Large gaps in our understanding of radionuclide emissions on public health: the current need for more data and greater health protection

Cindy Folkers
Mary Olson[1]

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SUMMARY

Adequate measures are NOT being implemented through existing radiation regulations to fully protect public health, contrary to public claims made by agency staff (Parties) and industry.

Large research **gaps** in our current understanding of radionuclide harms include:

- **Internal Exposures:** There is lack of appropriate data, and use of existing data, to determine damage from internally deposited radioisotopes (those inhaled or ingested into the body). We need proper and complete understanding of environmental pathways and proper monitoring for the purpose of assessing potential and actual internal exposures.
- **Disproportionate Impacts:** We need more complete assessment of, and accounting for, disproportionate impacts on females, children, and pregnancy.
- **Non Cancer vs Cancer:** We need more complete assessment of, and accounting for, cancer AND non cancer disease outcomes.

Our lack of understanding in these fundamental areas necessitates further research on radionuclides, and a CMC designation for radionuclides would support this need – especially acute in light of the fact that both Canada and the US have purposefully decided NOT to continue health studies that

[1] Biographies at end of article.

would have shed light on the lived experiences and impacts of radionuclide exposure on human health.

Despite finding increases in several diseases in the Port Hope, Ontario area (e.g. cancers, neurological, cardiovascular, and respiratory) CNSC and Health Canada concluded no further health studies were necessary. The industry continues to operate there, and is planning to locate and fast track the largest nuclear power facility in the world, on the northern shore of Lake Ontario.

The US Nuclear Regulatory Commission (NRC) had tasked the National Academy of Sciences (NAS) to conduct a study that would have examined increases of childhood cancer around NRC-licensed facilities, but then withdrew funding. The US is also trying to rewrite regulations to fast track nuclear power technology nationwide and revivify closed reactors along the Great Lakes.

In both instances, more as yet unknown and unquantified radioactive substances will be discharged into and over Lake Ontario and the Great Lakes system.

Both of these agencies appear to be ignoring data on health impacts, instead opting for reliance on their radiation exposure standards as being “safe enough”. Such reliance refuses to integrate new health data that, if implemented, could increase public and environmental protection. Instead, we are left with models and regulations that only partially represent potential risks (see LNT section below).

These actions on the part of our federal agencies reveal why a designation of CMC for radionuclides is imperative and long overdue. Clearly without such designation, respective country agencies are content to leave a wide swath of public health impacts unknown and unaccounted for, even while nuclear industries remain operational.

At the same time these agencies contend that “current actions are adequate, in *Summary of Binational Screening Criteria for Nominated Chemicals of Mutual Concern under Annex 3 of the Great Lakes Water Quality Agreement: Radionuclides*, the agencies recognize gaps in knowledge, including lack of guidelines for all relevant radionuclide/matrix combinations; and ecosystem science including ecological receptors. A designation of CMC would provide resources to close these knowledge gaps, and “opportunity to improve consistency in data”, which at least the Canadian agencies claim as a goal.

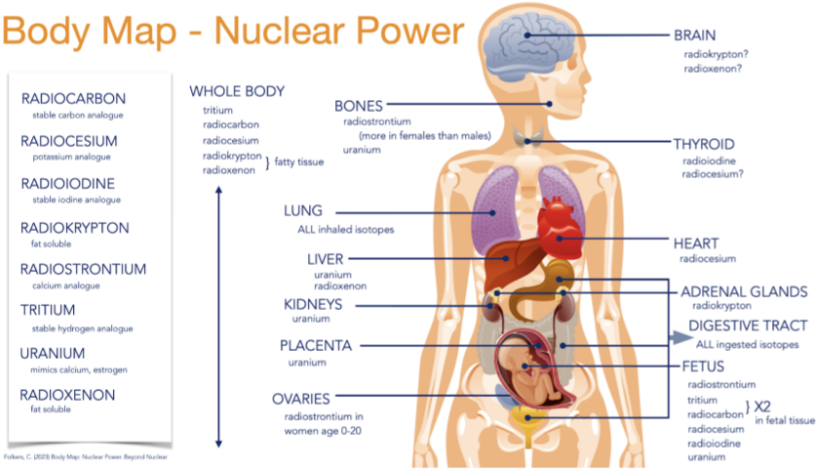
KNOWLEDGE GAP: Internal Exposures & Pathways

Appropriate assessment of radioisotopes that are inhaled or ingested is not included in US 10CFR20 – Standards for protection against ionizing radiation. These standards state that internal damage is based on external doses.

