Political Risk Assessment

Mitigating Risk to the NWMO’s Proposed Deep Storage Repository in Ignace and Teeswater

Prepared by the Leadership & Democracy Lab, University of Western Ontario

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Executive Summary

The Nuclear Waste Management Organization (NWMO) of Canada was established under the Nuclear Fuel Waste Act (NFWA) of 2002 to investigate approaches for managing Canada's used nuclear fuel. Presently, the NWMO is the sole organization that oversees the management of spent nuclear fuel in Canada. On January 24th, 2020, the NWMO announced Teeswater and Ignace as the two remaining potential host areas in the site selection process for the construction of a deep geological repository location for spent nuclear fuel from reactors in Ontario and New Brunswick. The deep geological repository project is projected to cost $23 billion dollars and take 40 years to complete, hence the significant discussion, research, and time spent in considering sites. Moreover, the NWMO is committed to only developing the repository in an area where the hosts are 'informed and willing.'

This report compiles research from various primary and secondary sources to identify potential risks to the proposed deep geological repository. Additionally, this report provides mitigation strategies to neutralize the risks and allow for improvement.

This document features four sections:

1. **Economic and Financial Risks**

A broad overview of the operations of the NWMO and how it might impact the repository project.

2. **Technological Risks**

An investigation into the technological trends relating to the transfer and storage of spent nuclear fuel which may present security concerns

3. **Health Risks**

An examination of the risks that the spent nuclear waste might pose to the health of the communities involved through passive and acute exposure to radiation, including the use of the Hanford Site as a case study.

4. **Social Risks**

An analysis of how the outlook regarding the repository and nuclear fuel might generate social trends in surrounding communities.

Figure 1: Opposition to the proposed location for disposing of spent nuclear fuel.

Economic and Financial Risks

Operational Risks

For any company like the *Nuclear Waste Management Organization (NWMO)* dealing with a used nuclear fuel project and long-term time frame, the costs of long-term waste management approaches will be high. Considering the perplexity of developing and implementing a waste management system, the many indirect factors, including the court of public opinion, and the exceptionally grand time frame for completion, a complete specification of all relevant cost issues is very challenging. In other terms, any cost estimate will be subject to a great deal of uncertainty.

The *NWMO* has provided a gross simplification of a life-cycle cost approach that includes:

- "processing and packaging costs of spent fuel before shipment to retrievable storage permanent disposal facilities;
- development and construction costs of storage/disposal facilities;
- transportation costs, from the reactor facility through to the ultimate disposal location, including any interim storage stops in between;
- interim storage costs between current on-site storage and eventual disposal, as applicable;
- costs of depositing the waste in the disposal site;
- monitoring and security; and,
- costs of ultimately closing and decommissioning the disposal site."[1]

The *NWMO* believes that the eight-bullet list is critical to achieving the "polluter-pays" principle, which ensures that future generations are not faced with the unfair financial burden of managing nuclear waste whose electricity production benefits were enjoyed by previous generations.

The *NWMO* Board comprises nine Directors, including Wayne Robbins as Chair, Laurie Swami as President and CEO, and Glenn Jager acting as Vice-Chair. The remaining seven directors are Jason Nouwens, Lesley Gallinger, Sean Granville, Ronald L. Jamieson, Josée Pilon, and Beth Summers. The Board is responsible for overseeing the corporate management and leading the strategic direction. Fiscal responsibility is of utmost importance, especially given the size and duration of the project.

In March 2021, *NWMO* (the "Organization") released its annual report for 2020. The independent auditor's report conducted by Deloitte LLP on February 16, 2021, concluded that the accompanying consolidated financial statements as of December 31, 2020, present fairly, in all material respects, the financial position of the Organization and the results of its operations and its cash flows for the year then ended in accordance with Canadian accounting standards for not-for-profit organizations.[2]

Ensuring Funding is in Place

Generally speaking, financial risk refers to the possibility of losing money on an investment or business venture. Funding risks are associated with a project's cash flow from higher costs or lack of funds. In the case of *NWMO*, Canadians have high expectations that the money necessary to pay for the long-term care of Canada's used nuclear fuel will be available when needed.

