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Environmental Issues and Challenges associated with Uranium Exploration and Uranium Mill Tailings

Invited Statement before

Quebec Uranium Inquiry Commission
Bureau D'Audiences Publique sur L'Environnment (BAPE)

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A slide presentation associated with this Statement are provided as separate attachments.

Introduction

This statement has been prepared at the Invitation of the BAPE Uranium Inquiry Commission. The questions addressed were provided by the BAPE Commission staff to as guidelines for the content of this statement. See Appendix A at the end of this Statement. The Commission's mandate is to "identify through consultation the challenges of uranium exploration and exploitation" and its approach is summarized in Appendix B attached at the end of this Statement. The author greatly appreciates the opportunity to provide this statement to the Commission and the Commission staff forwarding guidelines for this statement that reflect concerns of the Commissioners and concerns raised to the Commission.

A resume and brief biosketch of the author has been provided to the Commission and attached to the email conveying this statement and the accompanying slide presentation. The author provided a statement before the Commission during its Pre-Consultation Inquiry on June 17, 2014 available at: http://www.bape.gouv.qc.ca/sections/mandats/uranium-enjeux/documents/TRAN19.pdf.

Slide presentations have been prepared to support and illustrate the two parts of this statement. The accompany slide presentations have been provided to the Commission along with the Statements.

As noted in the resume and biosketch, the author has worked at Southwest Research and Information Center, a non-profit research and education organization based in Albuquerque, New Mexico, USA since 1976 where he is Research Director. The author's 1992 professional project for his Master's Degree in Natural Resource management from the Community and Regional planning Program at the University of New Mexico addressed "Planning for Reclamation of the Uranium Facilities of the Former Eastern Germany." The author taught Environmental Evaluation Methods and Environmental Policy classes at University of New Mexico 1983 – 2000 and developed and taught a course on Environmental and Sacred Sites Protection. at UNM in 2004.

The author's peer-reviewed articles have been published by the British Columbia Chamber of Mines, New Mexico Bureau of Mining and Mineral Resources, Colorado School of Mines, Freiberg Technical Institute–Germany and European Union – Science and Technology Directorate and the United States Geological Survey.

The author has appeared as a technical expert in licensing and environmental assessment proceedings for uranium facilities in the USA, Canada and the Russian Federation.

Part 1- Environmental issues and challenges of uranium exploration

1) Given the Canadian context, what are the main specific impacts (expected and possible) related to uranium exploration practices?

The intensive and divisive debate over uranium development projects and policy in Quebec, along with other northern regions such as Greenland, Labrador and Alaska and elsewhere in the world, is occurring during the exploration phase. The impacts of uranium exploration activities on pre-existing indigenous communities, including access to traditional land and value systems of traditional economies can result in irreparable damage, whether the exploration advances to full scale and sustained uranium mining or not. Exploration is the single time when the mining company first shows up and for most, first impressions ate lasting impressions. The accompanying slides have several views of different kinds of exploration activities.

Exploration activities are often the first source of sustained intrusion into a pristine region new to mineral investigations. As claim staking, aerial prospecting and surface sampling exploration typically involves little communication with local land users, much less sustained engagement, exploration activities often surprise area inhabitants, disturb traditional land use practices, wildlife habitat and subsistence species.

Exploration impacts include from noise, light, odors, and vibrations associated with the fields camps, drill sites, helicopter and truck transport, engine operations, hazardous materials management including fuels and lubricants. These activities can occur in areas previously used almost exclusively by historic residents for traditional hunting trapping, food gathering and other cultural practices for time immemorial.

Mining has a secretive nature to it; the companies and their employees are involved in a very competitive, high-risk business. The complex and unseen ways in which natural uranium occurs, how it functions biologically, how its processing has varied for different uses, the vast amounts of waste generated for each pound of product, and how the uranium market works are barriers to effective community engagement unless a strong and sustained effort is made.

2) What could be the worst case expected? The nature, the spatial and the time scale extension of significant impacts?

The physical and ecological impacts of exploration projects will differ significantly based on the environmental setting and scope of exploration activities actually conducted.

Large scale, long-term disturbance of environmental and social conditions can occur due to ineffectively implemented standards, biases in decision-making, poorly established and maintained environmental and social baseline database.

Drilling out a 100,000,000 pound ore body can leave a large scar - more than a square mile, forty years after drilling is completed. This scale of surface disturbance due to exploration drilling on US Forest Service managed land is readily visible at the Mt. Taylor mine where a 1100-m shaft remains in a third decade of stand-by status forty years after exploration was completed as shown in the accompanying slides.

Hydrologic impacts are usually of primary importance. The Matoush prospect appears, from graphics available, to lie below surface lakes at a depth similar to the Cigar Lake project in Saskatchewan. While concerns about the hydrologic consequences of the deep inclined shaft proposed at the site, some authorities didn't not defer action until a fuller assessment could be mounted. Determination of the probable and cumulative hydrologic consequences of exploration activities are needed prior to significant surface or subsurface disturbance like drilling and constructing test shafts penetrating aquifers or under lakes. These relationships are illustrated in the accompanying slides.

Summer 2014 uranium exploration activities in Ongon Soum (county) in southeastern Mongolia shows the consequences of poor characterization of the hydrologic environment where exploration work is being conducted. There, flowing artesian wells used during aquifer tests have been left to flow months after testing was completed. This waste of water appears to be depletion the sole aquifer in the region, reducing flows in the one natural spring that serves the community as a drinking water supply for both people and livestock. These sites are shown in the accompanying slides.

3) What needs to be improved? What are the specific controls required?

