Potential Impacts on Drinking Water and Wastewater Systems from Radiological Dispersal Events

Argonne's Environmental Science Division (EVS) conducted a preliminary scoping study that addresses the potential impacts on drinking water and wastewater resources that could result from a radiological dispersal event. The study was conducted for the U.S. Environmental Protection Agency's (EPA's) National Homeland Security Research Center to support its water security program.

PROBLEM/OPPORTUNITY

A radiological dispersal event (RDE) could result in the dispersal of radioactive material over a considerable area. In a malevolent attack, radioactive material could be dispersed mechanically, such as by an explosion or sprayer. As the plume moved downwind, radioactive material would settle out, contaminating the ground, building surfaces, vehicles, and other property. This contamination could directly and indirectly impact drinking water and wastewater treatment systems. Understanding the potential impacts to water systems is vital for developing response plans and for determining effective decontamination approaches.

Drinking water supply systems could become contaminated by an RDE in three general ways: (1) radioactive material could be deposited directly on a drinking water source (e.g., river or lake); (2) radioactive material could be washed off of contaminated surfaces by precipitation or post-event decontamination and run off into a system water source; and (3) radioactive material could be discharged into a drinking water source from a wastewater or storm water treatment system upstream.

Wastewater treatment systems could become contaminated from radioactive material being washed off of contaminated ground by precipitation or decontamination procedures. In an urban area, it is likely that a large percentage of the surface area would be impermeable, resulting in a considerable fraction of water running off into storm water collection systems. In combined sewer systems, storm water and sanitary wastes are collected and conveyed in the same pipe to a treatment plant. Contaminated runoff could also infiltrate sanitary sewer systems and be transported to a wastewater treatment plant.

APPROACH

The EVS study addresses four major topics: (1) estimated secondary effects on drinking water and wastewater treatment systems from a range of hypothetical urban RDEs; (2) potential impacts of decontamination activities on drinking water and wastewater systems following an RDE; (3) a survey of water treatment technologies and their application to an RDE; and (4) a survey of site remediation and restoration technologies and their implications with regard to water systems. Secondary impacts are

those that occur under circumstances in which the systems of interest are not the intended target of the attack. The study focuses on eight radionuclides of interest: americium-241, californium-252, cesium-137, cobalt-60, iridlum-192, plutonium-238, radium-226, and strontium-90.

Because of the large uncertainties associated with RDE scenarios, water treatment systems, physical and chemical characteristics of potential radioactive contaminants, and environmental conditions, the analysis conducted in the report is necessarily at a screening level. Given the large uncertainties involved, bounding analyses were conducted with the intent to shed light on the potential magnitude and scale of impacts from which vulnerabilities of water systems could be better understood and future strategies developed. As such, assessment assumptions were generally chosen in a manner designed to result in the maximum predicted impacts, although potential ranges are also discussed and compared. By evaluating the significance of these impact calculations, potential issues and areas of impact are identified in the report for which further research, development, and a more detailed and refined analysis are recommended.

For screening purposes, the amount of radioactive material entering the plants was generally assumed to span six orders of magnitude, ranging from 37 MBq (0.001 Ci) up to37 TBq (1,000 Ci). For each radionuclide of interest, potential activity concentrations in drinking water reservoirs, treatment plant sludges, and treated waters were estimated as a function of the amount of activity entering the treatment plant and the efficiency of the treatment train. Furthermore, potential radiation doses to treatment plant workers who process contaminated sludge were also estimated based on dose factors developed by the Interagency Steering Committee on Radiation Standards (NUREG-1783, Feb. 2005) regarding sewage sludge.

RESULTS

The results presented in this study indicate that the potential impacts to drinking water and wastewater treatment plants from an RDE could range from levels below concern to quite significant levels, depending on the size of the radiation source and mechanisms of migration and transport in the environment. If a large source was used and the contamination was very mobile, significant impacts could occur. Of particular concern would be impacts related to the handling and management of treatment plant sludge, because contamination could be concentrated within sludge.

FUTURE

Based on the results of this preliminary scoping study, it is recommended that a more thorough systems study be conducted, including consideration of contaminant fate and transport in urban and water system environments and alternative approaches for impact mitigation. The further studies should include case studies for specific metropolitan areas and specific RDD event scenarios that provide the basis for reference information on RDD events and potential impacts on water systems tailored to drinking water and wastewater utilities. Feasibility studies and cost-benefit analyses are needed to define options for development and deployment of drinking water and wastewater facility radiation detection systems and mobile treatment systems.

The regulatory basis and national policy for managing radioactive waste generated as a result of a malevolent act, such as an RDE, remains to be fully developed.

COMMUNICATION OF RESULTS

Argonne's work for the EPA National Homeland Security Research Center resulted in the following recent publication:

F.A. Monette, et al., "*Preliminary Scoping and Assessment Study of the Potential Impacts from Communitywide Radiological Events and Subsequent Decontamination Activities on Drinking Water and Wastewater Systems*" EPA/600/R-07/037 (for official use only), (April 2007).

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