



TRITIUM

A TOOL IN EVALUATING GROUND WATER SYSTEMS

The tritium concentration in ground water provides a useful tool for determining the degree of confinement of an aquifer and is identified by the U.S. EPA as an acceptable means of assessing the vulnerability of ground water systems to contamination. Tritium can be used to trace and date ground water, calculate rates of water circulation in the hydrologic cycle, and assess how long a specific ground water source has been stored out of contact with tritium laden recharge. More importantly, the absence of tritium is a strong indicator that a well or aquifer system is not susceptible to contamination and possesses a "very low" geologic sensitivity.

Background Information

Tritium is a naturally occurring radioactive isotope of hydrogen, which decays as a beta emitter. It is produced in small quantities in the upper atmosphere where it is incorporated into water molecules and present in rainwater and surface recharge to aquifer systems. In comparison to many other atmospheric radioactive isotopes, tritium is extremely rare and not affected by chemical processes. The naturally occurring tritium level in recharge waters is 5 to 10 tritium units (TU). Tritium has a radioactive decay half-life of 12.3 years and possesses an equivalent gross beta radiation of 3.2 picocuries/liter.

The amount of tritium in the atmosphere was greatly increased as a result of above ground nuclear weapons testing in the 1950s. Nuclear weapons testing resulted in atmospheric levels in excess of 1000 TU with recharge waters "tagged" with excess tritium beginning in about 1954. Modern day values have declined to levels between 50 and 100 TU with the decline attributed to the elimination of atmospheric nuclear weapons testing and radioactive decay.

Relationship to Ground Water System Evaluation

Recharge water entering the ground water system prior to the 1950's would have had a tritium level indicative of the naturally occurring atmospheric concentration of 5 to 10 TU. Table 1 presents a scenario for the radioactive decay of pre-bomb recharge water that entered the ground water system in or before 1950 with a tritium concentration of 10 TU.

Table 1: Radioactive Decay – Pre-Bomb Recharge Water

Year	Recharge 1950	1962	1974	1986	1998	Present Day 2010
Concentration (TU)	10	5	2.5	1.25	0.675	0.3375

By present day the concentration of tritium would be decreased by radioactive decay to levels significantly below one TU. Such a ground water system, and any wells completed within the system, would be considered "not vulnerable."

Recharge water entering the ground water system after the early 1950's contained tritium levels significantly above the natural "pre-bomb" background concentrations. Table 2 presents a radioactive decay scenario with post-bomb recharge water entering the ground water system with a tritium concentration of 100 TU.

Table 2: Radioactive Decay – Post Bomb Recharge Water

Year	Recharge 1955	1967	1981	1993	2005	Present Day 2010
Concentration (TU)	100	50	25	12.5	6.25	~4.0

Present day tritium levels would be in the range of 4 TU and the aquifer system from which the



sample was taken and any wells completed within the system would be considered susceptible to contamination and possess a “moderate” or “high” geologic sensitivity.

In summary, tritium sampling is a useful and inexpensive way of assessing the susceptibility of an aquifer system or well to contamination. Tritium levels at or below one tritium unit (TU) are indicative of a well or aquifer system that may be considered not susceptible to contamination.

Tritium Samples and Analysis

Sampling for tritium is not difficult as few, if any chemical processes will alter its concentration. However, tritium is naturally occurring and it must be assumed that excessive exposure of the sample to the atmosphere might alter the tritium concentration. More importantly, for the acquisition of meaningful data, the required sensitivity in the analysis is very low (<one TU).

Tritium concentrations for ground water system evaluation are measured by the liquid scintillation method on concentrated samples after "sample enrichment." While many labs are equipped to measure tritium levels by the liquid scintillation method, few are equipped to conduct the sample enrichment and obtain the necessary one TU or better detection limit. The sample enrichment process takes about four weeks so expect a minimum six-week turn around time between sampling and obtaining results.

Though the DEQ does not endorse any particular laboratory, below is a list of laboratories that provide tritium analysis at the required level of detection. Contact the laboratory to confirm sample collection methodology and cost before sampling.

Environmental Isotope Laboratory University of Waterloo

200 University Avenue West
Waterloo, Ontario
N2L-3G1
Phone: (519)888-4567
Fax: (519)746-7484
Email: eilab@uwaterloo.ca
Cost: \$185.00

Isotope Geochemistry Laboratory Illinois State Geological Survey

Prairie Research Institute
University of Illinois, Urbana-Champaign
615 E. Peabody
Champaign, IL 61820
Phone: (217)244-2414
Email: hackley@isgs.illinois.edu
Cost: \$300.00

Environmental Isotope Laboratory Department of Geosciences

1040 E. Fourth Street, Room 208
University of Arizona
Tucson, AZ 85721-0077
Phone: (520)621-1638
Email: webmaster@geo.arizona.edu
Cost: \$190.00

Tritium Laboratory University of Miami

4600 Rickenbacker Causeway
Miami, Florida 33149-1098
Phone: (305)421-4000
Fax: (305)421-4112
Email: tritium@rsmas.miami.edu
Cost: \$325.00

Isotech Laboratories, Inc.

1308 Parkland Court
Champaign, Illinois 61821
Phone: (877)362-4190
Fax: (217)398-3493
Email: dixon@isotechlabs.com
Cost: \$400.00

If you have any question with regards to sampling for tritium please contact Brant Fisher, Environmental Engineer Specialist at 517-241-1415 or Wayne Kukuk, Environmental Quality Analyst at 517-241-1434.