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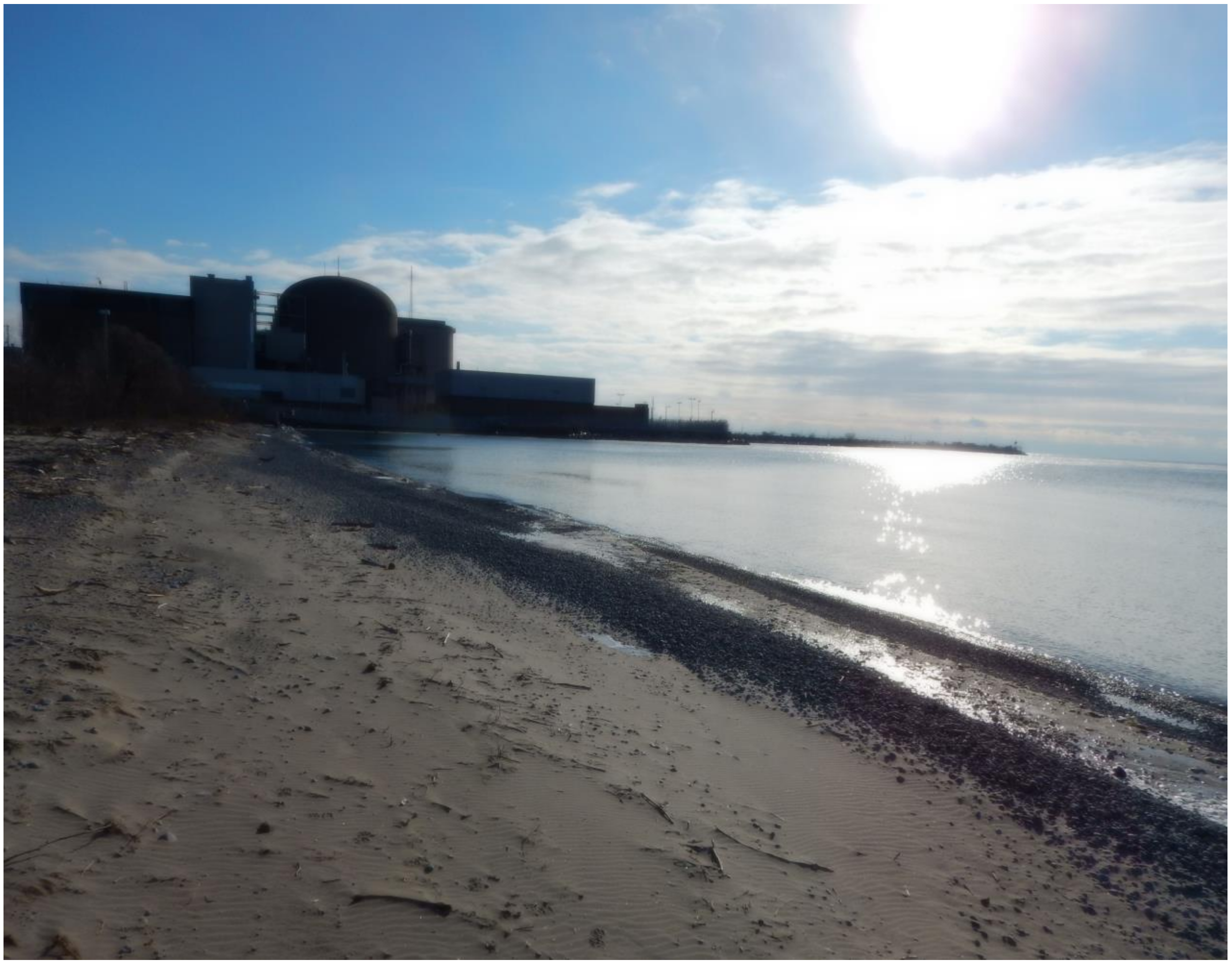

# Radionuclides as a Chemical of Mutual Concern in the Great Lakes Basin

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Cover photos: Pickering Nuclear Power Plant on the shores of Lake Ontario (front); Shoreline of Lake Ontario (back)

# Introduction

In Annex 3 of the Great Lakes Water Quality Agreement 2012 the Canadian and United States (U.S.) federal governments (the Parties) committed to “contribute to the achievement of the General and Specific Objectives of this Agreement by protecting human health and the environment through cooperative and coordinated measures to reduce the anthropogenic release of chemicals of mutual concern into the Waters of the Great Lakes, …” [Annex 3, Section A.] The Parties were given the responsibility to designate the chemicals of mutual concern.

The purpose of this paper is to provide an explanation of why radionuclides should be designated as “chemicals of mutual concern” under the Great Lakes Water Quality Agreement. The first part summarizes the health and environmental effects associated with radionuclides. The second part explains why radionuclides are of particular concern in the Great Lakes Basin. The third part discusses the availability of data on the presence of radionuclides in the Great Lakes and on the releases of radionuclides into the Great Lakes Basin. The fourth part describes some of the expressions of public concern around the threats posed by human activities that could result in the release of radionuclides. The final part presents our findings and recommendations.

