SWIMMING IN SEWAGE

The Growing Problem of Sewage Pollution and How the Bush Administration Is Putting Our Health and Environment at Risk

Project Design and Direction

Natural Resources Defense Council
Environmental Integrity Project
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ABOUT NRDC

The Natural Resources Defense Council is a nonprofit environmental organization with more than 1 million members and online activists. Since 1970, our lawyers, scientists,

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EXECUTIVE SUMMARY

oday, the United States is the richest and mo

The BEACH Act also authorizes $30 million per year for state grants for monitoring and public notification, yet the EPA has provided only $10 million in annual grants since 2001 due to inadequate congressional funding. The BEACH Act should be fully funded and grants should be used for identification of beachwater contamination sources, as well as for monitoring and public notification.

Promulgate provisions of the sanitary sewer overflow (SSO) rule: In January 2001, the Bush administration announced it would set aside for further review a proposed regulation designed to keep bacteria-laden raw sewage discharges out of America's streets, waterways, and basements and make public reporting and notification of sewer

Centers for Disease Control should work together to fill that gap with comprehensive data from across the country, new analysis and epidemiological studies, a publicly available, searchable database, and a public education campaign. Lack of adequate information on waterborne disease is putting people at risk.

CHAPTER 1

CONTEXT

hat goes up must come down. But what goes down the sewer should not come up into our basements, streets, or streams. Few Americans give much thought to the fate of the infectious wastes we flush down the toilet or the toxic wastes we pour down the drain. Most assume that raw sewage from

Teddy Roosevelt said in 1910, "[C]ivilized people should be able to dispose of sewage in a better way than by putting it in the drinking water."[18]

Exposure to inadequately treated sewage causes illness across the nation. The EPA estimates as many as 1.8 million to 3.5 million people get sick each year just from swimming in waters contaminated by SSOs.[19] Burgeoning populations increase both the volume of sewage sent into sewer systems and the number of people potentially exposed when SSOs and CSOs occur. A trend toward increased resistance to antibiotics and

HOLLYWOOD'S BLOCKBUSTER BACKUPS

Good operation and maintenance practices could prevent sewage spills and backups that are a chronic problem in the aging sewer pipes under Los Angeles.[a]

- **In-Need-of-Soap Opera:** Over the past three years, Los Angeles had more than 2,000 sewage spills—an annual average of about 10 per 100 miles of pipe. About 17 percent, or 341, of those spills were in buildings or on private property, but caused by problems in the city's sewer pipes.
- **Box Office Flop:** The California State Water Resources Control Board estimates public losses for the City of Los Angeles at about $2.4 million due to beach closures that reduced attendance and prohibited swimming following sewage spills in February and March 1998.[b]
- **The Vile Vile West:** In the southwest region as a whole, the rate of basement backups doubled between 1999 and 2000 from an average of 3.6 per 100 v2 Tc0 0 9.48 92.85601ui7O 0.:

- Ratcheting down EPA enforcement efforts. The Bush administration's budget proposals for 2004 would have eliminated 270 EPA enforcement positions, or about 13 percent of the workforce engaged in inspections and support of enforcement actions at the start of the administration.[26] So far, Congress has rejected these proposals, and should resist any further attempts by the administration to cripple the enforcement program. Reduced enforcement means increased pollution. The EPA estimates that 660 million pounds of pollutants were prevented from reaching our waters as a result of enforcement activities in fiscal year 2001, while only 261 million pounds of pollutants were blocked in fiscal year 2002.[27] As a result of its CSO and SSO enforcement actions in recent years, the EPA prevented more than 19 billion gallons of sewage from entering our nation's waters untreated in 2003.[28,29]

According to evidence compiled in a 1999 study by the American Society for Microbiology, the government should be doing more to protect public health. The group found

that exposure to microbial pollution through surface water and groundwater "may become more important in the future—unless some key contributing factors are addressed immediately: improper treatment and disposal of wastewaters, aging water treatment and distribution systems, mismanagement of animal wastes, and the current lack of an integrated regulatory approach."[30]

The costs of prevention are likely to be less than the full costs of reaction to sewer overflows. When the full costs associated with SSOs and CSOs are accounted for, it is generally more expensive to repair a breach in a sewer system and clean up after a spill than it is to avoid the spill in the first place. Some of these additional costs include health care, lost revenue at recreational or commercial fishing sites closed due to sewage contamination, reduced property values, and lost worker productivity.

This report lays out some of what we know about the public health, environmental, and economic impacts of sewage discharges and outlines the major steps needed to reduce them.

the data needed to ensure effective sewage treatment regimes and better assessment of the risk of exposure to raw sewage overflows.

Pathogens

A small drop of fecal matter can contain millions of microorganisms of many types, some of which are pathogenic.[33] Microbial pathogens in raw or inadequately treated sewage can cause illnesses ranging from temporary stomach cramps to life-threatening conditions such as inflammation of the heart. While, in a healthy population, most of the illnesses resulting from exposure to inadequately treated sewage are relatively minor (respiratory illness; ear, nose or throat irritation; gastroenteritis), they can become serious in more vulnerable populations, including pregnant women, young children, the elderly, and people with suppressed immune systems (such as people with HIV, transplant recipients, and cancer patients).[34] This group accounts for 20 to 25 percent of the U.S. population and is rapidly growing in number.[35]

Infants and children show a higher incidence of waterborne illnesses than the general population.[36] The elderly, too, are at greater risk—people older than 74 have the highest mortality from waterborne or food-borne diarrheal illnesses.[37,38] Adding insult to injury, some medications required to treat waterborne illnesses (such as metronidazole, which is used to treat amoebic dysentery) may be carcinogenic or have other toxic side effects.[39]

Table 1 identifies most common waterborne pathogens and the diseases they cause. Giardiasis (a protozoan infection) is the most commonly reportsest commd6.7(WtTjns)6.(r)-0.9(tcTjkh)6.(r

Figure 1 Sewage Contamination at Ogden Dunes Beach on Lake Michigan. Aerial photo of Burns Waterway, Porter County, Indiana, Earth Day, April 22, 2000, one day after a major rain storm and a 20 million to 30 million gallon combined sewer overflow reported by the City of Valparaiso. Photo: Lake Erie Land Company, Coffee Creek Watershed Conservancy Project, and Tom Anderson, Save the Dunes Council.[44]

by viruses.[45] While most of the waterborne pathogens enter the sewage system through human wastes, others may enter through animal wastes such as cat feces, which many urban pet owners flush down the toilet. Cat feces may contain the infectious protozoan *Giardia lambia* [46] or the SARS (Severe Acute Respiratory Syndrome) virus.[47]

Conversely, inadequately treated human sewage can contaminate edible filter-feeding shellfish, such as clams, mussels, scallops, and oysters that eat plankton—microscopic plants and animals—by filtering them from water, which can reinfect humans with concentrations of viruses that are 100 to 900 times greater than in the surrounding water. High concentrations of infectious viruses can cause disease in unsuspecting consumers. Nationally, at least 100 outbreaks of hepatitis and viral gastroenteritis have been associated with sewage-contaminated shellfish.[48] Between 1973 and 1994, 65 cases of cholera were

ear infections were associated with swimming in sewage-contaminated marine waters.[59] The amount of human illness after exposure to marine water appears to be increasing, and there is evidence that the rate of infection is proportional to both the amount of time swimmers are exposed and the levels of pollution in the waters where they swim.[60]

