
[44] Ibid.
[45] Ibid.
[46] U.S. Department of Health and Human Services. Agency for Toxic Substances and Disease Registry. 1999. Toxicological Profile for Lead <www.atsdr.cdc.gov/toxfaq.html> [Hereinafter USDHHS 1999]
[47] Ibid.
[48] Ibid.
[49] Ibid.
[50] Ibid.
[51] Ibid.
[52] Canfield, R.L., et al. 2003. Intellectual impairment in children with blood lead concentrations below 10ug per deciliter. *The New England Journal of Medicine* 348 (16): 1517-1526.
[53] Ibid.
[54] Ibid.
[55] Ibid.
[56] USDHHS 1999.
[57] Ibid.
[58] Ibid.
[59] Ibid.
[60] Schettler, T., J. Stein, F. Reich, M. Valenti, and D. Wallinga. 2000. In Harm's Way: Toxic Threats to Child Development. Prepared for Greater Boston Physicians for Social Responsibility, a Joint Project with Clean Water Fund <www.igc.org/psr>
[61] Ford and Hasslebach 2001.
[62] Ibid.
[63] Ibid.
[64] Ibid.
[65] E&E 2002.
[66] Ibid.
[67] Ibid.
[68] Ibid.
[69] Ibid.
[70] Ibid.
[71] Ibid.
[72] Ibid.
[73] Ibid.
[74] Ibid.
[75] Exponent. 2002. Draft 2001 Fugitive Dust Data Report, DeLong Mountain Regional Transportation System, Alaska. Prepared for Teck Cominco Alaska, Inc. [Hereinafter Exponent 2002]
[76] Ibid.
[77] Ibid.
[78] Ibid.
[79] Ibid.
[80] Ibid, p.24.
[81] Exponent 2002.
[82] Alaska Department of Health and Social Services, Division of Public Health, Environmental Public Health Program (EPHP). 2001. Public Health Evaluation of Exposure of Kivalina and Noatak Residents to Heavy Metals from Red Dog Mine. Juneau, AK. [Hereinafter EPHP 2001]

[83] Arctic Monitoring and Assessment Program. 1998. AMAP Assessment Report: Arctic Pollution Issues. Chapter 7. Heavy Metals. Oslo, Norway.
[84] EPHP 2001.
[85] Ibid.
[86] Ibid.
[87] Ibid.
[88]Ibid.
[89] *Codex Alimentarius* Commission. 2001. Official Standards <http://www.codexalimentarius.net>
[90] EPHP 2001
[91] E&E 2002.
[92] EPHP 2001.
[93] Dieter, M.P., et. al. 1993. Comparison of lead bioavailability in F344 rats fed lead acetate, lead oxide, lead sulfate, or lead ore concentrate from Skagway, Alaska. *Journal of Toxicology and Environmental Health* 39: 79-93.
[94] Ibid.
[95] Weis, C.P., and J.M. LaVelle. 1991. Characteristics to consider when choosing an animal model for the study of lead bioavailability. *Chemical Speciation and Bioavailability* 3: 113-119.
[96] Casteel, S. W., R.P. Cowart, C.P. Weis, G.M. Henningsen, E. Hoffman, W.J. Brattin, R.E. Guzman, M.F. Starost, J.T. Payne, S.L. Stockham, S. V. Becker, J.W. Drexler, and J.R. Turk. 1997. Bioavailability of lead to juvenile swine dosed with soil from the Smuggler Mountain NPL site of Aspen, Colorado. *Fundamental and Applied Toxicology* 36: 177-187.
[97] Arnold, S., and J.P. Middaugh. 2001. Bioavailability of Red Dog Mine Lead Ore; Assessment of Battelle Study "Evaluation of Lead Ore in Fischer 344 Rats" to the National Toxicology Program, June 1993. <www.doerun.com/ENGLISH/html/leadinforeddog.htm>

Appendix

A Comparative Analysis of Data Regarding Heavy Metals Found in Subsistence Foods Near Red Dog Mine, Alaska

By Fred Youngs, PhD.
University of Massachusetts

August 2002

Introduction

This analysis was undertaken in an effort to help answer questions regarding the human health risks associated with consumption of wild foods, specifically berries and plants, gathered near Red Dog Mine by Inupiaq Eskimos living in the vicinity of the mine. Red Dog Mine is operated by Teck Cominco Ltd. (Cominco), a Canadian mining company based in Vancouver, British Columbia.

