Nos. 07-984, 07-990

IN THE

Supreme Court of the United States

COEUR ALASKA, INC.,
Petitioner,
v.

SOUTHEAST ALASKA CONSERVATION COUNCIL, ET AL.,
Respondents.

STATE OF ALASKA
Petitioner,
v.

SOUTHEAST ALASKA CONSERVATION COUNCIL, ET AL.,
Respondents.

ON WRITS OF CERTIORARI TO THE
UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

BRIEF OF *AMICI CURIAE* IN SUPPORT OF RESPONDENTS

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INTEREST OF *AMICI*

Amici are three expert mining and water quality scientists, with diverse backgrounds in the private, public, and public interest sectors.[1] Collectively, the *amici* have worked extensively within the mining industry, within the governmental entities charged with regulating mining and milling impacts, in academia studying the technical and scientific aspects of these impacts, and in providing expert advice to mining and with milling-affected communities around the globe. *Amici* are deeply interested in this case, as its outcome could affect lakes, rivers, and other waterways throughout the United States, and potentially set international precedent for the disposal of processed mill wastes around the world.

David M. Chambers, Ph.D., is president of the Center for Science in Public Participation, a non-profit corporation formed to provide technical assistance on mining and water quality to public interest groups and tribal governments. David Chambers has 32 years experience in mineral exploration and development – 15 years of technical and management experience in the mineral exploration industry, and for the past 17 years he has served as an advisor on the environmental effects of mining projects both nationally and

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[1] Pursuant to Rule 37, letters of consent from the parties have been filed with the Clerk of the Court. In accordance with Rule 37.6, *amici* state that no counsel for either party has authored this brief in whole or in part, and no person or entity, other than *amici* and their attorneys, has made a monetary contribution to the preparation or submission of this brief.

internationally. He is a registered professional geophysicist (California # GP 972) with a Masters Degree in Geophysics from the University of California at Berkeley, and Professional Engineering Degree in Physics from the Colorado School of Mines. Dr. Chambers received his Ph.D. in Environmental Planning from Berkeley.

Catherine Coumans, Ph.D., is Research Coordinator and responsible for the Asia-Pacific Program at MiningWatch Canada, a non-profit organization that provides policy advice to the Canadian government and research and technical support to mining-affected communities. Dr. Coumans' academic work on mining dates back to her Ph.D. research in the Philippines in 1988-1990. She has provided expert testimony on mining in two congressional inquiries in the Philippines (1999, 2001), as well as before the Constitutional Court in Indonesian (2005) and before the Sub-Committee on Human Rights and Democratic Development in Canada (2005). Dr. Coumans participates in multi-stakeholder processes led by the Canadian government, providing expertise on water issues through Mine Environment Neutral Drainage (2003-present) and reviews of the Metal Mining Effluent Regulations (1999 - present). She holds an M.Sc. (London School of Economics) and a Ph.D in anthropology (McMaster University, Hamilton, Ontario).

Carol Ann Woody, Ph.D., has over 25 years of professional experience including: 13 years as a scientist with the USGS; 4 years as a researcher with the Fisheries Research Institute at the University of Washington, and 2 years at the

National Fishery Research Laboratory in Wisconsin. She is a past- President of the Alaska Chapter of the American Fisheries Society and Adjunct faculty at the University of Alaska. Her research on salmon behavior, genetics, and evolution is published in more than 25 peer-reviewed journals and a recent book focused on sockeye salmon. Her current research focuses on identifying risks to fisheries relative to industrial mining.

SUMMARY OF ARGUMENT

With the passage of the Clean Water Act cleaning up and maintaining clean water became a policy of the U.S. Government. This legislation reflected the growing problems with pollution of rivers and lakes in this country. The mining industry contributed significantly to this pollution with its pre-1970 waste disposal practices. Allowing mining operations to dispose of process wastewater in lakes (and potentially rivers and streams) would be a return the pre-Clean Water Act policy of process waste disposal.

It is not necessary to use natural water bodies for the disposal of mill process tailings and wastewater. If lakes (and potentially rivers) are allowed to be utilized for the discharge of mill process wastewater and tailings, there will be impacts. While the ability to predict the chemical reactions that drive water contamination is much better now than it was even ten years ago, it is still not good enough to predict impacts on aquatic organisms due to the long term migration of low levels of metals. The present state of the sciences geochemistry and aquatic biology does not allow us to predict with certainty magnitude and term of the impacts on lakes used for these discharges.

The only advantage in using lakes for mill process wastewater discharges is the cost savings to mining companies. Man-made structures can and have been successfully employed for this type of waste disposal, both financially and technically, for over 35 years.

The mill waste disposal in lakes situation in Canada, which was similar to that in the U.S. in terms of its prior prohibition of the use of lakes for process waste disposal, is demonstrating that mining companies will preferentially use lakes over man-made impoundments because of cost savings, and that it will be the mill process waste with the most potential to contaminate water which will be placed in these lakes.