According to public health experts, the EPA's proposed policy of allowing sewage to be discharged without full treatment during rain events would exacerbate these health risks.[61] Analysis by a leading microbiologist indicates that approximately 1000 times more people would become sick from swimming in waters into which this inadequately treated sewage—euphemistically called "blended" sewage by the EPA—has been discharged.[62] The increased risk of illness from exposure to blended sewage comes from several factors: little or no treatment for *Cryptospiridium*, *Giardia*, or viruses, and ineffective treatment for bacteria.[63] Chlorination, the most widely used form of disinfection for sewage, does not work well when the wastewater to which it is being applied is cloudy, as blended sewage inevitably is.[64] In addition, the high concentrations of suspended solids in the partially treated wastewater could impede the switch from chlorine to less toxic and hazardous disinfection methods such as ultraviolet light—UV disinfection is less effective when wastewater contains large amounts of solids.[65]

In 2002, CSOs, sanitary sewer overflows (SSOs), and discharges of inadequately treated sewage from treatment plants were responsible for 25 percent of closing and

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Pathogenic Agent	**Acute Effects/Chronic or Ultimate Effects**[67]	**Wastes**[68]
Reovirus	Respiratory infections, gastroenteritis	Domestic sewage
Rotavirus	Gastroenteritis	Domestic sewage
Protozoa:		
Balantidium coli	Dysentery, intestinal ulcers	Human/animal feces (especially swine)
Cryptosporidium parvum	Gastroenteritis/death in immuno-compromised host	Human/animal feces
Cyclospora cayetanensis	Gastroenteritis	Human feces
Dientamoeba fragilis	Mild diarrhea	Human feces
Entamoeba histolytica	Amoebic dysentery, infections of other organs	Human/animal feces, domestic sewage
Giardia lambia	Giardiasis, diarrhea, abdominal cramps/failure to thrive, severe hypothyroidism, lactose intolerance, chronic joint pain	

patient… infected… the rest of the residents in that block through the sewage system [and by other means]."[72]

Escherichia coli O157:H7, another emerging infectious organism, is mainly a food-

themselves, in their sewage effluents.[86] In the age of frequent intercontinental jet travel, it is not improbable that exotic foreign diseases could find their way into the United States—indeed, that appears to have been the case with SARS from China and HIV from Africa. Hospitals in the United States caring for patients who have contracted particularly virulent diseases from overseas may be discharging exotic-disease pathogens into sanitary sewers. For example, CDC reports that in Africa, transmission of viral hemorrhagic fever caused by the Ebola and other viruses has been associated with exposure to body fluids, including urine and feces.[87] While CDC expects viral hemorrhagic fever infection

are potentially associated with human, in

research has shown that some chemical combinations can have additive or synergistic toxic effects;[98] and

- Virtually nothing is known about the effects of simultaneous exposure to industrial chemicals and infectious organisms.

But important health effects are being uncovered, such as the tendency of some industrial chemicals to interfere with hormones—messengers that normally regulate a wide variety of functions in the human body: "The impact of endocrine disruptors on immune system function and disease resistance is poorly understood…. [T]here are hints, nonetheless, that this may be one of the most important and far reaching routes by which endocrine disrupting chemicals undermine human health. Several studies and reviews… indicate that contaminants can erode disease resistance in ways that make people mortally vulnerable to infectious diseases they might otherwise have been able to resist."[99] More than a third of the

Seventy-one percent of the 247 TRI chemicals were associated with two or more of these suspected health impacts, accounting for 45 percent (155 million pounds) of the total discharged to publicly owned treatment works in 2001. Just over 1 million pounds of suspected endocrine disruptors were discharged in 2001.[110]

More than 55,000 pounds of persistent, bioaccumulative toxins (PBTs) were sent to publicly owned treatment works in 2001—an 18.9 percent increase over the previous year.[111] While this amount may seem relatively low, it's important to recognize that these substances persist and accumulate in fatty tissues where they can reach toxic levels, particularly in humans and other creatures at the top of the food chain. Lead accounts for the bulk of PBTs sent to publicly owned treatment works, followed by polyaromatic compounds and mercury.[112]

with demand. When enough sewage is discharged, dissolved oxygen is depleted faster than it can be replenished by photosynthesis, wave action, or other natural means. The microorganisms instead deplete the oxygen of the receiving waters, doing grave harm to other living things in the water.

According to the EPA, primary treatment typically removes only about 35 percent of oxygen-demanding pollutants. Primary and secondary treatment together remove 84–89 percent of oxygen-demanding pollutants.[114] Too little dissolved oxygen means that fish and other aquatic organisms can't breath. Hypoxic conditions arise, causing fish kills, noxious odors, and habitat loss, and leading to decreased tourism and recreational water use.

According to the EPA's most recent national water quality assessment, low dissolved oxygen is the third most frequent pollution problem in impaired estuaries. The EPA reports that the largest known pollution sources in impaired estuaries are municipal sewage treatment plant discharges, which contribute to 37 percent of the reported water quality problems in the impaired estuaries.[115] Dissolved oxygen levels in Lake Erie, whose revitalization has often been trumpeted as one of the great success stories of the 1972 Clean Water Act,[116] remains "a persistent problem," according to the EPA.[117]

In 2000, the EPA reported oxygen depletion to be a leading cause of estuary impairment in Long Island Sound,[118] which generates at least $5 billion a year in immediate revenue through boating, tourism, commercial and sport fishing, swimming, and beach-going, and generates untold billions more in enhancement of property values, aesthetic value, and climate control.[119]

Nutrients

For thousands of years, we've known that animal wastes enrich soil with important nutrients for plant growth; human waste is no different. These wastes are high in nitrogen and phosphorous, the so-called "limiting" nutrients because their absence limits the extent of plant growth, while their abundance accelerates it. Hence, the widespread use of natural or synthetic fertilizers on crop fields and lawns. But too much of a good thing is no good.

Nutrients have the same effect on aquatic plants as they have on terrestrial plants. Overfertilization of lakes and estuaries triggers massive blooms of green algae that can kill submerged aquatic vegetation by blocking their access to sunlight. As succeeding generations of algal blooms die off, they settle to the bottom where they become food for microorganisms, which deplete dissolved oxygen as they live, breath, and multiply. Unbridled input of nutrients can result in water bodies that are overgrown with algae and rooted plants, and have persistent oxygen-deprived "dead zones" that may infringe on vital fishery habitats.[120]

dicted that conditions will worsen in 86 estuaries by 2020 as population and development increase in coastal areas.[121]

other water-related recreational activities, such as kayaking, canoeing, and surfing, at even greater rates of growth (see Table 2). Despite these large numbers, few epidemi-

While bacteria die off comparatively quickly in the environment, viruses may remain active for days or weeks, and helminth eggs and protozoan cysts may remain active for many months.[151] Pathogens often survive long enough in the environment to be a potential health threat.[152]

Future Forecast

The Bush administration has recently begun to acknowledge the serious consequences of climate change.[153,154] Precipitation increased 5 to 10 percent over land areas of the Northern Hemisphere during the 20th century,[155] and global warming is predicted to further increase the intensity of rainfall events for parts of the United States.[156] What might be the impact of climate change on sewer overflows and the related health effects?

CHAPTER 3

ECONOMIC IMPACT

Besides causing illness and even death, sewer overflows wreak economic damage as well. Clean water is worth hundreds of billions of dollars to the U.S. economy, including such sectors as recreation and tourism, commercial fishing, beverages, and agriculture, as well as the chemical and electronics industries, which need clean water for processing. The value of clean water to the economic and social well-being of the nation is not a recent revelation. A group of attendees at the 1909 Conference of State and Provincial Boards of Health concluded: "[t]he fact that many of our streams and lakes have been ruined for boating, bathing, and fishing, by reason of their pollution, cannot be else than a material loss to the people at large and a serious diminution in the value of the resources of the country."[161]

Nearly 100 years later, we are still in the dark regarding the real cost of sewage-contaminated waters because there is no coordinated and comprehensive national database covering the occurrence and impact of sewer overflows. For example, the Environmental Protection Agency reports that "[a]lthough SSO events that impact

This section provides an overview of the estimated economic impacts of sewage-contaminated waters described in EPA, CDC, university, state government, public interest, and trade association reports. Table 3 lists the major cost elements associated with responding to, or preventing, sewer overflows.

