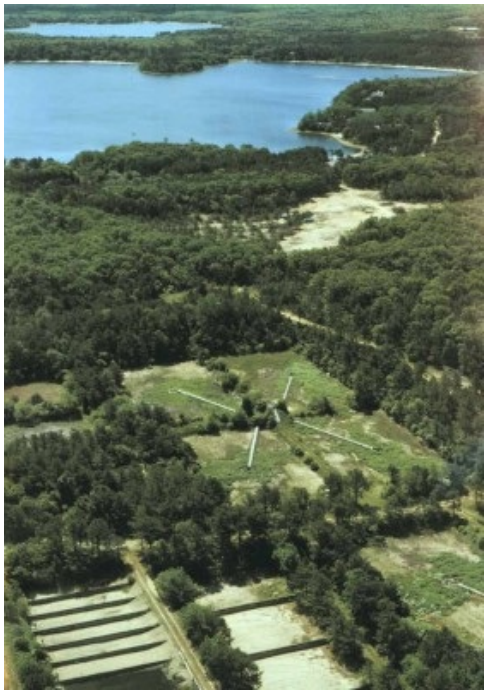
Sewage-Contaminated Groundwater—Cape Cod, Massachusetts



Treated wastewater disposal beds on Cape Cod, Massachusetts, which created a large subsurface plume of contaminated groundwater. A team of scientists has been conducting long-term multidisciplinary research on the physical, chemical, and biological processes that control the transport of contaminants in groundwater.

Shallow unconsolidated coastal aquifers are critical sources of drinking water to millions of people in the United States and provide environmentally important freshwater flows to rivers, lakes, and coastal waters. These aquifers are also vulnerable to contamination from point and non-point sources including wastewater disposal through wastewater infiltration beds and septic systems.

This investigation is focused on wastewater-derived contaminants in shallow unconsolidated aquifers that serve as drinking-water supplies and are a source of water for freshwater to lakes, rivers, wetlands, and coastal ecosystems. Understanding the transformations and transport of the complex mixtures introduced to groundwater is essential to understanding the real versus perceived risks for humans and other organisms.

Much of the foundational understanding of interrelationships between the hydrologic and biogeochemical systems was done at the Cape Cod field research site. This foundation includes:

- An extensive network of groundwater and surface-water monitoring sites;
- Access to research facilities courtesy of the U.S. Military;
- A large historical database of hydrologic, chemical, and biological data; and
- Ongoing and proposed collaboration with agencies and universities.

U.S. Geological Survey (USGS) scientists conducted a unique study which demonstrated that the ecology of natural groundwater bacteria changed after exposure of the bacteria to the antibiotic sulfamethoxazole (SMX). The study was conducted within the zone of the historic wastewater-contamination plume at the Cape Cod Toxic Substances Hydrology Research Site, Massachusetts. SMX and bromide (contained in the plastic drums on the far right) were repeatedly injected into the row wells (in the center of the photo) for 30 days. The SMX traveled through the subsurface to the observation wells on the far left. Photo credit: Denis LeBlanc, USGS.

The investigation provides the science needed to understand how to economically and effectively minimize the health risk due to exposures of anthropogenic chemical contaminants from wastewater plumes and spills that have persisted for decades in the subsurface. The investigation does research that integrates physical chemical and biological processes that occur along the groundwater-flow pathway from waste sources to environments where exposures can occur.

News

Poly- and Perfluoroalkyl Substances From Firefighting and Domestic Wastewater Remain in Groundwater for Decades

New study explores the persistence and transport of poly- and perfluoroalkyl substances (PFASs) that originated from both firefighting and domestic wastewater sources. Although the fire training area and wastewater facility were decommissioned over 20 years ago, both sites continue to be sources of PFASs to groundwater. ...

Nitrate Addition Enhances Arsenic Immobilization in Groundwater

The addition of nitrate in a low oxygen groundwater resulted in the immobilization of naturally occurring dissolved arsenic and the conversion of nitrate to innocuous nitrogen gas. ...

DOI Distinguished Service Award Given to Two Program Scientists

Two USGS Toxic Substances Hydrology Program (TSHP) scientists, Denis R. LeBlanc and Dr. Michael T. Meyer, received the Department of Interior's (DOI) highest honor—the Distinguished Service Award. ...

MORE SCIENCE FEATURES

USGS scientists collecting water-quality samples from shallow groundwater under Ashumet Pond, Cape Cod, Massachusetts. USGS scientists determined that the colmation layer (top 25 centimeters of lake sediments) was highly effective in removing cyanobacteria, viruses, and dissolved organic carbon during water passage through the lake bottom to aquifer sediments. Photo Credit: Denis R. LeBlanc, USGS

Publications

Bibliography

Access to publications from this investigation.

New Publications

- Heat as a groundwater tracer in shallow and deep heterogeneous Media--Analytical solution, spreadsheet Tool, and field applications: Kurylyk, B.L., Irvine, D.J., Carey, S.K., Briggs, M.A., Werkema, D.D., and Bonham, M., 2017, Hydrological Processes, doi:10.1002/hyp.11216 (Advanced Web release).
- Geochemical and hydrologic factors controlling subsurface transport of poly- and perfluoroalkyl substances, Cape Cod, Massachusetts: Weber, A.K., Barber, L.B., LeBlanc, D.R., Sunderland, E.M., and Vecitis, C.D., 2017, Environmental Science and Technology, doi:10.1021/acs.est.6b05573.
- Anoxic nitrate reduction coupled with iron oxidation and attenuation of dissolved arsenic and phosphate in a sand and gravel aquifer: Smith, R.L., Kent, D.B., Repert, D.A., and Böhlke, J.K., 2017, Geochimica et Cosmochimica Acta, v. 196, p. 102-120, doi:10.1016/j.gca.2016.09.025.

Multimedia

Photo Gallery

A collection of photos illustrating this investigation's activities.

More Information

More Information on this Investigation

The Cape Cod research team maintains its own home page that contains additional information about the Cape Cod Toxics Site.

Connect

- For additional information please contact Denis R. LeBlanc, USGS New England Water Science Center

Back to Toxic Substances Hydrology Program Investigations Index