Uranium exploration-related impacts are difficult identify or address well without a thorough baseline characterization of the area and population likely to be impacted. That baseline of ecological and human health conditions is fundamental to identification of environmental, social and health impacts. Compilation of a detailed ecological and social baseline database, with follow-up monitoring during operations, is fundamental to effective assessment of operator performance. Comprehensive baseline data is fundamental to both:

a) effective environmental and social impact assessments of proposed activities and alternatives to achieve similar objectives, and

b) fully delineated reclamation plans with full financial guarantees to insure performance of post-decommissioning objectives.

To regulate exploration and mining effectively, government programs require fee mechanisms that insure that the full cost of application review, inspection and monitoring, and permit implementation is borne by the operators, at the cost level identified as necessary and appropriate by the responsible agencies. Leaving funding levels to legislative bodies seldom provides sufficient funds for the “world class program” states and provinces need to effective monitor a “world class” industry.

Governments seeking to establish optimal uranium-related programs will need to invest in the research necessary to support policy statements, draft of regulations to implement that policy, and provide expert testimony in administrative proceedings associated with creation of regulations and guidelines. To insure that proposals withstand challenges from companies and other parties, agencies need the funds to retain the best witnesses and evidence available during rulemaking proceedings, as the companies and other participants are likely to do so to support their proposals and challenge those of other parties. Without public participant funding, it is unlikely that civil society organizations or resident representatives will be able to participate at a level of involvement similar to either the companies or agencies involved in such proceedings.

4) Who is (are) offering the best example(s) of existing guidelines on uranium exploration? And how does that works?

The New Mexico Mining Act and the associated New Mexico Mining Act Regulation are a good model of a relatively recent program that is current in operation. However, the program lacks consultation requirements as relations with Native Americans regarding use of their lands and cultural resources are primarily a federal rather than a state responsibility in the US.

Several uranium exploration and mining projects have been approved by the agencies implementing the New Mexico Mining Act regulations. Records related to permitted and pending permits exploration and mining applications and other aspects of the program are available on the New Mexico Energy and Minerals and Natural Resources Department - Mining and Minerals Division – Mining Act Reclamation Program web site at http://www.emnrd.state.nm.us/MMD/MARP/marpmainpage.html.

New Mexico Mining Act of 1993 is available at:
http://www.emnrd.state.nm.us/MMD/MARP/documents/MiningAct.PDF

New Mexico Mining Act Regulations are available at:
http://www.nmcpr.state.nm.us/nmac/_title19/T19C010.htm

Understanding the various stages of uranium exploration and development is critical to a regulatory system effectively addressing the type of activities to be conducted and the assessments of the deposit resulting from the exploration work actually conduct.

The NI43-101 Guidelines are very specific about which exploration activities need to be conducted to attain specific level of mineral resource information. Agencies and the public are better informed when they rely on NI43-101 technical filings as they must meet detailed specifications and publically available, rather than focusing on press coverage of the company news releases that are likely to put the best possible spin on such reports.

NRCan's "Generalized Model of Mineral Resource Development" at http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/mineralsmetals/files/pdf/generalized_model_e.pdf provides a detailed description of the various stages in mineral exploration and exploitation that is useful in defining the activities that needed to be address by programs that address exploration. While useful, the "Generalized Model" is based on a 1992 source, and does not discuss early and sustained community engagement, early and sustained baseline data gathering, environmental assessments early in the exploration process, fees necessary for effective regulation of the different stages of exploration, or financial guarantees and relegates environmental restoration to the last stage after mine production rather than incorporating it into each stage of the mineral development process.

Uncertainty over whether the Matoush project was in fact advanced exploration, or mining, or both, and how that uncertainty affected the decision-making process, reflected a lack of clarity and specificity in the regulatory requirements for the proposal. This uncertainty also reflected the proponent's effort to develop mine works that could be used for mining purposes beyond the bulk sampling activities proposed.

5) Among those best practices, what would be the more suitable in Québec territory context?

The NM rules provide a good framework for evaluation of programs applicable to site in Quebec. The NI43-101 and NRCan Generalized Model are already in force. The legal framework for and scope of the program, and providing sufficient financial support for a strong program, will require Quebec based actions. The "cookie cutter approach" of cutting and pasting together good looking regulations is not a best practice, and not optimal. Quebec and the jurisdictions within its boundaries will have to determine the level of program that is needed to insure that an effective set of best practices are used in all aspects of uranium exploration and subsequent uranium development activities.

6) What would be the obstacles for implementing optimal practices ?

One of the biggest is deciding, "What is optimal?" Social engagement before exploration, a thorough and evolving description of best exploration technology, ecological and health baseline before changes can be identified and cctv and photo monitoring of drill site activities would be optimal. These programmatic elements are fundamental to many involved in the uranium policy debate in Quebec and other regions. Some consider social engagement and "social license" established through effective social engagement to be outside the regulatory arena asserting that uranium mining is about conducting a profitable business not establishing a long-term partnership with existing residents and traditional caretakers for the land. This position is often a barrier to establishing relationships with traditional community leaders.

Establishing optimal social welfare conditions as well as minimizing or eliminating environmental and social impacts of uranium exploration and development should be part of a jurisdiction's authority. Recognizing the risk in uranium exploration and mining, its is optimal for communities to have to the resources to balance a uranium project's potential risks and benefits with those for other community and economic development strategies.

7) Is there a conflict between best practices and profitability?

Defining the terms in a meaningful way is very difficult, for both terms.

All companies say they use best practices; no one says, "I'm using out-of-date methods," but without effective inspections or reporting of activities, including photo and video imagery, few will know what is really happening day-to-day in the field. Recording practices in the field without intruding into the exploration activity is easier than ever.