Table 3
Costs Associated with Sewer Overflows

Response	Prevention
• Cleanup	• Sewage system upgrades
• Emergency repair	• Preventive operation/maintenance
• Medical care	• Data collection/management/reporting
• Reduced tourism/commerce/property values	
• Lost productivity	
• Increased drinking water costs	
• Natural resource damages (i.e., dead fish)	
• Fines/legal fees	
• Reporting requirements	

The EPA estimates $50.6 billion is needed to control CSOs,[165] and $28 billion to $88 billion in capital spending is needed for reducing wet weather SSOs.[166] Yet no national framework for SSO control that addresses cost information exists.

Annual costs of responding to SSOs (including basement backups) range from $1.1 billion to $6.1 billion in 1999 dollars.[167] These response costs are likely a gross underestimate due to the paucity of comprehensive information on the occurrence and consequences of sewer overflows. The EPA estimated in 2000 that monetized costs of its proposed SSO rule were on the same order of magnitude as the anticipated benefits.[168] But the agency was not able to monetize any of the following: enhanced commercial fishing, enhanced recreational shellfishing, improved water quality, reduced health risks, reduced property damage, improved aesthetic quality such as clean water and beaches, or avoided illnesses from contaminated drinking water.[169] While many of these are difficult to qualify, they are central to the value of reducing sewer overflows from the public's perspective. The EPA estimated that better monitoring and management practices required by the proposed rule would, on average, cost only $1.92 per household per year. Even in the smallest communities (under 10,000), the average cost would be $4.87 per year.[170]

COSTS ASSOCIATED WITH SEWER OVERFLOWS

At the local and regional levels, costs of responding to the impacts of sewer overflows is often in the tens of millions of dollars. In 1993, the *Cryptosporidium* outbreak in Milwaukee, for example, cost that community well over $55 million. The 1997 *Pfiesteria* bloom in the Chesapeake Bay region caused $43 million in economic losses.[171]

THE U.S. ECONOMY DEPENDS ON CLEAN WATER[a]

- A third of all Americans visit coastal areas each year, making a total of 910 million trips while spending about $44 billion.
- Coastal waters support 28.3 million jobs and generate $54 billion in goods and services each year.[b]
- The travel, tourism and recreation industries supported more than 6.8 million jobs and generated annual sales in 1996 of more than $450 billion.
- The EPA estimates medical wastes and sewage on beaches cost New York and New Jersey $4 billion in losses from recreation and tourism in 1988.[c]
- The $45 billion commercial fishing and shellfishing industries need clean wetlands and coastal waters to stay in business. Every year, 250,000 people in the Great Lakes, Gulf of Mexico and coastal areas harvest more than 10 billion pounds of fish and shellfish.[b]
- In 1995, the Fish and Wildlife Service reported that the fishing industry in the U.S. Great Lakes generated about $2.2 billion in sales to local businesses.[c]
- Thirty-five million American anglers, aged 16 or older, spent $38 billion in pursuit of their sport in 1996. Fishing expenditures increased by 37 percent between 1991 and 1996. If sportfishing were incorporated as a single business, it would rank 24th on the Fortune 500 list of top sales producers, surpassing such giants as General Motors, Exxon, Mobil, and AT&T.[b]
- Manufacturers use about 9 trillion gallons of fresh water every year. The soft drink manufacturing industry alone uses more than 12 billion gallons of water annually to produce products valued at almost $58 billion.
- A *Money Magazine* survey found that clean water and clean air are two of the most important factors Americans consider in choosing a place to live.

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was eliminated. Property values of the nearby residences increased 40 percent, nearly twice the rate at Fall's Creek (an average of 23 percent). On the basis of these findings, IKE urges the State of Indiana and/or the City of Indianapolis to conduct a rigorous and comprehensive analysis by financial experts to determine the overall economic benefits that these communities may expect from reducing or eliminating CSOs.[178] For more detailed information, see the Indianapolis case study in Chapter 4.

Businesses in Allegheny County, Pennsylvania, that depend on tourist dollars during the local river recreation season may be feeling more than the effects of a national recession—river users face an increasing number of days in which they must be wary of sewage-contaminated river water. "CSO Alert Days" in 2003 were the highest since the alert program began, affecting 79 percent of the river recreation season (see Figure 3).[179]

PITTSBURGH'S "THREE RIVERS" ARE JOINED BY A FOURTH IN WET WEATHER

Pittsburgh is famous for its location at the confluence of the Allegheny, Monongahela and Ohio rivers. But during wet weather, CSOs form a river of their own, according to Professor Jared L. Cohon, Carnegie Mellon University president recruited by the Allegheny Conference on Community Development to spearhead efforts to rectify southwestern PA's water condition:[a]

- "After a rainstorm, [the Allegheny, Monongahela and Ohio rivers] are dangerous for human contact."
- "We have the problem worse than anyone else—Pittsburgh leads the nation with the most combined sewage overflow."
- "We have to limit new development and its ability to tap into the existing sewage system."
- "We're looking at something like $10 billion to fix this."
- "By working together, there are a lot of savings to be had."

[a] Dickerson, L.A. "Perspectives: CMU's Cohon sounds $10 billion alarm on sewage treatment needs," *Pittsburgh Post Gazette*, 10/27/02 (as presented on 12/23/2003 at http://www.post-gazette.com/businessnews/20021027dickerson4.asp).

approximately 4,600 *Giardia*-related hospitalizations annually at an average cost of $3,100 per case for a total of $14 million.[187]

Transmission of drug resistance could cost the nation's health-care system upwards of $30 billion.[188]

CHAPTER 4

CASE STUDIES

Sewage overflows affect the lives of real people, in real places, sometimes with devastating and tragic results. While systematic, quantitative studies on the occurrence, causes, and health, environmental, and economic impacts of sewage overflows are too few and far between, information from those who experience these events firsthand is all too common. This chapter provides a handful of case studies describing the uphill struggle facing communities that have experienced sewage overflows.

HAMILTON COUNTY, OHIO

Although the ebb and flow of tides are not associated with the U.S. Midwest, the municipal sewer system in Hamilton County, Ohio, might be an exception. But it is not ocean water coming and going—it is thick, odiferous, and infectious raw sewage from toilets flowing into the county's residential basements, playgrounds, streets, and nearby waterways.

Figure 4 Basement Backup, Cincinnati, OH

The Setting

Bordered on the south by the Ohio River and on the west by the Indiana state line, Hamilton is Ohio's third largest county, with a population of 845,303, including Cincinnati's 331,285 residents.

Thirty percent of the county's 3,000 miles of sewer lines are combined with storm sewers; most of these predate the 1950s, particularly those in the county's oldest neighborhoods. In Cincinnati, about 90 percent of the sewer lines carry both sewage and stormwater, for example.[190] Currently, the county has 256 permitted combined sewer overflows (CSOs), 99 numbered sanitary sewer overflows (SSOs) (like the one shown in Figure 5), and approximately 45 unnumbered points where SSOs occur—ranging from manholes to illicit connections to the stormwater system.[191] Such SSO discharges have been illegal for more than three decades—since the Clean Water Act was passed in 1972.[192]

The Problem

The fundamental problem with Hamilton County's sewer system is that it is overloaded. New connections have been added in areas with insufficient capacity, even while the system is badly in need of upgrades to control wet-weather infiltration that overloads the system. As a result, for a generation, millions of gallons of raw sewage and toxic industrial chemicals have been directly discharged into local waters and private homes from illegal SSOs.

