Saskatchewan Environmental Society

The Legacy of Uranium Mining in Saskatchewan:
The Unacceptable Environmental Impacts of Uranium Mining

Saskatchewan Environmental Society March 2015

Executive Summary
The Saskatchewan Environmental Society does not support an expansion of the uranium mining industry in Saskatchewan. Our organization has worked for decades to propose improvements to environmental practices at existing uranium mine operations, and to try to persuade governments to stop uranium exports to countries intent on using uranium for military purposes. Yet only nominal progress has been made on these fronts. The fundamental problems associated with uranium mining and uranium exports have not been resolved.

This referenced paper summarizes the legacy of uranium mining in the province of Saskatchewan. In it you will find pertinent information about the history of uranium mining in Saskatchewan, environmental contamination at mined-out sites that have some remediation work underway, environmental problems at mine sites that are currently operating, the unresolved challenges of disposing of high level radioactive waste that originates from uranium's use, and the connections between Saskatchewan uranium exports and nuclear weapons proliferation.

This paper makes it clear that despite current remediation efforts, surface water contamination in the Uranium City area and on the shores of the Crackingstone Peninsula (Lake Athabasca) will continue to be a significant problem because of the damage caused by earlier uranium mining. We document in detail the current levels of surface water contamination in many watersheds in northwestern Saskatchewan.

The paper then shifts to northeastern Saskatchewan and examines environmental loading of contaminants at the currently operating Rabbit Lake mine and mill site near Wollaston Lake. Several areas of the site have significant levels of pollution that will be very difficult to clean up. Moreover, the recommendations made by a Federal Environmental Assessment Review Panel that would have given the community of Wollaston Post and environmental organizations a real voice in decision making around tailings and waste rock reclamation on site have never been implemented.

Most uranium mine sites in northern Saskatchewan have tailings disposal facilities at them that pose a long term risk to the environment. In this paper we focus in on the Key Lake uranium mill site as a current example. At Key Lake the issue to consider is whether uranium mill tailings can be properly contained for thousands of years into the future. In our judgement, Cameco is taking significant risks. Instead of limiting tailings disposal to areas of its mined-out pit characterized by rock formations with low permeability, it plans to elevate tailings disposal into the sand outwash portion of its disposal pit. This increases the risk that radionuclides and heavy metal contaminants in the tailings will ultimately migrate into the larger environment.

The connections between uranium exports and nuclear weapons proliferation are perhaps the most disturbing part of Saskatchewan's uranium legacy. From sales of uranium to the US Atomic Energy Commission in the 1950's and 1960's to currently planned sales of uranium to India today, this paper explores how Saskatchewan uranium exports have been facilitating the buildup and proliferation of nuclear weaponry in the world. Despite the Joint Federal-Provincial Panel on Uranium Mining

Developments in Northern Saskatchewan flagging the weapons proliferation issue for both the Saskatchewan and Canadian governments in the 1990's, no corrective action has been taken.

At the end of the day, Saskatchewan uranium exports ultimately become high level radioactive waste at nuclear reactor sites around the world. This paper explores the inability of national governments, such as the United States government, to resolve the high-level waste disposal issue. This in turn poses important questions about the future viability of nuclear power. A 2014 accident in New Mexico at a site for low-level and medium level nuclear waste, after only 15 years of operation, is raising even more concerns about the risks that will come with trying to dispose of high level radioactive waste. Disposal – to be effective - must be secure for thousands of years into the future.

We hope the detailed information in this paper will be useful to the reader.

Table of Contents:

Background on the Principal Authors

This submission was prepared by Peter Prebble and Ann Coxworth on behalf of the Saskatchewan Environmental Society. The Society is a non-profit organization with a long history of involvement in the uranium mining issue in the province of Saskatchewan, and has formally intervened in numerous public hearings on proposed uranium mine developments dating as far back as 1977.

Peter Prebble is Director of Environmental Policy with the Saskatchewan Environmental Society. He has a Bachelor of Business Administration degree from the University of Prince Edward Island, where he received the Governor General's Gold Medal. He holds a Master of Sustainable Environmental Management and a Master of Education, both from the University of Saskatchewan. In addition to his long time involvement with the Saskatchewan Environmental Society, he served as a Member of the Saskatchewan Legislature for 16 years, including several years as Legislative Secretary to the Premier and as a Saskatchewan Cabinet Minister.

Ann Coxworth is a long time board member of the Saskatchewan Environmental Society. She has a bachelor's degree in chemistry from the University of Durham in the United Kingdom, a Master of Science in nuclear chemistry from the University of California, Berkley, and a Master of Arts from Smith College, Massachusetts. Her nuclear research experience was gained at the Lawrence Berkeley Radiation lab in California and the Windscale Sellafield Lab in Cumbria, UK.

Additional Note:

The Saskatchewan Environmental Society submitted a version of this paper to a special Quebec Commission reviewing the merits of uranium mining (BAPE).

In the summer of 2015 the BAPE issued a report to the Government of Quebec on uranium mining. The BAPE has recommended to the Government of Quebec that uranium mining in Quebec not be permitted.

1. Mined-out uranium sites currently under remediation

1.1 Background information on two mined-out uranium mine sites that are being remediated today in Saskatchewan

Saskatchewan has been involved in mining uranium since 1952. The first mines in our province were developed in the Uranium City area of northwestern Saskatchewan. By 1956 Uranium City was the fastest growing municipality in all of Saskatchewan.[1] The anchor uranium mine in the area was known as the Beaverlodge mine. It was run by the Government of Canada through its federal crown corporation Eldorado Mining and Refining Ltd., and operated from 1952 to 1982. During this period the Government of Canada mined uranium and produced uranium-related wastes in two Saskatchewan watersheds – the Ace Creek watershed and the Fulton Creek watershed. Those watersheds in turn drain into Beaverlodge Lake, a 57 square kilometre water body near Uranium City. Although the Beaverlodge mine and mill site were decommissioned in the 1980's, active remediation work is still required on the Beaverlodge site today. That work is being led by Cameco Corporation, and is being funded by the Government of Canada.

A second major uranium mine also began operation in northwest Saskatchewan in the mid 1950's. The Gunnar open pit and underground uranium mine opened in 1955 on the northern shore of Lake Athabasca. Lake Athabasca is one of Canada's most important lakes and straddles part of the border between northern Saskatchewan and Alberta. The Gunnar uranium mine and mill were built near the edge of two bays of Lake Athabasca – Langley Bay and Zeemel Bay. A community of over 1,000 people was created to support the Gunnar site. The mine operated from 1955 to 1963. Gunnar was thus the first major uranium mine to close in Saskatchewan. Today, site rehabilitation work is underway through a joint agreement between the Government of Saskatchewan and the Government of Canada.

1.2 The atomic weapons connection at Gunnar and Beaverlodge

In the early 1950's the Government of Canada entered into a contractual agreement to supply uranium to the United States Atomic Energy Commission. This set the stage for the development of the Gunnar and Beaverlodge uranium mines. Their primary purpose became to supply uranium for military purposes, specifically the building of nuclear weapons.[2] Saskatchewan uranium was mined for this purpose until the United States signaled in 1962 and 1963 that it had a sufficient supply of uranium to meet its military needs. This led to the closure of the Gunnar uranium mine site, and the stockpiling of ore at the Beaverlodge mine site for many years.