As "best practices" is a generic rather than specific term, agencies must define what they mean by best practices in great detail for operators under their jurisdiction to use as guidance and for the agency to identify the activity it needs to be capable of performing to implement the policy established.

All companies explore "valuable deposits," no company will say it is spending money on a "poor prospect." Companies, especially shareholders, make money when the value of the stock rises so companies market uranium properties to attract investors whether or not the project, if independently evaluated, has the potential the company says it does. The whole NI43-101 system is a response to inaccurately represented mineral deposits.

Mineral exploration has low potential for success, "About 1 out of every 200 projects that reaches the discovery stage moves to development. This is equivalent to about 1 out of every 10,000 grassroots exploration projects." "Stages of Mineral

Development Aboriginal Affairs and Northern Development," Government of Canada, 2007
https://www.aadnc-aandc.gc.ca/eng/1100100023711/1100100023713

Best technical practices and best social practices are seldom if ever illustrated in detail in regulatory and governance system related to uranium mining, or other mines. Taking the time to attempt to do that well, is necessary for the term "best practices" to mean specific activities that meet certain performance criteria, not a general "state of the art," best judgement" or other unverifiable level of performance.

Profitability is a very subjective, speculative concept. it is a term that emphasizes the potential reward side of the fundamental risk-reward aspect of investments, Profitability is often focussed very narrowly, on the exploration company/ies involved, an not necessarily and the essential aspects of who profits and when and for how long?

A clear policy direction as to future visions for the region would be wise to address sustained values and long-term benefits for the communities in the region rather than short-lived projects like most uranium mines. Energy production and distribution have been beneficial to the region for decades and the carbon-reducing, price-driven wind power boom provides better prospects, and better potential for long term value – and profitability if well designed and run – than uranium or other energy fuels. Wind development along existing areas of accessibility may be a better long term development strategy that a development strategy that backing uranium mining "juniors" likes the exploration companies active in Quebec. Juniors are small companies focused on exploration with little if any production experience, like the companies who people watched put in camps across the province wherever a uranium geologist claimed was worthwhile, explore widely while hyping their projects hoping for someone with real potential to mine shows interest.

The uranium market is well saturated with current and proposed production sites relative to the demand for uranium by the world's nuclear reactor fleet through 2035. Recently uranium production capacity has exceeded demand and projections of future nuclear reactor capacity. Announcements of newly permitted uranium mines and mills in the USA, Canada and Australia delaying production until market conditions improve frequently have followed permit issuance announcements in recent years. While the US produces some 4,000 tons of uranium per year, its domestic uranium industry is operating at less than 40% of production capacity according to the US Department of Energy, Energy Information Administration at http://www.eia.gov/uranium/production/annual/pdf/dupr.pdf.

The current problem for the global uranium industry isn't getting mines permitted, the problem is a long-term excess supply available at prices far below, about 50% below, the $65 – 75 prices needed to support expanded production at existing sites or a need for new sites. The accompanying slides include several figures to uranium market relationships.

The view of those doing the measurements will determine the outcome of the "best practices vs. profitability" quandary. Few exploration project become mines but all exploration companies see growth potential in their projects – or they wouldn't be looking where they are looking.

Pressure from operators often directs decision-makers to actions that allow "less-than-best-practice" performance in laws, rules, staffing, data reporting, standard setting, inspection and penalties for violations of standards. Well defined requirements, with fully funded staff capable of expert reviews and facilities that are well characterized in well characterized environments, well monitored and inspected, with fully funded fully-designed reclamation plan and perpetual care program are needed to for preventative program.

8) Are guidelines realistically applicable in the field? Can controls be suitable to implement it?

The quality of the regulations and the capacity of the staff to implement them determine whether the performance required by guidelines are attained in the field. Effective application of guidelines require acquisition of strong pre-development baseline to determine if critical conditions are being affected as exploration or mining proceed, no data no demonstration of effect.

Without "evidentiary" quality baseline data, and subsequent inspection and monitoring date through out the life of the project a jurisdiction will not be able to effective enforce its guidelines, whether they are optimized accommodate all relevant concerns or no. Photo or video records of daily exploration activities is likely among the many inexpensive measures to prevent the types of activities shown on the North Shore region of Quebec in the accompanying slides.

Development of the professional capacity of environmental and health regulatory agencies including that sufficient to insure that a strong enough baseline data is gathered as early as possible in a project – pre-drilling – and data compilation sustained through and beyond the life of a project requires extensive forethought and a significant investment. Few if any examples exist where compilation of ecological and community environmental health baseline databases is required before significant exploration is conducted.

Similar challenges face native people seeking to develop the capacity to play a full governmental role during and beyond the life of the project, including ownership roles – with their inherent mix of potential economic rewards and risks and capacity to enforce impact-benefit agreements. Combining owning portions of projects with long-term resource protection and conservation responsibilities, in which native institutions balance income management with conduct of strong independent environmental and cultural resource monitoring and enforcement programs throughout the life of a project is a very difficult and expensive capacity to establish and sustain.

Such challenges are best addressed when given the time and research needed to make wise and sustainable decision and not well addressed in response to marketing and political pressure of junior uranium companies.

9) Given optimal guidelines and controls, what would be the residuals impacts (if any) ?

Exploration, and other resource development plans, are a kind of a partnership. The nature of the partnership, the relationship of the mineral exploration right holder to the residents and users of the target area is critical to the successful progress of exploration without dissent.

