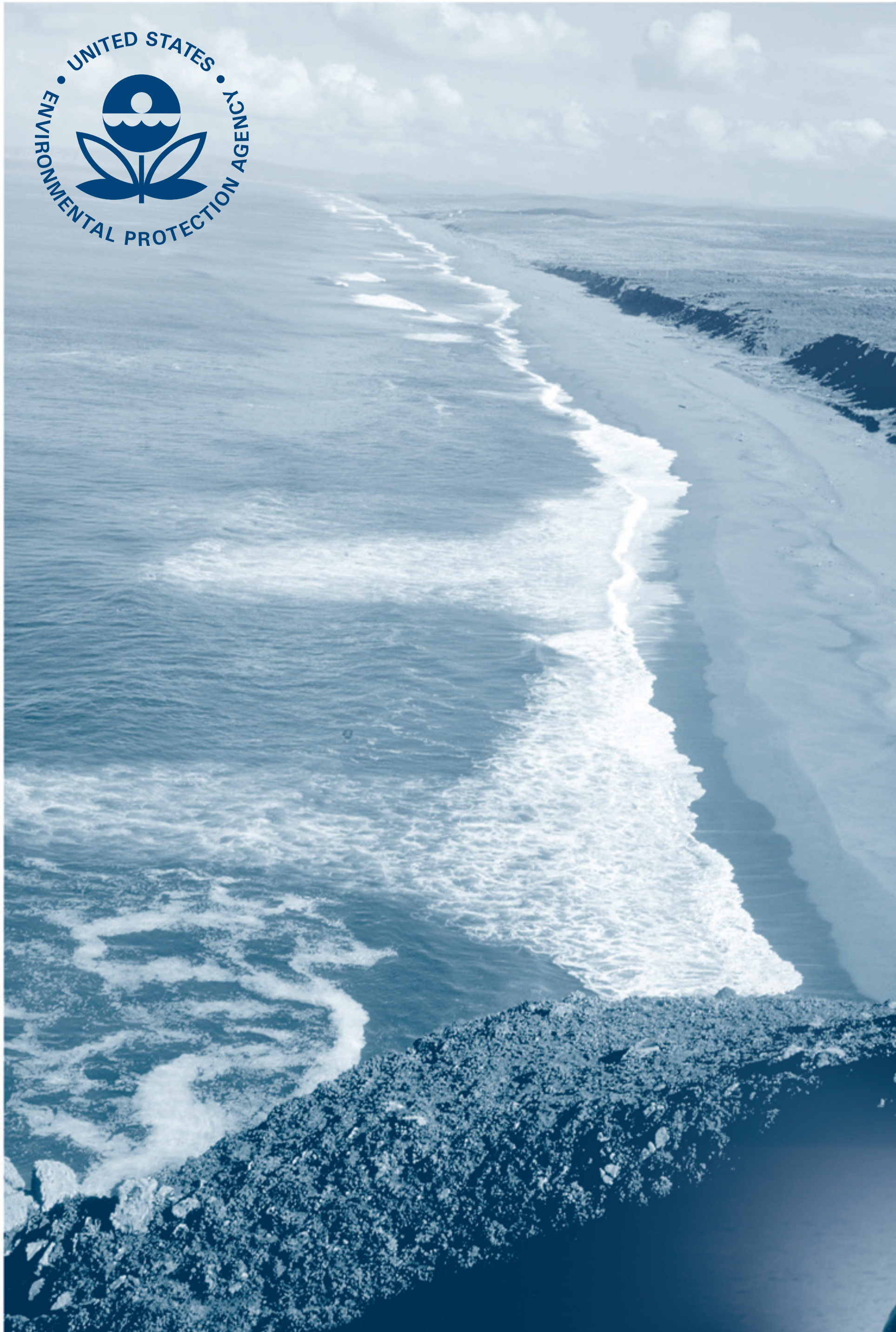

Implementing the BEACH Act of 2000

Report to Congress

October 2006

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EPA-823-R-06-001

Contents

Executive Summary

Section 7 of the BEACH Act of 2000 requires EPA to publish reports to Congress on the implementation of the Act. This is the first Report to Congress since the passage of the BEACH Act in 2000. This report documents the significant progress that the states, territories and EPA have made to implement the BEACH Act.

Our coastal beaches are one of our nation's natural treasures. They are ecologically important, psychologically important, and economically important to us. In 2000, EPA estimated that a third of all Americans visit coastal areas each year, making a total of 910 million trips and spending about $44 billion (USEPA 2000). For many people, a day at the beach

> ***"The Beach. Say the words and they conjure the gentle tickle of waves against the shore, the harder kick of surf dashing against the rocks, the slap of spray against heated skin. For most of us, the place where earth meets ocean is the very essence of play—romantic, full of novelty and joyful abandon. At the beach, we are all children. As we gambol in the shallow surf and toss in the deeper waves, we feel the freedom of helplessness and the satisfaction of improvising defenses. Unburdened by consciousness or self-consciousness, we are caught in the moment. Suffused with pleasure, we exult in the sheer lightness of being."***
>
> —(Marano, Psychology Today, 1999)

provides recreation, relaxation, and a chance to renew the spirit. Americans also make coastal areas their home. Over half the U.S. population lives in coastal watershed counties, and roughly one-half of the nation's gross domestic product ($4.5 trillion in 2000) is generated in those counties and in adjacent ocean waters (U.S. Commission on Ocean Policy 2004).

Americans have recognized the need for improved protection of public health at beaches, including stronger beach monitoring programs, and in 2000 Congress passed the Beaches Environmental Assessment and Coastal Health (BEACH) Act. Since then, the EPA, in partnership with state and local governments, has made significant progress in improving public health at our nation's beaches. EPA is pleased to report the following:

1. States have significantly improved their assessment and monitoring of beaches; the number of monitored beaches has increased from about 1,000 in 1997 to more than 3,500 out of approximately 6,000 beaches, as identified to EPA by the states for the 2004 swimming season.
2. EPA has strengthened water quality standards throughout all the coastal recreation waters in the United States; the number of coastal and Great Lakes states with up-to-date water quality criteria has increased from 11 in 2000 to 35 in 2004.
3. EPA has improved public access to data on beach advisories and closings by improving its electronic system for beach data collection and delivery systems; the system is known as "eBeaches." The public can view the beach information at http://oaspub.epa.gov/beacon/beacon_national_page.main.

4. EPA is working to improve pollution control efforts that reduce potential adverse health effects at beaches. EPA's Strategic Plan and recent National Water Program Guidance describe these actions to coordinate assessment of problems affecting beaches and to reduce pollution. (See section 3.5).
5. EPA is conducting research to develop new or revised water quality criteria and more rapid methods for assessing water quality at beaches so that results can be made available in hours rather than days. Quicker tests will allow beach managers to make faster decisions about the safety of beach waters and thus help reduce the risk of illness among beachgoers.

These achievements are the result of specific actions implemented by EPA and the states under the BEACH Act. The actions are summarized in Table ES-1 and described following.

Improving water quality standards, water quality criteria, and water quality

EPA and states took regulatory action to improve the existing water quality standards. In addition, the Agency devoted significant resources for conducting new research and developing new or revised recommended water quality criteria.

Promulgation of water quality standards

EPA responded to the BEACH Act's requirement that the Agency propose water quality standards using its most current water quality criteria if states had not adopted these criteria by April 10, 2004. On November 16, 2004, EPA published a final rule that put federal standards into place for the 21 states without criteria that are as protective of human health as EPA's 1986 criteria for coastal recreation waters.

Technical research

Since passage of the BEACH Act, EPA has initiated and conducted significant research activities. For example, EPA—through its National Epidemiological and Environmental Assessment of Recreational (NEEAR) Water Study—is evaluating rapid indicator methods to detect fecal contamination and assessing them with epidemiological studies that relate the rapid indicator measurements to human health. EPA has completed its recommended studies of Great Lake waters and is now assessing this new information, as part of a process to develop new or revised water quality criteria. EPA is assessing its further research needs at this time.

Recommendations to improve beach water quality

In its Strategic Plan (USEPA 2003c), EPA identifies "Water Safe for Swimming" as an important objective for the Agency. EPA's *National Water Program Guidance* for both FY 2005 and FY 2006 (USEPA 2004a and USEPA 2005b) summarized the Agency's key national strategies and actions to help improve beach water quality. For FY 2005 and FY 2006, EPA's national strategy for improving the safety of recreational waters includes four key elements:

1. Establish a new generation of pathogen indicators based on sound science.
2. Identify unsafe recreational waters and begin restoration.
3. Reduce pathogens levels in all recreational waters.
4. Improve beach monitoring and public notification.

Implementing the BEACH Act

EPA and the states have focused on another set of actions to help reduce the human health risks at beaches through better water quality monitoring and improved public notification. Important progress has been made working cooperatively with state and local environmental and public health agencies. Actions include the following:

- ***Beach grants.*** EPA provided beach program development grants to states in FY 2001 and has provided implementation grants to all states (except Alaska) since then. EPA has awarded, or is in the process of awarding, approximately $52 million in grants to states to develop and implement beach monitoring and public notification programs.
- ***State and local accomplishments.*** Many of the actions discussed below were accomplished through the diligent efforts of state and local public health and environmental agencies. State-written "spotlights" that provide detailed descriptions of achievements resulting from state and local beach programs are provided in Section 4.3 and Appendix B of the report.
- ***National program requirements and guidance.*** EPA published *National Beach Guidance and Required Performance Criteria for Grants* in July 2002. This document established the fundamental framework for beach programs and provides guidance for receiving implementation grants. EPA developed the document in consultation with coastal states and other interested parties over a two-year period.
- ***National List of Beaches.*** States completed the first national, comprehensive listing of beaches using a risk-based classification scheme to identify monitoring and notification priorities. This list will eventually be linked to detailed geographic identifiers, monitoring stations, and other data systems.

- ***eBeaches.*** EPA has improved public access to data on beach advisories and closings by improving its electronic system for beach data collection and delivery systems; the system is known as "eBeaches." This online system includes a database of monitoring results and notification actions, thereby fulfilling the National Pollution Occurrence Database requirement of the BEACH Act. The public can view the beach information at http://oaspub.epa.gov/beacon/beacon_national_page.main.

Recommending improvements to methodologies and techniques for monitoring of coastal recreation waters

EPA and others have taken a number of actions to improve our understanding of beach water quality monitoring and modeling. For example, EPA is developing faster indicator methods that will provide more rapid results than the currently used tests. The goal is to help beach managers quickly test the water and make available the results about the safety of beach waters in hours, rather than days. This technology will help reduce the risk of waterborne illness among beachgoers.

EPA's Office of Research and Development (ORD) conducted an intensive monitoring program (the Environmental Monitoring for Public Access and Community Tracking, or EMPACT, study) at several beaches to determine what factors influence microbial indicator concentrations. This study provides state and local governments with information for improving the design of site-specific beach monitoring programs. Included is an examination on how environmental factors like sunshine, tide, rain, or wind and sampling variables (such as sampling times and sample depth and distance from the shore) affect fecal indicator levels.

