LOW CONCENTRATIONS OF ORGANIC CONTAMINANTS IN THE HYDROLOGIC SYSTEM

Recent improvements in laboratory analytical methods and detection have enabled results that were not possible a decade ago. Low levels of organic contaminants are present in surface and groundwater throughout the nation. Chloroform and N-Nitrosodimethylamine (NDMA), associated with water treatment plant disinfection is commonly found in surface and groundwater samples near broken pipes carrying chlorinated water or chlorinated wastewater effluent.

In 1999 and 2000, the U.S. Geological Survey collected surface water samples from 139 streams in 30 states across the lower 48 United States. The streams tended to be downstream of intense urban or livestock areas, and consequently were suspected of contamination. The surface water samples were chemically analyzed for organic wastewater contaminants (OWCs). The results of the surface water sample evaluation were published this year Environmental Science & Technology (Kolpin, D.W., et al., 2002), and are summarized below.

The USGS found that 80 percent of the streams sampled generally contained low concentrations of OWCs in the (<1.0 µg/L) range, impacted primarily by residential, industrial and agricultural products. Seven chemical groups (steroids, nonprescription drugs, insect repellent, detergent metabolites, disinfectants, plasticizers, and fire retardants) were found in over 60% of the stream samples, and three groups (detergent metabolites, steroids and plasticizers) contributed to almost 80% of the total measured concentration. More than one third (33 of 95 target OWCs) of the chemicals detected are known or are suspected to exhibit at least weak hormonal activity with the potential to disrupt normal endocrine function.

One source of the chemicals identified appears to be related to products and materials typically used in farming and industrial activities. Additionally, a significant contribution was from residential use, drugs typically found in the medicine cabinet, and disposed of as is or as processed human waste in toilets and sinks. Some commonly detected constituents include: caffeine in 70.6% of the samples with a maximum concentration of 5.7 µg/L; insect repellant N,N-diethyltoluamide in 74.1% of the samples with a maximum concentration of 1.1 µg/L; plant/animal steroid cholesterol in 84.3% of the samples with a maximum concentration of 60 µg/L; and fecal steroid coprostanol in 85.7% of the samples with a maximum concentration of 150 µg/L. This landmark USGS study reveals that the chemicals used in modern life survive human processing, the current wastewater treatment plant processing, as well as biodegradation in the natural environment, and end up as contaminants in our water supplies.

These contaminants have been documented in surface waters throughout the nation. Considering the interconnection of surface water and groundwater, these contaminants are also likely occurring in our shallow groundwater resources. The five laboratory methods utilized for evaluating the chemicals in the USGS study are not capable of identifying all chemicals or their breakdown products due to analytical limitations.

Although these common chemicals are being detected in very low or trace amounts, the possible cumulative or synergistic effects of these chemicals on plants, animals and humans deserves further evaluation. The potential adverse health effects of these chemicals at such low concentrations are uncertain and difficult to assess. However, the chemical combinations should be considered to see if they disrupt human reproductive cycles, act as carcinogens, allow for microbial increases in resistance to antibiotics, or allow for an increase in mental or physical disabilities of newborns. And if warranted, after a thorough regulatory review, guidelines could be established for unregulated chemicals or combinations of chemicals at low concentrations that may be hazardous to the environment or humans.

If treatment or remediation is deemed appropriate, advanced oxidation, enhanced bioremediation or improved water polishing/filtering could be added to existing wastewater treatment plants to reduce contaminants of these types from entering into the environment. More limited, pretreatment for septic systems could also help to reduce these chemicals in the environment. Passive treatments for OWCs derived from agricultural, industrial and commercial properties would reduce some contaminants. For individual water users, small point-of-use treatment systems could be utilized to remove trace amounts of contaminants.

Additional toxicological studies of chronic low-level contaminant exposure to the food chain and to humans are recommended for consideration. A California "Blue Ribbon" panel of experts could assess the results, evaluate the risk potential, and make recommendations to agencies, legislators and the governor including potential additional studies, monitoring, and risk related issues. Additional testing and monitoring of surface waters and groundwater should be considered in California and the nation to protect our valuable groundwater resources. Additionally, low level analysis of reclaimed and treated water for OWCs should be considered for permitting discharge to water or land.

Reference:

Kolpin, D.W., et al., 2002, Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999-2000: A National Reconnaissance, USGS, Environmental Science & Technology; Vol. 36, No. 6, p. 1202-1211.

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