

A river is more than an amenity . . . it is a treasure. It offers a necessity of life that must be rationed among those who have power over it.

Oliver Wendell Holmes, Jr.

WATER QUALITY

## EPA: Funding and Pollution Problems Persist

The provision of wastewater treatment and clean drinking water may experience a funding gap of more than \$500 billion between projected needs and current spending levels during the next two decades. Despite this crisis, nonpoint-source pollution (NPSP) remains the nation's largest water quality threat. These are the findings of two reports released by the U.S. Environmental Protection Agency (EPA) in 2002, *The Clean Water and Drinking Water Infrastructure Gap Analysis* and the *National Water Quality Inventory: 2000 Report*.

The starting points for the gap analysis were ongoing EPA surveys of the nation's 16,000 publicly owned wastewater treatment plants and 75,400 drinking water systems. Comparing projected growth to current spending levels, the gap analysis projects an average capital and operations/maintenance gap of \$271 billion for wastewater treatment and \$263 billion for drinking water by 2019. And assuming that spending will increase by 3% per year, the gap narrows to \$31 billion for wastewater treatment and \$45 billion for drinking water.

Paul Pinault, executive director of the Narragansett Bay Commission and president of the Association of Metropolitan Sewerage Agencies, says the gap was created in large part when the federal government backed away from "its commitment to fund water and wastewater infrastructure." He notes, for example, that the EPA's proposed fiscal year 2004 budget would cut monies for the Clean Water State Revolving Fund Program by nearly \$500 million over previous budgets. This fund was mandated by the Safe Drinking Water Act Amendments of 1987 to provide low-interest loans for infrastructure improvements.

G. Tracy Mehan III, EPA assistant administrator of the Office of Water, says the 2004 budget extends the federal commitment to fund wastewater treatment through 2011 and drinking water through 2018. He further says that utilities need to look at every opportunity to close the gap, including full-cost pricing (charging customers the actual cost of the service), proper asset management, and anticipating problems before they occur. He also recommends implementing water reuse projects, increasing federal funding, and consolidating resources, purchasing power, and systems.

The crisis in water infrastructure funding is dire, but NPSP is an even greater threat to U.S. water quality, according to the *National Water Quality Inventory: 2000*

*Report*. In this latest version of the report, which is released every two years, the EPA assessed 19% of the nation's river and stream miles, and found that 39% do not support all their intended uses (for example, drinking water supplies or fishing areas). Impairment was slightly higher for the 43% of the lake, pond, and reservoir acres and the 36% of estuarine square miles assessed. Approximately 78% of the 92% of Great Lakes shore miles assessed were impaired.

Mehan says this report includes point-source data and so does not provide an accurate "watershed" picture. In addition, monitoring is not standardized across data, so different municipalities collect data differently. The report will not be used in the EPA's state-of-the-environment report, due later this year.

Kenneth Reckhow, director of the University of North Carolina Water Resources Research Institute on the campus of North Carolina State University in Raleigh, agrees. Monitoring strategies vary by state, but there is a focus on assessing the impacts of point-source discharge, even though NPSP is a leading cause of water pollution, he says. In addition, states tend to visit the same monitoring sites year after year.

To develop a comprehensive picture of statewide water quality, Reckhow says, states should undertake probability sampling so that monitoring results could be extrapolated to unmonitored sites. To assess NPSP, however, he recommends that researchers sample during and after rainstorms at locations affected by NPSP.

Mehan says the nation needs to maintain the water infrastructure gains of the past 30 years while controlling NPSP. "We've made all the gains we're going to make without dealing with the whole watershed," he says. Techniques such as water quality trading, watershed management, and the EPA's Total Maximum Daily Load, or TMDL, program, which assigns load allocations of pollutants to watersheds, can be used to alleviate some NPSP. He estimates that 40,000 TMDLs will be implemented by municipalities in the next 15 years.

The reports are available online at <http://www.epa.gov/owm/gapreport.pdf> and <http://www.epa.gov/305b/2000report/>. —Tara Hun



**A gap in the infrastructure.** Two new EPA reports find that funding for drinking water infrastructure will lag behind need until well into the next decade, and that nonpoint-source pollution remains the largest threat to clean water.

National Oceanic and Atmospheric Administration Restoration Center, Northeast Region

## MARINE SCIENCE

## Is Sewage Destroying Coral?

About 38% of the coral reefs in the Florida Keys have died in the past five years, according to marine ecologists Kathryn Patterson and James W. Porter of the University of Georgia, Athens, and their colleagues. Some experts have blamed global warming or overfishing. Now Patterson and Porter have found that bacteria and viruses found in human sewage are responsible for some of the coral decline—and another team of scientists, led by environmental microbiologist Erin Lipp of the University of South Florida in St. Petersburg, says these microbes may be more widespread than thought. Although non-human sources of the microbes have not been ruled out, these findings raise the question of whether Florida needs to be doing more to contain its sewage.