ORD has also been investigating means to improve the monitoring of beach water quality and to develop strategies, including modeling, for timely notification of the public when bacterial contamination poses a risk to bathers. New software called Virtual Beach is being developed to support both empirical and physical approaches in an integrated application. In collaboration with the U.S. Geological Survey (USGS), EPA is developing a prototype of Virtual Beach to automate statistical analytical techniques developed by USGS. The goal is to develop a user-friendly application that can help beach managers predict the need for a beach advisory or closing up to three days in advance.

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Table ES-1. **Accomplishments in Implementing the BEACH Act**

Activity	Date	Page
Water Quality Criteria and Other Actions To Improve Coastal Recreation Waters		
• **Existing Water Quality Standards** Promulgated water quality standards for states and territories that had not yet adopted water quality criteria for bacteria that were as protective of human health as EPA's 1986 bacteria criteria.	November 2004	3-1
• **National Epidemiological and Environmental Assessment of Recreational (NEEAR) Water Study** Initiated joint study with the CDC, USGS, and others to test potential new water quality indicators.	2001-present	3-3
• **Rapid Methods** Developing new water quality tests that will provide rapid results.	2001-present	3-3
• **Water Quality Criteria Development** Will update water quality criteria based on ongoing and planned studies.	2001-ongoing	3-5
• **Recommendations to improve beach water quality** EPA's strategic plan included combination of actions to improve recreational water quality.	September 2003	3-7
Evaluation of Federal, State, and Local Efforts		
• ***National Beach Guidance and Required Performance Criteria for Grants*** Published the *National Beach Guidance and Required Performance Criteria for Grants*, establishing the basic requirements for beach programs that receive federal beach funds.	July 2002	4-1
• **Awarded BEACH Grants** EPA has awarded, or is in the process of awarding, approximately $52 million in grants to states to develop and implement beach monitoring and public notification programs.	2000-present	4-3
• ***"eBeaches"*** Designed, built, and implemented an electronic data system called eBeaches to collect, store, and provide beach information to the public. http://oaspub.epa.gov/beacon/beacon_national_page.main.	May 2005	4-4
• ***National Health Protection Survey of Beaches*** Continued the National Health Protection Survey of Beaches through 2002 to collect information about state and local beach programs.	1997-2002	3-5
• ***National List of Beaches*** Developed and published a "list of beaches" ("list of waters") that includes those with a monitoring and notification program, as well as those without a program.	2004-present	4-7
• ***Floatables*** Published guidance titled *Assessing and Monitoring Floatable Debris* to help states, tribes, and local governments develop their own assessment and monitoring programs for floatable debris in coastal recreation waters.	August 2004	4-7
• ***State and Territory Accomplishments*** States and territories have used BEACH Act grant funds to implement and improve their beach monitoring and public notification programs.	2001-present	4-9
Recommendations to Improve Integrated Coastal Water Monitoring and Modeling		
• ***Environmental Monitoring for Public Access and Community Tracking (EMPACT) Beaches Project*** Conducted a study to identify those characteristics of a beach environment that have a significant impact on monitoring in coastal recreation waters.	September 2005	5-1
• ***Modeling*** Investigated the USGS Project SAFE model. Collaborated with USGS to design the Virtual Beach model.	2005	5-2

Chapter 1

Introduction

1.1 What is the nature of the problem?

Over the past 50 years, epidemiological studies and "outbreak investigations" have linked swimming in polluted water with adverse human health effects. Epidemiological studies determine the relationship between water quality and health effects in swimmers. Swimming-related diseases can range from less severe gastrointestinal diseases (e.g., sore throats and diarrhea) and non-gastrointestinal diseases (e.g., respiratory, ear, eye, and skin infections) to more serious illnesses, such as meningitis or hepatitis (Rose et al. 1999).

Fecal contamination of our nation's recreation waters originates from many sources, including coastal and shoreline development, wastewater collection and treatment facilities, septic tanks, urban runoff, disposal of human waste from boats, bathers themselves, animal feeding operations, and natural animal sources like wildlife. People who swim and recreate in water contaminated with fecal pollution are at an increased risk of becoming ill because of pathogens from the fecal matter (Craun et al. 2005).

1.2 What is the BEACH Act?

On October 10, 2000, the Beaches Environmental Assessment and Coastal Health Act (BEACH Act) was signed into law, amending the Clean Water Act (CWA). The BEACH Act addressed pathogens and pathogen indicators in coastal recreation waters, and it contains three significant provisions, summarized as follows:

- The BEACH Act amended the CWA by adding section 303(i), which requires states and tribes that have coastal recreation waters to adopt new or revised water quality standards by April 10, 2004, for pathogens and pathogen indicators for which EPA has published criteria under CWA section 304(a). Section 303(i) also directs EPA to promulgate standards for states that fail to establish standards as protective of human health as EPA's published criteria.
- The Act amended the CWA by adding section 104(v) and 304(a), which together require EPA to conduct studies associated with pathogens and human health

and to publish new or revised CWA section 304(a) criteria for pathogens and pathogen indicators based on those studies. Under section 303(i)(1)(B), states that have coastal recreation waters are directed to adopt new or revised water quality standards for all pathogens and pathogen indicators to which EPA's new or revised section 304(a) criteria are applicable by not later than three years after EPA's publication of the new or revised section 304(a) criteria.

- The Act amended the CWA to add section 406, which authorizes EPA to award grants to states or local governments to develop and implement beach monitoring and assessment programs.

The Beach Act also amended part 502 of the CWA to define *coastal recreation waters* as the Great Lakes and marine coastal waters (including coastal estuaries) designated under CWA section 303(c) for swimming, bathing, surfing, or similar water contact activities. The term *coastal recreation waters* does not include inland waters or waters upstream of the mouth of a river or stream that has an unimpaired connection with the open sea.

A copy of the BEACH Act is in **Appendix A**.

The BEACH Act is also available online at: *www.epa.gov/waterscience/beaches/act.html*

1.3 Organization of the Report to Congress

Section 7 of the BEACH Act required EPA to publish a report to Congress four years after enactment and every four years thereafter. Specifically, the act required that the report include

- Recommendations concerning the need for additional water quality criteria for pathogens and pathogen indicators and other actions that should be taken to improve the quality of coastal recreation waters (Chapter 3)

- An evaluation of federal, state, and local efforts to implement the act (Chapter 4)
- ⋆ Recommendations on improvements to methodologies and techniques for monitoring coastal recreation waters (Chapter 5)

This report to Congress fulfills EPA's obligation for the first report. It provides a synopsis of the health concerns related to pathogens, followed by chapters that address the three requirements of Section 7 of the BEACH Act. This report documents the significant progress that EPA and its partners have made in implementing the BEACH Act. The Agency's collaborative work with other federal agencies, states, and territories, as well as local environmental and public health agencies, has resulted in better beach monitoring and notification and, consequently, better public health protection at America's beaches.

1.4 References

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Chapter 2

Health Concerns at Beaches

2.1 What are pathogens and bacterial indicators?

This section includes background information about pathogens and bacterial indicators to allow a better understanding of the BEACH Act's requirements for water quality standards and criteria.

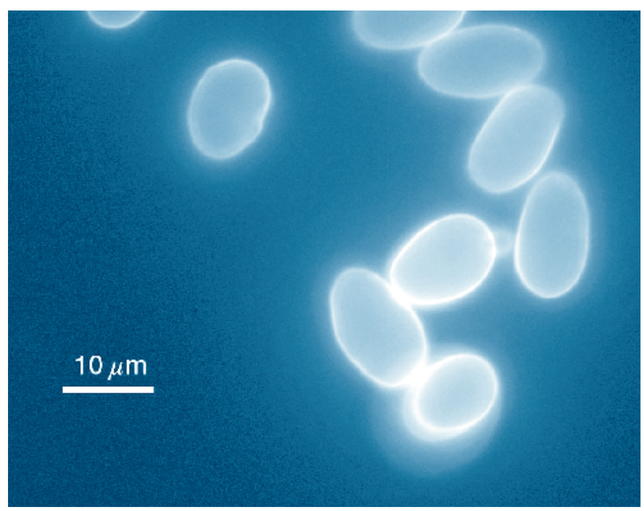
Pathogens

A *pathogen* is defined as any disease-producing microorganism (Dorland's Illustrated Medical Dictionary, 2000). Microorganisms are ever-present in all terrestrial and aquatic ecosystems. Many types are beneficial, functioning as agents for chemical decomposition, food sources for larger animals, and essential components of the nitrogen cycle and other biogeochemical cycles. Some microorganisms reside in the bodies of animals and aid in the digestion of food; others reside on the skin, providing protection against pathogens. Still others are used commercially for medical purposes, such as providing antibiotics.

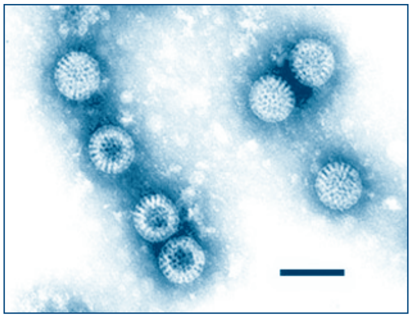
The small subset of microorganisms that cause human diseases are known as human pathogens. If taken into the body, they can cause gastrointestinal illness, other medical problems, or even death. The source of human pathogens is usually the feces of humans and other warm-blooded animals. For recreational waters, there are three groups of gastrointestinal pathogens of concern—bacteria, viruses, and protozoans.

- ***Bacteria*** are unicellular organisms that lack an organized nucleus and contain no chlorophyll (Chapra 1997). They contain a single chromosome and typically reproduce by binary fission, during which a single cell divides to form two new cells. A primary bacteria source of concern at beaches is feces from people and other warm-blooded animals, including fecal waste associated with farming and the discharge of domestic sewage. Feces can contain many types of bacteria found in waterbodies, including the coliform group, streptococcus, lactobacillus, staphylococcus, and clostridia. It is important to understand, however, that most bacteria are not pathogenic or disease-causing.

- ***Protozoans*** are unicellular organisms with a nucleus that reproduce by fission and occur primarily in the aquatic environment. Pathogenic protozoans, which constitute almost 30 percent of the 35,000 known species of protozoans, are found in the feces of people and other warm-blooded animals (Mitchell et al. 1988, cited in NCSU 1997). They can exist in the environment as cysts that hatch, grow, and multiply after ingestion, causing associated illness. Encystation of protozoans facilitates their survival by protecting them from harsh conditions like high temperature and salinity. Two protozoan species of major concern as waterborne pathogens are *Giardia lamblia* and *Cryptosporidium parvum* (*Academic Press* 2003).



Giardia lamblia. (H.D.A. Lindquist. USEPA)



Rotavirus. *(F.P. Williams. USEPA)*

- ***Viruses*** are a group of infectious agents that require a host in which to live and reproduce. They are composed of a sequence of nucleic acids—either DNA or RNA, depending on the virus—that is covered by a protein shell for protection. The most significant virus group affecting water quality and human health grows and reproduces in the cells of the gastrointestinal tract of people and infected animals. These enteric viruses are excreted in feces, and they include hepatitis A, rotaviruses, caliciviruses (noroviruses), adenoviruses, enteroviruses, and reoviruses.

