# Pharmaceutical Disposal and the Environment

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Pharmaceuticals can contaminate the environment via a complex network of sources and pathways.

Environmental Life-Cycle of Pharmaceuticals created by CG Daughton US EPA, Las Vegas 2 December 2006
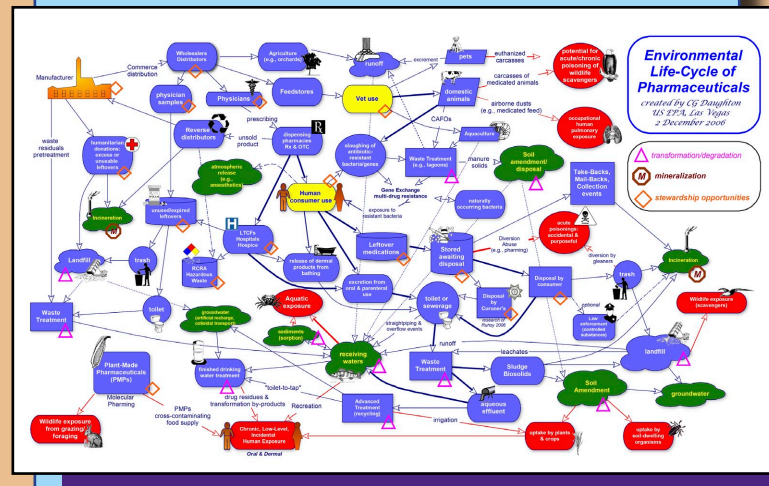
Pharmaceuticals have myriads of uses for both humans and animals (see: *yellow nodes*), including therapy, disease prevention, diagnosis, cosmetics, and lifestyle. Hundreds of widely used active pharmaceutical ingredients (APIs) can gain entry to the environment from numerous locations in society (*green nodes*), primarily as a result of their intended use – as caused by excretion or bathing. Disposal of unwanted, leftover medications to sewage and trash is another source of entry, but its relative significance is unknown. As ultra-trace pollutants, wildlife and humans can experience long-term exposure to APIs via contaminated water and foods (*red nodes*).
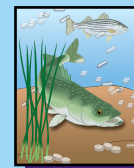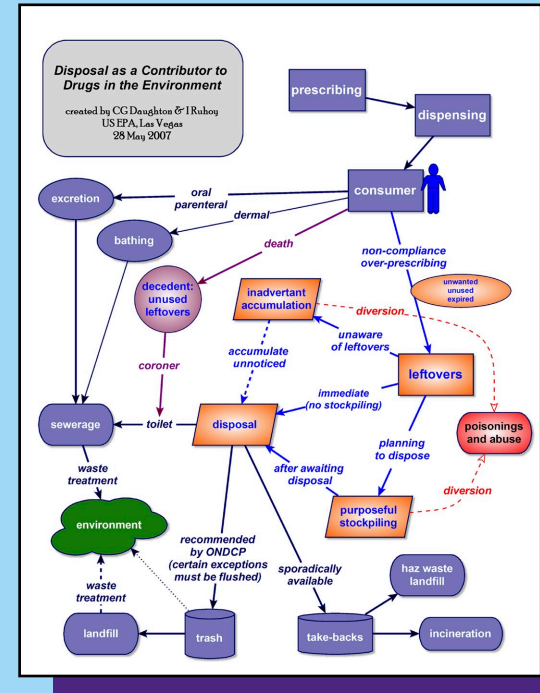
Leftover, unwanted pharmaceuticals can accumulate at many locations.

Accumulation and Disposal of Pharmaceuticals IS Ruhoy & CG Daughton U.S. EPA-Las Vegas 15 December 2006
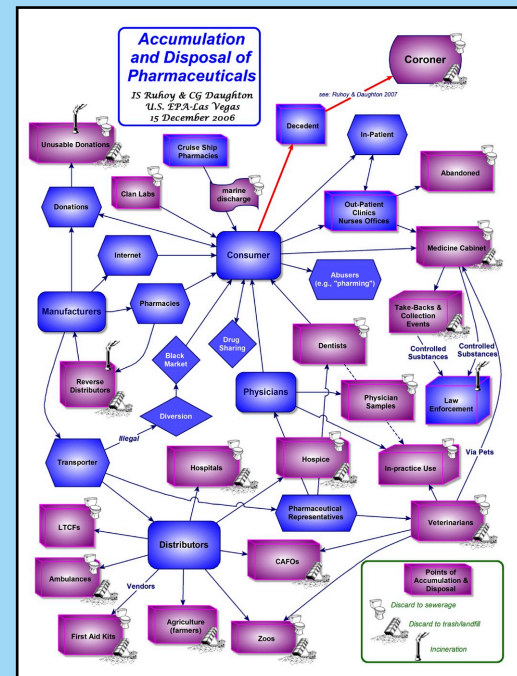
At numerous locations, unwanted pharmaceuticals are stored and eventually disposed by various means of collection or by discarding directly into sewerage or trash. Collected, leftover medications are generally disposed at landfills or by incineration.

Disposal of consumer medications can occur after leftover drugs are set aside or stored.

Disposal as a Contributor to Drugs in the Environment created by CG Daughton & I Ruhoy US EPA, Las Vegas 28 May 2007

Leftover drugs tend to accumulate. These unwanted medications are intentionally (or unknowingly) stored prior to a decision to dispose of them. During storage, a leftover drug can be diverted to those for whom the medication was never intended. This can lead to poisoning of humans and pets, or to abuse and addiction.

Many factors cause medications to remain unused, creating leftover drugs that accumulate.

Factors Influencing Drug Consumption created by CG Daughton & I Ruhoy US EPA, Las Vegas 13 November 2007

A wide spectrum of forces underlies the generation of leftover drugs, ranging from certain practices of manufacturers, distributors, prescribers, dispensers, and patients themselves. Much of the need for drug disposal could be eliminated by focusing corrective actions on these major causes.

available from: http://www.epa.gov/nerlesd1/chemistry/images/drug-disposal-2.pdf

Products

Ruhoy, I.S. and Daughton, C.G. "Types and Quantities of Leftover Drugs Entering the Environment via Disposal to Sewage - Revealed by Coroner Records," *Sci. Total Environ.*, **2007**, 388(1-3):137-148.

Ruhoy, I.S. and Daughton, C.G. "Beyond the Medicine Cabinet: An Analysis of Where and Why Medications Accumulate." Manuscript in preparation, 2008.

Ruhoy, I.S. "Examining Unused Pharmaceuticals in the Environment," Doctoral Dissertation, University of Nevada, Las Vegas, Department of Environmental Studies. In preparation, 2008.

Daughton, C.G. "Pharmaceuticals in the Environment: Sources and Their Management," Chapter 1, 1-58, In Analysis, Fate and Removal of Pharmaceuticals in the Water Cycle (M. Petrovic and D. Barcelo, Eds.), Wilson & Wilson's Comprehensive Analytical Chemistry series (D. Barcelo, Ed.), Volume 50, *Elsevier Science*, **2007**, 564pp.

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