Attainment of "free, prior informed consent" as a measure of social license requires significant and sustained community engagement before intrusive exploration work begins. Leaving exploration as a geology testing activity without requirements for community engagement leaves the question of "social license" unaddressed. Exploration permitting that fails to provide for sustained community engagement, strong comprehensive ecological, health and land use baseline data gathering, and hydrologic impacts assessments leaves the affected community out of the decision-making process when it is most needed, and with little sense for how they will benefits and how resources they value will be affected.

Optimal controls should involve establishment of a thorough enough baseline of environmental, community health and social data for any scale project to effectively restore pre-existing conditions, or other standards that may be adopted, and identify its long-term impacts if any. Geotechnical measures such as restoration of slope and vegetation after exploration and development activities may not effectively address the loss associated with disturbed wildlife habitat intruded upon during critical periods for species survival or use of hunting and trapping rights that have been interfered with or ignored.

Identification of goals to optimize development that seeks to maximize benefits and reduce negative impact makes good public policy. Citizens are more likely to benefit when their leaders make choices based on those goals, not on pressure from whoever has first mining claims or best lobbying team, An evaluation of economic potential and sustainable development might show that sustainable developments like wind energy may be more likely to a long-term generator of income and jobs than uranium exploration or mining.

Optimal community development policy, rather optimal uranium exploration, would be a wise approach for communities in landscapes near uranium exploration sites. This policy should consider sustained development relying on traditional economic activities and the pristine nature of the region such as increased recreation and ecotourism and sustainable energy production through siting of wind energy stations near or within existing powerline rights of way.

Issues and challenges of uranium tailing management

1) Impacts: Given modern (since ~1980) tailing management practices in the Canadian context, what are the worst possible and expectable impacts ? What are the main causes of the impacts ? What types of impacts ? How far could it go and how long could it last ?

If the goal in Canada were to develop tailings facilities where "the tailing be considered stable enough to be left alone without risk in perpetuity" then the examples of the perpetual pump and treat technology required in-pit disposal sites in Saskatchewan and the dams diverting natural flow around tailings-filled lakes in Ontario don't pass the test as they require extensive perpetual maintenance programs. Conducting review of decommission <u>after</u> decommissioning work was completed rather than <u>before</u>, as was the case with the larger tailings facilities at Elliot Lake was poor public policy.

The answer to the worst possible and expectable tailings impact question has been illustrated for all at the broken tailings dams at Mt. Polley in British Columbia and Cananea in Mexico. Recommendations from the many efforts to determine lessons learned for future operations, including both new operations at new sites and new sites for continued operations at operations with poor tailings disposal conditions are likely to trickle in for years.

Recommendations might include an emphasis on tailings facility designs that prevent, or phase-out, the disposal of tailings behind dams or above the surrounding land surface ("above grade"). New tailings design standards might include a strong preference for high-density thickened or dry stack tailings disposed of in purpose-built phased cells excavated below grade at well selected sites in the materials are well dewatered and not subject to flow, "liquefaction." Below grade disposal in purpose-built cells is the US Nuclear Regulatory Commission (NRC) "prime option" tailings facility design. See NRC regulations at 10CFR20 Appendix A for NRC tailings design criteria and examples in the accompanying slides.

The many lessons to be learned from the experience at Mt. Polley in British Columbia and Cananea in Mexico are also likely to include responses to the failure of:

a) federal, provincial or company requirements and monitoring to detect and prevent the releases and
b) compliance, or the apparent compliance, with enforceable permits issued by "world class" regulatory systems, with design and construction conducted by "world class" consultants for "world class" companies to prevent the dam failures.

How long does the response to a tailings spill take? More than fifty years, if the experience of the Navajo residents of the area near Church rock uranium district. A

1979 uranium mill tailings spill due to the failure of the General Electric-owned (formerly United Nuclear) Churchrock uranium mill tailings dam is still commemorated by the nearby Navajo tribal members. The spill ,releasing of 400 million liters of liquid with pH 2 – like battery acid - and 1100 curies of radium-226 among other contaminants, and was visible in the Rio Puerco at least 80 kilometers downstream of the broken dam. Other problems at the Churchrock tailings site include groundwater contamination seepage under three different portions of the tailings dam which prompted the US Environmental Protection Agency to list the Churchrock mill tailings site on the nation-wide Superfund National Priorities List (NPL). The Churchrock site is one of three uranium mill tailings sites on the NPL, all still in the remediation phase decades after operations ceased. The sites are shown in the accompanying slides.

The residents of the Churchrock area still face another decade of continued exposure to contaminated soil and mine waste as tailings-affected groundwater and mine site remediation is projected to continue for more than 10 years. GE is responsible for development of the detailed application for a Nuclear Regulatory Commission (NRC) permit for the tailings site in order to obtain a permit to place receive mine waste from a nearby GE-owned mine on top of the mill tailings. This co-disposal approach has never been proposed at any tailings site in the US, much less at one of the uranium mill tailings site on the Superfund National Priorities List. More than 100 residents are being offer "alternative housing options" by EPA due to the risk of exposure from the 5-7 years, or more after a permit is issued. The mine waste remediation program will include mine waste excavation, hauling and dumping associated with the mine-waste-on-top-of-mill-waste disposal program approved by EPA however the multi-volume application for necessary permits from the NRC has yet to be filed.

As Canada was able to establish NI43-101 framework as a comprehensive approach to the mineral resource estimation problems following the "BRE-X" scandal, the institutions here may be able to develop a comprehensive approach to addressing the types of problems that resulted in the Mt. Polley failure, and the other recent dam failures in Canada and other countries.