Bacterial indicators

Bacterial indicators[1] are used to measure fecal contamination in environmental waters and the potential presence of a diverse group of hard-to-detect pathogenic organisms. A bacterial indicator organism provides evidence of the presence or absence of fecal waste and the potential presence of pathogenic organisms that survive under similar physical, chemical, and nutrient conditions. An ideal indicator organism should have as many of the following characteristics as possible: be easily detected using simple laboratory tests; generally not be present in unpolluted waters; appear in concentrations that can be correlated with the extent of contamination; and have a die-off rate similar to the die-off rate of the pathogens of concern (Sloat and Ziel 1992, Thomann and Mueller 1987).

Most disease-causing microbes exist sporadically, often at very low concentrations, and are difficult and expensive to detect. Indicator organisms, therefore, have been used for more than a century to help identify where fecal contamination has occurred and to indicate where disease-causing microbes might be present. These organisms generally do not cause illness directly; however, they have characteristics that make them good indicators that fecal contamination has occurred and that harmful pathogens might be in the water (Thomann and Mueller 1987, Wilhelm and Maluk 1999). Figure 2.1 shows the relationship of various bacterial indicator organisms.

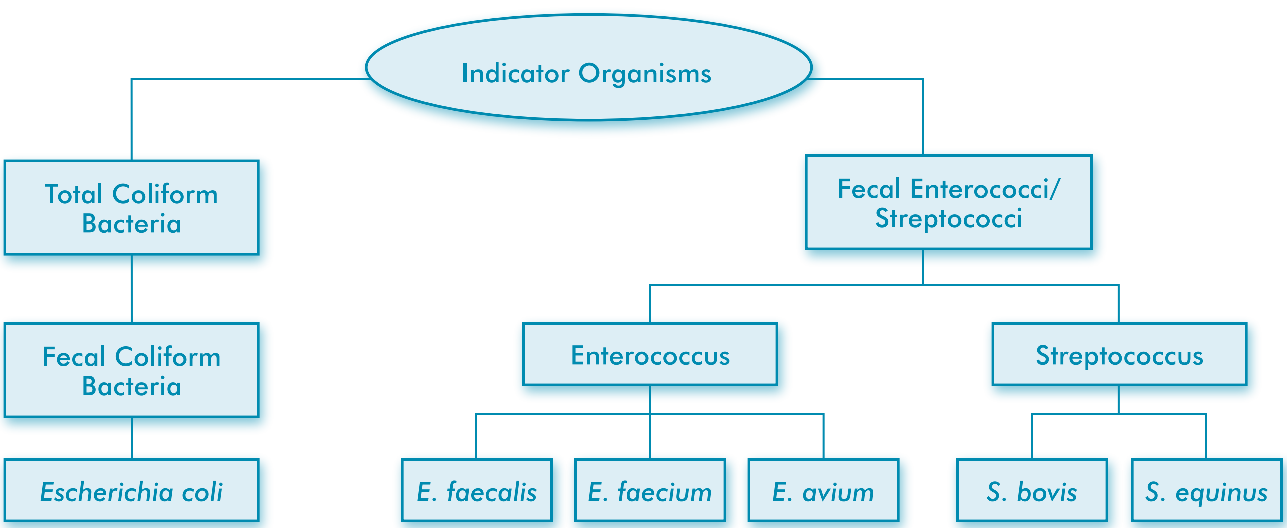


Figure 2.1. Relationship between bacterial indicator organisms

[1] This report uses the term *bacterial indicators* because it is the term more commonly used by microbiologists. The CWA defines a pathogen indicator as a substance that indicates the potential for human infectious disease. EPA interprets the term pathogen indicators, as used in the BEACH Act, to refer to any indicators for pathogens, which include bacterial indicators.

Table 2.1. Waterborne Pathogens *(adapted from Metcalf and Eddy, 1991)*

Pathogen	Disease	Effects
Bacteria		
Escherichia coli (enteropathogenic)	Gastroenteritis	Vomiting, diarrhea, and death in susceptible populations
Helicobacter pylori	Gastritis	Diarrhea. Peptic ulcers are a long-term sequela.
Legionella pneumophila	Legionellosis	Acute respiratory illness
Leptospira	Leptospirosis	Jaundice, fever (Weil's disease)
Pseudomonas	Infections in immuno-compromised individuals	Urinary tract infections, respiratory system infections, dermatitis, soft tissue infections, bacteremia, and a variety of systemic infections
Salmonella typhi	Typhoid fever	High fever, diarrhea, ulceration of the small intestine
Salmonella	Salmonellosis	Diarrhea, dehydration
Shigella	Shigellosis	Bacillary dysentery
Vibrio cholerae	Cholera	Extremely heavy diarrhea, dehydration
Yersinia enterolitica	Yersinosis	Diarrhea
Protozoans		
Balantidium coli	Balantidiasis	Diarrhea, dysentery
Cryptosporidium	Cryptosporidiosis	Diarrhea
Entamoeba histolytica	Ameobiasis (amoebic dysentery)	Prolonged diarrhea with bleeding, abscesses of the liver and small intestine
Giardia lamblia	Giardiasis	Mild to severe diarrhea, nausea, indigestion
Naglaria fowleri	Amoebicmeningoencephalitis	Fatal disease; inflammation of the brain
Viruses		
Adenovirus (31 types)	Respiratory disease	Eye infections, diarrhea
Astroviruses	Gastroenteritis	Vomiting, diarrhea
Enteroviruses (67 types, e.g., polio, echo, and Coxsackie viruses)	Gastroenteritis	Diarrhea. Heart anomalies and meningitis are long-term sequela and are very rare.
Hepatitis A and E	Infectious hepatitis	Jaundice, fever
Noroviruses (Norwalk- and Sapporo-like viruses)	Gastroenteritis	Vomiting, diarrhea
Reovirus	Gastroenteritis	Vomiting, diarrhea
Rotavirus	Gastroenteritis	Vomiting, diarrhea

2.2 What are the health concerns at beaches?

Various studies and reports have documented the adverse health effects that might result from human exposure to fecally contaminated waters. The main route of exposure to disease-causing organisms in recreation waters is contact with polluted water while swimming.[2]

In waters that contain fecal contamination, bathers could potentially contract all the waterborne diseases spread by the fecal-oral route (Henrickson et al. 2001). These illnesses include diseases resulting from exposure to various pathogens, such as

- Bacteria that can cause cholera, salmonellosis, shigellosis, and gastroenteritis
- Viruses that can cause diseases like infectious hepatitis, gastroenteritis, and intestinal diseases
- Protozoans that can cause diseases like amoebic dysentery, cryptosporidiosis, and giardiasis

These and other diseases that can result from contact with water contaminated with introduced or naturally occurring pathogens are summarized in Table 2.1.

When people become ill as a result of contact with contaminated water, one common illness is gastroenteritis. Gastroenteritis is the inflammation of the gastrointestinal tract, usually caused by a microorganism. It can involve chills, nausea, diarrhea, and sometimes fever.

People can also contract diseases that affect the eyes, ears, skin, and upper respiratory tract. Infection might result when pathogenic microorganisms come into contact with abrasions in the skin, or ruptures in delicate membranes in the ear or nose, resulting from swimming exposures.

Epidemiology studies

The relationship between water quality and human health has been studied for many years. EPA began studies to quantify the relationship between the quality of bathing water and the resultant health effects in 1972. Studies in the 1970s and 1980s examined the differences in symptomatic illness between swimming and nonswimming beachgoers at marine and freshwater bathing beaches. The studies found the following (USEPA, 1999):

- Swimmers who bathe in water contaminated with sewage are at greater risk than nonswimmers of contracting gastroenteritis.
- The swimming-associated illness rate increases as the quality of the bathing water degrades.
- The illness rate in marine swimmers is greater than that in freshwater swimmers when indicator densities are equivalent in marine waters and freshwaters.
- Most swimming-related illnesses are of undetermined etiology (cause).[3]

In 1995, researchers with assistance from the Santa Monica National Estuary Program, launched a large-scale study in the Santa Monica Bay area to assess both the effectiveness of bacterial indicators in predicting health risks to bathers and the relative health risk associated with bathing near storm drains. In this study, approximately 15,000 beachgoers who bathed and immersed their heads were interviewed. Approximately 13,000 of the beachgoers were contacted for follow-up interviews designed to assess the occurrence of symptoms such as fever, chills, nausea, and diarrhea. The study found that there is a significant correlation between swimming in water with high densities of indicator bacteria and the incidence of adverse health effects. In addition, the study indicated that people who swim in front of flowing storm drains are twice as likely to exhibit adverse health effects as people who swim 400 yards away from such storm drains (Haile et al. 1996).

A review of studies conducted during the past several decades has provided the following overall conclusions (Prüss 1998):

- An exposure-response relationship exists between bacterial indicator counts in recreational waters and gastrointestinal symptoms in bathers.
- There is no demonstrated relationship between bacterial indicator counts and symptoms not related to the gastrointestinal tract (such as eye, nose, ears, and skin symptoms).

[2] The terms *swimming* and *bathing* are used in this report to encompass recreational activities (such as swimming, bathing, water skiing, surfing, and kayaking) where ingestion of, or immersion in, the water is likely. States and territories typically identify these uses in their water quality standards as "primary contact recreation."

[3] The illnesses can be identified, but the specific pathogen (i.e., bacterium, virus, or protozoan) often is not identified unless there is a specific outbreak investigation.

E. coli, a bacterial indicator organism that correlates with adverse effects in freshwater. *(Rocky Mountain Laboratories. NIAID. NIH)*

- The relative risk of swimming in contaminated waters ranged from one to three times above the risk associated with swimming in uncontaminated waters.

- The indicators showing the best correlation with adverse health effects were enterococci (marine water and freshwater) and *Escherichia coli* (freshwater).

Illness Outbreak Reports

Another source of information about adverse human health effects is reports of waterborne disease outbreaks. In 1971 EPA, the Centers for Disease Control and Prevention (CDC), and the Council of State and Territorial Epidemiologists initiated a surveillance system for reporting the occurrence and causes of waterborne outbreaks in the United States. This system resulted in a series of annual reports on waterborne disease outbreaks.

These reports are an important source of information about human health problems in our nation's recreational waters. A recently published article titled "Outbreaks associated with recreational water in the United States" summarizes these reports from the past 30 years (Craun et al. 2005). In the article, the authors review the causes of outbreaks associated with recreational water during 1971–2000 and note the following:

- A bacterial or protozoan etiology was identified in three-quarters of the outbreaks; 23 percent of the outbreaks were of undetermined etiology. The most frequently identified agents were *Cryptosporidium* (15 percent), *Pseudomonas* (14 percent), *Shigella* (13 percent), *Naegleria* (11 percent), *Giardia* (6 percent), and toxigenic *E. coli* (6 percent). Outbreaks attributed to *Shigella*, *E. coli* O157:H7, and *Naegleria* were primarily associated with swimming in fresh waters such as lakes, ponds, and rivers. In contrast, outbreaks caused by *Cryptosporidium* and *Giardia* were primarily associated with treated water in swimming and wading pools.

- An important source of contamination for both treated and untreated recreational waters was the bathers themselves. Contamination from sewage discharges and wild or domestic animals were also important sources for untreated waters. A contributing factor in swimming-pool outbreaks was inadequate attention to maintenance, operation, disinfection, and filtration.