The role of the federal government's Crown Corporation Eldorado Mining and Refining Ltd. was critical during this time. Not only did Eldorado Mining and Refining supply all of its uranium from its Beaverlodge operation for atomic weapons purposes, but it became the intermediary for supplying Gunnar's uranium supply to the US military as well. It did this by purchasing the Gunnar mine's

[1] *The Encyclopedia of Saskatchewan* (2005), Entry entitled 'Uranium City'. http://esask.uregina.ca/entry/uranium_city.html

[2] Robert Bothwell, *Eldorado: Canada's National Uranium Company* (The official history of Eldorado Nuclear Ltd. Commissioned by Eldorado Nuclear Ltd.) Refer to pages 315-386.
The contracts negotiated between Eldorado Nuclear and the US Atomic Energy Commission were intended to deliver uranium to the United States up to March 31, 1962, a date that was later revised to March 1963. (Bothwell, ibid, p. 386)

production.[3] and then selling it to the United States Atomic Energy Commission.[4] Thus, Eldorado Mining and Refining was at the centre of a dark chapter in Saskatchewan history – the supplying of the raw material for hundreds, if not thousands, of nuclear weapons.

1.3 Radioactive contaminants on the Gunnar site and remediation objectives for nearby surface waters

The legacy of Gunnar is not limited to its role in supplying the US military. The mine's operations also left behind a damaged local environment and an expensive cleanup legacy for taxpayers.

In 2006 the Government of Saskatchewan and the Government of Canada entered into a joint agreement to carry out remediation work at the Gunnar uranium mine and mill site. The remediation work was sub-contracted to the Saskatchewan Research Council.

Remediating the mined-out Gunnar uranium mine site will be no small undertaking. There are between 2.2 and 2.7 million cubic metres of waste rock on the site.[5] Today, Zeemel Bay and St. Mary's Channel of Lake Athabasca are contaminated with runoff from these waste rock piles. The 'East Waste Rock Pile' accounts for 70% of the Radium 226 going to the lower section of Zeemel Bay and subsequently to St. Mary's Channel, so clearly this must be addressed.[6]

There are also over 4.4 million tonnes of unconfined radioactive tailings on the site. There are three main tailings areas, but wind and water have also transferred tailings beyond those three areas. In the Gunnar Main Tailings area, the tailings volume is large, and at its peak is 14 metres deep.[7] Unfortunately, some of the tailings at the Gunnar site were allowed to move into Lake Athabasca itself. They sit in Langley Bay of Lake Athabasca to this day. In all, the total tailings area at the Gunnar site occupies 70 hectares of land.

Lake Athabasca is a vast water body and beyond the bays in question, the pollution affects are ultimately diluted, but it should not be forgotten that there can be potential re-concentration of some pollutants as they move up the aquatic food chain.

1.3 Large cost overruns in the Gunnar remediation effort

When the Government of Saskatchewan and Government of Canada first agreed to cost-share remediation work on the Gunnar site, the cost was valued at $24.6 million and was to be equally shared. However, no provision was made for cost-overruns.[8]

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[3] Natural Resources Canada, 'Evaluation of the Gunnar Mine Site Rehabilitation Project', 2012. NRCan confirms that all the mine's uranium production was purchased by the Crown Corporation Eldorado Mining and Refining Limited.
[4] Robert Bothwell, *Eldorado: Canada's National Uranium Company* (The official history of Eldorado Nuclear Ltd. Commissioned by Eldorado Nuclear Ltd.) Refer to pages 326-333.
[5] Saskatchewan Research Council, Project Cleans: Gunnar Mine Site, http://www.src.sk.ca/resource%20files/project%20cleans%20-%20gunnar%20mine%20site%20fact%20sheet.pdf
[6] Gunnar Site Remediation Project Environmental Impact Study, Executive Summary of Revised Volume 1, Saskatchewan Research Council, February 2013, page iv. http://environment.gov.sk.ca/2007-068EISExecutiveSummary
[7] Saskatchewan Research Council, Project Cleans: Gunnar Mine Site, http://www.src.sk.ca/resource%20files/project%20cleans%20-%20gunnar%20mine%20site%20fact%20sheet.pdf
[8] Natural Resources Canada, "Evaluation of the Gunnar Mine Site Rehabilitation Project", 2012.

The initial cost estimate for remediation proved far too low. To date $20 million has been spent on the demolition of buildings alone (including asbestos abatement), when an amount of $3 million was originally budgeted. So far the Saskatchewan government has spent $58 million on overall remediation. The Government of Canada to date has spent approximately $1.1 million.[9]

Now the Government of Saskatchewan has posted a $208.5 million liability on the provincial ledger to cover Gunnar site remediation and future monitoring and maintenance. So far, there is no sign of the Government of Canada increasing its $12.3 million funding commitment. There is thus clearly a high risk that Saskatchewan taxpayers will be left paying the vast share of the costs of remediating a mine site that was largely driven by Canadian government policy decisions. (The full story in this matter has yet to play out, and further negotiations between the Saskatchewan and federal government may take place.)

1.4 State of contamination of watersheds in the Uranium City area

The Gunnar mine and mill site were abandoned in 1964, when provincial and federal Departments of Environment did not yet exist. Moving forward 20 years, the Beaverlodge uranium mine and mill site was decommissioned by the Government of Canada in 1985, with the approval of the Saskatchewan Department of Environment and the federal Atomic Energy Control Board (the predecessor of the Canadian Nuclear Safety Commission). The Canadian government (through Canada Eldor Inc.) continues to assume responsibility for the Beaverlodge properties up to this day, making the question of who is ultimately responsible for environmental stewardship on these properties very clear.[10] The Government of Canada contracts Cameco Corporation to manage the Beaverlodge properties on its behalf. There are 62 properties in all.

What then is the current state of the two Saskatchewan watersheds that these uranium properties lie within, and what is the state of the adjacent watersheds downstream of them? [11] The findings will offer some insight about the Government of Canada, and how it handles issues around the mining of uranium.

The Government of Canada's Beaverlodge mining properties were located in Saskatchewan's Ace Creek watershed; while its mill tailings disposal sites were located in the smaller Fulton Creek

[9] Natural Resources Canada, "Evaluation of the Gunnar Mine Site Rehabilitation Project", 2012.

[10] *Beaverlodge Project Annual Report – Year 25* (January 1, 2010 to June 30, 2011), page 2-3. The Annual Report notes: "the Government of Canada, through Canada Eldor Inc.(CEI) retained responsibility for the financial liabilities associated with the properties".

[11] The sections of this paper that cover the state of contamination of the Beaverlodge properties and the waters downstream of them, and that discuss remedial work planned at the Beaverlodge site (1.4-1.7) are reproduced here from a 2013 article by the authors published by the Canadian Centre for Policy Alternatives (CCPA). The article prepared for CCPA is entitled: "The Government of Canada's Legacy of Contamination in Northern Saskatchewan Watersheds". For further details refer to: *Saskatchewan Notes: The Government of Canada's Legacy of Contamination in Northern Saskatchewan Watersheds* by Peter Prebble and Ann Coxworth, Canadian Centre for Policy Alternatives, July 2013, pages 3-5. The authors are grateful to CCPA.
https://www.policyalternatives.ca/sites/default/files/uploads/publications/Saskatchewan%20Office/2013/07/SKnotes_Govt_Legacy_Contamination_Watersheds.pdf

watershed.[12] These two watersheds are now home to many lakes with excessive uranium concentrations in surface waters and sediments.