Internal exposure to radiation from internalized radionuclides is not included in US 10CFR20 – ‘Standards for protection against ionizing radiation’ including the public.

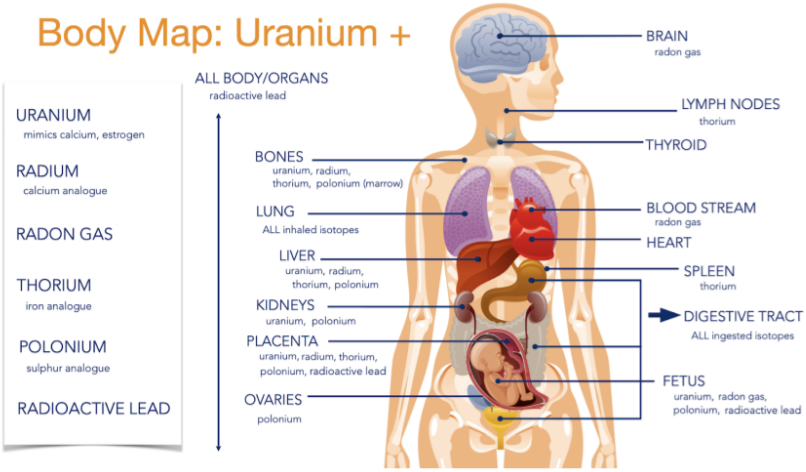
Current methodology for evaluation of the biological harm from radioactive pollution is inadequate. This pollution can encompass many forms, and results in incorporation of radioactivity into our cells, tissues, organs, and in our children, and grandchildren.

1 Internal Exposure



SOURCE: Cindy Folkers, Beyond Nuclear Radiation and Health Hazard Specialist

Internal Exposure



SOURCE: Cindy Folkers, Beyond Nuclear Radiation and Health Hazard Specialist

These two body maps show where radionuclides from nuclear power and uranium processes travel in the pregnant body. They demonstrate why prevention of radionuclide exposure is of vital importance to public health.

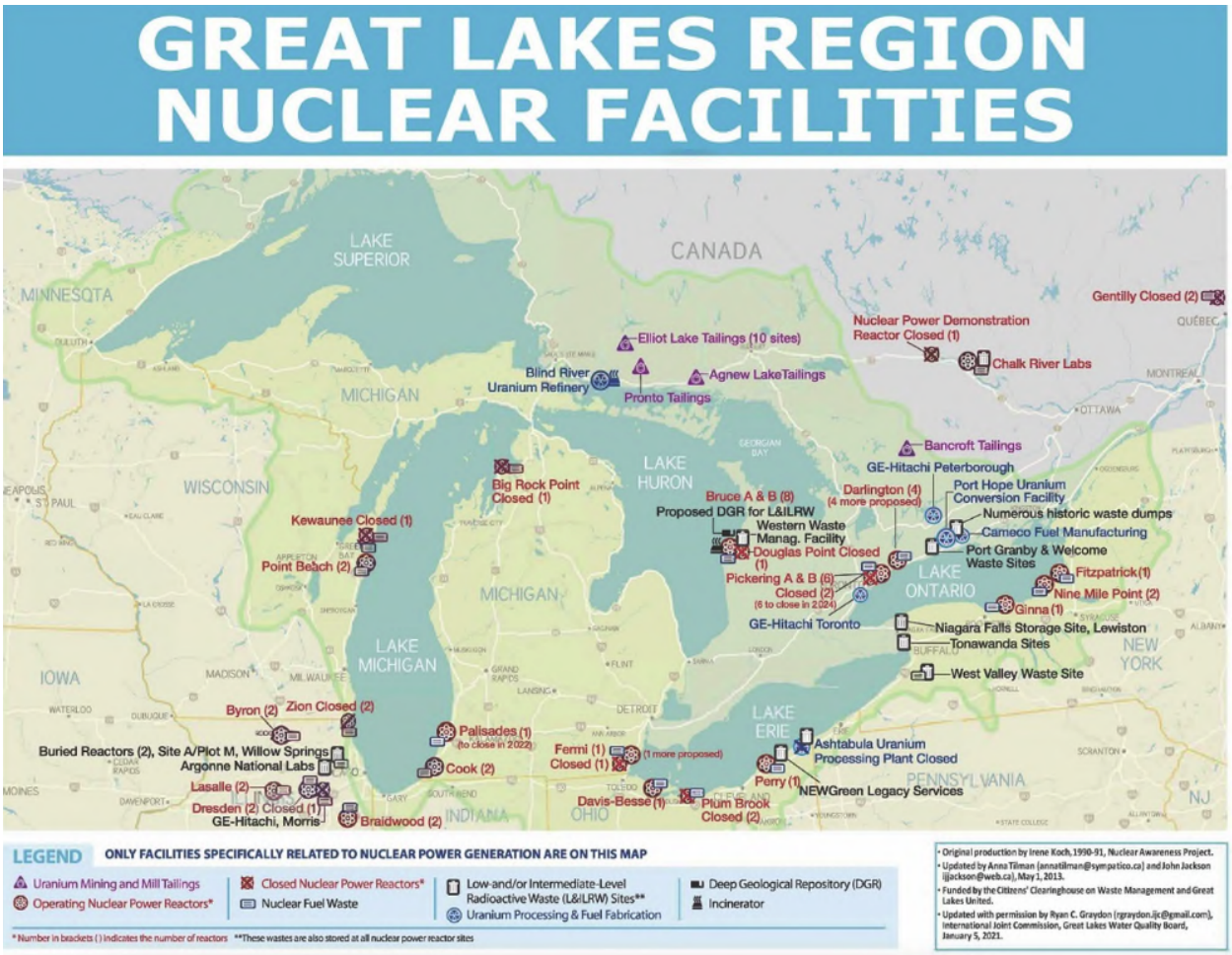
All of these substances from nuclear technologies are associated with various diseases including a number of cancer and non-cancer diseases, particularly in children. Impacts to fetal and growing children include impaired neural development, heart problems, most cancers – particularly leukemia and central nervous system cancers – blood diseases, heart, liver, and kidney diseases, various autoimmune diseases, including multiple sclerosis.