- Although not all waterborne outbreaks are recognized or reported, the national surveillance of these outbreaks has helped identify important sources of contamination of recreational waters and the etiologic agents. This information can be useful in making prevention recommendations and setting research priorities that might lead to improved water quality guidelines.

These reports provide insight into the health effects and, to some degree, the causes of human illnesses. Unfortunately, the reporting has limitations. For example, it is difficult to detect and document illness outbreaks in the population. People who acquire an illness from bathing in contaminated water do not always associate their illness with swimming. The symptoms might arise after leaving the beach and might be attributed to other causes, such as food poisoning. As a result, disease outbreaks often are inconsistently recognized (Craun et al. 2005). Disease surveillance reports also cannot accurately determine the incidence of disease among bathers.

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Chapter 3

Water Quality Criteria and Quality of Water at Beaches

EPA has made significant progress in meeting the BEACH Act requirements related to water quality criteria and standards. EPA promptly issued a regulation to promulgate water quality standards in coastal recreation waters in the states that had not adopted criteria as protective of human health as EPA's current recommended bacteria criteria. EPA is conducting research to identify better indicators and develop faster indicator methods. The Agency is assessing this information as part of a process to develop new or revised water quality criteria.

3.1 Existing criteria and standards

Water quality standards consist of designated uses, the criteria necessary to protect those uses, and an antidegradation policy. A waterbody's designated uses determine what criteria apply to the waterbody. CWA section 101(a)(2) sets the national goal of achieving water quality that provides for the "protection and propagation of fish, shellfish, and wildlife" and "recreation in and on the water" wherever attainable. This national goal is commonly referred to as the "fishable/swimmable" goal of the CWA.

CWA section 303(c)(2)(A) requires that water quality standards "be such as to protect the public health and welfare, enhance the quality of water, and serve the purposes of this Act." States have generally provided for the "swimmable" goal by designating "primary contact recreation" as a use for their waters. Primary contact recreation encompasses activities that could be expected to result in ingestion of water or immersion. These activities include swimming, waterskiing, surfing, and any other activity where contact and immersion in the water are likely. Water quality standards form the foundation of the nation's water quality management program and set the baseline by which success is ultimately measured for a given waterbody or watershed.

EPA's existing recommended water quality criteria for bacteria

Section 303(i) of the CWA calls for states to adopt "initial standards and criteria" for the pathogens and pathogen indicators for which EPA has published criteria under CWA section 304(a), namely, EPA's *Ambient Water Quality Criteria for Bacteria–1986* (USEPA 1986). The scientific basis for the criteria was a series of studies conducted by EPA in the late 1970s and early 1980s (Cabelli 1983, Dufour, 1984). The studies considered several organisms, including

fecal coliforms, *E. coli*, and enterococci, as possible indicators.

EPA found that enterococcus is a good predictor of illness in all waters and that *E. coli* is a good predictor in freshwaters. As a result, in 1986 EPA recommended the use of the indicator organisms *E. coli* for fresh recreational waters and enterococci for fresh and marine recreational waters. EPA recommended a geometric mean level of 126/100 mL for *E. coli* in freshwater. EPA recommended geometric mean levels of 33/100 mL for enterococci in freshwater and 35/100 mL for enterococci in marine water.

EPA's *Ambient Water Quality Criteria for Bacteria–1986* can be found online at *www.epa.gov/waterscience/beaches/1986crit.pdf*

Information about EPA's promulgated water quality standards for states can be found online at *www.epa.gov/waterscience/beaches/bacteria-rule.htm#final*

EPA promulgation: State water quality standards for bacteria

The BEACH Act directed coastal and Great Lakes states to adopt for their coastal recreation waters, by April 10, 2004, water quality criteria for pathogens or pathogen indicators as protective of human health as EPA's 1986 water quality criteria for bacteria. The BEACH Act also required EPA to propose and promulgate such standards for states that did not do so.

EPA worked collaboratively with all the states and territories that contain coastal recreation waters to identify their existing water quality standards, review them for consistency with the BEACH Act requirements, and determine what steps were needed to meet the BEACH Act requirements. On November 16, 2004, EPA published in the *Federal Register* a final rule that promulgated water quality standards for 21 states and territories that had not yet adopted water quality criteria for bacteria that were as protective of human health as EPA's 1986 bacteria criteria. The states and territories subject to this rulemaking are listed in Table 3.1.

Table 3.1.
States and Territories Subject to the November 2004 Water Quality Standards Rule

Alaska	Mississippi
California	New York
Florida	North Carolina
Georgia	Ohio
Hawaii	Oregon
Illinois	Pennsylvania
Louisiana	Puerto Rico
Maine	Rhode Island
Maryland	Virgin Islands
Massachusetts	Wisconsin
Minnesota	

3.2 Recommended water quality criteria under development by EPA

Under CWA section 304(a)(9), as amended by the BEACH Act, EPA is required to publish new or revised water quality criteria for pathogens or pathogen indicators for the purpose of protecting human health. The BEACH Act also added section 104(v), which requires EPA to conduct studies for use in developing these new or revised recommended water quality criteria. Section 104(v) directs EPA to initiate new studies by not later than 18 months after enactment (April 10, 2001) and complete the studies by not later than 3 years after enactment (October 10, 2003).

The section 104(v) studies are to provide additional information for use in developing:

(1) an assessment of potential human health risks resulting from exposure to pathogens in coastal recreation waters, including nongastrointestinal effects;

(2) appropriate and effective indicators for improving detection in a timely manner in coastal recreation waters of the presence of pathogens that are harmful to human health;

(3) appropriate, accurate, expeditious, and cost-effective methods (including predictive models) for detecting in a timely manner in coastal recreation waters the presence of pathogens that are harmful to human health; and

(4) guidance for State application of the criteria for pathogens and pathogen indicators to be published under section 304(a)(9) to account for the diversity of geographic and aquatic conditions.

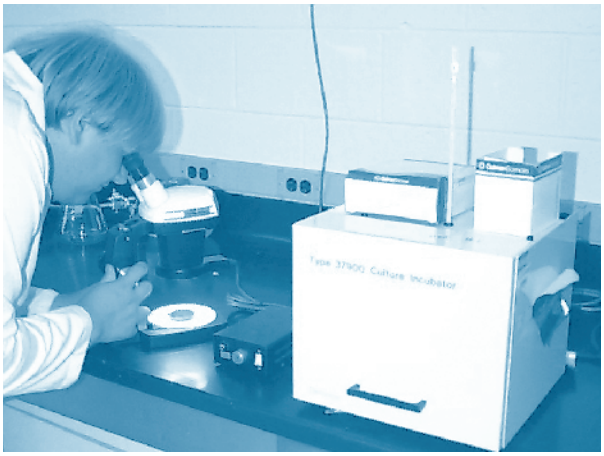
EPA's NEEAR Water Study and methods development

In response to the section 104(v) requirements, EPA's Office of Research and Development, in consultation with the Office of Water, started the ongoing National Epidemiological and Environmental Assessment of Recreational (NEEAR) Water Study in 2001. It is a collaborative research study between EPA and the CDC. EPA also coordinates the study with USGS and other interested agencies.

The indicators and rapid methods that EPA is evaluating through the NEEAR study are bacterial indicators of fecal contamination. The goal of the NEEAR research is to produce information defining the relationship between water quality, as measured with rapid indicators of fecal contamination, and swimming-associated health effects.

Indicator methods development

EPA is developing faster indicator methods that will provide more rapid results than the currently used tests. The goal is to help beach managers to quickly test the water in the morning and make results about the safety of beach waters available in hours, rather than days. Providing faster results to beach managers and the public should help reduce the risk of waterborne illness among beachgoers.



The NEEAR Water Study includes examining detection methods that will produce results in 2 hours or less.

A number of rapid methods were evaluated for use in the NEEAR Water Study, but only a few were included. Methods were included in the study if they met the following criteria:

1. Results could be obtained within a few hours.
2. Enterococci, bacteroides, or other new fecal indicator organisms were detected by the method.
3. The sensitivity and specificity of the method were adequate.
4. The detection limit was lower than the EPA-recommended enterococci limits.
5. Valid data could be obtained because sample carryover or other problems did not occur.

The four methods chosen are as follows:

- *Method 1600* is the EPA-approved membrane filter method using mEI Agar for the detection of enterococci in recreational water.
- The *Quantitative Polymerase Chain Reaction (PCR) Method*, a modified rapid gene probe method, is used to detect enterococci and Bacteroides in water samples.
- The *RAPTOR Fiberoptic Biosensor* is a portable, automated fiberoptic biosensor that can be used to detect microbiological and chemical analytes in water samples.
- The *Luminex 100 System* is a compact flow cytometer that analyzes immunoassays, complex genetic analyses, or enzymatic assays through the use of optics, fluidics, and advanced signal processing.

Epidemiology study

The second part of the NEEAR Water Study is an epidemiology study that combines health data and water quality analyses using the indicator methods described above. The study measures human health outcomes such as diarrhea and gastrointestinal illness as well as non-enteric swimming-related illnesses (such as skin, ear, eye, urinary tract, and respiratory infections). This health information is collected through interviewer-conducted surveys in beach areas. On the same days that health interviews are conducted at these beaches, multiple water samples are collected and tested using the fast indicator methods described in the previous section.

Planning and implementation of these studies have been under way for several years. The initial studies focused on freshwater sites in the Great Lakes. The beaches were selected on the basis of the potential number of beachgoers, water quality parameters, and sources of microbial pathogens in the water (e.g., domestic sewage vs. animals). These studies place emphasis on beaches that have identified point sources of contamination (e.g., sewage treatment plants).

The NEEAR Water Study team has completed three summers of data collection, including a one-year pilot study and two full-year studies. (EPA also conducted a recreational monitoring characterization study before starting the Great Lakes studies.)

- **Pilot Study**

  West Beach, Indiana Dunes National Lakeshore, Portage, Indiana *(2002)*

- **Full-Scale Study (Freshwater)**

  1. West Beach, Indiana Dunes National Lakeshore, Portage, Indiana *(2003)*
  2. Huntington Beach, Bay Village, Ohio *(2003)*
  3. Washington Park, Michigan City, Indiana *(2004)*
  4. Silver Beach, St. Joseph, Michigan *(2004)*

More than 10,000 volunteer households at freshwater beaches were recruited on weekends during the summers of 2003 and 2004, from Memorial Day through Labor Day. These households provided information about their activities and health status after beach visits. Families and individuals were interviewed about a variety of activities, including swimming, to determine their potential exposure to disease-causing pathogens. During the three-year study, more than 21,000 interviews were completed and more than 1,500 water samples were collected and analyzed.

The data are being analyzed to determine whether swimmers exposed to higher levels of rapid indicators experience more illness than non-swimmers, or swimmers exposed to lower levels of rapid indicators. Analysis of the data from the Great Lakes study shows a promising relationship between one of the rapid indicators methods (Quantitative PCR) and gastrointestinal illness among swimmers. These results have been published in a peer reviewed scientific journal (Wade, 2006).