The mine is located in northwestern Alaska approximately 90 miles north of Kotzebue and 52 miles inland from the Chukchi Sea in the western Brooks Range between Cape Krusenstern National Monument and Noatak National Preserve. The lead and zinc ore concentrates from the mine are delivered via truck along a 52-mile road that transects Cape Krusenstern National Monument and ends at the DeLong Mountain Port Facility, where the ore is stored until it can be shipped (Ford and Hasslebach 2001).

The nearly continuous heavy traffic along the 52-mile haul road generates a significant amount of dust from the road bed and also from ore truck surfaces (Ford and Hasslebach 2001). The National Park Service (NPS) undertook a study to examine whether there were elevated levels of lead and zinc along the haul road within Cape Krusenstern National Monument. The NPS study prompted both Cominco and the Alaska Department of Environmental Conservation (ADEC) to initiate studies of heavy metal deposition from fugitive dust in the transportation corridor. ADEC's study was conducted by Ecology and Environment, Inc (E&E), an international consulting firm headquartered in Lancaster, New York. Cominco's study was conducted by Exponent, a consulting firm based in Bellingham, Washington. The Alaska Department of Health and Social Services' Division of Public Health, Environmental Public Health Program (EPHP) evaluated the potential for exposure of residents of the villages of Kivalina and Noatak to heavy metals released by mine operations. The following report provides an independent analysis of the studies conducted by E&E and Exponent and the investigation done by EPHP. It also provides recommendations for future studies needed to effectively evaluate and address the human health consequences of heavy metals contaminants resulting from Red Dog Mine operations.

E&E and Exponent Data

A team of researchers lead by E&E collected berry and other vegetation samples in August and September of 2001 (Ecology and Environment, Inc. 2002). The team lead by Exponent collected various samples between July 2001 and October 2001. More specific dates for vegetation collected by the Exponent team are not given in their report (Exponent 2002).

The E&E team collected berry and other vegetation samples from four areas (Ecology and Environment, Inc. 2002). The first area encompassed land immediately south of the port, next to the port's tank farm. This sample site was referred to as the "Terminal" area. The second sample area encompassed lands north and south of the port that are used for traditional harvest by the villagers of Kivalina. This sample area was referred to as the "Port Site". The third of E&E's sample areas, the

"Noatak" area, encompassed lands used for subsistence by the villagers of Noatak northwest and upriver from the village. And the fourth sample area, the "Point Hope" area, encompassed lands used for traditional harvest west of the village of Point Hope.

The Exponent team collected berry samples at varying distances along transect lines perpendicular to the haul road at locations not sampled in the National Park Service study, and at four locations close to port facilities near E&E's "Terminal" sample site (Exponent 2002.)

For purposes of comparing data from the two studies, samples collected from E&E's "Port Site" sample area (that includes Kivalina's subsistence harvest sites) are hereinafter referred to as "Kivalina" samples. Samples collected from E&E's "Terminal" sample area and Exponent's "port site" sample area are hereinafter referred to as "Port" samples.

The E&E data comprises the larger data set. As such, and because it was received before the Exponent data, it was analyzed first. Also, it is informative to view this data on its own to identify relative levels of lead and cadmium in the four areas sampled. Below are some of the results from the E&E data. Mean values (wet weight basis) for salmonberries and sourdock are presented for four different collection areas as well as some comments regarding values reported below the detection limit. Detection limits (wet weight) for lead and cadmium in vegetation were approximately 0.002 mg/kg and 0.001 mg/kg, respectively.

Since washed samples of salmonberries were not available from all locations, the unwashed samples are presented for comparison. Both washed and unwashed data for sourdock are presented since a limited number of samples were collected (none from the Port nor Point Hope).

Results for mean lead concentrations in salmonberries (unwashed) are as follows. Numbers in brackets [ ] are standard deviations:

Noatak	0.0054 mg/kg [0.0095] (8 of 10 samples had levels below the DL)
Kivalina	0.027 mg/kg [0.0089]
Port	0.23 mg/kg [0.063]
Point Hope	1.9 mg/kg [0.67] (10 of 10 samples had levels below the DL)

It is not explicitly stated why some of the reported values are below the detection limits (DL). It may be that for the Noatak samples, the reason is low levels of lead and for the Point Hope samples, the reason is small sample size.