One would expect uranium mill tailings disposal sites to exceed Saskatchewan Surface Water Quality Objectives for Aquatic Life, but the state of contamination extends far beyond the initial deposit locations. In fact, contamination currently spans large areas of both watersheds.

For example, discharge from Dubyna Lake in the Ace Creek watershed has uranium concentrations that are 16 times higher than Saskatchewan Surface Water Quality Objectives for the Protection of Aquatic Life. A location known as the Hab site, upstream of the confluence of Hab and Pistol Lakes, in the Ace Creek watershed, has uranium concentrations that exceed Saskatchewan Surface Water Quality Objectives by a factor of 9. Verna Lake discharge to Ace Lake exceeds Saskatchewan Surface Water Quality Objectives for uranium by a factor of 11.[13]

Meanwhile, in the Fulton Creek watershed, Greer Lake, located downstream of lakes that were used for disposal of uranium mill tailings, discharges water with uranium concentrations 24 times higher than Saskatchewan Surface Water Quality Objectives. Radium and selenium contamination are also a problem. For example, radium concentrations in Greer Lake discharge are 24 times above the provincial guideline, and selenium levels are at least 4 times higher than Saskatchewan Surface Water Quality Objectives.[14]

These contaminant concentrations in surface waters of Saskatchewan lands that were mined by the Government of Canada contrast sharply with the current Saskatchewan Guidelines for Northern Mine Decommissioning and Reclamation. These guidelines state that areas disturbed by mining operations "should be reclaimed to an ecological (physical and biological) condition that will be similar to what was observed in the area prior to disturbance". The guidelines go on to say that "lake shorelines and river banks should be reclaimed to their pre-disturbed condition". Moreover, "surface water quality should be within the natural range of variation for the area".[15] With respect to tailings facilities, the guidelines recognize that some areas cannot be reclaimed to their original ecological condition, but state that the potential for contaminants to "migrate from impacted areas within the project sites to ecosystems outside of the project area ….should be minimized through site specific mitigation measures…"[16]

Today's Saskatchewan Guidelines for Northern Mine Decommissioning and Reclamation were drawn up after the Government of Canada's operations in the Ace Creek and Fulton Creek watersheds were closed, and one would not expect that the guidelines could be fully complied with. However, what one would expect is that the Government of Canada would make a reasonable effort to comply wherever possible, to set an example of how remediation of a mine site can be properly carried out. Unfortunately, there is little evidence to date that the Government of Canada plans to move in this direction.

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[12]During the mill operating period approximately 60% of the radioactive tailings were placed into small water bodies within the Fulton Creek watershed, while the remainder were deposited underground. (Source: Beaverlodge Project Annual Report – Year 25 (January 1, 2010 to June 30, 2011, page 2-3.)

[13] *Beaverlodge Project Annual Report for January 1, 2011 to June 30, 2012*, Table 4.1.1

[14]*Beaverlodge Project Annual Report for January 1, 2011 to June 30, 2012*, Table 4.1.1

[15] *Guidelines for Northern Mine Decommissioning and Reclamation*, November 30, 2008, Version 6, EPB 381. Refer to section 3.0 'Final Mine Closure Objectives and Criteria' and to section 3.1 'General Site Objectives'.

[16] *Guidelines for Northern Mine Decommissioning and Reclamation*, November 30, 2008, ibid. Refer to section 3.1 'General Site Objectives'.

1.6 Downstream contamination from the Beaverlodge mine and mill sites

Both the Ace Creek and Fulton Creek watersheds drain into Beaverlodge Lake, a Saskatchewan water body with a surface area of 57 square kilometres [17], and water depths commonly in the 40 to 60 metre range.

Under normal conditions, the large size of Beaverlodge Lake would quickly dilute pollution. However, Beaverlodge Lake has been so badly contaminated by the polluted discharge from the Ace Creek and Fulton Creek watersheds that concentrations of uranium in surface waters in Beaverlodge Lake are now 7 times higher than Saskatchewan Municipal Drinking Water Quality Objectives.[18] Depending on sampling locations within the lake, uranium concentrations in surface waters are 8 to 9 times higher than Saskatchewan Surface Water Quality Objectives for the Protection of Aquatic Life.[19]

Meanwhile, selenium concentrations in Beaverlodge Lake surface waters are two and one half times higher than Saskatchewan Surface Water Quality Objectives for the Protection of Aquatic Life.[20] Not surprisingly, elevated levels of selenium have been found in fish tissue.

Over time the sediment in the bottom of Beaverlodge Lake has suffered a serious buildup of pollutants. Beaverlodge Lake sediment has become so heavily loaded with selenium and uranium that the sediment at the bottom of the lake is becoming a source of on-going contamination to the lake's surface waters.

In effect, the federal government's uranium mining operations have left Beaverlodge Lake in a badly damaged state. As a result, limits have had to be placed on weekly fish consumption from the lake. Saskatchewan's Ministry of Environment has issued a drinking water advisory and an advisory on fish consumption.[21]

The damage to downstream watersheds from federal government uranium mining activities is not limited to Beaverlodge Lake. The Martin Lake watershed is immediately south of Uranium City and is used as a recreational site by the community. In 2011 the sampling station at the outlet of Martin Lake recorded uranium concentrations over 4 times higher than Saskatchewan Surface Water

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[17] SENES Consultants Ltd., *Beaverlodge Quantitative Site Model* (Prepared for Cameco Corporation), May 2012. Refer to Part A, Table 5.1-1 Summary of Limnological Characteristics of Modeled Lakes in the Beaverlodge Study Area. SENES reports the area of Beaverlodge Lake to be 5.7×10^7 m^2. The reported volume of water is 1.2×10^9 m^3.

[18] *Beaverlodge Project Annual Report for January 1, 2011 to June 30, 2012*, Table 4.3.3-1 to Table 4.3.3.-2; Table 4.1.1. Prepared by Cameco.

[19] *Annual Report for the Beaverlodge Project, January 1, 2011 to June 30, 2012*, Section 4. This Annual Report was prepared by Cameco. For example, in 2011 the Beaverlodge Lake outlet (Sampling Station BL5) recorded uranium concentrations approximately 9 times higher than Saskatchewan Surface Water Quality Objectives, and selenium concentrations approximately 2 times higher than Saskatchewan Surface Water Quality Objectives. Radium concentrations were below current guidelines.

[20] *Annual Report for the Beaverlodge Project, January 1, 2011 to June 30, 2012*, Section 4, ibid.

[21] Canadian Nuclear Safety Commission Meeting, November 3, 2010.
Canadian Nuclear Safety Commission, Record of Proceedings Including Reason for Decision in the Matter of Cameco Corporation's Application to Renew the Beaverlodge Mine and Mill Site Waste Facility Operating License, Hearing Dates: February 18, 2009 and November 5, 2009.