The Canadian Nuclear Safety Commission (CNSC) is reviewing uranium tailings facilities in recognition of the significance and severity of the Mt. Polley dam failure. As the event is still being analyzed though, no time table for the CNSC reaction-response, or others results, recommendations or policy actions from the post- Mt Polley investigations has been announced.

www.wise-uranium.org maintains as comprehensive a tailings dam failure list as any agency, as well as a thorough chronology of uranium exploration, mining, milling, and processing information.

2) Best practices: Are the present government controls and requirements on tailing management sufficient to face the worst case? Are financial guarantees adequate ? Do they need to be improved ? How?

Financial guarantees for uranium tailings reclamation are recognized as the means to assure performance of decommissioning and post-decommissioning activities if the facility owner fails to complete applicable permit conditions and requirements. Financial guarantees related to catastrophic failure are another matter. Such insurance may now be a necessary consideration for operations with tailings disposal behind dams or in impounded lakes.

Financial guarantees are only as effective as the value of the instrument providing the guarantee. Funds are needed to cover the estimated cost of a third part doing all the work to be conducted should the licensee fail in their responsibility. Assuring a full level of guarantee for the full scope of third-party costs, and licensing fee requirements with the full cost of regulatory performance included in the application fee are fundamental to agencies insuring the adequacy of long-term financial guarantees. Typically in the US and Canada, post-decommissioning perpetual care of tailings facilities – the decades and beyond care, and some mines, have evolved into site addressed as federal or provincial responsibilities.

The Mt. Polley and Churchrock cases demonstrate the need for the question of financial guarantee to include guarantees to insure prompt and full responses to the catastrophic failures for the owners and subcontractors involved in design, construction and maintenance of the dam.

Financial guarantees are developed to reflect the needs of specific facilities, the tailings management and disposal technology will determine the overall amount of financial assurance needed, and how complex the guarantees decommissioning effort will be to implement.

Current controls on uranium mill wastes are under review to assess this questions. As mine wastes present similar risks associated with the hazards in the material and the instability of disposal sites. Management of uranium mine waste may be due for assessment as well.

Useful compilations of guidelines and analyses of uranium mine and mill waste management include:

- "Management of Radioactive Waste from the Mining and Milling or Ores," IAEA, Vienna, 2002 at http://www-pub.iaea.org/MTCD/publications/PDF/Pub1134_scr.pdf. provides extensive guidelines recommending integrated management of uranium mine and mill waste recognizing the similarly in risk content and physical instability associated with both waste forms.   Selected portions of these guidelines are included in the accompanying slides.

- The IAEA report on "The Long-term Stabilization of Uranium Mill Tailings, TECDOC 1403, 2004 at http://www-pub.iaea.org/books/IAEABooks/7054/The-Long-Term-Stabilization-of-Uranium-Mill-Tailings provides a useful comparison of the advantages and disadvantages of the range of uranium mill tailings disposal options considered likely to be used.

- "Management of Uranium Mine Waste Rock and Mill Tailings," (RD/GD-370), Canadian Nuclear Safety Commission, March 2012 http://nuclearsafety.gc.ca/eng/lawsregs/regulatorydocuments/published/html/rdgd370/index.cfm, This recent set of guidelines is likely to be reviewed for its adequacy after the Mt. Polley event, in addition to the review of practices at uranium mine and mill sites.

Selected portions of the guidelines and analyses in all three sources are included in the accompanying slides interspersed with images of existing uranium sites.

As we now have a worst case-type scenario after the recent tailings dam failures, we shall see how many issues provincial, national and international government and multi-lateral agencies find to explore in efforts improve their performance, or not.

The 2012 US National Academy of Science study "Uranium Mining in Virginia: Scientific, Technical, Environmental, Human Health and Safety, and Regulatory Aspects of Uranium Mining and Processing in Virginia" available at http://www.nap.edu/catalog.php?record_id=13266, is an excellent review of issues related to uranium develop for a jurisdiction with extensive mining history but no uranium mining history. The NAS study identifies geotechnical, social, environmental and political concerns associated with effective management of uranium development projects.

Examples of uranium mill tailings disposal facilities with no potential for dam failures and release of liquefied tailings readily available. As a design concept for uranium mill tailings facilities, development of fully below grade disposal cells is currently the "prime option" for the US based in NRC regulations. The Moab Tailings Relocation Project is a fully below grade facility operated by US Department of Energy contractors in Utah. The project involves relocating a 16 million ton tailings pile from a site on the flood plain in which the tailings are excavated, hauled, dumped and covered 30 miles away at a site underlain by a clay layers more than 100 meters thick. DOE has relocated more than 6 million tons so far. these tailings are handled dry. See http://www.moabtailings.org/ and the accompanying slides.

The Pinon Ridge uranium mill in Colorado has been licensed to operate a facility that approach the below-grade design standard however licensing and water right issues remain for the owner, now Energy Fuels, Inc. the company that is the owner of the single uranium mill currently licensed to operate in the US. A description of the Pinon Ridge design is included in the accompanying slides.

A second facility, the Pena Ranch mill had been designed for Roca Honda Resources in New Mexico using fully below grade disposal cells, though the notice of intent to apply to the Nuclear Regulatory Commission (NRC) for a mill license was withdrawn after the project owner merged with Energy Fuels, Inc. An engineered drawing illustrating the below grade design at Pena Ranch is included in the accompanying slides.

Yes in both case, Energy Fuels bought up it potential competitors.

3) What need most to be improved in the current tailing management practices?

Designing to minimize or eliminate long-term active care and maintenance should be fundamental to all phased of uranium development activity. Designs using high density thickened tailings or dry-stack minimize potential of water-borne chemical reactions and release, maximize water recycle, and reduce volume of tailings to be disposed. Dry tailings not amenable to flow as saturated tailings under water covers. Disposal below grade includes both in mine and in-purpose built cells. see www.tailing.info among other sources.