Results for mean cadmium concentration in salmonberries (unwashed) are as follows:

Kivalina	0.021 mg/kg [0.0053]
Noatak	0.029 mg/kg [0.0065] (10 of 10 samples <5x mean blank concentration)
Port	0.064 mg/kg [0.012] (only 4 samples collected)
Point Hope	1.3 mg/kg [0.11]

Sourdock was only collected from the Kivalina and Noatak sample areas. Results for mean concentrations of lead in sourdock are as follows:

Noatak (unwashed)	0.015 mg/kg [0.0046]
Kivalina (unwashed)	0.19 mg/kg [0.15]
Noatak (washed)	0.014 mg/kg [0.0072]
Kivalina (washed)	0.15 mg/kg [0.11]

Results for mean concentrations of cadmium in sourdock are as follows:

Noatak (unwashed)	0.029 mg/kg [0.018]	
Kivalina (unwashed)	0.0093 mg/kg [0.0064]	(10 of 10 samples <5x mean blank concentration)
Noatak (washed)	0.021 mg/kg [0.012]	
Kivalina (washed)	0.0077mg/kg [0.0046]	(10 of 10 samples <5x mean blank concentration)

Summary Points

- The mean lead concentration in unwashed salmonberries from Point Hope is more than two orders of magnitude higher than the mean lead concentration in unwashed salmonberries from Noatak.
- The mean cadmium concentration in unwashed salmonberries from Point Hope is more than one order of magnitude higher than the mean cadmium concentration in unwashed salmonberries from Kivalina.
- For the two areas in which sourdock was collected, the mean lead concentration was an order of magnitude higher in Kivalina than in Noatak for both washed and unwashed samples. Results for cadmium were the opposite, with sourdock samples from Kivalina having cadmium levels greater than one order of magnitude lower than those from Noatak.

The data for Table 1 were compiled for the purpose of comparing the E&E data with the Exponent data. The table includes additional data indicating number of samples and concentration ranges. Exponent data were reported as dry weight in their report and have been converted to wet weight here for easier comparison. Conversion was accomplished using the relationship: dry weight = wet weight ÷ % solids (expressed as a decimal).

No specific information was available regarding sample locations for the E&E data. Exponent salmonberry data include three samples collected at the Port and four samples collected from two transects along the haul road. For the three samples collected at the Port, PO3 was collected approximately 800–850 feet NNW of the main facility road and 320–380 feet N of one of the port buildings, PO17 was collected approximately 500 feet SSE of the main facility road and 125 feet S of one of the port buildings, PO18 was collected approximately 900–1000 feet NNW of the main facility road. Transect HR-01 is near the Port and HR-04 is east of the Mile 30 marker (Exponent 2002).

Summary Points

- The ranges of lead and cadmium concentrations in salmonberries collected at the Port by Exponent were lower than those collected by E&E at the Port.
- The mean values of lead (2.3x) and cadmium (1.3x) concentrations in salmonberries collected at the Port by E&E were higher than those collected by Exponent at the Port.
- Lead levels found in salmonberries collected along the transects (HR-01, HR-04) at 3 meters from the haul road were higher than the mean lead levels and higher than the upper range limit in salmonberries from Noatak, Kivalina and the Port.

Table 1. Salmonberries, unwashed, wet weight. All concentrations are in mg/kg, wet weight. NA = not applicable. * = Haul Road transect data are for single samples and are not mean values.

Sample	# of Samples	Lead Range	Lead Mean*	Cadmium Range	Cadmium Mean*	Data Source
Noatak	10	0.0053 - 0.028	0.0054	0.017 – 0.038	0.029	E&E
Kivalina	10	0.015 – 0.040	0.027	0.013 – 0.031	0.021	E&E
Port	4	0.17 – 0.31	0.23	0.056 – 0.081	0.064	E&E
Point Hope	10	0.72 – 2.6	1.9	1.1 – 1.5	1.3	E&E
Port	3	0.085 – 0.12	0.099	0.033 – 0.068	0.049	Exp.
Haul Road Transect HR-01, 3m	1	NA	1.8	NA	0.21	Exp.
Haul Road Transect HR-01, 100m	1	NA	0.13	NA	0.042	Exp.
Haul Road Transect HR-04, 3m	1	NA	0.48	NA	0.048	Exp.
Haul Road Transect HR-04, 100m	1	NA	0.055	NA	0.0069	Exp.

Comparison of E&E and Exponent data to the United Nations' *Codex Alimentarius* chermission's standards and guidelines

The *Codex Alimentarius* Commission, a joint commission established by the United Nations' Food and Agriculture Organization (FAO) and World Health Organization (WHO) to develop food standards and guidelines to protect human health, has produced the only to-date standards and guidelines for acceptable concentrations of heavy metals in fruits, vegetables and leafy vegetables. These are published in the *Codex Alimentarius*, the Commission's index for food standards and guidelines. Acceptable levels of heavy metals levels in foods are expressed as maximum levels (MLs). For lead, the *Codex* ML is 0.2 milligram/kilogram (mg/kg) for small fruits and berries, 0.1 mg/kg for vegetables, and 0.3 mg/kg for leafy vegetables. The *Codex* ML for cadmium is 0.05 mg/kg for vegetables and 0.2 mg/kg for leafy vegetables. No draft ML was provided for cadmium in fruit, (www.codexalimentarius.net/).