# Part 1: Health & Environmental Effects of Radionuclides

Radionuclides are defined as follows:

> Radioactivity is a natural phenomenon that occurs when unstable atoms (isotopes) seek stability by emitting energy in the form of radiation (radioactive decay). The amount of energy and the form of emitted radiation vary a lot among the radioactive elements. Highly radioactive substances such as cesium-137 are transformed very quickly, with a high number of disintegrations per second and a short half-live [sic][1]. Isotopes such as uranium-235 or uranium-238 only decay with a few disintegrations per second and their corresponding half-lives [sic] are in the range of several hundred million years.[2]

[1] Nevertheless these are still long-lived. For example, cesium-137 has a half-life of 30 years. It is only in comparison with the extremely long-lived substances such uranium-235 that they are shorter-lived.
[2] “Radionuclides in the environment: Information Sheet,” Centre Ecotox, May 2013. http://www.ecotoxcentre.ch/media/40674/2013_radionuklide_en.pdf

*Health Effects:*

The decay of radioactive substances results in health problems.

> Some isotopes are unstable and radioactive, which means they decay into other elements, emitting alpha and beta particles and gamma rays from the nucleus. These three kinds of radiation, known as ionizing radiation, are highly energetic and are able to break chemical bonds. This gives them the ability to damage or destroy living cells.[3]

The description of health effects here is primarily based on U.S. Environmental Protection Agency (E.P.A.) materials.[4]

Some types of health effects result from on-going, long-term exposure to low levels of radiation. Cancer is the most commonly referred to health effect from this kind of exposure. Lung and bone cancer, and leukemia and lymphoma are the most common cancers resulting from exposure to radionuclides. Childhood leukemia is of particular concern.[5]

Very severe non-cancer effects also occur as a result of exposure to radionuclides. Radiation can cause changes in the DNA, resulting in mutations. These can be teratogenic mutations, which directly affect a fetus and can result in birth defects and developmental problems. Radiation can also result in genetic mutations, in which case irreversible DNA damage occurs. This means that the negative effects of exposure to radionuclides can impact future generations, even if they weren't themselves directly exposed to radionuclides.

There are also health effects that result from short-term exposure to high doses of radiation. This is often referred to as acute effects. This can result in radiation poisoning, leading to premature aging or death. Death usually occurs within a couple of months of the exposure. Workers in nuclear facilities are most likely to be the victims of such a situation.

Chart 1 shows some examples of the organs targeted by certain radionuclides resulting in damage to that organ.

[3] Anna Tilman, "On the Yellowcake Trail, Part Two," *Watershed Sentinel*, September-October 2009, p. 29.
[4] See http://www.epa.gov/radiation/understand/health_effects.html
[5] Rudi H. Nussbaum, "Childhood Leukemia and Concerns Near German Nuclear Reactors: Significance, Context, and Ramifications of Recent Studies," *International Journal of Occupational & Environmental Health*, Vol. 15/No. 3, Jul/Sep 2009, pp. 318-323.

### Chart 1: Examples of Organs Targeted by Radionuclides

**IONIZING RADIATION**

| TARGETED ORGAN | ISOTOPE |
|---|---|
| Thyroid | Iodine 131 |
| Skin | Sulfur 35 |
| Lungs | Radon 222 |
| | Uranium 233 |
| | Plutonium 239 |
| Liver | Cobalt 60 |
| Kidneys | Ruthenium 106 |
| Ovaries | Iodine 131 |
| | Cobalt 60 |
| | Ruthenium 106 |
| | Cesium 137 |
| Bone | Radium 226 |
| | Strontium 90 |
| Muscle | Cesium 137 |

How ionizing radiation is concentrated in the human body

Source: *Radiation Protection Manual*, 3rd Edition, Lita Lee, 1990, p. 13.

There have been only limited studies of the impacts of radionuclides on wildlife, birds, fish and other aquatic species, and plant life. The United Nations Scientific Committee on the Effects of Atomic Radiation concluded that to understand health effects on non-human biota,

> there is a need to better understand the chronic effects at a multi-generational time scale, chronic effects for multiple stressors, and the propagation of effects at the molecular and cellular levels to higher levels of ecological organization.[6]

In its assessment of environmental impacts, Environment Canada concluded that

> …the releases of uranium and uranium compounds contained in effluent

[6] United Nations Scientific Committee on the Effects of Atomic Radiation, *Sources and Effects of Ionizing Radiation*, 2008, Annex E, section 320.

> from uranium mines and mills are entering the environment [in Canada] in quantities or concentrations that may have a harmful effect on the environment and its biological diversity.[7]

This brief synopsis shows that radionuclides are a substance of concern.

Two controversies commonly arise around the question of how concerned we should be about long-term exposure to low-levels of radiation resulting from human activity.

The first controversy is whether exposure to low-levels of radiation is significant. Is there a no-effects level for exposure to radionuclides, i.e., is there a level of exposure below which there will be no effects on humans or wildlife? The U.S. National Academy of Sciences set up an expert panel to explore this issue. This panel is commonly referred to as the BEIR (Biological Effects of Ionizing Radiation) panel. It rejected the no-effects level idea, concluding "that the preponderance of information indicates that there will be some risk, even at low doses."[8] This is called the "no-threshold" assumption. The panel went on to say that "there is no compelling evidence to indicate a dose threshold below which the risk of tumor induction is zero."[9] The U.S. E.P.A. has adopted this position in setting its standards.

The second controversy is over whether we should pay attention to radiation releases as a result of human activities. Some people argue that we are exposed to radiation all the time from naturally occurring sources, often referred to as background levels, and that exposure to radionuclides as a result of human activities is relatively insignificant. Exposure to naturally occurring radiation creates increased risks of cancer and hereditary disease. These background levels may be greater than the levels we are exposed to as a result of human activities such as uranium mining, processing, waste handling, etc. Some argue that, therefore, we should not worry about exposure as a result of human activities because it is "insignificant" in comparison with the impacts of exposure to naturally occurring background levels.

