Quebec Hearings into Uranium Mining

Abstract

By its very nature, the BAPE is a true sustainable development tool. I am very glad to hear this. Uranium mines do not meet the definition of sustainable development – they will impact—negatively, on future generations. In Saskatchewan, it is even questionable whether the mines are meeting the needs of the present generation, especially the Northerners, who are primarily First Nations. I would argue that information and public involvement in decisions are also not forthcoming.

Quebecers need to take an extremely keen look at the current monitoring paradigm that is in place in Saskatchewan's north and decide for themselves if the management plans are effective. Are they capable of confirming whether they contained the waste streams, or not, and what protocols are in place to make sure changes are made, if and when needed? These protocols are essential. The companies must be able to test the effectiveness of their plans beyond doubt. Scientific principles must be used to predict and confirm that all the elements in the waste stream are accounted for. All this material, past and present, must also be located and remediated. I think the management plans are tragically lacking.

Surface tailings are even more of a problem. The elements in the tailings are too mobile and too vulnerable to erosion. Saskatchewan's north was once a mountain range. Erosional and sedimentary processes have worn down the hard durable rock. Given time, what would erosion do to tailings material left on the surface under a clay cap? What are the dangers to the environment? The companies give mine and mill sites a 10,000 year guarantee for the integrity of their decommissioning. Ten thousand years sounds like an impressive length of time but is it a reasonable warranty?

The tailings piled on the surface will eventually be exposed to erosion and water infiltration and they will be dispersed. This will release toxic elements like arsenic, mercury, and the radioactive minerals such as thorium. Thorium has a half life of 76,000 years, outliving the warranty by hundreds of thousands of years. Capping is the easiest and cheapest solution for the companies. It is unacceptable!! It serves to defer the environmental impacts to generations in the future.

Surface tailings are also vulnerable to terrorist attacks that could use dirty bombs to disperse the toxic elements in the tailings.

Current disposal concepts for reactor waste also involve extremely significant environmental risks over similar time frames during which it must be kept isolated. I think Bentonite Clays could be particularly problematic - see discussion on page 11.

SASKATCHEWAN URANIUM MINES: THEIR WASTES AND IMPACTS

Saskatchewan's first involvement with mining radioactive material began in the Uranium city area during the Second World War. Materials were needed for the nuclear bombs which were dropped on Japan. Indigenous people were utilized for manual labour. No protection from radiation was used. Mill effluent was dumped into the lake along with a lot of the waste rock and mill tailings. A lot of material was also left on the surface. Everything was abandoned when the mines closed. Eldorado and the other companies took no responsibility and the clean up of these sights is only now beginning in earnest by the Saskatchewan Research Council as Environmental assessments are taking place. Most of the sights were left un-posted as to the radioactive danger the tailings posed – after all, hadn't that material been removed. The reality is that even in modern mines about 85% of the radioactive material remains in the tailings. Radioactive minerals left in the tailings include radium, radon, thorium, etc. Also remaining in the tailings are arsenic and mercury as well as sulphide minerals. The sulphide minerals make the tailings acidic and could facilitate the leaching out of the arsenic and mercury from the tailings. In Uranium City, it was common for children to play in the tailings areas and even adults used them as a golf course. The environmental assessments are a welcome event as the hazard will be reduced around these sights. It is still a bad situation, the main problem with the solutions being favoured is the tailings and waste will essentially remain on the surface, but covered, or in the lake where they were dumped. Many of the radioactive elements contained in the tailings have long half lives that will take them into the realm of geologic time. This means that at a later date these tailing areas, constantly under attack by forces of erosion, will again pose a threat as their contents are reintroduced into the environment - unless future generations take on the responsibility of maintaining the tailings areas in order to protect the environment. There are absolutely no guarantees about what will transpire in the future, whatever our intentions are in the present. It is wishful thinking to assume that the tailings will be taken care of permanently – we are merrily delaying the inevitable.