ARGUMENT

I. *Background*

Robert Redford's 1992 movie, "A River Runs through It"[2] made the Blackfoot River in Montana famous, depicting a pristine river that daily yielded healthy trout to two fly fishing brothers. The Blackfoot meets with and becomes the Clark Fork River at the Milltown Reservoir near Missoula, Montana. Both rivers have been impacted by mining. Over 200 km (124 miles) of the Clark Fork River are contaminated from about 99.8 billion

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[2] Movie based on a novel by Norman F. Maclean.

kilograms (220 billion pounds) of mine tailings.[3] United States Environmental Protection Agency (EPA) scientists found that metals from these tailings contaminated local wells and caused multiple fish kills.[4] The region is one of the Nation's largest Superfund sites and is the focus of an ongoing massive cleanup campaign costing hundreds of millions of dollars.[5]

The EPA reports that "States have identified almost 300,000 miles of rivers and streams and more than 5 million acres of lakes that do not meet state water quality goals. Many of these waters are not considered safe for swimming and are unable to support healthy fish or other aquatic life."[6] The 2004 National Listing of Fish Advisories is an EPA database of all available information describing federal, state and tribal issued fish consumption advisories in the U.S. and Canada; it lists 3,221 advisories.[7] Waters under advisory represent:

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[3] Glenn Philips & Joshua Lipton, *Injury to aquatic resources caused by metals in Montana's Clark Fork River basin: historic perspective and overview*, Canadian Journal of Fisheries and Aquatic Sciences 52: 1990-1993 (1995).

[4] Robert M. Hughes, *Use of watershed characteristics to select control streams for estimating effects of metal mining wastes on extensively disturbed streams*, Environmental Management 9:253-262 (1985). *See also,* http://cfrtac.org/clarkforksite.php

[5] http://www.epa.gov/region08/superfund/mt/milltown/ factsheets.html

[6] U.S. Environmental Protection Agency, *Liquid Assets 2000, America's water resources at a turning point*, (2000), http://www.epa.gov/ow/liquidassets/.

[7] The National Listing of Fish Advisories (NLFA) available at http://map1.epa.gov/

- 35% of the Nation's total lake acres (excluding the Great Lakes), or approximately 14,285,062 lake acres

- 24% of the Nation's total river miles, or approximately 839,441 river miles

- 65% of the Nation's contiguous coastal waters (excluding Alaska) including 92% of the Atlantic coast and 100% of the Gulf coast

- 100% of the Great Lakes and their connecting waters.

Mining waste has contributed significantly to the impairment of our Nation's freshwater ecosystems.[8]

A. *Fresh Water, a Precious Limited Resource*

Over half of the human body is comprised of water, without which it could not survive. Although 75% of the planet Earth is covered with water, just 3% is fresh, and less than 1% of that is usable.[9] The health of human beings is inextricably linked to the health of aquatic ecosystems and these systems' continued ability to provide "ecosystem services", such as clean fresh water to drink and uncontaminated fish to catch and eat. Freshwater ecosystems provide many services, for example they:

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[8] Walter K. Dodds, *Freshwater Ecology Concepts and Environmental Applications* 271 Figure 14.2 (2002);, Ronald Eisler, *Handbook of Chemical Risk Assessment*, Volume 1, Metals 656-668 Table 9.6, 927-931 (2000).

[9] Brett Schulte, *"A World of Thirst,"* U.S. News and World Report, June 4 2007, at 1.

- transport water vital to the survival of life within a region.

- act as a "storage" area for excess nutrients, sediment, and other pollutants that could degrade our waterways.

- recharge groundwater aquifers.

- regulate water flow, runoff and erosion.

- cycle nutrients through a host of unique plant and animal species.

- link land and sea acting as a transportation corridor for nutrients, fish, sediments, etc.

- provide beauty and recreation.

- support a diverse aquatic community of fish, insects and plants.

The majority of literature on water pollution focuses, understandably, on its impacts to human health. The current status of the Nation's fishery resources serves as a barometer of how well humans are conserving freshwater ecosystems. The American Fisheries Society Endangered Species Committee recently revised their list of imperiled North American fishes. About 39% of all described North American fishes are now imperiled[10]; 700 species of fishes that rely on freshwater are considered at risk

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[10] Howard L. Jelks, et al., *Conservation Status of Imperiled North American Freshwater and Diadromous Fishes*, American Fisheries Society, Fisheries 33(8): 372-405 (2008).

and habitat degradation is considered a primary factor in their decline.

B. *Mining and Freshwater Ecosystems*

Hardrock metals mining was the number one source of toxic pollution in our Nation during 1998 to 2006, with 1998 being the first year, and 2006 being the most recent year available, that the industry reported to the Environmental Protection Agency's Toxic Release Inventory.[11] The EPA estimates 500,000 abandoned hardrock mines exist in the U.S. and that 40% of western headwater streams are polluted from mining; clean up costs are estimated at $32 - 72 billion,[12] with no federal funds available for cleanup. Between 1961 and 1975 a conservative estimate of fish killed by mining-related incidents was 10 million;[13] no recent estimates are available.

C. *Potential Impacts of Tailings to Aquatic Ecosystems*

Tailings, one waste generated from mining, can comprise over 99% of the total processed ore;[14] for example, processing 10 million tons of ore can

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[11] U.S. Environmental Protection Agency (EPA TRI), Toxics Release Inventory, TRI Explorer (2007). Accessed online 4 Oct. 2007 at http://www.epa.gov/triexplorer/.

[12] U.S. Environmental Protection Agency, *Liquid Assets 2000, America's water resources at a turning point*, (2000), http://www.epa.gov/ow/liquidassets/

[13] U.S. Environmental Protection Agency, *Fish kills caused by pollution: fifteen year summary, 1961-1975*, EPA-440/4-78-006 (1979).