E&E Data. Table 2 compares the E&E data to *Codex* standards. Of a total 82 berry samples collected (washed and unwashed, all types of berries), 13 (15.9%) were found to be greater than or equal to the *Codex* ML of 0.2 mg/kg for lead. The same 13 samples were also found to equal or exceed the cadmium ML of 0.05 mg/kg (vegetable guideline). All of the berry samples that were found to equal or exceed *Codex* MLs were salmonberries collected at either the Port or Point Hope. The mean lead and cadmium values for salmonberries collected at the Port and Point Hope exceeded the ML of 0.2 mg/kg and 0.05 mg/kg, respectively. Mean salmonberry lead levels and the corresponding *Codex* MLs for lead and cadmium are compared in Table 2. Since only unwashed salmonberries were collected from all four sites, this table presents mean values for unwashed salmonberries only.

Of a total of 40 sourdock samples collected (washed and unwashed), 12 (30%) were found to equal or exceed the lead ML of 0.1 mg/kg. Four samples (10%) equaled or exceeded the 0.3 mg/kg ML for leafy vegetables. It is unclear at this point which guideline is applicable. No sourdock samples exceeded the 0.05 mg/kg nor the 0.2 mg/kg (leafy vegetable) ML for cadmium.

Table 2. Comparison of E&E data for lead and cadmium levels in berries (salmonberries unwashed) to *Codex* maximum levels (ML). All concentrations are in mg/kg, wet weight.

	Lead	Lead ML	Cadmium	Cadmium ML
Noatak	0.0054	0.2	0.029	0.05
Kivalina	0.027	0.2	0.021	0.05
Port	0.23	0.2	0.064	0.05
Point Hope	1.9	0.2	1.3	0.05

Exponent Data. Of a total 7 salmonberry samples collected (all unwashed), 2 (29%) were found to be greater than or equal to the lead ML of 0.2 mg/kg. Three samples (43%) were also found to equal or exceed the cadmium ML of 0.05 mg/kg (vegetable guideline).

Exponent collected no sourdock samples.

Comparison of E&E and Exponent Data to U.S. Food and Drug Administration Total Diet Study Statistics on Elemental Results

The U.S. Food and Drug Administration (FDA) collects food samples four times each year from supermarkets/grocery stores in four geographic areas in the United States for analysis of various contaminants and nutrients as part of its ongoing Total Diet Study (TDS). The study originated in the 1960s, with an updated food list and protocol implemented in 1991. Subsistence foods information are not part of the TDS. Therefore, for purposes of comparison of the E&E and Exponent data for lead and cadmium found in subsistence foods at Red Dog, data for two raw fruits, including one berry, were selected from the TDS for inclusion in Tables 3 and 4. These data were collected after 1991. Food items collected for the TDS are prepared for consumption before analysis, but it is unclear whether that entails washing of raw fruit.

Table 3. Comparison of lead levels in subsistence foods at Red Dog to levels found in sample fruits in TDS. * = Haul Road transect data are for single samples and are not mean values. Numbers in brackets [ ] represent standard deviations. ND = “non detects”, that is, the number of samples with lead levels below detection limits.

Sample	Number of Samples	Number of ND	Mean* (mg/kg)	Data Source
Salmonberry, Noatak (washed/unwashed)	10/10	0/0	0.0016/0.0054	E&E
Salmonberry, Kivalina (washed/unwashed)	10/10	0/0	0.025/0.027	E&E
Salmonberry, Port (washed/unwashed)	0/5	---/0	---/0.23	E&E
Salmonberry, Point Hope (washed/unwashed)	0/10	---/0	---/1.9	E&E
Salmonberry, Port (unwashed)	3	0	0.099	Exponent
Salmonberry, Haul Road Transect HR-01, 3m (unwashed)	1	0	12.	Exponent
Salmonberry, Haul Road Transect HR-01, 100m (unwashed)	1	0	0.97	Exponent
Salmonberry, Haul Road Transect HR-04, 3m (unwashed)	1	0	3.7	Exponent
Salmonberry, Haul Road Transect HR-04, 100m (unwashed)	1	0	0.41	Exponent
Strawberry	26	23	0.001 [0.003]	FDA
Apple	26	20	0.002 [0.004]	FDA

Table 4. Comparison of cadmium levels in subsistence foods at Red Dog to levels found in sample fruits inTDS. * = Haul Road transect data are for single samples and are not mean values. **Non-detects for the FDA data were set equal to zero for statistical calculations.