Today's mines, while appearing to be operated in a much more responsible way, make the same mistake, the mines continue to think that a surface tailings area that has been capped off from the today's environment will survive the test of geologic time. Perhaps the mines fully understand this because they are being allowed to operate without an approved decommissioning plan in place for the mills. In fact new mines are giving the go ahead to operate without any considerations for the mills because existing mills at older mine sites are being used. This also opens up issues of protection of

workers who are transporting the ore to the mills, and to the communities through which this ore must pass. The lack of a decommissioning plan is completely unacceptable. The mills must step forward with an approved decommissioning plan that accepts the reality of timelines that are relative to geologic time. The tailings at Rabbit Lake are placed inside mined out open pits (ie: Dielman pit) although the crumbling edges of these pits are being reinforced and built upwards so they contain even more tailings. At Key Lake they are spread out over a large area of ground.

One might argue that the tailings should be put back underground but, I think the milled tailings are now in a much too mobile form to do this. The uranium deposits are sedimentary in nature. Dissolved radioactive elements have travelled into fault zones where they came out of solution and concentrated to form the deposits. Water flows through these fault zones and these ore zones can be quite unstable to try to mine, as can be witnessed by the flooding problems and closures the Cigar Lake mine has experienced. We are mining the deeper, higher grade deposits like Cigar Lake because we have already mined out the easier, closer to the surface, deposits. These high grade ore deposits are brought to the surface and placed on ore pads, exposed to the wind, where they can remain for years, awaiting the opportunity to be milled. Runoff from rain is apparently captured and treated. In the mill, the ore is ground up into a fine rock flour and treated with solvents to release “only” the radioactive isotopes desired, ^{235}U and ^{238}U. The waste, still containing 85% of the original radioactive elements, but now much more loosely bound, is put into the tailings To put this now relatively mobile material back into the ground in this condition, into a fault zone, where groundwater finds a favourable place though which to flow, may not be the most responsible solution to the tailings. In the end, the current mine and mill operators find it is cheaper to leave them on the surface rather than deal with them properly.

As stated, these fault zones are also problematic during the mining process, because they are unstable and have water running though them. To combat this, a large amount of energy must be used to freeze and stabilize the ground during the mining phase.

I believe the Cluff Lake mine has been decommissioned, having been declared good to go for ten thousand years. Basically most of the tailings and mine waste there have been pushed into the reducing environment of the nearby lake, where the acid nature of the tailings will be neutralized for now – but what about the future, beyond 10,000 years. The landscape is not going to remain the same forever. Weathering and erosion will continue nonstop.

Back in the 80”s, having experienced more modern mining operations at Cluff Lake and Rabbit Lake the province had to decide whether they would allow the uranium mining in the province to open up new mines and expand their operations. The mines had experienced their share of “avoidable” spills due to overflowing tailings ponds,

rupturing effluent pipes and the like over the years – some of them quite serious. They decided to hire Beak Consultants to determine whether the environment had been adversely impacted by the mining operations around Rabbit Lake, an area where many of the current mining operations are in close proximity.

Beak Consultants was commissioned to review the monitoring data of the Rabbit Lake operations and reach a conclusion. The report was not a great endorsement for the quality of monitoring that was being carried out and raised all kinds of red flags that should have been checked. Monitoring requires a predictive and scientific approach to collection points for samples, quality of samples taken, analytical techniques used, and more accountability in reporting. A quality monitoring program should be designed to predict results and establish monitoring locations, methods and techniques to confirm, or not, these predictions. It sounds like the monitoring “required” was taking place fairly randomly with inattention being paid to the results.

