COMMUNITY CONCERNS RELATED TO
URANIUM MINING IN VIRGINIA

December 2008
Uranium Study Group
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HALIFAX COUNTY CHAMBER OF COMMERCE

Uranium Study Group

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Introduction

Virginia has prohibited the mining of uranium statewide since 1982. The issue was studied and reports submitted to the General Assembly 1981-85. A moratorium remains in place.

The Virginia Coal and Energy Commission has proposed that the Virginia Center for Coal and Energy Research conduct a study on the impact of uranium mining in the Commonwealth. Virginia Uranium Inc. has indicated an interest in initiating mining and processing operations in Pittsylvania County (“the Coles Hill site”) should the moratorium be ended.

Removing the statewide ban would open the entire Commonwealth to uranium mining. See Appendix 1 for maps showing areas within which there may be economically viable uranium deposits. With the first site actively considered being located in neighboring Pittsylvania County, Delegate Clarke Hogan requested that the Halifax County Chamber of Commerce sponsor an effort to identify issues that the community believes should be addressed by the proposed study.

A local group was formed. The group reviewed existing literature and studies and sought input from knowledgeable and/or interested organizations and individuals. (Appendix 2) Much of the balance of this report combines issues highlighted in the literature with input from our citizens in order to develop recommendations regarding the structure and content of the proposed study.

Four areas of concern are outlined below, with more detailed discussion in subsequent sections. While not exhaustive, it is believed these fairly represent the community’s - and indeed any community’s - questions and concerns.

**Health and Environment:** Uranium mining in the United States has a history of environmental pollution. Virginia’s climate, geology and population density make that history all the more problematic, particularly in light of information indicating there is no safe level of exposure to radiation, radon, and the heavy metals that are associated with uranium mining. See Section 1, beginning on page 5.

**Economic Effects:** The economic effects of initiating uranium mining in a community are unclear. Increases in tax revenue and industry related jobs may be offset by negative impacts on economic development and the costs of containing and monitoring hazardous wastes literally forever. Individuals have an intuitive sense that property values will decline sharply. It seems likely that one group of stakeholders may gain benefits while a different group bears the costs. See Section 2, beginning on page 10.

**Scope and Methodology of the Study:** The credibility of the study will depend upon the independence and qualifications of the research institution, the transparency of the study, the facilitation of public education and participation, the degree to which the study addresses the community’s specific concerns, and the extent to which study conclusions are based upon actual experience. Our citizens endorse the selection of the National Academy of Sciences. See Section 3, beginning on page 12, for suggestions.

**Quality of Life:** Virginia’s Piedmont is a mix of cities, small towns and rural areas. Livestock and agriculture are plentiful; the area has abundant rivers and lakes and streams; fishing, hunting and water sports are popular pastimes. Many people choose to reside in the area because of these natural resources. Any perceived or real contamination would have a devastating effect.
Section 1  Health and Environment

In local discussions of proposed uranium mining, the concern most frequently cited is the fear of negative effects on the health of the people around or downstream from the mining site.

Following are citations from public sources that underscore the validity of these concerns and that lead to the questions and issues outlined in Section 3.

Certain background assumptions appear to be undisputed:

- Uranium mining and milling is associated with hazardous byproducts. Individual studies have confirmed the adverse health effects of these elements in sufficient dosages.
- Uranium mining has caused substantial pollution in other parts of the United States. Dangerous and long-lived pollutants have migrated into and contaminated waterways, aquifers, and groundwater with regularity.
- Virginia has significantly different population density, climate, hydrology and geology compared to most previous and current U.S. uranium mining sites.
- With specific regard to Coles Hill, the area is traversed by numerous streams, which feed waterways that are the source of consumable water for downstream communities. Thousands of area residents rely upon wells for drinking water and for agriculture.

The following citations address environmental and health concerns associated with uranium mining and processing. The source documents are available for review in the appendices.

National Academies of Sciences 2005: (Appendix 3)

There is no safe level of exposure to radiation — even very low doses can cause cancer. Risks from low dose radiation are equal or greater than previously thought.

Radiation causes other health effects such as heart disease and stroke, and further study is needed to predict the doses that result in these non-cancer health effects.

It is possible that children born to parents that have been exposed to radiation could be affected by those exposures.

Every exposure causes some risk and . . . risks are generally proportional to dose.

The U.S. Nuclear Regulatory Commission (NRC) 2006: (Appendix 4)

Uranium mill tailings contain the radioactive element radium, which decays to produce radon, a radioactive gas. The radium in these tailings will not decay entirely for thousands of years. The mill tailings pose a potential hazard to public health and safety.

EPA Technical Report 2008: (Appendix 5)

Underground mines that intersect an aquifer could contaminate the aquifer, as could large surface mines with deep pits. In areas with greater precipitation or near-surface unconfined aquifers.... contaminated
water may more easily reach the groundwater, where it could be transported and pose significant cancer
risks to people who obtain their drinking water from the aquifer.

Because radon-222 has a half-life of approximately 3.8 days, it has the opportunity to travel a significant
distance in the atmosphere before decaying. U.S. EPA (1983) states that the health of populations living
at a distance greater than 80 km from a tailings pile might be affected.

**The Colorado Medical Society 2007:** (Appendix 6)

In areas where uranium mining has been performed in the past there is documented increase in rates of
testicular and ovarian cancer, leukemia, childhood bone cancer, miscarriages, infant death, congenital
defects, genetic abnormalities and learning disorders in the population living near the mining site.

**The Environmental Protection Agency 2007:** (Appendix 7)

Tailings contain radium, which decays to produce radon. When people breathe air containing radon, it
increases their risk of developing lung cancer. Radon gas can diffuse from the piles into the atmosphere
where it can be inhaled or ingested. The dispersal of tailings by wind or water, or by leaching, can carry
radioactive and other toxic materials to surface or ground water that may be used for drinking water.
Other potentially hazardous substances in the tailings are selenium, molybdenum, uranium and thorium.

**U.S. Public Health Service 1999:** (Appendix 8)

Exposure to high levels of radium results in an increased incidence of bone, liver, and breast cancer. The
EPA and the National Academy of Sciences, Committee on Biological Effects of Ionizing Radiation, has
stated that radium is a known human carcinogen.

Uranium mining results in higher levels of radium in water near uranium mines.

**The British Columbia Medical Association 1980:** (Appendix 9)

Radium 226 (released from uranium tailings) is a superb producer of osteosarcoma (bone cancer).
A U.S. Public Health Service study shows increased bone cancer in communities with 4.2 picocuries per
liter of [dissolved] radium-226 in drinking water, as compared with communities having only 1 picocurie
per liter.

**Pembina Institute: A 2006 Study of the Nuclear Power Industry in Canada:** (Appendix 10)

Releases of radiation and other contaminants through air and water also have an impact on the
surrounding community. The main exposure pathways for radioactivity from tailings are direct gamma
radiation, inhalation of radioactive particulates, and ingestion of radionuclides through the food chain.
While radiation has been shown to accumulate in the biota (flora and fauna) near uranium mines, the
impacts of exposure to the health of the surrounding community are highly contested.

Saskatchewan Health does not study the health impacts of uranium mines on communities near the
uranium mines due to confounding factors such as radon in homes and cigarette smoking. However,
studies have been performed to assess the health of foodstuffs near uranium mines in northern Saskatch-
ewan by toxicology researchers at the University of Saskatchewan.

In one study in this area, tissues from moose and cattle to be consumed as food were collected. The
study concluded that moose and human radiation doses in the Wollaston area were two to three times
higher than in control areas. (Pembina page 38)

**The Navajo Nation 2005:** (Appendix 11)

Many . . . have died as a result of exposure to radioactivity and uranium, whether by mining, dust,
contaminated water or contaminated livestock.
A search of the literature can find additional studies by reputable researchers, governmental agencies, and medical organizations that construct a powerful case for the proposition that pollutants associated with uranium mining are hazardous to human health.

The issue then turns to the frequency with which these pollutants find their way into the environment, and whether or not such occurrences are avoidable. Further citations follow:

**Coloradoans Against Resource Destruction:** (Appendix 12)

Despite using “state-of-the-art technology,” the environment-friendly Smith Ranch received 42 license violations involving surface spills and leaks from December 31, 1999 through May 21, 2007 (WISE - World Information Service on Energy - Uranium Project). On March 10, 2008 Wyoming’s Department of Environmental Quality/Land Quality Division (LQD) issued a Notice of Violation to Power Resources, Inc. (PRI) a wholly owned subsidiary of Cameco Corp for numerous deficiencies at their Smith Ranch-Highland Uranium Project. The seriousness of these deficiencies is apparent . . .

**Pembina Institute 2006 Study Nuclear Power in Canada:** (Appendix 10)

Uranium mining and milling facility surface water discharges have resulted in the contamination of the receiving environment with radionuclides and heavy metals. Effluent from historic and operating uranium mines and mills, particularly uranium discharges, have been determined to be toxic for the purposes of the Canadian Environmental Protection Act by Environment Canada and Health Canada. (Pembina page 23)

The environment and biota in the vicinity of uranium mines and mills has been contaminated with radionuclides particularly via windblown dust from tailings sites. Windblown dust from mine sites and TMFs (tailings management facilities) contains a range of heavy metals. (Pembina page 23)

**Goliad County, Texas, Caller-Times 2008:** (Appendix 13)

Goliad County, Texas has filed a lawsuit against a uranium mining company alleging contamination of drinking water. Three of fifteen wells tested had “alarming” levels of radiation.

**EARTHWORKS 2004 Study Predicting Water Quality at Hardrock Mines:** (Appendix 14)

100% of the mines studied predicted compliance with water quality standards before operations began, while 76% of the mines studied actually polluted ground water or surface water severely enough to exceed water quality standards.

The science of mine water quality prediction is imperfect.

There is an inherent bias toward favorable projections by consultants hired by the mine operator. Models may be “tweaked” to predict outcomes that are required in order to receive regulatory approval to begin operations.

... the transport of pollutants through complex geological and hydrological systems over the longer term...five years to thousands of years...is difficult to predict.

... it is not well known how minerals react in complex systems.

... geology, climate, methods of mining and mineral processing, and mine waste management approaches vary among and within mine operations. These variations limit the degree in which information from one site can be applied to another.

**Virginia Tech researchers who have studied the Coles Hill site in Virginia:** (Appendices 15 & 16)
Uranium is toxic.... In nature, there are deposits that are extremely concentrated and they should be of great concern, as uranium may be transported in solution through ground water activity. But, in nature, things have a way of reaching a ‘steady state’. The Coles Hill deposit, for instance, shows no measurable evidence of leakage into the surrounding soils and rocks.

... how water moves through fractured rock. It’s very complicated. It’s even hard to understand within a single watershed.

There is extensive literature documenting recent spills and environmental degradation that have been occasioned by uranium mining, including mining in the modern era. The frequency of these underscores the difficulty of predicting and controlling these complicated operations, and calls into question the ability of even the best operators, despite assurances, best intentions, regulatory oversight, and current technology, to eliminate these excursions.

Further, the limitations of monitoring systems as a reliable control mechanism are demonstrated by the following references that underscore the difficulty in returning a polluted site to its original condition:

**Bill Von Till of the Uranium Recovery Branch of the NRC:** (Appendix 17)

_What the groundwater community has found over the years is that trying to achieve cleanup to background (pre-existing levels) is virtually impossible._

**Texas Commission on Environmental Quality, Goliad Caller-Times 2006:** (Appendix 17)

Texas Commission on Environmental Quality data for 32 closed _in situ_ mine sites confirms water was not returned to its original condition at any of them.

**Wyoming Department of Environmental Quality, Greeley Tribune 2008:** (Appendix 18)

_Mark Moxley, with the Wyoming’s Department of Environmental Quality, said mining companies are responsible to get water quality levels back to their original background levels for chemicals and elements, but most companies rarely ever do because of the difficulty of meeting that standard._

**U.S. Nuclear Regulatory Commission 2006:** (Appendix 4)

This NRC document notes that the Department of Energy (DOE) initiated the groundwater cleanup phase of the UMTRCA (_Uranium Mill Tailings Radiation Control Act of 1978_) Project in 1991. Fifteen years later, DOE has demonstrated groundwater cleanup compliance to DOE developed standards, not original conditions, at only eight of the initial 18 sites.

**Southwest Groundwater Consulting, LLC (SGC)** (Appendix 19) studied over 50 _in situ_ uranium mines. The following comments have been excerpted from the _Report on Findings Related to the Restoration of In-Situ Uranium Mines in South Texas:_

_The Primary Drinking Water Standard (PDWS) for Uranium is 0.03 mg/l. In all cases, the Amended and Last Sampled Concentrations of uranium (after remediation) exceed the PDWS. (SGC page 4)_

_The higher Amended Restoration Values and the Last Sampled Concentrations are results of the inability of site operators to reduce uranium concentrations based on their respective proposed groundwater restoration programs. This calls into question the operators’ understanding of the geochemistry of the hydrogeologic systems that they are exploiting. (SGC page 4)
The report documents multiple breaches of PDWS across a range of chemicals, the routine raising of the standards by the regulatory bodies in order to facilitate compliance, and the failure in most cases of the operators to be able to achieve even the revised standards.

Discussion:

The environmental problems of the uranium mining industry are a matter of record. A casual survey of the literature turns up myriad accounts of environmental failures. While some of the most egregious violations date to a time when regulation and environmental concerns were minimal, it is not clear that increased scrutiny and improved technologies have proven an adequate remedy. Violations continue as a present day problem, as illustrated by the examples above.

Additionally, there is no analogue to mining uranium in Virginia. The state’s climate and hydrogeology pose a heretofore untested set of circumstances for the industry. The population density around the known sites raises the stakes. Virginia Uranium Inc. acknowledges this in their prospectus when they note that: “Virginia..... has a wetter climate than most states in the western United States where uranium mines have been historically located, and Virginia has more people per square mile than do Western States. Accordingly there is the potential for magnification of environmental liabilities such as water pollution.” (Emphasis added) (Appendix 20)

With regards to the specific effect of environmental pollution on surrounding populations, no definitive long-term studies have been conducted. Doug Brugge, who has a Ph.D. in cellular and developmental biology and a M.S. in industrial hygiene from Harvard University, is currently an associate professor in Public Health and Family Medicine at Tufts University School of Medicine, and is involved in original research on the health effects of uranium mining and processing, spoke recently in Pittsylvania County and shared his view that “More public health research about community exposure to uranium mines and mills is needed as newer studies are adding new concerns rather than alleviating them.” (Appendix 21)

Like Dr. Brugge, numerous research and academic organizations . . . several quoted above . . . have concluded that exposure to the radiation and byproducts of uranium mining and milling can indeed be harmful. Others have found no harm from exposure to uranium mining, and still others have found the evidence inconclusive. In the Technical Report referenced in Appendix 8 the EPA concluded:

Some studies of risks to human health from uranium mills have been conducted in the last several years (Boice et al 2007; Pinkerton et al 2004; Boice et al 2003). The authors reported no increases in mortality to some statistically significant increases in mortality for some diseases. However, all three studies share problems of limited size and control for confounding factors, such as lack of smoking data, specific exposure data, and population migration. Thus, the results of the studies are uninformative about the potential risks from uranium mills.

Some might embrace this lack of consensus as proof that there are no proven public health effects. This is uncomfortably similar to the position taken by the tobacco industry for many decades. It is important to remember that absence of evidence is not evidence of absence.

The references offered above suggest:

- There is evidence of the toxicity of uranium and its byproducts to humans and animals. The lack of credible, controlled, long-term research leaves important questions unresolved.
- These toxic products can find their way into the environment as a result of the mining process.
• Regulations have proven ineffective. Predictive models have inherent limitations and have not proven reliable. Violations of permitted standards have been frequent.

• Contaminated water systems have proven difficult or impossible to restore to pre-contamination standards.

Some have suggested that new technologies and heightened scrutiny have eliminated the industry’s historical deficiencies. All agree with the need to protect the environment and public health. Our citizens have expressed to us a desire to get all of the known facts and the existing science in front of the public. They have a sense that the science is uncertain and incomplete, and they reasonably ask that it be credibly demonstrated that successful, zero-pollution operations do actually exist, and that those practices can be reliably transferred to Virginia. The prevailing view is that retaining the moratorium offers no risk and should be the default option. They respectfully suggest the burden of proof rightly belongs on those who wish that situation be changed.

Section 2 Economic Issues

The previous section dealt with potential environmental and health consequences. There are also economic effects to consider.

Taxpayers have paid a steep price. This is not solely due to decades-ago production. Consider the example cited earlier of the “state-of-the-art” Smith Ranch - Highland Uranium project in Wyoming. In 2008 the Wyoming Land Quality Division (LQD) noted:

“Considering that reclamation will take several times longer, require at least twice the staff with higher wages and require much greater investments in infrastructure than PRI (Power Resources, Inc.) has estimated, a realistic reclamation cost estimate for this site would likely be on the order of $150 million, as compared to PRI’s current calculation of $38,772,800. PRI is presently bonded for a total of only $38,416,500. No bond adjustments have been made since 2002.” (Appendix 12)

Thomas Power has a Ph.D. in economics from Princeton, is currently Research Professor and Professor Emeritus at the University of Montana, and has submitted a 2008 report titled “An Economic Evaluation of a Renewed Uranium Mining Boom in New Mexico.” Portions of that report are excerpted here and in Appendix 22.

Regarding public costs, Dr. Power notes: (Appendix 22)

The costs associated with trying to clean up the persistent radioactive waste and other pollution associated with past uranium mining across the United States provide a stark reminder that uranium mining is not an environmentally benign activity. Up through 1999 the federal government had spent about $1.5 billion to reclaim 24 “inactive” or abandoned uranium mills and tailings that were the legacy of the nation’s nuclear weapons program through 1970. As of 2003 that total topped $2 billion. (Power page 29)
It is almost unavoidable that future mining will release enormous amounts of additional radioactive waste that will require costly remediation efforts. The public, no doubt, will have to shoulder some of that burden too. (Power page 30)

Taxpayer funded remediation will likely be necessary for some significant part of this future cleanup too, just as it has for remediation of past mining and milling sites in New Mexico. (Power page 30)

Some of the environmental costs associated with uranium and other metal mining are nearly permanent in character. Large open pits cannot be realistically reclaimed. Some of the chemical and biological processes triggered when millions of tons of metal ore are brought to the surface and exposed to air and water or where air and water are brought to underground ore deposits cannot be easily stopped. They can only be controlled by perpetual treatment. When the chemical processes used in ISL (in situ leaching) mining processes escape their intended geological formations or the hydrology turns out to be more complicated than expected, it is nearly impossible to contain them and return the groundwater to its previous condition. In general, American ISL uranium mining operations have not been able to return groundwater to its pre-mining condition. Uranium mining brings both short- and long-lived radioactive material to the surface, increasing human exposures. (Power page 55)

Additional examples are readily searchable. Taxpayers have paid, and are continuing to pay, enormous sums for remediation and/or reclamation of these sites. It has been noted that containment and monitoring of closed sites literally must be maintained forever, given the life of the materials is measured in millennia.

For communities, the issue is complex. Economic benefits are associated with the establishment of any new business. However, many associate uranium with a health risk. It is reasonable to consider whether such a perception will have a negative effect on economic development and some existing businesses. Experience has shown that rural areas already have difficulty attracting professional and executive personnel. Local economic development executives have expressed the view that an operating uranium mine in the area will be another obstacle in that regard.

Dr. Power notes: (Appendix 22)

Industry claims (regarding benefits) are a gross exaggeration built around indefensible economic assumptions. (Power page 1)

Important environmental and social costs must be considered when evaluating the commercial economic benefits of renewed uranium mining. Uranium mining has most of the same near-permanent environmental costs that metal mining in general has and, because of its radioactive character, uranium poses some additional public health concerns. Substantial natural resources, such as groundwater, have been irreparably contaminated by uranium mining and therefore cannot be considered as a resource to support future economic growth in the area. (Power page 2)

In sum, the economic impacts of a renewed uranium boom would be quite modest at best. At the state level the impact would be almost imperceptible. At the local level it would make a difference, boosting both county revenues and county costs to deal with the impacts of renewed mining, but would not in any sense transform the local economies. In both cases the impact would be temporary, until uranium mining retrenched. (Power page 4)

Uranium mining, like all metal mining, is a landscape-intensive activity that almost always has had significant negative impacts on the natural environment. That means that it has the potential to damage
one part of the local economic base, environmental quality, while developing another, the mineral deposit. To the extent that the environmental damage could be significant and near permanent while the mineral development, in contrast, is a relatively temporary “boom,” significant public economic policy issues are raised. (Power page 5)

For individual property owners the situation is clearer. Most have expressed their view that property values will decline as a result of proximity to a uranium mine. Whether the risk is real or perceived, many people will not choose to live close to such an operation.

The Pembina study noted that uranium mining operations involve extensive dewatering, with impacts on groundwater and surface water storage and flows. (Appendix 10, Pembina page 7) As would be true throughout much of the Piedmont, property surrounding Coles Hill is used as farmland and pasturage. Crops and livestock are highly dependent on available water. In addition, thousands of people obtain their drinking water from wells. Loss of access to adequate supplies of consumable water, for whatever reason, would render their property worthless.

As with environmental and health issues, our citizens have a view that the moratorium was instituted and maintained for a reason; that retaining the moratorium protects them from harm caused by the prohibited activities, and that any decision that reverses that twenty-five year moratorium should be studied very carefully indeed.

Section 3 Scope and Methodology of the Study – Suggestions

Our recommendations as to the proposed study flow from the research noted above and from discussions with organizations and individuals who possess expertise and/or an interest in the issue of uranium mining in Virginia.

In general, it seems prudent that a study might be conducted in two phases:

- First, ascertain whether there are any safe and nonpolluting uranium mines operating anywhere. If that minimal threshold cannot be achieved, the study should be discontinued and the moratorium maintained.

- If there are in fact successful operations, consider the economic and social implications of the operation on the surrounding communities. Are they beneficial or harmful to the broader community? If they are harmful, the study should be discontinued and the moratorium maintained.

- Second, if safe, beneficial operations are found, can those be emulated successfully in Virginia, given the climatic and hydrogeological characteristics of the state, and the population density surrounding many of its potentially viable uranium deposits?

The credibility of the study will depend on its scope and methodology. Research must be comprehensive, incorporating information from a wide range of locations that have experience with uranium mining. Initial research should look at environmental, health, social and economic effects and determine whether or not there is convincing evidence that safe and successful uranium mining exists, without detrimental effects to the surrounding community. If affirmative, a second study should be undertaken to evaluate the ability to transfer proven uranium production techniques to the Commonwealth of Virginia. This second study must address desirable environmental standards,
Virginia’s unique hydrogeology and climate, the historical failure of predictive modeling and regulation, and the fact that there may be economically viable uranium deposits in other, even more densely populated areas of the state.

We recommend that the Subcommittee ask the Virginia Center for Coal and Energy Research (the Center) to contract with the National Academy of Sciences (NAS) for an initial study that focuses on recent evidence regarding the “modern” uranium industry.

Virginia should study and learn from actual experiences with all types of mining over the past twenty years at the many known, regulated sites worldwide. A complete study should examine all of these sites, including all three methods of extraction: open pit, underground, and in situ leaching. This study should include the perceptions of, and the effect on, the communities in proximity to these operations.

Our citizens expect engineering based on demonstrated performance. They expect evidence that uranium mining, millings, and tailings containment are being done “safely” in real life – real life which includes severe weather events, economic pressures, human error, and acts of God. They expect researchers to find and assess available environmental quality and health data from current regulated mines, mills, and tailings cells.

Only if there is convincing evidence of uranium mining, milling and tailings facilities operating without detrimental effects should there be a second study, focusing on Virginia and its unique conditions.

Parameters for Study 1: Consider Existing Sites and Mining Communities.

It bears repeating that, if during the course of the first study, no facility is found to be operating consistently within its original permitted standards, that finding would seem sufficient to conclude that current technology and practices are not capable of maintaining a conforming operation. The study should be ended and the moratorium maintained.

If the study indicates that consistent environmental compliance is the norm, then the research institute should continue the study and consider the health, economic and social effects on surrounding communities.

For each operating site studied, the research institution should develop and consider, at a minimum, the following information:

1. What environmental quality standards and monitoring procedures are in place?
2. What are the methods of mining, milling, and tailings containment?
3. What technological improvements are in place compared to legacy operations?
4. What are the site conditions: geology, hydrology, geochemistry?
5. What is the climate: rainfall extremes, severe weather events, net precipitation or evaporation?
6. What are the population density and the population’s proximity to the site?
7. Who regulates the site?

8. Are there benefits of uranium mining to the individuals in the area and/or to the community as a whole? Outline and quantify those.

9. Are there measured changes associated with mining in environmental quality: water, air, soil?

10. Were initial permitted standards violated?

11. Were violations found by the operator’s monitoring systems, by off-site evidence, or by complaining property owners?

12. Have there been repeat violations?

13. Have the initial permitted standards been modified since mining operations were initiated?

14. If there has been remediation, was the environment returned to the original permitted standards?

15. What remediation, monitoring, or reclamation costs have been borne by the public?

16. Has there been an effect on surrounding and/or downstream and downwind property values?

17. Has there been an effect on the cost of health insurance and homeowner’s policies?

18. Have there been adverse economic effects on: crops, dairy milk, other food sources, livestock, pets, fish, or wildlife? For those private individuals whose property or health have been affected, what recourse have they had? Are they satisfied?

19. Has there been litigation by surrounding landowners or others?

20. What has been the effect on regional economic development of introducing a uranium operation?

21. Is there evidence that business or professional prospects consider the proximity of uranium mining as a negative when considering locating in the area?

22. Is there evidence that businesses or individuals have relocated away from the area where mining operations have been proposed or initiated?

23. Have any lands or waterways surrounding the site been restricted from public use in any way?

24. What is the effect of mining operations on the water tables?

25. Do blasting and mining activities release large quantities of radon from the rock? Do large explosions associated with this blasting throw up clouds of radioactive dust to float downwind?

26. Is there divisiveness within communities, regions, or states due to controversy regarding uranium mining and waste storage?

27. Do realtors find that the presence of the uranium industry influences people’s decision whether to move to the area?

28. Given the volatility of the uranium market, is tax revenue stable and predictable?

Once data has been gathered, the research institution should address the following issues and questions:

1. Have there been increases in measureable toxins in the environment surrounding any operation?
2. Are there any examples of uranium mines, mills, and tailings facilities that have operated without environmental violations?

3. If there are examples of sites operating without environmental violations, what would happen if the sites were flooded or subjected to hurricane force winds?

4. Given the history of environmental failures in the industry, does it make any sense to trust that current technology is sufficient to guarantee that any given uranium mining and processing operation can operate safely - with zero off-site excursions - over the life of the mine?

5. Given that safety and health depend on conformance to appropriate environmental standards, what has been the industry’s recent record of compliance with initial permitted standards?

6. Have there been cases where standards have been relaxed because of an inability to operate within the permitted standards? When and where?

7. Regarding the effects on human health, reconcile the diverse standards promulgated by the various regulatory and interest groups.

8. Are there known or suspected health effects on the surrounding animal or human population from operations at any of the mines studied? What research has been done?

9. Have there been any studies as to the long-term health effects on populations surrounding uranium mining operations?

10. What meaningful data is available regarding long-term and cumulative health impacts or potential health impacts for a 50-mile radius for: 1) workers, 2) general population, 3) children, 4) pregnant women, 4) elderly, and 5) immune compromised? Is there active research?

11. Would there be a health effect if dust from operations or a tailings pile blew downwind and settled on pasturage or crops or water supplies?

12. Should residents who consume local deer and livestock and crops be concerned?

13. Would there be a health effect if heavy metals or other byproducts from mining found their way into drinking water or agricultural water?

Recurring questions from our citizens include the following:

1. Is there a health or economic risk to people whose water intake is downstream of a site?

2. Is there a health or economic risk to area residents who depend on wells for consumption and for agricultural purposes?

3. Is there a health or economic risk to area property owners?

4. Is there economic risk to businesses that depend on the recreational resources in the area?

5. How will a farmer or homeowner be compensated if their source of water becomes unusable or unavailable?

6. Who is responsible if property values do fall?

7. What guarantees exist to insure that taxpayers bear no cost of monitoring, remediation, or reclamation of the site?

8. How will damage claims be investigated and compensated?
9. What are the beneficial and negative economic impacts on distinct groups and interests: 1) owner and investors, 2) workers, 3) near-by residents, 4) area farmers, 5) local communities, 6) recreation, 7) tourism, 8) historic and archaeological resources, 9) existing businesses/schools/institutions, 10) regional economic development, 10) downstream water users, and 11) state governments?

10. Are there health or economic risks due to transportation of waste products, ore, and uranium?

11. Are area residents disturbed by noise and/or dust from blasting? If so, at what maximum distance?

12. How can area residents be certain their water and air are not being adversely affected before damage is done?

13. What are the economic impacts of perceived risk or stigma associated with uranium and mining?

14. Does uranium mining provide jobs to local citizens, and at what average wage?

15. What is the expected net financial effect on local and state governments?

16. What happens if mining proceeds and all the assurances prove to be wrong? Who will unring the bell?

17. If my water quality is reduced, how will I know if it is adversely affecting my children’s long term health?

18. My children play outdoors, and swim in the creeks and rivers. How do I know they will not be affected?

19. Given the research that indicts predictive modeling, the complex hydrogeology in Virginia, the severe weather events, the population density, the criticality of groundwater, and the repeated failures of the uranium mining industry to meet regulatory standards, why should Virginia’s citizens be expected to rely on the assurances and models of a for-profit company and its paid consultants?

20. How much is peace of mind worth?

At the conclusion of Study 1, it would seem that three propositions must be considered:

- Can we be certain that a uranium operation would not present a danger to the community or the environment?
- Can we be certain that a uranium operation would not have adverse economic consequences to the community or other property owners?
- Can we be certain that a uranium operation would not create a burden to current or future taxpayers?

Only if each of these is answered in the affirmative should a second study be undertaken, to ascertain whether such operations could be successfully emulated in conditions unique to Virginia. Otherwise, the study should be discontinued and the moratorium maintained.

Parameters for Study 2: Consider Virginia.

If a second study is undertaken, it should consider:
• Environmental quality standards that would be acceptable to Virginians living in proximity to a uranium mining operation
• Demonstrated reliability of computer modeling as compared to empirical data
• Physical conditions in Virginia relative to the applicable technology and practices being proposed or considered

A. Environmental quality standards for Virginia

Virginia Uranium Inc. has promoted an independent, scientific study to determine whether uranium can be mined “safely” in Virginia. Our group does not question VUI’s integrity and good intentions. We are confident they would endeavor to operate in a safe and environmentally appropriate manner. The questions that have arisen are with reference to whether the current technological state of the industry lends itself to reliably safe operations 24/7/365, for decades into the future, and who defines what is meant by “safe.” As with the airline industry, 99.99% safe is not acceptable when the consequences of even one random failure are potentially devastating. Legislators should be aware that most people believe the word “safe” implies a true absence of harm. Citizens living in proximity or downstream from a uranium mining operation have no interest in the abstract concept of “acceptable” levels of risk. As they point out, acceptable to whom? The question is why the present circumstances should be changed to benefit a private company if that change introduces incremental risk to their health or economic well being. People are as important as spotted owls.

Standards for heavy metals and other toxins, as well as limits for radon gas and radiation exposure, should protect health. Scientists vigorously debate “safe” levels of pollutants and appropriate health-protective standards. As long as there is debate, prudence dictates that Virginia must set standards at the most protective level.

These standards must be developed for uranium, uranium’s decay products, such as thorium, radium, radon gas and its decay products, as well as leachate chemicals used in milling or in situ leaching. Virginia currently has a non-degradation standard for water. The 1985 Virginia Coal and Energy Commission affirmed this standard and required that no water from a uranium mine or mill site be released to surface water. The 1985 Commission debated other standards in its final report. The current commissioners should thoroughly review the work of their predecessors in the 1980s and address the standards issue.

B. Reliability of computer models

Virginia should be wary of computer modeling of predicted future outcomes. A recent study comparing such predictions against actual environmental impacts found a 76% failure rate among computer models used to predict water quality at hard rock mineral mines. (Appendix 14) Modeling techniques need validation. Actual experience in many uranium operations have found initially predicted standards have been exceeded.