The *Nuclear Fuel Waste Act (NFWA)* requires the major owners of used nuclear fuel in Canada to fund the planning, development, and implementation of the project. The major owners are Ontario Power Generation, NB Power, Hydro-Québec, and Atomic Energy of Canada Limited. These companies are required to establish independently managed trust funds and make annual deposits to ensure the money to fund this project will be available when needed.[3] In 2002, these funds were established and annual contributions have been made by each waste owner since. At the end of 2020, the total value of these funds, including investment income, was approximately $5.4 billion (balance estimates are rounded to the nearest $ million). This grand sum is in addition to other segregated funds and financial guarantees the companies have set aside for nuclear waste management and decommissioning.

The *Act* also requires the *NWMO* to maintain a funding formula and define the number of deposits to trust funds required by each company on an annual basis. The *NFWA* explicitly addresses the future financial obligations expected for managing used fuel over the long term. The box below describes the requirements of the *Act*.

> **"Requirements of the *NFWA* (2002)**
>
> The NWMO is required to provide a range of financial information in each of our annual reports following the government's decision, as defined in subsection 16(2) of the *NFWA*.
>
> 16(2) Each annual report after the date of the decision of the Governor in Council under section 15 must include:
>
> (a) the form and amount of any financial guarantees that have been provided during that fiscal year by the nuclear energy corporations and Atomic Energy of Canada Limited under the *Nuclear Safety and Control Act* and relate to implementing the approach that the Governor in Council selects under section 15 or approves under subsection 20(5);
>
> (b) the updated estimated total cost of the management of nuclear fuel waste;
>
> (c) the budget forecast for the next fiscal year;
>
> (d) the proposed formula for the next fiscal year to calculate the amount required to finance the management of nuclear fuel waste and an explanation of the assumptions behind each term of the formula; and
>
> (e) the amount of the deposit required to be paid during the next fiscal year by each of the nuclear energy corporations and Atomic Energy of Canada Limited, and the rationale by which those respective amounts were arrived at."[4]

In addition to trust fund contributions, the major owners are also responsible for funding the *NWMO*'s annual operating budget and are required to provide financial guarantees that are dedicated to nuclear waste management and decommissioning to the *Canadian Nuclear Safety Commission (CNSC)* as per the *Nuclear Safety and Control Act (NSCA).*

Ensuring adequacy and sustainability of funding mechanisms

From a political stakeholder standpoint, the nuclear repository project presents some significant but manageable risks regarding the stability of agreements with political stakeholders in the community and any surrounding nearby indigenous communities. It cannot be emphasized enough to ensure political stakeholder

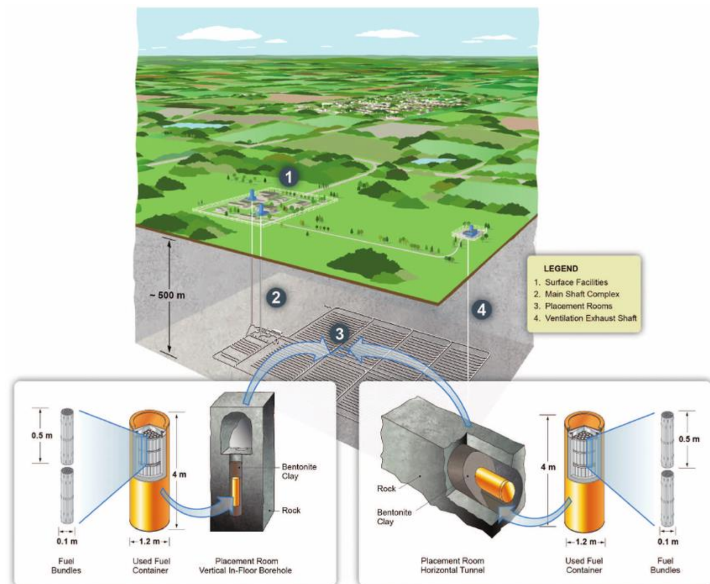

Figure 2: Options for spent nuclear fuel disposal in Canada

relationships are in good standing with the community and any indigenous peoples before this project begins.[5]