When I look back at the 1985 Beak study which utilized data collected on Hidden Bay since 1974 (under the watchful eye of Environmental departments of both the federal and provincial governments), there are at least four red flags that popped up. There was no consistency in how the data was collected or the way it was reported and many errors in sampling and analysis technique were identified. According to the introduction, "In preparing the data for analysis in this study, it was necessary to reduce large amounts of individual monitoring data which was often expressed in different ways and which often had various degrees of uncertainty associated with it. When monitoring values appeared which were either very low or very high as compared with other data collected from the same area, they were identified as outliers and not included in the analysis. In many cases, the presence of outliers could be traced to incorrect units or faulty analyses. In cases where a reason for the outlier could not be identified, its significance from an environmental perspective was evaluated and recommendations for cross checking were made." Based on this, they eliminated most of the anomalous data. To me, if I got some particularly high levels in my data, that would be cause to go back immediately and redo the monitoring at that location to confirm the results. Also, the fact that they were not more elevated readings should have been a concern, because if the pollutants were not in Hidden Bay, the question should have been asked – where are they and they should they have been looking to verify this. Lake bottoms are very soft and mushy. The Ekman dredge used at Rabbit Lake prior to the Beak Study was a clamshell sampler using for grabbing up bottom sediment samples. Think of the Digger found in Arcade Games that pick up plush toys. It is not what I would consider a delicate and discriminating sampling tool. Water and material gushes from it as it is brought to the surface and it would be difficult to define horizons when it is opened up to attempt collecting a quality sample from a specific layer. There are samplers now available that will take a nice clean core sample that can be brought up intact, without releasing water, so that reliable data can be measured from a particular horizon. The conclusions of the report stated that "based on the available data, the operation of the Rabbit lake uranium mine and milling operation has had no discernible effects." It also said "These large analytical uncertainties, coupled with changes in

analytical procedures and techniques throughout the monitoring period, makes it impossible to discern any trends in much of the data." I guess this sounded positive enough for the government because expansion went forward on new mines!!!

This is quite a close analogy to the recent Schindler Report on the tar sands. Using snow samples, Schindler et al proved beyond doubt that tar sands mining and refining operations were responsible for hydrocarbon contamination of the environment. When I look at the essence of the report on tar sands monitoring by Schindler, Kelly et al from 2010 and the follow up report made to the government, the industries involved were doing due diligence and conducting the monitoring that was required of them. However their approach was not very scientific in that they were not using predictive models to test out the effectiveness of their environmental management efforts. As a result both the Federal and Provincial Governments, as well as all the major tar sands operations were maintaining that their operations were having no impact on the environment. This was not the case and now environmental monitoring is being overhauled around the tar sands to get a clear and real picture of the impacts of the tar sands operations, which continue operating regardless.

The mines are now apparently using more modern sampling technology and the 14000 series of ISO model for their environmental management. It provides guidelines for measures that could be taken by a company but don't necessarily have to be followed and which can be adapted to suit the needs of the operator. It does not provide any assessment tools to evaluate or assess the performance of their management efforts. Hopefully CNSC is working very closely with them to develop a quality monitoring program and, hopefully, a decommissioning plan for the mills as well!!!

I had assumed that all the uranium could be extracted at the mill but, apparently at least 5% remains in the tailings. I had also assumed that since Uranium was a heavy metal, it would settle out in the settling ponds before mill water was released to the environment – it seems that this is also not the case. It is my understanding that once reintroduced into the environment, uranium will have potential impacts in its receiving environment for billions of years. As in the spills that have taken place into the environment over the years, the companies know how much total load is being released into the environment at any particular time – they just seem to choose to ignore it.

I remember one particularly disturbing news report of a famous spill at Rabbit Lake in the 70's where water escaped from the effluent pipe. The news report showed someone taking samples from a stream that clearly had a very strong current at that location. This was some time after the spill and the company was pleased to reassure the public that no significant damage to the environment could be detected. Given the

timing of the sampling – reporters were able to capture it on film at this remote location – and the apparent rate of stream flow, I would have been very surprised if they had been able to detect any evidence of the spill, at that location. Winter temperatures in Saskatchewan can drop below -40^{o}C. The effluent pipe had been allowed to freeze. It froze at a valve location within an unheated shack. The shack was unheated because a transformer had blown and when a replacement arrived on the mine site, it was installed elsewhere at the mine and another one was not reordered. When the valve froze and cracked, normally it would have been contained within a ring of ditches around the settling pond. However, culverts had been opened up in the ditches the previous spring to allow runoff to escape and had never been closed. The effluent escaped to the nearby creek. The spill continued for 16 hours before it was detected when a local from Hatchet Lake, Chief Ed Benoanie, spotted it from the air when he was flying over and reported it in. Mine staff had no idea it was occurring, apparently they dismissed the drop in pressure in the effluent pipe as faulty gauges. Cameco was taken to court and eventually fined $5000.