C. Physical conditions in Virginia and applicable technology and methods

There has been much discussion about the physical differences in Virginia compared to current existing mining sites, and the implications of those differences. The potential challenges posed by these differences are significant. As noted earlier, VUI comments on this in the “Risks” section of their prospectus. (Appendix 20)
Consider:

- Virginia experiences 35-45 inches of annual rainfall, increasing the difficulty of containing runoff from tailings and from the actual mining operations.
- Virginia is subject to hurricanes and tropical storms, requiring containment in the face of hurricane force winds and dramatic deluges. Hurricane Camille dropped 29 inches of rain in Virginia in 12 hours in 1969 and an unnamed storm dropped 27 inches in 1995. The challenge of controlling contaminated water in the face of such forces should be a serious concern. To see a video of flooding around Coles Hill after Hurricane Fran dropped 10-12 inches of rain in 1996, go to http://www.youtube.com/watch?v=F7mcUYAi_O4
- Creeks, streams, and rivers flow throughout the Virginia Piedmont, including the Coles Hill site. Much of the land surrounding potential sites is a combination of densely populated areas and active agriculture. Much of the consumable water is derived from wells. Throughout the state, there are known uranium deposits upstream from municipal water supply points. (Appendix 1)
- As cited by the Virginia Tech researchers in Appendix 16, the geology of the Coles Hill site is such that the uranium is currently “bound” in the rock. A legitimate question is what will happen to that uranium when these chemical bonds are destroyed by blasting, crushing, and pulverizing the ore and exposing it to air and water and other solvents? It seems unlikely that all of these chemical elements can be stopped from migrating into the air and the groundwater. As has been cited by several experts, understanding how elements migrate through fractured rock is complex.
- Depending on the method of mining used, there is extensive experience that demonstrates mining operations can consume enormous amounts of water, significantly affecting the water table and water flows. Reducing the availability of water in an area that already experiences periodic droughts, and that uses groundwater and wells for human consumption and agriculture, is a significant concern.
- Certainly in Halifax County, and perhaps throughout the Piedmont, thousands of people grow, sell, and consume their own crops and livestock. Many more hunt and consume game. As the Pembina study showed (Appendix 10), radioactive elements accumulate in the flora and fauna in the vicinity of mine and mill sites and enter the food chain.

One would reasonably expect that decisions should be based on actual plans, such that the Commission and the research institution can consider accurately what is actually being proposed, as opposed to concepts. Such an approach would allow the public to understand how the operators intend to address site specific issues and the concerns that have been outlined throughout this report. A totally transparent and credible plan, subject to public and legislative scrutiny and debate, would be invaluable in reassuring area populations that the Commission’s study is thorough.

At the conclusion of Study 2, the Commission’s recommendation to the General Assembly should be guided by the hard evidence and actual experience as outlined in the scientific study. A public policy change of this magnitude should not rest upon unproven assumptions or unverifiable assurances:
If the Commission has **any reasonable doubt** as to the possibility of adverse environmental, health, or economic effects to Virginia citizens that might be caused by Virginia allowing uranium mining operations, the Commission should recommend the moratorium remain in place.

If the Commission is convinced that uranium production in Virginia would meet stringent health-protective environmental standards and not be detrimental to the community and regional economies and quality of life, then the Commission should consider under what conditions the Commission would recommend lifting the moratorium, including such stringent health-protective environmental quality standards as non-degradation of water and prohibition of release of processed mine and mill wastewater to surface waters. These conditions should be a required part of any draft legislation that would establish uranium mining regulations and end the moratorium. The conditions should clearly specify adequate bonds to cover the costs of reclamation, remediation, reconstruction of tailings containment cells, compensation for harm or injury, and monitoring in perpetuity. The conditions should also stipulate adequate regulatory staff and funding, close monitoring, strict enforcement, severe penalties, and safeguards that will provide protection or prompt and adequate compensation if a permitted operation fails and contributes to harm or injury of people or contributes to damage or loss of property.

**Conclusion**

A knowledgeable official recently speculated that a study may say that, **conceptually**, regulations can be written to describe uranium mining in Virginia with an acceptable level of risk. On paper, policy makers can define stringent regulations that suggest that uranium mining is **conceptually, theoretically, hypothetically** safe.

Our citizens accept that the **idea** of safe mining is possible. However, prudence and experience demand a thorough consideration of **what could happen in practice if human beings undertake uranium mining, milling, and tailings storage in Virginia**. For this, Virginia would do well to look squarely at existing operations and communities and face the realities of today’s uranium industry. The results of a study will depend heavily on whether commissioners and researchers look beyond good ideas and good intentions and focus on evidence from experience. It is not rational, realistic, or scientific to presume that mine operators in Virginia - however ingenious, honest, professional, hard-working, caring, responsible, and patriotic they may be – would do better than other experienced professionals already involved in modern, regulated uranium mining. Virginia’s climate and population density would add considerably to both the risk of failures and the consequences of those failures.

Virginia’s uranium debate is not about the cost-benefit of remedying an existing problem. It is about whether the state should **create** a situation that carries with it the potential for real risks to real people and the environment, as well as affecting people’s right to the safe enjoyment of their property. In considering whether to lift Virginia’s moratorium, legislators will make a decision regarding an
‘acceptable’ level of risk – but acceptable to whom? To a single mother of two small children living a mile from Coles Hill on land that once belonged to her grandparents? To a dairyman and his family and hundreds of cows three miles and a light breeze from the proposed mine? To community citizens wondering if it’s safe to drink the water, shower, swim, garden, buy local produce, fish, hunt, start a business, or buy a home? In considering whether to enable a voluntary act by a private company, legislators will decide what involuntary and unwanted risks to impose on private citizens who want nothing more than to live peacefully, safely and without worry in their own homes and on their own land.

Respectfully Submitted to the Virginia Coal and Energy Commission

By the Halifax County Chamber of Commerce Uranium Study Group

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Appendix 1        Piedmont Environmental Council Maps

http://www.pecva.org/anx/index.cfm/1,391,1323,0,html/Uranium-Mining-Maps

The Piedmont Environmental Council created the following maps:

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<thead>
<tr>
<th>Map Description</th>
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<td>Water Supplies Potentially Impacted by Uranium Mining in Virginia - Senate Districts</td>
<td>22</td>
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<td>Water Supplies Potentially Impacted by Uranium Mining in Virginia - House Districts</td>
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<td>Drinking Water Sources Downstream from Proposed Coles Hill Uranium Mining Site</td>
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<td>Properties with Former 1980s Uranium Mining Leases and Downstream Water Supplies</td>
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*Note: This last map shows acreage leased in 1980s in Virginia’s Northern Piedmont region. Currently, there is no map showing more than 35,000 acres where mineral rights were leased in Pittsylvania County and some in Henry County in the 1980s.*
Water Supplies Potentially Impacted by Uranium Mining in Virginia Showing State Senate Districts

Map created by PECC for presentation purposes only. Data source: County Governments, VA Dept of Health. Although efforts have been made to verify data, accuracy is not guaranteed. For information, please visit www.peccva.org.
August 26, 2008 | WARRENTON | Jor
Drinking Water Sources Downstream from Proposed Coles Hill Uranium Mining Site
[Southern Piedmont]
Properties with Former 1980s Uranium Mining Leases and Downstream Water Supplies

[Northern Piedmont]
Organizations and individuals who met with the study group or gave public presentations:

• Ward Burton Wildlife Foundation
  – Tom Inge, Executive Director

• Bob Burnley, Former Executive Director
  – Virginia Department of Environmental Quality

• Virginia Uranium, Inc.
  – Walter Coles, Sr., Chairman; Henry Hurt, Investor; Patrick Wales, Geologist

• Piedmont Environmental Council
  – Todd Benson, Staff Attorney – Spoke in Pittsylvania County on the uranium issue

• Southside Concerned Citizens
  – Jack Dunavant, Gregg Vickrey, Wallace Nunn, George Stanhope – Board Members

• Southern Environmental Law Center
  – Kay Slaughter, Senior Attorney

• Doug Brugge, PhD, MS, Associate Professor in Public Health and Family Medicine at Tufts University School of Medicine – Spoke in Pittsylvania County on the effects of uranium mining and processing on public health

• Division of Mines, Minerals, and Energy
  – Thomas Bibb, Engineering Manager, Division of Mineral Mining; William Lassetter, Manager, Economic Geology
http://www.nirs.org/press/06-30-2005/1

Nuclear Information and Resource Service (NIRS)

FOR IMMEDIATE RELEASE
June 30, 2005

CONTACT
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All Levels of Radiation Confirmed to Cause Cancer. [Excerpt]

Washington, DC July 30, 2005 The National Academies of Science released an over 700-page report yesterday on the risks from ionizing radiation. The BEIR VII or seventh Biological Effects of Ionizing Radiation report on "Health Risks from Exposure to Low Levels of Ionizing Radiation" reconfirmed the previous knowledge that there is no safe level of exposure to radiation—that even very low doses can cause cancer. Risks from low dose radiation are equal or greater than previously thought. The committee reviewed some additional ways that radiation causes damage to cells.

Among the report's conclusions are:

- There is no safe level or threshold of ionizing radiation exposure.
- Even exposure to background radiation causes some cancers. Additional exposures cause additional risks.
- Radiation causes other health effects such as heart disease and stroke, and further study is needed to predict the doses that result in these non-cancer health effects.
- It is possible that children born to parents that have been exposed to radiation could be affected by those exposures.
- The "bystander effect" is an additional, newly recognized method by which radiation injures cells that were not directly hit but are in the vicinity of those that were. "Genomic instability" can be caused by exposure to low doses of radiation and according to the report "might contribute significantly to radiation cancer risk."
- These new mechanisms for radiation damage were not included in the risk estimates reported by the BEIR VII report, but were recommended for further study.

The Linear-No-Threshold model (LNT) for predicting health effects from radiation (dose-response) is retained, meaning that every exposure causes some risk and that risks are generally proportional to dose. The Dose and Dose-Rate Effectiveness Factor or DDREF which had been suggested in the 1990 BEIR V report to be applied at low doses, has been reduced from 2 to 1.5. That means the projected number of health effects at low doses are greater than previously thought. RADIATION RISKIER THAN THOUGHT--RISKS TO PUBLIC and NUCLEAR WORKERS

The BEIR VII risk numbers indicate that about 1 in 100 members of the public would get cancer if exposed to 100 millirads (1milliGray) per year for a 70-year lifetime. [1] This is essentially the US Nuclear Regulatory Commission's allowable radiation dose for members of the public.

In addition, 1 in about 5 workers [2] would get cancer if exposed to the legally allowable occupational doses [3] over their 50 years in the workforce. These risks are much higher than permitted for other carcinogens.

Specifically, the US Nuclear Regulatory Commission allows members of the public to get 100 millirems or mr (1 milliSievert or mSv) per year of radiation in addition to background. The BEIR VII report (page 500, Table 12-9) estimates that this level will result in approximately 1 (1.142) cancer in every 100 people exposed at 100 mr/yr which includes 1 fatal cancer in every 175 people so exposed (5.7 in 1000).[4]

...
Fact Sheet on Uranium Mill Tailings [Excerpt]

Background

In the early 1980s, the price of uranium fell due to a lack of orders for new nuclear power plants in the U.S. and the importing of uranium from other countries. As a result, U.S. uranium mills were shut down or had their operations scaled back. Recently, the price of uranium has rapidly increased from $9.70 per pound in 2002 to over 90 per pound in 2007. Due to this price increase, there have been numerous inquiries about the licensing of new uranium production facilities. Uranium mill tailings contain the radioactive element radium, which decays to produce radon, a radioactive gas. The radium in these tailings will not decay entirely for thousands of years. The mill tailings pose a potential hazard to public health and safety.

To provide for the disposal, long-term stabilization, and control of these mill tailings in a safe and environmentally sound manner and to minimize or eliminate radiation health hazards to the public, Congress enacted the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA). This Act established two programs to protect the public and the environment from uranium mill tailings.

The UMTRCA Title I program established a joint Federal/State-funded program for remedial action at abandoned mill tailings sites where tailings resulted largely from production of uranium for the weapons program. Now there is Federal ownership of the tailings disposal sites under general license from the Nuclear Regulatory Commission (NRC). Under Title I, the Department of Energy (DOE) is responsible for cleanup and remediation of these abandoned sites. The NRC is required to evaluate DOE’s design and implementation and, after remediation, concur that the sites meet standards set by the Environmental Protection Agency (EPA).

The UMTRCA Title II program is directed toward uranium mill sites licensed by the NRC or Agreement States in or after 1978. Title II of the Act provides:

- NRC authority to control radiological and non-radiological hazards.
- EPA authority to set generally applicable standards for both radiological and non-radiological hazards.
- Eventual State or Federal ownership of the disposal sites, under general license from NRC.

There are five Agreement States - Colorado, Illinois, Texas, Utah and Washington – that license "Atomic Energy Act section 11e.(2)"; material (i.e., certain mill tailings and related waste containing thorium or uranium). NRC is required to make a determination that all applicable standards and requirements have been met by uranium mills before termination of their Agreement State license.

Regulations and Standards

UMTRCA charged the EPA with the responsibility for issuing generally applicable standards for control of uranium mill tailings. In 1983, EPA issued standards for both Title I and Title II sites. In November 1985, as mandated by UMTRCA, NRC changed its regulations in 10 CFR Part 40, Appendix A to be consistent with EPA Title II standards. Since 1985, various changes have been made to Part 40 for the Title II sites. In 1995, EPA issued final Title I groundwater standards.
**Discussion**

**Title I - Reclamation Work at Inactive Tailings Sites** - Under the Uranium Mill Tailings Remedial Action (UMTRA) Project, DOE was charged with completing surface reclamation at 24 inactive uranium mill tailings piles. Two sites in North Dakota were withdrawn and tailings from some sites were combined, resulting in 19 tailings disposal sites. These piles range in size from approximately 60,000 to 4.6 million cubic yards of material. Except for a site at Canonsburg, Pennsylvania, and an associated property at Burrell, Pennsylvania, the inactive sites are located in western states. In 2001, the Atlas site near Moab, Utah was transferred to DOE for remediation under Title I of UMTRCA.

In 1993, DOE became a licensee of NRC under the general license provisions of 10 CFR 40.27. This transpired when NRC concurred in the completion of construction and surface cleanup at the Spook, Wyoming, inactive tailings site and accepted DOE’s plan for long-term surveillance at the Spook site. By August 1999, 17 more sites were completed and brought under the general NRC license, including sites at Ambrosia Lake, New Mexico; Burrell, Pennsylvania; Canonsburg, Pennsylvania; Durango, Colorado; Falls City, Texas; Green River, Utah; Gunnison, Colorado; Lakeview, Oregon; Lowman, Idaho; Maybell, Colorado; Mexican Hat, Utah; Naturita, Colorado; Rifle, Colorado; Salt Lake City, Utah; Shiprock, New Mexico; Slick Rock, Colorado; and Tuba City, Arizona. The only remaining sites are those at Grand Junction, Colorado and Moab, Utah. Legislation allows a portion of the Grand Junction site to remain open until 2023 to accept additional waste from tailings contaminated properties. DOE has decided to transfer the Moab mill tailings to a site near Crescent Junction, Utah, and is preparing a remedial action plan for NRC concurrence describing its proposed action.

DOE initiated the groundwater cleanup phase of the UMTRA Project in 1991. It has completed all of the 20 scheduled baseline risk assessments for the groundwater cleanup phase and has transmitted them to concerned parties. Two sites did not have groundwater contamination. DOE has developed Groundwater Compliance Action Plans for demonstrating groundwater compliance at 13 sites and submitted them to the NRC for concurrence. DOE has demonstrated groundwater cleanup compliance at eight of those sites.
Appendix 5  Environmental Protection Agency – April 2008 Technical Report Excerpts

http://www.epa.gov/rpdweb00/docs/tenorm/402-r-08-005-volii/402-r-08-005-v2.pdf

U.S. Environmental Protection Agency
Office of Radiation and Indoor Air
Radiation Protection Division (6608J)
1200 Pennsylvania Avenue
Washington, DC 20460
Published on-line as Vol. 2 of EPA 402-R-05-007, August 2007
Updated and printed April 2008 as EPA 402-R-08-005

Page 3-21 to 3-22
3.6 Migration of Uranium Waste into Groundwater
Chemical and physical processes can enhance or retard the movement of the contaminants into and through an aquifer. Infiltration of water into soil is an example of a physical process, while partitioning of the contaminant between the soil and water is an important chemical process (which gives rise to the soil–water distribution coefficient, Kd). On the Colorado Plateau, where many uranium mines are located, the dry climate limits the available water for transporting the radionuclides and for drinking. Much of the precipitation is lost to evapotranspiration, thus limiting the infiltration, although high intensity precipitation events may contribute to increased infiltration at times. In large parts of the Colorado Plateau, the only usable water available in quantity is from groundwater (U.S. EPA 1983b), particularly in relatively deep confined aquifers, but near-surface aquifers are present in some areas. The impact of small surface uranium mines on most of the groundwater in this region is expected to be minimal. As an example described in more detail below, drilling and sample analysis of a groundwater aquifer located under the Yazzie-312 pit lake found no direct communication or correlation of water chemistry with the overlying lake (Panacea 2002). However, underground mines that intersect an aquifer could contaminate the aquifer, as could large surface mines with deep pits. Also, in areas with greater precipitation or near-surface unconfined aquifers, including higher elevations in the Colorado Plateau, contaminated water may more easily reach the groundwater, where it could be transported and pose significant cancer risks to people who obtain their drinking water from the aquifer.

Appendix IV. Risks Associated with Conventional Uranium Milling Operations [Excerpt]

Introduction

Although uranium mill tailings are considered byproduct materials under the AEA and not TENORM, EPA’s Science Advisory Board (SAB) recommended that EPA present information on uranium mill operations, as well as in situ leaching (ISL) mining operations, to provide a more complete picture of uranium production. While this report focuses on the impacts associated with conventional surface and underground uranium mines, it provides limited background materials, in this and other appendices, on risks associated with uranium milling and ISL operations and wastes generated by those processes, even though they may not be considered TENORM by virtue of their regulation by the NRC and its Agreement States under the Atomic Energy Act and its amendments.

The NRC stated its intent in July 2007 (NRC 2007b) to develop a Generic Environmental Impact Statement (GEIS) on uranium milling which would provide more detailed information and may include more recent information on the impacts of uranium milling. The reader is referred to that document when made available to the public in the future for additional background information and associated risk assessment.

Potential Environmental and Health Issues from Mill Tailings

The wastes produced during the milling process and stored in tailings impoundments are the principal source of milling-related health and environmental hazards. Typical properties of these mill tailings are shown in Table AIV-1. During the milling process, nearly 90% of the uranium contained in the ore is removed, and so the primary radiological concern is the remaining progeny associated with uranium such as thorium, radium, radon, and lead. The actual activity of these uranium progeny can vary depending on the specific methods employed; however, as much as 50-86% of the original activity of the ore is retained in the mill tailings (U.S. EPA 2006). Hazardous stable elements are also extracted from the ore and transferred to the tailings piles, including arsenic, copper, selenium, vanadium, molybdenum, and other trace heavy metals.

### Table AIV-1: Typical Properties of Uranium Mill Tailings

This table displays the chemical and radiological properties of the three classifications of uranium mill tailings (sand, slime, and liquid). Table was adapted from U.S. NRC 1980 and found in U.S. EPA 2006

<table>
<thead>
<tr>
<th>Tailings Component</th>
<th>Particle Size (μm)</th>
<th>Chemical Composition</th>
<th>Radioactivity Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sands</td>
<td>75 to 500</td>
<td>SiO2 with &lt;1 wt% complex silicates of Al, Fe, Mg, Ca, Na, K, Se, Mn, Ni, Mo, Zn, U, and V; also metallic oxides</td>
<td>0.004 to 0.01 wt % U3O8a Acid Leaching: 26-100 pCi 226Ra/g; 70 to 600 pCi 230Th/g</td>
</tr>
<tr>
<td>Slimes</td>
<td>45 to 75</td>
<td>Small amounts of SiO2, but mostly very complex clay-like silicates of Na, Ca, Mn, Mg, Al, and Fe; also metallic oxides</td>
<td>U3O8 and 226Ra are almost twice the concentration present in the sands Acid leaching:b 150 to 400 pCi 226Ra/g; 70 to 600 pCi 230Th/g</td>
</tr>
<tr>
<td>Liquids</td>
<td>c</td>
<td>Acid leaching: pH 1.2 to 2.0; Na+,NH4+, SO42, CI, and PO43; dissolved solids up to 1 wt % Alkaline leaching: pH 10 to 10.5; CO32 and HCO3; dissolved solids 10 wt %</td>
<td>Acid leaching: 0.001 to 0.01% U; 20 to 7,500 pCi 226Ra/L; 2,000 to 22,000 pCi; 230Th/L Alkaline leaching: 200 pCi 226Ra/L; essentially no 230Th (insoluble)</td>
</tr>
</tbody>
</table>

a U3O8 content is higher for acid leaching than for alkaline leaching

b Separate analyses of sands and slimes from alkaline leaching process are not available. However, total 226Ra and 230Th contents of up to 600 pCi/g (of each) have been reported for the combined sands and slimes.

c Particle size does not apply. Up to 70 % vol. of the liquid may be recycled. Recycle potential is greater in the alkaline process.

The five on-site environmental pathways through which these tailings impoundments pose a risk are represented schematically in Figure AVI-3. In addition to the on-site scenarios, tailings have also been taken off-site and used as an inexpensive building material by some local populations. Each of these hazard pathways is listed below and the associated risks are discussed later.

(i) The release of gaseous radon-222 to the atmosphere and subsequent inhalation

(ii) Possible dust loading of contaminants from the impoundment due to natural wind conditions

(iii) The localized effect of direct external gamma radiation exposure from the tailings impoundment
(iv) Ground seepage and subsequent contamination of local aquifers, which has the potential to affect the water supply

(v) Dam failure due to erosion or natural disasters (flood, earthquake, etc.)

(vi) Improper use of tailings as a building material

All six of these hazard scenarios can apply to the general public and, with the exception of building materials, to the plant workers themselves. In addition, plant workers have added risks associated with accidents that may occur within the mill. The additional issues associated with workers are discussed in a separate section.

Figure AIV-3: On-Site Accident and Risk Scenarios Associated with Uranium Mill Tailings
This Figure shows a visual depiction of the possible environmental and health related pathways of concern
Source: http://www.wise-uranium.org/ujai.html

(i) Gaseous Radon-222 Inhalation

Radon-222 is an inert radioactive gas that can readily diffuse to the surface of a tailings impoundment where it would be released to the atmosphere. The main hazard of radon inhalation is the damage to the lung from four of its shorter-lived decay products (Po-218, Pb-214, Bi-214, and Po-214). Of particular concern are the two isotopes of polonium (Po-218 and Po-214), because they produce alpha particles, which are approximately 20 times more destructive than gamma or beta radiation. Because radon-222 has a half-life of approximately 3.8 days, it has the opportunity travel a significant distance in the atmosphere before decaying. U.S. EPA (1983) states that the health of populations living at a distance greater than 80 km from a tailings pile might be affected. The radon concentration at the edge of a typical tailings pile is approximately 4 pCi/l (WISE 2004). Using the methodology outlined in Chapter 1 of this report, a year-long exposure under these conditions would correspond to a lifetime risk of lung cancer of 1.1x10⁻².

(ii) Inhalation of Particles from Dust Loading

Dust loading occurs when wind blows over a dried portion of the tailings and dust containing hazardous contaminants is suspended in the air. Dust loading typically becomes a hazard in the post-operational phase of a uranium mill, as the tailings pile begins to dry, and may be exacerbated by any de-watering treatment that is performed to minimize ground seepage [see section (iv)]. The hazards associated with dust loading are dependent on the weather conditions and the amount of dried material that is available for suspension. It has been estimated that a person would have to inhale 2 grams of uranium mill tailings in a year to reach the annual dose limit for the general public (100 mrem). Assuming a continuous exposure and a breathing rate of 0.9 m³/hr, this would correspond to a dust loading of 0.24 mg/m³ (WISE 2004).

(iii) Direct Gamma Exposure

Uranium mill tailings pose an external exposure hazard from radioactivity that is present in the waste. Although milling operations generally remove about 90% of the uranium from the ore, the remaining waste can contain up to 86% of the original radioactivity which is mostly composed of uranium decay products such as radium and thorium. Worst-case external exposures have been estimated to be 0.41 mrem/h, if the subject were standing directly on top of the tailings; for a continuous yearly exposure, this yields a dose of 3.6 rem.

(iv) Groundwater Contamination

Groundwater contamination is so heavily dependent on site-specific parameters, such as the chemical characteristics of the waste products and soil, the location of neighboring aquifers, and the hydrology and geology of the site, that any general numerical risk assessment of groundwater contamination is of limited utility. Groundwater contamination can become a problem if liquid wastes from tailings impoundments seep into the ground and are transferred into shallow local aquifers. Mills employing acid leaching processes are of special concern, because this method renders the waste products more soluble than an alkaline leach process. The
radiological contaminants would likely be pulled out of the seepage water into the immediate soil and so do not have the mobility to move offsite into neighboring aquifers. However, water-soluble non-radiological hazards may be problematic, including molybdenum, selenium, chlorine, sulfate, nitrate, arsenic, lead, and vanadium. An NRC report (1980) concluded that 95% of any possible groundwater contamination would occur while the site was in operation. Also, seepage should be expected unless the tailings pile was built on an artificial liner or impermeable natural clay formations. Besides lining tailings impoundments, milling waste is sometimes dewatered before disposal to reduce the risk of groundwater contamination. Dewatering, however, causes an increase in the rate of radon gas emissions (increase by a factor of 3.4 when comparing wet versus dry tailings) and also makes the pile more susceptible to wind-driven dust loading. An example of dewatering occurs at the White Mesa Mill, where the dry tailings are stored in an approved below-grade disposal cell. This disposal cell is covered with the excavated earth to mitigate the effects of radon emission and dust loading (Hochstein 2003).

Current controls exist as a result of the passage of UMTRCA to eliminate this hazard from existing and future licensed operations, as well as a certain number of previously closed and abandoned mills (see Volume I, Appendix VI for more background information). The EPA has been taking steps to work with the Navajo Nation to identify buildings constructed with uranium mine and mill wastes to assess their radiation risks, and conduct removal or other appropriate actions if necessary.

(v) Tailings Pile Dam Failure

The least predictable risk associated with conventional uranium milling operations is the failure of a tailings dam. A dam might fail because of poor design, natural erosion of the dam, or natural disasters such as flooding, heavy snow fall, tornados, or earthquakes. In the United States, notable dam failures include the 1977 spill in Grants, New Mexico (50,000 tons of sludge and several million liters of contaminated water), and the 1979 spill in Church Rock, New Mexico (1000 tons of sludge and 400 million liters of contaminated water). The second of these noted spill events, Church Rock, is the most notorious. It heavily contaminated the Rio Puerco river and shallow aquifers located near the river, which were used by the Navajo Nation as both an agricultural and domestic water source. As of 2003, the Navajo are still unable to use this water (Ali 2003).

(vi) Improper Use of Mill Tailings as a Building Material

As stated in Chapter 4 of the main report, the risk of radiological exposure to the general public is not only from the tailing piles themselves, but also the improper use of mill tailings as building materials. The sandy properties of mill tailings and their availability in certain economically depressed areas make their inclusion in concrete and use as a building material possible. This has occurred when tailings piles have been abandoned without having been properly closed, or when piles of tailings have fallen from trucks along rural highways. Though the problem has been documented in Grand Junction, Colorado (Elmer 2005), Monticello, Utah (EPA 1989), on the Navajo reservation in New Mexico, and elsewhere, its current pervasiveness remains unknown. Tables 4.1 and 4.2 of the main report present annual dose values based on a few sample activity concentrations within a Navajo hogan. See Chapter 4 of the main report for more in-depth discussion and analysis of the improper use of tailings.

Summary of Modeled Risks to the Public

In a study by the Nuclear Regulatory Commission, a generalized case was modeled in which it was assumed that a “low level” of environmental controls were in place. This report concluded that if the mills in place during the time of the study (by 1980 there were 16 mills producing approximately 43,900 megatons of ore annually) were in full operation through the year 2000, it would result in approximately 610 premature deaths in North America through the year 2100 and 6,000 premature deaths through the year 3000. This model was based on a low level of environmental control, and did not take into account mitigating factors, such as covering the tailings to reduce the atmospheric release of the radon. The estimated 15-year committed dose to the public is shown in Table AVI-3, at the end of the document, which also includes an estimate of the risk as a percentage of the risk from normal background radiation exposure. For example, an individual near by a cluster of mills would accrue a 15-year committed dose of 340 mrem to the lung (an effective dose equivalent of 41 mrem), and would represent an increase of 38% above the normal risk from background exposure (U.S. NRC 1980).
These risk estimates for fatal cancer have since been updated in U.S EPA (1983) and the results are shown in Table AVI-2. This study estimated the individual risk of cancer for a 15-year exposure to an individual at distances of 1,000-20,000 meters from the mill. The model also takes into account whether the mill was in an operational or post-operational phase. For each phase of operation, the individual 15-year risk is given as an average and a maximum value. The maximum value represents the individual who is downwind of the mill, while the average value represents the average of all wind directions (U.S. EPA 1983).

* Effective dose equivalent based on the tissue weighting factors of ICRP-26

### Table AVI-2: Results of the 1983 EPA Studyα – Estimated 15-Year Risk of Fatal Cancer by Region and Phase of Operation

<table>
<thead>
<tr>
<th>Distance (meters)</th>
<th>Total Risk (Operational Phase)</th>
<th>Total Risk (Post-Operational Phase)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Maximum</td>
</tr>
<tr>
<td>1000</td>
<td>1.12E-03</td>
<td>1.97E-03</td>
</tr>
<tr>
<td>2000</td>
<td>3.39E-04</td>
<td>6.78E-04</td>
</tr>
<tr>
<td>3000</td>
<td>1.76E-04</td>
<td>3.60E-04</td>
</tr>
<tr>
<td>4000</td>
<td>1.17E-04</td>
<td>2.33E-04</td>
</tr>
<tr>
<td>5000</td>
<td>8.48E-05</td>
<td>1.74E-04</td>
</tr>
<tr>
<td>10000</td>
<td>3.18E-05</td>
<td>6.57E-05</td>
</tr>
<tr>
<td>20000</td>
<td>1.40E-05</td>
<td>2.76E-05</td>
</tr>
</tbody>
</table>

α Risk estimates are derived U.S. EPA 1983 Tables 6-1 and 6-2

Some studies of risks to human health from uranium mills have been conducted in the last several years (Boice et al 2007; Pinkerton et al 2004; Boice et al 2003). The authors reported no increases in mortality to some statistically significant increases in mortality for some diseases. However, all three studies share problems of limited size and control for confounding factors, such as lack of smoking data, specific exposure data, and population migration. Thus, the results of the studies are uninformative about the potential risks from uranium mills.

### Additional Risks to Workers

Mill workers, beyond the six pathways described above, experience added risks associated with accidents inside the milling facility. The hazards due to chemical spills inside the plant exist, but may be minor relative to potential radiological accident scenarios.

At acid leaching mills, sulfuric acid is present. Though the acid is corrosive to the skin and eyes, the leaching process is carried out at atmospheric pressure, and the risk of workers coming into contact with a spray during a pipe failure is not plausible. If there were a fire coupled with the release of sulfuric acid, then the inhalation of acid aerosols and sulfur dioxide could result in severe irritation of the eyes, mucus membranes, and respiratory tract. In addition to sulfuric acid, ammonia is often added to help control the pH level during the uranium precipitation phase. It is likely that this ammonia would be under significant pressure, creating the risk of a spray, in the event of a pipe failure, that poses a risk to the skin and eyes of any nearby worker. The ammonia would also quickly evaporate, adding an inhalation hazard if the accident occurred in a poorly ventilated area.

The radiological hazards associated with milling work potentially involve the yellowcake product in a dangerous respirable form. The two most notable accident scenarios are a thickener tank failure where the yellowcake slurry is spilled to the floor and allowed to dry, or a yellowcake dryer accident. Inhalation of the yellowcake particulates is a significant inhalation hazard, because of the presence of U3O8 in the cake. The reader is referred to Appendix III: Risks Associated with In Situ Leaching [see section (ii) Radiological Hazards] for a more detailed description of operational accidents in the milling facility, specifically those involving yellowcake.

In the NRC report (U.S. NRC 1980), it was calculated that the committed annual dose to a worker at a conventional milling facility ranges from 2.0 rem to the bone up to 7.1 rem to the lung. These annual doses would result in an
effective dose equivalent of 240 mrem to the bone marrow (red) and 60 mrem to the bone surface and lung. Any exposures accrued because of accidental exposure to yellowcake would be in addition to this. This information is summarized in Table AVI-3 found at the end of the document. A study by Pinkerton et al (2004) reported mixed results in a study of a cohort of uranium mill workers, but concluded that for several limiting factors, such as small cohort size, they could not make “firm conclusions about the relation of the observed excesses in mortality.”