Sample	Number of Samples	Number of ND	Mean* (mg/kg)	Data Source
Salmonberry, Noatak (washed/unwashed)	10/10	0/0	0.030/0.029	E&E
Salmonberry, Kivalina (washed/unwashed)	10/10	0/0	0.022/0.021	E&E
Salmonberry, Port (washed/unwashed)	0/5	---/0	---/0.064	E&E
Salmonberry, Point Hope (washed/unwashed)	0/10	---/0	---/1.3	E&E
Salmonberry, Port (unwashed)	3	0	0.049	Exponent
Salmonberry, Haul Road Transect HR-01, 3m (unwashed)	1	0	1.4	Exponent
Salmonberry, Haul Road Transect HR-01, 100m (unwashed)	1	0	0.30	Exponent
Salmonberry, Haul Road Transect HR-04, 3m (unwashed)	1	0	0.37	Exponent
Salmonberry, Haul Road Transect HR-04, 100m (unwashed)	1	0	0.051	Exponent
Strawberry	26	0	0.015 [0.011]	FDA
Apple	26	22	0** [0.001]	FDA

Summary Points

- Mean values for lead and cadmium from all samples locations, as well as individual values for the four transect samples (lead and cadmium), equal or exceed mean values for strawberries and apples from the FDA Total Diet Study.
- The lowest lead mean value for all salmonberry samples (0.0016 mg/kg, Noatak, washed) is approximately equal to the mean strawberry and apple levels.
- The lowest cadmium mean value for all salmonberry samples (0.021 mg/kg, Kivalina, unwashed) is 1.4 times higher than the mean strawberry cadmium value.

Comparison of E&E and Exponent Data to Data Used in EPHP Investigation of Exposure Risk of Kivalina and Noatak Residents to Heavy Metals from Red Dog

In 2001, the Alaska Department of Health and Social Services Division of Public Health, Environmental and Public Health Program (EPHP) conducted an evaluation of the risk of exposure to heavy metals from Red Dog Mine for villagers in Noatak and Kivalina (EPHP 2001). EPHP compared the E&E data to data collected in 1998 in the Yukon and Northwest Territories for the Arctic Monitoring and Assessment Programme (AMAP) of Indian and Northern Affairs Canada. Although this 1998 data set (referred to as the Gamberg data set) was published in the 2001 AMAP comprehensive report, it is not a peer reviewed data set.

The Gamberg data set is comprised of 88 berry samples that were analyzed for a variety of metals. Only one of these samples is of *Rubus chamaemorus*, the salmonberry species gathered in the 2001 E&E study. EPHP used the Gamberg data set as the control, to represent standard metal background levels for berries in arctic regions (EPHP 2001). This extrapolation is at best a rough estimation and should be regarded as such, and not as an infallible benchmark. Table 5 compares the Gamberg data to the data collected in the E&E and Exponent studies.

Table 5. Comparison of Lead and Cadmium Levels in subsistence foods near Red Dog Mine to levels found in berries in the Yukon and Northwest Territories, identified as background levels in the EPHP evaluation, (Gamberg data). Gamberg data were based on a mean of 88 samples representing 16 different species of berries. Non-detects for the Gamberg data were set equal to zero for calculation of means. Neither the total number of non-detects nor the standard deviations were provided.

Sample	Sample Size	Lead (mg/kg)	Cadmium (mg/kg)	Data Source
Gamberg Mean	88	0.022	0.0092	EPHP
Gamberg Range	88	ND – 0.36	ND – 0.28	EPHP
Salmonberry, Noatak (washed/unwashed), mean	10/10	0.0016/0.0054	0.030/0.029	E&E
Salmonberry, Kivalina (washed/unwashed), mean	10/10	0.025/0.027	0.022/0.021	E&E
Salmonberry, Port Site (washed/unwashed), mean	0/4	---/0.23	---/0.064	E&E
Salmonberry, Point Hope (washed/unwashed), mean	0/10	---/1.9	---/1.3	E&E
Port (unwashed), mean	3	0.099	0.049	Exp.
Haul Road Transect HR-01, 3m (unwashed)	1	1.8	0.21	Exp.
Haul Road Transect HR-01, 100m (unwashed)	1	0.13	0.042	Exp.
Haul Road Transect HR-04, 3m (unwashed)	1	0.48	0.048	Exp.
Haul Road Transect HR-04, 100m (unwashed)	1	0.055	0.0069	Exp.