In the last controversy, we spoke of the "no-threshold" standard. But that is only part of the assumption used by most regulators. The full assumption is "linear-no-threshold." The "linear" part assumes that each addition to exposure, even if small, will add to the other exposures to keep increasing risks.[10] The U.S. E.P.A. uses this "linear-no-threshold" assumption when setting limits.[11]

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[7] Environment Canada, "Synopsis of PSL2 Assessment Report," September 2006 at http://www.ec.gc.ca/ese-ees/default.asp?lang=En&n=2A379917-1

[8] National Academy of Sciences, *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII*, 2006, p. 10.

[9] Ibid., p. 23.

[10] Joachim Breckow, "Linear-no-threshold is a radiation-protection standard rather than a mechanistic effect model," *Radiation and Environmental Biophysics*, March 2006, Vol 44, Issue 4, pp. 257-260, February 2006.

[11] Jerome S. Pushkin, Center for Science & Technology, Radiation Protection Division, "Perspective on the Use of LNT for Radiation Protection and Risk Assessment by the U.S. Environmental Protection Agency," *Dose*-Response, 2009 http://www.epa.gov/radiation/understand/health_effects.html

The linear-no-threshold assumption means that, even if the exposure to radiation as a result of human activities is smaller than the exposure from natural sources, the exposure as a result of human activities can have a significant impact on human health and the environment. This leads to the conclusion that we should be even more cautious to avoid exposure to additional body burdens resulting from human activities because these are activities over which we can have the most control.

These two conclusions make it clear that radionuclides resulting from human activities should be considered as of concern even at very low levels and even if these levels are lower than the exposure levels from natural sources.

## Part 2: Radionuclides in the Great Lakes Basin

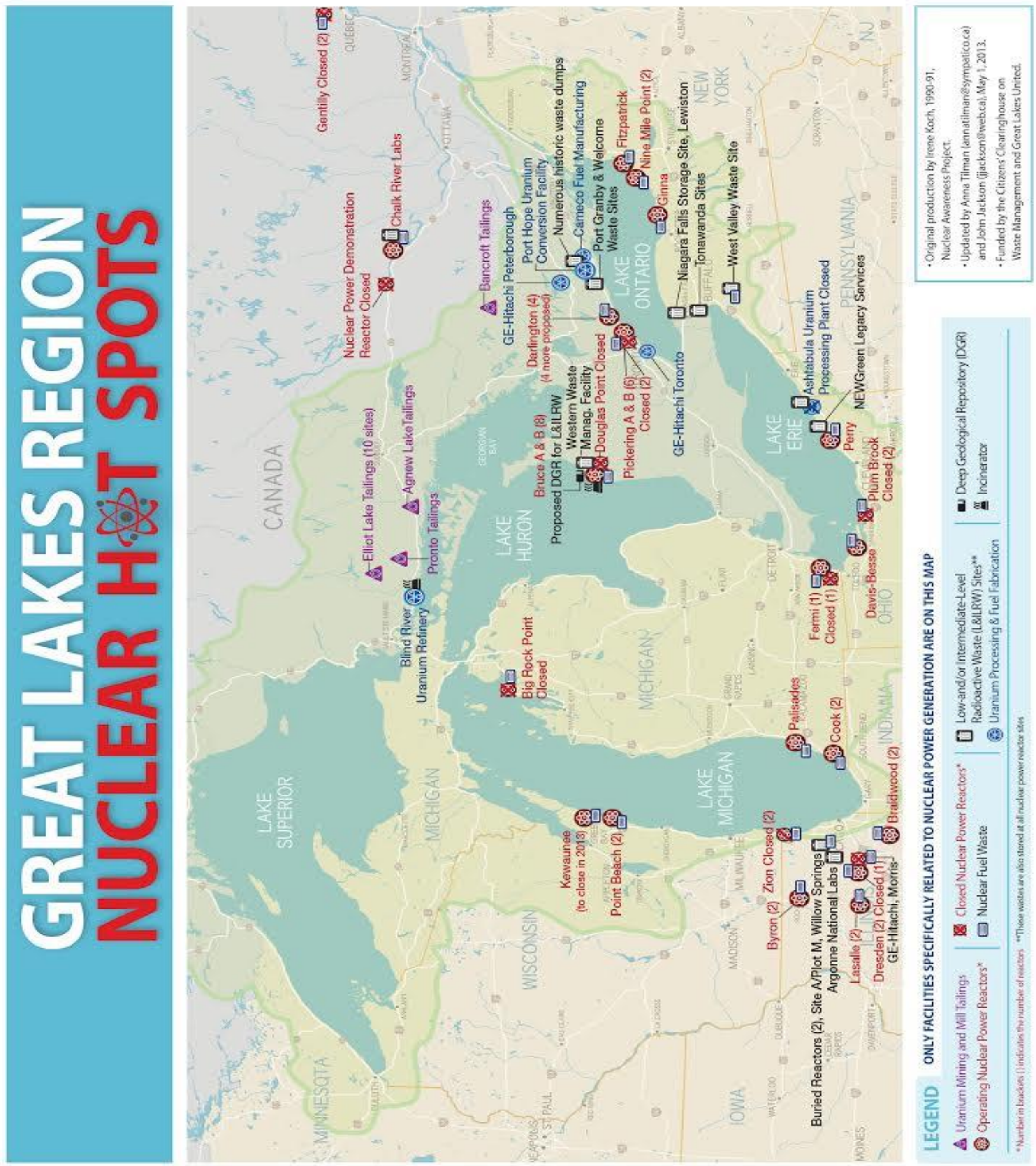
The following is an important question to consider when deciding whether a substance should be designated as a substance of mutual concern in the Great Lakes: Is the situation in the Great Lakes different than elsewhere? If so, it may mean that country-wide actions in Canada and the U.S. are not sufficient to take care of the unusual threats in the Great Lakes.