Summary

The primary hazard associated with conventional uranium milling operations is the high level of radioactive contamination contained in the mill tailings (waste products). The decay progeny of uranium are the most significant of these radioactive contaminants, including radium and radon-222, which readily moves through the interstitial spaces of the tailing pile and is released to the atmosphere. Once inhaled, radon and its decay progeny can cause significant damage to the lung via alpha radiation. Other radiological hazards include direct gamma exposure from the tailings pile and the inhalation of any dust resuspended by wind. These hazards are typically mitigated through the use of a suitable cover over the tailing to reduce the radon released to the atmosphere and attenuate direct gamma exposure. A suitable cover can also eliminate the risks associated with the suspension of dust in the air.

Ground seepage of chemically hazardous constituents of tailings piles has been known historically to contaminate nearby aquifers. Modern milling facilities often employ a liner beneath tailings piles to prevent any ground seepage and subsequent groundwater contamination. The NRC concluded that 95% of the possible contamination would happen while the mill was operating, and that the threat was mainly from toxic elements such as arsenic, not the radioactive constituents of the pile.

As with any industrial facility, safe management practices are critical to the safe operation of uranium mills. Catastrophic accidents, such as a dam failure, have the potential to release large quantities of tailings, resulting in the contamination of local water supplies and the residential population. The improper use of mill tailings as a building material can also pose a severe radiological risk to private individuals, particularly in tribal communities. Accidents occurring within the milling facility could expose workers to chemical risks, and radiological risks from contact with or inhalation of uranium yellowcake.

References


Resolution and Bibliography


Colorado Medical Society Resolution

Introduced by: Larimer County Medical Society
Subject: Opposition to in-situ and open pit Uranium Mining in Colorado
Referred to: Reference Committee on Health Affairs

1 WHEREAS, the value of Uranium has increased due to the current number and
2 projected increase in Nuclear Power Plants in the world (436 currently and 90
3 projected for the next 15 years), and

5 WHEREAS, in 2006, Colorado had 3000 (three thousand) new uranium mining
7 claims, and

8 WHEREAS, Colorado geology shows a rich source of Uranium and the Uranium
9 mining industry has filed for 29 new Uranium mining permits in addition to 35
10 existing Uranium mining projects in Colorado, and

12 WHEREAS, all aspects of Uranium mining have adverse environmental
13 consequences and, the main proposed mining method for Colorado sites is in
situ and open pit mining that are known to contaminate groundwater (aquifers)
16 and surface water resources with heavy metal and traces of radioactive
17 uranium, and

18 WHEREAS, in areas where uranium mining has been performed in the past
19 there is documented increase in rates of: testicular and ovarian cancer,
20 leukemia, childhood bone cancer, miscarriages, infant death, congenital defects,
22 genetic abnormalities and learning disorders in the population living near the
23 mining site, and

24 WHEREAS, safe drinking water is a key pillar of public health, and

26 WHEREAS, water is in short supply in Colorado and contaminating this natural
28 resource can be an irreversible disaster to communities that depend on that
29 aquifer, therefore be it

30 RESOLVED, that the Colorado Medical Society opposes the practice of in-situ
32 and open pit mining of Uranium in geographical areas that are utilized by the
33 farming or ranching communities or where there are human residents due to the
34 adverse health conditions associated with the mining process, and be it further
35 RESOLVED, that the Colorado Medical Society Delegation to the American
37 Medical Association take to the AMA House of Delegates a resolution that would
38 provide a similar opposition at the federal level.
Bibliography [for Colorado Medical Society resolution]


Uranium Mill Tailings [Excerpt]

Sources and Volume

Uranium mill tailings are the radioactive sandlike materials that remain after uranium is extracted by milling ore mined from the earth. Tailings are placed in huge mounds called tailings piles which are located close to the mills where the ore is processed.

The most important radioactive component of uranium mill tailings is radium, which decays to produce radon. Other potentially hazardous substances in the tailings are selenium, molybdenum, uranium, and thorium.

Uranium mill tailings can adversely affect public health. There are four principal ways (or exposure pathways) that the public can be exposed to the hazards from this waste. The first is the diffusion of radon gas directly into indoor air if tailings are misused as a construction material or for backfill around buildings. When people breathe air containing radon, it increases their risk of developing lung cancer. Second, radon gas can diffuse from the piles into the atmosphere where it can be inhaled and small particles can be blown from the piles where they can be inhaled or ingested. Third, many of the radioactive decay products in tailings produce gamma radiation, which poses a health hazard to people in the immediate vicinity of tailings. Finally, the dispersal of tailings by wind or water, or by leaching, can carry radioactive and other toxic materials to surface or ground water that may be used for drinking water.

Figure 6
Uranium Mill Tailings Piles

... All the tailings piles except for one abandoned site located in Canonsburg, PA, are located in the West, predominantly in arid areas (Figure 6). ...
Appendix 8  
U.S. Public Health Service– FAQ for Radium July 1999

http://www.atsdr.cdc.gov/tfacts144.html#


Frequently Asked Questions for Radium

This fact sheet answers the most frequently asked health questions about radium. For more information, you may call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Radium is a radioactive substance formed from the breakdown of uranium and thorium. Exposure to high levels results in an increased risk of bone, liver, and breast cancer. This chemical has been found in at least 18 of the 1,177 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is radium?

Radium is a naturally occurring silvery-white radioactive metal that can exist in several forms called isotopes. Radium is formed when uranium and thorium break down in the environment. Uranium and thorium are found in small amounts in most rocks and soil. Two of the main radium isotopes found in the environment are radium-226 and radium-228.

Radium undergoes radioactive decay. It divides into two parts—one part is called radiation and the other part is called a daughter. The daughter, like radium, is not stable, and it also divides into radiation and another daughter. The dividing of daughters continues until a stable, nonradioactive daughter is formed. During the decay process, alpha, beta, and gamma radiation are released. Alpha particles can travel only a short distance and cannot travel through your skin. Beta particles can penetrate through your skin, but they cannot go all the way through your body. Gamma radiation can go all the way through your body.

Radium has been used as a radiation source for treating cancer, in radiography of metals, and combined with other metals as a neutron source for research and radiation instrument calibration. Until the 1960s, radium was a component of the luminous paints used for watch and clock dials, instrument panels in airplanes, military instruments, and compasses.

What happens to radium when it enters the environment?

- Radium is constantly being produced by the radioactive decay of uranium and thorium.
- Radium is present at very low levels in rocks and soil and may strongly attach to those materials.
- Radium may also be found in air.
- High concentrations are found in water in some areas of the country.
- **Uranium mining results in higher levels of radium in water near uranium mines.**
- Radium in the soil may be absorbed by plants.
- It may concentrate in fish and other aquatic organisms.
How might I be exposed to radium?

- Everyone is exposed to low levels of radium in the air, water, and food.
- Higher levels may be found in the air near industries that burn coal or other fuels.
- It may be found at higher levels in drinking water from wells.
- Miners, particularly miners of uranium and hard rock, are exposed to higher levels of radium.
- It may also be found at radioactive waste disposal sites.

How can radium affect my health?

Radium has been shown to cause effects on the blood (anemia) and eyes (cataracts). It also has been shown to affect the teeth, causing an increase in broken teeth and cavities. Patients who were injected with radium in Germany, from 1946 to 1950, for the treatment of certain diseases including tuberculosis were significantly shorter as adults than people who were not treated.

How likely is radium to cause cancer?

Exposure to high levels of radium results in an increased incidence of bone, liver, and breast cancer. The EPA and the National Academy of Sciences, Committee on Biological Effects of Ionizing Radiation, has stated that radium is a known human carcinogen.

Is there a medical test to show whether I've been exposed to radium?

Urine tests can determine if you have been exposed to radium. Another test measures the amount of radon (a breakdown product of radium) in exhaled air. Both types of tests require special equipment and cannot be done in a doctor's office. These tests cannot tell how much radium you were exposed to, nor can they be used to predict whether you will develop harmful health effects.

Has the federal government made recommendations to protect human health?

The EPA has set a drinking water limit of 5 picocuries per liter (5 pCi/L) for radium-226 and radium-228 (combined).

The EPA has set a soil concentration limit for radium-226 in uranium and thorium mill tailings of 5 pCi per gram (5 pCi/g) in the first 15 centimeters of soil and 15 pCi/g in deeper soil.

The federal recommendations have been updated as of July 1999.

Glossary

- Anemia: A decreased ability of the blood to transport oxygen.
- Carcinogen: A substance that can cause cancer.
- CAS: Chemical Abstracts Service.
- National Priorities List: A list of the nation's worst hazardous waste sites.
- Picocurie (pCi): A unit used to measure the quantity of radio-active material.
- rem: A unit used to measure radiation dose.
HEALTH DANGERS OF URANIUM MINING AND JURISDICTIONAL QUESTIONS [Excerpts]

The British Columbia Medical Association

A SUMMARY OF MATERIAL BEFORE THE BRITISH COLUMBIA ROYAL COMMISSION OF INQUIRY

HEALTH AND ENVIRONMENTAL PROTECTION ~ URANIUM MINING ~

PRESENTED: AUGUST 1980

BY
E.R. YOUNG, B.Sc., M.D.
R.F. WOOLLARD, M.D.

ON BEHALF OF
THE ENVIRONMENTAL HEALTH COMMITTEE OF
THE BRITISH COLUMBIA MEDICAL ASSOCIATION

VANCOUVER BC

Brief Summary of Major Points:

- Uranium Industry: Occupational Exposures
- Uranium Industry: Public Exposures
- Regulatory Framework: Setting Standards

URANIUM INDUSTRY: OCCUPATIONAL EXPOSURES

Delay of hazard recognition and consequent worker non-protection is an unfortunate but recurring theme in the Canadian regulatory and uranium industry history:

- Radon daughter radiation is a health hazard to workers in advanced stages of exploration, such as in tunnels and shafts, where very high levels of 1.6 working levels (WL) have been recorded in low grade deposits (1600 times normal background levels).
- Average radon daughter levels in underground mines range from 0.1 WL to about 1 WL (that is, 100 to 1000 times normal background levels).
- In open-pit mines, the high density of radon (7.8 times heavier than air) and atmospheric inversion conditions can cause levels of from 2 to 10 WL in moderate to high grade ore bodies.
- Workers in open pits with low to moderate grade ore receive 2 to 4 times the normal lifetime dose of radon daughter radiation during their employment life, under conditions where there are no inversions.
- In a uranium mill, with low to moderate grade ore, the millers receive from 5 to 14 times the normal background lifetime dose of radon daughter radiation during their 30-year working lives.
- Uranium millers may receive doses of gamma radiation 1000 times background from high grade ores.
Although the AECB assumes workers are receiving only a small fraction of the annual limits, this is not borne out by the facts.

Despite AECB claims to the contrary, the risks from radiation in uranium mining far exceed those of a "safe" industry.

The 4 WLM annual maximum permissible exposure to radon and thoron daughters should be lowered to less than 1 WLM per year immediately, and serious consideration should be given to lowering it to 0.4 WLM per year [a factor of 10 lower than present permissible levels]. This would still exceed risks for a safe industry using AECB criteria.

The AECB is unfit to regulate uranium mining.

Canada has lagged many years behind other countries in its collection of cancer death statistics among uranium miners. It is most unfortunate that there has been such a long delay in publication of the follow-up study of the Elliot Lake miners.

Nuclear industry proponents have tended to minimize risk through lack of knowledge, generalizations, quoting outdated studies, dilution of risk estimates, unsubstantiated arguments, personal bias, basing conclusions on inadequate studies, doublethink, and assuming workers cannot absorb the full truth.

The new ICRP weighting system [based on the concept of an "effective dose equivalent"], if accepted, will permit much larger doses of radiation at a time when reports indicate that cancer risk is many times what it was considered to be 22 years ago.

AECB reliance on the ICRP as a basis for standards is unwise. That body has become a political and social arbiter rather than a scientific advisory group.

URANIUM INDUSTRY: PUBLIC EXPOSURES

Uranium tailings will remain radioactive for hundreds of thousands of years, and will require such expensive long-term surveillance and maintenance by government and the local citizenry as to make statements about uranium mining providing revenue very misleading:

- Misuse of uranium tailings has led to internal lung doses calculated to be 100 rems per year to the public.
- Conservative calculations show that the public near uranium tailings will receive a 25 percent increase in lifetime radon daughter radiation.
- Uranium tailings will have appreciable radioactivity for more than 100,000 years.
- In Canada we now have approximately 100 million tons of radioactive tailings; this will eventually increase to about one billion tons by the year 2000.
- There have been many uranium tailings disasters in Australia, Canada and the United States, even with the most modern "state of the art" tailings dams.
- The present average allowable exposure to the public [of 0.02 WL of radon exposure] could result in 200-300 extra cases of lung cancer per 10,000 people per lifetime. In light of current knowledge, this might be considered tantamount to allowing an industrially induced and publicly sanctioned epidemic of cancer.
- This present guideline of 0.02 WL must be immediately withdrawn and replaced with "no exposure (above ambient levels) of any carcinogen permitted to the local public".
- Radon contamination of ground water may be a health risk in pincushion drilling typical of advanced exploration, yet under present AECB regulations, a couple of hundred drill holes can be made without obtaining a license. AECB admitted to having no scientific data to show this is safe; the regulation was based on an arbitrary administrative decision.

**Radium-226 [released from uranium tailings] is a superb producer of osteosarcoma [bone cancer].**
• In 1959 the ICRP recommended a maximum exposure of 3 picocuries per liter (pCi/l) of [dissolved] radium-226 to the public.
• In 1968 Canada allowed a maximum permissible concentration of 100 picocuries per liter, with an objective of 10 picocuries per liter [of dissolved radium-226].
• Ontario has retained a maximum permissible concentration of 3 picocuries per liter [of dissolved radium-226].
• New "recalculations" of the ICRP recommend relaxing the radium-226 standard to 27 picocuries per liter (9 times the Ontario limit of 3 picocuries per liter). [NOTE: Canada has since authorized this increase in permissible radium levels in drinking water.]
• Certain uranium mining companies in Ontario are discharging radium-contaminated effluents which exceed the standard of 3 picocuries per liter. With the relaxation of the standard to 27, this will no longer be [considered as] a technical or regulatory problem.
• American standards are as usual more stringent than Canada's; in the U.S.A., [dissolved] radium-226 plus radium-228 cannot exceed 5 picocuries per liter.
• A U.S. Public Health Service study shows increased bone cancer in communities with 4.2 picocuries per liter [dissolved] radium-226 in drinking water, as compared with communities having only 1 picocurie per liter.
• The concept that a radium-226 limit for the public can be set ten times too high because the usual radium-226 levels will only be one-tenth of that is as inane as setting a speed limit of 200 kilometers per hour in a school zone because most caring people will only drive at 20 km/hr anyway.
• There are no standards for total radium-226 (dissolved and particulate); one wonders if that is because total radium-226 effluents range as high as 168 picocuries per liter.

REGULATORY FRAMEWORK: SETTING STANDARDS
The BCMA calls for an Emergency Task Force into tightening the present radiation standards. Review by the AECB or by its Committees is unacceptable; the Task Force should be under the Advisory Council on Occupational Health and Safety or the Science Council of Canada:

• Industry and regulatory officials are overly eager to select conversion factors for dose calculations that are at the lower end of the spectrum of values proposed. This consequently leads to lower risk estimates of radiation effects. The fact that the calculations are subject to "large unquantifiable uncertainty" leaves one with little confidence in the conclusions of health risks made by nuclear physicists and former employees of Atomic Energy of Canada Limited, now associated with the Atomic Energy Control Board.
• Canadian regulations lag far behind countries which are more conscious and concerned about occupational and public health and safety.
• Canadians cannot continue to allow vested interest Ministries and regulatory bodies to promulgate maximum permissible exposure levels [of radiation].
• The BCMA is on record as calling for a national enquiry into nuclear energy in Canada, [including] a total reassessment of the structure and function of the AECB; this resolution arose out of our investigations of nuclear waste management and uranium mining.
• That the AECB consistently and seriously neglected its statutory responsibility for the regulation of uranium mines is obvious to the most casual observer.
• We believe that the continued use of the ALARA principle, [unenforced] guidelines, and the encouragement of industrial self-regulation is a combination of objectives that will [continue to] compromise the effectiveness of the AECB as a regulator of uranium mining.
Nuclear Power in Canada: An Examination of Risks, Impacts and Sustainability

Published: Dec 14, 2006

By: Mark S. Winfield, Alison Cretney, Paulina Czajkowski, Rich Wong

Page 3-7:
Executive Summary

This study examines the environmental impacts of the use of nuclear energy for electricity generation in Canada through each of the four major stages of nuclear energy production: uranium mining and milling; uranium refining, conversion and fuel fabrication; nuclear power plant operation; and waste fuel management. It is intended to inform public debate over the future role of nuclear energy in Canada, and to facilitate comparisons of nuclear energy with other potential energy sources.

The study examines waste generation, atmospheric releases, impacts on water quality and water use, and landscape and ecosystem impacts of nuclear energy production. It also examines the occupational and community health impacts of nuclear power and key long-term challenges to its sustainability, including security and weapons proliferation risks. Specific environmental impacts are examined in the context of CANDU nuclear technology, the only reactor type currently in use in Canada.* *(Different types of reactors are associated with different impacts and risks. Lightwater reactors, employing enriched uranium fuel, for example, are associated with the generation of lower volumes of waste fuel. However, the process of producing enriched uranium fuel for these types of reactors is associated with much higher emissions of greenhouse gases, particularly where gas diffusion based enrichment processes are employed, as well as higher atmospheric releases of uranium and the generation of large volumes of depleted uranium (DU) wastes.)*

...The study findings likely underestimate the overall impacts of the use of nuclear energy for electricity production in Canada. This is a result of significant gaps in the publicly available information on releases of pollutants and contaminants, as well as on the fate of certain waste streams related to the nuclear industry. In addition, the study relies on what are likely conservative estimates in a number of key areas, particularly with respect to the generation of greenhouse gas (GHG) emissions.

Is nuclear power clean?

The study finds that nuclear power, like other non renewable energy sources, is associated with severe environmental impacts. Each stage of the nuclear energy production process generates large amounts of uniquely difficult-to-manage wastes that will effectively require perpetual care, imposing costs and risks arising from current energy consumption onto future generations. The process also has severe impacts on surface water and groundwater water quality via a range of radioactive and hazardous pollutants, and results in releases to the atmosphere of a wide range of criteria (i.e. smog and acid-rain causing), radioactive and hazardous pollutants and greenhouse gases. Effluent from uranium mines and mills was found by Health Canada and Environment Canada to be ‘toxic’ for the purposes of the Canadian Environmental Protection Act in 2004.
What is particularly noteworthy about the radioactive waste streams produced at every stage of the nuclear life cycle are the timeframes over which these materials will need to be managed. Secure containment will be required for not hundreds, but hundreds of thousands of years – timeframes over which it is extremely difficult, if not virtually impossible, to predict outcomes with any level of assurance. There are no approved long-term strategies for the management of these wastes in place. The federally mandated Nuclear Waste Management Organization expects it will take over 300 years to implement its proposed “phased adaptive management” approach to containing waste nuclear fuel. As well, the effectiveness and adequacy of tailings management facilities at mine sites in Canada has been subject to serious question. There is a long history of uranium mine tailings management facility failures in Canada and elsewhere in the world, resulting in severe surface water and groundwater contamination.

Is nuclear power sustainable?

Nuclear energy is no more a renewable energy source than oil or gas. It relies on a finite and non-renewable fuel supply – uranium. World uranium prices have increased more than six fold since 2001. Current Canadian uranium reserves are estimated to be sufficient for 40 years at current levels of consumption (compared to estimated natural gas reserves of approximately 70 years). The exploitation of lower-grade uranium deposits in the future would increase the already substantial emissions (including greenhouse gas emissions) from uranium mining and milling operations, as well as significantly expanding the enormous amounts of waste rock and tailings generated by uranium mines and mills.

Efforts to increase the available fuel supply through the reprocessing of waste fuel or the use of fast breeder reactors are seen to present serious waste management, technological and weapons proliferation risks. Other suggested fuel sources, such as thorium or extraction of uranium from seawater, face major technological, environmental and economic hurdles.

Is nuclear power greenhouse gas ‘emissions free’?

The study finds that GHG emissions arise at each stage of the nuclear energy cycle, with power plant construction being the most significant source of releases. Further releases of GHGs occur as a result of the operation of equipment in the uranium mining process, the milling of uranium ore, mill tailings management activities, and refining and conversion operations. The generation of greenhouse gases from mining and milling operations would increase proportionally with the use of lower grade uranium ores, as larger amounts of ore would have to be extracted and processed to produce the same amount of uranium concentrate.

The road transportation of uranium between milling, refining and conversion facilities results in additional releases. As with criteria air pollutants, the management of waste nuclear fuel along with other radioactive wastes could involve significant transportation activities, leading to further generation of GHG emissions.

In Canada, total GHG emissions associated with uranium mining, milling, refining, conversion and fuel fabrication are between 240,000 and 366,000 tonnes of CO2 per year. Total emissions associated with the sector, including the emissions associated with power plant construction, are in the range of 468,000 and 594,000 tonnes of CO2 per year, equivalent to the emissions of between 134,000 and 170,000 cars per year. Total annual GHG emissions that are primarily associated with domestic power production are estimated at between 267,000 and 289,000 tonnes of CO2 per year. This total is almost certainly an underestimate, due to a lack of complete information. Other recent estimates suggest total GHG emissions associated with nuclear power in Canada are in the range of at least 840,000 tonnes per year.

These figures relate to the CANDU-type reactors used in Canada. The process of producing enriched uranium fuel for other types of reactors is associated with much higher emissions of greenhouse gases, particularly where gas diffusion-based enrichment processes are employed.

Is Nuclear Power Reliable?

The Ontario CANDU reactor fleet has been subject to severe performance and maintenance problems. Over the past decade, some Ontario facilities have had average operating capacities below 40 per cent rather than the
expected 85–90 per cent range. Reactors expected to have operational lifetimes in the range of 40 years have turned out to require major refurbishments after approximately 25 years of service. Refurbishment projects themselves have run seriously over budget and behind schedule.

Heavy reliance on coal-fired electricity to backstop under-performing or offline nuclear units has been associated with major increases in releases of greenhouse gases and other air pollutants. The shutdown of eight reactors between 1995 and 2001 under the 1997 Nuclear Asset Optimization Plan led to emissions of GHGs from the province’s coal-fired power plants increasing by a factor of 2.3, sulphur dioxide emissions by a factor of 2, and nitrogen oxide emissions by a factor of 1.7, significantly exacerbating the severe air quality problems regularly experienced in southern Ontario.

Is it a cost-effective solution?

Nuclear power generating facilities are subject to very high capital costs and long construction times relative to other electricity supply options. In addition, in Ontario there is a history of serious delays and cost overruns on nuclear generating facility projects, accounting for $15 billion of the nearly $20 billion “stranded debt” left by Ontario Hydro.

Nuclear energy also brings with it a unique set of risks, largely arising from the very high costs and levels of uncertainty involved in handling, storing and managing waste fuel and other radioactive wastes. Implementation of the Nuclear Waste Management Organization’s proposed strategy for managing waste fuel from existing reactors is estimated to be likely to have a total cost in the range of $24 billion. This would be in addition to the costs for the development and management of facilities for low and intermediate level radioactive waste and for managing waste rock and tailings at uranium mine sites. The costs of decommissioning Ontario’s existing reactors have been estimated at $7.474 billion.

Even with extensive subsidies and financial guarantees provided by governments, these costs, timelines and risks make it difficult for nuclear power projects to compete for private capital investments against potential investments that will bring much more rapid and secure returns.

Is it safe?

Much has changed in our understanding of radiation risks since the construction of Canada’s first commercial reactors in the early 1970s. For example, recent research on the effects of even very low levels of ionizing radiation suggests that no level is safe to health. The International Agency for Research on Cancer (IARC) lists a number of radionuclides as carcinogenic to humans, including isotopes produced in uranium mining and milling, fuel production and nuclear power plant operations.

Yet despite our improved understanding of these risks, Canadian standards and practices appear to have not kept pace with this changing knowledge. It has been suggested, for example, that existing standards in Canada for cancer risks arising from radiological hazards permit much higher levels of acceptable risk than is the case for chemical and other hazards. Current Canadian standards in some areas are substantially weaker than those in place in other comparable jurisdictions. The existing drinking water standard in Ontario for tritium (of which discharges from nuclear power plants are the primary source), for example, of 7,000 Bq/L is significantly weaker than the standards in the United States of 740 Bq/L and in the European Union of 100 Bq/L.

Workers in the mining and refining, conversion and fuel fabrication subsectors are also found to be routinely exposed to levels of radiation above those that would be considered acceptable to members of the general public. There is a history of significant occupational health effects, particularly elevated incidences of lung cancer, among uranium miners attributed to radon exposure. Increased mortality among uranium miners is also attributed to exposure to silica, solvents, asbestos and radiation.

As well, substantial health risks have been identified in relation to the consumption of certain types of “country” food, particularly caribou, in the vicinity of uranium mine/mill operations as a result of contamination by radionuclides.

While nuclear generating facility operators argue that the levels of public exposure to radiation arising from facility operations are trivial in comparison to other sources, recent studies suggest that health impacts of low-level radiation exposure may be more significant than previously thought, and that children and infants may be particularly at risk from such exposures.
Nuclear generating facilities are additionally subject to uniquely severe accident and security risks. A serious accident or incident could result in the release of large amounts of radioactive material to the atmosphere, which could be distributed over a large area. By comparison, the impacts of major incidents or accidents at facilities employing other generating technologies would be short term and largely limited to the facility site itself. It has been estimated that the monetized value of the off-site environmental, health and economic impacts of a major accident at the Darlington generating facility east of the City of Toronto, for example, would exceed $1 trillion (1991 $Cdn).

Nuclear energy's shared origins with nuclear weapons programs raises the potential for -- and reality of -- links between technologies and materials used for energy production and for nuclear weapons development. Concerns about these connections have grown in the past few years as a result of nuclear programs in North Korea, Iran, India and Pakistan. Any large-scale expansion of reliance on nuclear energy would carry significant risks of the proliferation of materials and technologies that could be applied to weapons development. India's 1974 nuclear bomb test, a project developed in part using Canadian-supplied technology and uranium, demonstrated this problem clearly.

The big picture

Any life-cycle analysis of an energy source is likely to identify previously unrecognized or unquantified impacts. However, the range and scale of impacts and risks associated with nuclear power production make it unique among energy sources.

While the greenhouse gas emissions associated with nuclear power are less than those that would be associated with conventional fossil fuel energy use, no other energy source combines the generation of a range of conventional pollutants and waste streams -- including heavy metals, smog and acid rain precursors, and water contaminants -- with the generation of extremely large volumes of radioactive wastes that will require care and management over hundreds of thousands of years. The combination of these environmental challenges, along with security, accident and weapons proliferation risks that are simply not shared by any other energy source, place nuclear energy in a unique category relative to all other energy supply options. In essence, reliance on nuclear power as a response to climate change would involve trading one problem -- greenhouse gas emissions -- for which a wide range of other solutions exist, for a series of other complex and difficult problems for which solutions are generally more costly and difficult and for which the outcomes are much less certain.

In this context, proposals for the retention and expansion of the role of nuclear power must be approached with the greatest of caution. Such proposals must be examined in the full light of their environmental, economic and security implications, not only for Canada, but the rest of the world as well. They must also be examined in the context of the full range of available alternatives. Such an examination is likely to conclude that better options are readily available. These options range from making the most efficient use possible of existing energy resources to expanding the role of low-impact renewable energy sources that offer far safer, cheaper, more reliable and more sustainable options for meeting society's energy needs.

Nuclear energy production waste streams -- a synopsis

Solid and Liquid Wastes

_Uranium mining and milling_

- An estimated 575,000 tonnes of tailings per year, of which 90–100,000 tonnes can be attributed to uranium production for domestic energy purposes. Uranium mill tailings are acidic or potentially acid generating, and contain a range of long-lived radionuclides, heavy metals and other contaminants. Tailings generation would increase proportionally with the use of lower grade uranium ores, as larger amounts of ore would have to be processed to produce the same amount of uranium concentrate.
- Up to 18 million tonnes of waste rock, which may also contain radionuclides, heavy metals, and be acid generating. Of this total, up to 2.9 million tonnes can be attributed to uranium mining for domestic energy purposes.
- It is estimated that there are more than 213 million tonnes of uranium mine tailings in storage facilities in Canada, and 109 million tonnes of waste rock.

Refining and conversion operations
It is estimated that nearly 1,000 tonnes of solid wastes and 9,000 m³ of liquid wastes are produced per year as a result of uranium refining, conversion and fuel production for domestic energy generation purposes. Information on the precise character and fate of these wastes could not be obtained.

**Power Plant operation**
- Approximately 85,000 waste fuel bundles are generated by Canadian nuclear reactors each year. As of 2003, 1.7 million bundles were in storage at reactor sites. It is estimated that these wastes will have to be secured for approximately one million years for safety, environmental and security reasons.
- Approximately 6,000 cubic metres of lower level radioactive wastes are generated each year in Ontario as a result of power plant operations, maintenance, and refurbishment.
- Power plant maintenance and refurbishment also result in the generation of substantial amounts of additional hazardous wastes, including heavy metals and asbestos.
- Very large amounts of low-, intermediate- and high-level radioactive wastes will be produced as a result of the eventual decommissioning of refining, conversion and fabrication facilities as well as power plants.

**Water**
- Severe contamination of groundwater with radionuclides, heavy metals, and other contaminants has occurred at tailings management facilities and waste rock storage areas.
- Uranium mining and milling facility surface water discharges have resulted in the contamination of the receiving environment with radionuclides and heavy metals. Effluent from historic and operating uranium mines and mills, particularly uranium discharges, have been determined to be toxic for the purposes of the Canadian Environmental Protection Act.
- Uranium mining operations are associated with the extensive removal of groundwater (in excess of 16 billion litres per year).
- Routine and accidental releases of radionuclides to surface waters occur in the course of power plant operations, with tritium oxide and carbon-14 being key radioactive pollutants of concern. Groundwater contamination with tritium has occurred at the Pickering generating facility in Ontario.
- Ontario’s nuclear power plants are found to be the leading source of discharges of hydrazine, an extremely hazardous pollutant, to surface waters in Canada. Nuclear generating facilities have also been sources of discharges of metals (copper, zinc, and chromium) and ammonia to surface waters.
- Nuclear power is a major consumer of water. Uranium mining operations involve extensive dewatering, in the range of at least 16–17 billion litres per year, with the implication of impacts on groundwater and surface water storage and flows.
- Generating facilities require large amounts of cooling water. The Darlington and Pickering facilities in Ontario are alone estimated to use approximately 8.9 trillion litres of water for cooling purposes per year — more than 19 times the annual water consumption of the City of Toronto. Adverse thermal impacts of cooling water discharges on fish populations in the vicinity of nuclear power plants have been observed.

**Air**
- Atmospheric releases of a range of radionuclides occur at all stages of nuclear power production. Atmospheric releases of radon gas result from mining and milling operations and from tailings management facilities.
- Windblown dust from mine sites and tailings management facilities (TMFs) contains a range of radionuclides. Atmospheric releases (principally uranium) also arise from refining and conversion activities.
- Routine and accidental releases of radiation and radionuclides occur from power plant operations, including tritium oxide, carbon-14, noble gases, iodine-131, radioactive particulate and elemental tritium.
- The incineration of low and intermediate-level radioactive wastes from power plant operations and maintenance in Ontario has resulted in further atmospheric releases of radionuclides, particularly tritium. A wide range of hazardous air pollutants have been released by the Bruce Western Waste Management facility. A new incinerator installed in 2003, has reduced emissions of hazardous, but not of radiological, pollutants.
- Windblown dust from mine sites and TMFs contains a range of heavy metals. In addition, releases of a number of hazardous air pollutants, including dioxins and furans, hexachlorobenzene, heavy metals (principally lead) ammonia and hydrogen fluoride arise from uranium refining and conversion operations.
• Ontario nuclear power plants are the only National Pollutant Release Inventory reported source of releases of hydrazine to the air in Canada.
• Uranium mining and milling operations are found to be significant sources of releases of sulphur dioxide (SO2), volatile organic compounds (VOCs) and nitrogen oxides (NOx). Releases of NOx, particulate matter (PM) and sulphuric acid arise from refining and conversion activities.
• The road transportation of uranium from mill sites in northern Saskatchewan to the Blind River refinery in Northern Ontario and then on to the Port Hope conversion facility in Southern Ontario produces additional releases of NOx and PM. Further transportation related releases of criteria air pollutants would arise from the long-term management of waste nuclear fuel and other radioactive wastes arising from facility operations, maintenance and decommissioning, particularly if the management strategies for these materials require the movement of wastes from reactor sites to centralized facilities.