Areva, at Cluff Lake, also had problems. For instance, at one time the tailings pond got too full and actually overflowed for a significant period of time – how does that happen??? They also had some high grade tailings material they decided to enclose in concrete canisters which later cracked during winter conditions. They decided to enclose the containers within a building but found the materials were too radioactively hot. They ended up reprocessing these tailings for the gold that was within them and dumping the rest into the main tailings area.

In 2006 the CNSC found that uranium and uranium compounds were entering into the environment at uranium mine and milling operations, at Rabbit Lake and Key Lake, in concentrations that may have immediate or long term effects on the environment and biodiversity. At that time the effluent being released into the environment, via the effluent pipe at Horseshoe Bay at the Rabbit Lake operations had averaged out at 1.7 metric tonnes of uranium per year, as well as amounts of molybdenum, selenium and likely many other elements. The CNSC asked them to clean up their act and, in the 2007 CNSC Annual Report, the findings stated Cameco had managed to reduce the uranium released back to 238 kg. – about an 80% reduction. Since 2006 the reduction in uranium has actually averaged out to about 61%, according to Cameco. This means that over the past 16 years alone about 20 metric tonnes of uranium, as well as quantities of other elements, have passed into the environment at this one location. If this had been a one time release event there would have been hell to pay. As it is, if Cameco can't account for where these elements ended up in the environment, that's a problem. It also concerns me that this much was being passed into the receiving environment and no concerns were being raised. We can collect a lot of data, but if it is not analyzed, it is of no use. If they have not done it already, they need to do a mass

balance analysis, using sediment sampling, to see if the amount of these materials entering the receiving body is remaining there or is moving on. If it is not there, they need to revise their modelling and confirm where it has actually ended up.

I think they should be measuring total loading into the environment, and not using surface water objectives which measure concentrations. Concentrations depend on volume of water, and in the case of radioactive elements, may not be a good measure of impact on environment – dilution does not neutralize radiation, it spreads the effects over a wider area. If the monitoring of emissions into the air and water are accurate, we will know the load into the environment and should be able to predict impacts. If the impacts are other than those expected, their model needs correcting.

It is not only the tailings that concern me but also the airborne and water borne materials generated at the mine and mill sites. I have to wonder how much material escapes in the runoff from waste and ore piles and leachate from the tailings. Mine and mill ventilation and the wind blowing across ore pads on the surface must distribute the radioactive pollutants into the surrounding areas but monitoring would seem to indicate that levels are not above background. Is this Logical? Are they sampling vegetation and soils to test for longer lived decay products of radon gas. At this date, the problem is partly how to discern between what is happening now and what is a result of past mining and milling activities. The mines are operating without a decommissioning plan. What needs to be done prior to decommissioning is to determine where wastes that have gone into the environment are now located and clean them up. The mines would likely argue this would be too expensive for them to continue to operate. So far governments seem to defer action in favour of company shareholders.

We need to look at pathways for radionuclides and heavy metals – air, surface water, ground water, vegetation, effects due to ingestion by humans, wildlife, and fish, public health, epidemiological studies of all miners, past, present and future. We should be looking at all the physical and chemical linkages to help determine aerial extent, frequency, duration and certainty in predictions. We do know that large lakes such as Lake Athabasca have seasonal turnover, which can cause materials in the sediment to be remixed into the water column. Strong currents also exist that can carry these materials long distances. We also know that fish, such as Lake Trout, travel long distances to return to their spawning grounds. Wollaston Lake is also a very large lake and is close to most of the operating mines. It is not unreasonable that contamination of the food supply can spread far beyond the mines.