Quality Objectives for the Protection of Aquatic Life and selenium concentrations approximately one and a half times higher.[22]

Martin Lake and Cinch Lake in turn drain into Saskatchewan's Crackingstone River. While radium and selenium concentrations are within accepted guidelines in the Crackingstone River, uranium concentrations are still 3 times higher than Saskatchewan Surface Water Quality Objectives.[23] The Crackingstone River ultimately flows into Lake Athabasca. It is only when it reaches Lake Athabasca, where the vastness of the water body results in a rapid dilution of pollution, that Saskatchewan Surface Water Quality Objectives for uranium are finally met.

1.7 Remedial work planned by the Government of Canada at the Beaverlodge site

The Government of Canada and its site manager, Cameco, do plan to undertake a limited set of remediation activities at some of the Beaverlodge properties in the Ace Creek and Fulton Creek watersheds. These plans were formulated after a comprehensive set of studies was undertaken. Cameco will divert a creek (Zora Creek) around one of the waste rock piles (Bolger waste rock pile). Flowing and non-flowing boreholes at decommissioned uranium mine properties will be plugged to prevent potential groundwater outflow. Caps on all vertical mine openings will be replaced. And a gamma survey of waste rock and tailings areas will be performed, and then easily accessible areas that display elevated gamma radiation fields will be covered.

Beyond that, however, Cameco's focus will only be on monitoring. It will continue monitoring water quality on the Beaverlodge properties and on Beaverlodge Lake in the decade ahead, and will seek to co-operate with the Saskatchewan Research Council on implementing a regional monitoring program.[24]

The completion of these measures will still leave Canada Eldor Inc., the Government of Canada, and Cameco with many mined-out Beaverlodge properties that have extremely high levels of contamination. Moreover, nothing whatsoever is planned to actually remediate Beaverlodge Lake, Martin Lake or other downstream water bodies, which will therefore continue to remain polluted over the long term.

Cameco has presented surface water quality environmental performance objectives to the Canadian Nuclear Safety Commission (CNSC) for the mined out properties in the Ace Creek and Fulton Creek watersheds, as well as for Beaverlodge Lake. Acting on behalf of Canada Eldor Inc. and the Government of Canada, Cameco has proposed to the Commission that - after the planned remediation activities are completed – CNSC should deem it acceptable to have uranium contamination levels that are frequently 8 to 20 times higher than Saskatchewan Surface Water Quality Objectives in many of the lakes and discharge points in the watersheds.[25] These pollution

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[22] *Annual Report for the Beaverlodge Project, January 1, 2011 to June 30, 2012*, Section 4, ibid. Refer to data for monitoring station ML1.

[23] *Annual Report for the Beaverlodge Project, January 1, 2011 to June 30, 2012*, Section 4, ibid. Refer to data for monitoring station CS1.

[24] Cameco, *Beaverlodge Mine Site Path Forward*, December 2012, page 5-1.

[25] For example, in setting its performance objectives, Cameco is asking CNSC to accept uranium concentrations in Greer Lake that are 20 times higher than Saskatchewan Surface Water Quality Objectives (SSWQO) in 2020 and 18 times higher than SSWQO in 2050. Performance objectives for Radium for 2050 in Greer Lake are proposed to be 18 times higher than current guidelines. This lake will clearly be an ongoing source of contamination that extends beyond the Beaverlodge

levels do not include the tailings ponds in the Fulton Creek watershed, where the proposed performance objectives would permit even higher contaminant levels. Cameco and Canada Eldor Inc. have proposed to the CNSC that, provided these performance objectives are met over the course of the next decade, the mined-out properties would be ready to be returned to the Government of Saskatchewan to manage.

1.8 Observations regarding the Government of Canada's remediation efforts at Beaverlodge

We suggest that the Government of Canada, having contaminated the above-mentioned sites, should assume full responsibility for their remediation, prior to turning the properties back to the Province of Saskatchewan. The cost of remediation is likely to exceed $200 million. Yet it seems evident that the Government of Canada has no plans to undertake this work, and may never do so. Yet this is the same level of Government that we are supposed to trust to regulate other uranium mines in Canada and to regulate the sale of uranium overseas. The example our national government has set in Saskatchewan today does not inspire confidence.

2. Currently operating uranium mines and mills

2.1 The Rabbit Lake uranium mine and mill site: Local environmental impacts of a currently operating uranium mine and mill site in Saskatchewan

The Rabbit Lake uranium mine site is located in northeast Saskatchewan and lies near the shores of Wollaston Lake, one of the important commercial fishery resources in our province. The mine is on the west side of Wollaston Lake, and just over 30 km from the community of Wollaston Post and the Hatchet Lake First Nation. The Rabbit Lake site is owned and operated by Cameco Corporation, the world's largest uranium producer.

Cameco's Rabbit Lake operation has been the site of several uranium mining projects, including an open pit uranium mine that is slightly inland of Wollaston Lake (known as the Rabbit Lake mine), and three open pit mines that were developed just offshore in a bay of Wollaston Lake. These three mines were referred to as Collins Bay A-Zone, Collins Bay B-Zone, and Collins Bay D-Zone. In addition, the Rabbit Lake site is home to a large underground uranium mine that is still operating, and is known as the Eagle Point mine. The other uranium deposits referred to above have now been mined out.

Two of the three Collins Bay deposits and the Eagle Point mine were carefully assessed by a Federal Environmental Assessment Review Organization (FEARO) Panel in 1993. The Hindmarsh Panel, as it was called, did give approval for development of the Eagle Point mine, but declined to give a green light to the two Collins Bay mine proposals, saying more information was needed before a proper assessment of the risks could be made. By way of example, the FEARO Panel discussed risks associated with waste rock that was loaded with arsenic and nickel, and noted: "The information presented to the Panel on waste rock management and decommissioning plans for the A-Zone and D-Zone open pits is insufficient to determine whether the environmental effects of these operations are acceptable….The Panel therefore recommends that mining of the A-Zone and D-Zone ore bodies not proceed until the required studies are completed and the specific issues identified in the

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properties itself and directly affects Beaverlodge Lake. (Data source: Written submission from Cameco Corporation for the License Renewal for Beaverlodge, February 2013, Addendum A) report are resolved." [26] However, the Government of Canada declined to take the Panel's advice, and gave all three projects an immediate go-ahead.

Unfortunately another key recommendation of the Hindmarsh Panel was not implemented, namely that an Environmental Management Committee be created for the Rabbit Lake mine site, which in addition to Cameco, would have included representation from Saskatchewan Ministry of Environment, Environment Canada, the Atomic Energy Control Board, Athabasca Basin communities (including Wollaston Post), informed environmental interest groups, the scientific community and other federal departments such as Fisheries and Oceans.[27] Had the Government of Saskatchewan or the Government of Canada acted on this recommendation, Wollaston Post and other northern communities, and leading environmental organizations would have had a direct voice in addressing issues such as effluent treatment, waste rock management and tailings disposal. It was particularly unfortunate that the people of Wollaston Post and the Hatchet Lake First Nation did not get a direct say in environmental management decisions. They will have to live with the inadequacies of the reclamation and decommissioning of the Rabbit Lake uranium mine/mill site for thousands of years into the future.