[14] Bernd G. Lottermoser, *Mine Wastes, characterization, treatment, environmental impacts* 152-157 (2d ed. 2007).

produce up to 9.9 million tons of tailings. Mine tailings contain solids and liquids, metals, and processing chemicals. The solids are primarily clay, silt and sand. Some mined minerals and associated elements will occur in tailings, such as: aluminum, antimony, arsenic, barium, cadmium, copper, chromium, cobalt, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, zinc, sulfides, and natural radioactive constituents. Process wastewater will contain process chemicals (e.g., Cyanide, Xanthates, etc.) and some petroleum products (e.g., diesel, oil, gas, etc.).[15] Tailings that contain reactive sulfides - a common component in hard rock deposits - can generate sulfuric acid if exposed to both air and water.[16] The mill process wastewater and solid components of tailings can harm aquatic organisms and impair natural ecosystem function.

Ore beneficiation mill tailings and process wastewater can affect aquatic life both directly and indirectly, and effects can be lethal, nonlethal, or chronic. Disposal of fine sand, silt and clay into lakes can increase turbidity of water and bury living benthic organisms. Turbidity acts like an umbrella, limiting solar energy transmission to aquatic plants for photosynthesis thereby reducing overall lake productivity. Suspended solids can cause sublethal effects on fish and invertebrates including reproductive interference, reduced feeding and growth, respiratory impairment, reduced tolerance

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[15] *Id.*

[16] U.S. Environmental Protection Agency, *Acid Mine Drainage Prediction* (1994); http://www.epa.gov/nps/acid_mine.html.

to disease and toxicants, and physiological stress.[17] Tailings solids deposited on the benthos (bottom dwelling organisms) can suffocate sedentary invertebrates and fill interstitial spaces of gravel where they live. Changing bottom sediment size from larger to smaller (e.g., gravel to silt) changes invertebrate abundance, diversity and species richness.

For example, fish such as salmonids and char generally prefer mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera). These live in interstitial spaces of gravel. If fine sediment loads increase significantly (feet or more), less preferred, less accessible, mud burrowers such as worms (Oligochaetes) and caddisflies (Chronomids) increase.[18] Tailings solids deposited on gravels can suffocate developing fish embryos and alevins[19] and can reduce available spawning, incubation, and cover habitat for fish.[20] Fine sediment from mill discharges can have significant direct and indirect impacts on aquatic communities. However, it is important to remember that mill discharges contain not just clay, silt and sand; but the mill process wastewater also contains metals, process chemicals and organics.[21]

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[17] Thomas F. Waters, *Sediment in streams*, American Fisheries Society, Monograph 7 82 (1995); Walter K. Dodds, *Freshwater Ecology* 291 (2002).

[18] Thomas F. Waters, *Sediment in streams*, American Fisheries Society, Monograph 7, (1995).

[19] Alevins = newly hatched fish

[20] Thomas F. Waters, *Sediment in streams*, American Fisheries Society, Monograph 7 79-118 (1995).

[21] Bernd G. Lottermoser, *Mine Wastes, characterization, treatment, environmental impacts* 153-157 (2d ed. 2007).

II. *Tailings: Metals, Process Chemicals and Organics*

"The processing of ore promotes the dissolution and mobilization of elements present in the ore…Consequently, tailings undergo chemical reactions after their deposition in the repository and their composition changes over time."[22] Tailings composition varies greatly among ore beneficiation mills as do physical, chemical and biotic components among lakes, as do environmental conditions through time (e.g., wind, rain, earthquakes). When so many dynamic parameters are integrated into predictive mathematical models of future conditions, prediction accuracy declines,[23] making restoration success difficult to predict. To date, fisheries scientists are still teasing apart effects *of a single metal* on an aquatic organism under different environmental conditions and exposure methods (e.g., ingestion[24] or water exposure) without regard to *cumulative effects* of added stressors, such as fine sediments, other metals, organics, petroleum products, and global warming.

Toxicity of metals and organic chemicals to aquatic creatures varies depending on many factors of water quality, including: pH, temperature, hardness, salinity, suspended solids, organic content in water; presence of other elements, organism species, age, size, sex, prior exposure, and whether

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[22] *Id.* at 154.

[23] John Neter, et al., *Applied linear regression models*, (2d ed. 1989).

[24] Joseph S. Meyer, et al., *Toxicity of dietborn metals to aquatic organisms*, Society of Environmental Toxicology and Chemistry (SETAC Press) (2005).

organisms encounter the element in the water or ingest it.[25] Mill wastewater discharges are a complex cocktail of metals, metalloids and organics; many of which alone can be toxic to aquatic species at very low concentrations. To illustrate this concept, toxic effects of single elements commonly occurring in wastewater discharges are highlighted below.

A. *Cadmium and Aquatic Organisms*

Cadmium is a relatively rare metal, and is highly toxic to all life.[26] It is always found in association with zinc and is a byproduct of copper, zinc and lead production; it is associated with sulfide ores which can be acid generating.[27] Cadmium is cancer-causing with severe sublethal and lethal effects at low environmental concentrations.[28] Several species of freshwater invertebrates and fish show high mortality at concentrations of 0.8 to 9.9 parts per billion (ppb: equivalent to one drop in 2,200 gallons).[29] Water concentrations exceeding 10.0 ppb of cadmium are associated with high fish mortality, reduced growth, inhibited reproduction, and impaired breathing, muscle contractions, and

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[25] Elsa M. B. Sorenson, *Metal Poisoning in Fish* (1991); Ronald Eisler, *Handbook of Chemical Risk Assessment Volume 1 Metals Volume II Organics* (2000).