Erosion of physiological systems is endemic in those impacted by radioactive pollution in our environment.

While impacts of radionuclides are poorly assessed—we have even less data on the outcomes of multiple mixed exposures that include man-made toxic chemicals as well as radioactive pollution.

We need adequate pathway assessment to protect from ongoing and cumulative internal exposures to radionuclides. Effluent monitoring by the polluter is not enough to protect our children or theirs, and measurement at the fence line is not adequate.

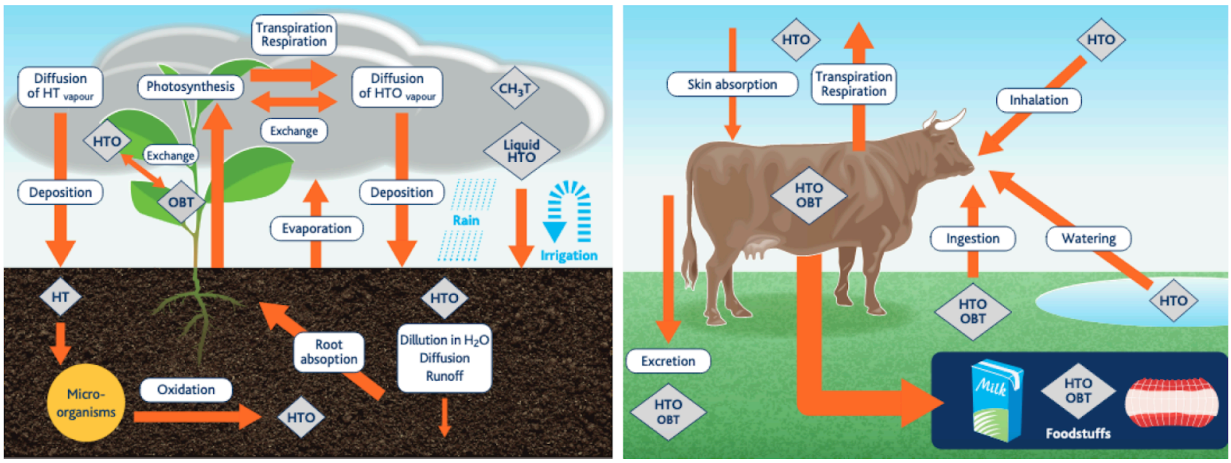
Characterization of radionuclide exposure pathways are essential for protection because our environment, including human and other lifeforms – today and into the future – require evidence-based approaches that adequately describe movement of radioactivity in the food chains of life and encompass both external and internal radiation exposure.



This map, created by NGOs, not government agencies, shows dozens of source sites for radionuclides.

However, this is not a map of where the releases have gone. It is not a map of cumulative bio-sequestration. It is not a map of health outcomes known to be attributable to radiation exposure–either single, cumulative, lifelong or intergenerational.

TRITIUM PATHWAYS



Tritium pathways in the environment from Tritium and the Environment, IRSN 2010.