Rabbit Lake is a site where total contaminant loading to the environment has been high. In the following paragraphs, we will give you a sense of some of the challenges the site is facing.

a) In the first two or three years of mine operation, there was no effluent treatment system in place at Rabbit Lake. As recently as 10 years ago, annual loadings into the local environment at the final point of effluent discharge averaged over 50kg of arsenic per year, 100kg of nickel per year, 1,200 kg of uranium per year and 22,000kg of molybdenum per year.[28] This discharge has been released into Hidden Bay of Wollaston Lake. As a result, sediments in Hidden Bay have substantial loading of contaminants. Only in the last 4-5 years has Cameco made notable improvements to the effluent treatment system.

b) The sediment of two smaller lakes on the Rabbit Lake mine property – the Link Lakes (jointly occupying 45 hectares) - is seriously contaminated with a broad array of radionuclides and heavy metals. Sediment quality guidelines are exceeded for many primary contaminants and substantial recovery has not occurred. Sediment contamination is worse in Upper Link Lake, but uranium, radium and arsenic levels in sediments in Lower Link Lake are well above Canadian Nuclear Safety Commission guidelines. When the time comes for mine decommissioning, the ecological risk will clearly lie with the sediments and the potential for bioavailability of contaminants. To get a sense of sediment loading of radium and uranium in the Link Lakes, the company Ecometrix reported on work done in 1999, which estimated loading at 190,000MBq of Ra226 and 57,000 kilograms of uranium in the upper 5 centimetres of the Link Lakes sediment.[29]

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[26] *Rabbit Lake Uranium Mining A-Zone, D-Zone, Eagle Point*: Report of the Environmental Assessment Panel, November 1993, page 1 (Executive Summary) and page 8.
[27] *Rabbit Lake Uranium Mining A-Zone, D-Zone, Eagle Point*: Report of the Environmental Assessment Panel, November 1993, page 9.
[28] *2012 Annual Report for the Rabbit Lake Operation*, Table 6.10.9.7 The data provided is annual loadings at the effluent treatment system discharge final point of control. The time period covered by these annual loadings is 2003 to 2005.
[29] E-DOCS # 3349418 *Sediment Pore Water and Fish Investigations In The Link Lakes At The Rabbit Lake Operation*, Final Report (Canada North Environmental Services), January 2009, p. xv, pp. 24-25, and Table 10 in Appendix E: 'Results of chemical analysis performed on pore water samples from Upper Link Lake- Upper Basin, Upper Link Lake – Lower Basin and Lower Link Lake').

c) Long after mining has been completed, Cameco continues to struggle to meet Saskatchewan Surface Water Quality Objectives in the mined out B-Zone open pit that extends out into Collins Bay of Wollaston Lake. Canadian Nuclear Safety Commission staff reported in 2011 that nickel and arsenic concentrations in the flooded pit were still significantly above Saskatchewan Surface Water Quality Objectives. (Nickel levels were 0.096 mg/L compared to the Saskatchewan Surface Water Quality guideline of 0.025 mg/L . Arsenic concentrations were at 0.009 mg/L compared to the Saskatchewan Surface Water Quality guideline of 0.005 mg/L.) In 2012 Cameco reported that pit surface water quality samples for nickel and arsenic continued to significantly exceed Saskatchewan Surface Water Quality Objectives.[30]

d) The Rabbit Lake In-Pit Tailings Management Facility (RLITMF) has had 7.95 million tonnes of radioactive tailings deposited in it since 1984**.** The Rabbit Lake Above Ground Tailings Management Facility has another 6.5 million tonnes of radioactive tailings spread over 53 hectares. This radioactive legacy will extend tens of thousands of years into the future, and must be contained over that period of time.

The real test of these facilities is not while the Eagle Point mine and Rabbit Lake mill are operating, since leakage from the tailings facilities is promptly piped to the water treatment facility. Instead, the real test will come once the Rabbit Lake site has been decommissioned, natural water levels on site have been restored, and several decades have passed. The question will be whether the contaminants in the radioactive tailings begin to move beyond the tailings facility itself, and out into the larger environment.

e) As predicted by the 1993 FEARO panel, waste rock management on the Rabbit Lake site is an important issue, with the risk of contamination of adjacent surface waters with arsenic and nickel, as well as radionuclides. The Saskatchewan Guidelines for Northern Mine Decommissioning and Reclamation currently state: "The quality of water running off waste rock piles should meet Saskatchewan Surface Water Quality Objectives". However, these are unfortunately only guidelines. They are not a regulatory requirement. We have noticed that when Cameco presented its decommissioning objectives and criteria to the Canadian Nuclear Safety Commission in its *Preliminary Decommissioning Plan* for the Rabbit Lake site, there was no mention of meeting Saskatchewan Surface Water Quality Objectives for the waste rock piles on site.

2.2 Key Lake uranium mill site operations and the challenge of containing uranium mill tailings

The ore at Cameco's Key Lake site was mined out by 1997, but the uranium mill at the site still plays a pivotal role in Cameco operations, along with associated uranium mill tailings facilities.

While extraction of uranium from the Key Lake mine's Gaertner and Deilmann pits was taking place, uranium mill tailings were placed in an Above Ground tailings facility at Key Lake that is now 20 metres in height and has a footprint that is 720 metres by 720 metres. The upper plateau is 44 hectares in size.[31] The approximate volume of tailings is 5,800,000 cubic metres. Tailings placement in this Above Ground Tailings Management Facility ceased in 1996.

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[30] Cameco Mid-Term Report on the Safety Performance of the Rabbit Lake Operation, May 24, 2011 (Submitted by CNSC staff), page 28; and Cameco's *2012 Annual Report for the Rabbit Lake Operation*, p. 6-8 and Table 6.8.2.1

[31] *Key lake Operation: Preliminary Decommissioning Plan,* Section 3.3.1

We suggest that one of the long term risks with this tailings facility is that the east cell of the tailings pile contains layers of frozen liquid.[32] To reduce the likelihood of contaminants in the tailings migrating beyond the tailings facility after milling operations at Key Lake cease, it would be preferable if the tailings were free of ice that could potentially melt and percolate into the surrounding area.

The second tailings facility at Key Lake is the mined out Deilmann pit. The pit was mined from 1984 to 1994. Today ore from Cameco's McArthur River uranium mine (north of Key Lake) is shipped by truck - in the form of a slurry- for processing at the Key Lake mill. The tailings left behind after mill processing are transferred to what Cameco calls the Deilmann In-Pit Tailings Management Facility. We will give tailings management practices at this pit more attention, since they reflect current conditions.

To assess the risks now being taken, it is helpful to understand a little more about the mined-out Deilmann pit. Cameco describes it as follows: "The upper portion of the pit consists of outwash sand, while the lower portion consists of rock formations with a permeability several orders of magnitude lower." [33] At the base of the pit is a pumping chamber connected to 3 dewatering wells. There are other dewatering wells around the perimeter of the pit. There is a complete bottom and partial side drain system to improve tailings consolidation.

The Deilmann In-Pit Tailings Management Facility was planned with the expectation that the tailings would be accommodated up to a level of approximately 448 masl (metres above sea level) once the McArthur River uranium mine tailings were added to those from Key Lake mine operations. The original plan thus envisaged that 100% of the tailings would lie within the Pre-Cambrian basement rock envelope. That basement rock envelope reaches up to about 460 masl.

Then Cameco's license was amended several years ago to allow for the final compacted tailings to come as high as 466 masl, which brings the tailings up into contact with the more permeable sandstone. Then in May of 2014 Cameco received Saskatchewan government approval to expand the height of the compacted tailings to 505 masl.[34] This will take the radioactive tailings well into contact with the sand outwash and till overburden.