3.3 Survey of beach advisories and closings

Beach advisories and closings are based on water quality information, and therefore they are, in effect, one measure of water quality. A beach advisory or closing typically occurs when monitoring results show that levels of fecal indicators exceed the applicable water quality criterion. State and local public health agencies use beach advisories and closings to communicate to the public that the level of pathogens in the water is unsafe for swimming. As required under the BEACH Act, EPA collected state data on beach water quality and beach advisories.

EPA was able to build on the existing voluntary National Health Protection Survey of Beaches, which was conducted annually from 1997 to 2002, to collect information about state and local beach programs. The purpose was threefold:

1. Create an accurate national inventory of swimming beaches and the agencies that oversee them.
2. Survey agencies about their beach programs, including applicable water quality standards, monitoring methods, cost, and notification procedures for beach advisories and closings.
3. Document critical aspects of beach advisory and closing issues during the swimming season, including the time and length of the actions, the reason the actions were taken, and the source(s) of pollution that necessitated the actions.

Participation in EPA's beach survey was voluntary. In 2002, the last year the survey was conducted, a total of 227 out of 261 local and state agencies surveyed from

NEEAR Water Study interviewers asked beachgoers about their activities and health status after visits.

A preliminary copy of the NEEAR study report is available online at: *http://ehp.niehs.nih.gov/docs/2005/8273/abstract.html*

31 states and 5 territories submitted information. The number of beaches in the survey had grown from 1,021 in 1997 to 2,823 in 2002.

Beginning with the 2003 swimming season, coastal states were required by the BEACH Act to submit monitoring, notification, and other important information concerning their beaches to EPA. To aid in this effort, EPA developed a database called PRAWN (PRogram tracking, beach Advisories, Water quality standards and Nutrients). This new system of data management replaced the annual volunteer questionnaire EPA had sent out to states, territories, and other agencies since 1997.

The results of the 2004 PRAWN data collection cycle indicate that, of the days that beaches could be open, only 4% were lost due to an advisory or beach closure (26 percent of the beaches—942 of 3,574 beaches—had at least one advisory or area closed). Most of the advisories or closings lasted only one or two days. Monitoring frequency, however, varies among beaches, making state-to-state comparisons of beach water quality difficult.

Table 3.2 presents the trends in agency participation, the number of beaches, and the number and percentage of advisories and closings reported to EPA for 1997–2004.

3.4 Major sources affecting water quality at beaches

Point and nonpoint sources

Both the sources and the mechanisms that transport pathogens and other pollutants that affect beach water quality vary according to location (USEPA, 2001). In general, sources are categorized as either point sources or nonpoint sources.

- *Point sources* include discharges from wastewater treatment plants, combined sewer overflows (CSOs), municipal storm sewer systems, Concentrated Animal Feeding Operations (CAFOs), meat-processing facilities, and fish- and shellfish-processing facilities. Municipal stormwater often contains pathogens from a wide variety of sources,

Table 3.2. National Health Protection Survey of Beaches Trends, 1997–2004 *(USEPA, 2005a)*

	Voluntary Survey						Required Reporting	
	1997	1998	1999	2000	2001	2002	2003	2004
Number of beaches	1,021	1,403	1,891	2,354	2,445	2,823	1,857[a]	3,574
Number of beaches affected by advisories or closings	230	353	459	633	672	709	395	942
Percentage of beaches affected by advisories or closings	23	25	24	27	27	25	21	26

[a] Incomplete data from 11 states; EPA working to complete data set

including domestic animals, wildlife, illicit discharges, and cross-connected sanitary and storm sewers.

- *Nonpoint source* pollution comes from numerous diffuse sources and is the result of water running off the land and picking up pollutants along the way. Identifying potential sources and tracking their movement is often technically challenging. Nonpoint sources of pathogens can include farm animals, wildlife, failing septic systems, and faulty sanitary sewer lines, as well as land application of manure and sludge.

EPA's National Health Protection Survey of Beaches queried participants about the source(s) of pollution that caused beach advisories or closings during the swimming season. Figure 3.1 presents data from the 2002 swimming season. In many cases (42 percent), respondents indicated that the pollution source was unknown. When respondents indicated that the source was known, stormwater runoff was most often identified as the cause for the advisory or closing (21 percent).

SSOs and CSOs

In some areas of the United States, sanitary sewer overflows (SSOs) and CSOs have the potential to impact beach water quality and swimmer's health. As with most pathogen source investigations, CSO and SSO discharges are often hard to identify and characterize. One complication is that the volume and frequency of CSO and SSO discharges vary, usually in response to wet weather. Consequently, they are hard to monitor and track. Nevertheless, their potential impact on beaches might be significant.

In its *California Beach Closure Report 2000*, for example, the California State Water Resources Control Board reported that 42 percent of beach closings in 2000 were attributable to SSOs (CSWRCB 2001). Orange County, California, has noted that the total number of ocean and bay beach closings due to SSOs has increased each year since 1999 (Orange County 2003). In the Midwest, the Alliance for the Great Lakes, an organization that tracks beach closings in Michigan, Indiana, Illinois, and Wisconsin, believes that CSOs are associated with a high percentage of the beach closings. This conclusion is based on data collected from local health departments, parks managers, and other municipal agencies.

3.5 Recommendations for actions to improve beach water quality

EPA, in its *Strategic Plan* (USEPA 2003c) and *National Water Program Guidance* for both FY 2005 and FY 2006 (USEPA 2004a and USEPA 2005b), has identified

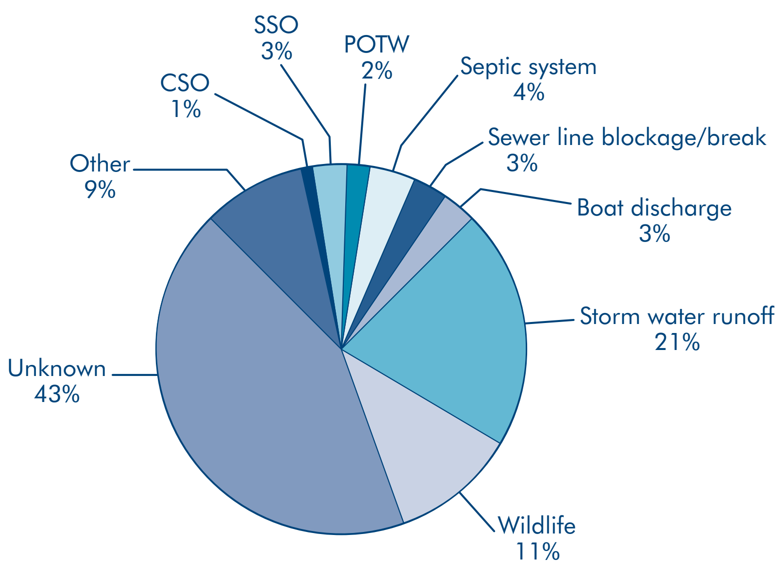


Figure 3.1. Sources of pollution that resulted in beach actions in 2002 *(EPA 2003d)*

"Water Safe for Swimming" as an important objective for the Agency and has summarized its key national strategies and actions to help improve beach water quality. EPA's national strategy for improving the safety of recreational waters includes four key elements:

1. Establish a new generation of pathogen indicators based on sound science.
2. Identify unsafe recreational waters and begin restoration.
3. Reduce pathogens levels in all recreational waters.
4. Improve beach monitoring and public notification.

Establish pathogen indicators based on sound science

EPA worked with states and tribes throughout the country to implement the adoption of the most recent (1986) scientific indicators of unsafe pathogens in all recreational waters.

Identify unsafe recreational waters and begin restoration

A key component of the strategy to restore waters unsafe for swimming is to identify the specific waters that are unsafe and develop plans to accomplish the needed restoration. A key part of this work is to maintain strong progress toward the development of Total Maximum Daily Loads (TMDLs) based on the schedules established by states in conjunction with EPA.

In a related effort, EPA's Office of Water will work in a new partnership with the Agency's Office of Enforcement and Compliance Assurance (OECA) to better focus compliance and enforcement resources on unsafe recreational waters. Moreover, wet weather discharges, which are a major source of pathogens, are one of OECA's national priorities for FY 2005 through FY 2007.

Reduce pathogen levels in recreational waters generally

In addition to focusing on waters that are unsafe for swimming, EPA, states, territories, and tribes will work to reduce the overall level of pathogens discharged to recreational waters using three key approaches:

For beach safety information visit EPA at:
www.epa.gov/waterscience/beaches

For EPA grant information visit:
www.epa.gov/water/waterplan

1. Address point sources discharging pathogens to recreational waters under the permit and enforcement program, including discharges associated with CSOs, SSOs, POTWs, sewer line breaks and urban storm water.
2. In conjunction to implementing NPDES requirements, work with municipalities to support sustainable municipal wastewater infrastructure by insuring adequate funding from all applicable sources, better management, effective water use and watershed approaches.
3. Encourage improved management of septic systems, boat discharges and other nonpoint sources

Discharges from storm sewers, POTWs, CSOs, and SSOs in urban areas can result in high levels of pathogens being released during storm events. Because urban areas are often upstream of waters where people swim, these discharges can be a significant source of unsafe levels of pathogens. EPA is working with states and local

governments to fully implement NPDES requirements for municipal point sources that contribute pathogens to recreational waters. This includes fully implementing the CSO Policy, issuing and implementing permits for municipal storm sewer systems, and clarifying and applying NPDES requirements for wet weather flows at POTWs to improve the capacity, management, operation and maintenance of POTW treatment plants and separate sanitary sewer collection systems.

Other key sources of pathogens to the nation's waters are discharges from CAFOs, municipal storm water systems and industrial facilities. EPA expects to work with states to ensure that CAFOs are covered by permits. EPA expects that most states will have current general permits requiring storm water management programs for Phase II municipalities and construction by the end of 2006.

Finally, there is growing evidence that ineffective septic systems are contributing pathogens to recreational waters. In 2003 EPA issued the *Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems* to enhance the performance and reliability of decentralized wastewater treatment systems through improved management programs. EPA encourages state and local governments to use these voluntary guidelines as a template for their efforts to strengthen existing management programs and implement new ones. In addition, EPA published a draft *Handbook for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems*, which complements the voluntary guidelines, to help state and local governments evaluate and upgrade their management programs for onsite and clustered (decentralized) wastewater treatment systems.

Improve beach monitoring and public notification

Another important element of the strategy for improving the safety of recreational waters is improving monitoring of public beaches and notifying the public of unsafe conditions. EPA is working with states to implement the BEACH Act and has awarded, or is in the process of awarding, $52 million in grants. EPA will continue to receive and display state information on beach water quality through the eBeaches system and will seek to increase the voluntary participation of inland states. EPA will also continue to develop and maintain information on beach safety available through the Internet.