***Anthropogenic Sources of Radionuclides in the Great Lakes Basin:***

There is a uniquely large number of facilities containing, using, storing and disposing of radionuclides near the shores of the Great Lakes, with the exception of Lake Superior.

Many of these are associated with nuclear power generation. The map below shows the extent to which the facilities related to the nuclear fuel cycle are spread around the Basin. These include old uranium mines and their tailings, uranium processing facilities to generate fuel, open and closed nuclear power reactors, and the nuclear fuel and radioactive non-fuel wastes stored at most of these facilities. Many of these sites are now closed but closure of a site does not mean removal of the threat to the Great Lakes. The remaining hulk with its contaminated structures and wastes that were generated while the facility or mine was in use may remain there for decades with ongoing discharges as well as the threat of failure or breach of waste containers and more sudden release.

Facilities Related to Nuclear Power in the Great Lakes Basin[12]

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[12] The map shows those facilities that were present or proposed as of April 2013.

In addition, Canada's Nuclear Waste Management Organization (NWMO) is in the midst of a site selection process to choose one centralized site for the management/disposal of all the highly radioactive used nuclear fuel generated in Canada. Eight of the nine sites still under consideration are located within the Great Lakes Basin on the Canadian sides of Lake Superior and Lake Huron.

There are also many sources of radionuclides from other human activities in the Great Lakes Basin. These include facilities that use radioactive substances such as medical facilities, universities, and some industries. On the U.S. side, in addition to these facilities, there are major concerns related to radionuclide contaminants from weapons-related facilities. One of the impacts of such a large concentration of facilities in the Great Lakes Basin with radionuclides as the core part of their operation is the likelihood of the transportation of radioactive materials on the Lakes themselves, on the bridges over rivers that connect the Lakes, and on roads throughout the Basin. In 2011, the head of the Canadian Nuclear Safety Commission testified before the Canadian Parliament's Natural Resources Committee that "millions of shipments of nuclear substances in Canada are transported every year." As an example, he said that each year there are over "1,000 shipments [of radioactive materials] through the Port Of Montreal."[13]

A study carried out by the State of Nevada's Nuclear Waste Project Office on the then plan to bury nuclear fuel wastes at Yucca Mountain concluded that "While accidents severe enough to cause a failure of the transport cask and a resulting release of radioactive material are likely to be rare, the potential exists for serious accidents to occur."[14] They went on to state that the "release of only a small fraction of shipping cask's contents would be sufficient to contaminate a 42 square mile area and cost over $620 million to cleanup."[15]

Just within the past several years, we have had three proposals for transportation that have generated considerable public concern because of accidents that could result in spills that could immediately affect the waters of the Great Lakes. Canada's NWMO says that one of the options it is considering for transporting high level radioactive nuclear fuel waste from nuclear reactor sites to the central disposal facility it plans to build is by water. In this option it would transport "about 2 water shipments per month and about 36 road shipments per month" for each month of the thirty-year or more operating life of the facility.[16] This would create ongoing potential for a serious spill.

In 2011, Bruce Power Inc. received a permit from a Canadian federal government agency, the Canadian Nuclear Safety Commission, to transport 16 radioactive

[13] Dr. Michael Binder (President and Chief Executive Officer, Canadian Nuclear Safety Commission) at the Natural Resources Commission, March 8, 2011.
[14] State of Nevada Nuclear Waste Project Office, "Transportation of Spent Nuclear Fuel and High-Level Radioactive Waste to a Repository," May 20, 1999, p. 5.
[15] Ibid.
[16] Nuclear Waste Management Organization, *Ensuring Safe Transportation of Used Nuclear Fuel*, 2010.

decommissioned steam generators at their nuclear reactor near Kincardine by ship from Owen Sound through Lake Huron, Lake Erie, Lake Ontario and thence out the St. Lawrence River to Sweden for "recycling." These steam generators, each of which weighed 100 tonnes, were contaminated with a variety of radioactive substances, including various isotopes of plutonium. When people became aware of this proposal, a major outcry broke out all across the Great Lakes on both sides of the border. Bruce Power did not proceed with its plan because of the outcry; the permit has since expired.[17]

A third example is a proposal to transport highly radioactive liquid waste by truck from a storage tank at a research nuclear reactor in Chalk River northwest of Ottawa, Ontario, to the U.S. Department of Energy's Savannah River site in South Carolina. It is estimated that it would take approximately 170 trips to transport all the material.[18] This would require crossing the Great Lakes-St. Lawrence River system at some point. They currently are looking at crossing the Niagara River at Erie-Buffalo.[19] This proposal is still under consideration.