Patterson and Porter have discovered that white pox disease, which targets elkhorn corals (*Acropora palmata*), is caused by the fecal bacterium *Serratia marcescens*. The magnificent branching elkhorn corals live close to shore and are “the giant redwoods of the reef,” says Porter. Since white pox disease was first documented in the Florida Keys in 1996, it has killed 85% of the area’s elkhorn corals. White pox disease also has killed elkhorn corals in Jamaica, Belize, the Bahamas, and other Caribbean locations. White pox disease is characterized by white lesions. The coral’s tissue is lost, and its limestone skeleton is exposed. The disease is highly contagious, and lesions can grow as rapidly as 2.5 square centimeters a day.

Patterson and Porter’s team collected mucus samples from the surface of corals infected with white pox disease. The mucus layer is composed largely of polysaccharides that slough off periodically. They isolated bacteria from the mucus and grew it in pure culture in the laboratory. Healthy elkhorn corals were then infected with bacterial isolates. One bacterium caused the corals to contract white pox disease. A combination of DNA sequencing and standard



**Coral corpses?** New research shows that microbes found in human sewage are killing off elkhorn coral.

microbiological tests identified the bacterium as *S. marcescens*. The study appears in the 25 June 2002 issue of *Proceedings of the National Academy of Sciences*.

Lipp’s study, published in the July 2002 issue of the *Marine Pollution Bulletin*, put a new twist on measuring fecal contamination in coastal waters. Traditionally, such contamination is monitored by obtaining seawater samples at different depths. Instead, in a proof-of-concept experiment, Lipp and her team collected samples not only of seawater, but also of the outer mucus layer from 15 coral colonies in the Florida Keys within a few miles of shore.

Common fecal bacteria such as enterococci were identified in two-thirds of the coral mucus samples, and 93% contained viruses found in sewage. Fecal microbes appear to “attach to the mucus surface layer and survive,” says Lipp. She speculates that when corals become contaminated with fecal microbes, it may set up hospitable conditions that allow opportunistic infections to take hold.

However, the seawater samples did not contain detectable amounts of fecal microbes, partly because the size of the ocean allows for great dilution and partly because the microbes show a preference for attaching to coral mucus. This indicates that detecting microbes just by sampling the water is not as accurate as once believed. Lipp says she and her team will repeat the methods in waters progressively farther from shore to see how far out fecal microbes reach.

Whereas Patterson and Porter’s findings are specific for one species of coral and one bacterium, Lipp’s data “show without a shadow of a doubt that fecal microbes are resident on corals and are widespread,” Porter says. Other tracer studies have confirmed that wastewater from septic systems and cesspools migrates to coral reefs near shore. According to county statistics, the Florida Keys are home to 24,000 septic systems and as many as 10,000 cesspools that rest on porous, leaky limestone. Building sewage treatment plants to prevent sewage leakage is a “local remedy that can and should be implemented,” says Porter.

—Carol Potera

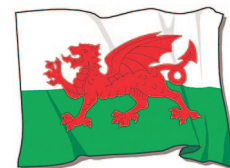
## Shipsape Strategy

In November 2002 the European Commission proposed stricter limits for sulfur in marine fuels to reduce emissions from seagoing ships. The strategy is expected to cut sulfur dioxide emissions in the EU by more than 500,000 metric tons each year, a reduction that should lower rates of asthma, bronchitis, and heart failure in coastal areas. Other expected health benefits include saving 2,000 life years that would have been lost due to long-term exposure to ship emissions, 750 fewer deaths from short-term exposure, and 300 fewer hospital admissions for respiratory illness. The initiative calls for the International Maritime Organization to establish more stringent global ship engine standards, introduces market-based incentives to further reduce emissions, and establishes a Clean Marine Award to promote low-emission shipping.



## UK’s New Environmental Research Park

Port Talbot, South Wales, is the site of the new £5 million Geoenvironmental Research Park, which will host academic, government, and commercial partners that are working to develop recycling, remediation, and waste management technologies and sustainable land management expertise. The park is partially funded by the EU’s Objective 1 program. Satellite sites will transfer technologies developed at the park to companies for use in cleaning up the many mining and manufacturing sites in Wales. Partners are already developing products from quarry dust waste and recycled plastics, inventing new gasification methods for treating soils contaminated with organic compounds, and studying the use of French drains to control potentially harmful runoff from roadways.



## VOC Limits in Sight

Volatile organic compounds (VOCs), which contribute to the creation of ozone, are one of the EU’s biggest air quality problems. During the summer months, ground-level ozone pollution exceeds safety thresholds in all EU countries, exposing more than 40 million people to potentially harmful levels and causing eye irritation, sore throats, and respiratory problems. To reduce VOC emissions, the European Commission proposed in January 2003 to phase in limits on the content of VOCs in paints, varnishes, and vehicle-refinishing products. The proposal would reduce the VOC content in the designated products by 50% per year beginning in 2007.



