SOUTHWEST RESEARCH INSTITUTE

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Radioactive Impacts on Water Resources

Q: Why would there be radioactive particles in my water?

A: Radioactive particles, known as radionuclides, can occur in water. In high enough concentrations, these radionuclides can pose risks to human health. Thus, it's important to thoroughly evaluate the radiological content of water to determine any potential impacts on the communities that use the water as a resource.

Radionuclides can be naturally occurring or artificially introduced. Traces of radioactivity are typically found in all drinking water, with the types and concentrations of the radionuclides varying based on natural characteristics such as the type of rock that groundwater occurs in, or soils to which surface water is exposed. Naturally occurring radioactive materials (NORM) that found in water supplies include potassium-40 (40K), uranium-234 (234U), uranium-238 (238U), radium-226 (226Ra), radium-228 (228Ra), lead-210 (210Pb), and radon-222 (222Rn), among others. These radionuclides can enter water supplies via absorption from the soil or rock formations, or from human activities involving naturally occurring radionuclides.

Anthropogenic or human-made radionuclides can enter water supplies from a variety of sources, including nuclear fuel-cycle facilities, medical facilities and radiopharmaceuticals, and facilities using radioactive substances for industrial applications. Human activities such as mining, oil and gas production, coal power production, and fertilizer production can also concentrate NORM into Technologically Enhanced NORM, or TENORM.

To protect human health, regulatory bodies such as the U.S. Environmental Protection Agency have established rules and standards regarding permissible concentrations of radionuclides in public drinking water.

Q: How does one determine the extent of radiological contamination in a drinking water supply? How does one determine the impact of that radiological contamination?

A: Determining the radiological composition of a water supply involves multiple steps, while characterizing impact may require additional steps.

Water Sampling

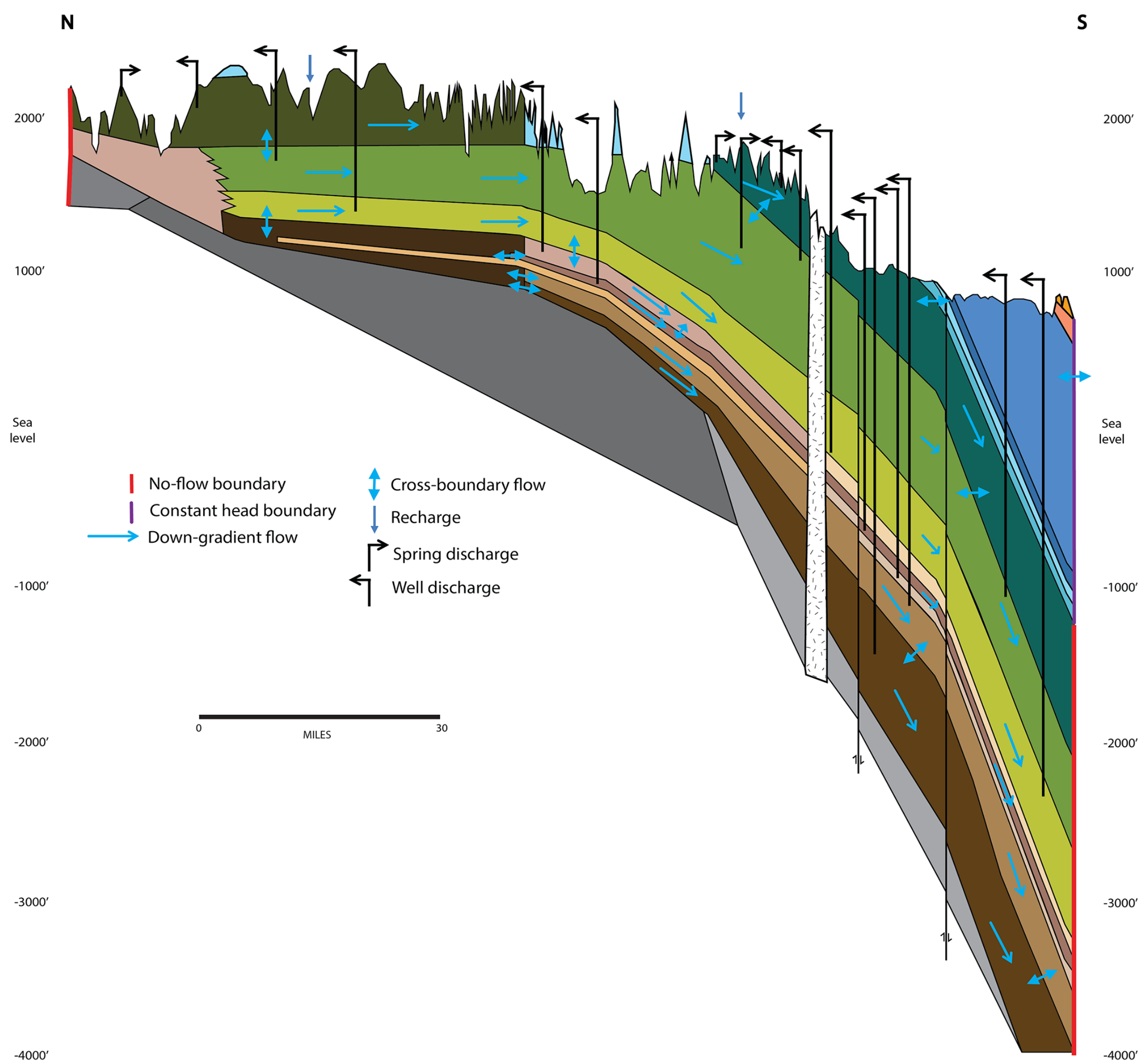
The first step in determining the radiological impact on a water supply is to characterize what substances are present in the surface water, groundwater, or both, depending on the hydrologic system being studied. A sampling plan is developed to determine representative sampling locations, depths, and quantities. Depending on the project need, water samples may be collected once, periodically over time, or even timed with weather events, such as before and after rainfall.