Climate
• Total greenhouse gas (GHG) emissions associated with uranium mining, milling, refining, conversion and fuel fabrication in Canada are estimated at between 240,000 and 366,000 tonnes of CO2 per year.
• Total emissions associated with the sector, including the emissions associated with power plant construction, are in the range of 468,000 and 594,000 tonnes of CO2 per year, equivalent to the emissions of between 134,000 and 170,000 cars per year.
• Total annual GHG emissions associated with domestic power production alone are estimated at between 267,000 and 289,000 tonnes of CO2 per year. Other recent estimates suggest total GHG emissions associated with nuclear power in Canada are in the range of at least 840,000 tonnes per year.

Pages 23-25:
2. Phase I: Uranium Mining and Milling

Summary of Key Findings

• The environmental impacts of uranium mining and milling are severe. They represent the most significant short-term environmental impacts of nuclear energy production in Canada. A number of jurisdictions in Canada and Australia have adopted bans on the establishment of new uranium mines due to concerns over the potential environmental and health impacts of such operations.
• The key impacts of uranium mining and milling include the following:
  – The generation of large quantities of waste rock and mill tailings. These are typically acidic or potentially acid generating, comprise long-lived radionuclides, heavy metals, and other contaminants.
  – Uranium mining milling to supply Canadian domestic power generation is estimated to result in the production of more than 90,000 tonnes of tailings, and up to 2.9 million tonnes of waste rock per year.
  – Canadian uranium mines and mills have an inventory of 109 million tonnes of waste rock, and 214 million tonnes of tailings.
  – There are major concerns regarding long-term integrity of tailings and waste rock containment facilities. These facilities will require perpetual care. The adequacy of current financial assurances required by governments for the closure and long-term care of containment facilities has been questioned.
• Severe contamination of groundwater with radionuclides, heavy metals, and other contaminants has occurred at tailings management facilities and waste rock storage areas.
• Uranium mining and milling facility surface water discharges have resulted in the contamination of the receiving environment with radionuclides and heavy metals. Effluent from historic and operating uranium mines and mills, particularly uranium discharges, have been determined to be toxic for the purposes of the Canadian Environmental Protection Act by Environment Canada and Health Canada.
• Uranium mining operations are associated with the extensive removal of groundwater (in excess of 16 billion litres per year).
• The environment and biota in the vicinity of uranium mines and mills has been contaminated with radionuclides particularly via windblown dust from tailings sites. Significant potential increases in cancer risks to humans from the consumption of caribou in the vicinity of uranium mines have been identified.
• Uranium mines and tailings storage areas have been identified as significant sources of atmospheric releases of radon gas.
• Major atmospheric releases of sulphur dioxide and VOCs are associated with the uranium milling process. In 2004, VOC emissions from the sector were equivalent to the average annual emissions of more than 300,000 cars. The Rabbit Lake facility acid plant reported releases of 43,000 tonnes of SO2 in 2004.
• Atmospheric releases of NOx and PM result from the milling process and the operation of fossil fuel-powered machinery and equipment.
• Annual CO2 emissions resulting from uranium mining, milling and tailings management activities in Canada are estimated at between 160,000 and 250,000 tonnes.
• The mining of lower grade ores would result in the generation of proportionally larger amounts of tailings, other wastes and emissions, as larger amounts of ore would have to be processed to produce the same amount of uranium concentrate. Processing of ore that is 0.01% uranium, for example, would generate approximately ten times the tailings of ore that is 0.1% uranium. Workers at uranium mines and mills typically receive annual effective radiation doses higher than those considered acceptable to members of the general public. Increased incidences of lung cancer as well as deaths resulting from silica exposure are reported among uranium miners.

2.1. Introduction

The mining and milling of uranium is the first step in the production of nuclear energy. Canada is currently the world’s largest uranium producer, extracting uranium from four Saskatchewan mines: McClean Lake, Key Lake, Rabbit Lake and McArthur River. Uranium milling occurs on-site at each mine with the exception of McArthur River, which trucks its uranium ore 80 km to Key Lake for milling. While all current and proposed uranium mining and milling operations are based in northern Saskatchewan, there are potentially developable uranium reserves in a number of Canadian provinces and territories. Historically, there have been uranium mines in both Ontario and the Northwest Territories.

Table 2.1 lists Canadian mining and milling sites, and their respective operational state as reported by NRCan.
The historical environmental and health impacts of uranium mining and milling in Canada have been severe. The effects have included the extensive contamination of surface water, groundwater and the surrounding environment in the vicinity of facilities with radioactive, toxic, and conventional pollutants, and the creation of major occupational health concerns. Although major uranium mining operations began in Ontario in the 1950s, for example, occupational health and safety requirements in the province were not fully established until 1984.2

As a result of such negative impacts, some Canadian provinces have imposed moratoriums on uranium exploration and mining. After significant uranium exploration took place in Nova Scotia in the late 1970s, that province imposed a moratorium on uranium exploration and mining in 1981. An inquiry in 1985 recommended that the moratorium be renewed for another five years. An interdepartmental committee on uranium was then established, releasing a final report in 1994. The moratorium remains in place.3

In British Columbia, a seven-year moratorium was imposed in 1980 after a royal commission concluded that health risks associated with uranium mining made it too dangerous. The moratorium expired in 1987 and was not reinstated. No uranium mines have been established in British Columbia since then, although some exploration activity is occurring.4 A number of Australian states also have bans in place on the establishment of new uranium mines.5

The approval of uranium mining and milling projects has continued to be a source of major controversy. In 1993, the joint federal–provincial environmental assessment panel examining the then proposed McClean Lake mine recommended that approval of the facility be delayed for five years to permit a better understanding of the likely performance of the proposed tailings management facilities, community health and social impacts, and the

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cumulative biophysical and socio-economic impacts of the project. The Atomic Energy Control Board’s (now Canadian Nuclear Safety Commission) subsequent decision to approve the McClean Lake tailings facility was successfully challenged by the Inter-Church Uranium Committee Educational Cooperative (ICUCEC) before the Trial Division of the Federal Court of Canada. The challenge was, however, overturned on appeal to the Federal Court of Appeal. The Supreme Court of Canada declined the ICUCEC leave to appeal the Court of Appeal’s decision in April 2005.

Table 2.1: Overview of Canadian Uranium Mining and Milling Operations

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<th>Producing Operations</th>
<th>Projects under Development</th>
<th>Past Producing Operations</th>
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<tr>
<td>Rabbit Lake (Northern SK)</td>
<td>Midwest (Northern SK)</td>
<td>Cluff Lake (Northern SK)</td>
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<td>Key Lake (Northern SK)</td>
<td>Cigar Lake (Northern SK)</td>
<td>Port Radium (Port Radium, ON)</td>
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<td>McClean Lake (Northern SK)</td>
<td>Kiggavik (Baker Lake, NWT)</td>
<td>Agnew Lake (Espanola, ON)</td>
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<td>McArthur River (Northern SK)</td>
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<td>Madawaska et al. (Bancroft, ON)</td>
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<td>Rayrock (Marian River, NWT)</td>
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<td>Beaverlodge et al. (Uranium City, SK)</td>
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<td>Quirke/Panel/Denison and Stanleigh et al.</td>
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<td>Gunnar and Lorado et al. (Uranium City, SK)</td>
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2.3.5.2. Community Health Impacts

Releases of radiation and other contaminants through air and water also have an impact on the surrounding community. The main exposure pathways for radioactivity from tailings are direct gamma radiation, inhalation of radioactive particulates, and ingestion of radionuclides through the food chain. While radiation has been shown to accumulate in the biota near uranium mines, the impacts of exposure to the health of the surrounding community are highly contested.

Saskatchewan Health does not study the health impacts of uranium mines on communities near the uranium mines due to confounding factors such as radon in homes and cigarette smoking. However, studies have been performed to assess the health of foodstuffs near uranium mines in northern Saskatchewan by toxicology researchers at the University of Saskatchewan.

In one study in this area, tissues from moose and cattle to be consumed as food were collected. The study concluded that moose and human radiation doses in the Wollaston area were two to three times higher than in control areas.

Another tissue study from 18 Wollaston caribou concluded that an adult eating 100 g/day of caribou meat would receive annual effective doses of 0.85 mSv/year. Additional eating one liver and ten kidneys per year would double this dose to 1.7 mSv/year. A one-year-old child who consumed only 10 per cent of the adult caribou intake would receive more than half the adult dose of radiation. These doses are predominantly from the presence of polonium-210 in the soft tissue. The lichen–caribou–human food chain is considered the most critical food chain in the world for concentrating airborne radionuclides.

While the study concluded that consumption of moose did not carry with it significant health risks, the consumption of caribou was found to potentially increase the chance of developing cancer to as high as 0.6 per cent over a 70-year lifetime, which is equivalent to a rate of six cancers per 1,000 people.

This far exceeds the US Environmental Protection Agency (EPA) range of acceptable cancer risks of 1 in 10,000 to 1 in 1,000,000.

The issue of whether radiation risk models correctly estimate risks to human health is a subject of considerable debate. Recently, these debates have questioned whether current models are appropriate for assessing the effects of radioactive substances taken into the body. These models are based on significant uncertainties, and it has been suggested that the risks posed by radioactive sources inside the body must be judged carefully.
Navajo Nation President Joe Shirley, Jr.
signs Diné Natural Resources Protection Act of 2005
New law bans uranium mining, processing throughout Navajo Nation

CROWNPOINT, N.M. Navajo Nation President Joe Shirley, Jr., today April 29th 2005 closed the book on a 65-year legacy of death and disease by making uranium mining and processing illegal on the Navajo Nation.

“As long as there are no answers to cancer, we shouldn’t have uranium mining on the Navajo Nation,” the President said after signing into law the Diné Natural Resources Protection Act of 2005. “I believe the powers that be committed genocide on Navajoland by allowing uranium mining.”

The President signed the bill at the Crownpoint Chapterhouse before a crowd of 50 thankful elderly and young Navajos who have fought against uranium mining for a decade.

He said many Navajo medicinemen and women and hundreds of Navajo uranium miners have died as a result of exposure to radioactivity and uranium, whether by mining, dust, contaminated water or contaminated livestock. Many other families continue to live with this painful and deadly legacy of the Cold War, he added.

“I don’t want to subject any more of my people to exposure, to uranium and the cancers that it causes,” he said. “I believe we reinforced our sovereignty today.”

The uranium prohibition is needed to address the deadly legacy of past uranium mining and processing on Navajo lands, and to protect the economy, environment and health of the Navajo people from future uranium mining and milling, the President said.

Mitchell Capitan, president of ENDAUM, the Eastern Navajo Diné Against Uranium Mining, said he was thrilled that the Navajo president and the Navajo Nation Council supported his 10-year effort to stop uranium mining in his community.

“I feel like the eyes and ears of the people have been opened,” he said. “There are many people who are suffering from the effects of uranium mining. I don’t know if the federal government will ever be able to compensate us.”

Mr. Capitan said he began his work against uranium mining on Navajoland 10 years ago when he wondered why mining was again being planned for his community, a place where water is so precious and scarce. He said by then the harmful health effects of radiation exposure were already well-known and thoroughly documented.

Seeing that concern end with the signing of this legislation, he said, made the day historic.

http://www.sric.org/voices/2005/v6n2/Navajo_pr_dnrpa.html
“I can always tell my grandchildren that I did something to protect them, something that I am proud of,” he said.

Concerns of protecting the area’s underground water from radiation contamination was expressed by speaker after speaker during the brief ceremony and luncheon.

Lynnea Smith, a 21-year-old member of ENDAUM, said she was grateful to President Shirley who was patient, attentive, “and listened with all his heart” to the group’s concerns shortly after becoming president two years ago. She said his support for the group’s goals never wavered.

“This is the first time the Navajo Nation has taken a huge step to protect the people and the Navajo Nation,” she said.

She thanked all of the Navajo Nation Council delegates and gave special praise to the Southwest Research and Information Center and its long-time representative, Chris Shuey.

Norman Brown, president of Diné Bidzill, said thousand of Navajos are still affected by uranium-caused cancers and need help through the Radiation Exposure Compensation Act amendments now before Congress.

“Hundreds of mines still sit open to the wind and air,” he said. “I have witnessed our elders crying and families pleading for some type of relief from the many cancer deaths that continue daily across our great Navajoland.”

*Press Release from the Office of the President, Navajo Nation, released on April 30, 2005. For further information contact George Hardeen, Communications Director, (928) 871-7917, georgehardeen@opvp.org, P.O. Box 9000, Window Rock, AZ 86515. For additional information, contact: Lynnea Smith, (505) 786-5209, and Chris Shuey, (505) 262-1862.*

**Environmental Problems and Violations Accumulate for Uranium Mining and Processing**

While the uranium mining industry insists that the in-situ leaching process for extracting uranium is environmentally safe, mining violations and associated fines imposed by mining regulatory agencies continue to accumulate. To avoid violations, some mining companies request more lax environmental standards. Significant problems also occur with uranium processing and transportation.

Here are some recent examples:

- Cameco Resources agrees to pay $50,000 fine for deficiencies identified during abandoned drill hole inspection at Smith Ranch ISL site. See [http://www.wise-uranium.org/umopwy.html#SMITHR](http://www.wise-uranium.org/umopwy.html#SMITHR).
- According to Texas Commission on Environmental Quality records, 51 requests for “amended restoration tables to make them higher” have been granted out of 80 uranium mining production areas. See [http://www.victoriaadvocate.com/goliad_county/story/323434.html](http://www.victoriaadvocate.com/goliad_county/story/323434.html).
- Strathmore pays $18,000 fine for numerous violations connected to exploration activities at Sky ISL project site (Wyoming). See [http://www.wise-uranium.org/upusawy.html#SKY](http://www.wise-uranium.org/upusawy.html#SKY).
- $50,000 penalty imposed on Cameco’s subsidiary Crow Butte Resources for violations at ISL uranium mine (Nebraska). See [http://www.wise-uranium.org/umopusa.html#CROWBCD080523](http://www.wise-uranium.org/umopusa.html#CROWBCD080523).
In-Situ Leaching (ISL) Impacts

Spills, Leaks, and Excursions are Common Hazards of In-Situ Uranium Mining

Cameco Corporation owns the Highland Smith In-Situ Leaching plant located in the Powder River Basin near Douglas and Glenrock, Wyoming. It is the largest uranium production facility in the United States, employing about 140 people. Cameco’s website proclaims mining at Smith Ranch-Highland “uses environment-friendly in-situ recovery (ISR) mining technique to extract uranium” and the Smith Ranch facility “employs state-of-the-art technology.” (Editor’s Note: In-Situ Leaching and In-Situ Recovery refer to the same process.)

Despite using “state-of-the-art technology,” the environment-friendly Smith Ranch received 42 license violations involving surface spills and leaks from December 31, 1999 through May 21, 2007 (WISE - World Information Service on Energy - Uranium Project). On March 10, 2008 Wyoming’s Department of Environmental Quality/Land Quality Division (LQD) issued a Notice of Violation to Power Resources, Inc. (PRI) a wholly owned subsidiary of Cameco Corp for numerous deficiencies at their Smith Ranch-Highland Uranium Project. The seriousness of these deficiencies is apparent by LQD’s section on Reclamation Cost/Bonding: “Considering that reclamation will take several times longer, require at least twice the staff with higher wages and require much greater investments in infrastructure than PRI has estimated, a realistic reclamation cost estimate for this site would likely be on the order of $150 million, as compared to PRI’s current calculation of $38,772,800. PRI is presently bonded for a total of only $38,416,500. No bond adjustments have been made since 2002. Clearly the public is not protected.” (For more information, see Wyoming In Situ Leach Uranium Mines Violated State Law).
Smith Ranch does not have an unusual track record. Accidents, spills and leaks are the norm for ISL uranium mining. It is difficult, if not impossible, to find an ISL uranium site that has not recorded a spill, leak, or excursion.

A listing by The Wise Uranium Project of uranium mining companies that have recorded spills and contaminations is extensive and disturbing. In addition, ISL uranium mining, by altering the PH in the aquifer, releases not just the mined uranium but other metals into the aquifer, making restoration of pre-mining conditions almost impossible. It is not unusual for uranium mining companies to ask that required ground water standards be amended and lowered before they complete site restoration, or to appeal for relaxed environmental regulations before mining begins.

Sites where these issues have occurred includes, but is not limited to: Bear Creek (Wyoming); Boots/Brown, (Texas); Bruni (Texas); Burns/Moser (Texas); Cañon City uranium mill (Colorado); Christensen Ranch (Wyoming); Clay West (Texas); Cotter (Colorado); Crow Butte (Nebraska); Highland (Wyoming); Irigaray (Wyoming); Hobson (Texas); Holiday - El Mesquite, Duval County (Texas); Kingsville Dome (Texas); Mt. Lucas (Texas); O'Hern (Texas); Palangana (Texas); Rosita (Texas); Smith Ranch (Wyoming); Tex-1 (Texas); West Cole (Texas); Western Nuclear Split Rock uranium mill site (Wyoming); Zamzow (Texas). For specific details, please see these WISE Uranium Project links:

- [http://www.wise-uranium.org/umopusa.html](http://www.wise-uranium.org/umopusa.html)
- [http://www.wise-uranium.org/udusail.html](http://www.wise-uranium.org/udusail.html)
- [http://www.wise-uranium.org/udwy.html](http://www.wise-uranium.org/udwy.html)

The problem with in-situ mining goes much deeper than surface spills and leaks. After well drilling, the land area around an in-situ mining field has an orderly appearance compared to conventional mining techniques.

"The most critical part of the ISL process is to control the movement of the chemical solutions within the aquifer. Any escape of these solutions outside the ore zone is considered an excursion, and can lead to contamination of surrounding groundwater systems." ([Summary of "An Environmental Critique of In Situ Leach Mining: The Case Against Uranium Solution Mining"](http://www.uraniumresources.com/technology/2.htm))

Surface leaks and spills can be seen while those that occur underground and within the aquifer are often not detected until years after the excursion occurred. Galvin Mudd writes "The technique of In Situ Leaching is not always controllable, safe, nor environmentally benign, and the hidden costs are usually borne by the underground environment. The process of ISL can lead to permanent contamination of groundwater, which is often used by local people and industries for drinking water supplies, and can also contaminate land which was otherwise good agriculturally productive land." The legal battles in the Texas communities of Goliad and Kleberg County support Galvin Mudd’s claim. Texas is finding out, once contamination occurs in
water wells and aquifers, it is difficult to prove who is at fault since the trail of evidence exists hundreds of feet underground.
(See article on Groundwater Quality Restoration.)

Of notable concern for citizens living in northern Colorado, ISL has never been used within close proximity to large population centers. Powertech’s proposed uranium mining site is within 7 miles of Wellington, 11 miles of Fort Collins, and 16 miles of Greeley. The uranium ore body Powertech targets for ISL process is within the Laramie-Fox Hills aquifer which has extensive commercial, municipal, agricultural and residential use. In 2001, prior to northern Colorado’s recent population growth, the Laramie-Fox Hill aquifer had recorded 33,700 wells. The Laramie-Fox Hills aquifer is one of four aquifers that make up the Denver Basin. [Illustration omitted]

Beneath the Laramie-Fox Hills aquifer, separated by a thick deposit of impermeable Pierre Shale, lays the state’s most significant reservoir of ground water, the Dakota-Cheyenne aquifer. It cannot be known whether faults, folds, uplifts and fractures have made paths through the Pierre Shale layer that contaminated water could be forced through when subjected to the pressure created by ISL. Because of the unique geological make-up of northern Colorado, there is no guarantee that underground pressure used in the ISL process can’t drive contaminants into any surrounding aquifers. While bore holes give geologists an exact stratigraphic section of that specific spot, it is impossible to know for certain what the underground terrain is within yards of that spot due to unseen faults and fractures underneath the earth’s surface.

“Some of the most common causes of excursions, identified by international operations in the United States and across Europe, can be through old exploration holes that were not plugged adequately, plugging or blocking of the aquifer causing excess water pressure buildup and breaks in bores, and failures of injection/extraction pumps.” (http://www.sea-us.org.au/pdfs/isl/islsummary.html)

The escape of leaching solutions occurs because water is pushed away from a higher pressure area, like the pressure that will occur during the ISL process, to areas where there is less or no pressure. Besides the faults or breaks in the geological formation across the aquifer system discussed above, any hole or opening in the ground will become a flow path for solutions. The most obvious examples of holes that exist in and near the Laramie-Fox Hills aquifer can be any of the 3,500 drill holes from the early 1970s performed by RME which may not have been properly capped and the 275 wells that exist in the immediate Centennial project area. While Powertech has not released their information as to the location of drill holes done by RME in the early 1970s on the Centennial Project, there is concern RME’s mode of operation during the 1970’s was similar to concurrent ISL operations at Keota Colorado where uranium miners left the area littered with uncapped and improperly covered drill holes. Some drill holes from those early explorations were exposed by Powertech while conducting ground work for new exploratory wells within the Centennial project, as can be seen in one of the photos below. [Some uncapped drill holes illustrations omitted]
Once water contamination from uranium in-situ leaching occurs, water quality is irreversibly damaged. "Despite nearly 25 years of commercial ISL uranium mines in the United States (all using alkaline leaching solutions), regulators are yet to review or approve a report on the full scale restoration of groundwater at these sites" (http://www.sea-us.org.au/pdfs/isl/islsummary.html).

"There is a lack of understanding surrounding an aquifers restoration after in-situ mining has taken place. Even where unproportionately large amounts of ground water were used in the restoration of a 1.25 acre site, not all contaminants were returned to baseline levels." (Source: SpringerLink).

**ISL - Out of Sight, Out of Mind: The Hidden Problems of ISL Worldwide**

The following information was taken from the website of [SEA-US, The Sustainable Energy and Anti-Uranium Service Inc.](http://www.sea-us.org.au/pdfs/isl/islsummary.html).

There are numerous ways in ISL can lead to significant contamination of surrounding groundwater systems or the wider environment:

**Escape of Leaching Solutions**

Water moves from high pressure to low pressure, and thus any hole or opening away from the ore zone could act as a flow path for solutions. These may include features such leaking boreholes, fault planes running across the aquifer system, old underground workings, or any other similar opportunity for water to flow freely.

**Difficulties in Geochemistry**

When the solutions are injected into an ore body aquifer to mobilise uranium, many other minerals are dissolved into solution and many other radionuclides and heavy metals are mobilised also. These can include radium, arsenic, vanadium, molybdenum, cadmium, nickel, lead and others. The subsequent increase in concentrations can be up to a thousand times higher or more.

**Precipitation of Solids**

Due to the nature of the groundwater and orebody chemistry, it is possible to form solid minerals that precipitate from solution and thereby act to reduce or at worst block the flow of solutions through the intended areas. These can include the formation of calcite (calcium cabornate - CaCO3), gypsum (2) (calcium sulphate - CaSO4.2H2O), jarosite (2) (potassium iron sulphate - KFe3(SO4)3.9H2O) and other minerals.

**Waste Water Disposal**

The inherent nature of ISL is that it produces extremely large quantities of waste water and solutions which need to be disposed of in an environmentally responsible manner. These are from the bleed water (excess pumping water) and waste solutions from the uranium extraction plant. Typically these solutions are mixed and re-injected into the same groundwater as that being mined, or injection into a deep aquifer remote from other groundwater users of the area or potential environmentally sensitive areas. Extremely high concentrations of radionuclides and heavy metals can be found in these waste waters, and the disposal area chosen also undergoes rehabilitation after the cessation of ISL mining.

**High Radon Exposures**

Due to the mobilisation of uranium in the groundwater and circulating solutions, high concentrations of radium and radon are often found, leading to possibly high radiation exposures.
Drill Holes Vent Radiation

Drill holes during exploration and ISL mining can release huge quantities of radon gas into the air. According to the US Surgeon General, radon is the second leading cause of lung cancer after cigarette smoking.

Radon gas might not be the only fallout problem associated with uranium mining drill holes for Colorado’s and Wyoming’s front range. Dr. Gordon Edwards writes "When radon gas is released from a uranium mine, it deposits solid radioactive fallout – including polonium-210 – on the ground for hundreds of miles downwind from the mine site. Even during exploration, each drill-hole acts as a chimney which vents radon gas into the air from deep underground." (www.pacificfreepress.com).

Polonium-210 is billions of times more toxic than cyanide. The best information available to use as an estimate for determining how many drill holes would be within the Centennial project would come from existing Wyoming ISL uranium mines. In Wyoming an ISL well is drilled with monitoring wells in a five spot pattern, 100 feet apart. There are ten wells per acre equaling 60 drill holes per acre. There are 6,880 acres in the currently proposed Centennial Uranium project. Click here to see a map of wind directions and communities downwind from the Centennial Project.

*Caller-Times*
*September 29, 2008*
*Goliad, Texas*

Report by hydrogeologist finds Texas in-situ uranium mines have been unable to restore ground water aquifers to premining water quality.

State regulators routinely approve leaving higher uranium levels in ground water; author questions mine operators’ scientific understanding of aquifers.

A groundbreaking report by hydrogeologist Bruce K. Darling, PhD, P.G. for the first time provides data from the Texas Commission on Environmental Quality (TCEQ) documenting the failure of Texas in-situ uranium mine operators to clean up ground water aquifers following mining. Darling concludes that Texas mining regulators have routinely granted requests for relaxed restoration standards at in-situ uranium mining sites and that no evidence has been found that Texas authorities have ever denied such a request.

He further claims that such relaxed restoration standards are an admission that the mine operator is unable to meet the original restoration standards and that “this calls into question the operators’ understanding of the geochemistry of the hydrogeologic systems that they are exploiting.”

The report was commissioned by Blackburn & Carter, a Houston law firm that represents Goliad County, Texas and local residents in a lawsuit against Uranium Energy Corp. The lawsuit alleges that UEC has contaminated local drinking water aquifers as a result of uranium exploration drilling in the county. UEC began drilling in July 2006. In December 2006, the Goliad County Groundwater Conservation District tested 15 wells and found that three contained “alarming” levels of radiation.

Dr. Darling is well-qualified to review these data, according to his bio published in the journal of the American Institute of Professional Geologists:

He has served as a hydrogeologist with the University of Texas Bureau of Economic Geology and Law Engineering and Environmental Services, and as a minerals economist with the US Bureau of Mines. Mr. Darling has extensive experience in water-resource development and management projects. He has completed site-characterization studies of low-level radioactive waste disposal facilities in Texas and North Carolina. His background encompasses supervising geological field reconnaissance, development of geochemical and analytic transport models, groundwater exploration and development programs, exploration geology, and mineral resource economics. Mr. Darling holds a Ph.D. degree in hydrology and an MA degree in mineral economics from the University of Texas at Austin. He also earned an MS in geology and a BA in philosophy from the University of Southwestern Louisiana. He is a member of the American Institute of Professional Geologists, the Association of Groundwater Scientists and Engineers, the Austin Geological Society, and the West Texas Geological Society. He is a licensed professional geologist in six states.

Darling used internal paper documents and spreadsheets from the Underground Injection Control office of the TCEQ to prepare the report. The original source documents are on microfiche and microfilm records located in the Central Records office of the TCEQ. Darling’s work was hampered because TCEQ staff were reluctant to certify
their own paper and digital documents as official records, and Darling found the microfiche and microfilm records to be poorly organized and difficult to search.

Darling found 27 permitted in-situ uranium mines in south Texas, including roughly 80 authorized production areas. Mine operations date from the 1980s through the present day.

Under Texas law, ground water restoration standards for 26 water quality indicators are established when production areas are permitted. Following mining, if the operator is unable to clean up the water to the original restoration standards, the operator may request that the standards be amended. Darling found 51 production areas where such ground water restoration amendments had been approved. With respect to uranium, mine operators were granted permission to leave higher levels of the radioactive metal in 43 different production areas.

In one area (Zamzow PAA-1) the acceptable level of uranium in the ground water was increased by an astounding 29,900%. The original restoration standard was 0.01 mg/l; the amended standard was 3.0 mg/l. For comparison, the federal maximum contaminant level (MCL) for uranium in drinking water is 0.03 mg/l. Zamzow is one of five ISL mines cited by Powertech as evidence that aquifers can be cleaned up after ISL mining. From Powertech’s web page titled "Groundwater Protection":

The groundwater restoration, or cleanup of an aquifer impacted by in-situ uranium solution mining has been shown to be technically, physically and economically achievable. (Ref. NRC NUREG/CR 6870) Some recent successful ISR mine closures include the O’Hern, Hobson, Zamzow, Pawlik, and Longoria mines in South Texas, all owned by different companies. There are no historical cases in the United States where ISR has made a long-term negative impact on public health or the environment.

TCEQ data paint a different picture. For all five mines, uranium restoration values were amended in response to requests by the mines’ operators. Amended restoration values were increased from 291% (O’Hern PAA-4) to 29,900% (Zamzow PAA-1). Although "last sample values" for uranium are not available for all five mines, three production areas showed significant increases in uranium levels after restoration efforts ceased: 213% for O’Hern PAA-4, 4,765% for Longoria PAA-2, and 10,538% for Longoria PAA-1.

Using Powertech’s logic, an aquifer is successfully cleaned up even if the level of uranium in the ground water is 29,900% higher than the premining water quality, as long as a government agency approves the change. And this enormous increase in uranium contamination does not constitute "a long-term negative impact on public health or the environment."

The table below was compiled from data contained in Dr. Darling’s report. Mine production areas in red are those cited by Powertech as examples of mines that have been successfully cleaned up.

JW

Restoration History of Texas In-Situ Uranium Mines

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62
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**Notes:**

1. Only mine production areas with original uranium restoration values and amended values and/or
last sample values are included.

2. Data are from the Texas Commission on Environmental Quality.

3. The federal maximum contaminant level for uranium in drinking water is 0.03 milligrams per liter (mg/l).
http://www.earthworksaction.org/publications.cfm?pubiD=213

A December 2006 EARTHWORKS white paper by Alan Septoff, *Predicting Water Quality at Hardrock Mines* summarizes and analyzes these groundbreaking studies by Ann Maest, PhD and Jim Kuipers, P.E.:

*Comparison of Predicted and Actual Water Quality at Hardrock Mines: The reliability of predictions in Environmental Impact Statements*

*Predicting Water Quality at Hardrock Mines: Methods and Models, Uncertainties, and State-of-the-Art*

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**Predicting Water Quality Problems at Hardrock Mines: A Failure of Science, Oversight, and Good Practice**

**Introduction**

**A failure of science, oversight and good practice**

This paper is a summary, written for the layperson, of the findings of a two-year research study on the accuracy of water quality predictions at hardrock mines. The study, conducted by Jim Kuipers and Ann Maest, brings to light a decades-long failure by government regulators, industry, and consultants to recognize and correct deficient procedures and methods for predicting contamination of water at hardrock mines.

Kuipers and Maest have discovered that, in practice, there is a failure to compare predictions made before the mines are permitted with the actual results. The predictive modeling results are not adjusted to account for real-life failures—this, despite the fact that at the vast majority of mines, problems were worse than predicted. Establishment of credibility in modeling requires that the predictions be tested, and then the models adjusted based on the results. This process appears broken when it comes to predicting the impact of mines on water quality for mine permits.

To permit mines, federal law requires regulators to apply scientific approaches to predict the environmental impacts of the mine proposal – including surface water and groundwater quality impacts. The accuracy of these water quality predictions is of significant public concern. Mining’s impacts on water quality may affect municipal, agricultural, and rural water supplies; important commercial, subsistence and sports fisheries; wildlife populations; tourism; and recreation. One of the reports from the study, *Comparison of Predicted and Actual Water Quality at Hardrock Mines (Comparison Report)*, asks a basic question that government regulators, industry officials and consultants should have asked long ago:

**Do predicted water quality impacts match reality?**

The answer, in short, is no. The *Comparison Report* reveals:

- 100 percent of mines predicted compliance with water quality standards before operations began (assuming pre-operations water quality was in compliance).

- 76 percent of mines studied in detail exceeded water quality standards due to mining activity.
Mitigation measures predicted to prevent water quality exceedances failed at 64 percent of the mines studied in detail.

Along with more analysis of this question, the Comparison Report and the companion report on methods and models used to predict water quality (Methods and Models Report), also seek to answer the necessary follow-up questions:

- In cases where predicted water quality impacts fail to match reality, why do they fail?
- Do certain types of mines fail more often than others?
- What can be done to address current failures and prevent future failures?

The Kuipers-Maest reports were prepared for a professional audience. The purpose of this paper is to translate and summarize the main findings of their research (for the layperson and the interested public), and to offer common sense recommendations based on those findings with an eye toward protecting natural resources and public health.