For instance, I have heard stories that animal life is much more scarce in the region surrounding the mines, or that Northern Pike eggs have been found deformed around Key Lake, or the caribou no longer migrate down to the Wollaston Lake area, or recently, even below the border with the territories. Is this true and what efforts have

been made to determine the cause – are caribou numbers in decline and why???, or do they simply avoid the amount of activity around mines? Are the alpha emissions from mine and mill ventilation and wind blowing off ore and waste piles a possible contributing factor?

Years ago the uranium industry had trailers that travelled to schools and community exhibitions to educate the public about uranium mining. I asked them about health studies being carried out on miners. The answer was that miners were too transient and hard to track to conduct health studies on. To this date, I believe no epidemiological studies have been carried out. I have heard many times that a lot of people in northern communities are experiencing cancers. Pinehouse residents claim that the cancer rate is as high as 1 in 7 in their community. . Many would like to know why there is so much cancer in the north. I myself have experienced a Hodgkin's Lymphoma after delivering a training program in the community of Stony Rapids for several months. A proper epidemiological study is long overdue. Such studies should have been ongoing from the start.

I can not comment on the quality of dosimeter monitoring of individuals at the mines for alpha, beta and gamma radiation. Beta and Gamma are penetrating radiations that can go right though someone without causing any damage. However, the higher the concentration, the more likely damage will happen. What really worries me at the mines however, is the alpha. The mines are in fault zones and water is present. It s my understanding that when one disturbs a puddle of water, such as walking though it, that the alpha particles, present in radon gas, are broadcast into the air like perfume from a spritzer. Alpha is not a penetrating radiation, but when it breathed in, or consumed, its ionizing nature can create damage. I don't believe the miners are protected from breathing in alpha particles

If I had to make a guess, I think the demographic distribution in Saskatchewan is very similar to Quebec's. Most of the population is in the south and the northern population is small and widely dispersed in a few communities. The Saskatchewan mines are in isolated areas in the north. The main selling point for mine expansion was the jobs and economic opportunities it would bring to the north. Please visit these communities for yourselves and decide for yourselves whether it has had a positive impact. What has changed in the communities since the uranium mines opened? Talk to the people, not the village councils. These jobs and economic opportunities have always been used as a lever to gain acceptance from northern communities for the mines. The mines promised 65% of the mine workforce would be northern. Depending on your definition of northerner, this target may never have been reached. Many of those who did get jobs found it hard to justify their suddenly found affluence while living in communities that have an 85% unemployment rate and have a tradition of sharing – and ended up leaving their communities and moving south. It might also be found that the 'majority' of

the kind of jobs they gained are menial. A couple of years ago, I was stunned to find out that the Hatchet Lake Band on Wollaston Lake, the closest community to all of the operating mines, only had a handful of people, (5 or 6), working in the mines. The other aspect of these employment and economic opportunities for the north is the fact they are in the north. The mines are isolated in the north of the province and the majority of Saskatchewan people have no idea what goes on at the mines or in the north – They only hear the propaganda from the mining companies and a provincial government that is all too eager to promote the mines and its rewards but pays no lip service to environmental damage, the socio economic conditions in northern communities or future impacts that will be accrued for a future time.

It begins to appear that the best interests of Northerners are not in the forefront. In fact their very poverty is used as a pawn in a chess game to promote and sustain the industry. Using sustainability principles would likely have a much better success rate in improving life in these communities that would be much better suited to their lifestyle and other resources available to them. Recently, Cameco and Areva tried to get Pinehouse to sign a Collaboration Agreement that, on the face of it, sounded fairly progressive because it offered preferential treatment in awarding of service contracts and hiring as well as some guidelines for settling any disputes that might arise. On the flip side it wanted full cooperation from the community, which many felt was akin to a gag order in regards to accepting what has gone in the past and the promotion of future developments. It also appeared to leave tailing management activities in the hands of the communities – this matter created a lot of division in the community and is still before the courts. A lot of it had to do with a difference between those who would accept economic development at whatever cost because it would bring money into the community and those who had more traditional values and wanted to protect the land. Almost no information was available to the community, beyond the village councillors, before the agreement was made. Life is very hard in an impoverished community with a host of social and economic problems when a company comes into town willing to spend a little money. Events in the community becomes very one sided towards the company and its supporters.