Water Testing

After collecting water from the subject water supply, the samples are preserved and sent to Southwest Research Institute laboratories for testing. Screening for gross alpha and gross beta particles is the first analysis performed. If elevated levels of radionuclides are detected, additional testing can be done to determine which specific radioactive isotopes are present in the water sample. Additional analyses can be run to provide details about other contaminants, such as metals, organic compounds, or various toxins. Together, the results of these tests can help determine where contaminants might have originated.

Development of Conceptual, Analytical, and Numerical Models

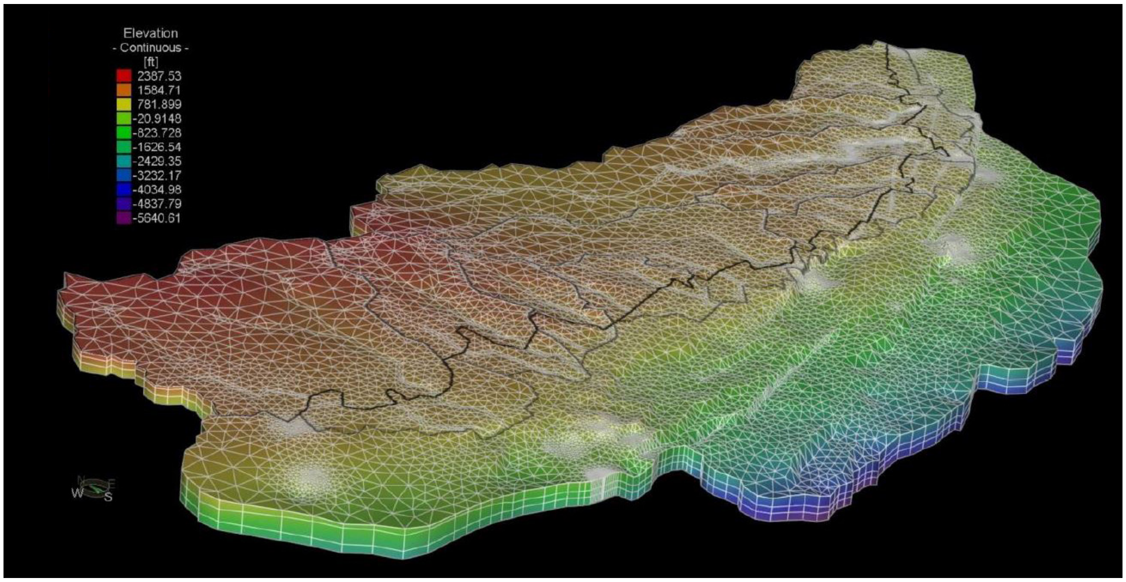
Upon determining the types of radiological constituents or other contaminants in the water supply, it may be beneficial to develop conceptual, analytical, and numerical models to simulate the impact of the radionuclies on the hydrologic system. The first step toward this goal is to develop a conceptual model to serve as the foundation of analysis in a computer or numerical model. A conceptual model is the representation of the hydrological and hydrogeological units in a hydrologic system. This includes determining the hydraulic parameters or characteristics of the system and each of its units, as well as the positions of its water levels. Once the system is sufficiently characterized such that a conceptual model can be developed, the objectives of the evaluation are used to determine whether analytical or numerical model development would be beneficial to achieving the goals of the study.



This figure represents the hydrologic dynamics in a given system, with recharge, cross-boundary flow, and discharge regimes specified with respect to geologic formations.

Development of a Numerical Model

Along with the development of the conceptual model, the development of a numerical model can be highly beneficial. A numerical model is a computer model that can be used to simulate and predict conditions of surface water bodies or aquifers. Numerical models can highlight chemical or physical processes that were not considered previously or they may help identify areas where additional data would be highly beneficial to improve understanding of the entire system. Numerical models can include surface-water models, groundwater models, and coupled surface-water/groundwater models, each of which helps characterize complex hydrologic systems as a whole. Along with modeling the flow dynamics of a system, numerical models can incorporate solute transport, or the movement of particles dissolved in or carried by the water. This information assists in characterizing how contaminants (including radionuclides) might be transported throughout the hydrologic system.



An example of a numerical model for an aquifer system

Q: Now that we have all of this information, what's next?

A: Using the information about the contents of the water as well as a comprehensive understanding of the hydrologic system, experts in environmental analyses can assist in determining where any contaminants may have originated or where they may be transported.

If the source of contaminants can be identified, actions can be taken to reduce or stop the contamination, or mitigate (reduce the severity) of impacts. In addition, a regulatory analysis can be conducted, where the results from the water sampling are compared against applicable federal, state, or local standards and laws.

Q: How can SwRI help?

A: SwRI has well-qualified geologists, hydrologists, chemists, and environmental scientists and engineers to assist with these evaluations from start to finish.

Our certified laboratories are well-equipped to provide high-quality, high fidelity chemical and radiological assays, and our water experts provide in-depth analyses of water resources. We even have extensive expertise in environmental characterization and regulatory analysis to assist with understanding contaminant sources and compliance with regulations. Most importantly, we're independent and unbiased, so you can be sure that the results are trustworthy and defensible.

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