A major risk associated with this project is the absence of contingency plans to get all people living in the vicinity of this repository to get to safety without becoming displaced persons. To mitigate this risk, the *Nuclear Liability and Compensation Act* has provisions to protect those who are involved if there is a nuclear incident. The 16th provision of the act under the liabilities section protects people from economic, physical, and psychological harm.[6] This will mitigate the risk by making sure community stakeholders feel protected. This law will also prove to give these people peace of mind. The other mitigation strategy employed by the NWMO is ensuring the hosting community and nearby indigenous communities undertake host-ships voluntarily. This means that these people know what they have agreed to and understand the risks of this. It is extremely important to make sure they have all the information and the decision is made in a democratic way using a referendum due to the small population size of each municipality.[7] This risk could be mitigated by making this an official community decision and making a stern request that all community members aged 18+ vote, which can be promoted through promotional campaigns.

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Technological Risks

Waste Transportation and Security

Spent nuclear fuel has a long half-life and thus remains radioactive for thousands of years. Consequently, the waste that is intended to be stored in the deep geological repositories would be of interest to bad actors - within Canada and outside. The nuclear material being stored in most deep geological repositories are high or intermediate-level waste.[8] Intermediary nuclear material is less radioactive than high-level waste, however, it is still hazardous and requires safety precautions.[9] High-level nuclear waste is the material that has been processed in nuclear reactors. This material is highly radioactive and requires extreme caution in handling and storing.[10] In addition to containing radioactive material, used nuclear fuel also contains mercury, which is chemically hazardous and used in weapons systems.[11]

Although the material being stored in the DGR would need to undergo significant reprocessing in order to be used by hostile actors, it does not entirely neutralize the threat these actors pose. Hostile actors may take action if they think gaining access to the materials stored in the DGR would benefit them in any way. Whether the risk of attack from hostile actors is significant or not, concern from the public will remain present. Therefore, the security of the DGR plants, and the security of the used fuel containers (UFC) during the transportation is a top priority. Historically, transportation of spent nuclear fuel in countries heavily reliant on nuclear energy, like France, has been successful. This is due to the safety systems and technology in place. In the case of France, safe transport is ensured by confirming all equipment used in the process undergoes rigorous testing to ensure all standards and requirements are met. Additionally, emergency management plans are in place to deal with any unexpected situation that arises. Finally, all operators undergo education and training to ensure their ability to safely handle the radioactive material and implement all security planning.[12] Due to the success of France's nuclear transport, the model should be implemented in the transport of UFCs to DGR sites in Canada. This would entail implementing a strict verification regime to regulate and monitor the entire process from the nuclear plant to repository. Equipment must be tested and maintained properly, emergency contingency plans must be in place and operators must have the proper training. In regards to the security of the UFCs, once they are being stored at the DGR, the plant must be adequately equipped to deal with actors who may want to gain access to the facility or compromise the security of the UFCs. This should include physical barriers such as walls and fencing, in addition to technological barriers restricting access and surveilling the facilities. Access to the facility should be highly regulated and monitored.

