Summary of Experience in Evaluating/Managing the Environmental Impacts of Mining and Mineral Processing, Including Restoration of Abandoned Mines

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A summary of Drs. G. Fred Lee and Anne Jones-Lee's expertise and experience in investigating and managing active and inactive/abandoned mine sites includes work on the environmental impact of taconite tailings, radium/uranium tailings, acid mine drainage, arsenic tailings, tailings-associated heavy metal impacts, mercury, contaminated sediments, landfills for mine waste management and site-specific water quality criteria/standards development. A summary of their work in these area is presented below.

Taconite Tailings

In the mid-1960's Dr. G. Fred Lee served as a consultant to the Reserve Mining Company of Silver Bay, MN, on environmental impacts of mining and mineral processing. For a several-year period he was the lead consultant on a several-million-dollar per year environmental study for Reserve Mining, evaluating the water quality impacts of the discharge of 50,000 tons/day of taconite (iron ore) tailings into the North Shore area of Lake Superior. That investigation included the study of a wide variety of characteristics and potential water quality implications of the tailings' disposal into the Lake via a density current, which deposited the tailings in an over-950-foot depression in the bottom of the Lake. These studies included evaluation of the leaching of heavy metals from the tailings and the toxicity of the tailings to aquatic life. During the course of that study Dr. Lee pioneered in the development of leaching tests to determine whether the contaminants in the tailings could be leached under the conditions that exist in Lake Superior water. He also conducted some of the first toxicity tests ever done to assess the toxicity of heavy metals associated with tailings, to various forms of aquatic life. The results of that work showed that, contrary to claims made by regulatory agencies, the tailings were not toxic to aquatic life, and the heavy metals and algal nutrients, such as phosphorus, were not leached under the conditions that exist in Lake Superior. Those studies ultimately led to litigation in a Minnesota Court where the judge ruled that the tailings were not having an adverse impact on the water quality of Lake Superior, including its aquatic life.

Acid Mine Drainage

Dr. Lee has had extensive experience in evaluating the production of acid mine drainage and the water quality problems associated with it. His work in that area has included research on the factors controlling acid formation from sulfuritic agglomerates found in western Pennsylvania coal mines, and on the production of acid from a massive copper sulfide ore body. Dr. Lee conducted a review and guided laboratory studies for Kennecott Copper Co. on water quality consequences of mining a sulfide ore body in northern Wisconsin. Of concern was the potential for the mined ore body to develop acid waters in a lake that would be formed after the ore had been mined. He developed a procedure to determine the potential for that un-mined ore to develop acidic conditions; his study showed that there was a high potential for acid production in

a lake that could be formed unless precautions were taken to prevent moisture from coming in contact with the un-mined, residual ore.

Dr. Lee was a technical advisor to the Idarado Mining Co. in the matter of a Colorado Attorney General's Office Natural Resources lawsuit filed against the company associated with mine drainage and tailings discharge to a stream near Telluride, CO. Dr. Lee assisted the company's attorneys in evaluation of the impacts of the heavy metals in the mine drainage and the tailings on fish (trout) and other aquatic life in a stream and in a downstream reservoir.

Radium-226

In the early 1960's, Dr. Lee and his graduate students conducted some of the earliest work done on the leaching of radium-226 from uranium mill tailings. They found that some uranium mill tailings leached large amounts of radium-226. They also found that the sulfate content of the water used for leaching was a primary factor controlling the amount of radium leached.

In the early 1980's, on behalf of several cities near Denver, CO, Dr. Lee assisted attorneys in evaluating the leaching of radium-226 and other radionuclides from uranium mining operation's discharge waters. The concern was the potential for the leached radium and uranium to exceed drinking water standards in a reservoir that served as the cities' domestic water supply.

Dr. Lee was involved in evaluating the leaching of radium-226 from waste uranium ores in the mid-1980's. The waste ores were a source of radium-226 used by watch dial painters in the 1920's; the waste ores were scattered over several communities in New Jersey and were judged to be a health hazard to residents who had constructed homes on them. The state of New Jersey Department of Environmental Protection proposed to excavate the waste ores and place them in a sand and gravel pit in the western part of the state. Dr. Lee showed that the proposed method of disposal represented a significant potential for groundwater pollution by radium-226. A judge reviewing this matter concluded that the State should not proceed with its proposed waste ore management plan.