The thoroughness of application and project modification reviews and inspection and monitoring program needs attention. Review of application and modifications documents by experts staff or contractors and upgrading the field instrumentation, video and photo monitoring and inspection and monitoring frequency are needed to verify operator performance.

4) Given the hypothesis that, in an ideal world, we could put tailings back where it come from and leave it physically and chemically equally stable as was the original bedrock... How close to that can we get with the best technology available ? What are the present day best management technology available for tailings ? What are the obstacles to apply it ? Is cost an issue or an obstacle? What part or % of mine tailings can be put back into mine galleries and mine pits ? Is there enough volume available in mines ? What happen with new mining regions without available mines and pits ? What part (%) have to be left above ground ? Is putting tailings back in mine holes always the best thing to do ?

Mine backfill may be capable of handling 30% to 50% of the material originally extracted, most of the mine waste and tailings will need to be disposed of outside the open pit or underground workings. Capacity is reduced by the bulking factor of blasted rock or tailings verses that of intact rock – a bulking factor of 2 or more can be expected; collapse zones and other effects of the mining methods used to extract ore; extensive barriers and pumping stations; mixture of tailings or mine waste with binders like cement, tailings storage and preparation capacity and other emplacement considerations.

Is best tailings management technology an end in itself of some kind, in isolation from potential post-decommissioning land uses at and around the site? A high goal is uranium facility operations, including waste management, that results in the best long-term benefit to nearby communities and least environmental consequences for the area where the waste from mining and milling will remain and whatever exploration and mine development is conducted that doesn't lead to mining or milling. Designing waste disposal facilities in line that that objective would help guide technology selection. US DOE has evaluated the placement of solar photoelectric stations on uranium mill tailings piles as a post-decommissioning use that can generate long-term income to offset current and future management.

If best technology refers to best technology for generating development driven by economic growth objectives, consideration of renewable energy development is recommended, including training school and construction facilities in the region, focussed in areas contiguous to existing powerline access as more sustainable, long-term value than expanded uranium development.

5) Should the best available technology be imposed even if it could compromise the mine profitability ? Who should decide?

Best available technology should be the measure of a design review but defining what is "best" and what is "available" are not generally agreed upon. A jurisdiction needs to determine what it means by "best available" as companies are likely to call whatever they choose the "best available" options, and reviewers need their own criteria for assessment, unless the company view is to be adopted without review or question. if this generation of potential uranium miners is not willing or able to meet what a communities considers best, a future generation of potential uranium miners may be willing to meet the "best" best being required.

Best is in the eyes of the beholder. If the province or a local sovereign wants to insure that its version of best available technology is used, they will have to define it by rule and enforce the rules with strong technical and legal support. To understate the challenge, mining companies are not shy and can develop strong cases to support their positions that require a major legal and technical effort to address effectively.

7) Somebody suggested to raise the minimal concentration at which uranium ore may be extracted in order to minimize the tailings volume. Would that be a good strategy to minimize impacts?

The question illustrates the uncertain and changeable relationship between "profitability," and mine and mill operations with an inherent set of waste management activities. The cost calculations for a mine and mill include plans for specific volumes of ore at specific uranium concentrations. Changing market forces and government policy has resulted in many mines shutting down before the originally projected volume of ore has been mined. Elliot Lake operations shutdown when high value ore was discovered in Saskatchewan. Uranium properties respond to market forces and are not somehow "locked in" to produce all of the uranium resource estimated to be recoverable at a property.

Operating mines with requirements to recover a specified amount of ore at a certain grade regardless of cost of production and market conditions is the type of policy that has resulted in very large mines and tailings piles in the former German Democratic Republic (East Germany) where all operating mines were shutdown upon unification more than 20 years ago.

For many mines, marginal ores are placed in "low grade ore stockpiles" rather than run through the mill to produce uranium and tailings. If low grade ore stockpiles become waste as occurs when mines close prior to processing those stockpiles, the low grade materials ore will present roughly same risk of contaminant release as the tailings. Whether decommissioning and long-term monitoring and maintenance is less expensive and problematic for a reclaimed low grade ore stockpile or a reclaimed tailings pile will be a important analysis to conduct, if the situation ever arises. Minimum ore grades change over time, over decades, but waste remains where disposed. Some may eventually be amenable to re-milling for secondary recovery of uranium as has been the case with gold mine tailings re-milled for uranium recovery at a vast scale in South Africa.

Some mines process uranium in the 200 part per million range, uranium mines in Namibia in particular, and others mines might leave waste with 325 parts per million uranium rather than recover the uranium as a by product such as phosphate miners and processors in the state of Florida.

Recently, a series of mineral exploration project has feature uranium associated with Rare Earth Elements (REEs). As little is know about the ecological or human health risks of exposure to REEs or REEs in association with other hazardous materials, a go slow approach to permitting sites that would release REEs into the environment is appropriate. As appropriate as a delay in uranium exploration until a full body of knowledge has been developed to guide policy making.

8) The time issues: How long should we take care of tailings ? Is the count in millenniums, centuries or decades?

Tailings are forever. Mine waste and mill wastes are perpetual care responsibilities that are likely to be transferred to government ownership and management for long-term care after a de-commissioning period.

The duration is in the millenniums if the responsibility to prevent the hazards materials from being released for the lifetime of the hazards is the measure of care.

The risks associated with more hazardous of the uranium decay products - radium-226 – an alpha emitting isotope decreases to half it current level of radioactivity after 1620-year half-life – and the non-radioactive constituents and uranium provide sources of risk with little change over the millenniums while environmental conditions and human settlement patterns may change significantly.