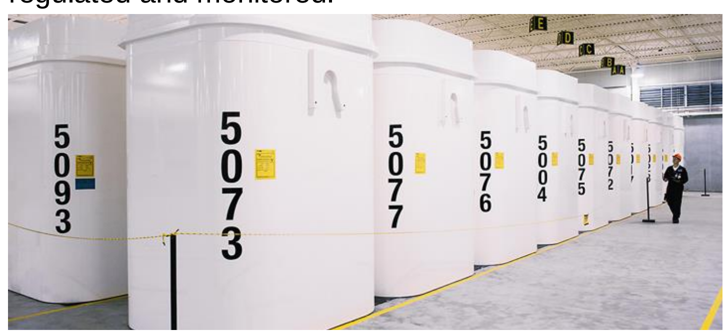


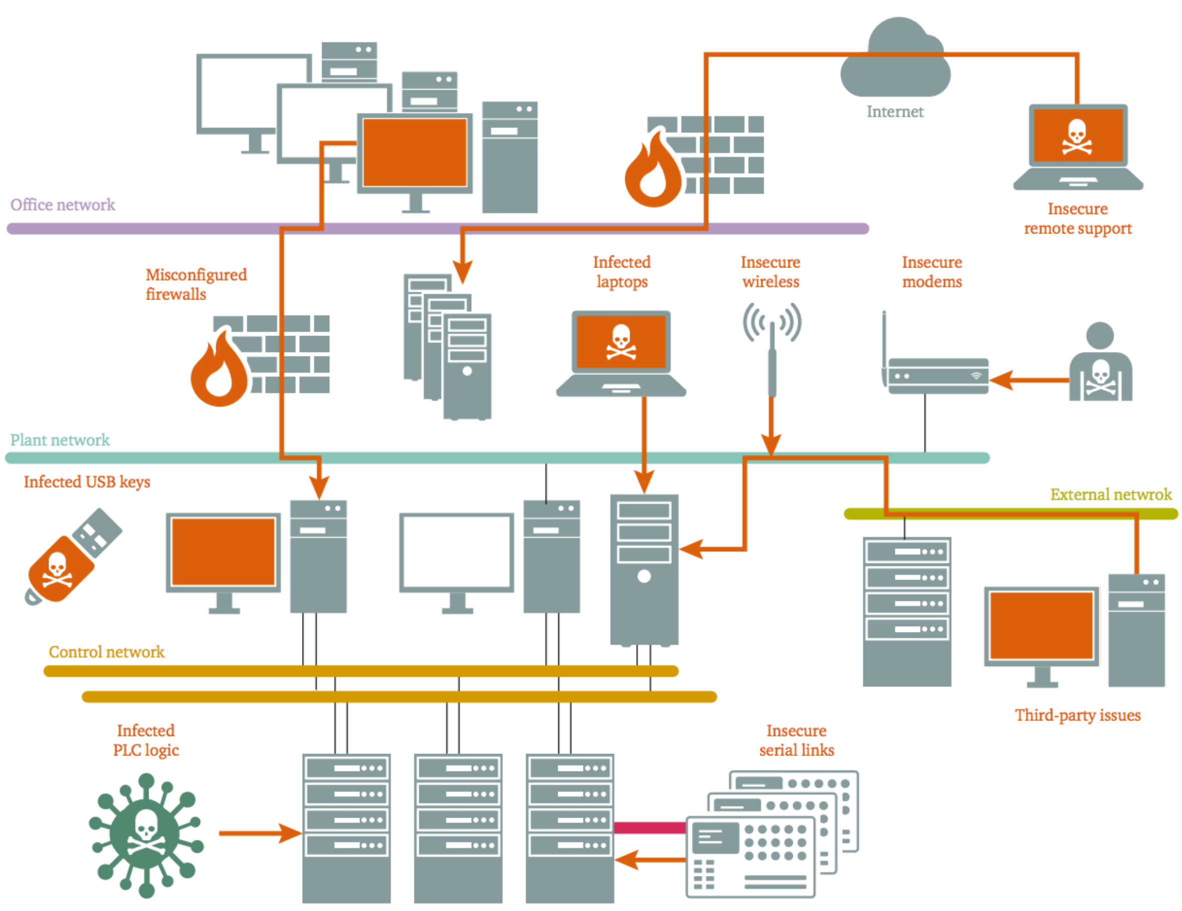
Figure 3: Options for spent nuclear fuel disposal in Canada

Susceptibility to Cyber Influence

In ensuring an adequately secured facility in the modern age, it is necessary that the DGR plant relies on computer technologies to maintain and protect the nuclear waste stored within. However, in the use of such information and communication technology, the facility becomes vulnerable to cyberattacks. In the past, cyberattacks on other nuclear facilities have come from bad actors within and outside the state.[13] These actors have successfully compromised the safety systems, leaving facilities vulnerable. This is increasing the concern that extremists could turn individuals working in the facilities who could help them to gain access to the cyber systems.[14] Due to the hazardous nature of the material being stored in the DGR, the safety and security implications should the facility experience a cyberattack are severe.