3.6 Improving beach water quality through related programs

EPA's National Estuary Program (NEP)

Improving beach water quality is one focus of EPA's National Estuary Program (NEP). The NEP program was established by Congress in 1987 to improve the quality of estuaries of national importance. The 28 NEPs around our nation's coasts, include many of the country's most popular beaches and recreational waters. A major focus of the Program is protecting and restoring water quality which complements the objectives of the BEACH Act. For example, the Tampa Bay, FL NEP has created an internet portal that provides citizens real-time access to the status of swimming beaches within the Tampa Bay area including recent water quality monitoring information. Also, the Tampa Bay NEP helped establish the Healthy Beaches program. This program was eventually adopted by the State and now Florida's 34 coastal counties perform bi-weekly beach water sampling analyzing for bacteria indicating enterococci and fecal coliform. The New York – New Jersey Harbor Estuary Program (HEP) worked with numerous federal, state, and municipal agencies to initiate a long-term water quality monitoring program that now covers all of the waters of the New York/New Jersey Harbor including the recreational waters of Raritan Bay. This work included assisting 12 municipal wastewater treatment plants in developing a comprehensive monitoring plan with annual reports to the public on the condition the region's waters. Many NEPs have established or support citizen volunteer monitoring networks that provide valuable data. The Buzzards Bay NEP in Massachusetts has recruited over 300 Bay Watchers to monitor 180 stations for various parameters that provide an immediate snapshot of the health of the Bay. The Indian River Lagoon NEP in FL, provides funding for the second largest volunteer estuarine monitoring network in the nation. Additional examples on NEP BEACH Act related activities can be found at www.epa.gov/owow/estuaries.

EPA's National Marine Debris Monitoring Program (NMDMP)

EPA's National Marine Debris Monitoring Program (NMDMP) was developed to determine the amount of marine debris and the sources of marine debris affecting U.S. coastlines. The Program is designed to gather scientifically valid marine debris data using a rigorous statistical protocol. The Monitoring Program covers approximately 88,000 miles of U.S. coastline (including Puerto Rico and the U.S. Virgin Islands). Monitoring is conducted every 28 days by teams of volunteers in nine different regions across the U.S. The program is currently in the fourth year of the five-year study period. A final report and analysis will be developed in late 2007 at the end of the five-year study. The report will provide an introduction to the study, the details of the methodology, and an analysis of the results, including amounts, types, and trends in marine debris.

EPA's Section 319 Nonpoint Source Management Program

Under its section 319 Nonpoint Source Management Program, EPA support includes grants, technical assistance, education, training, technology transfer, demonstration projects, and monitoring for nonpoint source implementation projects. The section 319 program has many projects addressing pathogens throughout the US.

Many watersheds are impaired by pathogens from nonpoint sources. Animal Feeding Operations (AFOs) are one category of nonpoint sources that can affect a given watershed. For example, there are nearly 300,000 Animal Feeding Operations (AFOs) in the United States. When AFOs are concentrated in watersheds, they may create very significant water pollutions problems because they can be prominent sources of pollution such as pathogens and nutrients. Another category, storm water discharges, can affect watersheds. Like AFOs, storm water discharges are often near smaller waterbodies and thus can have significant water quality impacts. Finally, non-human sources of pathogens (such as geese and other wild animals) can raise significant pathogen concerns.

Great Lakes National Program Office

Efforts are underway in the Great Lakes to identify, on a regional basis, the causes of beach closings and advisories. Importantly, state, local, and federal partners have worked together to identify actions that could be taken to improve water quality at Great Lakes beaches. One of these actions is the completion of watershed-based sanitary surveys to identify sources of bacterial contamination. EPA expects that this work will result in the development of a tool for watershed-based sanitary surveys that could be used by others.

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Chapter 4

Evaluation of Federal, State, and Local Efforts to Implement the BEACH Act

EPA has been working cooperatively with state and local partners to implement the provisions of the BEACH Act. The extensive efforts described in this chapter have helped reduce human health risks through better monitoring and public notification. In general, state and local agencies have the primary responsibility for conducting beach programs.

The following sections summarize key activities that federal, state, and local governments have been implementing since passage of the BEACH Act.

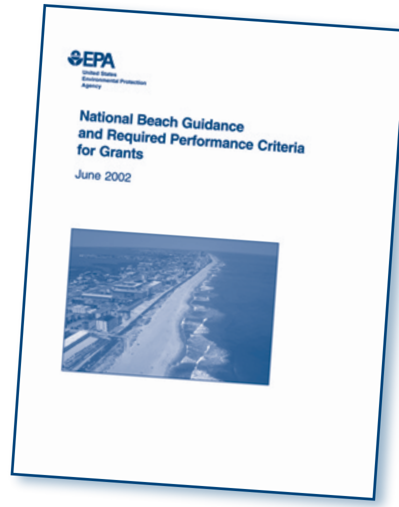
4.1 What has EPA done?

Monitoring and notification performance criteria

The BEACH Act directed EPA, by April 10, 2002, to publish "performance criteria" for a beach monitoring and notification program. The criteria must address the following:

- The monitoring and assessment of coastal recreation waters adjacent to beaches, or similar points of access that are used by the public, for attainment of water quality standards for pathogens or pathogen indicators, including the use of available methods for such monitoring and assessment.
- Prompt notification of local governments, the public, and the EPA Administrator of exceedances, or the likelihood of any exceedances, of applicable water quality standards for such waters.

To meet the BEACH Act requirement in CWA section 406(a), EPA published the *National Beach Guidance and Required Performance Criteria for Grants* (USEPA 2002a). The document specifies the performance criteria that eligible coastal or Great Lakes state, tribal, or local governments must meet to receive grants to implement coastal recreation water monitoring and public notification programs under the BEACH Act. The 2002 document also provides useful guidance for both coastal and inland beach monitoring and notification programs. EPA published a notice of availability of the document in the Federal Register (67 FR 47540, July 19, 2002).



In the *National Beach Guidance and Required Performance Criteria* document, EPA put forth nine performance criteria for the implementation of beach monitoring, assessment, and notification programs (Table 4.1). A brief summary of each criterion is provided below.

Chapter 3 of the National Beach Guidance is titled "Beach Evaluation and Classification Process." It describes the risk-based evaluation steps and information that EPA recommends a state or tribe consider when ranking beaches. There is one general performance criterion for this process as well as five specific requirements. The general requirement is as follows:

1. *Develop risk-based beach evaluation and classification plan*. A state or tribe is required to develop a risk-based beach evaluation and classification plan and to apply it to coastal recreation waters. The plan

Table 4.1. Summary of BEACH Act Performance Criteria

Evaluation and Classification
1. Develop risk-based beach evaluation and classification plan

Monitoring
2. Develop tiered monitoring plan
3. Monitoring report submission and delegation
4. Methods and assessment procedures

Public Notification and Prompt Risk Communication
5. Public notification and risk communication plan
6. Measures to notify EPA and local governments
7. Measures to notify the public
8. Notification report submission and delegation

Public Evaluation
9. Public evaluation of program

must describe the factors used in its evaluation and classification process and explain how coastal recreation waters are ranked as a result of the process. This process would yield a list of coastal recreation waters, including coastal recreation waters adjacent to beaches or similar points of access used by the public.

Chapter 4, "Beach Monitoring and Assessment", describes three general performance criteria and several specific requirements. It also provides additional technical guidance for beach monitoring programs. The general requirements are the following:

2. *Develop tiered monitoring plan*. Development of a tiered monitoring plan is required. The plan must adequately address the frequency and location of monitoring and assessment of coastal recreation waters based on the periods of recreational use of the waters, the nature and extent of use during certain periods, the proximity of the waters to known point sources and nonpoint sources of pollution, and any effect storm events have on the waters.

3. *Monitoring report submission and delegation*. States, tribes, and local governments are required to develop a mechanism to collect and report their monitoring data in timely reports and, for states, to document any delegation of monitoring responsibilities that might have been made to local governments. States, tribes, and local governments must report their monitoring data to the public, EPA, and other agencies in a timely manner. States are encouraged to coordinate closely with local governments to ensure that monitoring information is submitted in a consistent manner. If monitoring responsibilities are delegated to local governments, the state grant recipient must describe the process by which the state may delegate such responsibilities to local governments.

4. *Methods and assessment procedures*. Detailed methods and assessment procedures must be developed. States, tribes, or local governments must adequately address and submit to EPA methods for detecting levels of pathogens and pathogen indicators in coastal recreation areas. They must also provide documentation to support the validity of methods other than those currently recommended or approved by EPA. In addition, they must identify and submit to EPA assessment procedures for identifying short-term increases in pathogens and pathogen indicators in coastal recreation areas.

Chapter 5 of the guidance document, "Public Notification and Prompt Risk Communication," describes the performance criteria and technical guidance for these aspects of a beach program. The performance criteria below describe the four general requirements for an overall beach notification and risk communication plan:

5. *Public notification and risk communication plan*. The state, tribe, or local government must develop an overall public notification and risk communication plan. The plan must describe the state's, tribe's, or local government's public notification efforts and measures to inform the public of the potential risks associated with water contact activities in the coastal recreation waters that do not meet applicable water quality standards.

6. *Measures to notify EPA and local governments*. The state, tribe, or local government must adequately identify measures for prompt communication of the occurrence, nature of, location, pollutants involved, and extent of any exceeding of, or likelihood of exceeding, applicable water quality standards for pathogens and pathogen indicators. They must identify how this information will be promptly

communicated to EPA. States also must identify how this information will be promptly communicated to a designated official of the local government for the area adjoining the coastal recreation waters for which the failure to meet applicable standards is identified.

7. *Measures to notify the public*. A state, tribe, or local government program must adequately address the posting of signs at beaches or similar points of access, or functionally equivalent communication measures, that are sufficient to give notice to the public that the coastal recreation waters are not meeting or are not expected to meet applicable water quality standards for pathogens and pathogen indicators.

8. *Notification report submission and delegation*. States, tribes, and local governments must compile their notification plans in timely reports. States must describe any delegation of notification responsibilities that has been made, or that the state intends to make, to local governments.

Chapter 2, "Public Evaluation of Program," explains the last criterion:

9. *Public evaluation of program*. Provide the public with an opportunity to review the program through public notice, review, and opportunity to comment.

Cooperative consultation process

EPA developed the *National Beach Guidance and Performance Criteria* document through a cooperative consultation process with a wide variety of agencies and interested parties. As a first step in this process, EPA hosted several regional workshops to identify preliminary concepts and gather specific recommendations from various parties. EPA then worked with an external group composed of representatives from state and local environmental and health agencies, as well as various environmental groups. This external group provided much valuable input to the document. EPA developed a draft guidance document that reflected many of the concepts and recommendations suggested by the review groups.

EPA published the draft document on July 31, 2001, and provided a 60-day comment period that closed on

October 1, 2001. During the comment period, EPA hosted five public forums throughout the United States to discuss the draft. The final document incorporated responses to those comments obtained through the forums and other comments that EPA had received. Following publication of the performance criteria and before the award of the first implementation grants, EPA conducted five regional technical assistance workshops to help eligible states and territories develop their monitoring and notification programs.