And the map of the Great Lakes doesn't include information such as is shown here for Tritium. A similar process-diagram is needed for every radionuclide in multiple ecological cases, and needs to be used by regulators to assess potential for harm. The lack of such assessments represents a gap in knowledge admitted to by the regulating agencies.

New work is coming out based on evidence rather than a rote formula that reframes internal emission of radioactivity, especially beta and alpha particle emissions. This new work examines radioactive dust that can lodge inside our bodies and impart exposures orders of magnitude higher than currently officially recognized.

Internal deposition of radionuclides results in disproportionately greater harm compared to exposure that is external, particularly with the conventions currently in use to evaluate impacts of radioactivity emitted inside the body from ingestion and inhalation.

Further, an adult reference individual or average model used by governmental regulatory bodies does not work as the basis to adequately measure or assess environmental or public health protection.

KNOWLEDGE GAP: Disproportionate Impacts

Reference Man / Adult Reference Individual is used by regulators for compliance evaluations. It does not include consideration of other species. It doesn't include all humans or lifecycles. It doesn't recognize that females suffer more harm from exposure than males at ALL ages, particularly at younger ages (see chart below).

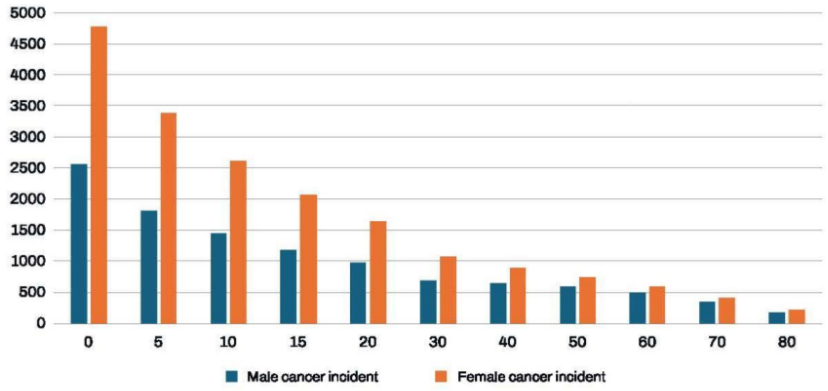
You are **EXCLUDED** if you:

- Work outdoors
- Have a kitchen garden or home milk or cheese production and consumption
- Home other than stick-built
- Use unregulated drinking / irrigation water supply including well or catchment rainwater
- Suffer from a radiation exposure outcome that is not cancer
- Does not factor full life-cycle including pregnancy, infants, children, elders
- Does not factor disproportionate harm to women and girls
- Does not factor socioeconomic factors outside the REFERENCE definition
- Does not include internal exposure from radioactive pollution in our air, food and water
- Does not consider additive or synergistic impacts
- Does not factor disease latencies correctly
- Does not correctly factor stochastic impacts which also evidence that there is no safe level of radiation exposure

A regulatory model must protect and preserve life—meaning all life.

FIGURE 2.

Cancer incidence by 100,000 by age at time of exposure



Based on Table 12D-1, NAS, 2006, Biological Effects of Ionizing Radiation (BEIR VII). This bar chart presents a hypothetical case of rate of cancer incidence by age at time of radiation exposure based on data presented in the LSS. Exposure rate (1 Gy) was consistent for each individual, which allows age of exposure and biological sex to be assessed as contributing factors in cancer incidence as a radiation outcome.

KNOWLEDGE GAP: Non cancer vs cancer

NRC tracks cancer as the only somatic outcome of radiation exposure, which includes blood cancers and solid tumors. However, peer-reviewed science also documents the following:

Selected Non-Cancer Somatic Outcomes (this generation)