What has also emerged within the last year is that Cameco was operating its marketing through a subsidiary in Switzerland, Cameco Europe Ltd. Through them they were able to avoid declaring billions of dollars in profits and avoid taxes amounting to over $1.6 billion, and still growing, for an eleven year period ending in 2013. They were selling the uranium to Cameco Europe Ltd. at a low price, which was then acting as a middleman and reselling it. This time it is revenue Canada that is taking them through the courts. Our royalty structure is set up so the province does not collect royalties unless the price is above a certain level.

Cameco has also been very successively in establishing itself onto the boards of educational institutions and making money available for nuclear related research. This has resulted in a deficit in these institutions in regards to climate change research and education in the areas of renewable energy and sustainable development – These kinds of things are not even at the edge of our thinking in Saskatchewan when visions of the future are thought about. If the educational institutions are not educating the public, then who else has the resources to do so.

For the present, what also greatly concerns me is the new trade deal that has just been entered into with China. I think it will make our resources vulnerable to exploitation and we may have much reduced abilities to protect the environment as well. I am even wondering if Quebec would even be able to prevent China from opening up mines in Quebec. As for provinces, which already has operating mines, I don't know what the future holds in this respect.

To me, what is even more important than what is going on in the present, although the accuracy of our predictions now reflect on our predictions for the future, is the fate our tailings. To me the big difference between the quality of the material in mill tailings and those wastes from a reactor is our mill tailings are not as radioactively hot or excited. They both contain long lived, toxic radioactive material. The tailings are going to have to be monitored into perpetuity (1997 Report from the Joint federal Provincial panel on mine development in northern Saskatchewan, concerning cumulative effects on operating mines as well as considerations for Midwest and Cigar Lake mines). The difference in the way we propose to handle them is: NWMO wants to bury the nuclear waste deep underground where, hopefully, they will never be able to find their way back into the environment; the mines want to leave the very fine, more chemically mobile mill waste on the surface where it will certainly be exposed to erosion and will flow back into the environment. Probably disposing of the mill waste into a surface tailings area is the most economical, efficient and safest way to handle the waste in the short term, but over the long term it is a recipe for disaster and we are just delaying the release of all this material into the general environment around the mines. Yes, in the short term we can design the capping of the tailings to drain runoff away from the tailings. I don't know what Cameco's vision of their tailings area (soon to be ours) is, but my vision, best case scenario, even if we managed the tailings and maintained them for hundreds of thousands of years, is we would find the bedrock around them worn away and be forced to move the tailings to another site to forestall the ultimate destruction, by erosion, of the tailings facility. Remember the tailings still contain about 85% of the radioactive materials that were in the ore body, but we don't want. They also contain about 5 to 10% of the uranium still, which could not be separated from the rest of the ore.

It concerns me when developments operate or move forward without proper foresight. Release of radiation will impact those of a more distant future. Future generations do not deserve this.

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NUCLEAR WASTE:

During the Seaborn Commission on nuclear waste Gordon Edwards talked about thermal pulses which could spread and bring nuclear waste from an underground dump site back to the surface. The heat source for this was the decay of the new radioactive elements that were created in reactors. He calculates the heat generated will be a problem for at least 50,000 years. During this period some of the resulting decay elements will be even more radioactively toxic than the original waste - strangely we have never been informed of this by the NWMO. We are always reassured otherwise. More toxic AND hotter with time!! We also need to understand that water exists in all rock underground, the rock itself is either porous to water or movements in the earth's crust have fractured it in seismic events. This was a problem with the White Shell facility in Manitoba used to study our deep disposal waste concept as well as with the Yuca Mountain in the US, the salt mines in Germany, etc. It is also impossible for us to create a repository without further damage to the bedrock. The combination of heat from the waste and underground water could conceivably create a thermal pulse that will carry the waste outward into our aquifers.