The original expectation was that after Key Lake milling operations cease, and normal water levels on the site re-establish themselves at about 518 masl, there would be approximately 60 metres of cover (likely a combination of 2 metres of till and waste rock and then a large pond cover) to provide shielding from radon emissions. Current plans clearly reduce the newly planned pond cover depth to only a few metres. Cameco states in their preliminary cost estimate work for decommissioning the Deilmann DTMF that "a two metre sand/till cap would be installed over the special waste and tailings in the DTMF prior to allowing the water level to rise to its pre-mining level (~518 masl)".

In our judgement, the design changes in the Deilmann In-Pit Tailings Management Facility (DTMF) increase the risk that contaminants in the tailings could ultimately migrate into the water cover and then, via the sandy upper pit wall, into surrounding surface waters. There is increased potential for radiological contamination, as well as contamination from heavy metals such as arsenic and molybdenum. Insufficient attention is being paid to the warning of the Joint Federal Provincial Panel on Uranium Mining Developments in Northern Saskatchewan, which, while giving its "cautious

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[32] Key *Lake Operation: Preliminary Decommissioning Plan*, Section 3.3.1

[33] *Key Lake Operation: Preliminary Decommissioning Plan, January 2013, page 3-7.*

[34] "Reasons for Decision (Ministerial Approval), Ministerial Change Approval Pursuant To Section 16 (2) (C), The Environmental Assessment Act, Cameco Corporation Key Lake Extension Project, May 13, 2014.

approval" to the DTMF as originally proposed, stated in the McArthur River section of its report: "Because it will eventually contain an enormous amount of waste that is both toxic and radioactive, this facility, if it is not managed carefully, could be very destructive to the northern environment. If seepage from the DTMF into the surrounding environment were to occur, extensive contamination of the now pristine northern rivers and lakes could develop….It is not likely that it will ever be possible to completely walk away from this pit once it has been filled with tailings." [35]

2.3 Why is long term containment of tailings so important?

Uranium by its nature disintegrates into a chain of other radioactive substances that include thorium, radium, radon gas and radon progeny, including polonium. These other radioactive substances are all present in uranium ore when it is mined, and account for the bulk of the ore's radioactivity. The result is that after uranium has been extracted during the milling process, approximately 85% of the radioactivity in the ore remains behind in the uranium mill tailings.

The process of radioactive decay cannot be turned off, but keeping uranium locked away deep below the surface of the Earth helps reduce human exposure to radioactivity. Conversely, crushing it up and leaving the uranium mill tailings on the surface of the earth in very large volumes inevitably increases the potential for human exposure and for long-lived radionuclides to move into the broader environment.

One of the radionuclides of greatest concern is radium 226, which is a potential pollutant of surface waters and ground water. The long radioactive half life of thorium 230, the parent of radium, means that the quantity of radium in the uranium mill tailings will decline by only half in approximately 80,000 years.

It is thus critical that if uranium is to be mined, the radioactive mill tailings that are left over as a waste product must be successfully contained for a very long time. The risks being taken at the Key Lake uranium mill site today, with the approval of regulators, reduce the chances of long-term tailings containment.

3.0 Broader public safety and ethical concerns related to mining uranium

3.1 The fissionable nature of uranium raises important ethical issues about its use

Uranium is fissionable. When bombarded with neutrons, the uranium atoms break apart, and a large amount of energy is released. This fission process can be controlled. It can either be used to boil water inside a nuclear power plant in order to produce electricity, or it can be used to produce an atomic explosion.

The fission process, whether used for civilian or military purposes, has the unfortunate quality of producing fission products that are far more radioactive than the uranium they originated from. These are, in effect, the split-apart pieces of uranium atoms. Two of the best known examples are cesium 137 and strontium 90.

[35] *McArthur River Uranium Mine Project: Report of the Joint Federal-Provincial Panel on Uranium Mining Developments in Northern Saskatchewan*, February 1997, pages 28 and 29.

Over the past few decades, the vast bulk of the uranium that has been exported from Saskatchewan has been used for the production of electricity at nuclear power plants. In the course of being used for that purpose, important ethical issues arise. One is that in the event of a serious accident at a nuclear power plant, fission products and plutonium pose a grave risk to the general public in the surrounding area, and to many others downwind of the facility. Second, the high level radioactive wastes that are created during reactor operation pose a major, unresolved disposal challenge. Both these issues will be discussed briefly below, using current case examples.

3.2 The risk that fission products from uranium supplied to a nuclear reactor will become part of a catastrophic accident that exposes tens of thousands to excessive radiation and dislocation

The day-to-day operations of nuclear power plants pose relatively low risks to the public, but that equation changes rapidly in the event of a serious accident. The most recent such accident is the meltdown of three nuclear reactors at Japan's Fukushima Daiichi power station, each with massive releases of fission products that contaminated the air, the ocean, groundwater, soil and crops.[36]

The accident at Fukushima was triggered by a combination of a 9.0 magnitude earthquake, and tsunami waves of up to 14 metres striking the facility.[37] The operating reactors were successfully shut down. However, the cooling systems for the nuclear reactors failed as a result of a loss of on-site and off-site electricity, and this led to a series of hydrogen explosions on site, and the melting down of uranium fuel bundles inside each operating nuclear reactor.[38]

The Fukushima accident has reinforced understanding of one of the important dangers of nuclear power, namely that even when a nuclear reactor is successfully shut down in an emergency situation, a major radiation release can still occur.[39] That is because, after shutdown, nuclear reactors must be cooled for a long period of time. If electricity is not available to run the cooling system pumps, as was the case at Fukushima, the uranium fuel bundles can reach temperatures of over 2,800 degrees Centigrade and melt down, releasing a vast store of dangerous radionuclides.[40]

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[36]*Fukushima Nuclear Accident Update Log,* International Atomic Energy Agency, March 24, 2011, p. 4. In the Fukushima and Ibaraki Prefectures, the IAEA reported that "of the 11 varieties of vegetables sampled from 18 to 22 March, iodine-131 and caesium-137 exceed limits for food and drink ingestion." Levels of iodine and caesium were also exceeded in nearly all of the milk samples taken in the two Prefectures between March 16th and 21st. In addition "permissible levels of iodine-131 were exceeded in drinking water samples taken in the Fukushima and Ibaraki Prefectures and in Tokyo from 17 to 23 March."
"Japan nuclear plant confirms meltdown of two more reactors" by Justin McCurry, *The Guardian*, May 24, 2011.
"Japan fears radioactive contamination of marine life", by Ian Sample *The Guardian*, March 30, 2011.
"Fukushima: third worker death not related to radiation", *The Guardian,* Oct 7, 2011 . The article reports that a study has found radiation levels of 307,000 becquerels of cesium per kg of soil in soil samples taken in Fukushima city, well above the government-set legal limit of 10,000 becquerels per kg.
[37] *IAEA International Fact Finding Expert Mission of the Nuclear Accident Following the Great East Japan Earthquake and Tsunami*, May 24-June 1, 2011, Preliminary Summary, June 1, 2011, p. 1.
[38] Ibid.
[39] *IAEA International Fact Finding Expert Mission of the Nuclear Accident Following the Great East Japan Earthquake and Tsunami*, May 24-June 1, 2011, Preliminary Summary, June 1, 2011, p. 1-2. The International Atomic Energy Agency team of experts concluded the operational units at Fukushima Daiichi nuclear power station and other nearby reactors were "successfully shutdown by the automatic systems installed as part of the design of the nuclear power plants to detect earthquakes." Nevertheless "with no means to control or cool the reactor units…" they "quickly heated up due to usual reactor decay heating…" A series of explosions ensued and "…radiological contamination spread into the environment."
[40] E-mail from Dr. Gordon Edwards, Chairperson of the Canadian Coalition for Nuclear Responsibility. Dr. Edwards notes that the temperature rise is caused by "decay heat", heat that results from radioactive decay. He states: "No one knows how to