The Context

Why this research was necessary

The Environmental and Public Costs of Faulty Predictions

The failure to accurately predict and manage water quality impacts can result in significant negative impacts on clean water and steep taxpayer liabilities for the costs of cleanup. Consider one often-cited example — the Summitville gold mine in Colorado. Water pollution at this mine has cost American taxpayers more than $200 million in cleanup costs. The majority of that money has been spent mitigating acid drainage and cyanide releases that were not predicted during the permitting process. When pollution spilled from a containment pond, 18 miles of the Alamosa River were effectively killed — impacting not only the aquatic life in the river, but also the adjacent farms and ranches that relied upon the Alamosa for irrigation and livestock watering.

While it may be argued that Summitville is one of the worst-case examples, problems abound. According to the U.S. EPA’s Abandoned Mine Land Team, the cost of mine cleanup at sites on the National Priorities List (i.e. Superfund sites, like Summitville) in the United States is $20 billion — almost 3 times the EPA’s FY 2007 budget request. Long term water treatment and management is often the single most significant cost associated with mine cleanup.

In fact, there is an increasing number of mine sites throughout the U.S. that will require water treatment in perpetuity. In the arid west, these types of long-term impacts place a tremendous burden on downstream communities who must deal with the consequences of failed predictions. For example, government regulators have determined that the Zortman Landusky mine, located near the Fort Belknap Reservation in Montana, will continue to generate acid mine drainage for thousands of years. As a result, the Fort Belknap Tribes are faced with a continual threat to important tribal water resources, and the state of Montana will be spending tens of millions in public funds for longterm water treatment.5

In order to ensure clean water and protect taxpayers from liability for cleanup costs it is important to understand the frequency and magnitude of failures in predicting water quality impacts. Consider that at most major mines, operators are required to post financial assurances prior to operating. This is the good news. These assurances are supposed to guarantee that, should the mine operator go bankrupt, the mine site will be reclaimed at no cost to the taxpayer. However, the bad news is that these financial assurances are based upon expected reclamation costs and expected reclamation costs are based in large part upon water quality predictions.
Previous research by Jim Kuipers demonstrates that taxpayers are potentially liable for up to $20.4 billion in financial assurance shortfalls at existing mine sites (in addition to the $20 billion for Superfund sites) – due in large part to inaccurate water quality predictions.

A Growing Problem

Without correction, the environmental and financial impacts of faulty predictions could grow. Recent increases in metals prices have triggered an increase in the number of new mines being proposed in the United States. According to the Bureau of Land Management, new mining claims filed in 2006 are on track to more than quadruple since metals prices began their precipitous rise in 2002.

In the United States alone there are approximately 180 large hardrock mines – in nearly all regions of the country – that are in various stages of permitting, development, operation or reclamation and closure. In order to better protect important water resources and reduce future economic liability, improvements must be made in the prediction and prevention of impacts to water quality at these sites. On the positive side, the increase in metals prices has resulted in fewer bankruptcies in the sector—and it is bankruptcies that trigger the use of reclamation bonds for mine site reclamation and water treatment. This may provide regulators and industry officials with a window of opportunity to solve the underlying problems with water quality prediction.

Unprecedented Research: the absence of previous studies and the data gap

When they began their research, the authors expected to incorporate data from some mines where government officials had already completed a comparison of predicted and actual water quality impacts. However, they were unable to find comparisons of water quality predictions and actual water quality impacts of mines.

The authors found that no single repository exists for the Environmental Impact Statements (EISs) currently mandated under federal law. EISs contain the water quality predictions analyzed in the study. In some cases, local federal offices that processed the studies did not have copies of them. Furthermore, in many cases, the authors were forced to submit Freedom of Information Act requests and pay fees to obtain copies of these studies. Similarly, water quality from mines was inordinately difficult to obtain and in most cases required personal visits to agencies and long hours sorting through paper files.

Taken together, the absence of previously published research and the difficulty in gathering information is evidence of a data gap that surprised the authors and may help explain the previous lack of a comprehensive study of this nature.

It is important to note that the predictions data were available – no matter how difficult to obtain – only because the National Environmental Policy Act (NEPA) requires it. Without NEPA, this study would have been impossible to conduct.

A Tool for Many Audiences

While the research focuses on the underlying scientific and engineering processes that form the basis of water quality predictions, its recommendations are intended for use by many audiences to increase the effectiveness of future mine water quality predictions – directly and indirectly:

- This study should be useful to the scientific and engineering communities for suggesting ways to better characterize risks to water quality and to better apply mitigation methods to minimize or prevent potential impacts.

- The regulatory community can look to these reports, especially Methods and Models, for recommendations on how to fundamentally improve the permitting process to ensure a more accurate analysis of potential mining
impacts. The inherent uncertainty in water quality predictions and mitigation failures should be conservatively viewed in order to ensure mine permitting decisions that are more protective of human health and the environment. The integrity of the mine permitting process is dependent on the use of accurate methods and models.

- This report can be utilized by the mining industry to improve current practices and more accurately predict consequences and ameliorate potential effects.

- It can be utilized by the insurance and investment industry as a tool to better understand the potential risks and costs associated with mining, and as a basis to reassess risks at current mines.

- And finally, it can be utilized by the interested public to more effectively advocate for water quality protections in the permitting process and to advocate in the public arena for legislative and regulatory changes that better protect water resources.

Do Predicted Water Quality Impacts Match Reality?

As indicated above, the answer is usually no — particularly when high risk mines, such as those with close proximity to water resources, are considered.

Sampled Mines

To arrive at this answer the authors initially reviewed 104 Environmental Impact Statements (EISs) and Environmental Assessments (EAs) for 71 major hardrock mines in the United States.7 The mines covered all important mineral sectors (gold, silver, copper, platinum group metals, molybdenum, lead, and zinc) and ten mining states (Alaska, Arizona, California, Idaho, Montana, New Mexico, Nevada, South Dakota, Utah, and Wisconsin).

A representative subset of 25 case study mines was then selected to evaluate the accuracy of the water quality predictions. Environmental impact reports for these mines were evaluated for predictions related to surface water, groundwater, and mine drainage quality during and after mining. These predictions were then compared with actual water quality conditions during and after mining.

Potential & Predicted Water Quality

The authors discovered a two-tiered system for water quality predictions, one-tier of which was based not on sound science, but on unsupported “good faith” projections. The two tiers of “predictions” made about water quality in environmental assessments are referred to by the authors as “potential” and “predicted” water quality:

- **Potential** water quality is the expected water quality conditions in the absence of mitigation efforts by the operator.

- **Predicted** water quality takes the effect of mitigating measures into account. It is what mine operators forecast actual water quality will be during and after operations.

All the environmental reviews analyzed in the *Comparison Report* predict acceptable water quality after mitigation at mines where water quality standards were met before mining began. If this prediction were not made, the regulatory agency would not be able to approve the mine.

However, inadequate information was provided to demonstrate how the mitigation measures would actually prevent water quality impacts. Therefore, regulators were generally accepting the final water quality predictions on “faith.”
Major Findings: Chronic Underestimates of Water Quality Problems

Prediction vs. Reality: Overall Water Quality Impacts to Ground and Surface Water

Of the 25 mines sampled:

- 76% of mines polluted groundwater or surface water severely enough to exceed water quality standards.
- 60% of mines polluted surface water severely enough to exceed water quality standards.
- At least 13 mines (52%) polluted groundwater severely enough to exceed water quality standards.

Predictions vs. Reality: the Failure of Mitigation

In the cases where water quality standards were exceeded, in some cases the mine proponent anticipated the potential for pollution and prepared mitigation strategies (e.g., a mine waste dump lined with plastic to prevent acid drainage leaching into groundwater). Predictions of the efficacy of mitigation were no more reliable than overall predictions of water quality:

- 73% of mines exceeded surface water quality standards despite predicting that mitigation would result in compliance. The other 4 mines didn’t predict the need for mitigation.
- 77% of mines that exceeded groundwater quality standards predicted that mitigation would result in compliance. The other 3 mines didn’t predict the need for mitigation.

Predictions vs. Reality: Mines near Water with Elevated Acid Drainage or Contaminant Leaching Potential are High Risk

Some mine projects are so high risk that water quality exceedances are a near certainty: those mines that are both near groundwater or surface water resources, and possess an elevated potential for acid drainage or contaminant leaching.

- 85% of the mines near surface water with elevated potential for acid drainage or contaminant leaching exceeded water quality standards
- 93% of the mines near groundwater with elevated potential for acid drainage or contaminant leaching exceeded water quality standards.
- Of the sites that did develop acid drainage, 89% predicted that they would not.

Water Quality Pollutants

Of the 19 mines that exceeded water quality standards, the pollutants that exceeded standards were as follows

- Toxic heavy metals such as lead, mercury, cadmium, copper, nickel or zinc exceeded standards at 63% of mines.
- Arsenic and sulfate exceeded standards at 58% of mines.
- Cyanide exceeded standards at 53% of mines.
Why Do Predictions Fail?

In order to evaluate water quality impacts during the permitting process, government regulators rely on water quality predictions created by hydrologists and geochemists and mining engineers using computer models and other types of field or laboratory studies. Those predictions are only as good as the science upon which the models/tools are based, and the site characterization information supplied to those models. So when water quality predictions fail to predict water quality for mining operations, they fail for two general reasons:

1. the science of mine water quality prediction is imperfect
2. the science of mine water quality prediction is imperfectly applied at mine sites

The Imperfect Science of Mine Water Quality Prediction

The complexity of pollutants’ interaction and movement in groundwater and surface water systems at mines is difficult to recreate in a model. This is addressed in detail in the companion report by Maest & Kuipers titled Predicting Water Quality at Hardrock Mines: Methods and Models, Uncertainties, and State-of-the-Art.

According to Methods and Models, factors that complicate the prediction of water quality at mine sites range in scale from small to large. On a small scale, for example, it is not well known how minerals react in complex systems. On a large scale, geology, climate, methods of mining and mineral processing, and mine waste management approaches vary among and within mine operations. These large scale variations limit the degree to which information from one site can be applied to another.

Also, extrapolation from the laboratory to the mine must address complicating factors such as environmental conditions, water and gas transport, differences in particle size, and how these variables affect drainage quality over periods of decades or centuries. However, there is virtually no available field information describing the effect of these variables over extended periods of time. The lack of this field information introduces significant additional uncertainty into predictions.

Just as weather cannot be accurately predicted beyond a certain point because weather models and their inputs are not perfect, the transport of pollutants through complex geological and hydrological systems over the longer term, which can range from five years to tens of thousands of years is similarly difficult to predict.

One of the study’s most significant findings, however, is where the practice of predicting weather and the practice of predicting water quality at mining operations part ways. Weather models are consistently reevaluated based on a comparison of predictions with actual weather conditions that occur subsequently.

Not so with the models used for predicting water quality at mining operations. The very fact that the study is unprecedented shows that professionals who predict mine water quality do not revisit their predictions, and neither do the regulators responsible for ensuring the accuracy of those prediction. The models used for the predictions cannot be improved if their failures and successes are not evaluated. Where predictions of water quality at mining sites are concerned, the scientific process is broken.

Imperfect Science, Imperfectly Applied

A mine water quality prediction model can only reach its potential at any individual mine site if that site is correctly characterized (in terms of its hydrology and geochemistry) to the extent possible. According to Maest and Kuipers, that potential is not being reached.
There are two types of characterization failures described in the Comparison Report: hydrologic (related to water flow at a mine site) and geochemical (the chemistry, geology and mineralogy of the materials/minerals that comprise the mine site).

The Comparison Report documents that six of the 25 case study mines were inadequately characterized hydrologically, and that eleven of the case study sites were inadequately characterized geochemically.

Another example of “imperfect science, imperfectly applied” is the bias of mine water quality predictions made by consultants hired by the prospective mine operator. This problem is implied by the number of site characterization failures, and by the failure to check the results of past mine water quality predictions.

Regulatory agencies, both federal and state, allow the mining company to select and directly pay consultants to predict mine water quality impacts, and to review and comment on (or even reject) those predictions, prior to release to the agency. It is an understatement to say that consultants heavily influence mine water quality predictions. Unfortunately, given the client/customer relationship between prospective mine operators and their consultants, consultants are rewarded for having favorable predictions. On the other hand a prediction of poor water quality will usually delay a permit, which increases the permitting costs. While exceptions exist, consultants that predict poor water quality often are not rehired. This perverse incentive is contrary to the spirit of unbiased science, and contrary to the public interest.

Preventing Future Failures (and Addressing Current Failures)

Recommendations

Both the Comparisons and the Methods and Models Reports reveal that the prediction of future mine water quality is an uncertain business. And given the difficulty in modeling natural systems, even if the all the recommendations included here and in the Kuipers-Maest research are implemented, mine water quality prediction will always be an uncertain business. However, there is considerable room for improvement.

Just as weather prediction has improved over time, so can mine water quality prediction — if regulators and professionals in the sector learn from past predictions and improve characterization efforts.

With that in mind, the following recommendations are intended to help improve mine water quality predictions today and in the future.

Addressing the Consequences of the Existing Prediction Process

Assess existing mines. If the results of the Comparison Report are extrapolated to all operating major mines, water quality standards would be exceeded at roughly 75% of all mines in the United States. Regulators should, in a public process, canvass all permitted mines to:

- determine which mines are exceeding water quality standards,
- evaluate how surrounding communities and the environment are being affected, and what cleanup steps are necessary,
- revisit the original predictions, and
- reassess the adequacy of the financial assurances provided by mine operators to guarantee mine cleanup and long-term water treatment.
**Incorporate uncertainty into permitting process.** Regulators should take a suitably precautionary approach to the mine permitting process, and require that mine design, mitigation and financial assurance calculations prepare for reasonable worst-case rather than best-case scenarios.

**Better screen high-risk mines.** Regulators must demonstrate concrete improvement in the accuracy of mine water quality predictions and mitigation efforts. For example, additional regulatory scrutiny should be given to the highest risk proposals such as those mines near water resources and with elevated acid drainage or contaminant leaching potential. In cases where the risks are too high, regulators should not permit mines. It should be noted that this recommendation is supported by the *Comparison Report* which demonstrates that 93% of such mines near groundwater, and 85% near surface water, exceeded water quality standards.

Some major mining companies are realizing that the lifecycle costs need to be clearly evaluated, including the costs of *perpetual maintenance and water treatment after mine closure*. While some leaders in the industry are using life-cycle cost estimates, this is still not a uniform industry standard, and regulators ultimately must make the determination for many mine proposals.

**Inform the public about the uncertainty of water quality prediction.** As part of the mine permitting process, regulators should inform the public of the history of the accuracy of mine water quality predictions so they can better determine the risk involved in a mine proposal.

**Improving Future Mine Water Quality Predictions**

**Ease access to predictions and results.** Information regarding pre-mining, mining and post-mining water quality should be publicly available online, along with the associated mine water quality predictions made during the permitting process. This will facilitate a more informed mine permit process for regulators and the public.

**Review original predictions as water quality develops during mining.** Mine operations should be regularly assessed to determine if they are departing from mine water quality predictions. This will allow regulators and mine operators to take early action when mine water quality begins to depart from the predicted.

**Consult past predictions at other mines.** When permitting a mine, regulators should be required to seek similar mines, or similar aspects of different mines, and determine what predictions were made and what water quality actually occurred. These mine analogs should be publicly disclosed.

**Require improved characterization of mine sites.** This recommendation is covered in much greater detail in the *Methods and Models Report*. In summary, regulators should require better information about the mine site — before, during and after operations.

**Require more research on the effectiveness of mine water quality mitigation.** The *Comparison Report* found that where predictions of good mine water quality were predicated upon the mine operator using mitigation strategies, mine water quality usually exceeded water quality standards. More research is needed to determine how and why these mitigation efforts fail, and how to improve them.

**Change the procedure for selecting consultants to avoid the present conflict of interests.** Agencies should independently select and pay the consultants to conduct the studies. This will limit the ability of a mining proponent to influence the outcome of the predictions. The mine proponent can comment on the study, similar to public interest organizations, but they should not be able to exert sufficient influence to bias the outcome.

**Increase government expertise.** Many state and federal agencies are not sufficiently funded to employ staff with the technical expertise to provide appropriate analysis and oversight of the mine permitting process. Increased funding should be incorporated into agency budgets to ensure that technical expertise is available for permit review.
Endnotes

1. Jim Kuipers, PE, is a mining engineer with Kuipers & Associates in Butte, Montana, and Ann Maest, PhD, is an environmental geochemist with Buka Environmental in Boulder, Colorado.

2. The National Environmental Policy Act requires a science based review of mine proposals when federally-owned land is affected, or when a federal permit is required (e.g. the Clean Water Act requires a permit when a mine discharges into waters of the United States). Many states have similar laws, based on NEPA, that apply to mine proposals even when federal land is not involved.

3. Mitigation is the effort by a mine operator to prevent or reduce pollution. For example, some mine waste (e.g., tailings impoundments) is underlain by thick plastic to prevent contaminants from moving into nearby water resources.

4. In this paper, an “exceedance” is the presence of a pollutant in concentrations higher than a water quality standard. This is different from a water quality “violation,” which is a breach in the terms of a water quality permit. A water quality permit, although based on standards, may allow exceedances under some conditions. A mine operator is legally liable for a water quality violation.


6. Kuipers, J, 2003, Putting a Price on Pollution: Financial Assurance for Mine Reclamation and Closure. This report was funded by Mineral Policy Center. 7. Many mines have multiple EISs or EIAs for different eras of mining.
Virginia Tech scientists, students conduct research at Coles Hill
By TIM DAVIS/Star-Tribune Editor
tim.davis@chathamstartribune.com
Wednesday, September 10, 2008

A team of scientists and students from Virginia Tech is trying to see what's underground -without doing any digging- at the Coles Hill uranium deposit in Pittsylvania County.

The site, about six miles northeast of Chatham, is believed to be the richest uranium deposit in the United States.

Marline Uranium Corp. discovered the Coles Hill deposit 30 years ago, but abandoned the project when the price of uranium fell.

A little over a year ago, Walter Coles, who owns the land and a majority of the ore, formed Virginia Uranium Inc. to explore the possibility of eventually mining the deposit, which is now worth an estimated $10 billion.

Three Virginia Tech graduate students started work on the three-year project in late May and early June, and two more are scheduled to begin this fall.

"This is an extremely unique opportunity to come in with a large group of faculty and students and do a truly integrated study using all different types of expertise and techniques to study an ore deposit before it's mined," said Dr. Robert J. Bodnar, a distinguished professor in the Department of Geosciences at Virginia Tech.

Bodnar has studied ore deposits for 30 years and has been at Virginia Tech 23 years. A geochemist, he has a master's degree from University of Arizona and doctorate from Penn State.

Virginia Uranium is providing support for the teachers and students - basically a stipend that covers expenses and part of their salary - but their studies are being conducted independently.

"We obviously have mutual interests, but we have an agreement where they don't tell us what to do," said Bodnar. "I don't think any of us have ever felt that we have been pressured by Virginia Uranium to come up with any specific outcomes or results. As a scientist, I look at the facts and try not to let politics or other pressures influence them."

"They're professionals, and ultimately it's their name that's on the research," said Mick Mastilovic, vice president of operations for Virginia Uranium.

According to Mastilovic, Virginia Tech intends to publish its research and make it available to the public, much like earlier studies on the Coles Hill deposit.

"Our goal with Virginia Tech is to turn the science on," he said. "Before you can answer a lot of questions you've got to collect a lot of information."

Mastilovic said Virginia Tech's research focuses on geology and what's underground and is not intended to take the place of a study on uranium mining by an independent organization like the National Academy of Science.
Earlier this year, Virginia Uranium had hoped to convince the state to conduct a study on uranium, but the bill was bitterly opposed and ultimately defeated. Opponents feared the study would open the door for uranium mining.

"It's a research tool," said Coles, noting the study will provide a better understanding of the ore body and water table. "All their work will benefit us down the road when we develop our mining and milling plan."

Virginia Uranium hopes to move forward on a broader, state-sponsored study next year.

"We're pushing every day to get some sort of study under way," said Coles. "We're hoping it will happen sooner rather than later."

Core samples
Virginia has had a moratorium on uranium mining since 1982, but Virginia Uranium received a state permit to conduct exploratory drilling to verify the deposit.

The company began test drilling in December and has drilled 10 holes, according to Mastilovic.

Core samples from the test holes are kept in a storage unit next to Virginia Uranium's temporary office on Coles Road.

Those cores will be analyzed before other test holes are drilled, said Mastilovic. The company has a permit for 40 test holes.

Across the dirt road from Virginia Uranium's office stands an unassuming building that houses Marline Uranium's 65,000 feet of core samples taken from 1977 to 1983.

Marline donated the cores - basically long cylinders of solid rock - to the Virginia Museum of Natural History in Martinsville 20 years ago.

James S. Beard, curator of earth sciences for the Virginia Museum of Natural History, is a geologist and adjunct professor at Virginia Tech. He is helping with the Virginia Tech study.

Visitors to the core shed are required to sign in and out and workers wear radiation badges as a safety precaution, although Mastilovic said there is no danger.

"It's essentially a rock collection," he said of the core shed's 7,500 boxes. "The biggest danger is if a box falls on you."

What's underground?
Over the past three months, graduate students have employed ground-penetrating radar, electromagnetic studies, and seismic tests - essentially "mini-earthquakes" - to learn more about the uranium deposit.

"What we're trying to do is predict what's beneath the surface," said Bodnar. "All of these studies are telling us something about the subsurface - the rocks, when the rock type changes, where the major faults are.

"All those pieces of information are critical to understanding the ore deposit as it exists today, and that will be very useful information as the company starts to develop the deposit in the future," he said.

Dr. Thomas J. Burbey, an associate professor of hydrogeosciences at Virginia Tech, is studying hydrology - how water moves through fractures in rocks in the soil, what controls movement, and how that might be affected once the ore body is disturbed.

Before coming to Virginia Tech, Burbey was with the U.S. Geological Survey in Nevada for 12 years. He has master's degree and doctorate from the University of Nevada.

"I'm always interested in how water flows through fractured rock. It's very complicated. It's even really hard to
understand within a single watershed,” said Burbey, who teaches and conducts research at Virginia Tech.

"Anytime we have an opportunity to learn something we're going to take it," he said. "Fortunately Virginia Uranium opened up an opportunity for us to learn something new."

Other Virginia Tech professors participating in the study include Dr. John Holle, a geophysicist; Dr. Chet Weiss, a faculty member in the geosciences department; and Dr. Eric Westman, a faculty member in the Department of Minerals and Mining Engineering.

Dr. Marilyn Maisano, a professor at Virginia Military Institute, also is lending a hand with field work and research.

Graduate students
Graduate students conducting research for their master's theses include J.P. Gannon of Franklinville, N.J.; Josh Whitney of Fredericksburg; and John Wyatt of Appomattox.

Gannon is doing his thesis on how water moves through fractures in the rocks in the vicinity of the ore body.

To get an underground profile of the permeability of the rock and soil around the uranium deposit, he employed a resistivity study, which uses a straight line of evenly spaced electrodes.

"There are these really long lines that have to go straight through about anything," said Gannon, "so there's a lot of barbed wire fence jumping, having to line them up to avoid buildings, and hacking through thickets."

Whitney, a student in Virginia Tech's Department of Mining and Minerals Engineering, is conducting an electromagnetic and ground-penetrating radar study of the Coles Hill site with Weiss and Westman.

"They are looking at slight variations in the magnetic and electrical properties of the rocks and the subsurface," explained Bodnar.

Wyatt, a graduate student in the Department of Geosciences, is conducting a surface mapping study.

Wyatt, 29, has ties to the area. His mother, Carolyn Mason Wyatt, is from Gretna and his dad, Harold Wyatt, is from Mount Airy.

"It's something I've always known," he said about the uranium deposit. "When I was offered the chance to study here, I didn’t have to think about it. I said yes."

Wyatt is working closely with William Henicka, a retired field geologist with the Virginia Department of Mines and Minerals and an adjunct professor at Virginia Tech.

Henicka is familiar with Coles Hill, having mapped the area for the state years ago.

A recent day found Henicka and Wyatt huddled under a makeshift canopy, their noses inches from a rock outcropping.

"What we're trying to do is see how the deposit evolved," Henicka said. "It just didn't happen all at once. We're trying to unravel one piece at a time - CSI fashion."

Even though classes have begun at Virginia Tech, Bodnar said students will continue field research on a limited basis during the school year.

"We're just interested in the basic science," the professor said.
Geologists learning uranium containment from nature

Blacksburg, VA, March 13, 2001 -- Three decades ago, possibly one of the richest uranium deposits in the US was discovered at Coles Hill in rural South-central Virginia. Although the deposit was considered for mining, it was never developed. However, this site may yield knowledge of great value as a natural laboratory for radioactive waste containment.

"The uranium has just been sitting there for hundreds of thousands of years," says A. K. Sinha, professor of geological sciences at Virginia Tech. "Sitting there" are the operative words. "There is a water table about 11 meters (36 feet) down, and the uranium-rich bedrock about 20 meters (66 feet) down. The uranium should have migrated to the next county, but it hasn't."

"You would expect ground water in this type of natural system to have carried the uranium away from the site into the surrounding environment, but we don't see that," says Virginia Tech Ph.D. student Jim Jerden, of Atlanta, Ga. "We think we can learn something from this site that can be applied to existing contaminated sites and nuclear waste repositories."

Sinha explains, "Uranium is toxic, particularly when it is concentrated, such as in nuclear fuel, weapons, and radioactive wastes. In nature, there are deposits that are extremely concentrated and they should be of great concern, as uranium may be transported in solution through ground water activity. But, in nature, things have a way of reaching a 'steady state'. The Coles Hill deposit, for instance, shows no measurable evidence of leakage into the surrounding soils and rocks. This 'natural analog' provides a scientific window where we can study what prevents uranium from contaminating its surroundings."

As geologists, Sinha and Jerden are looking at the natural system that contains the Coles Hill uranium deposit as a unique geologic analog for uranium-contaminated sites and nuclear waste repositories. "Nature may present a model for the scientifically sound management of nuclear wastes and contaminated sites," says Jerden.

Jerden will present some of his research from Coles Hill at the 36th annual meeting of the Northeastern Section of the Geological Society of America (GSA) in Burlington, Vermont, March 12-14. "I will talk about the interaction of soil, rock, and ground waters, and the details of the minerals that inhibit uranium from being transported into the surrounding environment. Specifically, we have discovered that the abundance of phosphorous and its interaction with uranium is likely the cause for the lack of migration," he says.

Later this month, Sinha, Jerden, and Lucian W. Zelazny, professor of soil sciences at Virginia Tech, will meet with scientists from the University of Georgia's Savannah River Ecology Laboratory (SREL) and the University of South Carolina medical program to discuss a research partnership for using advanced technologies for a better understanding of the behavior of uranium in soils.

"SREL scientists have been experimenting with phosphorous and uranium in the laboratory. The goal of these experiments was to develop new cost effective technologies that can be applied for remediation of uranium contaminated sites, so they were very interested when we told them we were researching a natural system in which uranium and phosphorus are combining to naturally limit uranium transport," explains Jerden.
It is not just the richness and the self-containment of the deposit located only two hours away from Virginia Tech's Blacksburg campus (south east of Chatham, Virginia, near the little town of Gretna) that makes it such a unique resource for researchers. "The corporation that discovered the site did extremely good exploration of this deposit," explains Sinha. "They drilled approximately 70,000 feet of solid rock (70,1,000-foot cores). They created an enormous database. It would cost the government tens of millions of dollars to do that today, but this cost was borne by industry." When the mining activities were abandoned the corporation donated their information to Virginia Tech, and gave the cores for storage to the Virginia Museum of Natural History.

"We have an infrastructure database already generated at no cost to the taxpayer," says Sinha. "Virginia Tech has augmented this database through shallow drilling supported by the Virginia Division of Mineral Resources and is using the data and the samples to prove the site is a world class scientific target for research.

"We are asking basic questions," he says. "What are the natural processes that inhibit migration of uranium? If we can understand that, then our colleagues in engineering and other sciences can apply that knowledge to develop better strategies for cleaning up and managing contaminated sites and nuclear waste repositories.

"We are working in partnership with other institutions that wish to characterize this site so that all the people interested in the environment can use these resources to understand the transport of uranium," Sinha concludes.

The subject of Jerden's doctoral research is to understand the geology of the uranium containment at the Coles Hill deposit. His GSA presentation, "Uranium transport in weathered bedrock: Application of environmental petrology," will be presented at 10:50 a.m. March 13, at the Sheraton Conference Center, Diamond Salon II.

For additional information, reach Dr. Sinha at 540-231-5580 or pitlab@vt.edu and Jim Jerden at 540-231-7083 or jjerden@vt.edu.

The following illustrations are posted at www.rgs.vt.edu/resmag/ColesHill/. Additional figures may be available from Jerden.

FIGURE CAPTIONS:
Figure 1. Three-dimensional visualization of the uranium ore body at Coles Hill, Virginia. The environmental response of the uranium ore within the soils represents the predicted fate of nuclear wastes at contaminated sites or repositories. This location thus represents a world class "natural analog" for studying and monitoring the interaction of uranium with ground waters in the near-surface environment. Results of research at Virginia Tech suggest that abundant uranium present in the soil is not being removed by ground waters leading to a "closed system" behavior of uranium.

Figure 2. Soils developed over the Coles Hill uranium deposit yield information on the formation of new uranium minerals being produced as a result of the interaction of ground water with primary uranium ore minerals. Research at Virginia Tech is leading the way in demonstrating the geologic mechanisms controlling the growth of new uranium minerals. The availability and stability of these minerals in the soil environment lead to low abundances of uranium in the ground waters. The multidisciplinary science team is investigating the application of these observations towards developing technologies for sound management and remediation of uranium contaminated sites and repositories.

Figure 3. Specimen of rock core extracted from the chemically weathered uranium ore. This photograph was taken in ultra-violet light. The green material is the new uranium mineral that is forming within the weathering environment. These new minerals are effectively trapping the uranium so that it can not be moved by ground water away from the site.

Figure 4. Remediation technologies require an assessment of uranium in the soils at all different scales. These chemical maps of the new uranium mineral forming within the soils above the uranium deposit illustrate the scale at which these minerals must be characterized (one micron is one millionth of a meter).
As uranium mines closed, state altered cleanup goals

Initial targets were unrealistic and unnecessary, companies say

*Dan Kelley/Caller-Times*

*Sunday, November 5, 2006*

As uranium mines in Texas closed one-by-one during the past two decades, the mining companies had one thing in common: They asked the state to relax the groundwater restoration standard listed in their mining permits.

State regulators had one response: "OK."
The Caller-Times examined 32 permits from closed South Texas mines that had used a water-pumping method to mine. In each case, companies were permitted to leave behind minerals such as uranium, molybdenum and selenium at higher levels than were listed in the original permit. Other permits were reviewed, but it is unclear if a similar pattern was repeated because the boundaries of mine areas were changed or merged with other mines, making it difficult to establish what the stricter, original cleanup standard should have been.

Mining companies say the permits require them to clean groundwater that never was fit for human consumption. They also say there never has been a documented case of drinking water contamination from their mining operations.

The increases that appear in the amended permits aren't uniform. In some cases, companies were able to meet the restoration target for one mineral but reported 10- and 20-fold increases in others.

Older mines tended to require more drastic permit amendments than mines started later.

"It's a kind of a shell game," said George Rice, a groundwater hydrologist hired by a citizens' group in Kleberg County to help enforce cleanup standards at a mine known as Kingsville Dome. "They tell people, 'Here are the standards we're going to meet.' All along, they know they aren't going to meet those standards and the state knows they aren't going to meet those standards."

John Santos, a geologist with the Texas Commission on Environmental Quality, said he performed an informal examination of all permits and produced similar results. It is unclear if the study ever appeared in written form. The commission is the state agency that agreed to the permit amendments.

Selenium in low doses is necessary for human health, but in high doses is linked to respiratory inflammation. Molybdenum in high doses is an irritant of the ears, nose and throat, according to the Centers for Disease Control.

Uranium, mined primarily for use in nuclear power plants, is linked to kidney failure, according to the CDC.

These minerals occur naturally in the mining areas and across South Texas.

The issue of how far a mining company must go to restore a property's groundwater has cropped up in a handful of court cases.

In a federal lawsuit involving two ranches in Webb and Duval counties, a federal judge recently ruled that the groundwater on the property was used for drinking water before mining, which could mean companies are required to clean water to drinking water standards.

In two affidavits filed in federal court, ranchers claim the levels of selenium and uranium left behind by Cogema Inc. impacted potential ranching and hunting uses. The ranchers say mining company representatives promised that the water would be restored to pre-mining conditions.

The owner of one ranch told the court in an affidavit that she and her husband would not have leased their property to uranium miners if it wasn't going to be restored to pre-mining conditions.