[26] Ronald Eisler, *Handbook of Chemical Risk Assessment*, Volume 1 Metals 1 (2000).

[27] Earle A. Ripley, et al., *Environmental effects of mining* 157 (1996).

[28] Ronald Eisler, *Cadmium hazards to fish, wildlife, and invertebrates: a synoptic review*, US Fish Wildl. Ser. Biol. Rep. 85(1.2) (1985).

[29] Parts per billion (ppb) corresponds to one penny in $10,000,000, or 1 second in one second of time in approximately 31.7 years.

enzyme activity.[30] Cadmium bioaccumulates at all trophic levels and accumulates in the livers and kidneys of fish.[31]

B. *Copper and Aquatic Organisms*

Copper is a heavy metal and an essential element. However, it is one of the most toxic metals to aquatic life and can accumulate and cause harm at concentrations just above that needed for growth and reproduction.[32] Slight increases in dissolved copper above normal background levels can reduce productivity of key links in aquatic food chains including algae, zooplankton, insects and fish.[33] In salmon, increases of just 2-10 ppb above natural levels, has been shown to affect their sense of smell, which is crucial to homing, feeding, and predator avoidance.[34] Copper can interfere with normal

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[30] Ronald Eisler, *Handbook of Chemical Risk Assessment*, Volume 1 Metals 19 (2000).

[31] Emmanual Sindayigaya, et al., *Copper, zinc, manganese, iron, lead, cadmium, mercury, and arsenic in fish from Lake Tanganyika, Burundi,* The Science of the Total Environment 144:103-115 (1994); Muhammad Sadiq, *Toxic metal chemistry in marine environments* (1992).

[32] Susan B. Betzer & Paul P. Yevich, *Copper toxicity in Busycon canaliculatum L.*, The Biological Bulletin 148:16-25 (1975); W. Scott Hall, et al., *Monitoring dissolved copper concentrations in Chesapeake Bay, USA*, Environ. Monitoring and Assessment 11:33-42 (1988).

[33] Ronald Eisler, *Handbook of Chemical Risk Assessment,* Volume 1 Metals 656-668 Table 9.6, 927-931 (2000).

[34] David H. Baldwin, *Sublethal effects of copper on salmon*, Environmental Toxicology and Chemistry 22(10): 2266–2274 (2003); James A. Hansen, et al., *Chinook Salmon (Oncorhynchus tshawytscha) and rainbow trout (Oncorhynchus mykiss) exposed to copper: neurophysiological and histological effects on the olfactory system*, Environmental Toxicology and

migration, impair immune systems, interfere with brain function and breathing, disrupt osmoregulation, delay or accelerate natural hatch rates, and change enzyme activity, blood chemistry and metabolism.[35] Recent evidence suggests that copper is an endocrine disruptor.[36] Copper often co-occurs with zinc at hard rock mines. When combined in hard water at a ratio of 6 parts zinc to 1 part copper, additive toxicity results (individual toxicities are summed), but when combined in soft water, copper has a synergistic toxicity (more than additive toxicity).[37] Such interactions among elements and the resulting effects on aquatic species are neither well studied nor understood.

Chemistry 18(9):1979-1991 (1999); Toshiaki J. Hara, et al., *Effects of copper and mercury on the olfactory response in rainbow trout*, *Salmo gairdneri*, Journal of the Fishery Research Board of Canada 33:1568-1573 (1976); Janet Raloff, *Aquatic Non-Scents: repercussions of water pollutants that mute smell*, Science News 4:49-66 (2007).

[35] U.S. Environmental Protection Agency, *Wildlife Exposure Factors Handbook*. vol. I. EPA/600/R-93/187a (1993); Michael T. Horne & William A. Dunson, *Effects of low pH, metals, and water hardness on larval amphibians*, Archives of Environmental Contamination and Toxicology 29:500-505 (1995); James A. Hansen, et al., *Differences in neurobehavioral responses of Chinook salmon (Onchorhynchus mykiss) exposed to copper and cobalt: behavioral avoidance*, Environmental toxicology and chemistry (1998).

[36] Daniel A. Medesani, *Interference of cadmium and copper with the endocrine control of ovarian growth, in the estuarine crab Chasmagnathus granulata*, Aquatic Toxicology 69(2):165-174 (2004).

[37] Elsa M.B. Sorensen, *Copper* in *Metal Poisoning in Fish* 235–284 (Elsa M.B. Sorensen ed. 1991).

C. *Cyanide and Aquatic Organisms*

Sodium cyanide is an organic chemical, commonly used as a process chemical to extract gold from mined ore. It is highly toxic to fish at low concentrations.[38] Fish are sensitive to cyanide and exhibit chronic effects at 5 to 7 parts per million (ppm) and lethal effects at 20 to 76 ppm.[39] Sublethal effects in fish include reduced reproductive capacity (decreased egg number and viability, and reduced embryo and larval survival), impaired swimming ability, altered growth, and hepatic necrosis (liver disease).[40] Invertebrates show adverse nonlethal effects between 18 and 43 ppb and lethal effects between 30 and 100 ppb.[41]

D. *Lead and Aquatic Organisms*

Lead is neither essential nor beneficial to life and causes adverse effects on human survival, metabolism, growth, development, behavior, learning, and reproduction.[42] Adverse effects on aquatic life are shown at waterborne concentrations of 1.0 to 5.1 ppb, and bioconcentrates in aquatic species. Lead commonly occurs in association with

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[38] Gerard Leduc, et al., *The effects of cyanides on aquatic organisms with emphasis upon freshwater fishes*, National Research Council of Canada, NRCC 19246 (1982).