One way to safeguard against individual workers' choices is to ensure that all processes require two operators rather than one. Additionally, to reduce the risk of a cyberattack on the DGR, the NWMO should ensure that they are hiring qualified candidates to maintain and update the technology used in the facility. This could help ensure that security features are regularly updated and developed to be more advanced. In hiring, the NWMO should utilize the creativity and innovation of new graduates from related fields and draw applicants from top programs. The facility should also invest in hackathons, where participants try to find weaknesses in the defenses of the DGR systems. The employment of 'white hat' ethical hackers would help identify areas of weakness and ensure that they are updated to maximize security. Moreover, the facility should have thorough emergency response plans, including but not limited to safeguards built in that rely on brick and mortar defenses in case cyber protections were compromised. Physical defenses, such as additional barriers and gates that automatically lockdown at signs of attacks should be implemented.

Figure 1: Potential control system vulnerabilities



Source: Eric Byres, Byres Security.

Figure 4: System vulnerabilities in nuclear controls

Public Health Risks

Similarly to other energy sources, nuclear energy and its radioactive waste pose health risks to the people in the area. This section will be a risk assessment of the health of the inhabiting Teeswater and Ignace populations. Radioactivity has the potential to contaminate food and water resources which could negatively impact consumers. Excess passive radioactive emissions over a long period of time from nuclear waste can increase the risks of radiation-related diseases such as cancers. If there is a malfunction of storage then acute risks to local populations may be present. While nuclear energy has appealing impacts, nuclear waste stored improperly poses significant adverse impacts to the local populations.

Hanford Case Study

Hanford is a nuclear production and waste storage site that was constructed during the second world war as a part of the Manhattan Project. It is located on a desert plateau near the Columbia River, one of Washington's main waterways, in the southern area of Washington State. Over its lifetime, the facility produced 70 million gallons of high-level radioactive waste that was evaporated into solid states and placed into steel tanks.[15] These tanks were then placed underground beneath relatively loose soil. Due to the lack of safety measures at the site, high-level nuclear waste and other chemicals have leaked into the surrounding soil and the Columbia River. "Other high-level waste tanks have also leaked. Between August 1958, and this June [1973], an estimated 422,000 gallons containing more than half a million curies seeped out of 15 other tanks, all of which have since been "retired".[16] According to Washington state's Environmental agency, over one million gallons of nuclear waste have leaked into the soil with tank B-109 being the latest tank to deteriorate.[17] With Hanford housing about 60% of the United State's nuclear waste, it is one of the most contaminated sites in the world.[18] Hanford demonstrates that improperly stored nuclear waste can cause immense damage to the surrounding environment and its inhabiting populations