9) What is the difference between uranium and other mines tailings on the matter of time? Is there a difference ?

The problem of long-term risks for uranium mine and mill waste was recognized in the US in the 60s and 70s when reuse of tailings in construction of homes, schools and road in uranium mining communities was discovered. The tailings were readily available from the local sources and radiation hazards for tailings re-use were not acknowledged (similar to the lack of health and safety training for uranium miners and millers). In hind sight, we can see the principle of , "it is hard for someone to see a problem that it is not in their economic interest to see..," in effect.

The difference in intensity and complexity of decommissioning and post-decommissioning care will be site specific and a function of how well designed, constructed and monitored it is. Decommissioning in place such as the lakes filled with tailings at the Elliot Lake district or use of convenient locations like a nearby open pit mine that require long-term active maintenance and monitoring, may look good in the short run but may require major revisions and face significant unforeseen costs if and when problems occur in the long run. They are designed that leave the final "closure with no active monitoring and maintenance" decisions to future generations.

Site-specific conditions will determine how similar or different a uranium site is to a non-uranium site. It is unwise to generalize when the conditions, affected community and environment, and the materials being explored are unknown.

Many of the thousands of mine and mill waste sites around the world contain uranium in concentrations above global averages, as uranium is found in many rock types at well above the part per million level. Releases of uranium from metal mining tailings site can often be detected. The problem of perpetual care for uranium mill tailings has only been in focus for forty years. Programs to address the problem are still struggling to determine ways to effectively contain the long-term risks from the mixture of heavy metals in those wastes whether they contain significant amounts of uranium or not.

10) Do management technologies permit to reduce the time required ? After how long can the tailing be considered stable enough to be left alone without risk ? After how long does a tailing ceased to cost money ? Is that achievable within one generation ? What should be the criteria to decide when to release the responsibility of a mining company ?

Site specific conditions will result in wide variation in long-term management strategies and associated costs. A site could close after all proposed ore is extracted or early due to market conditions or other factors, or anywhere along that spectrum of operational variation. Whether the site is designed for decommissioning and perpetual care at any stage in the mine life cycle, or only "the ore body is exhausted" will determine the expense and effectiveness of decommissioning after early shutdown. We may find that long-term cost and risk associated with the stabilization in place of the decommissioned tailings piles resulting from the early shutdown of Elliot Lake operations is reevaluated after Mt. Polley, though the efforts to reworked the stabilized in place waste will be very expensive.

Some are concerned that operating a uranium waste disposal site will attach other waste needed disposal. The tailings site could attract waste from other nearby uranium mining operations to minimize the "foot print" of waste site for uranium mining and milling waste or other generators waste uranium content that are not ores, as has been the case with the processing of "alternate feed" source of uranium at the White Mesa mill in Utah and anything in between. it is not wise or reasonable to try to predict the future so preparation for the worst case scenario is the only effective approach to trying to maximum the capacity to reduce or eliminate unwanted or unnecessary impacts

11) Can we infer long term performance of recent management technologies ? What about uncertainties about long term behaviour ? What faith should be given to modelling results for next 1 000 years ? How long observation data should be rely on to take decisions with confidence ?

US tailings facility must meet a NRC design standard of containment for up to 1000 years, but in no case less than 200 years, however no uranium tailings containment system has been in place for more than 30 years. Many structures have lasted 1000 years or more, as have many traditional societies.

The questions are important to recognize as pre-Mt. Polley inquiries. Designs that prevent releases by isolation through subsurface burial of dry materials will minimize or eliminate potential for release and reduce the need for reliance on active long-term treatment systems, or address potential release by peak hydrologic event or intrusion by animals or people. Monitoring provides observations that are beneficial as a measure of confidence and verification, and demonstrations of commitment fulfilled. Continuing observations for multi-decades, and retaining the capacity to respond if conditions deteriorate, has proven necessary at all decommissioning sites in the US and Canada.

The experience at the Waste Isolation Pilot Plant (WIPP) site in New Mexico is relevant to these concerns. The WIPP has received low-level, trans-uranium waste from US government laboratories for 15 years. The plant is a "waste disposal mine," where waste, in containers, is transported down a mine shaft for disposal in rooms excavated from salt deposit 700 meters below ground.

WIPP was designed to prevent releases and exposure for 10,000 years. In February of this year, radioactive material was released from at least one waste container that was able to move more than 500 meters horizontally through the WIPP tunnels, up the 700 m shaft and reach workers who were exposed to radiation more that 500 m away from the shaft. Six months later, the WIPP site is still closed, the cause of the container breach and mechanism for the spread of the radiation release has not been identified yet. Reopening the facility is likely to require decontamination of the WIPP mine shaft before it can be reused, a task never accomplished at uranium mine. See www.sric.org, http://www.nmenv.state.nm.us/wipp/, among other sources.

12) How do the extreme climatic events are taken into account in the design of tailing management structures? Is that adequate and sufficient?

One person's extreme is another person's normal; whether dry, desert-like conditions are more extreme than extended Arctic cold is very subjective.

Application of rigorous site selection and analyses, design engineering, and social license requirements present very challenging conditions for tailings management as they require consideration of a 1000-year-plus time frame and each need to account for extreme climatic events.

Designing sites to minimize or eliminate potential for release is a very high design standard in any climatic condition. Establishing and enforcing effective design and performance criteria is critical to determining what sites are subject to extreme climatic conditions that threaten to cause releases and which sites will be isolated from extreme climatic conditions. Designs for below grade disposal of dry tailings are likely to be able to be resistant to most climatic factors, if well sites and well armoured.