[39] http://www.epa.gov/region5superfund/ecology/html/toxprofiles.htm#al; Ronald Eisler, *Handbook of Chemical Risk Assessment. Volume 2 Organics* 904-905 (2000).

[40] Ronald Eisler, *Handbook of Chemical Risk Assessment. Volume 2 Organics* 904-905 (2000).

[41] *Id.* at 927-931.

[42] *Id.* at 269.

zinc, copper, iron, and silver in sulfide ores. Waterborne criteria for the protection of aquatic life range from 1.3 to 7.7 ppb, although within this range adverse effects are documented.[43]

E. *Zinc and Aquatic Organisms*

Zinc is an essential element and occurs with sulfides in ore.[44] Significant adverse effects on growth, survival, and reproduction occur in plants, fish amphibians, and invertebrates at zinc concentrations between 10–25 ppb.[45] Zinc is usually found in sulfide ores with copper, lead and trace amounts of cadmium, thallium and other metals.[46]

III. ***Impacts of Milling Waste Disposal in Lakes, and the Failure of Current Mitigation Technology to Alleviate Water Quality Concerns at Mines***

Scientists are beginning to study primary causal factors in the decline of aquatic species affected by multiple stressors due to mining. One tool in such studies is called paleolimnology, where cores of lake sediments are removed and annual sediment layers dated and analyzed to determine when species

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[43] *Id*. at 280.

[44] Carl-Gustaf Elinder, *Zinc* in *Handbook on the Toxicology of Metals* v.2 664-679 (Lars Friberg, et al., eds., 2d ed. 1986).

[45] Ronald Eisler, *Zinc hazards to plants and animals with emphasis on fishery and wildlife resources* in *Ecological issues and environmental impact assessment, Advances in environmental control technology series* 443-537 (Paul N. Cheremisinoff ed., 1986).

[46] Whitmel M. Joyner (ed.), *Compilation of air pollutant emission factors* (4th ed. 1985).

declined and what elements might have caused their decline during that period.

One study examined the cause of invertebrate declines in Lake Superior due to discharge of over half a billion metric tones of tailings from copper and silver mining.[47] The study found biological life indicators decreased during the period of discharge and hypothesized that discharge of copper was a likely factor in biotic decline. The study tested its hypothesis by creating sediment suspensions in aquaria with pre-mining and active mining sediment layers from lake cores. The sediment suspension made with the layer representing active mining caused high mortality of aquatic invertebrates, with high copper concentrations found to be causal. The study also determined that resting eggs from the invertebrates could not be hatched from sediments older than 70 years in age, the period of intense mining.[48]

Despite the historical evidence, there is a perception that "modern mining" does not cause significant harm to water quality, largely due to innovative technological advances. However, a recent comparison of predicted versus actual impacts to water quality at 25 modern hard rock mines showed 76% violated U.S. EPA water-quality standards, despite predictions made from 1979 to 2003 that they would not.[49] Levels of potentially

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[47] John P. Smol, *Pollution of Lakes and Rivers* 142-143 (2008).

[48] *Id.*

[49] James Kuipers & Ann Maest, et al., *Comparison of Predicted and Actual Water Quality at Hardrock Mines: The reliability of predictions in Environmental Impact Statements* (2006); James Kuipers & Ann Maest, et al., *Predicting Water Quality at*

toxic metals at surveyed mines, such as lead, mercury, and cadmium, exceeded EPA standards for ground and surface water at 63% of sites, and levels of arsenic and cyanide exceeded standards at over 50% of sites.[50] Mining technology has improved vastly over historic practices. However, pollution problems persist today, especially when sulfide ores are mined in regions with nearby ground and surface waters.[51]

IV. *Why Use Waters of the US for Ore Beneficiation Mill Waste Disposal?*

Mining has been an important part of the American economy for over 150 years. It arguably led the way to settling the West. During the late 1800s and early 1900s mining drove settlement of the largest cities in the west, from Denver to San Francisco, and enriched miners and mining investors. In its heyday mines provided jobs for tens of thousands of miners, and for workers in support industries that supplied food, equipment, and entertainment for these miners. There was little thought or concern for mine waste disposal in that era, although it was understood even then that mining could have significant environmental impacts. Georgius Agricola published his seminal and oft-quoted work on mining and metallurgy in 1556,[52] and noted the impacts from acid mine

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Hardrock Mines: Methods and Models, Uncertainties, and State-of-the-Art (2006).

[50] *Id.*

[51] *Id.*

[52] Georgius Agricola, *De Re Metallica* (1556). Georg Bauer, better known by the Latin version of his name Georgius Agricola, is considered the founder of geology as a discipline.

drainage.[53] In 1893 congress passed the Caminetti Act to limit impacts to California cities from hydraulic placer mining tailings dumped into the Sacramento and San Joaquin river systems.

During that era, which extended into the 1960s, the primary consideration was finding the minerals, and getting them out of the ground at the lowest cost. Mine waste was routinely dumped near or directly into streams, and mine closure consisted of locking the door on the office. Today mining is conducted on a completely different scale. It is no longer the pick and shovel operation that producing a few hundred tons of ore per day. Production from today's mines is often tens of thousands of tons of ore per day, utilizing mass production techniques that not only have resulted in increases in worker productivity that drastically reduced the need for human labor at a mine, but also allows the mining of low grade ores leading to the generation of massive amounts of mine waste. Mining produces significantly more waste on an annual basis than the

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De Re Metallica literally translated, means "On the Nature of Metals." In 1912, the Mining Magazine (London) published an English translation. The translation was made by Herbert Hoover, a mining engineer and future President of the United States, and his wife Lou Henry Hoover.