## RECYCLING

## Plastic Bags—Prolific Problems

It's taxed in Ireland and banned in Bangladesh—the convenient, ubiquitous plastic shopping bag. Because of litter problems, the Irish government last year began charging shoppers a €0.15 tax on every bag used. And after drainage clogs caused by wayward bags contributed to two floods, Bangladesh last year banned them from its capital city.

In the United States, plastic bags are used heavily, and their recycling rate is low. A July 2002 report by the U.S. Environmental Protection Agency (EPA), *Municipal Solid Waste in the United States: 2000 Facts and Figures*, says Americans discarded more than 3.3 million tons of low- and high-density polyethylene bags, sacks, and wraps in 2000. Of those, only 5.4% were recovered. The report puts the recycling rate for all materials at 30.1% in 2000.

The EPA does not see the bags as a big problem in the United States. “While the EPA would like to see plastics as a whole recycled at a higher rate, plastic bags as a specific commodity haven't been a huge issue,” says an agency official. He adds that the problems in Ireland and Bangladesh occurred in part because those countries' waste disposal infrastructures are not as advanced as that of the United States.

But the United States still has room to improve its recycling processes. In July 2002, New York City stopped all plastics recycling because it could no longer afford the vendor's fee for transporting and processing—\$65 a ton (for mixed metal and plastics). In July 2003, the city will



**Bagging plastic bags.** Bangladesh recently banned plastic shopping bags after they were found to have clogged drains, contributing to two floods.

resume plastics recycling, this time with a company that will pay the city about \$5 per ton for the materials. To address similar problems, the EPA is developing “product stewardship” projects to spread recycling costs among all parties involved in the life cycle of products, including manufacturers, consumers, and governments.

Although the costs of recycling can be prohibitive, recycled bags are in demand. “The users of recycled resin would like to purchase more than is currently available,” says Thom Metzger, manager of

communications at the American Plastics Council, a trade association. Melvin Weiss, president of WeisCo Recycling in Danville, California, agrees. “There's a very open, large market for clean recycled bags,” he says. Much of this demand comes from manufacturers of composite plastic building materials. There is also a large market for recycled resin in China.

Plastic bags are among the 12 items of debris found most often in coastal cleanups, according to the nonprofit Center for Marine Conservation. Marine mammals, seabirds, and sea turtles can become entangled in the bags, and sea turtles can mistake them for food such

as jellyfish, then die from starvation resulting from intestinal blockage.

Besides litter, the energy and resources used in producing plastic bags are also an issue. They are made from ethylene gas derived from nonrenewable natural gas or crude oil using water, energy, and refrigeration. Still, according to the American Plastics Council, producing a plastic bag uses about 30% less energy than making a paper bag.

But the EPA official says that no one has fully resolved the paper versus plastic debate. The best choice, he says, is neither—bring your own reusable bag. —Angela Spivey

## CLIMATE CHANGE

## Hot Nights in the City

U.S. cities average 10 more hot summer nights—classified as above 70°F in the East, South, and Midwest, and above 80°F in the Southwest—than they did 40 years ago, climate researchers have found. While long-time city dwellers may have already suspected as much, the recent study surprised researchers by showing, nationwide, a 300% greater rate of warming in cities than in the rural countryside.

The study, by Arthur DeGaetano, an associate professor of Earth and atmospheric sciences at Cornell University, and Robert J. Allen, then a research support specialist at the university, appeared in the November 2002 issue of the *Journal of Climate*. The scientists analyzed historical data on daily high and low temperatures from 361 weather stations across the United States from 1910 to 1996, adjusting for omissions, differences in observation

times, and other discontinuities (weather stations have been manned largely by volunteers since the station network's inception around 1900). The result is a first-of-its-kind analysis of day-to-day extremes—the hottest 10%, 5%, and 1% of all the daily high or low temperatures recorded by a station over its period of operation.

For the period 1960–1996, the pair found that 75% of stations showed an average increase in both hot summer days and hot summer nights. The rate of warming was greatest in the East and least in the central section, reflecting those regions' relative population growth and urbanization. The results also showed that cities are warming at more than triple the rate of rural locales.

What's to blame for the sharp rise in hot city nights—urbanization? global warming? natural climate variation? thermal pollution (cities generating and retaining more heat)? All contribute, DeGaetano says, “but how big each component is, I'm not sure.”

Kenneth Kunkel, head of the Atmospheric Environment Section of the Illinois State Water Survey at the University of Illinois, says

that the very hot nights may have been a major factor in the number of deaths during the 1995 Chicago heat wave. “There was no chance for people to get a break—the effect on the body accumulated over time,” he says. That heat wave killed more than 700 people in just four days. Yet the average temperature that month was close to normal.