Observing this concentration of facilities around the Great Lakes Basin, especially those related to nuclear power generation, Health Canada's Radiation Protection Bureau concluded:

> Comprising one of the world's largest sources of freshwater and supporting a population of over 36 million residents, the basin is unique in that it contains nearly all components of the nuclear fuel cycle, from uranium mining to radioactive waste management… As a result of the large inventories of radioactive material at these facilities, there is a potential for a significant accidental release of radionuclides into the environment. Although the probability of such an occurrence is extremely small, the health, social, and economic consequences could be significant.[20]

Such an accident within the Great Lakes Basin has already come very close to leading to disaster. On an October afternoon in 1966, there was a partial fuel meltdown at the Fermi liquid metal fast breeder reactor a few miles from Monroe, Michigan. Located just downwind from the Fermi plant is Detroit, which led to the title of the book detailing the accident - *We Almost Lost Detroit*.[21] Fortunately, the reactor was operating at very low power at the time of the accident so the full potential consequences did not occur. This plant, which was only operated again for a limited

[17] Canadian Environmental Law Association, "Environmental Groups Commence Legal Proceedings Against Proposed Shipment of Radioactive Waste Through the Great Lakes," March 8, 2011.
[18] Ian MacLeod, Bomb-grade uranium to be shipped secretly from Chalk River, Ontario nuclear plant to U.S.," *National Post*, February 11, 2013.
[19] Letter from Fuel Cycle and Transportation Security Branch to Secured Transportation Services, May 20, 2013.
[20] Brian A. Ahier & Bliss L. Tracy, "Radionuclides in the Great Lakes Basin," *Environmental Health Perspectives*, Vol 103, Supplement 9, December 1995, p. 89.
[21] John G. Fuller, *We Almost Lost Detroit*, 1975.

period of time, ultimately shutdown under pressure from the Atomic Energy Commission in 1973, still sits on the shores of Lake Erie in what the U.S. Nuclear Regulatory Commission calls "safe storage" after removal of the most highly radioactive components. How many other potential catastrophic accidents are sitting around the Great Lakes?

But such an accident does not have to occur to have negative impacts on the Great Lakes Basin. Each of the facilities around the Basin (see map on page 8) is releasing radionuclides to the environment every day.

### *The Special Nature of the Great Lakes Basin*

The Great Lakes have characteristics that make them particularly susceptible to certain kinds of contaminants. As the eight scientists who wrote the *Prescription for Great Lakes Ecosystem Protection & Restoration* stated: "The lakes represent a more closed system than coastal ocean waters. And respond more slowly to contaminant loadings."[22]

Unlike river and estuarine systems, the Great Lakes have long turnover times. Lake Superior has a turnover time of 182 years; Lake Michigan 106 years; Lake Huron 21.1 years, and lakes Erie and Ontario of just over 2 years.[23] Even the shorter time frames here are longer than river or estuarine systems, where water moves very quickly through and out of the system. This means that toxic substances stay within the Great Lakes for longer periods of time and accumulate in the system – especially if they are substances that are persistent, i.e., have long lives before they break down.

The understanding of this special nature of the Great Lakes system has led to the recognition of the need for special provisions to protect the Great Lakes. That is why the 1978 Great Lakes Water Quality Agreement introduced the goal of "virtual elimination" of persistent toxic substances and the technique of "zero discharge" as the method to achieve virtual elimination.[24] The governments recognized the need to put a special emphasis on addressing toxic substances that are persistent because they will not disappear from the lakes and will accumulate.

The persistence of radionuclides varies dramatically depending on their half-lives, their decay products, and their stable end-products. Many of the radionuclides currently being generated and stored around the Great Lakes are from the used fuel bundles in nuclear reactors. These have very long half-lives. For example iodine-129

[22] Jack Bails et al, *Prescription for Great Lakes Ecosystem Protection & Restoration (Avoiding the Tipping Point of Irreversible Changes)*, December 2005, p. 8.
[23] *The Great Lakes Water Quality Agreement: An Evolving Instrument for Ecosystem Management*, National Research Council & The Royal Society of Canada, 1985, p. 18.
[24] For a description of the development of this concept and the movement around it, see Paul Muldoon & John Jackson, "Keeping the Zero in Zero Discharge: Phasing Out Persistent Toxic Substances in the Great Lakes Basin," *Alternatives*, Vol. 20 No. 4, 1994, pp. 14 – 20.

has a half-life of 15.7 million years; plutonium-239 has a half-life of approximately 24,000 years.

The quantities of these highly persistent and toxic substances are substantial. As of the end of 2004, the NWMO estimated that Canada had approximately 36,000 tonnes of uranium in its used nuclear fuel bundles and estimated that this amount would double by the end of the life span of the existing nuclear reactors.[25] Most of this quantity is now being generated and stored within the Great Lakes Basin.

On the U.S. side of the Great Lakes, the amount of irradiated fuel by nuclear power facilities in or near the Great Lakes Basin was estimated to be 13,825 tonnes in 2011.[26]

The Canadian agency responsible for these used fuel bundle wastes (the NWMO) has concluded that it takes a million years for the radioactivity from this waste to become comparable to the radioactivity from a natural ore deposit.[27] They also have concluded that it takes 200,000 years for the "decay heat" from used fuel to approach that of natural uranium.[28] Therefore, the NWMO has taken "the position that used nuclear fuel will need to be contained and isolated from people and the environment essentially indefinitely."[29]

These estimates of sources of highly persistent and toxic substances are only for the wastes from the fuel for the nuclear power plants around the Great Lakes Basin. Many of the other human activities that release radionuclides also release highly persistent toxic substances.

It was because of this that the International Joint Commission (IJC) made the following recommendation to the Canadian and U.S. federal governments in 1996:

> The Governments should address the treatment of radioactive materials discharged to the Great Lakes as they have approached other persistent toxic substances. Many radionuclides fit the Agreement's definition of persistent toxic substances because they are persistent and toxic.[30]

[25] Nuclear Waste Management Organization, *Choosing a Way Forward: The Future Management of Canada's Used Nuclear Fuel*, 2005, p. 350.
[26] Kevin Kamps, Beyond Nuclear, June 7, 2011 at http://www.beyondnuclear.org/storage/How%20much%20high%20level%20radioactive%20waste%20exists%20in%20or%20near%20the%20Great%20Lakes%20and%20St%20Lawrence%20River.pdf
[27] Nuclear Waste Management Organization, *Choosing a Way Forward: The Future Management of Canada's Used Nuclear Fuel*, 2005, p. 341.
[28] Ibid.
[29] Ibid., p. 348.
[30] *Eighth Biennial Report Under the Great Lakes Water Quality Agreement*, June 1996, p. 37.