The EPHP report also mentions a risk-based screening concentration (except for lead) calculated using numbers from the U.S. Environmental Protection Agency (EPA) for the reference dose, ingestion rates of berries for adults and children, child body weight and a Target Hazard Quotient for non-carcinogens. The risk based screening concentration for cadmium is 4.0 mg/kg for adults and 0.88 mg/kg for children.

Summary Points

- With the exception of samples collected at Noatak (washed and unwashed), all mean values and individual sample values for lead are higher than the Gamberg mean.
- All mean values and individual sample values for cadmium, except for the sample collected from transect HR-04 at 100 meters, are higher than the Gamberg reported mean.
- Mean lead values for samples collected by E&E at Noatak, Kivalina and the Port are within the Gamberg range. The mean lead values for Point Hope and two of the four individual transect values (both the 3 meter samples) are greater than the upper limit of the Gamberg range. All four transect samples had lead levels greater than the Gamberg mean.
- Mean cadmium values for samples collected by E&E at Noatak, Kivalina and the Port are within the Gamberg range. The mean value for Point Hope is greater than the upper range limit of the Gamberg data. Three of the four transect samples had cadmium levels greater than the Gamberg mean.

Discussion

The E&E data for salmonberries demonstrate a general trend. Samples for Noatak have the lowest levels, followed by the Kivalina sites, the Port Site and Point Hope. Except for the Point Hope data, this trend would be consistent with contamination due to proximity to mining operations. Noatak is east of the Port Site and south of the mining operations. This places it in a generally crosswind or upwind direction from possible sources of contaminants and would lead to the assumption that the lowest levels would be found there. The sites identified as “Kivalina” are closer to the port, with some of the salmonberries having been collected directly downwind of the port facility. This would increase the probability of detectable effects from the haul road and port site operations. The Port Site would be expected to show higher levels of metals associated with mining operations since it is within the operational area. Point Hope is certainly a greater distance from the mining activities that the Kivalina collection sites, although both are downwind. To determine whether the levels seen at Point Hope are significantly influenced by the mining operations, more samples need to be collected, and/or modeling of the air transport of fugitive dust needs to be performed.

Unlike the findings in this report which show the lead levels in the salmonberry samples collected at Point Hope to have the highest levels, the E&E report shows very low lead levels in Point Hope salmonberries. This is of interest in that the numbers used in this report were taken from the initial E&E data with the only difference being that this report states concentrations in wet weight (for the purposes of comparison to other data sets and to standards) while the E&E report gives dry weight concentrations. The conversion between wet weight and dry weight is a very simple calculation utilizing the percent solids of each sample (see earlier in this report).

To investigate this anomaly, the wet weight lead concentrations reported in this appendix were converted to dry weight lead concentrations and checked against the E&E report. This was done for three salmonberry samples from each of the four collection sites. Agreement was found for the samples from the Noatak, Kivalina and Port sites. However, a large disagreement was found for each of the three Point Hope samples. In each case the E&E reported values were orders of magnitude lower than the calculated values. There is no apparent reason for this discrepancy.

The comparison of the E&E and Exponent data to the FDA Total Diet Study data may also indicate increased levels of heavy metals. While the comparison of salmonberries collected as subsistence food to strawberries collected from supermarkets is not ideal, it is still useful in comparing relative levels of exposure. For example, the lowest lead mean value for all the salmonberry samples was collected at Noatak (0.0016 mg/kg). This is approximately equal to the levels found in the FDA analyzed strawberries (0.001 mg/kg) and apples (0.002 mg/kg). If Noatak is assumed to be representative of "background" levels, then this makes sense as it implies that natural levels of lead in salmonberries are not much different that those in commercially produced strawberries. This would then suggest that the levels found in salmonberries collected from other locations are higher than "normal" or "background" levels.

A comparison of heavy metal concentrations in salmonberries at Red Dog to the Gamberg data from berries collected in the Yukon and Northwest Territories tends to support this hypothesis. Again, the mean lead values for samples collected at Noatak (the "background" samples) are the lowest and compare favorably to the Gamberg mean. Berries from the Kivalina sites produced a mean lead value similar but slightly higher than the Gamberg mean, and mean lead values for berries (or individual values for berries collected from the haul road transects) from other locations were significantly higher than the Gamberg mean.