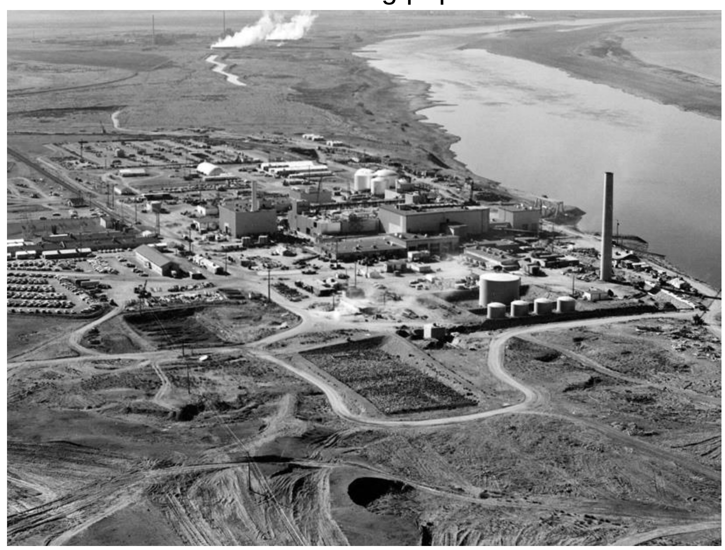


Figure 5: The Hanford nuclear prooduction and waste storage site

Passive Radiation Exposure

The human body is accustomed to low levels of passive radiation and can withstand periodic incidents of elevated radiation exposure, though not without long-term impacts at higher doses. Different types of radiation exposure have varying levels of danger due to the broad spectrum in emission energy and distribution.[19] For example, Gamma radiation poses more risk than alpha or beta radiation.[20] The proposed nuclear waste site would house spent nuclear fuel rods which are considered High-Level Waste (HLW). These rods emit more radiation than less radiative low or intermediate-level waste. Due to the higher radioactivity, HLW poses more risk to public health newly spent nuclear fuel spends years in wet pools located in on-site storage facilities as the most dangerous radiation depletes.[21] The old fuel that would be placed in permanent underground storage would not be as unstable as newly spent fuel. This means that the risk to the local communities from passive radiation would be lessened. Natural background radiation varies from 1.5 to 50 millisieverts (mSv/yr) and these levels do not pose a heightened risk to populations.[22] However, even low doses of radiation can increase risks to vulnerable groups such as pregnant women, older people, and children, as well as the immunocompromised.[23] To compound the impact of passive radiation, the location of the nuclear storage site being underground presents a risk of radiation leaking into the surrounding rock and local water sources. radioactive soil or rock leaks into the food supply. Consumption of irradiated food or water can lead to detrimental health effects relating to radiation ingestion. This is an especially crucial variable to consider for the proposed Ignace site due to its proximity to lake George. While passive radiation in the environment does not pose a major public health risk, added radiation from an improperly constructed nuclear waste site can increase rates of cancer and other health issues. This causes a health domino effect that can impact the health of the local population.

There are ways to mitigate the risks of passive radiation. To prevent excess radiation, steps can be taken before and during the construction of the nuclear waste deposit to ensure that the materials used to shield the radiation, such as the steel and concrete cube, is well constructed and effective at blocking radiation. This requires at least 510 millimeters of high-density concrete lined with 12.7 millimeters thick steel plate in accordance with CSA standards.[24] [25] To prevent destabilization or degradation of the deposit tunnel, inspections should take place every 7 years by nuclear engineering specialists. The location of the deposit is also crucial to containing radiation. The nuclear deposit site should be constructed in dense and non-porous rocks that do not contain much water. This will lower the amount of radiation that leaks into the local water system. Construction of residential neighborhoods should be prohibited in an area of 2.5 kilometers surrounding the nuclear deposit site. In addition, updated radiation measurement systems should monitor the amount of environmental radiation to ensure that it does not reach a concerning level. Measures must be taken in order to ensure that passive radiation levels do not elevate to mitigate the risks of cancer later in life. If properly constructed, a nuclear waste deposit site, such as the geographic deposit reservoir proposed, should not significantly add to the already present environmental radiation levels.

Acute Exposure Risk

While much more uncommon, the risk of an acute radiation leak occurring from a storage site malfunction is still present. Vulnerable areas of the reservoir such as the disposal tunnel, may pose a potential for structural instability and result in leakage.[26] If leakage does occur due to negligence or structural instability, large amounts of radiation could be released which would have an immediate impact on the surrounding populations. When exposed to radiation, the radioactive particles impact the body's cells causing damage to structures such as DNA. This can increase the risk of developing cancers later on in life. If enough radiation impacts the cells, they will die, causing the affected person to experience symptoms of radiation sickness. Symptoms of radiation sickness can include burns, nausea, intestinal and bone damage, and eventful death.[27] If a leak occurs in the nuclear waste site, it is paramount that actions be taken to reduce the amount of radiation affected populations are exposed to.

In the event of a radiation leak, an early warning system with preset evacuation and decontamination protocols should be implemented and reviewed every 10 years. Areas should be evacuated by sections with those living downwind of the nuclear site being evacuated first. At least more than one evacuation route should be available to facilitate swift evacuations and avoid backups. This will decrease the amount of time people are exposed to radiation, thus lowering the health impact. Hospitals nearest to the nuclear waste site should have updated equipment and staff training to treat radiation poisoning. Along with evacuation protocols, all residents within 5km of the nuclear waste site and all nuclear site staff should have access to potassium iodide pills in case of exposure.[28] Due to the location of the nuclear waste site being underground with standard construction, the risk of radiation exposure to residents and staff is very low, and there are easy solutions to prevent or counteract the impacts of radiation.

