

USGS Investigations involving pharmaceuticals and other anthropogenic organic compounds in New England water resources

1. **National stream reconnaissance (1999-2000)**--First nationwide reconnaissance of the occurrence of pharmaceuticals, hormones, and other organic wastewater contaminants (OWCs) in U.S. streams. USGS National team measured concentrations of 95 OWCs in water samples from a network of 139 streams across 30 states (including Massachusetts) during 1999 and 2000. Selection of sampling sites was biased toward streams susceptible to contamination (i.e. downstream of intense urbanization and livestock production). OWCs were found in 80% of the streams sampled.

Published report:

Kolpin, D.A., Furlong, E.T., Meyer, M.T., Thurman, E.M., Zaugg, S.D., Barber, L.B., and Buxton H.T., 2002, Pharmaceuticals, hormones, and other wastewater organic contaminants in U.S. streams 1999–2000—a National reconnaissance, *Environmental Science and Technology*, v. 36, no. 6, p. 1202-1211.
<http://pubs.acs.org/cgi-bin/article.cgi/esthag/2002/36/i06/pdf/es011055j.pdf>

Locations of New England sampling sites and raw data are presented in:

Barnes, K.K., Kolpin, D.W., Meyer, M.T., Thurman, E.M., Furlong, E.T., Zaugg, S.D., and Barber, L.B., 2002, Water-quality data for pharmaceuticals, hormones, and other organic wastewater contaminants in U.S. streams, 1999-2000: U.S. Geological Survey Open-File Report 02-94.
<http://toxics.usgs.gov/pubs/OFR-02-94/>

Massachusetts sampling sites:

Station ID	USGS ID	Station name	Latitude	Longitude
MA01	01100000	Merrimack River below the Concord River, MA	42°38'45"	71°17'56"
MA02	01104615	Charles River above Watertown Dam, MA	42°21'54"	71°11'26"
MA03	01104640	Laundry Brook at Watertown, MA	42°21'53"	71°11'25"
MA04	01104660	Faneuil Brook at Brighton, MA	42°21'22"	71°09'20"
MA05	01104683	Muddy River at Brookline, MA	42°20'14"	71°06'42"
MA06	01104687	Stony Brook at Boston, MA	42°19'05"	71°06'10"
MA07	01104710	Charles River at Boston Science Museum, MA	42°21'57"	71°04'14"

2. **National ground-water reconnaissance (2000 and 2001)**--A USGS national reconnaissance (2000) of OWCs in ground water sampled 47 sites suspected to be susceptible to contamination from either animal or human wastewaters. A second

study (2001) sampled 25 ground-water sources of public drinking-water supply (one each on the Blackstone and Assabet Rivers in Massachusetts and one in New Hampshire). Four analytical methods were used to determine the environmental extent of 134 OWCs in the 72 ground-water samples. The analyzed compounds included antibiotics, prescription drugs, nonprescription drugs, steroids, personal-care products, products of oil use and combustion, and other extensively used chemicals. At least one OWC was found in 93 percent of the sites sampled (67 of 72). The five most frequently detected compounds were cholesterol (a plant and animal steroid), bisphenol A (used in manufacturing of polycarbonate resins, antioxidant, flame retardant), estriol (reproductive hormone), N,N-diethyltoluamide (DEET, used in insect repellent), and 4-nonylphenol monoethoxylate (a nonionic detergent metabolite).

Published report:

Barnes, K.K., Kolpin, D.W., Furlong, E.T., Zaugg, S.D., Meyer, M.T., Barber, L.B., and Focazio, M.J., 2005, Studies examine contaminants—Pharmaceuticals, hormones, and other organic wastewater contaminants in ground-water resources: National Driller Magazine, v. 26, no. 3, p. 38-39.

http://toxics.usgs.gov/pubs/contaminant_studies_article.pdf

3. **Cape Cod ground-water reconnaissance (June 2004)**--USGS Massachusetts-Rhode Island Water Science Center (WSC) sampled water from 14 wastewater sources and drinking-water supplies on Cape Cod, Massachusetts, for the presence of organic wastewater contaminants, pharmaceuticals, and personal care products. Of the 85 different organic analytes measured, 43 were detected, with 13 detected in low concentrations (less than 1 microgram per liter) from drinking-water supplies thought to be affected by wastewater. Compounds detected in the drinking-water supplies included the solvent, tetrachloroethylene; the analgesic, acetaminophen; the antibiotic, sulfamethoxazole; and the anticonvulsive, carbamazepine. Nitrate-nitrogen, an indicator of wastewater, was detected in the water supplies at concentrations ranging from 0.2 to 8.8 milligrams per liter.