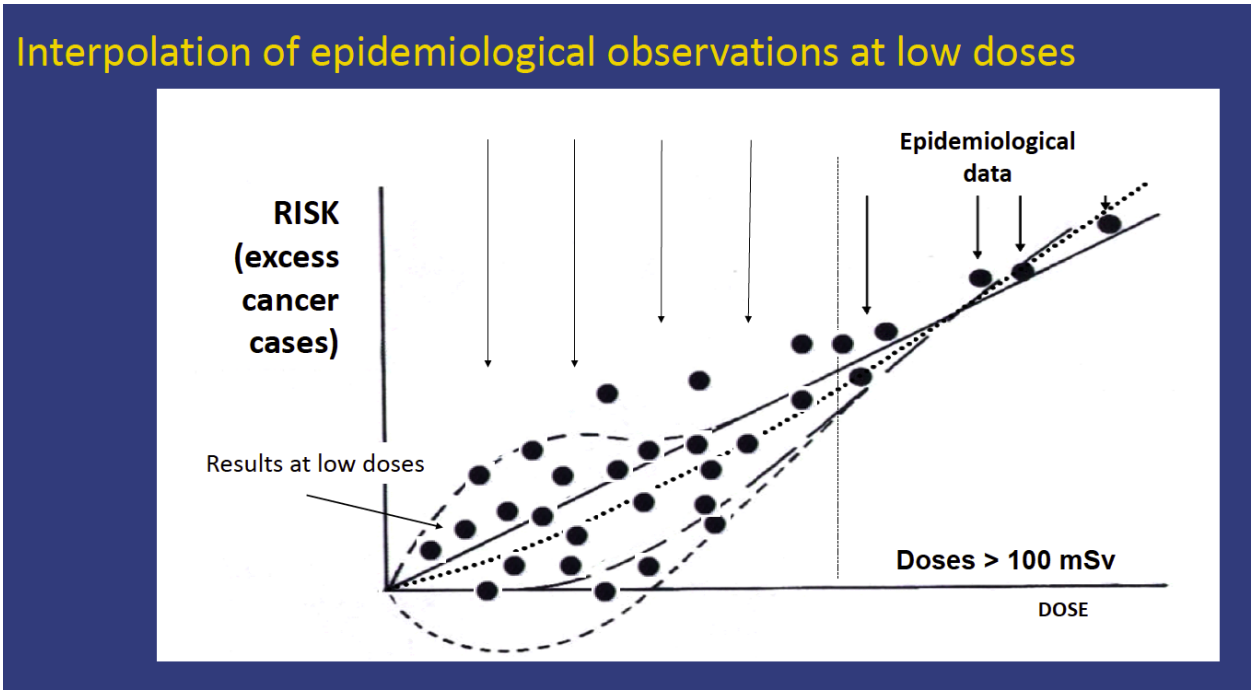
- Cardiovascular impact including: heart disease, heart attack, stroke,
- Chronic Fatigue Immune Dysfunction Syndrome (CFIDS)
- Disproportionate somatic harm to children compared to adults
- Disproportionate somatic harm to female bodies compared to male bodies

And these additional Generational Outcomes (past, present, and future generations)

- Infertility
- Deleterious Pregnancy impacts
    - Birth defects (MCM) Heritable and Non-Heritable

- Loss of pregnancy: early spontaneous abortions, miscarriage, still birth
- Infant Death
- Childhood cancers (leukemia and CNS) ~A post-birth defect
- Genomic impacts

These health outcomes reveal that radiation and radioactive pollution exposure impacts are multiple, cumulative, synergistic, and likely intergenerational. And the current model, on which U.S. regulations are based, is not protective enough according to current scientific evidence.



This graph is a representation of the contemporary state of scientific evidence regarding low dose radiation and cancer. It illustrates the increasing number of results of studies that provide direct estimates of radiation associated cancer risks in the low dose range. Many of these estimates are derived from national and international studies of radiation workers.

This graph shows that about half the time, the LNT underestimates cancer risk from low radiation exposures. This confirms that LNT is not overly

protective and clearly the data show there is not a threshold below which radiation exposure does not cause harm. More importantly for public health, this scientific evidence is primarily from exposure of adult male workers, and does not fully represent impacts on females, children or pregnancy. While LNT is useful, we need more models.

Taken together, the need for more research and analysis of radionuclides and our call to center regulation on those most harmed—pregnancy and young girls—are good reasons to reduce, and control our use of radionuclides, **and designate them now as a chemical of mutual concern, creating support for more research.**

List of References for this document are available at these links:

CMC presentation REFERENCES 07-14-2025.pdf

LNT graph evidence

Cindy Folkers
Since joining Beyond Nuclear in 2007, Cynthia Folkers has focused on ionizing radiation and its impact on health and the environment, from both a scientific and historical perspective. She advocates for fully protecting the health of females and early life stages in the face of uncertain health outcomes. She earned an M.S. in Environmental Science from The Johns Hopkins University.

Mary Olson
Mary Olson is the founder of the non-government organization Generational Radiation Impact Project. Olson holds a degree in Evolutionary Biology and has been an educator on radiation health impacts while serving nuclear-impacted communities. She has also been relied upon by State and US Federal government agencies for independent counsel on radioactive waste policy. She served from 1991 to 2019 as Staff Biologist and Senior Radioactive Waste Policy Analyst at the US-based Nuclear Information and Resource Service (NIRS), a non-government organization.