Repeated Sewage Backups and Overflows

funding issues pose a serious challenge, they are not the major stumbling block either; rate analyses suggest that system improvements are affordable over a 20-year period.[203]

The primary barrier to preventing overflows appears to be the lack of political will to

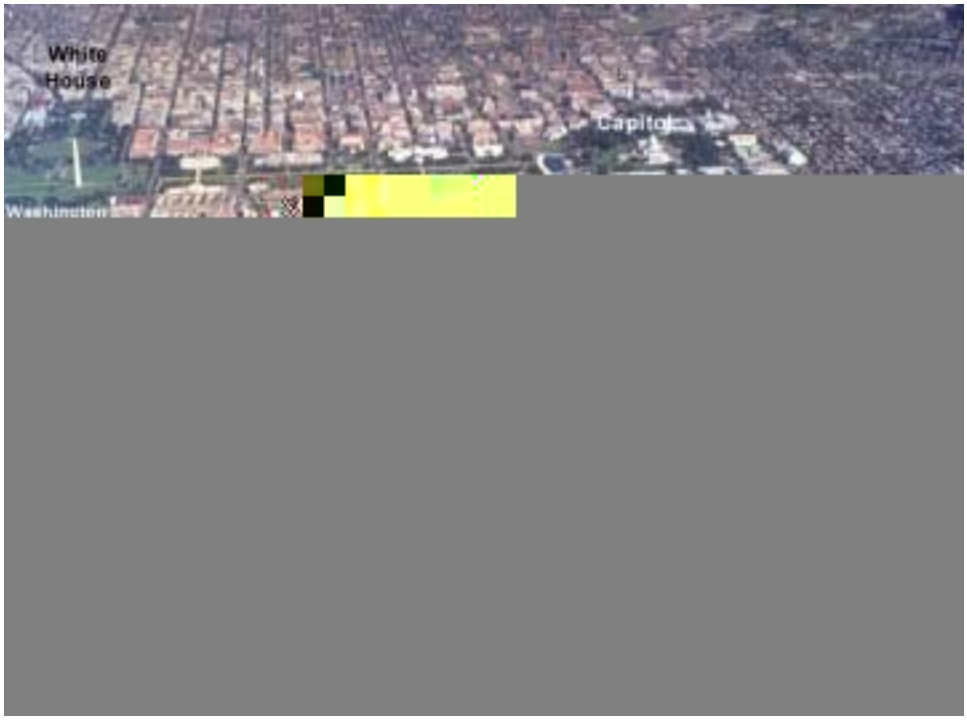

Figure 6 A Dirty River Runs Through It: The Anacostia meets the Potomac in George W. Bush's backyard. The dramatic difference in color is due to the high level of sediments from combined sewer overflows and stormwater runoff.

Anacostia watershed before reaching the river, these conditions may have been advantageous to spawning fish and delicate aquatic seedlings. But now that 80 percent of the lower Anacostia's watershed is "developed,"[211]

Figure 7 Tip of the Trashberg: Street litter washes into the Anacostia via stormwater and overflows.

The principal causes of these problems: CSOs and stormwater runoff, with recent information suggesting that SSOs are also a contributing factor.

Combined Sewer Overflows

Approximately one-third of the capital city—including the White House, U.S. Capitol, Supreme Court, U.S. Naval Observatory, many federal office buildings, and embassies—is served by a combined sewer system built by the federal government in the 1890s. Although 29 percent of Washington's 58 CSO discharge points are along the Anacostia, the river receives 66 percent (2.1 billion gallons) of the average annual volume of the city's CSOs with its cargo of raw sewage, trash, oil, grease, and other pollution. CSOs occur on average about 75 times per year in the Anacostia River, and according to the District of Columbia Water and Sewer Authority (DCWASA), as little as one-tenth to one-half inch of rain can cause CSOs.[217]

The CSO policy of April 1994 requires sewage authorities in communities with combined stormwater and sewage systems to develop a Long Term Control Plan to reduce discharges from CSOs.[218] Part of the water and sewer authority's $1.3 billion Long Term Control Plan includes the design and construction of an Anacostia River Tunnel, planned to store raw sewage during rain events long enough to be treated. NRDC and other local groups support full funding and prompt implementation of the plan, along with the use of stormwater controls to reduce the volume of the combined sewer system.[219]

Sanitary Sewer Overflows

While the CSOs have been the focal point of local efforts to clean up sewage in the Anacostia River, DNA testing shows that 14 percent of sewage in the Anacostia is of

Figure 8 Raw sewage leaking from a broken pipe (left) into the Sligo Creek, which flows into the Anacostia (right). When a staff member of the Anacostia Watershed Society noticed raw sewage flowing in the creek, he notified Washington sanitation officials who claimed its source was a stormwater pipe under the jurisdiction of another agency. Continuing upstream, he found and photographed the real source of the sewage leak: a broken WSSC sewer pipe.[220] Photo source: Anacostia Watershed Society.

human origin. It comes from sources in suburban Maryland, upstream of D.C.'s CSO outfalls.[221] Montgomery and Prince George's counties in suburban Maryland are served by an antiquated sewer system under the jurisdiction of the Washington Suburban Sanitary Commission, whose aging pipes leak human waste into tributaries of the Anacostia River.

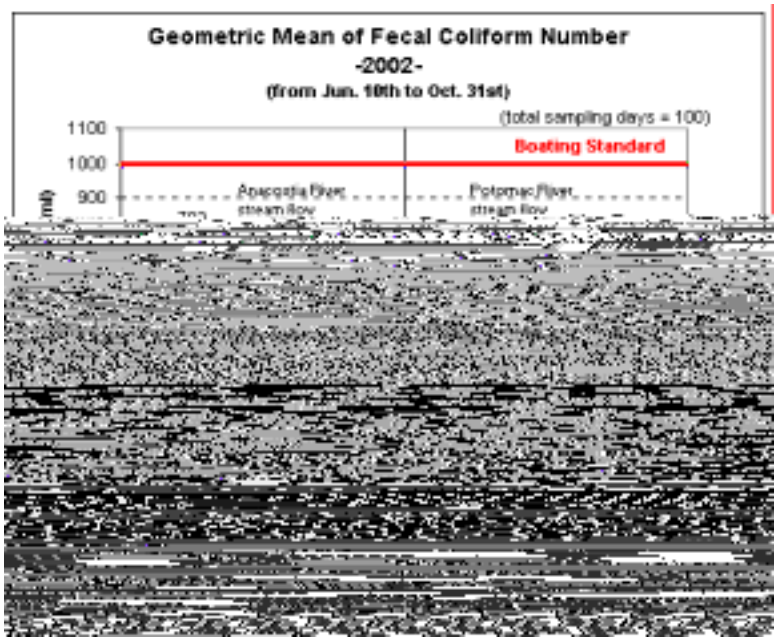

Figure 9 Fecal Coliform Levels in the Anacostia. The Bladensburg Bridge is upstream of CSO outfalls; the 11th St. Bridge is downstream.

Data collected by DCWASA and the Anacostia Watershed Society's annual Water Quality Monitoring & Flagging Project demonstrate that fecal coliform concentrations are higher upstream in suburban Maryland, above the CSO outfalls, than downstream in the District of Columbia (see Figure 9).[222, 223] That finding indicates that the sewage system in suburban Maryland is a large contributor to the pollution in the river, and it contradicts the presumption that stormwater pollution alone represented the greatest and most significant pollution source in the upper Anacostia. Sewage flows into the river from various point and nonpoint sources are literally flooding the Anacostia with human and animal waste. Therefore, upgrading the CSO system downriver in the district will only alleviate a small portion of the fecal contamination problem in the Anacostia. The problem of sewage drainage from suburban Maryland must be addressed as well; indeed, it is essential to the long-term goal of a clean and healthy Anacostia River.