When the fuel bundles are removed from a reactor they are cooled in pools for at least 10 years and then placed in dry storage in concrete containers. These canisters are ventilated so the fuel bundles can be air cooled. .After 48 years they are considered to be radioactively cool enough to bury. Once buried underground this ventilation will not be possible, sufficient cooling will not take place, and the heat could build up as, during the decay process, more heat is released More heat will be created at some stages than others.

Edwards warns the industry needs to be perceived as having a solution to nuclear waste in order to be able to justify expansion of the industry. Also the nuclear industry is viewing nuclear waste as a money maker and a growth industry. At almost every stage of the chain waste has to be repackaged and the volume of waste increases. As the packaging deteriorates with time, the packaging and contents have to be repackaged. Reprocessing in particular uses large volumes of powerfull acids to separate the plutonium and then these acids must be repackaged - tanks last 50 years and almost entire facility needs to be packaged and stored and replaced. The Selefield Reprocessing Facility in England pumps its waste two miles out into international waters in the Irish Sea, which is now extremely contaminated. The plutonium was thought to be heavy enough to remain on sea bottom but is being found in people's vacuum cleaners for homes that are built along the shore. Low level waste containers lasts 30 years. The containers for deep disposal are guaranteed for 300 years. By law, nuclear waste from a reactor can not be removed from the site for 30 years. After 48 years it is considered cool enough that it can be buried. The toxicity of this material is much reduced over this time since it was removed from the reactor but 90% of the toxic materials will now be in the waste still at the surface. As long as the nuclear industry continues to expand, the most dangerous materials will remain on the surface and continue to be a health and security threat. Deep disposal does not make any sense unless the nuclear industry, and its weapons connections, is being phased out and we are no longer accumulating the most dangerous material on the surface. There is no solution to nuclear waste and it will remain a problem in perpetuity. The Porter Report 1978 stated that reprocessing should not be pursued so a central storage system should not be necessary. The establishment of a repository will almost certainly mean that reprocessing will occur at the repository. The expansion of the industry into reactors that will use reprocessed fuels will also mean that large amounts of plutonium will be available to countries involved in reprocessing and will always remain a security risk.

I used to think that if we kept the nuclear waste dry that we could isolate it from escaping into the environment. If it is exposed to the air, this might be the case as it could dissipate the heat from the radioactively hot waste. Buried deep underground, there would be no way for this heat to dissipate – water has to be present to do this –

unless the rock itself is sufficiently conductive. At any rate water is always present underground.

Bentonite buffers are the key element of the waste disposal concept. NWMO describes how they are looking at a number of sites (21?) in Canada? I asked them how long this waste needed to be cared for. They responded that for at least a million years. This is a very long time and a community would have to consider very carefully the possible fate of future generations. I asked them why they are doing this, since it is fairly common knowledge that everywhere underground there is a presence of water, making deep underground storage impractical? As we were most recently reminded by the events at Fukushima, nuclear waste from a reactor is in an excited state and will continue to generate a significant amount of heat (and continue to do so for 50,000 years - NWMO would assent to 1000 years). The presence of water would facilitate the circulation of heated water, and whatever is dissolved within it, into the equation. I asked them why are we looking for sights that contain water that will bring this toxic material back into our environment. Their answer was that they would be looking for a sight that was free from water. I don't think they are being truthful!!

Their concept relies on the buried canisters, containing spent fuel, to be surrounded with bentonite clay that, when wet, will swell up and seal the containers away from the intrusion of water. **I think the bentonite is a big problem!!**

Dry bentonite will not do the job that is needed. It needs to be wet to be able to transfer heat to the surrounding rock. If it can not do this, the waste will heat up, resulting in a thermal pulse. The host rock also has to have certain heat conductive properties to assist the dispersal of the heat. Even if the clay is wet the heat will drive water away from the canisters, towards the rock, creating a dry layer next to the canister that will be affected by the heat. As water moves away silicification will occur, changing the properties of the clay.