## Part 3: Monitoring for Presence and Discharge of Radionuclides in the Great Lakes

***Presence of Radionuclides in the Great Lakes:***

In 1997, the IJC's Nuclear Task Force carried out an in-depth study to assess the adequacy of monitoring for radionuclides in the Great Lakes. They concluded that:

> …monitoring of radionuclides in the Great Lakes primarily meets the need for compliance by users of radioactive materials with the conditions of the licenses for discharge. This results in differences in the radionuclides reported, how radionuclide levels in the environment are reported, the extent of off-site monitoring, and the specific biological compartments included in monitoring by facilities in Canada and the United States. Very little of the monitoring activities are designed to address or are capable of considering the movement and cycling of radionuclides through environmental compartments and ecosystems.[31]

This situation has not improved since that 1997 report. A lengthy public hearing concluded in September 2014 regarding a proposal by Ontario Power Generation to build a deep geologic repository for low and intermediate level waste about one kilometer from the shores of Lake Huron. In the fall of 2013, the hearing panel asked the Canadian Nuclear Safety Commission [CNSC] "for updated information on radionuclide levels in Lake Huron." Approximately eight months later, CNSC provided the following response to the request:

> As per your request to CNSC for updated information on radionuclide levels in Lake Huron during the public hearing in the Fall of 2013, enclosed are three reports - Bruce Power. *Environmental Monitoring Program Report*. April 2012; IJC Nuclear Task Force. *Inventory of Radionuclides for the Great Lakes*. December 1997; and Ahier, Brian A. and Bliss L. Tracy. "Radionuclides *in the Great Lakes Basin.*" Environmental Health Perspectives Volume 103, Supplement 9 (December 1995) - for your information.[32]

Significantly, one of the three reports sent was the IJC's report from 1997, which emphasized the inadequacies of monitoring data. One of the other two is a publication from 1995, prior to the IJC Task Force's assessment of adequacy of data.

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[31] Nuclear Task Force, International Joint Commission, *Inventory of Radionuclides for the Great Lakes*, December 1997, Overview.
[32] Correspondence Robyn Robyn-Lynne Virtue, DGR Joint Review Panel Secretariat, Canadian Environmental Assessment Agency to DGR Review Hearing Panel Members, June 26, 2014.

The only report they sent that is more recent is the monitoring report that Bruce Power is required to provide as part of maintaining its license. That report has the same fundamental failings in terms of allowing us to have a scientific understanding of radionuclides in the Great Lakes Basin that the IJC Task Force highlighted. It is facility-specific and does not try to come to an understanding of lake conditions. Facility-by-facility monitoring cannot give us the understanding of the conditions of the Lakes for the reasons detailed in the IJC Task Force's report.

In addition, there are problems with the consistency of monitoring results among labs. Blind inter-laboratory testing for radionuclides in the U.S. of samples of drinking water found the "analyses to be laboratory-dependent and demonstrated that the methods … cannot accurately determine whether samples are below trigger levels."[33]

The most effective on-going monitoring system that we have in the Great Lakes to help us understand the status of contaminants in the waters, biota, and sediments is conducted by the governments and other research institutions under the Coordinated Science and Monitoring Initiative, commonly called the CSMI.[34] Environment Canada and the U.S. E.P.A. coordinate this system. Each year they focus monitoring on one of the Great Lakes going through an ongoing five-year cycle to come back again to each lake. But because the governments have not highlighted radionuclides as a chemical of concern in the Great Lakes, radionuclides are not included in this intense and strategic monitoring program.

Therefore, seventeen years after the IJC's Task Force pointed out the inadequacies of data, we still do not have adequate monitoring in the Great Lakes Basin to understand the impacts of radionuclides on the condition of the Great Lakes ecosystem.

***Data on Releases of Radionuclides:***

We do not have consistent comprehensive data on the releases of radionuclides from facilities around the Great Lakes Basin. Neither Canada's National Pollutant Release Inventory (NPRI) nor the U.S. Toxics Release Inventory (TRI) includes radionuclides as substances that polluters must report annually to the government and the public. Since 2009, Canada has been saying that it is considering adding radionuclides to their inventory, but it has not yet seriously proceeded with this.[35]

Since radionuclides are not included in either country's annual reporting requirements for facilities, it is impossible to obtain an overview of the extent of releases of radionuclides into the Great Lakes Basin as a whole. As a result it is impossible to

[33] Eaton et al., "Evaluation of variability in radionuclide measurements in drinking water," *Journal AWWA*, 103:5 May 2011.
[34] For description of this program, see Paul J. Horvatin & Jacuqline Adams, U.S. E.P.A. Great Lakes National Program Office, "Monitoring and Research Across the Great Lakes: The Cooperative Science and Monitoring Initiative" [undated] http://acwi.gov/monitoring/conference/2012/K6/K6Horvatin.pdf. Accessed November 2015.
[35] Environment Canada, *Stakeholder Discussion Document on Implementation of Mine Waste Reporting Through NPRI*, July 16, 2009.

have a reasonably good assessment of the risks from radionuclides being released as a result of human activity.