[53] Acid mine (rock) drainage is a common effluent of metal mining and one of the major environmental impacts resulting from mining activities. It is caused by the natural weathering of pyrite and other metal sulfides in the mineral deposit, or through the accelerated weathering of waste products generated by the mining process. The sulfide minerals react with oxygen in air or pore water and produce sulfuric acid.

total municipal solid waste.[54] Waste disposal from early mining (into the 1960s) has caused the degradation of thousands of miles of streams in the US.[55] Discharges from modern mines are regulated by the Clean Water Act, the Clean Air Act, and state solid waste disposal regulations. Reclamation is required (to differing degrees) by state and federal regulations, and financial sureties are usually required for these reclamation activities. Financial sureties do not cover unplanned or catastrophic events, only those events that are reasonably foreseeable.

With the passage of the Clean Water Act in 1972 mine waste could no longer be dumped in streams or lakes. This has not prevented mining from prospering in the US, even with its environmental laws, because these same institutions that regulate the mining industry provide a great deal of political predictability and stability. To the extent mining has moved to developing countries, this was driven more by the attractiveness of better ore bodies (the best ore bodies in the US have been developed) than by a lack of environmental and social regulation in those countries. Most mining companies will readily say they apply the same high environmental standards in each country they work in – regardless of a lack of regulation in those countries.

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[54] Office of Technology Assessment, *Managing Industrial Solid Wastes from Manufacturing, Mining, Oil and Gas Production, and Utility Coal Combustion* 10, 29, OTA-BP-O-82 (1992).

[55] Carlos Da Rosa & James Lyons, *Golden Streams, Poisoned Dreams* 24 (1997).

Even in a state like Alaska, which contains many lakes and streams and most of the nation's wetlands, regulations under the Clean Water Act have not prevented mining from prospering. At worst it could be argued that it is more expensive to operate a mine under regulations of the Clean Water Act, largely because waste disposal costs must now be internalized to the mining operation.

This raises the question of why mining companies and government regulators would argue they need to return to a policy of allowing the disposal of mine waste in Waters of the US when the industry has been operating without this option for more than 35 years. The primary reason is that tailings disposal in natural water bodies is the cheapest way by far of disposing of mill waste. It is significantly less expensive to use a natural water body than to construct a tailings impoundment. It is generally assumed that it is approximately 10 times less expensive to use a natural water body for waste disposal than to build a tailings impoundment. Using a lake for waste disposal would save the typical mine tens to hundreds of millions of dollars in capital construction costs.[56]

It is generally true that putting tailings underwater is the best way to prevent the onset of acid mine drainage.[57] However, it is not necessary to use natural water bodies for tailings disposal –

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[56] For example, see the Vale-Inco example discussed herein.

[57] "It is apparent from laboratory and field studies, that flooding tailings is the most successful method presently known for preventing and controlling ARD (Acid Rock Drainage)." Ernest K. Yanful & Paul H. Simms, *Review of Water Cover Sites and Research Projects, MEND Project* 2.18.1 (1997).

man-made tailings dams are equally as effective, and potential environmental impacts are more manageable.

Disposal of non-acid generating tailings under water, like the tailings from the Kensington Mine, is not required for geochemical reasons. Disposal of non-acid generating tailings in natural water bodies would be the least expensive method of disposal.

Failures in regulatory agencies' ability to predict and mitigate acid mine drainage and water contamination through the Environmental Impact Statement process are documented in recent research which showed that EISs on mines from 1975 to 2005 failed to predict water quality degradation off the minesite in 76% of the cases studied.[58] This is an abysmal performance record.

There is also a body of research on the effects of tailings disposal in lakes. This research comes from Canada, which has climate and topography similar to that in parts of Alaska, and where there is also recent significant pressure from the mining industry and government regulators to use lakes for mine waste disposal. The research was conducted by an agency of the Canadian federal government, Natural Resources Canada, as a part of its MEND (Mine Environment Neutral Drainage) program.

The research program on subaqueous disposal of tailings in freshwater lakes was prompted by a review in 1992 by the Rawson Academy of Aquatic

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[58] James Kuipers, et al., *Comparison of Predicted and Actual Water Quality at Hardrock Mines* Table ES-7b (2006).

Science, Ottawa, which recommended a thorough study of the viability and impacts of tailings disposal in freshwater lakes.[59] Researchers looked at several lakes that had been used as tailings disposal sites and were now closed for periods ranging from over 20 years to during and just prior to data collection. The research focused on the geochemistry of the tailings after deposition in the lake, the mobility of contaminants from the process wastewater into lake water, and the short and long term impacts on aquatic organisms in the lake.

There were mining-related impacts in all of the lakes used for process wastewater disposal, some major, and some minor. However, the relevant scientific findings from these studies are that: (1) there are still significant gaps in the ability to predict the geochemistry that drives the movement of metals to and from tailings once they have been deposited underwater; and that, (2) it is not yet possible to quantify the long term effects from tailings disposal in lakes on aquatic organisms in these lakes. As one MEND reviewer recently noted: *"It is still a challenge to predict metal bioavailability and toxicity in sediments."*[60]

The science used to predict the chemistry of the water over the tailings, and in predicting potential impacts to any aquatic life living on or in the water

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[59] Rawson Academy of Aquatic Science, *A Critical Review of MEND Studies Conducted to 1991 on Subaqueous Disposal of Tailings*, MEND Project2.11.1d (1992).