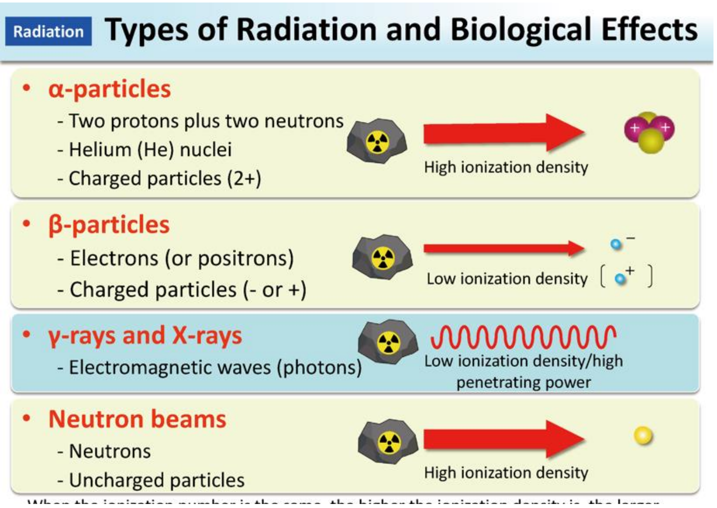


Figure 6: Biological effects due to different forms of radiation exposure

Social Risks

Demographic Risks

In terms of demographics, both villages have a small population of working-class individuals. In Teeswater, the population in 2016 was 995 people with an average age of 42.7 years old.[29] Whereas the 2016 population of Ignace is slightly larger at 1,202 with an average age of 46.8 years.[30] Most families in both communities live in single-family detached homes, small apartments, or motorhomes with an average household size of 2.3 and 2.1 for Teeswater and Ignace respectively.[31] Data suggests that both towns are composed of mostly married couples with some families having children. The average annual income for Teeswater is 38,000 CDN while Ignace is 30,000CDN a year which is within the range of the national average for 2016. Most people in Teeswater speak English primarily with a small percentage speaking French and a few others speaking languages such as German or Spanish. In Ignace, the primary language is English with the nearby reservation leading to some indigenous languages being spoken. From evaluating Teeswater, apart from the remoteness of the town limiting access to public goods, the population does not seem to be at elevated risk due to marginalization. Ignace has some demographic complications due to the Wabigoon Lake Ojibway Nation reserve with a population of 184 people located 35km away from the proposed nuclear storage site.[32] The marginalization of First Nations in Canada has resulted in a lack of accessible resources for reservations, placing the local population in the reserve at higher risk. Considering the demographic data of both of the drilling sites in Teeswater and Ignace, the smaller population size and non-reserve status of lands around Teeswater suggest that the site of Teeswater would pose a less immediate base risk to the population.

Unwillingness of Local Community to Accept Nuclear Repository

One of the guiding principles of the NWMO regarding its implementation plan for the long-term storage of nuclear waste requires that the management facility is located in an “informed and willing host community.”[33] Hence, the population residing at the proposed deep geological repository site must have enough of an understanding of the project and its likely impacts to be well-informed and to demonstrate a willingness to accept.[34] This has been a source of conflict for the NWMO in its proposed repository sites, Teeswater and Ignace. Despite attempts to present the safety protocols taken, many members of the proposed host communities and other localities and groups continue to display resistance. For example, a resident of Ignace was cited expressing their abhorrence towards the NWMO proposal, saying, "no matter how safe the project is [...] the very idea of Ignace as a nuclear waste 'dump' will sully its name."[35] Rejection is widespread due to large coalitions of protest groups, such as Nuclear Free North - who demand that the proposal to 'abandon' nuclear waste in Northern Ontario be done away with as a whole.[36] The NWMO has made appeal attempts by demonstrating the technical success of the project; however, opposition persists due to the lack of communication between the experts involved and the community that will be impacted.[37]

One way to reduce the disconnect between the NWMO and local community members is to facilitate more open communication forums. These would be similar to a 'town hall' for residents of the township wherein the repository is located, where they are able to express their concerns and feedback in a direct fashion, and on a regular basis. By ensuring that public input is consistently included in the NWMO project, community members will feel less isolated, and thus be more open to acceptance.