The Canadian Environmental Law Association and Environmental Defence have prepared reports totaling the releases of 204 pollutants from 3,960 facilities that reported to the governments and the public under both the NPRI and TRI. These reports have shown changes in releases to the Great Lakes Basin and changes in the sources.[36] This is invaluable in allowing us to have a comprehensive view of threats to the Great Lakes and helps us in making decisions about where the countries need to focus their energies to protect the Lakes. We do not have the data, however, to be able to prepare a similar report on radionuclides.

In Canada, the Canadian Nuclear Safety Commission periodically releases a report compiling the gaseous and liquid releases that each Canadian nuclear power plant has reported.[37] This report, while useful, does not adequately fulfill the need for data on radionuclides released into the Great Lakes Basin. The types of radionuclides reported are limited in number; no data is provided on non-nuclear power plant sources such as mining tailings ponds, tritium processing facilities and fuel manufacturing facilities, and the data are not comparable with data available in the U.S.

The IJC's Nuclear Task Force examined data on the sources of radionuclides to the Great Lakes and concluded that they were not comparable between Canada and the U.S. and were limited in comprehensiveness. This makes it impossible to obtain a comprehensive picture of radionuclides in the Great Lakes.[38]

## Part 4: Public Concern

Substantial public concern has been expressed about nuclear threats to the Great Lakes Basin over the decades. This concern increasingly has two characteristics:

1. concern about the cumulative impacts of multiple facilities; and
2. recognition that any existing, new or expanded facility or activity is a threat to people throughout the Great Lakes Basin – not just locally.

Below are a few recent examples of this.

[36] Canadian Environmental Law Association & Environmental Defence, *Partners in Pollution: An Assessment of Continuing Canadian and United States Contributions to Great Lakes Pollution*, February 2006; and *Partners in Pollution 2*, March 2010.
[37] The most recent is *Radioactive Release Data from Canadian Nuclear Power Plants 2001-10*, January 2012.
[38] Op cit., p. 88-89.

*Deep Geological Repositories:*

A proposal to bury radioactive waste about a kilometer from the Canadian shore of Lake Huron resulted in a major outcry across the Great Lakes Basin. As of November 2015, one hundred and seventy-eight municipalities had passed resolutions opposing the proposal; these municipalities represent 22.7 million people and are spread all across the Great Lakes Basin in both Canada and the U.S. Eighty-seven thousand Canadian and U.S. citizens had signed a petition expressing similar concerns.[39]

*Shipping of Radioactive Steam Generators on the Great Lakes:*

When there was a proposal to ship radioactive steam generators through the Great Lakes and the St. Lawrence River to Europe, the Great Lakes & St. Lawrence Cities Initiative investigated the proposal and came out in opposition. The Cities Initiative is a coalition of around 70 cities in Ontario, Québec and the eight Great Lakes states.[40]

*Participation in Facility-Specific Hearings:*

Formal public hearings on both sides of the border on proposals for new or expanded or refurbished nuclear-power-related facilities are attracting many intervenors. For example, the hearings in 2011 regarding a proposal to build four new nuclear reactors at the existing Darlington Nuclear site led to written submissions by 158 intervenors and thirty-four oral statements.[41] In a licensing renewal hearing for Darlington in 2015, written and oral presentations were made by 283 individuals or organizations; 65 of these did oral presentations.[42]

These are just a couple of examples of how Great Lakes residents are increasingly seeing radionuclides as a binational Great Lakes basin-wide concern. This adds important weight to the need for the Canadian and U.S. governments to designate radionuclides as chemicals of mutual concern in the Great Lakes Basin.

## Findings and Recommendations

***Recommendation 1: We recommend that the Canadian and U.S. federal governments jointly designate radionuclides as chemicals of mutual concern according to their responsibility in Annex 3, Part B, Sec. 2 of the Great Lakes Water Quality Agreement 2012.***

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[39] For the data on public opposition to the DGR, go to http://www.stopthegreatlakesnucleardump.com
[40] See http://www.glslcities.org/voice-of mayors/Bruce_CNSC_newsrelease_FINAL.pdf
[41] Joint Review Panel, *Environmental Assessment Report: Darlington New Nuclear Power Plant Project*, August 2011, p. 25.
[42] Canadian Nuclear Safety Commission, Summary Record of Proceedings and Decision.

This recommendation is based on the following findings in this report:

- Radionuclides have very serious immediate, long-term and intergenerational effects on human and non-human health;
- There is no level of radionuclides below which exposure can be defined as "safe;" therefore, very low levels of exposure can be significant;
- The inevitable exposure to naturally occurring radiation means that we should be even more cautious about avoiding additional body burdens resulting from exposure to radionuclides as a result of human activities over which we can have more control;
- There is a uniquely larger number of facilities containing, using, storing, and disposing of radionuclides for power generation purposes near the shores of the Great Lakes, and there are proposals for additional ones;
- The large number of facilities around the Great Lakes Basin, usually near the shoreline, result in continuing on-going regular discharges into the lakes as well as a high probability of accidents that release higher amounts of radionuclides. This cluster of facilities near the shores of the Great Lakes means a high likelihood of radioactive materials being transported on the lakes or across the rivers that connect the Great Lakes, with the potential for spills during transportation and loading and unloading;
- The Great Lakes have characteristics that make them particularly susceptible to persistent toxic substances. As some radionuclides persist for extremely long periods of time, this means that the protective measures will need to be different in the Great Lakes than in an ecosystem with different characteristics.
- There are substantial scientific, medical and public concerns about the threats posed by radionuclides in the Great Lakes Basin.