The Fukushima accident, thus, not only has important implications for all countries with nuclear power stations in earthquake and tsunami zones, but it also has an important lesson for every nation that relies on nuclear generated electricity: namely, that the safety of nuclear power plants is premised on the availability of back-up electricity. Germany has clearly grasped these implications; hence its decision to phase out of its nuclear reactors by 2022.

When an accident like Fukushima happens, even suppliers of the uranium used by the plant are in some way connected to the accident, albeit to a far more limited extent than the reactor operator. In the case of Saskatchewan, our largest uranium company, Cameco, was regularly providing uranium to Tokyo Electric Power Company, the owner of the Fukushima Daiichi nuclear power station.[41]

The fission products from the splitting of the uranium fuel bundles inside the three reactors at the Fukushima site are now the major cause of the radioactive contamination problems the Japanese have been trying to remediate over the past three years. The problems are still sufficiently severe that more than 120,000 residents of the Fukushima area are unable to return home.[42] Their homes, yards and neighbourhoods are simply too radioactive to do so. The majority of these people will likely never be able to reside in their family home again.

The actual cleanup of the Fukushima Daiichi nuclear power plant site will take several decades to complete. The damage inside the reactor containment chambers is so severe that special decommissioning equipment and technology will have to be developed to tolerate the high temperatures and harsh environment.[43] Meanwhile, the site operator, Tokyo Electric, has been struggling to prevent significant volumes of radioactive water on the site from moving into the Pacific Ocean.[44]

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speed it up, slow it down, start it, or stop it….. And as long as that decay heat is being produced, it will drive the temperature up and up, unless the heat can be removed as rapidly as it is being produced. For that you need pumps, and for those you need power." Edwards notes that the core meltdowns would take place at temperatures in excess of 2,800 degrees C (5,000 degrees F)

"Fukushima: The Crisis is Not Over", June 2011 by Arnie Gundersen, Fairewinds Associates, Inc. Gunderson, a nuclear engineer, explains that the heat is produced by the radioactive byproducts of nuclear fission, such as cesium 137 and strontium 90. Gundersen states "Unless the decay heat is removed as fast as it is produced, the temperature will continue to rise, eventually damaging the fuel and letting radioactive gases and vapors escape."

E-mail from Dr. Gordon Edwards. Dr. Edwards points out that the principal cause of the meltdowns at the Fukushima Daiichi reactors - a complete blackout of electrical power, both onsite and offsite, for an extended period – can be created by many different circumstances and can potentially occur in any nuclear power plant in the world. He notes: "Such a situation could be caused by conventional sabotage or warfare, by a combination of a natural disaster and equipment failure, by a massive fire in the electrical wiring of a nuclear reactor, or just by accident."

[41] "Uranium Processor Still Optimistic About Nuclear Industry" by Ian Austen, *The New York Times*, March 25, 2011. In addition to noting that Cameco is one of the uranium suppliers for the Fukushima Daiichil plant, the article states: "Long-term, Japan accounts for about 18 to 20 percent of Cameco's contracted sales".

[42] "Fukushima nuclear disaster: three years on 120,000 evacuees remain uprooted" by Justin McCurry, The Guardian, September 10, 2014.

[43] "Fukushima reactor shows radiation levels much higher than thought", by Associated Press. The Guardian, March 28, 2012.

[44] "Fukushima operator struggles to build ice wall to contain radioactive water", by Agence France-Presse, The Guardian, June 17, 2014.

3.3 All uranium fuel rods used at nuclear reactor sites will ultimately become high level radioactive waste

The problem of high level radioactive waste disposal is exceedingly challenging, and poses significant risks for impacted communities. As a result, high level nuclear waste is building up at nuclear power stations around the world.

The challenge of finding a disposal solution should not be underestimated. By way of example, Saskatchewan's biggest uranium customer over the past few decades has been electric power utilities that run nuclear reactors in the United States. With high level nuclear waste rapidly building up at reactor sites in the US, the US national government planned to move forward with a high level radioactive waste repository at Yucca Mountain, Nevada. However, the difficulties – including the risk of groundwater contamination – proved to be far greater than anticipated. The end result has been that the Yucca Mountain site has been abandoned by the U.S. government after an expenditure of well over $10 billion. The United States still has no site for disposal of what is now approximately 70,000 tonnes of high level radioactive waste.[45]

A second example of the high level nuclear waste dilemma is illustrated by South Korea, a country to which Saskatchewan has regularly sold its uranium. South Korea's 23 nuclear reactors add 750 tonnes of high level radioactive waste each year to the 13,300 tonnes that already fill its wet and dry storage capacity. That storage capacity is now 71% full, and could be completely full by 2021. Some storage pools will reach their capacity by the end of 2016.

Park Ji-young, director of the Science and Technology Unit at the well respected Asian Institute for Policy Studies is quoted as saying: "We cannot keep stacking waste while dragging our feet….If we fail to reach a conclusion (on how to manage spent fuel), it would be time to debate if we should stop nuclear power generation."[46]

Even low and medium level radioactive wastes are not easily disposed of permanently, without serious problems arising. Once again, one need look no further than the United States to see evidence of this. In 1999 the national government there opened a flagship 655 metre deep geological repository for handling low and medium level *military* nuclear waste in Carlsbad, New Mexico. It promised the repository would operate cleanly and safely long into the future. Yet this year the first serious accident at the facility has already occurred, resulting in a significant release of radiation, and exposing major safety deficiencies in the operation of the facility.[47]

If low and medium level radioactive wastes cannot be disposed of successfully, there should surely be major doubts about whether we can handle high level radioactive waste disposal without risking public safety and significant contamination of ground water. In the face of these uncertainties, does

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[45] The estimate of 69,000 tonnes is based on the work of the Blue Ribbon Panel on America's Nuclear Future. On page 14 of its January 2012 report to the Energy Secretary of the United States, it placed total spent fuel in the country at 65,000 metric tons, and noted that the industry as a whole generates between 2,000 and 2,400 metric tons on an annual basis. For further details refer to :
http://cybercemetery.unt.edu/archive/brc/20120620220235/http://brc.gov/sites/default/files/documents/brc_finalreport_jan2012.pdf

[46] "South Korea faces storage crisis" *Reuters*, October 12. 2014. The article is written by Meeyoung Cho.