Program development and implementation grants

The BEACH Act authorizes EPA to make grants to coastal and Great Lakes states, territories, tribes, and, in certain circumstances, local governments to develop and implement monitoring and notification programs. EPA may award implementation grants to states only if

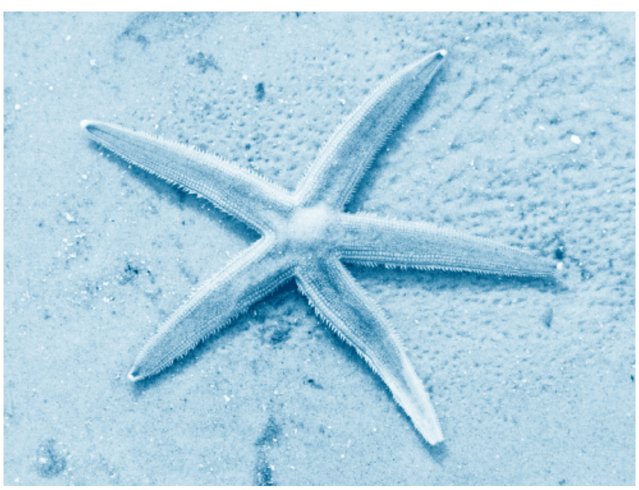
- The program is consistent with EPA's performance criteria.
- The state (or local government) prioritizes the use of grant funds on the basis of use of the water and risk to human health, and identifies to EPA the factors considered in prioritizing the use of funds.

- The state (or local government) develops a list of discrete areas of coastal recreation waters that are subject to the program for monitoring and notification for which the grant is provided and specifies any coastal recreation waters for which fiscal constraints will prevent consistency with the performance criteria
- The state (or local government) provides an opportunity for the public to review the program through a process that provides for public notice and an opportunity for the public to comment.

Since passage of the BEACH Act, EPA has awarded approximately $52 million of grant funds authorized under CWA section 406(b) to all 35 eligible coastal and Great Lakes states and territories to support the implementation of coastal recreation water monitoring and public notification programs that are consistent with EPA's required performance criteria for grants (Table 4.2). States are using the grant funds to implement beach monitoring and notification programs that are consistent with national guidance. The activities include

- Collecting and analyzing water samples to determine whether they exceed, or are likely to exceed, water quality standards for public health protection
- Notifying the public if water quality standards are exceeded or are likely to be exceeded
- Maintaining databases of beach water quality and advisory information

EPA has awarded grants to all eligible states that applied for funding, using an allocation formula that the Agency developed for allocating BEACH Act grant funds in 2002. EPA consulted with various states and other stakeholders to develop this formula. The formula uses three factors—beach season length, beach miles, and beach usage. Because the data for beach miles and beach usage were not readily available, shoreline length and coastal population were used as surrogates.



EPA's eBeaches: Information technology development for beaches

Section 406(e) of the CWA, as amended by the BEACH Act, directs EPA to establish, maintain, and make available to the public, by electronic and other means, a national coastal recreation water pollution occurrence database that provides the following:

- The data reported to the Administrator under subsections (b)(3)(A)(i) and (d)(3)
- Other information concerning pathogens and pathogen indicators in coastal recreation waters that
  - is made available to the Administrator by a state or local government from a coastal water quality monitoring program of the state or local government
  - the Administrator determines should be included

EPA is designing, building, and implementing an electronic system to support the BEACH Act requirements. The result is a new online system called eBeaches. The system provides for the fast, easy, and secure transmittal of information about beach water quality, and it improves public access to information about beach conditions and health risks associated with swimming in polluted water. The eBeaches system saves time and money by enabling electronic transactions and eliminating paper forms and outdated methods of data entry. The system also offers a secure electronic environment for fast, easy click-and-send reporting.

eBeaches receives beach water quality, swimming advisory, and monitoring program data from the states through EPA's Central Data Exchange (CDX), the central receiving point for environmental data submissions to the Agency and a cornerstone of EPA's e-government initiative. CDX provides built-in data quality checks,

Table 4.2. Annual BEACH Act Grants Awards

State/Territory	2001	2002	2003	2004	2005	2006	Total
Alabama	$58,683	$263,142	$261,514	$262,810	$262,650	$262,170	$1,370,969
Alaska	$61,153	$150,000	$149,025	$150,000	$150,000	$150,000	$810,178
American Samoa	N/A	$302,288	$300,364	$302,260	$302,230	$302,140	$1,509,282
California	$57,000	$535,643	$532,164	$527,850	$525,460	$516,960	$2,695,077
Connecticut	$58,694	$226,389	$223,921	$224,560	$224,290	$223,370	$1,181,224
Delaware	$58,694	$211,339	$210,299	$211,300	$211,170	$210,750	$1,113,552
Florida	$58,683	$530,893	$544,552	$540,220	$537,390	$528,410	$2,740,148
Georgia	$58,683	$288,490	$287,442	$288,130	$287,620	$286,200	$1,496,565
Guam	N/A	$302,775	$300,860	$302,740	$302,710	$302,600	$1,511,685
Hawaii	$57,000	$325,149	$322,897	$324,230	$323,930	$323,020	$1,676,226
Illinois	$58,694	$248,615	$245,043	$245,060	$244,630	$242,940	$1,284,982
Indiana	$58,694	$206,670	$204,963	$206,090	$206,030	$205,800	$1,088,247
Louisiana	$58,650	$383,287	$380,052	$328,520	$326,780	$322,010	$1,799,299
Maine	$58,675	$259,742	$257,766	$257,650	$256,880	$254,730	$1,345,443
Maryland	$58,694	$276,068	$273,429	$272,860	$271,970	$269,250	$1,422,271
Massachusetts	$58,675	$260,691	$257,453	$257,220	$256,580	$254,440	$1,345,059
Michigan	$0	$287,556	$283,360	$282,520	$281,530	$278,450	$1,413,416
Minnesota	$58,694	$204,631	$203,309	$204,490	$204,440	$204,270	$1,079,834
Mississippi	$58,683	$258,028	$256,481	$257,900	$257,810	$257,510	$1,346,412
New Hampshire	$58,675	$204,918	$203,594	$204,770	$204,710	$204,530	$1,081,197
New Jersey	$58,694	$285,719	$282,586	$281,680	$280,780	$277,730	$1,467,189
New York	$57,000	$366,030	$359,215	$356,240	$354,580	$348,740	$1,841,805
North Carolina	$58,683	$306,721	$305,007	$305,280	$304,540	$302,480	$1,582,711
Northern Mariana	N/A	$303,462	$301,648	$303,510	$303,470	$303,330	$1,515,420
Ohio	$58,694	$227,879	$224,227	$224,840	$224,580	$223,650	$1,183,870
Oregon	$54,888	$230,342	$229,757	$230,290	$229,910	$228,780	$1,203,967
Pennsylvania	$58,694	$226,953	$223,012	$223,650	$223,410	$222,530	$1,178,249
Puerto Rico	$58,694	$335,862	$328,757	$329,900	$329,570	$328,450	$1,711,233
Rhode Island	$58,675	$214,225	$212,340	$213,290	$213,140	$212,640	$1,124,310
South Carolina	$57,143	$300,253	$298,726	$299,140	$298,490	$296,660	$1,550,412
Texas	$58,650	$387,957	$387,508	$387,190	$386,150	$382,890	$1,990,345
U.S. Virgin Islands	$58,694	$303,488	$301,483	$303,350	$303,310	$303,180	$1,573,505
Virginia	$58,694	$282,355	$281,693	$280,910	$279,920	$276,900	$1,460,472
Washington	$59,959	$274,034	$274,585	$273,980	$273,080	$270,320	$1,425,958
Wisconsin	$58,694	$228,396	$225,970	$226,570	$226,260	$225,270	$1,191,160
Totals	**$1,812,580**	**$9,999,990**	**$9,935,002**	**$9,891,000**[a]	**$9,870,000**[a]	**$9,803,100**	**$51,311,672**

[a] EPA set aside an additional $50,000 for eligible tribes in 2004 and 2005. No eligible tribes, however, applied for BEACH Act grants during either year.

Web forms, standard file formats, and a common, user-friendly approach to reporting environmental data. Once CDX receives the beach water quality data, the data are transmitted to, and stored in, the Office of Water's STORET system, a repository for water quality, biological, and physical data. Local beach program and advisory data are stored in the Office of Water's PRogram tracking, beach Advisories, Water quality standards, and Nutrients (PRAWN) data system. Beach Map coordinates are stored in the Office of Water's Watershed Assessment, Tracking, and Environmental Results System (WATERS). Seamless user-friendly access to data in all of these systems is available to the public through an Internet application named BEACON (Figure 4.1).

eBeaches also allows state and local agencies to instantaneously create, edit, and display maps of the beaches they are monitoring. Using a tool called Web-based Reach Indexing (WebRIT), states or local agencies can make and edit maps available to the public on the Internet.

In 2002 EPA drafted a plan on how to meet its BEACH Act requirements to collect, store, and maintain state beach data and display the data for the public. The plan outlined a new approach for data collection within the Agency and for states using standardized file formats (XML files), secure electronic data reporting (CDX), data conversion interfaces (WebSIM), relational databases (PRAWN, STORET), and an Internet application (BEACON). This new approach has been challenging for both EPA and states to develop and implement.

The electronic data reporting has required new policy on data security, data ownership, data sharing, and data reporting. It has introduced new technical concepts and capabilities for beach program managers to learn and implement. It requires a new task for constant maintenance of the system hardware and software in areas such as version upgrades, data compatibility, and system connectivity. As a result, EPA's system has experienced periods of down time when states were unable to submit their data. Eventually, these maintenance periods will be planned maintenance events rather than episodic events.

Initially, all states did not have the trained staff, funding, or technological resources to build and maintain their data systems. EPA expects that data reporting will become easier for states as they further develop their systems. The Agency is providing continued support to assist states with their data-reporting work.

eBeaches is also part of the Agency's Environmental Information Exchange Network. The Exchange

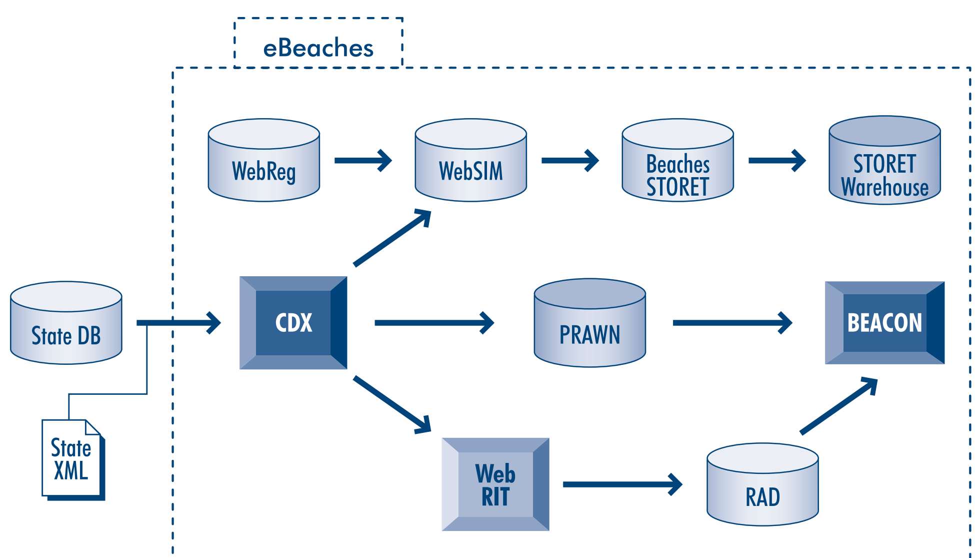


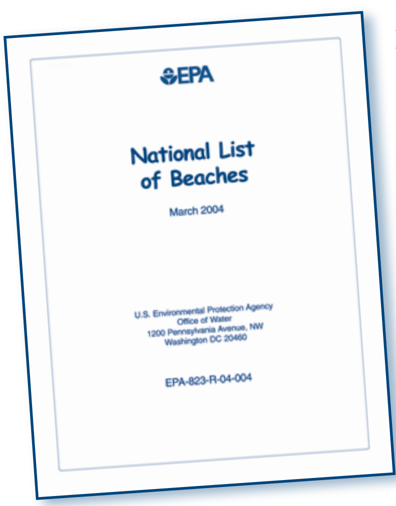
Figure 4.1. **The framework of e-Beaches allows seamless user-friendly access of data through the Internet**

Network is a new approach for exchanging environmental data electronically between EPA, states, and other partners using network nodes. The Exchange Network provides improved data quality, better data integration, and improved availability of environmental data. To share data on the Exchange Network, the data must be formatted to common data standards and the state must have an operating node. EPA has been working with states to develop their ability to use this system. States are beginning to use this technology to submit beach advisory data to PRAWN. EPA is developing the technology to allow beach water quality data submissions over the Exchange Network.