INDIANAPOLIS, INDIANA

New hookups to already overflowing systems inevitably result in more sewage overflowing into local streams. In essence, IDEM's permitting standard allows more sewage into the sewer, regardless of the certain damage to water quality and the potential impact on public health.

Even as it issues these new permits, IDEM mandates that communities with CSOs

Chronic CSOs Depress Property Values

Fall Creek downstream from Keystone Avenue and White River downstream from 30th Street suffer the most severe effects of sewage overflows. CSO outfalls along Fall Creek are especially bad. The city's own estimates reveal that the sewer system along the creek performs much more poorly than in other areas. In normal years, it captures less of the wet weather flow (between 33 percent and 40 percent goes into the stream) and has a larger overflow volume (1.4 billion gallons) than the other systems. And for 85 days a

Industries discharging toxic chemical wastes directly into the sewer collection system are required to "pretreat" their wastes. But discharge-permit requirements also anticipate that a certain level of treatment will be conducted at the municipal wastewater treatment plant, prior to release into the environment. So when sewers overflow, certain of these industrial toxic wastes can be released into the environment before that additional treatment, and may pose additional health risks to exposed individuals.

Table 6 lists the quantities discharged according to suspected health effects associated with these substances. Some chemicals may cause more than one health effect. In 2001, more than 265,000 pounds of 24 individual substances associated with three or more suspected health effects were discharged into the Marion County sewers.

mental community in Indiana continues to ask for public notification of SSOs when they occur.[235]

FLORIDA KEYS

Coral reefs are not only stunningly beautiful, they are among the oldest, most biologically diverse and economically important ecosystems in the world. Millions of aquatic organisms, from tiny crustaceans to giant fish, rely on reefs for their survival.[236] Thousands of coastal communities around the world depend on coral reefs for their food, jobs, tourism dollars, and protection from destructive ocean waves.[237] Globally, coral reefs provide an estimated $375 billion each year from food, tourism, and coastal protection.[238]

Coral reefs are considered to be the medicine cabinets of the 21st century, seen as potential sources of new disease-fighting medicines drawn from the spectacular array of self-defense and predatory chemicals produced by many of these organisms.[239] That promise of medical advances is accompanied by economic benefit: The pharmaceutical value of coral reefs in Jamaica's Montego Bay reef system alone is calculated to be between $54 million and $85 million.[240]

But coral reefs are in trouble. Over the past 10 years, the frequency of coral diseases has increased significantly, with the subsequent death of many reef-building corals around the world. Water pollution, including human sewage, and rising sea surface temperatures are thought to be major causes, because they provide suitable conditions for the proliferation and colonization of disease-causing microbes.[241]

Over the past 10 years, the frequency of coral diseases has increased significantly.

Once diseased corals die, their exposed limestone skeletons attracts foreign organisms, a process that often leads to the "health of the entire [coral reef] colony taking a downward spiral from which it seldom recovers."[242] At the current rate, coral reefs could shortly disappear. If that happens, they will not soon return. Growth rates range from 0.3 to 10 centimeters (0.1 to 4 inches) per year, and so it can take up to 10,000 years for a coral reef to form. Depending on their size, barrier reefs and atolls can take from 100,000 to 30 million years to fully form.[243]

The Setting

The Florida Keys are home to the third-largest shallow-water coral reef in the world, extending 220 miles west from just south of Miami to the Dry Tortugas. The Keys include the only emergent reefs off the continental United States.[244,245] The Keys comprise 88 percent of coral reefs in Florida, excluding the reefs of the Middle Grounds situated 100 miles off the coast in the Gulf of Mexico, reefs whose isolation and distance from populated shorelines likely provide protection from pollutants and heavy recreational fishing activity.[246] The remaining 12 percent are in southeastern Florida, extending north from Miami to Palm Beach County, and in the eastern Gulf of Mexico. Millions of people visit the coral reefs of the Florida Keys every year, and the reefs have an estimated asset value of $7.6 billion.[247]

Almost all the reefs off the Florida coast are at risk from a number of threats, including runoff of fertilizers and pollutants from farms and coastal development.[248] Coral reefs of the region are in decline, as demonstrated by decreases in coral coverage,

species fluctuations, and disease.[249] The Coral Reef/Hardbottom Monitoring Project of the Water Quality Protection Program documented a 36.6 percent decline in coral cover at monitoring stations during the period between 1996 and 2000.

Human Sewage Contributes to Diseased Coral in the Florida Keys

Much of the pressure on Florida Keys coral reefs is a byproduct of heavy tourism; some 3 million visitors travel to the region each year. But tourists are not the sole source of environmental pressure. Monroe County, home of the Keys, has 78,556 permanent residents, and nearby Miami-Dade County has 2.3 million.[250] Those numbers are increasing, too. Populations in both counties grew between 1990 and 2000—by 16.3 percent in Miami-Dade and 2 percent in Monroe.[251] Monroe's slower growth rate during the last decade obscures a much more precipitous long-term population gain—160 percent since 1960.

Of course, growing populations generate larger volumes of wastewater and spur increased stormwater runoff from expanded development. Declining water quality from "highly inadequate" wastewater and stormwater management in the region already

LOSING NEMO

A 1998 World Resources Institute study finds that nearly 60 percent of the earth's coral reefs are threatened by human activity—ranging from coastal development and overfishing to inland and marine pollution—leaving much of the world's marine biodiversity at risk:[a]

- "Close to half of Hawaii's reefs are threatened."[a]
- "Virtually all of Puerto Rico's reefs are at risk—reef fisheries have plummeted during the last two decades, dropping 69 percent between 1979 and 1990."[b]
- "Jobos Bay National Estuarine Research Reserve in Puerto Rico is in poor condition due to sewage disposal and coastal erosion—coral cover averages less than 5 percent."[c]
- "Dredging, sand extraction, pier construction, and sewage effluent have all impacted U.S. Virgin Island reefs, especially those off St. Thomas and St. Croix. On some reefs, living elkhorn coral cover has fallen from 85 percent to 5 percent."[b]

contributes to the degradation of coral reefs.[252] Approximately 900 prefabricated wastewater treatment systems called "package plants" discharge sewage underground, and more than 25,000 septic tanks continuously leach sewage in or near coastal waters.[253] Nutrient levels in septic tank effluents are likely unsafe for coral reefs.[254]

Some attempts have been made to improve the situation. A Key West wastewater treatment plant has been upgraded to incorporate "nutrient-stripping advanced wastewater treatment" technology, and to replace a 7-million-gallon-per-day ocean outfall pipe with a deep-well injection system for treated effluent. Plant officials are also considering effluent reuse options.[255] But underground injection remains a serious problem for Florida corals, according to documents prepared on behalf of a coalition of local groups that included the Eastern Surfing Association, Palm Beach County District, Floridians for Environmental Accountability and Reform, Inc., the Surfrider Foundation's Palm Beach County and South Florida (Miami-Dade) Chapters, and Wetlands Alert, Inc.[256] The groups maintain that sewage effluent and other fluid contaminants injected into Florida's aquifer system, via hundreds of shallow and deep wells throughout the Florida Keys and south Florida, contribute to the eutrophication of nearshore waters and the death and decline of the coral reefs. The groups conclude that if harmful pathogens associated with

they will not be destroyed while in the aquifer either. In fact, some may proliferate after injection. Approximately 404 billion gallons of injected effluent from the South Dade Wastewater Treatment Plant exceeded the fecal coliform standards over a six-and-a-half-year period.[257]