Published data report:

Zimmerman, M.J., 2005, Occurrence of Organic Wastewater Contaminants, Pharmaceuticals, and Personal Care Products in Selected Water Supplies, Cape Cod, Massachusetts, June 2004: U.S. Geological Survey Open-File Report 2005-1206, 16 p.

<http://pubs.usgs.gov/of/2005/1206/>

4. **Massachusetts Alternative Septic System Test Center study (2006)**--USGS MA-RI WSC examined the effectiveness of selected on-site wastewater treatment systems (located at the Massachusetts Alternative Septic System Test Center in Sandwich, MA) at removing organic wastewater contaminants, pharmaceuticals, and personal-care products from wastewater.

Presentation:

Zimmerman, M.J., 2007, Effectiveness of selected on-site wastewater treatment systems in removing pharmaceutical and personal care products: NEIWPCC 2007 Northeast Water Science Forum--Pharmaceuticals and Personal Care Products: State of the Science, August 8-9, 2007, Portland, ME.

<http://www.neiwpcc.org/ppcpconference/ppcp-docs/MarcZimmerman.pdf>

Published report: In preparation; data available on request from USGS MA-RI WSC (contact: Marc Zimmerman).

5. **Lower Charles River Basin study (2005-2006)**--Water samples were collected during dry weather in June 2005, and in April and July 2006, from 13 tributary sites and 2 storm drains that discharge to the lower Charles River. Samples also were collected from one tributary site during storms in May and June 2006. The samples were analyzed for fecal-indicator bacteria, human-specific genetic markers in *Enterococcus faecium* and in fecal *Bacteroidetes*, 5 fluorescent whitening agents (FWAs), and 16 PPCPs. Although fecal-indicator bacteria were present in 100% of the wet-weather samples and more than 93% of the dry-weather samples, the more frequently detected human-specific genetic marker (in *Bacteroidetes*) was detected in only 52% of the dry-weather samples and 64% of the wet-weather samples. Caffeine, acetaminophen, 1,7-dimethylxanthine, cotinine, and two FWAs were detected in more than 50% of both dry-weather and wet-weather samples. Other PPCPs and FWAs either were not detected (above the minimum reporting level) or were present in only a few samples.

Lower Charles River Basin sampling sites:

City	USGS ID	Station name	Latitude	Longitude
Brookline	01104682	Muddy River below Jamaica Pond	42°19'22"	71°07'15"
Brookline	01104683	Muddy River at Brookline	42°20'14"	71°06'42"
Watertown	01104664	Sawins Brook	42°19'37"	71°06'56"
Newton	01104646	Hyde Brook	42°21'49"	71°09'21"
Cambridge	01104640	Laundry Brook	42°21'37"	71°10'59"
Waltham	011045021	Beaver Brook at east culvert	42°22'20"	71°13'42"
Waltham	01104502	Beaver Brook at west culvert	42°22'20"	71°13'43"
Cambridge	01104500	Charles River at Waltham	42°22'20"	71°14'03"
Cambridge	01104681	Charles River at BU Bridge	--	--

Presentation:

Waldron, M.C., R. J. Tang, J. R. Sorenson, T. Bagshaw, T. Burdin-Davis, M. Tummalapalli, M. Bebirian, and O. C. Pancorbo, 2007, Pharmaceuticals and personal care products as indicators of human sewage in urban streams: 2007 Northeast Water Science Forum--Pharmaceuticals and Personal Care Products: State of the Science, August 8-9, 2007, Portland, Maine.

<http://www.neiwpcc.org/ppcpconference/ppcp-docs/MarcusWaldron.pdf>

Published report: In preparation; data available on request from USGS MA-RI WSC (contact: Chris Waldron).