Extreme day-to-day temperatures also cause buckling railroads, failed crops, empty reservoirs, and power blackouts, DeGaetano says. Understanding extreme trends could help power companies plan for increased generation capacity and emergency management services for opening more shelters.

“Everybody looks at annual average temperatures for the globe, but it's much more relevant to look at extremes,” says David Easterling, chief of scientific services at the National Oceanic and Atmospheric Administration's National Climatic Data Center. “You have to start looking at what is changing on shorter and shorter time scales, such as changes in daily temperature extremes, to get an idea of what factors are really influencing the climate.”

—Laura Alderson

ehpnet

## American Boating Association Clean Boating and Environmental Stewardship

More and more people in the United States are using water for a variety of recreational purposes. The 1997 National Survey on Recreation and the Environment found that from 1983 to 1995 the number of boaters increased 25% and the number of people swimming in bodies of water besides swimming pools increased over 38%. To educate boaters and the general public about keeping marine environments clean and safe, the Harwich Port, Massachusetts-based American Boating Association has developed a Clean Boating and Environmental Stewardship page as part of its American Boating Online website. The page, located at <http://www.americanboating.org/clean.htm>,



**ABA**  
American Boating  
Association

includes information on more than 30 topics, ranging from clean boat sanding techniques to harmful algal blooms.

The How to Be a Clean Boater section addresses the importance of environmentally friendly boat maintenance and use,

and explains how the processes of sanding, painting, fueling, pumping out, and trash disposal can negatively impact human and marine ecosystem health. This section offers guidelines for performing routine boat care in ways that reduce air and water pollution, and provides brief overviews of federal regulations on human waste disposal. Embedded links lead to brochures and fact sheets from federal agencies and the Marine Environmental Education Foundation on alternatives to conventional cleaning products and paints, as well as suggestions for best management practices that marina owners can implement to reduce their facilities' environmental impact on neighboring waterways.

The Boating and Family Health and Safety section includes information on three problems of special concern to those who might not boat themselves but who also enjoy recreational waters: disease-causing microorganisms, food poisoning from contaminated fish and shellfish, and personal injury from waterborne trash. This section outlines the extent of these problems in the United States and links to the U.S. Environmental Protection Agency (EPA) water quality report to Congress. Other resources include links to the EPA's BEACH Watch website (which posts updates on water quality at beaches around the country), fish consumption advisories, and educational materials from the Santa Monica Bay Restoration Project and Heal the Bay, a California-based advocacy group. Elsewhere in this section is information on harmful algal blooms and microbial threats including *Cryptosporidium* and *Pfiesteria piscicida*.

The Boating and Our Environment section describes the effects of air pollutant emissions, sewage dumping, shipboard trash, and fuel and oil spills, as well as the habitat disruption that results from a boat's wake. Visitors can read summaries or full *Federal Register* documentation of EPA regulations regarding these pollution sources. —Erin E. Dooley

## Cheesy Discovery

A bacterium found in kasseri cheese could be used to produce a natural preservative for some fresh cheeses and other minimally processed foods, say Greek and Belgian researchers. When grown in milk, *Streptococcus macedonicus* produces a food-grade antimicrobial peptide called macedocin.

Macedocin can kill a wide variety of bacteria, including some that cause foodborne disease and food spoilage, and can do so

without affecting human health. During studies, *S. macedonicus* was found to be stable under extreme pH and heat conditions, which could make it valuable as a protective starter culture in dairy processing.



## Birth Defects: No Clear Landfill Link

After the 1998 EuroHazcon study found a 33% increase in the risk of neural tube defects, cardiac septal defects, and malformations of major blood vessels among babies born to residents living within 3 kilometers of hazardous waste landfills, its authors decided to develop a scoring method to more precisely determine the hazard potential of such sites. Four landfill specialists were enlisted to assess the air, water, and overall environmental hazards surrounding 20 landfill sites in five Western European countries. The group found little evidence to suggest a causal relationship between living near a site ranked by the scoring method as being more hazardous and birth defects. If validated externally, the scoring method may be useful in future risk assessment studies.

## Keeping Copper off Boat Bottoms

Boaters use copper-based paints to protect their boat hulls from barnacle growth, which can reduce fuel efficiency and cause engine problems. But when docking areas aren't well flushed of toxicants by water currents, copper can accumulate in marina sediments to toxic levels. The University of California Sea Grant Extension



Program is educating marina and boat owners about alternatives to copper-based paints and creating an economic incentive program for California boaters who use less-toxic alternatives. The best of four alternative paints currently being tested is a two-part epoxy paint. This alternative is more durable than copper paints, a factor that could save boaters money.