[47] "An Accident Waiting To Happen: The release of radioactive material at a US nuclear-waste repository reveals an all-too-common picture of complacency over safety and a gradual downgrading of regulations." *Nature*, May 15, 2014, page 259. "Call for better oversight of nuclear-waste storage" by Declan Butler, *Nature*, May 15, 2014, page 267-268.

it really make sense to build even more nuclear reactors in the world, and open yet more uranium mines?

3.4 Uranium exports and the atomic weapons connection

In the years that followed the decision by the United States Atomic Energy Commission to stop buying uranium from Canada for atomic weapons purposes, the Government of Canada decided to pursue uranium development and Candu reactor exports for so-called peaceful purposes. But there has often been a lack of assurance that Canadian exports would only be used for civilian purposes. This became very clear in the 1970's when both India and Pakistan used nuclear reactors purchased from Canada as a critical component in their strategy for developing and exploding an atomic bomb.

In a Saskatchewan context, there have been many controversial exports of uranium over the past four decades. For example, the Government of Saskatchewan exported uranium to South Korea during years when that country was headed by a military government that had established a Nuclear Weapons Exploitation Committee. Saskatchewan uranium was sold to Argentina during years when that country was also headed by a military government working on an atomic bomb plan. French based uranium mining companies operating in Saskatchewan exported uranium to France during years when the French government actively tested atomic weapons in the South Pacific Ocean, and refused to separate its civilian and military streams of uranium.[48] Moreover, so-called depleted uranium of Canadian origin – left behind after the enrichment process in US facilities- has been used to manufacture the outer ring of the hydrogen bomb and to make heavy bullets and other military hardware.

Concerns about the potential for Saskatchewan uranium to be used for military purposes was raised by the Joint Federal-Provincial Panel on Uranium Mining Developments in Northern Saskatchewan in its October 1993 report to both the national and Saskatchewan governments. At that time the Panel said: "The Nuclear Non-Proliferation Treaty, of which Canada is a signatory prohibits the use of uranium in the production of enriched uranium for military applications. However, there is no process whereby exported Canadian uranium can be separated from uranium derived from other sources. Therefore, no proven method exists for preventing incorporation of Canadian uranium into military applications. Current Canadian limitations on end uses of uranium provide no reassurance to the public that Canadian uranium is used solely for non-military applications by purchasers."[49] Unfortunately, the Panel's concerns were promptly ignored by the respective governments of the day, who simply noted that the Panel had overstepped its mandate.

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[48] *Atomic Accomplice,* Paul McKay, 2010.
Canada and the Korean bomb – A Question of Complicity, a special half hour documentary aired by the program *Sunday Morning* on CBC in October 1984.
May 14-15, 1983 issue of *The Australian*, "Australia loses ground as Koreans Turn to Canada for Uranium".
"SMDC Offers Share of Land to South Korea", *Regina Leader Post*, May 13, 1983.
Not Man Apart, The Journal of Friends of the Earth, Volume 10, Number 7, July 1980, pages 10 and 11.
A Call to a New Exodus, published by Pacific Conference of Churches, 1982.
[49] *Report of the Joint Federal-Provincial Panel on Uranium Mining Developments in Northern Saskatchewan*, (Don Lee, Chair, James Archibald, John Dantouze, Richard Neal, Annalee Yassi), October 1993, page 26.

3.5 Circumventing the Nuclear Non-Proliferation Treaty

The Nuclear Non-Proliferation Treaty seeks to prevent the spread of nuclear weapons in the world, and has the largest ratification of any arms control agreement, with 190 countries participating. The world urgently needs the treaty to be strengthened, with more vigorous safeguard provisions, but there is no sign of that happening in the near future. Rather, the Canadian government has gone so far as to intentionally circumvent the treaty. It is doing so by allowing uranium mining companies in Saskatchewan to sell uranium to India, even though the government of India continues to refuse to sign and ratify the Nuclear Non-Proliferation Treaty. The Government of Canada has been strongly supported in facilitating uranium sales to India by the Government of Saskatchewan, which sees this as a way of expanding uranium exports.[50]

Under the agreement the Canadian Government signed with the Government of India in late 2012, Saskatchewan's uranium shipments to India will go to nuclear power facilities that are subject to International Atomic Energy Agency oversight. In this case, the risk is not that India will use imported uranium from Saskatchewan to build nuclear weapons, but rather that large quantities of uranium from Saskatchewan mining operations will help "free up" India's government to more easily utilize its small supplies of domestic uranium to expand its own atomic arsenal.[51] India already has approximately 80 nuclear weapons, and there is renewed tension in the region between India and Pakistan.[52]

3.6 Closing observations on the broader ethical concerns associated with uranium mining

Here, we offer some broad observations reflecting on the Saskatchewan experience and the ethical implications of uranium mining.

Our first observation is that once you open the door to uranium mining, there is constant pressure from the uranium mining companies to push the limit on which countries to which uranium can be exported. For instance, in the case of exports to India, the pressure to allow exports came not only from the Saskatchewan government, but from Cameco Corporation, the world's largest uranium company.

A second reality is the ongoing linkages in the nuclear fuel cycle between military and civilian nuclear facilities. They are often intertwined. For instance, for decades the enrichment of uranium for American civilian nuclear power reactors has primarily been conducted in enrichment facilities run

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50 "Premier welcomes uranium deal with India", Global News, November 6, 2012. "Harper's civilian nuclear trade deal ends Canada's long freeze on armed India", The Canadian Press, November 6, 2012.
"Canada and India resume nuclear trade: Deal shows Ottawa's growing trust in the South Asian country after decades of strained relations but details remain vague", *The Globe and Mail*, November 7, 2012.

51 "Harper's civilian nuclear trade deal ends Canada's long freeze on armed India", *The Canadian Press*, November 6, 2012. The article states: "India has never signed the Treaty on the Non-Proliferation of Nuclear Weapons or the Comprehensive Test-Ban Treaty. So the Canada-India deal is a watershed moment in the nuclear movement that goes beyond simply bilateral trade, say experts. Even if Canadian uranium never makes it near a weapons facility, our exports will still free up India's domestic (uranium) supply, said Cesar Jaramillo, a nuclear disarmament expert with Project Ploughshares. 'India requires uranium for both its civilian and military nuclear programs and, since it is generally in short supply domestically, the uranium imported for civilian needs may allow the country to allocate more of its domestic holdings for the military' Jaramillo said in an email."

52 The estimate for the number of nuclear weapons currently held by India was obtained from *Status of World Nuclear Forces 2012*, Federation of American Scientists.

by the military. That is primarily where Saskatchewan uranium exported to the United States is enriched. And at the end of the nuclear fuel cycle, if high level radioactive waste is reprocessed, the plutonium that is extracted can of course be used as a fuel. However, in the future, if the governments operating reprocessing plants choose to, the recovered plutonium could also be used as the critical component for building an atomic arsenal.

A third observation is that the operation of nuclear power plants presumes peace time. In times of war, the use of conventional weapons in the vicinity of a nuclear reactor poses extreme risks that far exceed the impacts such weapons could normally ever have. For instance, if high level radioactive waste storage facilities on a reactor site were bombed with conventional weapons, the result could be the release of enormous amounts of radiation, posing a significant health threat.

In closing, for all of the reasons enunciated in this paper, the Saskatchewan Environmental Society has concluded that, on balance, and when viewed over the entire nuclear fuel cycle, the environmental costs associated with the mining of uranium are not acceptable.