"We all recognize that water is the most valuable resource in Texas," the rancher stated in court documents, "and to permit Cogema to not do what it promised the landowners is nothing more than tolerating abusive behavior and breach of contract."

A lawyer representing Cogema Inc. disputed the claims that the water ever was potable.

"The water in the mining zone wasn't suitable for human consumption before the mining started," said Carlos M. Zaffirini Sr. of Laredo. "It is not suitable today. What they are complaining is that the levels are greater inside the mining zone. We aren't talking about wells outside of the mining zone. All of the wells outside the mining zone are at background levels."

Zaffirini said that claims the groundwater was used as drinking water before mining are fact questions to be settled at trial.

In an instance in Kleberg County, the operator of the Kingsville Dome mine, Uranium Resources Inc. of Lewisville, entered into a negotiated agreement that established groundwater standards. Uranium Resources Inc. also agreed to fund a citizens review board to independently monitor cleanup progress.
The result, according to the chairwoman of the citizens review board, has been mixed.

"We felt they had not complied with the agreement," Carola Serrato told a crowd in Goliad in September. "We filed a report saying URI had not complied with its restoration responsibilities."

Officials with the company said it met the terms of the agreement.

Industry experts say that testing when the water pumping mining technique, known as in-situ leach mining, was in its infancy wasn't accurate, and mistakenly set high standards for groundwater remediation.

Craig W. Holmes, a consultant to the industry, said that when companies began mining South Texas for uranium 30 years ago, they didn't drill enough monitoring wells and at times did not hit the ore body with the monitoring well. Because of this, the restoration standard was based on data that had less contact with uranium. When it came time to clean up, the companies realized the calculations were in error.

"That's what they say," said Santos, the Texas Commission on Environmental Quality geologist. "It's possible."

Restoration standards are based on the condition of the aquifer before mining, and companies are required to restore to levels consistent with pre-mining conditions, according to the statute.

In each case, the Environmental Protection Agency declared the mining area an exempt aquifer, which signifies that the underground water is not used and unsuitable for human consumption.

One of those exempt aquifers, in Live Oak County, sits on the banks of Lake Corpus Christi, which provides drinking water to Corpus Christi. When the mining operation there closed in March 1999, the Texas Commission on Environmental Quality allowed miners to leave behind underground water with 10 times the amount of uranium listed in the original permit.

Ben Knape, who oversees the state agency's underground injection control program, said provisions in the law allow for the amendment to permits within certain ranges that pose little risk as in this case.

The section of the Texas Administrative Code governing uranium mine cleanup says the state must take into account potential uses of groundwater and pre-mining uses of the groundwater. Other possible reasons for the permit amendments include the cost of restoration efforts, potential harmful effects and consumption of energy and water in further cleanup.

Most of the permits reviewed came from mines that closed in the 1980s and 1990s, when the price of uranium plummeted after the collapse of the Soviet Union sent a wave of inexpensive nuclear material across the world.

A recent spike in prices, combined with forecasts predicting supply will outstrip demand, has brought a renewed interest in uranium mining.

Brad Moore, an exploration and land tenure manager for Uranium Energy Corp. in Goliad, said the technology has improved.

"What happened 30 years ago could not happen today," Moore said. "The industry evolved and regulations evolved."

Others disagree.

"I don't agree with some people that this is a mature technology," said Kim Jones, a professor of environmental engineering at Texas A&M University-Kingsville, who is researching new cleanup technologies.

The method uranium miners use throughout the world was pioneered in South Texas about 30 years ago.

Uranium mining always is done in areas where there is naturally occurring groundwater.

During extraction, miners are required to remove slightly more water than they pump into the ground. This prevents uranium-contaminated water in the mine from migrating and contaminating neighboring waters by the creation of a "low-pressure" zone.

At the times mines are closed, miners pump more water into the ground to flush the aquifer. This water, like all water, has naturally occurring amounts of oxygen in solution.
Environmentalists argue that this water, and the amount of oxygen inside, can continue to interact with uranium and allow it to stay mobile.

"After you turn off your pumps, there is a possibility that it will move off site," said Rice, the groundwater hydrologist hired by Kleberg County residents. "There's a very good reason for the regulations - if not brought back to pre-mining, I think long-term monitoring is the answer."

Assessing the risk to humans and livestock is difficult and technical.

"The groundwater moves," Jones said, "sometimes fast, sometimes slow."

Miners scoff at this explanation, because they say groundwater moves too slowly to cause a serious risk - about 30 feet per year in some cases.

"The water moves slowly," said Mark Pelizza, vice president for environmental affairs for Uranium Resources Inc. "The mineral doesn't." He says geologic chemistry locked uranium in place before mining and will continue to do so after mining has ceased.

Concerns that in-situ leach mining might impact groundwater are well known, yet it is unclear whether the pattern of amending permits in Texas is repeated throughout the country.

Bill von Till of the Uranium Recovery Branch of the Nuclear Regulatory Commission, which regulates uranium mining in states that don't have their own rules, said the commission has overseen about four restorations. In each case the miners met the requirements for some minerals, but not for others.

"What the groundwater community has found over the years is that trying to achieve cleanup to background is virtually impossible, and it's moving to a risk-based approach," von Till said.

The exempt aquifer status granted to the miners removes the burden of federal Safe Drinking Water Act standards because most mining regulated by federal agencies occurs in remote areas where people are unlikely to dig wells or rely on groundwater.

Von Till said though groundwater inside the mining areas tends to contain increased levels of some minerals after closure, "outside the mine area, everything is looked at as a potential drinking water source."

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http://www.greeleytribune.com/article/20080210/NEWS/1157006

In Wyoming, economics often blurs health concerns in uranium mining  [Excerpt]

February 10, 2008
By Andrew Villegas

Charmaine White Face thinks there's enough sun and wind in South Dakota for all of America's energy needs.

That's why she doesn't think mining for uranium is a good idea, even if uranium mining officials in Wyoming and South Dakota say that there's no danger to anybody from their underground uranium leach mines, and that America needs uranium to reduce its intake of foreign oil.

People in Wyoming and South Dakota are afraid of how the uranium mining will affect their water, livestock and their families, just like their Coloradan neighbors to the south, but they are more afraid of the ramifications of speaking up, White Face said.

Most fear retribution, and because they live in economically-depressed places, residents often value the jobs the mines bring more than their own health, she said.

"Local people don't want to speak up -- they're afraid," White Face said. "This is like the wild west out here."

But the uranium mining industry -- with new speculation fueled by the high price of uranium -- still booms, particularly in Wyoming where mining for the radioactive substance isn't as taboo or nearly as controversial as it is in northern Colorado, the site of a proposed mine near Nunn that has raised concerns of many nearby residents.

There just aren't as many people living near the mines in Wyoming, officials say, so disputes are usually settled between one or two ranchers and a big corporation, whereas in northern Colorado, thousands of people live within 20 miles of the proposed mine.

Powertech, the Canadian company that wants to place the mine near Nunn, also is exploring three possible uranium mines in both Wyoming and western South Dakota.

White Face said she's seen firsthand the sorts of things uranium can do to public health, even in more remote parts of the United States. Uranium dust from abandoned open-pit mines in Wyoming makes its way into South Dakota, she said, and it even finds its way into the Cheyenne River, which flows into South Dakota's Black Hills, uranium-rich in its own right.

«Mining in Wyoming

In Wyoming, there are literally hundreds of abandoned open-pit mines as well as 3,000 open exploratory wells that are 6,800 feet deep, White Face said. Both of these prove a hazard to residents all over eastern Wyoming, she said, where Power Resources Inc. runs the state's only uranium leaching mine.

A recent meeting between northern Colorado's Coloradoans Against Resource Destruction, who have their own uranium mine worries, and White Face's Defenders of the Black Hills group led to a good dialogue and hopefully a four-state residents' coalition against the mining, White Face said.

All the groups are taking a stand against in-situ leaching of uranium, though uranium company officials say it is the most benign way of extracting the uranium ore.

Donna Wichers, senior vice president of Uranium One, a company that is applying for permits to run an in-situ uranium mine in northeast Wyoming, said leach mining in Wyoming has been practiced there since the 1970s, and that residents are used to mining's ubiquity in Wyoming since many people rely on the industry for jobs.
"People are very familiar with it," Wichers said. "People aren't afraid of it."

Moreover, the water that accompanies the uranium deep underground isn't water that people should drink anyway, Wichers said, trying to allay the fears of people who are afraid their wells or groundwater will be polluted by the mining.

"The water in the ore body is fairly nasty" to begin with, Wichers said. "So people shouldn't be drinking it anyway."

Mark Moxley, with Wyoming's Department of Environmental Quality, agreed that the water near the uranium deposits indeed isn't fit for human consumption, but that it doesn't matter anyway since most people don't live near the mines.

"In general, most (mines) in Wyoming are not very controversial," Moxley said, adding that in the past six months, Wyoming has gotten three applications for new uranium mining operations. "Most are out in the middle of nowhere."

A bigger concern of residents, Moxley said, are sand and gravel operations, which can be close to subdivisions.

But that's not to say that there are no regulations regarding uranium mining in Wyoming. **Moxley said mining companies are responsible to get water quality levels back to their original background levels for chemicals and elements, but most companies rarely ever do because of the difficulty of meeting that standard.**

Wichers said companies sometimes have trouble getting uranium and radium back to background levels, but added that it never turns out to be a problem.

"It's as benign a mining operation as you can have," said Marion Loomis, executive director of the Wyoming Mining Association.

**«Safeguarding water, restoring land**

Many areas actually have been restored and successfully reclaimed, because the water underground just doesn't move as much as people think, Loomis said.

"It's not like underground rivers down there," he said. Indeed, many compare the aquifers to sponges that don't allow for a free flow of water underground.

Tom Mast, business editor of the Casper Star-Tribune newspaper, has followed uranium mining in Wyoming through the boom, and said he's also found that most people say the water doesn't move around very much underground.

**People are worried about safety of the mining operations as well as declining property values, Mast said, but concern about water remains -- both the availability and quality of it.**

Shannon Anderson, an organizer for the Powder River Basin Resource Council -- a group trying to ensure safe mining practices in Wyoming, said her group is not necessarily against the mines, but they lobby to get the sites away from cities such as Douglas, east of Casper.

There's a lot of government support for uranium mining in Wyoming because of the boon it can provide to the economy, Anderson said.

That support, however, is not as clear in northern Colorado.

**The Fort Collins City Council passed a resolution last December against the proposed mine near Nunn** and Rep. Marilyn Musgrave, R-Fort Morgan, recently sent a letter to the Board of Weld County Commissioners voicing her opposition to the project.

...

Report on Findings Related to the Restoration of In Situ Uranium Mines in South Texas

September 29, 2008

Submitted to
Mr. Jim Blackburn
Blackburn & Carter
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RE: Report on Findings Related to the Restoration of In-Situ Uranium Mines in South Texas

Dear Mr. Blackburn:

You have asked me to research the files of the Texas Commission on Environmental Quality (TCEQ) to determine the track record of the Underground Injection Control (UIC) office with regard to the restoration of aquifers after mining operations have been completed.

As part of my investigation, I have talked with representatives of the office of Underground Injection Control (Mr. Ben Knape, and Mr. David Murry). Mr. Knape made available, for inspection and copying, ring binders of documents related to each in-situ mining site in south Texas; and Mr. Murry gave me a collection of spreadsheets that allow for comparison of Original Restoration Target Values, Amended Restoration Target Values, and Last Sampled Values of 26 water quality indicators listed on each table of restoration values approved by TCEQ. It will be necessary to verify data from the ring binders and the spreadsheets made available by Mr. Knape and Mr. Murry with data from microfiche and microfilm files in the Central Records office of TCEQ. I found the microfiche and microfilm files in Central Records to be unorganized and difficult to navigate, without reference to paper and digital copies from which the data in Central Records were copied.

The spreadsheets were compiled by Mr. John Santos, retired geologist with the UIC program. A copy of the spreadsheet with dates that restoration tables were amended is included with this report as Attachment A. Tables of Original Restoration Target Values, Amended Restoration Target Values, and Final Sample Values are listed as Attachments B through D. Comparisons of Original Restoration Target
Values with Amended Restoration Target Values and Last Sampled Values for uranium, radium-226, arsenic, and sulfate are included as Attachments E through H. I am pulling together information from the large volume of data scanned from the files of UIC in an effort to re-produce and update all of Mr. Santos’ spreadsheets. The final step will involve reconciliation of the above data with data from Central Records.

**Regulation of In-Situ Uranium Mining**

The regulation of in-situ uranium mining in Texas falls under the Texas Railroad Commission (TRC) and the Texas Commission on Environmental Quality (TCEQ). TRC oversees exploration, and TCEQ handles mine permitting, applications for aquifer exemptions, and aquifer restoration. The U.S. Environmental Protection Agency (USEPA) grants aquifer exemptions, based on recommendations made by TCEQ.

**Restoration**

Restoration is one of the final steps in the process of in-situ uranium mining. TCEQ sets restoration standards (in the form of Restoration Tables) in the mining permits of operators, based on 26 water quality indicators. Restoration standards vary from one Production Area to another, using background data and data from proposed Production Areas, as collected and submitted by mining companies. My survey of records at UIC and Attachments A through H reveals that Restoration Tables are routinely amended by TCEQ. Relaxed restoration standards allow operators to depart from original groundwater cleanup objectives.

**Amended Restoration Tables**

The columns in Attachment A list (1) the names of the in-situ uranium mines, (2) Production Area Authorization (PAA) numbers, (3) restoration methods used at each Production Area, (4 and 5) the starting and ending dates of restoration programs, (6) pore volumes of water removed, (7) millions of gallons of water removed, (8) the date a Restoration Table was amended, (9) the dates that wells at a Production Area were plugged, and (10) the revocation date of the mining permit.

Attachment A lists 76 Production Areas and 51 dates on which TCEQ approved Amended Restoration Tables. Some of the Production Areas have been combined, but the final count in this report is based on the number of sites listed in Column 1. Eighty sites are listed in Attachments B through H, and it will be important to reconcile discrepancies between listings in those attachments and the listings of Attachment A.

Some of the sites listed in the first column of Attachment A, such as Gruy, were never mined, and others, such as Kingsville Dome, are in production. In the latter case, the Original Restoration Tables remain applicable, until the operator requests amended values. New sites, such as Goliad, are not listed because Production Areas have not been delineated and Restoration Tables assigned. Thus far, I have not found, in UIC’s records, evidence that requests for Amended Restoration Tables have been denied by TCEQ.

**Figures**
Figures 1 through 4 show, in the form of bar charts, the Original Restoration Target Values, Amended Restoration Target Values, and Last Sampled Values for uranium, radium-226, arsenic, and sulfate from mining sites for which all three values were recorded by Mr. Santos (Attachments E through H). The figures are based on data in the spreadsheets listed as Attachments B through D. Attachment B is the list of Original Restoration Target Values; Attachment C is the list of Final Restoration Target Values; and Attachment D is the list of Last Sampled Values for all 26 water quality indicators. Attachments E through H list the differences and percent change between the Original Restoration Target Values and the Amended and Final Sample Values for uranium, radium-226, arsenic, and sulfate, respectively. The following observations are made with respect to Figures 1 through 4:

**Uranium**

- In all but two cases (Benevides 4 and Rosita), the Amended Restoration Table Values and the Last Sampled Concentrations of uranium for the Production Areas listed on Figure 1 (next page) exceed the Original Restoration Table Values approved by TCEQ.

- The Primary Drinking Water Standard (PDWS) for Uranium is 0.03 mg/l (or 30 g/l).

- In all cases, the Amended and Last Sampled Concentrations of uranium exceed the PDWS.

- The higher Amended Restoration Values and the Last Sampled Concentrations are results of the inability of site operators to reduce uranium concentrations based on their respective proposed groundwater restoration programs. This calls into question the operators’ understanding of the geochemistry of the hydrogeologic systems that they are exploiting.
Appendix 20

Virginia Uranium Inc./Ltd. – Prospectus Excerpts

The prospectus may no longer be available at this Web site:

From Virginia Uranium Ltd. Preliminary Prospectus
November 8, 2007
Pages 70-77

RISK FACTORS
An investment in the Common Shares should be considered a highly speculative investment that involves significant risk. Investors should carefully consider all of the information disclosed in this Prospectus prior to making a decision to purchase the Common Shares. In addition to the other information presented in this Prospectus, the following risk factors should be given special consideration when evaluating an investment in the Company. For the purposes of this discussion, references to “Holdco” shall also include (unless the context otherwise requires) reference to the Holdco Subsidiaries.

Holdco will require new legislation in Virginia before it can mine uranium.
The Virginia Code of 1950, as amended, provides that no application for uranium mining shall be accepted by any agency of the Commonwealth of Virginia until a program for permitting the mining of uranium is established by statute. The Virginia General Assembly previously held public hearings regarding uranium mining and, in 1983, established the Uranium Administrative Group whose task was to coordinate and review studies to examine the costs and benefits of allowing uranium mining in Virginia as well as the components of a regulatory program. Due to a downturn in the uranium market and the suspension of exploration and development activities at the Coles Hill Property, that process was not completed. Before mining operations at the Coles Hill Property can proceed, the Virginia General Assembly will need to enact legislation authorizing and establishing a permitting program. Holdco does not hold any property or mining right outside of the Commonwealth of Virginia.

Upon the enactment of such legislation, it will be necessary for the Virginia Department of Mines Minerals and Energy (the “DMME”), which regulates mining in Virginia, to adopt permitting regulations in accordance with the Virginia Administrative Process Act (the “VAPA”). Under the VAPA, new regulations are subject to a comment and review process that may include one or more public hearings. In developing uranium mining laws and regulations, Virginia authorities may refer to recommendations previously tabled and accepted, as well as those imposed by states that currently regulate uranium mining. In 1984, the Uranium Task Force considered uranium mining development in Virginia and made nine specific recommendations. The Uranium Task Force concluded that if such recommendations were enacted into law, uranium development could proceed. One of the recommendations made by the Uranium Task Force was that Virginia become an “agreement state.”

Agreement states are authorized to implement and enforce regulations controlling source and by-product materials (milling, processing and tailings management) in lieu of the Nuclear Regulatory Commission (the “NRC”). If the Virginia legislature follows this recommendation and chooses to have Virginia become an agreement state, additional delays may occur because of the need to develop new state regulations governing management of source and by-product materials, and to receive approval of the state program from the NRC. It is also possible that the Commonwealth of Virginia would allow processing to proceed subject to regulation by the NRC, pending completion of the federal-state agreement.

Once the DMME adopts permitting regulations, Holdco will need to acquire a mining permit from the DMME, as mining activities in the Commonwealth of Virginia are not allowed unless a permit is acquired from the DMME. Until State legislation establishing a uranium mining permit program is enacted and regulations are in place, it is not possible to predict with precision the procedures necessary to obtain a uranium mining permit. It is likely that those procedures will include one or more public hearings prior to issuance of the uranium mining permit.

Given the approvals that Holdco will have to obtain in order to commence mining on the Coles Hill Property, neither the Company nor Holdco can assure you when or if it will be able to commence mining operations on the Coles Hill Property. If Holdco is unable to commence mining on the Coles Hill Property on a timely basis or at all, the Company’s operations and financial condition would be materially affected in an adverse manner.
Holdco has no history of mineral production or mining operations.
Holdco does not have a history of uranium producing properties. There is no assurance that commercial quantity of uranium will be discovered at the Coles Hill Property or other future properties, nor is there any assurance that our exploration program thereon will yield positive results. Even if commercial quantities of uranium are discovered, there can be no assurance that the Coles Hill Property will ever be brought to a stage where uranium resources can profitably be produced therefrom. Factors which may limit our ability to produce uranium resources from the Coles Hill Property include, but are not limited to, the spot price of uranium, availability of additional capital and financing and the nature of any mineral deposits.

Holdco may not discover commercially significant deposits and if it does, it will face exploration and mining risks.
Resource exploration, development, and operations are highly speculative, and are subject to, among other things, significant risks such as failure to discover mineral deposits or finding mineral deposits which, though present, are insufficient in quantity and quality to return a profit from production. If Holdco is unable to return a profit, our shareholders may lose part or all of their investment. Few properties that are explored are ultimately developed into producing mines. Unusual or unexpected formations, formation pressures, fires, power outages, labor disruptions, industrial accidents, flooding, explosions, cave-ins, land slides and other conditions involved in the drilling and removal of material, any of which could result in damage to, or destruction of, pits and other producing liabilities, damage to property, environmental damage or legal liability.
The inability to obtain suitable or adequate machinery, equipment or labor are other risks involved in the operation of mines and the conduct of exploration programs. Should any of these risks occur, it may result in increased cost of production, delays, write-down of an industrial property, work stoppages, legal liability or injury or death to personnel or damage to property, all of which may have a material adverse effect on Holdco’s operations and financial condition.
Substantial expenditures are required to establish mineral reserves through drilling, to develop metallurgical processes to extract the metal from mineral resources and, in the case of new properties, to develop the mining and processing facilities and infrastructure at any site chosen for mining.
Holdco may not discover sufficient quantities of minerals to justify commercial operations and funds required for development may not be obtainable on a timely basis. Whether a mineral deposit will be commercially viable depends on a number of factors, some of which are: the particular attributes of the deposit, such as size, grade and proximity to infrastructure; mineral prices which are highly cyclical; and government regulations, including regulations relating to prices, taxes, royalties, land tenure, land use, importing and exporting of minerals and environmental protection. The exact effect of these factors cannot accurately be predicted, but the combination of these factors may result in Holdco not receiving an adequate, if any, return on invested capital.

We may face certain groups opposed to uranium mining which could impede our development.
In North America, there are organizations opposed to the mining and production of uranium. Although Holdco intends to comply with all environmental laws and permitting obligations in conducting its business, there is a risk that those opposed to its planned activities at the Coles Hill Property will attempt to interfere with Holdco’s development, exploration and operation, whether by legal process, regulatory process or otherwise. Such interference could have an adverse effect on Holdco’s ability to obtain necessary or appropriate permits and approvals or otherwise carry-out its operations and any such impact could materially adversely affect and the operations and financial condition of Holdco.

We face risks relating to government regulation.
Any failure to comply with applicable laws and regulations or permits, even if inadvertent, could result in enforcement actions there under including the loss of Holdco’s mining concessions, orders issued by regulatory or judicial authorities requiring operations to cease or be curtailed, fines, penalties or other liabilities. Holdco may be
required to compensate those suffering loss or damage by reason of its mining operations and may have civil or criminal fines or penalties imposed for violations of such laws, regulations and permits. Worldwide demand for uranium is directly tied to the demand for electricity produced by the nuclear power industry, which is also subject to extensive government regulation and policies, and any change in these regulations or policies may have a negative impact on our business or financial condition. There can be no assurance that industries deemed to be of national or strategic importance like mineral production, and in particular uranium mining, will not be negatively affected by changes to governmental policies. Government policy may change to discourage foreign investment, nationalization may occur or other government limitations, restrictions or requirements not currently foreseen may be implemented.

**The economic extraction of uranium may not be commercially viable.**

Whether a uranium deposit will be commercially viable depends on a number of factors, including the particular attributes of the deposit, such as its size and grade; costs and efficiency of the recovery methods that can be employed; proximity to infrastructure; financing costs; and governmental regulations, including regulations relating to prices, taxes, royalties, infrastructure, land use, importing and exporting of commodities and environmental protection. The effect of these factors, either alone or in combination, cannot be accurately predicted and their impact may result in Holdco not being able to economically extract minerals from any identified mineral resource.

**We face environmental risks and liabilities.**

Holdco’s future operations, including development and production activities, will be subject to environmental regulations. Holdco will be subject to potential risks and unanticipated liabilities associated with pollution of the environment and disposal of waste products from any mining operations it will be able to commence. Holdco’s operations are in Virginia, which has a wetter climate than most states in the western United States where uranium mines have been historically located, and Virginia has more people per square mile than do Western States. Accordingly, there is the potential for magnification of environmental liabilities such as water pollution. To the extent Holdco is subject to environmental liabilities, the payment of any liabilities or the costs that may be incurred to remedy environmental impacts would reduce funds otherwise available for operations. If Holdco is unable to fully remedy an environmental problem it may be required to suspend operations or enter into interim compliance measures pending completion of the required remedy. The potential financial exposure may be significant and may materially adversely affect Holdco’s operations and financial condition. Holdco does not currently [November 2007] carry any form of insurance for environmental risks (including potential liability for pollution or other hazards as a result of the disposal of waste products occurring from exploration and production).

**We face various insurance risks including the ability to obtain adequate coverage.**

The mining industry is subject to significant risks that could result in damage to, or destruction of, mineral properties or producing and processing facilities, personal injury or death, environmental damage, delays in mining, and monetary losses and possible legal liability. Where considered practical to do so, Holdco intends to obtain and maintain insurance against risks in the operation of its business and in amounts believed to be consistent with industry practice. There can be no assurance that such insurance will be available, or that it will be available on terms and conditions acceptable to Holdco. In addition, such insurance may contain exclusions and limitations on coverage. Although Holdco intends to obtain environmental liability insurance Holdco does not currently carry any form of environmental liability insurance. Accordingly, the insurance policies that Holdco is able to obtain, when put in place, may not provide coverage for all losses related to Holdco’s business and the payment of any such liabilities not covered by such insurance policies would reduce the funds available to Holdco and could have a material adverse effect on Holdco’s profitability, results of operation and financial condition. Furthermore, there can be no assurance that such insurance will continue to be available, or that it will be available on terms and conditions acceptable to Holdco in the future.

**There are title risks regarding our mineral deposits.**

The ability of Holdco to carry out exploration activities and potentially operate its mineral properties depends on the validity of title to such properties. Title to, and the area of mineral deposits may be disputed. Although Holdco
believes it has taken reasonable measures to ensure proper title to its properties, Holdco may face challenges in the future which, if successful, could impair the exploration and potential development and/or operations at such properties.

**We currently depend on a limited number of mining properties and negative developments affecting any of the properties could adversely affect our business.**
The Coles Hill Property accounts for most of Holdco’s mineralization and the potential for the future generation of revenue. Unless we acquire additional properties or projects, any adverse development affecting the Coles Hill Property such as, but not limited to, obtaining financing on commercially suitable terms, hiring suitable personnel and mining contractors, or securing supply agreements on commercially suitable terms, may have a material adverse effect on Holdco’s financial operations and future condition.

**We have a limited operating history.**
Holdco has a limited operating history and there can be no assurance of its ability to operate at a profit. While Holdco may in the future generate revenues through the development, operation, sale or possible joint venture of its properties, there can be no assurance that these revenues will materialize, or if they do, that they will be available for exploration or development programs.

**There are fluctuations in the market price of uranium which are beyond our control.**
Holdco’s future profitability and long-term viability will depend, in large part, on the global market price of uranium and the marketability of the uranium that can be extracted from Holdco’s properties. Market prices for physical uranium fluctuate. The future direction of the price of uranium will depend on numerous factors beyond Holdco’s control including, among others, the demand for nuclear power; political and economic conditions in uranium producing and consuming countries such as Canada, the United States, Russia and other former Soviet republics; reprocessing of used reactor fuel and the re-enrichment of depleted uranium tails; sales of excess civilian and military inventories (including from the dismantling of nuclear weapons) by governments and industry participants; and production levels and costs of production in countries such as Russia and the former Soviet republics, Africa and Australia. Uranium prices will also be affected by international, economic and political trends, expectations of inflation, currency exchange fluctuations, interest rates, global or regional consumption patterns, speculative activities and increased production due to new extraction developments and improved extraction and production methods.

[. . .]
Exposure to and Health Effects of Uranium Mining

Presented by Doug Brugge
PhD, MS, Associate Professor, Tufts University School of Medicine

Conclusion -- More public health research about community exposure to uranium mines and mills is needed as newer studies are adding new concerns rather than alleviating them.

Uranium mining has left a devastating legacy in the American Southwest, including among the Navajo people:

- A federal compensation program has paid over 6,000 former miners and their survivors for the illness and deaths caused by mining.
- Billions of dollars, most of it from the taxpayers, has been spent to decommission uranium mills, resulting in disposal cells that must be monitored forever.
- Many abandoned mines are still uncontrolled hazards. In 2007, the Navajo Nation asked the US Congress for $500 million to address the mines on their land.

Known health effects of uranium ore: Note that uranium decays into a series of radioactive elements, including thorium, radium and radon and, also that uranium ore contains other heavy metal contaminants.

- Radon is well studied and causes lung cancer. Smoking combined with radon synergistically increases risk.
- Uranium causes damage to the kidneys in humans and has been shown to cause birth defects in animals.
- Radium causes bone cancer, cancer of the nasal sinuses and mastoid air cells (in the nose) and leukemia.
- Arsenic causes lung and skin cancer, as well as neurotoxicity, hyper-pigmentation and hyperkeratosis of the skin.

Recent studies include:

- deLemos at al., (in preparation) — preliminary results show increased risk of kidney disease with environmental exposures such as proximity to certain mining features (e.g. mine shafts).
- Raymond-Whish et al., 2007 in Environmental Health Perspectives — showed that uranium has estrogenic properties in cultured animal cells.
- Stearns et al., 2005 in Mutation Research — discovered that uranium damages DNA as a heavy metal, independent of its radioactive properties.

*Dr. Brugge spoke on 11-8-2008 in Danville and in Chatham, sponsored by the Dan River Basin Association (DRBA). This summary, approved by Dr. Brugge, was written by DRBA volunteer Annette Ayres.
An Economic Evaluation of a Renewed Uranium Mining Boom in New Mexico [Excerpts]
A report prepared for the New Mexico Environmental Law Center
By Thomas Michael Power
Research Professor and Professor Emeritus, Economics Department, University of Montana
tom.power@mso.umt.edu
October, 2008

Executive Summary

As a result of a substantial increase in uranium prices between 2004 and 2008, uranium mining companies have shown increasing interest in New Mexico’s uranium reserves. After reaching peak levels of production in 1980, New Mexico uranium production plunged dramatically, reaching near-zero levels by 1990. This uranium boom and bust cycle had disruptive impacts in the area between Gallup and Laguna – the Grants mineral belt - where most of New Mexico’s uranium mining and processing historically took place. Now uranium mining companies and other business interests are promoting renewed uranium mining as a potential source of $30 billion and almost 250,000 jobs for New Mexico and the Grants area.

This report carefully explores this “economic bonanza” view of renewed uranium mining by first evaluating the calculation that generates the $30 billion and 250,000 jobs figures. Then, to get some perspective on what a renewed uranium mining industry might entail, it looks back at New Mexico’s economic experience with uranium mining over the last half-century. In order to understand whether New Mexico and the Grants area really need the economic stimulus that renewed uranium mining would allegedly provide, the report reviews the adjustments that have taken place since the uranium mining bust of the 1980s. With that as background, this report then estimates the upper end of the potential impact of a new uranium mining boom on employment, payroll, and state and local government revenues. The report ends with a discussion of the implications uranium mining has for the new “amenity-supported” economy that has been developing in New Mexico for several decades.

Based on the data and analysis contained in this report, I reach the following conclusions:

1) The $30 billion that industry claims would come to the state in a new round of uranium mining is a gross exaggeration built around indefensible economic assumptions. It assumes that uranium prices return to the $90 to $100 per pound range and stay there indefinitely into the future. It assumes that almost all of New Mexico’s uranium reserves would be mined. It assumes that all of the value of the uranium extracted and processed accrues to New Mexico workers and citizens. Finally the $30 billion is based on adding up assumed benefits over a 30 year period, rather than focusing on the annual benefits. If more defensible assumptions are made, the upper end of the potential annual direct benefit to New Mexico workers will be only about two-tenths of one percent of that $30 billion claimed. See Sections I and V.

2) New Mexico knows from experience with copper and uranium that metal mining is economically unstable. The state has been through many copper mining booms and busts and a major uranium mining boom and bust cycle. These cycles are a natural feature of global mineral markets and will
continue into the future. That means that a renewed uranium boom will also go bust, once again disrupting the economies of towns and regions in the state. Economic instability is one of the public costs associated with uranium mining that has to be balanced against the benefits. See Section II.

3) Since the uranium mining industry went bust in the early 1980s, the state and local economies have diversified, employment has been growing, average real income has been rising, and unemployment rates have returned to relatively low levels. Despite the loss of 10,000 metal mining jobs in New Mexico between 1979 and 2006, the state was able to add 50 new jobs for every metal mining job lost, a total of almost 500,000 new jobs. Real per capita income increased by 40 percent. The unemployment rate has been cut in half from 6.2 percent at the time of peak metal mining employment in 1978 to 3.3 percent in the first quarter of 2008. This is about as close to “full employment” as the economy can get. See Section III.