Identifying sites that are isolated enough for all stakeholders and still not too expensive may be possible, within a reasonable transportation radius, for mill tailings management. Uranium mine tailings are almost always disposed of in close proximity to the shaft or open pit where they were extracted and decommissioned in place often without the attention to containment and isolation given to uranium mill tailings.

Designating areas that are inappropriate for uranium exploration, mining and milling may be as important as finding places where such uses may be considered. The permanent nature of the potential hazards at uranium waste disposal site severely limit the areas where such activities are considered compatible with current land uses.

Appendix A

Guidelines for Content provided By Commission Staff

TALK #1 (about 20 minutes)
Tuesday evening, 9 of September
Theme : **Environmental issues and challenges of uranium exploration**

Guidelines for the content :
(The commission expect the talk would help answer the following questions)

- Given the Canadian context, what are the main specific impacts (expected and possible) related to uranium exploration practices ?
  What could be the worst case expected ? The nature, the spatial and the time scale extension of significant impacts ?
- What needs to be improved ? What are the specific controls required ?
- Who is (are) offering the best example(s) of existing guidelines on uranium exploration ? And how does that works ?
  Among those best practices, what would be the more suitable in Québec territory context ?
- What would be the obstacles for implementing optimal practices ?
  Is there a conflict between best practices and profitability ?
  Are guidelines realistically applicable in the field ? Can controls be suitable to implement it ?
- Given optimal guidelines and controls, what would be the residuals impacts (if any) ?
- Whatever else you consider relevant to the topic…

All these topics, if not fully covered in the talk, could be further developed in the following question/answer debate.

TALK #2 (about 30 minutes)
Wednesday evening, 10 of September
Theme : **Issues and challenges of uranium tailing management**

Guidelines for the content:
(The commission expect the talk would help answer the following questions)

Impacts :

- Given modern (since ~1980) tailing management practices in the Canadian context, what are the worst possible and expectable impacts ?
  What is the main causes of the impacts ? What types of impacts ? How far could it go and how long could it last ?

Best practices :

- Are the present government controls and requirements on tailing management sufficient to face the worst case ? Are financial guaranties adequate ? Do it need to be improved ? How ?
- What need most to be improved in the current tailing management practices ?
- Given the hypothesis that, in an ideal world, we could put tailings back where it come from and leave it physically and chemically equally stable as was the original bedrock…
  How close to that can we get with the best technology available ? What are the present day best management technology available for tailings ? What are the obstacles to apply it ?
  Is cost an issue or an obstacle ?
- What part or % of mine tailings can be put back into mine galleries and mine pits ? Is there enough volume available in mines ? What happen with new mining regions without available mines and pits ? What part (%) have to be left above ground ? Is putting tailings back in mine holes always the best thing to do ?
- Should the best available technology be imposed even if it could compromise the mine profitability ? Who should decide ?
- Somebody suggested to raise the minimal concentration at which uranium ore may be extracted in order to minimize the tailings volume. Would that be a good strategy to minimize impacts ?

The time issues :

- How long should we take care of tailings ? Is the count in millenniums, centuries or decades ?
  What is the difference between uranium and other mines tailings on the matter of time ? Is there a difference ?
  Does management technologies permit to reduce the time required ?
  After how long can the tailing be considered stable enough to be left alone without risk ? After how long does a tailing ceased to cost money ? Is that achievable within one generation ? What should be the criteria to decide when to release the responsibility of a mining company ?
- Can we infer long term performance of recent management technologies ? What about uncertainties about long term behaviour ? What faith should be given to modelling results for next 1 000 years ? How long observation data should be rely on to take decisions with confidence ?
- How do the extreme climatic events are taken into account in the design of tailing management structures ? Is that adequate and sufficient ?
- Whatever else you consider relevant to the topic…

All these topics, if not fully covered in the talk, could be further developed in the following question/answer debate.

Appendix B - Summary of BAPE Commission Mandate

The review's mandate is to look at potential issues, "identifying through consultation the challenges of uranium exploration and exploitation," according to Louise Bourdages, BAPE spokesperson.
http://magazine.cim.org/en/2014/August/news/Quebec-uranium-unease.aspx

Exploration and exploitation of the uranium industry: BAPE will hold public hearings

Quebec, March 3, 2014 - The Minister of Sustainable Development, Environment, Wildlife and Parks, Yves-François Blanchet, announced that he entrusts the Office of Public Hearings on the Environment (BAPE) the mandated to conduct an investigation and a public consultation on the environmental and social impacts of exploration and exploitation of the uranium industry in Quebec.

"The development of exploration projects and exploitation of uranium causes of concern. Entrusting this mandate BAPE, the government ensures to take into consideration the concerns of the population and is committed to make decisions that take into account the impact that such activities may have on the environment, economy and the social conditions of the communities living in the territory concerned. Furthermore, indigenous organizations will be invited to play a significant role in consultations, "said the minister.

The mandate of the BAPE will be conducted in collaboration with the advisory committees provided for in the provisions of the James Bay and Northern Quebec and the Law on Environmental Quality.

As part of this consultation, BAPE will make available a study by researchers at Laval University on the state of knowledge, impacts and mitigation measures of exploitation and exploration of the uranium deposits in Quebec.

Entrusted under Article 6.3 of the Law on Environmental Quality, the mandate of inquiry and public hearing BAPE begin May 20, 2014 and will end on May 20 2015
More details about this consultation service will be available on the BAPE website at www.bape.gouv.qc.ca.

http://www.mddelcc.gouv.qc.ca/infuseur/communique.asp?no=2803