***Recommendation 2: Once the Parties to the Great Lakes Water Quality Agreement have designated radionuclides as chemicals of mutual concern, they should emphasize their commitment in Annex 3, Part C. Science, item 1 for "identifying and assessing the occurrence, sources, transport and impact of chemicals of mutual concern, including spatial and temporal trends in the atmosphere, in aquatic biota, wildlife, water and sediments" as well as the other sections in Part C, which elaborate on item 1 in the Agreement.***

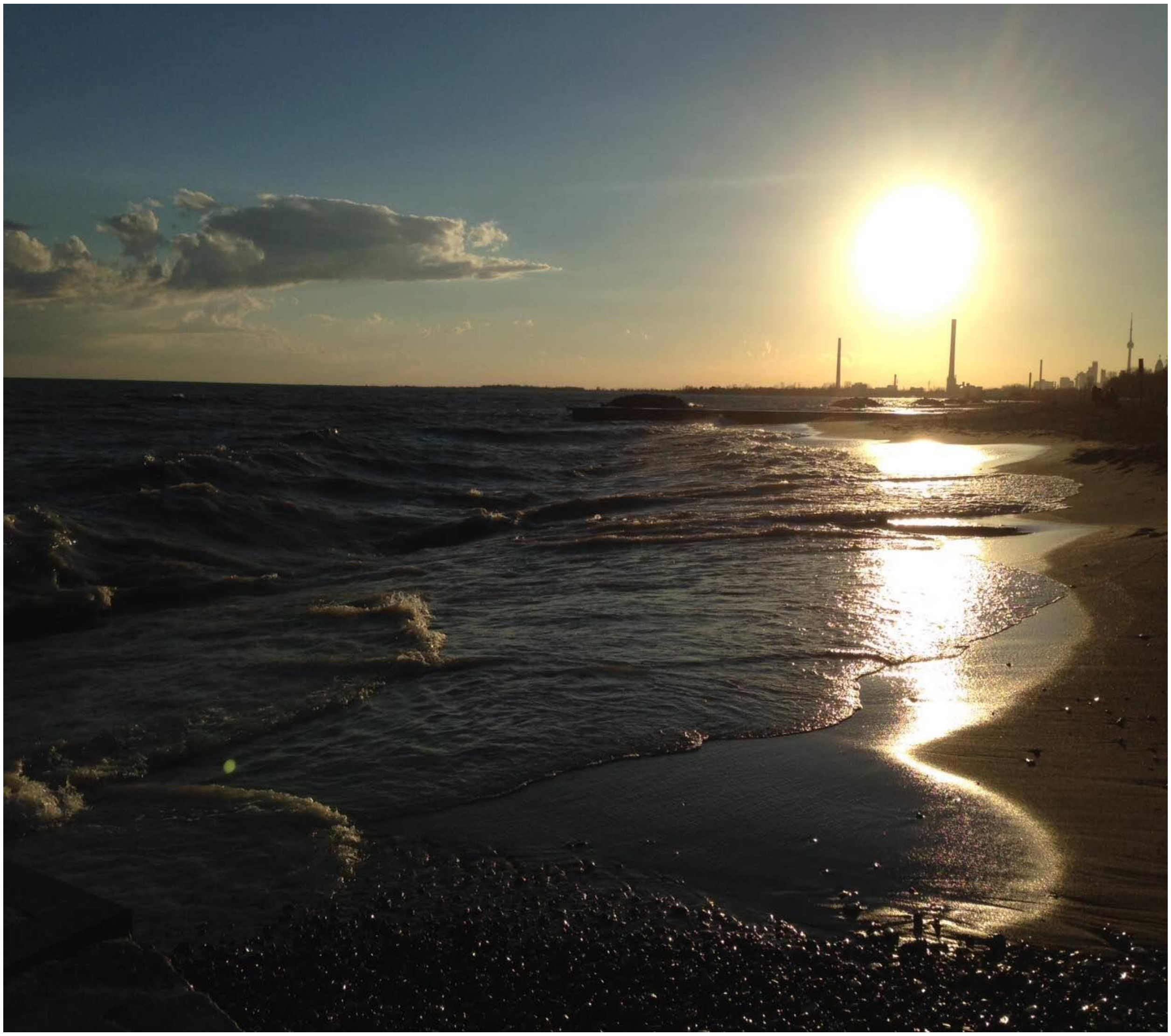
This recommendation is based on the findings by the IJC's Nuclear Task Force as discussed earlier in this report that the data currently available on releases and presence in the Great Lakes ecosystem are inadequate to gain an understanding of the sources and of the impacts on the ecosystem.

***Recommendation 3: In developing the binational strategy for radionuclides as a chemical of mutual concern, as required in Annex 3, Part B, the governments should be guided by the Principles and Approaches section in the Great Lakes Water Quality Agreement [Article 2, part 4].***

Particular emphasis should be placed on the principles listed therein of “anti-degradation,” “ecosystem approach,” “polluter pays,” “precaution,” “prevention,” “science-based management,” “sustainability,” “virtual elimination,” and “zero discharge.”

***Recommendation 4: The Parties should ensure full opportunities for public engagement in the development of the binational strategy for radionuclides as a chemical of mutual concern.***

This is a requirement of the Great Lakes Water Quality Agreement both in Article 2, Part 4.(k) and Annex 3, Part B. The governments should use a broad range of outreach, educational and engagement mechanisms so people have the opportunity to be involved at whatever level of engagement best suits them. Included in these mechanisms should be the inclusion of non-government scientists, activists, etc. on the bodies that develop and oversee the implementation of the binational strategy on radionuclides. Representatives of the diversity of the Great Lakes community should be involved in the development of the engagement plan.



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