4) The economies of the Grants area (Cibola and McKinley Counties) have also survived the near disappearance of the uranium industry by successfully diversifying. These small, relatively rural, economies suffered through a half billion dollar boom and bust in terms of mining payroll and lost 6,400 uranium jobs during the 1980s. But non-mining income and earnings were hardly affected. The mining sectors were effectively isolated from the rest of the economy during both the boom and bust. After the uranium bust, payroll for jobs in the government, services, and trade sectors continued to expand, as did income from retirement and investments. After digesting the loss of the uranium mining jobs, employment, aggregate real personal income and real per capita incomes in McKinley and Cibola Counties rose significantly, and by late 2007 unemployment rates had declined to near full employment levels, 3.5 to 4 percent. In the process, between 1983 and 2005, 17,000 new jobs were created, a 74 percent increase. See Section III.

5) Important environmental and social costs must be considered when evaluating the commercial economic benefits of renewed uranium mining. Uranium mining has most of the same near-permanent environmental costs that metal mining in general has and, because of its radioactive character, uranium poses some additional public health concerns. Substantial natural resources, such as groundwater, have been irreparably contaminated by uranium mining and therefore cannot be considered as a resource to support future economic growth in the area.

In addition, New Mexico and local communities will need to consider how mine and mill waste will be addressed. At 0.1% average ore grade, the industry will only extract 2 pounds of uranium for each ton of ore mined at conventional mines. At 2 pounds per ton, 157.35 million tons of tailings would be created in order to produce 315 million pounds of uranium. New Mexico already has about 100 million tons of waste at its existing sites. See Section IV.

6) To extract almost all of New Mexico’s uranium reserves, over 300 million pounds of uranium, the Uranium Producers of New Mexico have estimated that 15 new mines and 3 new mills will be required. This level of uranium development is highly unlikely for all of the following reasons:

a. It would require uranium prices to remain high (above $90 per pound) indefinitely into the future. Uranium markets have never behaved in this manner.

b. New Mexico, with only 2 percent of the world’s uranium reserves will have to compete successfully with the rest of the world’s uranium producers many of which have higher grade and lower cost reserves.
c. The Navajo Nation has banned uranium mining and milling in Navajo Indian Country, blocking the development of a substantial part of New Mexico’s uranium reserves.

d. Most of the suggested new mines and mills have not yet begun the lengthy permitting process required before production could begin. In addition, new conventional mines probably would not be viable without the construction of a new mill. For those reasons substantial increases in uranium production cannot take place for many years into the future. A boom is not imminent.

e. The financial and credit crisis that developed in 2008 has already blocked some proposed uranium developments in New Mexico. Other suggested developments will also face financial constraints especially given the uncertainty about uranium prices.

f. The current low cost method of extracting uranium, In Situ Leaching, can only be applied to part of New Mexico’s ore bodies.

7) **Assuming** that the uranium mining industry could recover almost all of New Mexico’s economically feasible uranium reserves over the next 30 years (a highly unlikely scenario; see 7., below) the following are the economic impacts at the upper end of what is actually likely.

a) About 1,575 uranium mining and processing jobs could be created. In 2008 this would represent about one-seventh of one percent of total New Mexico employment. Since 2000 the New Mexico economy has created this number of jobs every 4 weeks.

b) In Cibola and McKinley Counties where most of the mining would take place, these jobs would represent an increase in employment of about 4 percent. However, both counties are, according to the official unemployment figures, currently at close to full employment with less than 1,100 workers unemployed, and most of the unemployed are not miners. Most of the new mining jobs would therefore have to be filled by workers commuting in from other areas or new in-migrants, not existing residents.

c) These new jobs, incomes, and economic activity would have ripple or multiplier impacts that would generate additional jobs. This could increase the impact on personal income by 75 percent and the job impacts by 150 percent. Even then, those impacts would be very modest. Also, many of those “multiplier” jobs would be located in the larger trade centers including Albuquerque where both businesses and workers make their purchases.

d) Tax revenues to the state government would total about $36 million per year in the state’s annual general fund budget of $6 billion and total budget of $13 billion. The potential state tax revenues from uranium mining would cover only six-tenths of one percent of the state general fund budget.

e) Revenues to the county governments from the taxes they levy on uranium mining would be about $3.6 million per year. This represents about 5 percent of the two counties’ total budgets but as much as 20 percent of the counties’ general fund budgets. The new uranium mining industry, its workforce, and the increase in population, however, would also impose additional costs on the county government. There will be a net fiscal gain to the county governments only if the cost of the additional services is less than the increase in tax revenues.
f) In sum, the economic impacts of a renewed uranium boom would be quite modest at best. At the state level the impact would be almost imperceptible. At the local level it would make a difference, boosting both county revenues and county costs to deal with the impacts of renewed mining, but would not in any sense transform the local economies. In both cases the impact would be temporary, until uranium mining retrenched or shut down again. See Section V.

8) Communities and regions that have been successful at attracting significant amounts of new economic activity over the last two decades were not those that continued to specialize in natural resource extraction. In fact those areas lagged all other community economic categories. As economic activity in the American economy has become relatively more mobile, a different set of local characteristics, other than the presence of extractable natural resources, has become important in determining the location of economic activity: the quality of the local labor force, the quality of the public infrastructure, including schools, parks, and libraries, and the quality of the social and natural environments. Areas that are perceived to have the human, public, and environmental resources and amenities that make them attractive residential locations have prospered. See Section VI.

The Grants area can do the same. Cibola County is already a retirement destination county because of its attractive qualities. The ongoing growth in employment, real income, and population despite the disappearance of uranium mining and the loss of 90 percent of metal mining jobs overall in New Mexico makes clear that the Grants area and New Mexico can compete as the location of new economic activity. New Mexico’s presentation of itself to the rest of the nation and the world as the “Land of Enchantment” — rather than the land of uranium and copper mining or other industrial activities — sends the message that New Mexico understands the importance of natural and cultural amenities to its continued economic vitality.

The State of New Mexico and Cibola and McKinley counties, after suffering through the expected dislocations and adjustments, successfully “digested” the uranium “bust” of the 1980s and moved on to diversify their economies and expand the range of economic opportunity. The near disappearance of uranium mining and milling did not create ghost towns or permanently disable the state or local economies. Unemployment rates are low, real incomes are rising, and jobs are being created. In that sense, the New Mexico and the Grants area local economies are not irretrievably depressed and in need of rescue by another uranium boom. Citizens of New Mexico communities can afford to be critical, discriminating decision makers who weigh the benefits and costs of a renewed uranium boom.

The social costs associated with uranium mining and processing will remain significant. New Mexico has had intimate experience with the health consequences of past uranium mining practices. New Mexico also faces an enormous negative legacy associated with abandoned mines and very large mines that ultimately will be closed and have to be reclaimed as much as is physically possible. New Mexico and its mining communities have repeatedly suffered through the booms and busts associated with metal mining and its instability due to the volatility of worldwide metal prices. Renewed dependence on uranium mining will expose communities once again to this disruption.

Uranium mining, like all metal mining, is a landscape-intensive activity that almost always has had significant negative impacts on the natural environment. That means that it has the potential to damage one part of the local economic base, environmental quality, while developing another, the mineral deposit. To the extent that the environmental damage could be significant and near permanent while the mineral development, in contrast, is a relatively temporary “boom,” significant public economic
policy issues are raised: What are the long term public costs of renewed uranium mining? What are the long term benefits, if any, of the metal mining roller coaster? Is there a net gain or loss to the local economic base as a result of developing the uranium deposits?

The environmental record of uranium mining, including that of many mines closed at the end of the last uranium boom, clearly indicates that these questions must be explored carefully and critically. This is not “merely” a matter of aesthetics or an impractical effort to preserve “prettiness.” It goes to the heart of the future economic vitality and sustainability of the Grants area and New Mexican economies. That is the reason that a rational review and the careful public regulation of uranium mining must be an important part of New Mexico’s economic development policy as well as its environmental policy.

IV. The Public Costs of Uranium Mining and Milling

If uranium mining and milling involved only the private financial costs that commercial developers had to face, there might not be any controversy about New Mexico accommodating a new uranium mining boom. The risks and costs would be borne by the developers and owners and the rest of the citizenry could trust economic rationality and markets to guide development in an efficient and effective manner.

But uranium mining has most of the same substantial environmental costs that mining in general has and, because of its radioactive character, uranium poses some additional public health concerns. In addition, as discussed above, the uranium industry is unstable, and prone to booms and busts that disrupt families and communities. Before analyzing the potential economic benefits of a revival of uranium mining in New Mexico, it is important to recall the social and environmental costs that are also associated with that industry.

The costs associated with trying to clean up the persistent radioactive waste and other pollution associated with past uranium mining across the United States provide a stark reminder that uranium mining is not an environmentally benign activity. Up through 1999 the federal government had spent about $1.5 billion to reclaim 24 “inactive” or abandoned uranium mills and tailings that were the legacy of the nation’s nuclear weapons program through 1970. As of 2003 that total topped $2 billion.27 In addition, the U.S. Department of Energy expects to spend nearly $100 million in long-term monitoring and maintenance costs at these sites until 2070 and $50 million in groundwater remediation costs at only three of the 24 sites: Shiprock, New Mexico, and Tuba City and Monument Valley Arizona.28

In addition, as of the end of July, 2008, the federal government has paid about $625 million to former uranium workers or their families for the diseases and deaths associated with their exposure to radiation during employment in uranium mines and mills and in hauling uranium ore.29 These payments have been made under the Radiation Exposure Compensation Act (RECA) which provides compensation awards of up to $100,000 each to people who worked in the uranium industry between 1942 and 1971.30 Unfortunately, uranium workers employed after 1971 are not eligible for such compensation benefits under that law. That group of past uranium workers not eligible for compensation includes about 7,000 who worked in the New Mexico uranium industry in 1980.31
Further, the Navajo Nation has spent more than $23 million to correct safety hazards and perform limited reclamation at nearly one thousand abandoned uranium mines.32 Navajo Nation officials estimate that at least one-half billion dollars will be needed just to initiate full reclamation and environmental restoration at more than 500 abandoned uranium mines.33

**It is almost unavoidable that future mining will release enormous amounts of additional radioactive waste that will require costly remediation efforts.** The public, no doubt, will have to shoulder some of that burden too. The remaining uranium ore available to be mined in New Mexico has a relatively low percentage of uranium in it. The New Mexico reserves at or below a future $50-per-pound cost average only 0.167 percent uranium oxide.34 That is, only one part of the ore in 600 is actually uranium. That means that conventional uranium mining and milling generates massive amounts of ore that must be moved and processed to extract a relatively small amount of uranium, and the rest of the mined material has to be managed and disposed as wastes. Even ignoring the non-uranium ore material that has to be moved to extract the uranium ore, the low-grade ores assure that a large volume of tailings have to be disposed of after the uranium has been extracted.

Since 99.8 percent of the uranium ore extracted in New Mexico is not uranium, the volume of tailings is as great as the original volume of ore extracted. Even more problematic, uranium mills only seek to remove one of the radioactive components of the ore, uranium. The milling leaves other radioactive materials as well as a significant amount of uranium in the waste product. About 85 percent of the radioactivity of the ore remains after the uranium has been removed from it.35 In addition, tailings contain other toxic materials including heavy metals and the chemical solvents used to extract the uranium. That makes disposal of the tailings a serious toxic waste problem. This environmental burden of new mining will add to the legacy of abandoned, toxic and radioactive uranium wastes of the past. **Taxpayer funded remediation will likely be necessary for some significant part of this future cleanup too, just as it has for remediation of past mining and milling sites in New Mexico.**

The massive volume of toxic waste products associated with conventional uranium mining and milling are not generated by the *in situ* leaching technique, where chemicals are injected directly into the ground to dissolve the uranium. The uranium bearing solution is then pumped to the surface for processing to extract the uranium. While this technique avoids generating massive volumes of mine wastes and mill tailings, the recovery of all of the chemicals and their by-products from the groundwater has proven difficult and restoration of groundwater to pre-mining water quality has failed in all commercial-scale ISL operations.36 In addition, a stream of liquid waste is produced when the uranium is extracted from the solution pumped to the surface. This liquid waste is typically disposed of in an evaporation pond (or by land application or deep well injection), leaving behind waste that has to be carefully handled. As a result, the *in situ* leaching process causes groundwater contamination and the evaporation ponds, or other disposal methods, represent an additional threat of groundwater pollution. Because the vast majority of New Mexicans get their drinking water from groundwater sources, this is a major concern.

The radioactive character of the ore, tailings, and waste has also been a threat to the health of miners. Carelessness, negligence and willful indifference by the uranium mining industry in early mines, mills, and waste dumps led to the illness and death of many miners and family members. That deadly legacy
was one of the reasons that the Navajo Nation banned uranium mining and processing on Navajo lands. The primary rationale of the Navajo Nation in banning uranium mining and processing within Navajo Indian Country was to protect its valuable natural and cultural resources from further destruction by the uranium mining and milling industry.37

The point here is not that uranium is too dangerous to mine. Mining has been the source of accidents, disease and premature death among miners for centuries. Uranium mining and processing presents its own particular threats that have to be carefully dealt with. The residual environmental and health effects are part of the public costs associated with the uranium industry but which are not included in profit or benefit-cost projections. These costs are difficult to accurately quantify without more accurate public health and epidemiological statistics.

In addition, as discussed above, uranium mining, like metal mining in general, tends to be unstable, fluctuating widely with swings in worldwide uranium prices. New Mexico has been through many such cycles with copper mining over the last two centuries since European-Americans began extracting copper there. New Mexico has also been through one cycle of uranium boom and bust.

In previous studies of the economies of mining towns and regions, I have found that despite the great wealth that is extracted and the relatively high wages paid to workers, mining rarely makes mining towns prosperous places, primarily because of the economic instability associated with mining.38 In addition, the labor needs of mining operations are continually declining as new labor-saving technologies are deployed. Miners and their families, businesses that serve them, and governments that provide infrastructure and services do not know how long the jobs and payroll will last. As a result, everyone is cautious about making investments in homes, businesses, and public infrastructure because they do not know when the next big layoff will come. As a result, mining, milling, and smelter towns tend to have higher unemployment rates, lower average incomes, and slower rates of growth in jobs and aggregate real income. Mining, in general, does not support sustained local economic vitality. That is the “economic anomaly” of mining.39

This too represents a significant social cost that has to be weighed against the economic benefits of mining. When communities become specialized in metal mining, they go through severe cycles of economic expansion followed by economic collapse that severely stresses families and tends to tear the social fabric of communities as workers have to commute out to work or they and their families have to move away.40 The ongoing decline in labor demand can strand substantial local government infrastructure as well as private commercial infrastructure as the population declines. Mining communities come to be dominated by abandoned businesses and buildings and take on a run-down appearance. The massive damage to the surrounding landscape associated with extracting very low grade ores and disposing of the waste also discourages the in-migration of people and businesses not associated with mining. The result is ongoing local economic decline despite the high wages paid to miners and the huge amounts of wealth extracted.41


29 U.S. Department of Justice, Civil Division. Radiation Exposure Compensation System Claims to Date: Summary of Claims Received by 07/28/2008; All Claims. (http://www.usdoj.gov/civil/omi/Tre.SysClaimsToDateSum.pdf)


36 See the comments of Nuclear Regulatory Commission regional licensing branch chief Bill von Till and Mike Griffin from Uranium One as reported in the Chadron (NE) Record, September 12, 2008. http://www.thechadronnews.com/articles/2008/09/12/chadron/headlines/news905.txt. Also see, J. A. Davis and G.P. Curtis, Consideration of Geochemical Issues in Groundwater Restoration at Uranium In-Situ Leach Mining Facilities, NUREG/CR 6870, January 2007, at 18-23, which explores three examples of “successful” restorations where uranium and radium-226 levels, among other pollutants, were not returned to pre-mining conditions.

37 18 N.N.C § 1301.


VII. The Costs and Benefits of a New Uranium Boom Should be Weighed Before Uncritically Embracing It

As discussed above, the State of New Mexico and Cibola and McKinley counties, after suffering through the expected dislocations and adjustments, successfully “digested” the uranium “bust” of the 1980s and moved on to diversify their economies and expand the range of economic opportunity. The near disappearance of uranium mining and milling did not create ghost towns or permanently disable the state or local economies. Unemployment rates are low, real incomes are rising, jobs are being created. In that sense, the New Mexico and the Grants area local economies are not intractably depressed, needing to be rescued by another dramatic commodity boom. Citizens can afford to be critical, discriminating choosers who weigh the benefits and costs of a renewed uranium boom.

Also as discussed above, the economic impacts of a renewed uranium boom would be quite modest at best. At the state level the economic benefits would be almost imperceptible. At the local level it would likely make a difference but would not in any sense transform the local economies. Uranium mining, like all the mining sectors, has continued to deploy technological innovations that have steadily reduced the labor demands per unit of production. As a result, the number of jobs and the payroll associated with a renewed uranium industry would be quite modest.

The social and environmental costs associated with uranium mining and processing remain significant. New Mexico has had intimate experience with the health consequences of past uranium mining practices. New Mexico also faces an enormous legacy associated with abandoned mines and very large mines that ultimately will be closed and have to be reclaimed as best they can be. New Mexico and its mining communities have repeatedly suffered through the booms and busts associated with metal mining and its instability due to the volatility of worldwide metal prices.

Some of the environmental costs associated with uranium and other metal mining are nearly permanent in character. Large open pits cannot be realistically reclaimed. Some of the chemical and biological processes triggered when millions of tons of metal ore are brought to the surface and exposed to air and water or where air and water are brought to underground ore deposits cannot be easily stopped. They can only be controlled by perpetual treatment. When the chemical processes used in ISL mining processes escape their intended geological formations or the hydrology turns out to be more complicated than expected, it is nearly impossible to contain them and return the groundwater to its previous condition. In general, American ISL uranium mining operations have not been able to return groundwater to its pre-mining condition. Uranium mining brings both short- and long-lived radioactive material to the surface, increasing human exposures.
The challenge represented by uranium mining, like all metal mining, is that it is a landscape-intensive activity that almost always has had significant negative impacts on the natural environment. That means that it has the potential to damage one part of the local economic base, environmental quality, while developing another, the mineral deposit. To the extent that the environmental damage could be significant and near permanent while the mineral development, in contrast, is a relatively temporary “boom,” significant public economic policy issues are raised: Does New Mexico and the Grants area want to once again ride the metal mining roller coaster? Is there a net gain or loss to the local economic base as a result of developing the uranium deposits?

The environmental record of uranium mining, including that of many mines closed at the end of the last uranium boom, clearly indicates that these questions have to be explored carefully and critically. This is not “merely” a matter of aesthetics or an impractical effort to preserve “prettiness.” It goes to the heart of the future economic vitality and sustainability of the Grants area and New Mexico economies. That is the reason that a rational review and careful public regulation of uranium mining must be an important part of New Mexico’s economic development policy as well as its environmental policy.
Gene Curtis – Uranium Study Question

From: Gene Curtis  
Sent: Tuesday, September 30, 2008 11:45 AM  
To: uranium@halifaxchamber.net  
Subject: question for study

I'd be very interested in knowing if there has ever existed a uranium mine that has not caused a detrimental environmental impact.
November 15, 2008

Dear Nancy Pool (Halifax Chamber of Commerce President),

My concerns are that the process of uranium mining produces radioactivity which is odorless, colorless, and tasteless. Radioactive pollution permeates water, soil, and atmosphere. Once any of the above happens you can’t “clean it up.” It stays for thousands of years. How will we prevent this from happening?

A concerned citizen,

C. Johnson Willis, M.D.
Halifax, Va.

Dear Nancy Pool (Halifax Chamber of Commerce President),

I am concerned about being able to live on our property, drink our water, swim and kayak on the Banister River without fear. The river is 48 feet down from our back door. I fear for my children, grandchildren, all fishermen, animals and fish that will be affected by the radioactivity that will leak out of Mr. Coles’ property during high winds and rain.

Virginia is a beautiful state! There is a lot of uranium in Virginia and a lot of greed. We need you to vote to keep this moratorium. Money can’t bury peace and beauty, how dare they try!

When a property owner with a lot of acreage tries to develop it and an endangered rat is found, they can’t develop it. How can Mr. Coles and associates get by with this? There have been many sightings of an eagle on the Banister this summer. What more can I say except... I LOVE THIS PLACE. PLEASE HELP US.

Sincerely,

Betty Willis
Halifax, Va.
Anne Cockrell – Questions in letter submitted to newspaper editors

Please take to heart the concerns of Virginia residents: We don't want to live with multiple uranium mines. Lifting the moratorium on uranium mining and milling will open the door to any other uranium mining company that wants to mine our "uranium-rich" area. We don't want our property values to go down. Should we decide to sell our homes, we'd like to think our properties would be marketable. We'd like to continue to live in this beautiful state without the fear that our land, water or air will be contaminated by low-level radioactive fallout, for the next 30 years. We'd like our elected officials to speak on our behalf--the citizens who voted them into office--not for VUI or any other uranium mining company that seeks to make a huge profit to the detriment of Virginia citizens' health, livelihood and family life.

To the Editor:

Before Virginia considers lifting its moratorium on the mining and milling of uranium, critical questions need to be asked and thoroughly answered.

I have many, but here are two sets of questions dealing with health risks and water usage. (Does Virginia Uranium Inc. have any answers to add to mine?):

1) Will radiation, emanating from the huge piles of tailings, those produced by a uranium mining and milling facility, operating over a 30-year period, create health risks for Virginia residents? Will the health risks be mine site-specific or a statewide concern?

...Scientist Dr. Gordon Edwards recently wrote, “Uranium ore bodies are among the deadliest mineral deposits on earth. They harbor large quantities of dangerous radioactive materials” (pacificfreepress.com). Radium, a decay product of uranium commonly found in uranium mine tailings piles, has been labeled by the British Columbia Medical Association as a superb carcinogen because microscopic quantities can cause bone and head cancers, anemia, and leukemia. Polonium-210, which is as radioactive as uranium and a billion times more toxic than cyanide, is a by-product of uranium mining and found in mine tailings. A uranium mine releases radon, which blankets the ground hundreds of miles downwind from a uranium mine as solid radioactive fallout.” (http://www.nunnglow.com/impacts/)

About a ton of ore is required to extract two pounds of uranium. Huge quantities of pulverized rock (uranium tailings) are left over from the milling process. They contain thorium, radium, and all the other uranium by-products and retain 85 per cent of the ore's original radioactivity. The tailings give off at least 10,000 times as much radon gas as the undisturbed ore. Radon atoms produced inside hard rock have a low chance to escape from the grain, but when the rock is pulverized, radon gas escapes easily. (http://www.radonseal.com/radon-facts.html#minesfallout)

In 2005, the US National Academy of Sciences* released results of a study reporting: “There is no safe level of exposure to radiation—that even very low doses can cause cancer. Risks from low dose radiation are equal or greater than previously

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thought.”  (http://www.google.com/search?hl=en&q=Dr.Gordon+Edwards,+uranium+mining+radiation+dangers&start=10&sa=N)

*Note: This is the very same science academy, named in Senate Bill 525, which would have been tapped to perform the study to determine if uranium mining and milling could be done safely in the state of Virginia. Senate Bill 525 was defeated March 3, 2008 by a House Panel of the Virginia General Assembly.

(http://www.washingtonpost.com/wpdyn/content/article/2008/03/03/AR2008030302815.html?nav=emailpage)

2) Will a uranium mining & milling facility require large volumes of water to operate? How much and from where? Will the Banister River, running east of the proposed Coles Hill mine, be utilized as the mine's main water supply? Will downstream Raleigh, N.C. (Kerr Lake Reservoir) and Virginia Beach (Lake Gaston) residents, mind sharing their drinking water with a uranium mine? Considering the drought conditions the south experiences most years during the summer, will there be enough water for all on the receiving end? Will it be safe to drink?

From the 2005 World Nuclear Association Symposium Proceedings (a pro-nuclear group): "...Most uranium mines are power and water intensive, so that delivering the required wattage and volumes to site become a major cost centre. This is especially significant when development of a mine means the introduction of power and water to a region. While site-specific power can be installed, the energy source still needs to arrive at site (e.g. diesel fuel for on-site power generation). Similarly, while water treatment, recycle and discharge (also specific cost centres) are designed around water usage optimization, an initial water source must be introduced to site such that water transport systems can service base load water requirements for the life-of-mine." (Garrow, Dustin. Limitations to Progress in Developing Uranium Resources, (http://www.world-nuclear.org/sym/subindex.htm)

Towns and cities (Halifax, Clarkesville, Raleigh, Norfolk and Virginia Beach, etc.) and their drinking water sources, downstream from the proposed Coles Hill mine, can be viewed online by googling: Piedmont Environmental Council, Hot Issues and, then, Uranium Mining Maps. (http://www.pecva.org/)

Available data indicate that radium concentrations in the discharge waters of a producing mine tend to increase substantially as the ore body is developed. Whereas natural background radium concentrations are generally about several picocuries/liter (pCi/l), 100 to 150 pCi/l appear in the effluents of operating mines. The discharge of such highly contaminated mine effluents to streams and seepage from tailings ponds, creates a long-lived source of ground-water contamination. (http://www3.interscience.wiley.com/?CRETRY=1&SRETRY=0)

In addition to the leaking of contaminants from tailings management facilities (TMFs) and waste-rock storage sites, uranium mines and mills release radioactive (principally uranium), hazardous (e.g. heavy metals) and conventional (e.g. total suspended solids) contaminants to groundwater and surface water through discharges of mill and mine waters, and general run-off from mine sites. (http://pubs.pembina.org/reports/ClearingAir_UraniumMining.pdf)

One last question: Should all Virginia residents be concerned about the proposed Coles Hill mine or just those living in close proximity, namely the quaint town of Chatham?
According to the Canadian IPO (Initial Public Offering) of Virginia Uranium Ltd:

*Virginia Uranium Ltd. was incorporated on August 31, 2007 under the laws of the Yukon Territory [Canada] to invest and to actively participate in the management, business and operations of Virginia Uranium Inc. ("Holdco") through its representation on the board of Holdco and its shared management with Holdco. Holdco is focused on the exploration and development of significant uranium deposits located in the southern part of the Commonwealth of Virginia, United States... Holdco's goal is to become a significant producer of uranium through the development and construction of a mining and milling operation at the Coles Hill Property. If developed and permitted, the Coles Hill Property would be the first uranium mine in the Commonwealth of Virginia. Holdco will commence a regional exploration and acquisition program to target and acquire both new and historic uranium prospects in Pittsylvania County, Virginia.*

(http://ipo.investcom.com/cgibin/ipodetails1.cgi?ID=1&string=Virginia+Uranium+Ltd&exact=yes&com=yes)

Taking VUI at its word, not only will the Coles Hill mine be its "first" uranium mine in Virginia, but it will "target and seek both new and historic prospects in Pittsylvania County."

Pittsylvania County is a big county--Virginia's largest land mass county. Where will VUI explore next after Coles Hill? Once the state's moratorium is lifted, what's to keep other mining corporations (foreign or domestic) from following Virginia Uranium Inc.'s lead and opening additional mines, since we're reportedly uranium-rich in Southside Virginia?

Even if the old mineral leases (approx. 466) Marline held with Virginia landowners in the early 80s have expired, does this mean uranium is no longer on those properties?

Folks, alarm bells are ringing, will Virginia residents heed their warning?

A proposed uranium mine isn't just Chatham's little problem, it's a statewide issue that should be given grave consideration.

Anne Cockrell, Southside Concerned Citizen Member

Danville, Virginia

Additional website info, if above web pages do not open:

1) http://www.nunnglow.com/impacts/ Coloradoans Against Resource Destruction, In-Situ Leaching (ISL) Impacts: Spills, Leaks, and Excursions are Common Hazards of In-Situ Uranium Mining

2) Radon and Radioactivity - Facts and Controversies
Radon mitigation stacks, radon potions, health risk controversies, radon in tobacco, radioactive fallout, radiation experiments, nuclear accidents.
www.radonseal.com/radon-facts.htm - 51k - Cached - Similar pages

3) Good evening ... let me introduce myself ... my name is John Kittle

File Format: Microsoft Word - View as HTML
In 2005, the US National Academy of Sciences released results of a study reporting: ... Dr. Gordon Edwards, founder of the Canadian Coalition for Nuclear ...
www.lakemississippi.ca/Almonte%20V3%20speech.doc - Similar pages

4) House Panel Rejects Study of Uranium Mining - washingtonpost.com

RICHMOND, March 3 -- Lawmakers concerned about land, air and drinking water contamination killed a proposal Monday that would have allowed a study of ...
www.washingtonpost.com/wp-dyn/content/article/2008/03/03/AR2008030302815.html - Similar pages

5) World Nuclear Association Symposium Proceedings

Uranium Institute Symposia Home Page.
www.world-nuclear.org/sym/index.htm - 3k - Cached - Similar pages

6) Piedmont Environmental Council of Virginia (PECVA) - Piedmont ...

Promotes and protects the Virginia Piedmont’s rural economy, natural resources, history and beauty.
www.pecva.org/ - 15k - Cached - Similar pages

7) Effects of Uranium Mining and Milling on Ground Water in the Grants Mineral Belt, New Mexico
RF Kaufmann, GG Eadie, CR Russell - Ground Water, 1976 - Blackwell Synergy
Effects of Uranium Mining and Milling on Ground Water in the Grants Mineral Belt, New Mexico by Robert F. Kaufmann, Gregory G. Eadie, and Charles R. Russell3 ...
Cited by 7 - Related articles - Web Search - All 4 versions

8) Uranium Mining:

File Format: PDF/Adobe Acrobat - View as HTML
Uranium Mining: Nuclear Power’s Dirty Secret | The Pembina Institute | 1. Pembina Institute’s Life Cycle Study of Nuclear Power. Uranium Mining: ...
pubs.pembina.org/reports/ClearingAir_UraniumMining.pdf - Similar pages

9) Canadian IPO

Virginia Uranium Ltd. was incorporated on August 31, 2007 under the laws of the Yukon Territory to invest and to actively participate in the management, ...
ipo.investcom.com/cgi-bin/iodetails1.cgi?ID=1&string=Virginia+Uranium+Ltd&exact=yes&com=yes - 13k - Cached - Similar pages
Anonymously Submitted Questions – Three Sets

#1. Uranium study questions – submitted anonymously

Can science establish what “safe exposure” is for milled and mined uranium over a 50 year period for humans, the environment, and the regional economy? Can science establish the impact of uranium mining and milling in a new area on that region’s economic well-being? Can that analysis of well-being be done in a way that disaggregates the impact on mine and mill owners and non-owners?

Scientific Questions:

1. Where is or has uranium been mined and milled in the US, Canada, or Western Europe? In each location, what are the impacts over a 50-year time frame on human health, regional economic well-being, and ecological quality? In each location, what are variations (as distinct from impacts that might require statistically significant causation) in human health, regional economic well-being, and ecological quality over a 50 year period, as compared to similar areas without uranium milling and mining?

2. What are the effects of low-dose exposure to uranium mining and milling on human health in 50-year timeframes? This exposure should be calculated for both radioactive materials and heavy metals (uranium is both). [WWII bombing of Nagasaki and Hiroshima and the Chernobyl nuclear reactor meltdown are not comparable to uranium mining and milling. One cannot make meaningful predictions about the effect of mining and milling uranium on the basis of studies of the effects of atomic bombs or nuclear reactor accidents.]

3. Is there substantial agreement among and within scientific communities on standards for “safe exposure” to uranium mining and milling, as both heavy metal and as a radioactive material? How do these standards vary across the United States, Canada, and Europe? [Consider whether to include Australia, New Zealand, and/or other countries.]

4. What are the “safe exposure” thresholds for exposure to uranium mining and milling for pregnant women and fetuses?

5. What is the transportability and solubility of uranium in similar ecological regions over a fifty-year timeframe, of its decay by-products or daughters, and of other potential contaminants preexisting at a mine site or added during mining and milling operations? What brings these contaminants out of solution (biologically, chemically, or mechanically) and how can that cause concentration?

Economic Questions:

6. How does science examine the regional economic impact of producing hazardous or noxious materials?

7. What will be the regional economic impact of uranium development in Virginia if there is a fear of negative consequences of uranium exposure?

8. Using cost/benefit analytic tools, what are the distinct risks and rewards from the proposed mine in Pittsylvania County to these six distinct populations. What is the chance of each risk/reward?

   1) Owners of the mine and mill
   2) Local residents who are not owners
   3) Regional institutions and businesses
   4) Local governments
5) People living downstream or drawing on downstream water sources
6) State governments.

Structural Policy Questions:

9. If Virginia Uranium Incorporated is licensed to operate a mine and mill, could the license be structured in such a way as to be restricted to the current Virginia owners?
10. Can significant and adequate bond be created to pay for potential economic, health and environmental impacts and would the impacts require evidence of causation or contribution?