We need to know the heat transfer properties of dry bentonite clay, and silicified clay. The science behind this has to be solid!! - **OR**, it is a no go!! The clay has to be wet. It needs to be unreactive to the canisters, it must impede the flow of water, and if radioactive elements are able to leave the canisters, the platelets of clay must bond with these escaping elements so that they will never be able to migrate any further, and if it is chemically altered by heat and radiation, its new properties must also be up to the job. I don't have the science to answer these questions.

There are many kinds of clay, used for all kinds of purposes - plenty of literature. I know clay contains a lot of elements. I also know that clay bricks are used as an insulator to line stoves and chimneys. It can insulate when it is dry and conduct heat when it is wet. It also expands and seals when it is wet. We also need to understand how the movement of water will be affected in the suppository as it swells up and seals. Will the clay surrounding "all" of the canisters remain wet enough to transfer heat to the surrounding rock. Will some stay dry or partially dry? If not how will the heat and radiation change the clay? As the canisters age, will they become more susceptible to damage from the pressure exerted by the swelling clay and will they continue to resist the corrosive properties of some of the elements in the clay?

http://www.nda.gov.uk/documents/biblio/upload/Bentonite-A-Review-of-key-properties-processes-and-issues-for-consideration-in-the-UK-context.pdf search Key word bentonite clay by James Wilson et al, February 2011.

The above link is a British study. It is an excellent review of factors that affect the bentonite buffer. While it does not fully support my concerns, in terms of their potential, **it does indicate that the science is not solid** - much needs to be understood. There are many types of bentonite clay with specific characteristics which may, or may not, make a particular bentonite suitable for consideration for a particular site. Quality, consistency and purity will obviously also be factors. Fairly technical,

The key point is that the buffer material (bentonite) is THE KEY element to the safe operation of a facility. It seals the radioactive materials in - **or not**... A lot still needs to be understood but the composition of the rock and groundwater "at the site" are just as important as the composition of bentonite clay itself. The bentonite clay needs to be wet to do its job - dissipate heat to the surrounding rock and seal and isolate the waste so it can't migrate. It can be affected by heat and radiation can cause some change to its chemistry. The chemistry of the groundwater can also react with the bentonite. The bentonite can contain corrosive elements to the copper canisters - even worse if they were using steel. The bentonite has to be carefully packed and water added to it so the expanding clay does not damage the canisters (become crushed due to uneven pressures being exerted on the canisters).

The Canadian engineered barrier system uses bentonite and aggregate (cheaper if you add rock to bentonite) which transfers heat easier to the surrounding rock but it also makes it easier for it to allow passage of water. This may also be a game changer in regards to the characteristics and effectiveness of the bentonite.

However, it is the presence of water around the deposit/repository and the fact that it must circulate to dissipate heat that concerns me. The integrity of the containers must be maintained for such a long time (tens of thousands of years???) and the water is exactly the transport mechanism which can bring the material, we so badly wanted to bury, back into the living environment as we know it. As well, I know nothing of the life that must exist beneath the earth's surface and who is to speak on its behalf.

Anyway, the bentonite is a key part to the success of isolating and cooling the waste and I am not at all confident we can guarantee it's performance. I am not into calculated risks. If we are wrong, there is probably no safe way to mitigate the damage to the environment that would result.

May all your decisions be good ones!

Sincerely, Steve Lawrence

Should you have any questions, please contact me by email @ stvlawrence@gmail.com to set up a time I could be reached by phone. I can be available at my office after 3:30 pm Central Standard Time, Monday to Thursday and anytime Friday afternoons. My office phone number is 306-765-1624. If you wish to contact me at home my number is 306-922-1062. Mailing address 3463 -12th Ave E, Prince Albert, Saskatchewan S6V 7G6