Scientists at the Harbor Branch Oceanographic Institution (HBOI) agree with the groups' conclusionup80 0 -5(s)3.9(kSv0 0 e]TJ7(ryh)-5d0 0 ausio)-y3(th5HB)6.Ss Fl-4.4(o.7(ou)1.1(fer4.4

Chemical contamination may also pose risks to coral reefs, though little research has been conducted on the subject. A 1995 study in Hawaii showed that polycyclic aromatic hydrocarbons, common constituents of municipal wastes and urban runoff, become toxic and can kill coral larvae when exposed to ultraviolet radiation from sunshine.[263]

Human Sewage Contaminates Florida's Drinking Water

Underground injection of treated sewage threatens not just coral health but human health as

grew progressively worse. Less than a month after he had gone surfing in the polluted waters, doctors found that his blood had been infected with the Coxsackie B4 virus, a viral infection associated with domestic

"unknown."[267] As a first step, California's Clean Beaches Initiative funding priority list includes the City of Malibu's proposed $7 million study of beachwater pollution sources.[268]

Table 8
Swimming Advisories at Surfrider Beach[269]

Year	Number of Advisory Events	Total Days Posted	Average Number of Consecutive Days Posted
2002	14	49	3.5
2001	26	103	4.0
2000	30	160	5.3
1999	10	39	3.9
Average	**20**	**88**	**4.2**

California Beaches—No Stranger to Viral Contamination

Viral contamination is a well-documented problem in the area. A study by the Department of Environmental Analysis and Design of the University of California, Irvine, found human adenoviruses (a group of viruses that can infect the membranes of the respiratory tract, the eyes, the intestines, and urinary tract) in four of twelve samples taken on beaches and at the mouths of major rivers and creeks from Malibu to the border of Mexico, between February and March 1999.[270]

The Santa Monica Bay Restoration Project's 1996 large-scale epidemiological study investigated possible adverse health effects associated with swimming in ocean waters contaminated by urban runoff.[271] Researchers collected water samples at three stormdrain sites on Santa Monica Bay, including Malibu Creek at Surfrider Beach, and analyzed them for enteric viruses (viruses associated with the human intestinal tract). The study found viruses at all three stormdrain sites, and a higher incidence of illness associated with swimming near flowing stormdrain outlets in Santa Monica Bay, than with swimming more than 400 yards away. In addition, illnesses were reported more often on days when the samples were positive for enteric viruses.

But Surfrider Beach does not have the benefit of regular testing for viruses, which can persist in the ocean even when bacteria tests, used by California health agencies to determine beachwater safety, indicate that beaches are safe. Fewer than 100 miles to the

sources of contamination test positive for these viruses (see Table 9). In California, sewage contamination in beachwater is often blamed on stormwater runoff into creeks that empty into the ocean. But in the dry summer months when creeks are not running, a high percentage of the USC-tested samples still showed the presence of viruses, raising the possibility that leaky sewer pipes or septic fields are leaching into groundwater aquifers and contaminating beachwater.

Table 9
Santa Barbara Sites Testing Positive for Hepatitis A and/or Enteroviruses[272]

	Sites Testing Positive for:
	Hep A and/or Entero

Table 10
Contamination Sources of Closings/Advisories at Michigan Beaches, 2002[274]

Reported Source of Contamination	Total Closing and Advisory Days	Percent of Closing and Advisory Days	
		Total	With a Reported Contamination Source
Sewage overflows*	74	35%	61%
Septic systems	30	14%	25%
Stormwater, other**	17	8%	14%
"Unknown"	88	42%	
Total days	**209**		

* Includes CSOs, SSOs, bypasses of publicly owned treatment works, and broken sewer pipes; but excludes septic systems.
** Includes boat discharges, wildlife, etc.

Table 11
Michigan Counties Reporting Sewage Contamination at Local Beaches, 2002[275]

Great Lakes Shoreline County	Water Body	Closing and Advisory Days Due to Sewage Contamination
Macomb	Lake Saint Clair	50

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Manistee, and Kent counties ranked highest for the number of CSOs in 2001. Wayne and Ingham counties reported the highest number of CSOs without data on gallons of sewage discharged. In 2001, two beaches in Wayne County (Pier Park and Crescent Sail Yacht Club) were closed for 16 and 10 consecutive weeks, respectively—essentially the entire

Number of SSO Events

is rapid. Residents filed 18 sewage-related suits against the city between 1996 and 1999.[283]

In 1999 and 2000, about 2,000 homeowners in Michigan sustained sewage-related damage to their homes.[284] An attorney in St. Clair Shores, Macomb County, told the *Detroit Free Press* that sewer problems have become so common in Michigan since 1993 that he has built his law practice around suing governments.[285]

The Setting

Table 15
Reported Sewer Overflows in Milwaukee[297,298]

Collection System Owner	Year	SSOs	SSO Gallons	CSOs	CSO Gallons
Milwaukee Metropolitan Sewerage District	1994	1	2,300,000	1	171,200,000
	1995	5	73,200,000	1	773,300,000
	1996	3	67,700,000	4	674,900,000
	1997	5	248,600,000	2	1,991,500,000
	1998	4	79,600,000	2	629,300,000
	1999	8	271,700,000	6	4,105,400,000
	2000	5	136,029,000	5	3,489,700,000
	2001	8	56,227,400	3	464,600,000
	2002	4	no data	no data	no data
	Total	**43**	**935,356,400**	**24**	**12,299,900,000**
Milwaukee, City	2000	3	752,000	no data	no data
	2001	2	51,000*	no data	no data
	2002	3	40,200	no data	no data
	Total	**8**	**843,200**	**no data**	**no data**

* Gallons are from one event only.

Sewage-Contaminated Beachwater

The vast majority of swimming advisories at beaches in the city of Milwaukee are due to sewage-related contamination (see Table 16). The Milwaukee Health Department monitors three beaches (Bradford Beach, McKinley Beach, and South Shore Beach) daily during the swimming season for *E. coli*. Beginning in the 2001 swim season, the city began using both of the EPA's recommended *E. coli* standards for freshwater beaches—a geometric mean of 126 and a single sample of 235—to determine water safety. In the past, the city used only the single sample standard.

Table 16
Swimming Advisories at Beaches in the City of Milwaukee, 2000–2002[299]

Year	Total Advisory Days	Advisory Days Related to Sewage Contamination	Percent of Advisory Days Related to Sewage Contamination
2000	58	36	62%
2001	38	38	100%
2002	89	80	90%

Beach advisories are just one symptom of Milwaukee's water quality problems. Recreational enthusiasts, including boaters, hikers, kayakers and canoers have reported diminished enjoyment of what should be the city's greatest asset.[300] For example, a local Milwaukee sailor gave this account of his experience in August 2002:

> *What I experienced happened when I went sailing the day after the rain event on a Wednesday morning. I was about to douse my spinnaker when I sailed into a raw sewage slick. At first I thought the white objects floating on the surface was thousands of small dead fish about ten inches in length. The surface of the water was coated with one about every foot or so. Intermingled with these fish-like objects were rafts of a greenish-brown muck that were about 3–6 feet in diameter and about 1–2 feet deep. As I got closer I saw that the fish-like objects were really condoms. Thousands and thousands of used condoms. Then it was clear to me the*

> *rafts of greenish-brown material was no doubt solid human waste. As I examined the rafts closer, cigarette butts and used tampons emerged as well. Tampons were evident due to the blob with a small string dangling into the water. These too were quite frequently seen floating in and amongst the conspicuous condoms. Occasionally there was visible feces that had managed to remain intact in the rafts. Seagulls were fairly numerous. I think they were eating the used condoms. On following days I saw many seagulls sitting in the water around the area and they did not appear to have the ability to fly. I think many seagulls may have died ingesting the used condoms. Though I do not have evidence of that. This entire slick continued for quite some ways. I sailed for approximately 15 minutes at 3.5–4 knots before traversing the width. I estimated it at around a half-mile wide—it was much longer than it was wide. I did not get sick but I was briefly nauseated at the disgusting sight.*[301]