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#2. Uranium study questions – submitted anonymously

1. In the 1980s the Virginia Coal and Energy Commission adopted the EPA standard of 30 ug/liter for uranium drinking water, a standard weighted for economic costs associated with meeting the standard. The World Health Organization standard for uranium in drinking water is 2 ug/liter, the exposure level at which there are known negative health effects. I ask that current Commissioners consider standards more stringent than EPA standards in Virginia’s current study.

2. Why is radon testing not required for all home sales in this state?

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#3. Uranium study questions – submitted anonymously

1. Will property values drop in Pittsylvania Co. if there are multiple mining operations located here?
2. Will Pittsylvania Co. government lose more tax revenue from decrease in property values than will be gained in revenue from mining operations?
3. How will mining companies be held financially responsible for decrease in home and property values?
4. If mining is approved and there are twenty mining operations located throughout Pittsylvania Co., will the area be safe to live in?
I have a few questions on the uranium mining issue in Va.

1. I was told the initial drilling would go 500 ft. deep before the shaft would even be put in - where would this dirt/uranium extract required from initial digging be stored and where would it be disposed of?

2. Since it looks like money will rule - and peoples lives are immaterial - is there any way that independent testing could be ongoing with regard to environmental impact? (at the site and downstream of the site) This would include test kits that the average citizen could use on a regular basis to monitor their drinking water, air quality, and any other areas this could impact. If so, things could be stopped before we had another 'Love Canal' on our hands. (it would also require stopping production should any test come back questionable)

3. Who would monitor the site and how quickly could the mining be stopped and any leaching cleaned up?

4. How would employees working at the mine be safe regarding health risks?

5. How would you control undesirable material traveling outside designated areas through wind, runoff, etc?

Needless to say, I am against this possible lifting of the moratorium on mining. Please look into why Canadians are trying to put a moratorium on any additional mining in place - even when they are mining in an area not very developed. The government has dictated which fats can be used when cooking in restaurants, due to impact on health - they have dictated smoking bans, due to impact on health. These are two areas, as individuals, we could have controlled. We cannot control the impact this will have on us - I hope the government does.

Thank you,

Beth Blackburn
Uranium Mining Question:

Will VA Uranium Mining Co. be required to have funds reserved to cover the cost of cleanup in the event of radioactive run-off or leakage into Banister River?

Having lived on the Banister for over 30 years, I have seen how rainfall in Pittsylvania County affects those of us who live downstream.

We can be in the midst of a drought in Halifax County but if it rains in Chatham . . . the Banister River is muddy within 3 days.

Having radioactive mill tailings piled above ground for the duration of the mining process (proposed 15 years or more) and exposed to adverse weather conditions . . .

seems a very serious health risk.

Thank you for letting me express this concern.

Emmy Bass

Halifax, VA
Questions from Dan River Basin Association

Katherine Mull, DRBA Executive Director

Among other things, DRBA is interested in impacts on surface and ground water quality and quantity both at the site of operations and downstream. If no one else has submitted queries along these lines, following are just a few of the questions we would like to see answered by a white paper or study - at some point:

1. Given that open pit mining (and perhaps some underground mining) will be proposed, what quantities of water will be used during mining and milling and during remediation?

2. What will be impacts on local and downstream ground and surface water supplies during mining and milling as well as after the mines are closed?

3. How much of the water withdrawals will be for consumptive use during mining operations; how much water will be treated and released?

4. What pollutants are contained in untreated effluent?

5. What are the properties of these pollutants, including fate and transport?

6. What methods of treatment will be proposed and to what standards?

7. How and where will surface and ground water monitoring be conducted, both at the site of mining and milling operations and at points downstream?

Wayne Kirkpatrick, DRBA Vice President

8. What is the time required for uranium exposed to the surface to convert or breakdown into radon?

9. Is uranium contained in a waste pile soluble?

10. Are there research studies available that compare economic benefits derived from the mine to the local area versus the costs of future issues of health costs, mine debris remediation costs, and containment cost related to maintaining tailings isolated from the environment?
"Three decades ago, possibly one of the richest uranium deposits in the US was discovered at Coles Hill in rural South-central Virginia. Although the deposit was considered for mining, it was never developed. However, this site may yield knowledge of great value as a natural laboratory for radioactive waste containment."

- Will there be continued value as a natural lab for radioactive waste containment if mining occurs?
- How might mining at Coles Hill contribute to a of this radioactive waste containment system?
- In what ways might mining at Coles Hill contribute to loss of valuable information regarding this radioactive waste containment system?
- Would the public and the world be better served to study Coles Hill as a natural laboratory for radioactive waste containment rather than a mining and milling facility?

"The uranium has just been sitting there for hundreds of thousands of years," says A. K. Sinha, professor of geological sciences at Virginia Tech. "Sitting there" are the operative words. "There is a water table about 11 meters (36 feet) down, and the uranium-rich bedrock about 20 meters (66 feet) down. The uranium should have migrated to the next county, but it hasn't."

- If the water table is at a depth of 36 feet what technology will be utilized to keep radioactive material from entering the water table resource?
- Will mining and milling activity impact ground water or surface water? If so, in what ways?
- What plan will be utilized to mitigate contamination ground water and/or surface water if it occurred?

"You would expect ground water in this type of natural system to have carried the uranium away from the site into the surrounding environment, but we don't see that," says Virginia Tech Ph.D. student Jim Jerden, of Atlanta, Ga. "We think we can learn something from this site that can be applied to existing contaminated sites and nuclear waste repositories."

- If the "natural system" is disturbed will ground water in this type of natural system carry the uranium away from the site into the surrounding environment?
- How does Jerden propose to "learn something from this site that can be applied to existing contaminated sites and nuclear waste repositories" if Coles Hill is mined and milling takes place?
-Will mining and milling on the site taint the "natural laboratory" to a degree that data will be unusable or degraded?

Sinha explains, "Uranium is toxic, particularly when it is concentrated, such as in nuclear fuel, weapons, and radioactive wastes. In nature, there are deposits that are extremely concentrated and they should be of great concern, as uranium may be transported in solution through ground water activity. But, in nature, things have a way of reaching a 'steady state'. The Coles Hill deposit, for instance, shows no measurable evidence of leakage into the surrounding soils and rocks. This 'natural analog' provides a scientific window where we can study what prevents uranium from contaminating its surroundings."

-Is uranium toxic? If so, how?

-Will radioactive waste be produced at Coles Hill from the mining and milling of uranium?

-If radioactive waste is produced at Coles Hill from the mining and milling of uranium should there be concern "as uranium may be transported in solution through ground water activity"?

-Will this 'natural analog' no prove useless when disturbed by mining and milling?

As geologists, Sinha and Jerden are looking at the natural system that contains the Coles Hill uranium deposit as a unique geologic analog for uranium-contaminated sites and nuclear waste repositories. "Nature may present a model for the scientifically sound management of nuclear wastes and contaminated sites," says Jerden.

-Have Jerden and Sinha exhausted all information at Coles Hill that may provide a model for the scientifically sound management of nuclear wastes and contaminated sites?

-Do Jerden and Sinha advocate the mining and milling of uranium at Coles Hill?

-What concerns, if any, would Sinha and Jerden have re: mining and milling at Coles Hill?

Jerden will present some of his research from Coles Hill at the 36th annual meeting of the Northeastern Section of the Geological Society of America (GSA) in Burlington, Vermont, March 12-14. "I will talk about the interaction of soil, rock, and ground waters, and the details of the minerals that inhibit uranium from being transported into the surrounding environment. Specifically, we have discovered that the abundance of phosphorous and its interaction with uranium is likely the cause for the lack of migration," he says.

Later this month, Sinha, Jerden, and Lucian W. Zelazny, professor of soil sciences at Virginia Tech, will meet with scientists from the University of Georgia's Savannah River Ecology Laboratory (SREL) and
the University of South Carolina medical program to discuss a research partnership for using advanced technologies for a better understanding of the behavior of uranium in soils.

"SREL scientists have been experimenting with phosphorous and uranium in the laboratory. The goal of these experiments was to develop new cost effective technologies that can be applied for remediation of uranium contaminated sites, so they were very interested when we told them we were researching a natural system in which uranium and phosphorus are combining to naturally limit uranium transport," explains Jerden.

-What is the nature of research that is currently being conducted at Coles Hill?

It is not just the richness and the self-containment of the deposit located only two hours away from Virginia Tech's Blacksburg campus (south east of Chatham, Virginia, near the little town of Gretna) that makes it such a unique resource for researchers. "The corporation that discovered the site did extremely good exploration of this deposit," explains Sinha. "They drilled approximately 70,000 feet of solid rock (70,100-foot cores). They created an enormous database. It would cost the government tens of millions of dollars to do that today, but this cost was borne by industry." When the mining activities were abandoned the corporation donated their information to Virginia Tech, and gave the cores for storage to the Virginia Museum of Natural History.

-If the self containment system was to be breached due to uranium mining and milling activities, would the towns of Chatham and Gretna be impacted? if so, how might they be impacted?

-Why were previous mining activities abandoned?

-Does Virginia Tech (VT) "own" the data of the previous mining company (Marline)? if so, has VT made the data available to the newly formed company (VUI)?

-Does VT support the mining and milling of uranium at Coles Hill?

-Does VT support study of Coles Hill as a natural containment system?

- Can mining/milling at Coles Hill be done in conjunction with study of Coles Hill as a natural containment system? If so, how might that alter conventional mining plans?

"We have an infrastructure database already generated at no cost to the taxpayer," says Sinha. "Virginia Tech has augmented this database through shallow drilling supported by the Virginia Division of Mineral Resources and is using the data and the samples to prove the site is a world class scientific target for research.

-What is meant by "world class scientific target for research" in this instance?
"We are asking basic questions," he says. "What are the natural processes that inhibit migration of uranium? If we can understand that, then our colleagues in engineering and other sciences can apply that knowledge to develop better strategies for cleaning up and managing contaminated sites and nuclear waste repositories.

- Have the questions been answered?

- Has research at Coles Hill been exhausted? If not, how would it be best to proceed with continued research? If research is complete, how might knowledge from this site help in managing containment in radioactive materials and wastes resulting from mining and milling at Coles Hill?

"We are working in partnership with other institutions that wish to characterize this site so that all the people interested in the environment can use these resources to understand the transport of uranium," Sinha concludes.

The subject of Jerden's doctoral research is to understand the geology of the uranium containment at the Coles Hill deposit. His GSA presentation, "Uranium transport in weathered bedrock: Application of environmental petrology," will be presented at 10:50 a.m. March 13, at the Sheraton Conference Center, Diamond Salon II.
Deborah Lovelace – Letter, Petition, and Video (1996 Hurricane Fran Flooding near Coles Hill)

Home Video: Flooding in Coles Hill area after Hurricane Fran in 1996

The study in the 80’s determined it would be safe and this happened only a few years later. How is the mining company going to prepare for possibly another storm of this magnitude or even less. This is home footage taken days after Hurricane Fran came through in 1996. If you look closely you can read the street signs. It is a little jumpy but I think gets the point across. Major flooding was on the Frith Farm (which is where the proposed mill will be located). Who pays for the clean-up after a storm like this?

Even Mr. Coles notes on his tax card (public information in the commissioner’s office) that several hundred acres will not perk.

I am sure that after watching this and thinking about possible ramifications you can come up with several questions. The drinking water comes from this area for thousands of people. How is it going to be kept from being contaminated?

Please click on the following link.

http://www.youtube.com/watch?v=F7mcUYAi_O4

Thanks, Deborah Lovelace

Letter to Virginia Coal and Energy and Other Virginia Delegates:

I am sure that some of you in other areas that are not on the Virginia Coal and Energy Commission are wondering why you are receiving a copy of this. This is a state wide issue that all of our representatives should know about as it will affect your counties and cities as well. Please educate yourself for your constituents. If this becomes a reality in Pittsylvania County it will only be a start as uranium has been found in other parts of the state also. Do we want to be known as the Uranium State?

In a short period of time, 1 (one) day we got 675 signatures on the following letter that I composed to The Virginia Coal & Energy Commission & Other General Assembly Members. We found out about this meeting at the last minute, but think this is a good indication that Uranium Mining and Milling is not wanted in Pittsylvania County. We think the study by the Coal and Energy Commission is biased and absurd. The Uranium Company, (Virginia Uranium, Inc/Virginia and/or Virginia Uranium LTD/Canada, should do and pay for their own study and mining and milling plans and not expect the taxpayers to carry this additional expense in these economic troubled times for a private corporation.

Other items that I did not think of at the time I wrote the letter but needs to be addressed is: 1. What is this going to do to our Health, Life and Property Insurance Rates? In talking with insurance people they have indicated they will be raised. 2. What about the Psychological Effects? According to UVA Wise www.uvawise.edu/gmec/counties-cities/ the suicide rates are much higher in the counties where we have mining up to 131%(more than double) of our state average, with many elevated %’s of other health
problems especially respiratory diseases, pneumonia & influenza. This study also shows that the disabled population is higher than the state average yet their per capita income is much lower than state average. Maybe our tax dollars would be better used to see if mining contributes to these problems before we study new mines.

This is already having an impact on our economy. People are not building houses, not buying houses in our county if they know about the possibility of the mine, not remodeling, or even as simple as not buying furniture because they think they may have to move. I know as an investor I am not buying any more property in this county or other counties, but am planning on a trip to look for somewhere else to relocate my family out of state if the mine takes place. Others have indicated they also will move but what about the people who can not afford to move?

All of these possible problems are so unnecessary to make a few people rich and ruin our county and surrounding counties. It will not stop with Pittsylvania County but will spread to other counties in our Commonwealth for the sake of Money for a few. Have our morals and standards sunk so low as to value money over human life?

Uranium Mining and Milling uses enormous amounts of energy and releases so much carbon dioxide to just get it to the form of Yellow Cake with the use of heavy equipment, trucks, graders etc. and fossil fuels such as oil and gas to run them. What about using our tax money to further develop renewable energy? It would bring in more jobs to Southside to build and maintain such things as solar, wind, geothermal or even the switchgrass that is being developed here in Gretna.

I also want you to know that I do not belong to any groups, environmental, political or otherwise. I am just a Grandmother of the 11th Generation of Lovelace’s here in Virginia and I do not want to be forced from my home and family farm. I love Virginia and have always been proud to be a Virginian.

If you would like copies of the signatures I would be glad to forward them to you.

It is my opinion that a true study would take a lot longer than 12-24 months. As our representative Danny Marshall stated “It’s about more than just digging a hole and getting uranium out,” Marshall said after the meeting. “What happens to real estate values? What impact will it have on Chatham Hall and Hargrave enrollment? What impact will it have on health now, 30 years from now, 300 years from now — here and downstream?”

Sincerely,

Deborah Lovelace

A taxpayer and resident of Pittsylvania County

**Petition:**

To: Virginia Coal & Energy Commission and other General Assembly Members
We the undersigned,

DO NOT WANT URANIUM MINING IN PITTSYLVANIA COUNTY, NOR IN OUR COMMONWEALTH OF VIRGINIA!!

If you deem a study is necessary, it should be done by a representative in the following fields who has had experience in Uranium Mining, Millings and Tailings and represented by citizens of Pittsylvania County who will be affected by Uranium Mining in our county and who will not benefit from the proceeds such as;

1: Medical Professional on the possible health effects who has done extensive studies in Uranium Mining, Milling and tailings..

2: Water Conservationist who has experience in the amount of water used and the effects on our water supply and watershed from Uranium Mining, Milling & Tailings.

3: Climatologist who has expertise of Uranium Mining, Milling & Tailings in a climate such as ours.

4: Economist who has expertise of Uranium Mining, Milling & Tailings in other areas and can study the social and economic effects to our county and state.

5: Department of Game and Inland Fisheries who can determine the effects on our wildlife in this area from Uranium Mining, Milling & Tailings.

6: Tourism who has expertise in the effects to the tourism of other areas that have had Uranium Mines, Milling & Tailings.

7: Historical Society who will study the effects of the historical properties in our area that will be impacted by Uranium Mining, Milling & Tailings.

8: Representatives from our County Public Schools, colleges, private learning institutions that will be impacted from Uranium Mining, Milling & Tailings in our County.

9: Representatives (individuals) from our farming community who will be impacted from Uranium Mining, Milling & Tailings in our county such as the dairy farmers (we have the 1\textsuperscript{st} and 3\textsuperscript{rd} largest dairies in the state), poultry farmers, tobacco and beef cattle farmers, food producers, not an organization. etc.

10: Tax Representative who will study the effects of our real estate values and tax income to our county and state from Uranium Mining, Milling & Tailings.

11: EPA who has had experience with reclamation and cleaning up contamination in other parts of the US from Uranium Mining, Milling and Tailings and what the possible costs will be to do this in our wet environment with possible hurricanes, tornados and earthquakes.

12: Representatives from businesses, industries, and residential areas in Pittsylvania County who will be impacted from Uranium Mining, Milling and Tailings.

13: Study and make public any new technology in Uranium Mining, Milling & Tailings.
14: Require Scheduled and Unscheduled, unannounced monitoring and enforcement as well as on site monitoring and enforcement 24 hours a day, 7 days a week, year round, holidays not to be excluded by someone or staff in addition to any monitoring by equipment of any type, not affiliated with the Uranium Mining and Milling Company.

15: Cost estimates for State and County Programs to Regulate Uranium Mining, Milling and Tailings and subsequent monitoring of those programs, and risks after closure or during temporary shut-downs.

16: Require insurance, closure and post-closure plans, substantial financial assurances from uranium licensee to cover any damages, issues or contaminations now and forever, to insure, secure and promote the health, safety, and general welfare of all citizens here and elsewhere provided in Virginia Code, Section 15.2-1200.

17: We demand absolute 0 contamination and 0 exposure of any heavy metals, radon, radiation (high or low level) with proof of 5 active mines that have been done safely with the same climate and population that we have here in Southside Virginia.

18: Before lifting the moratorium or any permits issued on Uranium Mining, Milling & Tailings in Virginia, we demand a majority vote of the voters of Pittsylvania County after at least 3 public hearings in our county with at least 30 days of advertised notice. Provided in our Virginia Constitution, Article 1, Section 2 declares that “all power is vested in, and consequently derived from the people.”

19: Require the Uranium Company to submit plans of Uranium Mining, Milling & Tailings and not incorporate any plans of any type to this study but to be subject to review of their plans and require changes to meet all of these and other demands that may be brought up by a professional & independent study.

20: Require any private corporation or citizens to refund any and all expenses derived from this study and not be an additional cost to Virginia Taxpayers.

We love our County and State and do not want to be forced to move for any reason!
Southside Concerned Citizens – Uranium Mining Questions for Halifax County Chamber of Commerce

SCC-1. Is it true that VUI plans to produce 110 million pounds of yellow cake from the Coles Hill site?

SCC-2. We would like to see calculations from your engineers showing the tonnage of mill tailings that would be produced at Coles Hill to extract 110 million pounds of yellow cake.

SCC-3. All the existing tailings piles in the U S have by default become the responsibility of the federal government to monitor and clean up. Does VUI plan to abandon the Coles Hill site after mining and leave the costs of cleanup and forever monitoring this site to the government (taxpayers)?

SCC-4. Historically real estate values have plummeted within a 50 mile radius of a uranium mine, industrial development stagnates and farm products are banned from market. What guarantees will you have in place so that won’t happen in Pittsylvania County?

SCC-5. Knowing that some types of uranium have a half life of over 1 million years, how can you possibly confine the dust and runoff to the site—forever? Historically it has never been done.

SCC-6. What does VUI intend to do to indemnify Pittsylvania County and the states of Virginia and North Carolina now and forever?

SCC-7. Knowing that uranium mining has never been done safely anywhere in the world, why would any sane individual even consider mining it in a populated green area such as rural Virginia?

SCC-8. Tell us how you can guarantee that all pollution and radioactivity (dust & water) will be confined to the site?

SCC-9. Coles Hill receives 44 inches of rainfall per year; which translates to 1.2 million gallons of water falling on every acre, every year, forever. How can you possibly keep that amount of water from being contaminated when it leaves the site—forever?

SCC-10. The statement below on mill tailings and radon gas comes from the EPA web site. What will or can VUI do to insure that these concerns do not become a reality in Virginia?

“Uranium mill tailings are the radioactive sandlike materials that remain after uranium is extracted by milling ore mined from the earth. Tailings are placed in huge mounds called tailings piles which are located close to the mills where the ore is processed.

The most important radioactive component of uranium mill tailings is radium, which decays to produce radon. Other potentially hazardous substances in the tailings are selenium, molybdenum, uranium, and thorium.

Uranium mill tailings can adversely affect public health. There are four principal ways (or exposure pathways) that the public can be exposed to the hazards from this waste. The first is the diffusion of radon gas directly into indoor air if tailings are misused as a construction material or for backfill around buildings. When people breathe air containing radon, it increases their risk of developing lung
cancer. Second, radon gas can diffuse from the piles into the atmosphere where it can be inhaled and small particles can be blown from the piles where they can be inhaled or ingested. Third, many of the radioactive decay products in tailings produce gamma radiation, which poses a health hazard to people in the immediate vicinity of tailings. Finally, the dispersal of tailings by wind or water, or by leaching, can carry radioactive and other toxic materials to surface or ground water that may be used for drinking water.

The NRC and some individual states that have regulatory agreements with the NRC have licensed 26 sites for milling uranium ore. However, most of the mills at these sites are no longer processing ore. Another 24 sites have been abandoned and are currently the responsibility of DOE.

All the tailings piles except for one abandoned site located in Canonsburg, PA, are located in the West, predominantly in arid areas. The licensed tailings piles contain a combined total of approximately 200 million metric tons (MT), with individual piles ranging from about 2 million MT to about 30 million MT. (A metric ton is 2,200 pounds.) The 24 abandoned sites contain a total of about 26 million MT and range in size from about 50 thousand MT to about 3 million MT.

It is unlikely that there will be much additional accumulation of mill tailings in the U.S., because foreign countries now produce uranium much more cheaply than can domestic producers.“
(Source: http://www.epa.gov/rpdweb00/docs/radwaste/402-k-94-001ulllt.html)

SCC-11. The EPA report also states the following regarding radon gas:

"Almost all risk from radon comes from breathing air with radon and its decay products. Radon decay products cause lung cancer. The health risk of ingesting radon, in water for example, is dwarfed by the risk of inhaling radon and its decay products. They occur in indoor air or with tobacco smoke. Alpha radiation directly causes damage to sensitive lung tissue. Most of the radiation dose is not actually from radon itself, though, which is mostly exhaled. It comes from radon's chain of short-lived solid decay products that are inhaled on dust particles and lodge in the airways of the lungs. These radionuclides decay quickly, producing other radionuclides that continue damaging the lung tissue. There is no safe level of radon-any exposure poses some risk of cancer."

How can VUI eliminate all the risks from radon gas?
SPECIFIC AREAS TO BE ADDRESSED

1. Water
   
   a. Overall impact on water quality (both surface and subsurface),
   b. Impact on livestock and crops,
   c. Impact on irrigation as related to farming activities,
   d. Impact on the flow patterns of rivers and creeks,
   e. Determination of how much water will be required in a possible mining and milling operation and the impact on stream flow and wildlife habitat,
   f. Impact on water levels in wells.

2. Air
   
   a. Overall impact on air quality,
   b. Impact of any dust escaping the site on agricultural activities, particularly tobacco and dairy operations,
   c. Impact of any dust escaping on livestock and humans,
   d. Methods for insuring the containment of dust during mining or milling operations,
   e. Radon emissions and their impact.

3. Traffic
   
   a. Change in traffic patterns on the roads of Virginia and impacts of those changes,
   b. Change of traffic patterns on the roads in surrounding communities and impacts of those changes.

4. Radiation Concerns
   
   a. Overall health and environmental hazards of potential radiation from a mining/milling and tailings disposal operation,
   b. Comparison of radiation levels from mining and milling operations as compared to existing levels,
   c. Projections on how radiation from tailings storage can be controlled.
5. Health
   a. Impact of mining/milling operations on incidences of cancer in radii of 1, 2, 3, 4, 5, 10, 15, 20, 30, 40, 50, and 60 miles from site,
   b. Impact of mining/milling operations on workers and vendors in the immediate as well as surrounding community,
   c. Special examination of health impacts not only to the general public but also to sensitive populations,
   c. Information concerning the safety and health record of the uranium mining and processing industry in the United States and elsewhere.

6. Reclamation and Security
   a. Examination of security deposits and bonds to preclude negative impact of bankruptcy or natural disasters,
   b. Financial surety for proper reclamation at any time throughout the life of the project.

7. Technology
   a. Advances in mining/milling and tailings management technology over the past 25 years,
   b. Best Available Technology (BAT) in the mining industry today.

8. Supply
   a. Projected demand for uranium in Virginia,
   b. Projected demand for uranium in the United States,
   c. Projected sources of domestic uranium supply.

9. Weather
   a. Impact of significant weather events on mining/milling operations, as well as on future tailings storage,
   b. Information concerning uranium mining and milling operations that are being or have been conducted in net precipitation areas comparable to or greater than Virginia’s.

10. Regulatory Controls
    a. Federal, state, provincial, and other regulatory measures in place in jurisdictions both inside and outside North America to control the impacts of uranium mining and milling.
    b. Evaluate necessary regulatory controls and safeguards which mining and milling of uranium resources could be permitted in Virginia.
11. Miscellaneous Information

a. The nature, type, and extent of site-specific studies that would be necessary prior to evaluating any specific proposal for the mining or milling of uranium, including the management of tailings,

b. Information concerning uranium mining and milling operations that are being or have been conducted in areas with population densities comparable to or greater than Virginia’s,

c. Comparison to other commonly used mineral extraction technology—i.e. how does uranium extraction compare to gold, iron, coal and other similar minerals,

d. Case research on Environmental Management Systems that are being successfully implemented in the uranium mining and milling industry and the advantages of those systems.

e. Long-term care and management of the site after the production life of the mine and mill.

f. Impacts, both positive and negative, on present and future economic development and tourism in the surrounding communities as well as in Virginia,

g. Long-term and short-term impacts (both direct and indirect) to the state and local economies, positive and negative, posed by development of a uranium mining and milling operation.
Virginia Uranium's Foremost Questions

VUI-1. What will be the impact of mining/milling operations on incidences of cancer in radii of 40 miles from the prospective milling and mining site?

VUI-2. What will be the impact of mining/milling operations on workers and vendors in the immediate area as well as surrounding community?

VUI-3. What lessons are learned in terms of safety and health from uranium mining and processing industries in the United States and elsewhere?

VUI-4. What will be the overall impact on water quality (both surface and subsurface)?

VUI-5. What will be the impact on livestock and crops?

VUI-6. What will be the impact on irrigation as related to farming activities?

VUI-7. What will be the impact on the flow patterns of rivers and creeks?

VUI-8. How much water will be required in a possible mining and milling operation and the impact on stream flow and wildlife habitat?

VUI-9. What will be the impact on water levels in wells?

VUI-10. What will be the overall impact on air quality?

VUI-11. What will be the impact of any dust escaping the site on agricultural activities, particularly tobacco and dairy operations?

VUI-12. What will be the impact of any dust escaping on livestock and humans?

VUI-13. What will be the methods for insuring the containment of dust during mining or milling operations?

VUI-14. How are radon gas and its progeny mitigated at existing open-pit and underground mining facilities, and what, if any, are the increases of these constituents in air quality?

VUI-15. What will be the change in traffic patterns on the roads of Virginia and impacts of those changes?

VUI-16. What will be the change of traffic patterns on the roads in surrounding communities and impacts of those changes?

VUI-17. What are the overall health and environmental hazards of potential radiation from a mining/milling and tailings disposal operation?

VUI-18. How will radiation levels from mining and milling operations compare to existing levels?

VUI-19. How will security deposits and bonds be used to preclude negative impact of bankruptcy or natural disasters?

VUI-20. How will financial surety for proper reclamation at any time throughout the life of the project be assured?

VUI-21. What new mining and milling technology is utilized today versus 30 years ago?

VUI-22. What is the projected demand for uranium in Virginia?

VUI-23. What is the projected demand for uranium in the United States?
VUI-24. What are projected sources of domestic uranium supply?

VUI-25. What will be the impact of significant weather events on mining/milling operations, as well as on future tailings storage?

VUI-26. What can be learned from uranium mining and milling operations that are being or have been conducted in net precipitation areas comparable to or greater than Virginia’s?

VUI-27. What are federal, state, provincial, and other regulatory measures in place in jurisdictions both inside and outside North America to control the impacts of uranium mining and milling?

VUI-28. What are the regulatory controls and safeguards that would allow safe mining and milling of uranium resources in Virginia?

VUI-29. What are the nature, type, and extent of site-specific studies that would be necessary prior to evaluating any specific proposal for the mining (or mining plan) or milling of uranium, including the management of tailings?

VUI-30. What can be learned from uranium mining and milling operations that are being or have been conducted in areas with population densities comparable to or greater than Virginia’s?

VUI-31. What comparison can be made to other commonly used mineral extraction technology—i.e. how does uranium extraction compare to gold, iron, coal and other similar minerals?

VUI-32. What systems are in place for the long-term care and management of the site after the production life of the mine and mill?

VUI-33. What are the impacts, both positive and negative, on present and future economic development and tourism in the surrounding communities as well as in Virginia?

VUI-34. What are the long-term and short-term impacts (both direct and indirect) to the state and local economies, positive and negative, posed by development of a uranium mining and milling operation?
Uranium Mining in Virginia

What is current status of uranium mining and milling in Virginia?
Virginia allows exploration of uranium by permit by the Department of Mines, Minerals and Energy. Virginia's current moratorium (in place since 1981) can be lifted only if the Virginia General Assembly enacts enabling legislation to allow for development of regulations to mine uranium.

Who regulates uranium mining and milling?
- In situ leach (ISL) mining is the only mining method regulated by the Nuclear Regulatory Commission (NRC). Underground and open pit mining are regulated by the states.
- NRC regulates uranium milling (process of extracting uranium from mined ore) and mill tailings (radioactive wastes produced by the milling process) under Uranium Mill Tailings Radiation Control Act (UMTRCA).
  - NRC requires an Environmental Impact Statement (EIS) for any proposed mill.
  - If Virginia were to lift its moratorium and developed NRC-equivalent regulations, it could apply for Agreement State status.
  - An "Agreement State" replaces NRC as regulator of uranium mills and waste, and agreement states are not required to conduct EIS for mining activities.
  - Existing agreement states such as Arizona, Utah and New Mexico have experienced severe problems with environmental impacts from mining.
- Under the Clean Water Act, a mine would be required to get a stormwater permit to control rainwater runoff from the Virginia Department of Environmental Quality.

What are some of the potential impacts of mining and milling uranium in Virginia?
- Pollution to ground and surface waters from overburden, waste rock and ore, including acid drainage, tailings impoundments and other substances in drilling wastes, brines, solvents, etc. used in the extraction or processing of ore.
- Virginia would be the first state east of the Mississippi to allow mining. Virginia has significantly higher precipitation rates, more extreme weather events, including hurricanes, higher groundwater levels, larger watersheds of interconnected streams and rivers, and greater populations living nearby than sites in western U.S. or Canada where uranium has been mined.
- The impact of significant storm events on uranium mining is one of the concerns yet to be adequately addressed.
  - In August 2004, Tropical Storm Gaston dropped 14 inches of rain across Central Virginia over
a few hours, causing major flooding in low-lying areas. According to the U.S. Geological Survey areas near the James River in Richmond had as much as 6-8 feet of standing water.

- During 1996 Hurricane Fran flooded areas near Coles Hill; local citizens recorded the event with video: Pictures include flooding downstream from Coles Hill that reached to top of fence posts, washed out bridges and inundation of "Frith's Field," a possible mill and tailings disposal area.

- Polluted substances in the air and dust caused by extraction.
- Radon from underground mines, drill holes, surface extraction and processing operations
- Migration of radionuclides and soil disturbances due to loss of vegetative cover
- If Coles Hill produces 25 to 109 million pounds of Uranium, according to industry measures, it will generate 15 to 65 million cubic yards of waste material. This would translate into 75 to 325 Super Wal-Marts (each having volume of 200,000 cubic yards).
- Finally, if the moratorium on uranium mining were lifted, the impacts would not be confined to Virginia Uranium’s Coles Hill. Instead, without a moratorium, uranium mining and milling could occur statewide. In the 1980s, exploratory leases were obtained for many sites in the Northern and Central Piedmont of Virginia.

Sources:

Complete Report of Coal and Energy Commission to Virginia General Assembly
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Predicting Water Quality Problems at Hardrock Mines: A Failure of Science, Oversight and Good Practice. Alan Septoff, Earthworks, December 2006