

Saskatchewan Environmental Quality Guidelines

Radium-226 in Surface Water

SASKATCHEWAN ENVIRONMENTAL QUALITY GUIDELINES

The *Saskatchewan Environmental Quality Guidelines* (SEQG) is a searchable database that prescribes concentrations of substances in the environment that are protective of the applicable pathway and land use (see: <https://envrbrportal.crm.saskatchewan.ca/seqg-search/>). This fact sheet provides information on the selection of the environmental quality guideline for radium-226 (^{226}Ra) in surface water of 0.11 Bq/L (total).

 ^{226}Ra

Radium (Ra) is the heaviest alkaline earth metal and is the only radioactive member. Ra is found in Saskatchewan in minor quantities in the uranium ore uraninite, other various uranium minerals, and in thorium minerals. For example, one ton of pitchblende typically yields about one seventh of a gram of radium. Ra occurs as the isotopes ^{223}Ra , ^{224}Ra , ^{226}Ra , and ^{228}Ra as part of the decay chains of natural thorium and uranium isotopes. The most stable isotope, ^{226}Ra (a decay product of natural uranium), has a half-life of approximately 1600 years. It decays into radon-222 (^{222}Rn) through alpha decay or into lead-212 (^{212}Pb) by ejecting a carbon-14 (^{14}C) nucleus.

HUMAN HEALTH RISK

Surface water sources typically have lower levels of natural radium, while deeper groundwater may at times have higher concentrations. However, industrial activities such as uranium mining may contribute to increased concentrations in drinking water and in the air. Radium concentrates in the tissues and bones, which may cause cancer of the lung, breast, thyroid, bone, digestive organs, skin, or leukemia (Health Canada, 2014). Additionally, the decay of radium into radon presents another

potential health risk from drinking water and air contamination.

PROTECTION OF AQUATIC LIFE

The federal *Metal Mining Effluent Regulations* (MMER), pursuant to the *Fisheries Act* provide a discharge limit for end-of pipe effluent of 0.37 Bq/L (Government of Canada, 2016), which is also adopted in Saskatchewan's *Mineral Industry Environmental Protection Regulations, 1996* (MIEPR). To put this value into context, the Health Canada (2014) maximum allowable concentration for drinking water is 0.5 Bq/L. However, drinking water standards are protective of human health and may not provide sufficient criteria for more sensitive aquatic receptors that require a higher degree of protection.

The SEQG value of 0.11 Bq/L is intended to be low enough to be de facto protective of susceptible aquatic life receptors. No further work or corrective action is required for concentrations of ^{226}Ra in surface water below 0.11 Bq/L. As such, additional justification will likely be required for endpoint values above 0.11 Bq/L.

ENVIRONMENTAL QUALITY GUIDELINE DERIVATION

The USEPA (2016) *Code of Federal Regulations, Title 40 – Protection of Environment*, identifies the effluent limitations representing the degree of effluent reduction attainable by the application of the best practicable control technology currently available (BPT).

The concentration of ^{226}Ra pollutant discharged in mine drainage from mines, either open-pit or underground, from which uranium, radium and vanadium ores are produced excluding mines using in-situ leach methods shall not exceed:

Effluent characteristic	Effluent limitations	
	Maximum for any 1 day	Average of daily values for 30 consecutive days
	pCi/L(Bq/L)	
Ra226 (dissolved)	10(0.37)	3(0.11)
Ra226 (total)	30(1.1)	10(0.37)

The USEPA suggests a dissolved effluent limitation of the average of daily values for 30 consecutive days for ²²⁶Ra of 3 pCi/L (0.11 Bq/L). Saskatchewan has therefore selected the environmental quality guideline for ²²⁶Ra in surface water of **0.11 Bq/L** based on the USEPA suggestion.

Deriving the guideline based on the Canadian and Saskatchewan ²²⁶Ra effluent discharge limits of 1.11 Bq/L (total) by applying a factor of 10, to account for influence of a mixing zone (supported by the Water Security Agency, Surface Water Quality Objectives (WSA 2015)), similarly supports the approach provided in the factsheet and the limit of 0.11 Bq/L.

DEFINITIONS

Bq: Becquerel is the International System of Units (SI) derived unit of radioactivity. One Bq is defined as the activity of a quantity of radioactive material in which one nucleus decays per second.
Therefore $1 \text{ Bq} = \text{s}^{-1}$.

Ci: Curie is a unit used to describe the activity of a radioactive substance, based on radium-226, $1 \text{ Ci} = 3.7 \times 10^{10}$ decays per second (3.7×10^{10} Bq) of the activity of ²²⁶Ra.

pCi: 1 picocurie = 1/1,000,000,000,000 (one trillionth = 10^{-12}) of a curie.
 $1 \text{ Bq} \cong 2.703 \times 10^{-11} \text{ Ci} \cong 27 \text{ pCi}$.

References

Government of Canada. 2016. *Metal Mining Effluent Regulations - SOR/2002-222*.

From: <http://laws-lois.justice.gc.ca/eng/regulations/sor-2002-222/FullText.html>

Government of Saskatchewan. 1996. *Mineral Industry Environmental Protection Regulations*.

From: <http://www.qp.gov.sk.ca/documents/English/Regulations/Regulations/E10-2R7.pdf>

Health Canada. 2014. *Guidelines for Canadian Drinking Water Quality Summary Table*. From:

http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/sum_guide-res_recom/index-eng.php#t3

Saskatchewan Water Authority (SWA). 2015. *Surface Water Quality Objectives, Interim Edition*. EPB 356. From:

<https://www.wsask.ca/Global/Water%20Info/Surface%20Water/epb%20356%20-%20surface%20water%20quality%20objectives%20interim%20edition%20june%202015.pdf>

United States Environmental Protection Agency (USEPA). 2016. *Code of Federal Regulations, Title 40 – Protection of Environment*. From:

<https://www.gpo.gov/fdsys/pkg/CFR-2015-title40-vol30/xml/CFR-2015-title40-vol30-part440.xml>

World Health Organization (WHO). 2017. *Guidelines for Drinking-water quality: Chapter 9, Radiological Aspects, Fourth edition, Incorporating the First Addendum*. From: <http://apps.who.int/iris/bitstream/10665/254637/1/9789241549950-eng.pdf>

More info?

Contact the Saskatchewan
Ministry of Environment
Client Service Office at
Tel: 1-800-567-4224

(toll-free in North America)
or 306-787-2584.

Email: centre.inquiry@gov.sk.ca