6. **Connecticut River Basin Source Water Quality Assessment (2004-2005)**--USGS Connecticut WSC measured 260 anthropogenic organic compounds in raw and finished water from Running Gutter Creek, a tributary of the Connecticut River, drinking-water source for the town of Hatfield, MA. Analytes included 120 pesticides and pesticide degradates, 91 volatile organic compounds (VOCs) , and 49 other anthropogenic organic compounds (antioxidants, flavorings, flame retardants, non-prescription drugs, and steroids). Samples of raw and finished water were collected monthly for one year.

Published report: In preparation; data available on request from USGS CT WSC (contact: Virginia de Lima).

7. **Merrimack River Basin Source Water Quality Assessment (2008-2010)**--USGS MA-RI WSC is currently measuring 260 anthropogenic organic compounds in raw and finished water for a major water supplier on the Merrimack River in Massachusetts. Analytes include 120 pesticides and pesticide degradates, 91 VOCs, and 49 other anthropogenic organic compounds (antioxidants, flavorings, flame retardants, non-prescription drugs, and steroids). In addition, we are measuring 16 human-health pharmaceuticals. Samples of raw and finished water will be collected monthly for one year beginning in April 2008.

Published report: In preparation; data available on request from USGS MA-RI WSC (contact: Chris Waldron).

8. Cape Cod Toxics Research Site (2006-2009)--USGS MA-RI WSC and Toxics Substances Hydrology Program have been studying the subsurface fate and transport of organic micropollutants for more than two decades. The following paper summarizes this work:

Barber, L.B., in press, Fate of consumer product chemicals in the subsurface—
Twenty-five years of research on Cape Cod, Massachusetts, USA, *in* Securing ground-water quality in urban and industrial environments, Proceedings of the 6th International IAHS Groundwater Quality Conference, Fremantle, Western Australia, December 2-7, 2007: IAHS Publication [in press, October 2007].

During the past several years, the Cape Cod Toxics Research group has begun process-oriented research on the fate and transport of PPCPs. The work includes small-scale tracer experiments and *in situ* microcosm experiments. The following paper summarizes the results from two ground-water tracer experiments conducted in 2006. The paper has been expanded to include results from a sampling of the large-scale sewage plume at the Cape Cod site and is currently in review for submission to *Environmental Science & Technology*:

Barber, L.B., Meyer, M.T., LeBlanc, D.R., Kolpin, D.W., Bradley, P.M., Chapelle, F.H., and Rubio, Fernando, in press, Subsurface fate and transport of sulfamethoxazole, 4-nonylphenol, and 17 β -estradiol, *in* Securing groundwater quality in urban and industrial environments, Proceedings of the 6th International IAHS Groundwater Quality Conference, Fremantle, Western Australia, December 2-7, 2007: IAHS Publication [*in press*, October 2007].

The Cape Cod group also conducted a field study in 2007 to examine the antibiotic resistance of ground-water bacteria from pristine and wastewater-contaminated zones. The results have not been published yet. This coming summer the group plans to conduct a second set of ground-water tracer experiments to further examine the fate and transport of selected PPCPs.

9. **New Hampshire Seacoast Region Source Water Quality Assessment (2007)**-- USGS New Hampshire-Vermont WSC measured 260 anthropogenic organic compounds in raw and finished water from ground-water sources in the New Hampshire seacoast region. Analytes included 120 pesticides and pesticide degradates, 91 VOCs, and 49 other anthropogenic organic compounds (antioxidants, flavorings, flame retardants, non-prescription drugs, and steroids).

Published report: In preparation; data available on request from USGS NH-VT WSC (contact: Jeff Deacon).

10. **Lake Champlain Basin stream, wastewater, and CSO assessment (2008-2009)**-- USGS NH WSC measured 80 organic wastewater compounds and 16 human health pharmaceuticals in 2 urban streams, wastewater influent and effluent, and lake water in the Lake Champlain Basin near Burlington, VT.

Published report: In preparation; data available on request from USGS NH-VT WSC (contact: Jeff Deacon).