Recent EPA and MMSD Policies Could Lead to Another Disease Outbreak

When the Deep Tunnel was completed in 1994, it was intended to bring an end to SSOs. But as the Legislative Audit Bureau report concludes, "it has not achieved the anticipated results."[302] According to testimony by the Lake Michigan Federation, MMSD has recently changed its operating procedures in an attempt to avoid further SSOs. MMSD's initial protocol was to reserve 80 percent of the Deep Tunnel's 400-million-gallon capacity to accommodate CSOs. As SSOs persisted, MMSD and United Water, the district's private operations contractor, made the decision, with the approval of the Wisconsin Department of Natural Resources, to more than double the percentage of space allocated for sanitary sewage—from 20 percent to 50 percent.[303] In essence, MMSD decided to create a permanent placeholder for sanitary sewage regardless of whether flow from the sanitary sewer system ever materialized. This practice is acknowledged by the department in a fact sheet accompanying its National Pollutant Discharge Elimination System permit, which says, "it is possible should sufficient flow from the separated areas not materialize, that the Deep Tunnel would not fill to full capacity."[304] As a result of this policy change, the volume of individual CSOs has increased—six out of nine CSOs occurred when a significant portion of the Deep Tunnel was not full.[305]

MMSD has now applied this same policy to order bypasses of treatment processes within the treatment plant even when the Deep Tunnel is not filled to capacity. Under the district's permit, it can divert up to 60 million gallons of sewage per day around its secondary treatment unit even when the Deep Tunnel is not yet full.[306] The partially treated sewage is then recombined with fully treated sewage, disinfected, and discharged into local waterways, in a practice referred to as "blending" by the EPA. In June 2002, as a result of a sewage treatment bypass, 21 million gallons of only partially treated sewage were dumped into Lake Michigan, even though the Deep Tunnel was still two-thirds empty.[307]

Similarly, during a rainstorm on December 9 and 10, 2003, MMSD diverted nearly 40 million gallons of partially treated sewage from the Jones Island treatment plant—the third and largest such event in 2003. At the time, the 405-million-gallon Deep Tunnel was less than one-third full. MMSD officials said the bypass was necessary because winter plant maintenance had reduced the capacity of the secondary treatment units at the plant, making it necessary to reverse the flow from the plant back into the tunnels. In

04:00	206	-
06:00	180	-
07:25	222	300
10:10	233	1100
10:20	262	-
13:15	197	650
14.15	209	-
16.28	168	2900
17.45	169	-

The decision to divert sewage from full treatment is based on a judgment by United Water, using information it has received from MMSD's operations department. In August 2001, it was revealed that a faulty sluice gate had leaked thousands of gallons of untreated sewage into the river. Before that, it was learned that on several occasions, United's practice of switching to cheaper electric supplies during rain events had caused millions of gallons of sewage to be discharged. MMSD's explanation for the June 2002 diversion was that it had inaccurately assessed rainfall data; it said it expected another 1.6 inches of rain in the area, when in fact Milwaukee received only 0.78 inches

THE EPA'S PROPOSED SEWAGE TREATMENT BYPASS POLICY ("BLENDING") THREATENS KNOXVILLE'S E

in total.[314]

The EPA has proposed a national sewage "blending" policy that would authorize such sewage treatment bypasses even when a feasible alternative to the discharge of largely untreated sewage is available. Essentially, the proposal would attempt to legalize currently illegal practices by MMSD, instead of enforcing the law to protect the people of Milwaukee. In April 2003, the EPA declined to object to the state's natural resources

CHAPTER 5

RECOMMENDATIONS

rotecting all Americans from exposure to raw and inadequately treated sewage is not a matter of waiting for the next technology breakthrough. Keeping sewage in pipes

The Beaches Environmental Assessment and Coastal Health (BEACH) Act requires states with coastal recreational waters to adopt new or revised water quality standards for bacteria by April 2004. The state standards must be the same as, or as

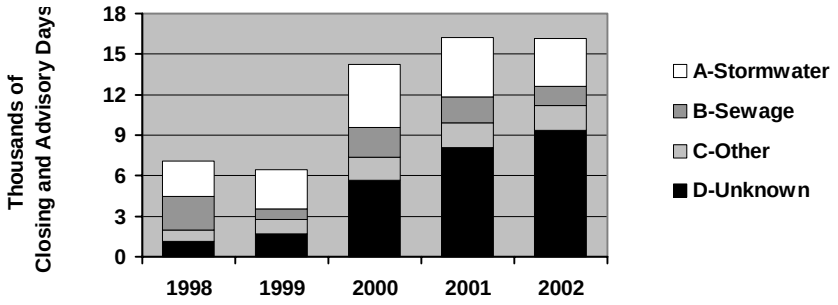

Figure 12 Reported Sources of Fecal Pollution Causing Beach Advisories/Closings, 1998–2002. Key: (A) polluted runoff, stormwater, or preemptive due to rain; (B) known sewage spills and overflows; (C) other reasons; (D) unknown.[329]

The BEACH Act authorizes $30 million a year for state grants for monitoring and public notification—the EPA has provided $10 million in annual grants since 2001. The law should be amended to allow these grants to be used for identification of beachwater contamination sources in addition to monitoring and public notification.

ENFORCE CURRENT SEWAGE TREATMENT PLANT REQUIREMENTS

Sanitary sewer overflows are illegal, yet the EPA estimates that the number of such overflows is growing. Enforcement of the Clean Water Act is critical to encouraging sewer operators to invest in solutions. Sewer operators, like everyone else, prioritize their expenditures. If there is no real threat of enforcement, they will not choose to invest in com-

Drop the EPA Proposal to Allow Sewage to Skip Treatment Processes in Rain Events

The EPA should abandon its "blending" guidance that changes the Clean Water Act's current prohibition on discharges of inadequately treated sewage. The agency proposes to allow primary treated sewage to be blended with secondary sewage during wet weather events. Effective treatment for sewage is essential, and to accomplish it, the sewage must receive treatment that effectively removes pathogens and other pollutants before it is discharged. The EPA should abandon its proposed policy change of allowing dilution to substitute for effective treatment when it is raining. Except in emergency situations when no feasible alternative exists, sewage should be fully and effectively treated to reduce pollutant loadings and to reduce the risk of spreading waterborne disease throughout the population.[330]

Microbiologists at Michigan State University analyzed the risks associated with blending and found that over 99 percent of the quantity of pathogenic viruses and parasites comes from the untreated portion of the flow. They found the risks of swimming in waters receiving blended effluent are between 100 and 1000 times greater than if the wastewater had been completely treated, and said, "As a result of blending effluents during a wet weather event, waterborne disease outbreaks could have a higher plausible occurrence."[331]

Inadequately treated and diluted sewage contains high levels of nitrogen and suspended particulates, both of which interfere with chlorine disinfection. Not only could viable viruses and parasites more easily escape into the environment, but bacterial pathogens that might otherwise be effectively killed by chlorine could survive by shielding from particulates.[332,333] As a result, treatment facilities would have to dump much larger

required the public to be notified when sewer overflows occur. The rule was based on consensus recommendations of a federal advisory committee that met for 5 years. It was specifically agreed to by the sewer operators who are now seeking to exempt themselves from the sewage treatment requirements that they are violating.