The next question that needs to be addressed is whether the levels found in the berries are a threat to the Alaska Native population that collects and consumes them. There are very few guidelines regarding acceptable levels of heavy metals in fruits and berries. One reason offered for the lack of guidelines is that the FDA just does not expect high levels of heavy metal contamination given how fruits and berries are typically grown and harvested for commercial purposes. This has the consequence of ignoring any problems with subsistence-harvested food from areas that may be contaminated. The only guidelines to which to compare the results of the Red Dog studies are the *Codex Alimentarius* Commission's standards and guidelines. With approximately 16% of the berry samples collected by E&E being at or higher than the *Codex* ML for lead and cadmium, it is evident that a significant portion is unfit for consumption. Also 10% to 30% of the sourdock samples exceed the *Codex* MLs for lead (depending on which ML is used). In addition, two of seven (29%) berry samples collected by Exponent exceeded the ML for lead and three of seven (43%) exceeded the cadmium ML.

Two possible points of confusion need to be addressed. First, it has been noted in other reports that both the FDA and Gamberg means incorporate zeros into the statistics for samples which are reported as non-detects. It is stated that these zero values artificially lower the mean with the implication that comparison of the data from samples collected in 2001 would show that data to be artificially high. Statistically, it is true that the mean will be reduced by including zeros for non-detects, which may not actually be zero. This is a fairly common practice (as is using one-half of the detection limit for non-detects). It is important to note that the Gamberg mean and FDA mean may be artificially low because there were a large number of samples with very low levels. Therefore, when analyzing the 2001 data, it is important to look not only at the mean values. One must also consider that many samples in previous studies showed very low, if not completely defined levels, while very few samples were reported as non-detects in the E&E and Exponent data sets.

Secondly, some confusion arises when comparing data to different standards. While the *Codex* standards are set at 0.2 mg/kg lead in small fruits and berries, 0.1 mg/kg in fruits and vegetables, 0.3 mg/kg lead for leafy vegetables, 0.05 kg/mg cadmium in vegetables and 0.2 mg/kg cadmium for leafy vegetables, the numbers given by EPA for risk based screening concentrations for cadmium (they do not provide numbers for lead) are 4.0 mg/kg for adults and 0.88 mg/kg for children. Only the Point Hope mean and one of the transect samples were higher that the screening number for children. Obviously, the EPA numbers are not standards and are significantly less conservative than the *Codex* numbers. Given the proximity of the mining operations and the dependence of the Alaska Native population on these and other subsistence food sources, the use of the more conservative *Codex* standards is warranted.

Discussion Regarding Bioavailability of Lead in Red Dog Ore. According to EPHP's investigation report, the National Toxicology Program (NTP) determined that the lead ore concentrate from the Skagway mine had low lead bioavailability (EPHP, 2001). NTP also found that the ore concentrate from the Red Dog mine was very similar to the ore concentrate from the Skagway mine. The summary of the Skagway results provided in the EPHP report also stated that one of the important facts identified by the Skagway analysis was that the finding of low lead bioavailability was "critical in evaluating health risk".

The published study of the Skagway ore (Dieter and Matthews 1993) indicates that male rats were fed a variety of lead containing substances. These were lead sulfide, lead oxide, lead acetate and the Skagway ore concentrate. Their findings were that the blood lead concentration of the rats fed either lead sulfide or the Skagway ore was approximately eight times lower than the blood lead concentration of rats fed either lead acetate or lead oxide. The authors do state, however, that lead from iron sulfide and lead from the Skagway ore was bioavailable and tended to accumulate, in proportion to dose, in bone and kidney tissue. Moreover, the authors leave open the possibility that prolonged exposure to low levels of the less soluble lead forms (lead sulfide and the Skagway ore) could result in the accumulation of lead in bone and kidney tissue to levels which would be toxic. They state that the possibility of this occurring had, at the time of their study, yet to be investigated.

The paper on the bioavailability of lead in juvenile swine (Casteel et al. 1997) is not in the exact same vane as the Dieter article. Casteel et.al. did not dose the test animals with a variety of lead containing compounds. They dosed them only with lead acetate (a soluble form of lead used as a "standard") and two samples of lead containing soil from a Superfund site (lead concentrations of 14200 and 3870 ppm). They present their results as "RBA", the bioavailability of lead from the source relative to the bioavailability of lead from lead acetate. The blood lead RBA for the two soil samples were 56% and 58%. The RBA for liver, kidney and bone were 86, 68 and 72% respectively for one sample and 74, 74 and 68% for the second sample.