[60] Bernard Vigneault & Yamini Gopalapillai, *Literature Review Report: Possible Means of Evaluating the Biological Effects of Sub-Aqueous Disposal of Mine Tailings* 3 (2007).

above the tailings, either in the short or long term, is not precise.[61]

Man-made impoundments are better alternatives to using lakes as a disposal sites for mine waste. This technique has been successfully employed – but constructing an impoundment costs more than using a lake. Supporters of lake-disposal argue that using a lake eliminates long term maintenance and uncertainty with impoundment failure in man-made structures. While there is indeed some uncertainty in man-made structures, mainly related to seismic risk, there is as much or more uncertainty in using natural lakes. Material deposited in lakes is subject to movement due to large storms,[62] earthquakes, avalanches, ice entrainment,[63] seiching,[64] seasonal turnover, currents, and other natural events.[65] Groundwater contamination is also potentially a greater problem with lake disposal, since lakes are hydrologically connected to groundwater, while

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[61] "… the secondary mineral assemblages that accumulate during subaerial exposure could have a profound influence on the geochemical behaviour of the waste when submerged, such that deleterious effects on water quality may result." Bruce Mattson & Ali Sahami, *Assessing the Subaqueous Stability of Oxidized Waste Rock* i, MEND Project 2.36.3 (1999).

[62] Wave Action – Sufficiently large waves can generate velocities along the bed that can mobilize the bed material.

[63] The ice layer can ground on the bed and bond bed material by freezing.

[64] A seiche (pronounced approximately saysh) is a standing wave in an enclosed or partially enclosed body of water. Seiches and seiche-related phenomena have been observed on lakes, reservoirs, bays and seas.

[65] *See* Canada Centre for Mineral and Energy Technology (CANMET), Mine Environment Neutral Drainage (MEND), *Design Guide for the Subaqueous Disposal of Reactive Tailings in Constructed Impoundments,* MEND Project 2.11.9 (1998).

impoundments can be engineered to be isolated from groundwater.

In addition, the mining industry has already created thousands of man-made tailings impoundments which require long term maintenance and are subject to uncertainty of impoundment failure. Impoundments built to submerge tailings under a water cover are virtually identical to the thousands of tailings impoundments already in existence, so using man-made impoundments is neither creating nor exacerbating a problem.

V. ***Canadian Lake Disposal – A Policy Perspective***

It is also instructive to describe the present situation with the use of lakes as mine waste disposal in Canada. For many years the Canadians had a similar prohibition on dumping process wastewater from ore beneficiation mills into lakes, but have recently implemented a regulatory change to allow the disposal of mine waste in lakes. The Canadian situation is instructive because it undoubtedly foretells the direction that the mining industry and regulatory agencies will go if process wastewater from ore beneficiation mills is allowed to be dumped into lakes in the US.

A. *Background on Canadian Federal Discharge Limits for Mining*

In 1977 Governor in Council passed the *Metal Mining Liquid Effluent Regulations*. The *Metal Mining Liquid Effluent Regulations* (MMLER) were promulgated under Section 36 of the *Fisheries Act* as it stood at that time.[66] The MMLER defined limits with regard to certain metals and chemicals, and with respect to pH that could not be exceeded if metal mine effluent were to be deposited into the natural environment.[67]

One of the key limits set in the 1977 MMLER was a limit on Total Suspended Solids (TSS). The limit on TSS was set at 25 mg/L[68] for monthly mean

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[66] Canada Department of Fisheries and Oceans, *Metal Mining Effluent Regulations, Regulatory Impact Analysis Statement*, Canada Gazette 135(30) (July 28, 2001). The MMLER applied to new, expanded and reopened metal mines. It did not apply to mines that commenced operations prior to 1977, to mines that had stopped operating, were orphaned or abandoned, to placer mining operations, or to mines that used cyanide in the milling process (gold mines). As such, the MMLER applied to approximately 1/3 of Canada's metal mines. While the Department of Fisheries and Oceans (DFO) is legally responsible to parliament for all sections of the Fisheries Act, Environment Canada (EC) administers those aspects of the Act in Sections 36 and 42 dealing with pollutants affecting fish as set out in a Memorandum of Understanding between DFO and EC.

Section 36 (3) of the Fisheries Act states that:

no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance that results from the deposit of the deleterious substance may enter any such water.

However, Governor in Council may pass regulations that authorize the deposition of a deleterious substance into waters frequented by fish under section 36(4).

[67] Authorized effluent concentration limits were set for arsenic, copper, lead, nickel, radium-226, total suspended solids (TSS) and zinc, and minimum levels were set for pH. One of the key limits set in the 1977 MMLER was a limit on Total Suspended Solids (TSS).

[68] mg/L = milligrams per liter (equivalent of parts per million)

concentrations. The concentration of TSS in process wastewater (typically 200,000-600,000 mg/L) greatly exceeds this limit. This MMLER limit on total suspended solids is significant as it effectively ruled out the deposition of mine tailings into natural water bodies frequented by fish without a ministerial authorization to overrule the regulation.