The SSO rule would keep bacteria-laden raw sewage discharges out of America's streets, waterways and basements, and make public reporting and notification of sewer overflows mandatory. It would help protect the public from illnesses caused by exposure to raw sewage; improve capacity, operation and maintenance of sewer systems; and cost

- The American Society of Microbiologists concludes that "[a]ny effective risk assessment [of microbial pollution in water] demands an adequate database of

require sewer operators to set up a program to monitor sanitary sewer overflows and notify the public and public health authorities of raw sewage discharges.

The Raw Sewage Overflow Community Right-to-Know Act (HR 2215), introduced by Rep. Timothy Bishop (D-NY) and nine other House members, would amend the Federal Water Pollution Control Act. It would require sewage authorities to implement a means of detecting SSOs, notify the public and health authorities in a timely manner when SSOs are detected, and submit a written report to the state environmental agency documenting the volume, duration, and cause of the SSO and the steps taken to mitigate its impact and prevent or reduce similar occurrences. The bill would also require sewage authorities to submit this information in an annual report to the state environmental agency. Passage of this legislation would warn the public not to swim in sewage-infested waters and would vastly increase the available public information about the number of

spurred to action to get out of the public spotlight. Conversely, others may be inspired by

ENDNOTES

[1] The EPA reports U.S. average daily sewage flow equals 50 trillion gal x 365 days = 18,250 trillion gal/year. Great Lakes occupy 5,652 miles^3 or 6,224 trillion gal (www.greatlakes-seaway.com/en/navigation/cruises_facts.html) = 0.34 years to fill Great Lakes with sewage.

[2] The EPA estimates ~500,000 miles of municipal pipes and ~500,000 miles of private pipes connected to municipal systems: U.S. EPA, Notice of Proposed Rulemaking, National Pollutant Discharge Elimination System (NPDES) Permit Requirements for Municipal Sanitary Sewer Collection Systems, Municipal Satellite Collection Systems, and Sanitary Sewer Overflows (January 4, 2001) (*note*: there are no official page citations available since this proposal was not published), p.17; average distance from earth to moon is ~240,000 miles.

[3] For this report, sewer overflows include all dry and wet weather releases of sewage into the surrounding environment from anywhere in the sewage collection system prior to the headworks of the publicly owned treatment works.

[4] U.S. EPA, Notice of Proposed Rulemaking, *op. cit.*, January 4, 2001, p. 25.

[5] U.S. EPA, *The Clean Water and Drinking Water Infrastructure Gap Analysis*, Office of Water, EPA-816-R-02-020, September 2002, p. 8.

[6] The EPA estimates 1.26 trillion gal discharged from CSOs alone annually. National Association of Counties counts 3,066 U.S. counties; Madison Square Garden = ~13.7 million ft^3 or 102.86 gal (www.praxair.com/praxair.nsf/0/cabd4f9cc57eccbe852565b00075aa23?OpenDo

[39] Metronidazole is a recognized carcinogen (California EPA, "Chemicals Known to the State to Cause Cancer or Reproductive Toxicity," July 11, 2003) and a suspected neurotoxicant (www.scorecard.org, Environmental Defense).

[40] Health Canada, Healthy Environments and Consumer Safety, Water Quality and Health Bureau, *Protozoa:* Giardia *and* Cryptosporidium, Ottawa, Ontario, July, 1996, revised May 1999 (www.hc-sc.gc.ca/hecs-sesc/water/pdf/protozoa_final.pdf).

[41] Simmons, O.D., M.D. Sobsey,

[75] “Cryptosporidiosis,” Fact

[109] www.scorecard.org., "Environmental Defense," compiled health effects information from scientific sources and regulatory agencies. See www.scorecard.org for specific toxicity references used for each chemical.

[110] Based on data downloaded from U.S. EPA's TRI Explorer (www.epa.gov/triexplorer/), October 2003, and data obtained from www.scorecard.org.

[111] U.S. EPA, *2001 Toxics Release Inventory Public Data Release*, Chapter 3, p. 20 (an increase of 1,093 pounds based only on those PBTs required to be reported in both years).

[112] Ibid., p. 15.

[113] Krümmel, E. M., R. W. Macdonald, L. E. Kimpe, I. Gregory-Eaves, M. J. Demers, J. P. Smol, B. Finney, J. M. Blais, "Delivery of pollutants by spawning salmon: Fish dump toxic industrial compounds in Alaskan lakes on their return from the ocean," *Nature*, vol. 425, September 18, 2003, p. 255.

[114] U.S. EPA, "Progress in Water Quality: An Evaluation of the National Investment in Municipal Wastewater Treatment," 2000, pp. 2–27.

[115] U.S. EPA, National Water Quality Inventory: 2000 Report, p. 30.

[116] U.S. EPA, *Clean Water Action Plan: Restoring and Protecting America's Waters*, February 1998, p. 2 ("Lake Erie is recovering from a time when pollution levels soared and beach closures were

[148] Herman, S.A., "Compliance and Enforcement Strategy Addressing Combined Sewer Overflows and Sanitary Sewer Overflows," April 27, 2000, memorandum to Water Management Division Directors, U.S. EPA Regions I-X.

[149] Ibid., p. 8.

[150] Bosch, A., "Human Enteric Viruses in the Water Environment: A Minireview," *International Microbiology*, vol. 1, 1998, pp. 191,196 (http://www.im.microbios.org/03setember98/04%20Bosch.pdf).

[151] Katonak and Rose, *op. cit.*, p. 28.

[152] "Draft On-site Sewage Risk Assessment System Rev A, April 2001" (http://www.dlg.nsw.gov.au/dlg/dlghome/documents/septicsafe/OSRAS_165-172.pdf).

[153] Claussen, E., President, Pew Center on Global Climate Change, "The Global Warming Dropout," *New York Times*, OpEd, June 7, 2002.

[154] "President Bush Discusses Global Climate Change," Office of the Press Secretary, The White House, June 11, 2001.

[155] Hileman, B., "Climate Change: Earth is warming, and the environmental changes—largely attributable to greenhouse gases—are dramatic and potentially dangerous in the Arctic," *Chemical & Engineering News*, American Chemical Society, December 15, 2003, p. 30.

[156] Tai, M., "Extreme Precipitation Linked to Waterborne Disease Outbreak," *The Johns Hopkins Gazette Online*, vol. 30, no. 41, August 6, 2001, quoting Jonathan Patz, assistant professor of environmental

[194] Miami Group of the Sierra Club, *Clean Water—Safer Homes: Stop the Sewage Overflows*, a PowerPoint presentation, April 2003.

[195] Sierra Club,

[230] Improving Kids' Environment, *Discriminatory Effects of Indianapolis' Combined Sewer System* (as presented on December 22, 2003, at www.ikecoalition.org/Sewers_Indy/indy_civil_rights.htm).

[231] Neltner, T., *op. cit.*, December 17, 2001.

[232] U.S. EPA, TRI Explorer,

[274] U.S. EPA, National Health Protection Survey of Beaches for the 2002 Swimming Season.

[275] Ibid.

[276] Data provided to U.S. EPA from the state of Michigan.

[277] U.S. EPA, "National Health Protection Survey of Beaches for the 2001 Swim Season."

[278] Ibid.

[279] Data provided to U.S. EPA from the state of Michigan.

[280] Ibid.

[281] "Lawyers of the Year, 2002," *Michigan Lawyers Weekly*, (www.milawyersweekly.com/loty2002/macugaliddle.cfm).

[282] Ibid.

[283] Martin, E. L., "Cities aim to plug sewer suits: Legislative proposal would limit their liability for basement floods," *Detroit Free Press*, March 20, 1999 (www.freep.com/news/locoak/qsewer20.htm).

[284] Ballou, B. "Old sewer

[327] Personal communication with Laurel O'Sullivan, Lake Michigan Federation, January 2004.

[328] Dorfman, M., *op. cit.*, August