The Dieter study indicates that blood lead levels are lower with ore than with lead acetate by a factor of eight while the Casteel data shows this difference to be less than a factor of two. The Dieter study indicates that the lead from a lead containing sample (either ore or contaminated soil) is bioavailable to the bone and kidney. The Casteel study supports this finding and shows that in juvenile swine the difference found in availability between lead acetate and lead contaminated soil to these organs is even smaller than for blood lead content (RBAs of 68% to 86%).

Casteel et.al. suggest that complications arising from rat based studies make their juvenile swine study more appropriate for estimating bioavailability of lead, particularly to children. Some of the relevant comments from the Casteel article are summarized below:

- Rats have a significantly higher biliary excretion rate of lead than do mammals. By using rat studies to estimate bioavailability of lead, a significant underestimation results when translating those results to humans. Juvenile swine resemble more closely human children in their biliary excretion rate of lead than do rats.
- To emphasize this point Casteel states, "Physiologically relevant estimates of Pb bioavailability are key to adequate exposure and risk assessment in areas of ongoing childhood exposure".
- Past studies, including the Dieter study, have used rats in older adolescent or adult developmental stages and have given dietary doses of lead that are much higher than would be likely in environmental exposures. High dietary dosing could potentially reduce the amount of lead absorb by the rats. The use of rats in later stages of development also increases the difficulty of relating these rat studies to human children as the transport mechanism for lead in the intestine changes quickly as the rats age.

As a result of the information learned from the more recent Casteel study, it would appear inappropriate to use solely the results from the NTP study as support for the conclusion of low lead bioavailability and, therefore, no risk from exposure to lead contamination from the Red Dog mine. The EPHP report itself states the importance of low lead bioavailability in the determination of potential health risks. It appears from the Casteel study that the true bioavailability of the lead from the Red Dog mine is, at best, unclear and may be significantly higher than previously estimated. Therefore, a more conservative approach to the determination of potential health risk to the native population subsisting near the Red Dog mine, and to the subsequent protection of their health, should be considered.

Conclusions

The data collected so far indicate that a number of locations used for subsistence gathering of berries have higher than normal levels of lead and cadmium. There is also some evidence which indicates that the operations associated with the Red Dog Mine are the source of these elevated levels. However, more data needs to be collected to properly delineate the extent and source of contamination of subsistence food supplies. Additional samples need to be collected in the areas previously sampled to obtain a better understanding of heavy metal levels. Other areas identified by local people as subsistence gathering locations should be included in the next round of sampling, including, but not limited to, additional areas near the port site, Kivalina, Point Hope and along the haul road.

It is also important in interpreting the current and any future data to understand the high levels of lead and cadmium found in the Point Hope region. Are these levels naturally occurring, is there an air transport mechanism at work carrying contamination from mining operations, or are there other sources of contamination affecting Point Hope?

Given the high levels found in berries near the port site, along the haul road and in Point Hope, it is also recommended that an education program be implemented to advise all local residents of the need to limit or completely restrict the areas in which they collect berries and other edible vegetation in order to protect their health. In addition, contaminated areas containing berries or other subsistence food should be identified by posted notices.

References

Alaska Department of Health and Social Services, Division of Public Health, Section of Epidemiology (EPHP). 2001. Public Health Evaluation of Exposure of Kivalina and Noatak Residents to Heavy Metals from Red Dog Mine. Anchorage, AK.

Casteel, S. W., R.P. Cowart, C.P. Weis, G.M. Henningsen, E. Hoffman, W.J. Brattin, R.E. Guzman, M.F. Starost, J.T. Payne, S.L. Stockham, S. V. Becker, J.W. Drexler, and J.R. Turk. 1997. Bioavailability of lead to juvenile swine dosed with soil from the Smuggler Mountain NPL site of Aspen, Colorado. *Fundamental and Applied Toxicology* 36: 177-187.

Dieter, M.P., and H.B. Matthews 1993. Comparison of lead bioavailability in F344 rats fed lead acetate, lead oxide, lead sulfate, or lead ore concentrate from Skagway, Alaska. *Journal of Toxicology and Environmental Health* 39: 79-93.

Ecology & Environment, Inc. 2002. Wild Foods Investigation Public Review Draft Report Northwest Alaska. Prepared for Alaska Department of Environmental Conservation.

Exponent. 2002. Prepared for Teck Cominco Alaska, Inc.

Ford, J., and L. Hasslebach. 2001. Heavy Metals in Mosses and Soils on Six Transects Along the Red Dog Mine Haul Road Alaska. Western Arctic National Parklands, National Park Service. Alaska Region.