In 2002 the MMLER were amended and became the *Metal Mining Effluent Regulations* (MMER).[69] At this time the limit on TSS was further reduced to 15mg/L for monthly mean concentrations. However, at the same time, a new schedule was added to the MMER. Schedule 2 of the MMER lists "tailings impoundment areas." In the MMER a "tailings impoundment area" is defined as:

> *(a) a water or place set out in Schedule 2; or*
> *(b) a disposal area that is confined by anthropogenic or natural structures or by both, but does not include a disposal area that is, or is part of, a natural water body that is frequented by fish.*[70]

Schedule 2 in essence redefines a natural water body (be it a lake, wetland or river "frequented by fish" as

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[69] In 2002, the MMER applied to 93 mines. Gold mines were included in the amended Metal Mining Effluent Regulations (MMER) of 2002, as were mines predating 1977, but not placer mines, or mines that had stopped operating, or orphaned and abandoned mines.

[70] In the 2006 MMER this definition is very slightly reworded to read: "(a) a water or place set out in Schedule 2; or
(b) a disposal area that is confined by anthropogenic or natural structures or by both, other than a disposal area that is, or is part of, a natural water body that is frequented by fish."

per section 36 of the *Fisheries Act*) as a tailings impoundment area and effectively removes it from the protections it would otherwise be afforded under the Fisheries Act and under the limits (for example on TSS) set by the Metal Mining Effluent Regulations.

B. *Stated Intent of Canadian Lake Disposal Regulation Versus its Application*

When Schedule 2 was added to the MMER, in 2002, 4 lakes and a valley of streams were listed on Schedule 2. These water bodies were all associated with existing or past mine projects. The rationale provided by Environment Canada civil servants for the addition of Schedule 2 to the MMER was legal advice they had received that operating mines using natural water bodies for tailings impoundments would be out of compliance once the new Regulations came of force unless these were covered by Schedule 2. In response to questions, Environment Canada civil servants gave assurances that it would be highly unlikely that mining companies would try to use Schedule 2 as a way to access new, as yet uncontaminated, water bodies as tailings impoundments as they would be unwilling to subject a project to the necessity of a regulatory review and amendment process and the need to get approval from Governor in Council (to amend Schedule 2 by adding another water body to it), just to secure a natural water body for a tailings impoundment.[71]

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[71] http://www.miningwatch.ca/updir/Auditor_General_petition_Nov_13_07.pdf

Counter to the Environment Canada rationale, in 2006, two healthy fish bearing lakes were added to Schedule 2. In January of 2008, Environment Canada provided a list of an additional eight mine projects seeking to add natural water bodies to Schedule 2 and announced the department would seek to push these projects through. Environment Canada also announced that more projects would follow in 2009 as there is now a "line up" of mine projects wanting to use natural water bodies as waste disposal sites.[72]

C. *Vale-Inco Example*

Vale-Inco is currently requesting approval to use Sandy Pond (a 38 ha fish-bearing lake) in Newfoundland for the disposal of its waste from a hydro-metallurgical processing facility. This facility will process ore from Vale-Inco's Voisey's Bay nickel mine, located in Labrador. Vale-Inco has an agreement with the government of Newfoundland and Labrador that it will process its ore in Newfoundland. However, the location of the processing plant was left up to Vale-Inco to determine. Vale-Inco chose a site in Long Harbour and subsequently argued that the waste from the plant would have to be deposited in Sandy Pond as other locations, including land-based, in the vicinity of the proposed plant would not be suitable. Clearly, neither Vale-Inco nor the regulatory authorities

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[72] For a list of 11 mine projects seeking Schedule 2 amendments in the near term, provided by Environment Canada, see http://www.miningwatch.ca/index.php?/mmer/mmer_coalition_forming

prioritized choosing a site for the processing plant that would avoid the destruction of a natural water body for the plant's waste disposal.

The example of Vale-Inco's proposed use, and destruction, of Sandy Pond as a disposal site for its process waste is illustrative of the key determinant that is driving the preference of proposed mines in Canada, which are located near natural water bodies, to use these water bodies for their process waste disposal. In all cases brought forward to date, the cost of using a natural water body for mine waste disposal has been less expensive than providing a land-based tailings impoundment option. The price differential is significant in all cases. For Vale-Inco's Long Harbour Processing Plant the cost of building a man-made, land-based, impoundment was estimated by the company to be CAD 490 million. The costs associated with using Sandy Pond were estimated at CAD 62 million.

Environment Canada officials have repeated assurances that permission to use natural fish-bearing water bodies would be the exception, not the rule. Nonetheless, it is clear that the use of natural water bodies is now proving to be the tailings impoundment option of choice for new mines coming on line in Canada.

CONCLUSION

Allowing mill waste disposal into natural lakes would mark a stark change in U.S. Clean Water Act policy. Such disposal represents a significant threat to natural lake and river ecosystems and predictions regarding mitigation for these biological and ecological impacts are far from precise. Thus, the lone benefit of such a change in policy is in terms of mine project economics.

It is not necessary to use natural water bodies for the disposal of mill process tailings and wastewater. Man-made structures can and have been successfully employed for this type of waste disposal, both financially and technically, for over 35 years.

The mine waste disposal in lakes situation in Canada demonstrates that mining companies will preferentially use lakes over man-made impoundments because of cost savings, and that it will be the mill process waste with the most potential to contaminate water which will be placed in these lakes.

The result of legalizing a rule to allow mill waste disposal in natural lakes, as put forth by Petitioners in this case, would have a regressive result in terms of the health and well-being of the nation's freshwater resources.

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