Population Loss in the Community

In ensuring a successful implementation plan, it is necessary that the proposed repository site contributes to the continued socioeconomic success of the surrounding community. Residents of the proposed repository sites fear that they will face a decrease in investment and economic development from new industries, due to investors not wanting their products and services to be tainted by being associated with nuclear waste. Members of these communities also express similar fears of property devaluation, increased costs of living, decreased livelihoods, and an increase in crime as a result of being a host for nuclear waste. Both fears could lead to population loss to neighboring municipalities.[38]

One way to mitigate potential population loss due to the perceived negative socioeconomic consequences of the repository site is to increase public awareness of employment and development opportunities that this project will bring to the community. As shown, the project expects to create jobs for many decades; the construction, operations, extended monitoring, and decommissioning phases are projected to create approximately 900, 1000, 260, and 420 jobs per year, respectively, in both skilled and semi-skilled areas.[39] To better amplify these opportunities to the public, the NWMO can mirror the American National Nuclear Security Administration (NNSA). Their job fair was marketed as a networking opportunity, wherein the 'next generation' of nuclear experts were to meet with hiring managers across all areas of the nuclear sector. It successfully demonstrated the future of nuclear energy as innovative and contributive to socioeconomic development nationwide.[40]

Persistence of Nuclear Stigma

The stigma surrounding nuclear energy significantly contributes to the difficulty in finding a location for any new developments - whether it be a power plant, a waste management facility, or even sites for nuclear research and development.[41] The negative connotation of nuclear energy as being 'dangerous' can persist due to a lack of public understanding of nuclear energy and a lack of transparency within the industry. More needs to be done to break down the secrecy barriers and increase the level of available information for public use to prevent public mistrust from contributing to a slowing of decision-making in the case of the NWMO.[42]

The Fukushima nuclear disaster is a relevant example that reveals how mismanagement and secrecy in the nuclear energy industry contribute to the continued existence of nuclear stigma. Although a natural disaster brought about the 2011 nuclear accident, poor risk management and a lack of proper communication between the Tokyo Electric Power Company (TEPCO), the government, and the public contributed to the magnitude of the catastrophe and the inadequate crisis response. This was a breeding ground for mistrust among Japanese citizens, facilitating widespread misinformation on nuclear energy.[43] A decade later, nuclear stigma is still prevalent, primarily maintained by misinformation and sensationalization -

particularly surrounding the health risks of radiation exposure from Fukushima. For example, in 2018, a pamphlet was distributed in Minamisoma city, one of the regions most impacted by Fukushima, wrongly claimed that the prevalence of thyroid cancer and leukemia had increased by approximately 30 and 10 percent, respectively. Despite the information contained in this brochure being proven inaccurate, it was still widely received, even reaching national attention via social media. Due to the mishandling of the crisis, there is a lack of valuable epidemiological data on the incidence rate of cancers post-Fukushima, which allows for false information and consequently, public mistrust of nuclear energy to continue to spread.[44]

To mitigate the consequences of nuclear stigma in the NWMO project, it is crucial to ensure that all steps are communicated fully to the public. The NWMO can mirror the French transparency framework for nuclear energy to do so. This framework includes The ASN which is an independent administrative authority that publishes relevant information on inspection results, reactor outages, incident and accident reports, and much more. There are also local information committees, which monitor the impact of nuclear facilities and report their findings to the surrounding population. In addition, they implemented a High Committee for Transparency and Information on Nuclear Security, a think tank that produces opinion pieces that facilitates debate on issues in France's nuclear energy sector. Finally, any person in France is entitled to obtain any documents held by the ASN and information about the environmental impacts of nuclear energy held by authorities.[45] By increasing transparency in the NWMO through this framework, public mistrust in nuclear energy that upholds stigmatizing beliefs would reduce.

Figures

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