Dr. Lee is the US EPA Technical Assistance Grant (TAG) advisor for the DOE/UCD LEHR Superfund site located on the University of California Davis campus in Davis, CA. UCD/DOE disposed experimentally used radium-226 and strontium-90 in waste pits. Dr Lee was responsible for evaluating the adequacy of the Superfund site investigation and remediation from the public's perspective.

Lava Cap Mine Superfund Site (Arsenic)

Dr Lee has been appointed the US EPA supported Technical Assistance Grant public advisor for the Lava Cap Mine Superfund site. The Lava Cap Mine was one of the largest former gold mines in California. It is s located near Nevada City, CA. The primary pollutant of concern is arsenic that is associated with the tailings. Soil, surface, and groundwater is polluted by arsenic and other metals. As the public's advisor, Dr. Lee is responsible for reviewing the adequacy of US EPA site investigation and remediation. This responsibility includes reviewing the RI for the site, including the human health and ecological risk assessments, and the FS, covering approaches for site management.

Drs. Lee and Jones-Lee have extensive experience in Superfund site investigation/remediation in various parts of the country. They served as internal consultants to Ebasco Co. in its $200 million US EPA REM III Superfund contract for RI/FS studies for sites east of the Mississippi River.

In the early 1990's the city of Sacramento, CA Department of Planning and Development selected Dr. Lee and Dr. Jones-Lee to conduct a comprehensive review of the evaluation and clean-up of a state of California "Superfund" railyard site in the central part of the city. Particular attention was given to evaluating the impact of residual contaminants (lead and chlorinated solvents) on the commericial and residential redevelopment of the site. They found that the site remediation approved by the California Department of Toxic Substances Control would not be protective of public health for residual chemicals that were proposed to be left at the site after remediation.

Mercury in Sediments
On behalf of the American Dental Association Dr. Lee evaulated the potential impacts of waste dental amalgam on water quality. He has also been active in reviewing the stuidies that have been conducted in the Sacramento River watershed on the mercury pollution problem from former mercury mines and the use of mercury to recover gold.

Contaminated Dredged Sediments
Drs. Lee and Jones-Lee have extensive experience investigating the water quality significance of contaminants associated with aquatic sediments. This experience has direct applicability to many mining-related environmental problems. They have conducted over a million dollars in research on the leaching of contaminants from US waterway sediments and their impact on water quality. Dr. Lee pioneered in the development of sediment toxicity tests and a tiered hazard assessment approach for evaluating the water quality significance of sediment-associated contaminants. Of particular importance is the unreliability of cooccurance-based so-called "sediment quality guidelines." The focus of Dr. Lee's approach on assessing the sediment chemical impacts on beneficial uses of waters is on effects-based approaches rather than the unreliable chemical-concentration-based approaches.

Landfills for Mine Waste Management
Dr. Lee has had extensive experience in evaluating the ability of clay and plastic sheeting membrane liners for landfills and disposal pits to prevent groundwater pollution for as long as the wastes in the landfill will be a threat. Today's US EPA-approved landfills typically provide only temporary storage facilities that will eventually fail to prevent groundwater pollution. Dr. Lee has developed information on protective landfills that will protect groundwater and surface water quality from landfilled wastes. He also has considerable knowledge of the transport and transformation of chemical contaminants in groundwater systems and groundwater monitoring.

Water Quality Criteria/Standards
Dr. Lee and Dr. Jones-Lee have been leaders in developing site-specific water quality criteria and standards that properly protect the designated beneficial uses of a waterbody, without leading to unnecessary expenditures. Through an integrated approach using aquatic chemistry and toxiciology they have developed the Evaluation Monitoring approach for defining the real

significant water quality problems at and downstream of a mine site. Further, their work on the water quality evaluation and management of complex industrial wastewater effluents provides them with high degrees of expertise in the area of mineral processing wastewaters.

Additional information on Dr. Lee's and Dr. Jones-Lee's experience and expertise in mining and mineral processing is available from their website, www.gfredlee.com, or by contacting Dr. Lee at (530) 753-9630 or gfredlee@aol.com.