In summary, EPA has improved public access to data on beach advisories and closings by improving its electronic system for beach data collection and delivery systems; the system is known as “eBeaches.” This online system includes a database of monitoring results and notification actions, thereby fulfilling the National Pollution Occurrence Database requirement of the BEACH Act. The public can view the beach information at http://oaspub.epa.gov/beacon/beacon_ national_page.main.

National List of Beaches

Section 406(g) of the CWA, as amended by the BEACH Act, directs EPA to maintain a publicly available list of waters that are subject to a monitoring and notification program, as well as those not subject to a program. As a BEACH Act grant condition, states and territories developed their lists of beaches, identified whether there is a monitoring program for each beach, and submitted this information to EPA. EPA compiled the submissions into the *National List of Beaches* and published the list in the *Federal Register* on May 4, 2004 (69 FR 24597).


EPA

National List of Beaches

March 2004

U.S. Environmental Protection Agency
Office of Water
1200 Pennsylvania Avenue, NW
Washington DC 20460

EPA-823-R-04-004

The *National List of Beaches* provides a national picture of the extent of

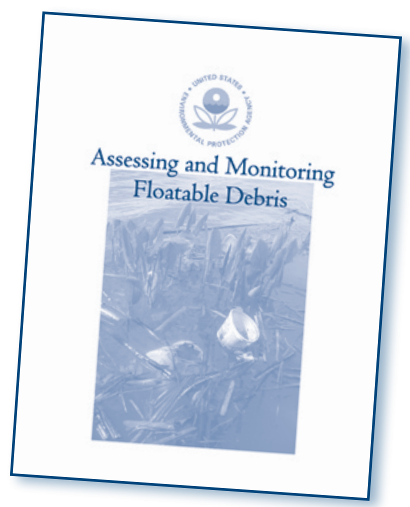
For more information about BEACON visit EPA at: *http://oaspub.epa.gov/beacon/beacon_national_page.main*

For EPA Exchange Network information visit: *http://www.epa.gov/water/waterplan*

beach water quality monitoring. The list identified 6,098 beaches, of which 58 percent are monitored. This is a significant increase from the 1,969 beaches of coastal recreation waters that states and territories had reported to EPA as part of the voluntary National Beach Survey. The number of beaches has increased because of BEACH Act grant support. These grants helped improve state oversight and coordination and allowed a more comprehensive inventory of beaches and monitoring locations. EPA will update this list periodically as new information becomes available from states and territories.

“Floatables”: EPA Technical Assistance

To protect public health and safety in coastal recreation waters, section 406(f) of the CWA, as amended by the BEACH Act, directs EPA to provide technical assistance for developing assessment and monitoring procedures for floatable materials. In August 2002 EPA published guidance titled *Assessing and Monitoring Floatable Debris*. The guidance provides examples of monitoring and assessment programs that have been established in the United States to address the impact of floatable debris, examples of mitigation activities to address floatable debris, and contact information.



EPA Implementation

Section 406(h) of the CWA, as amended by the BEACH Act, requires EPA, for a state that has not developed a program consistent with EPA's performance criteria, to conduct a monitoring and notification program, using grant funds that otherwise would have been awarded to the state. This "backstop" requirement is not triggered until at least three years after EPA lists waters in such states under CWA section 406(g). Because EPA listed the waters on April 12, 2004, under section 406(g) EPA is not yet authorized to implement the program in any state or territory.

4.2 What have other federal agencies done?

Section 406(d) of the CWA, as amended by the BEACH Act, requires federal agencies to develop programs for coastal recreation waters adjacent to beaches or similar points of access within federal jurisdiction by October 10, 2003. These programs should be designed to protect public health and safety, meet EPA's performance criteria, and address certain other matters required for state and local programs.

U.S. National Park Service

The U.S National Park Service (NPS) oversees a number of beaches in National Parks throughout the United States. Public health for NPS is overseen by the Office of Public Health, a part of the Visitor and Resource Protection Directorate in Washington, DC. This office develops the applicable public health guidance, and primarily members of the U.S. Public Health Service staff it.

The applicable NPS guidance and regulations govern activities at recreational waters in the parks. Specifically, *Director's Orders 83* is the governing document that describes the Public Health Program's expectations of park managers. The requirements in it are in keeping with the requirements set forth in *Management Policies 2001* of the NPS, Ground Penetrating Radar (GPR) Act requirements, and the NPS Strategic Plan.

The responsibility for administering the parks and implementing day-to-day activities rests with the regional NPS offices. In some cases recreational waters are monitored by state or county authorities; in others the responsibility falls on park management. The NPS guidance for conducting recreational water quality assessments is in the following reference manuals: *Reference Manual 83(D1)* for bathing beaches, *Reference Manual 83(D2)* for swimming pools, and *Reference Manual 83(D3)* for hot tubs and spas.

Discussed below are some specific beaches administered by NPS.

- *NPS Pacific West Region*. There are several designated public bathing beaches throughout Golden Gate National Recreation Area in San Francisco and Marin County. San Francisco beaches are Baker Beach, China Beach, Ocean Beach (north and south), Fort Funston, Crissey Field, and Aquatic Park. Marin County beaches are Stinson Beach, Rodeo Beach, Muir Beach, Kirby Cove, Black Sand Beach, Tennessee Valley Beach, and Horseshoe Cove.

  All the beaches are open year-round, but they are used more frequently in the summer. San Francisco's Bureau of Environmental Health monitors the water quality at park beaches in the city. Most of the San Francisco beaches are sampled once a week year-round for total coliforms, *E. coli*, and enterococcus. Additional monitoring is conducted whenever a CSO occurs from the city's sewer system. Test results are provided to the park only when there are positive samples. In accordance with state requirements, monitoring is coordinated in Marin County by the County of Marin Environmental Health Services. When there are positive test results, the park posts the beaches with approved signage. The park works with the county to determine the possible source(s) of contamination.

- *NPS Northeast and National Capitol Regions.* NPS staff monitored the presence of bacterial indicators of fecal contamination at six ocean beach locations within Assateague Island National Seashore weekly from May 23 to September 6, 2005. Using guidelines developed by EPA, water samples were collected from high-use public bathing beaches and analyzed for the presence of enterococci bacteria. Assay results were compared weekly to EPA-recommended numeric standards and used to assess risk to swimmer health from contaminants.

Sample results ranged from less than 10 to 64 most probable number (MPN) of colonies of enterococci bacteria per 100 mL, and all results were within the range of values considered indicative of safe conditions for water contact. Assateague Island National Seashore contracts with an EPA-approved laboratory (State of Maryland Department of Health and Mental Hygiene) to analyze water samples using the EPA-approved Enterolert analytical method to cut response time, travel time, and analytical costs. Results from this monitoring program are shared with Worcester County and the State of Maryland.

- *NPS Midwest Region*. At Indiana Dunes National Lakeshore (INDU), the park monitors its beaches daily and has occasionally closed them if *E. coli* reaches 235 colonies/100 mL. This typically happens after a heavy rainfall event. EPA helped INDU with monitoring procedures last year and helped fund studies for the park.
- *NPS Intermountain Region*. Padre Island National Seashore has two monitored beaches. One beach, Malaquite, is on the Gulf side of the island; the other, Bird Island, is on the lagoon side. The park uses Texas A&M University at Corpus Christi for collection and analysis.

  Historically, there have been some water quality issues of unknown origin. In 2003, 2,030 enterococci colonies/100 mL were reported from one sample. However, in 2005, all results have indicated low levels of bacteria with no beach closures posted. The park has not yet been able to determine why these variations have occurred, but it is possible that variables include hot, dry weather (no runoff) and the fact that construction has caused visitation to decrease.

4.3 What have state and territorial governments done?

As of the date of this report, 34 of the 35 eligible states and territories have developed and are implementing a beach monitoring and notification program consistent with the requirements of the *National Beach Guidance and Required Performance Criteria for Grants*. By doing so, these 34 states meet the requirements of the BEACH Act. The remaining state, Alaska, is in the process of developing a program.

The following sections were written by each state or territory to highlight the key accomplishments of beach programs in coastal states and territories. EPA has not verified and validated these data. These program descriptions describe recent activities and might include some actions not funded by BEACH Act funds. Readers should note that the summaries for the Gulf Coast area were written before hurricanes Katrina and Rita. These

Padre Island National Seashore

devastating events, which occurred in August and September 2005, will likely have a profound effect on the beach programs administered by the affected states in the short term.

Alabama

In June 1999 the Alabama Department of Environmental Management (ADEM), in cooperation with the Alabama Department of Public Health (ADPH), initiated a program to routinely monitor bacteria levels at five public recreational beaches along the Gulf Coast. The effort was later expanded to include six additional sites along the Gulf Coast and Mobile Bay. When the BEACH Act was signed into law in 2000, ADEM was designated as the state's lead agency and was awarded grant money to carry out the monitoring program. Through the BEACH Act, ADEM and ADPH expanded and enhanced monitoring and notification efforts for Alabama's public recreational waters. The goal of this program is to increase public awareness and provide water quality information to help the public make more informed decisions concerning their recreational use of Alabama's natural coastal waters.

- *Monitoring.* The monitoring program now involves the routine collection of water samples from 25 high-use or potentially high-risk public recreational sites from Perdido Bay to Dauphin Island. The selection of sites and the frequency of sampling have been determined using a risk-based evaluation and ranking process. This process considers a number of factors for a given site, most important the amount of use and the amount of risk. Depending on the site rankings, samples are collected twice a week, once a week, or once every other week during the swimming season (June through September) and once a month during the cooler months (October through May).

  Samples are analyzed for the indicator bacteria, enterococci. The indicator bacteria used and the threshold concentration, which triggers an advisory, are part of the state water quality standards, which are derived from EPA's recommended *Ambient Water Quality Criteria for Bacteria* (1986) and *Water Quality Standards Handbook* 2nd edition (1983). All enterococci analyses are performed by ADPH Laboratory using EPA Method 1600. Trained ADEM and ADPH staff collected samples from the sites.

  In addition, ADEM and ADPH staffs use YSI Environmental Monitoring Systems to collect in situ data of dissolved oxygen, pH, specific conductivity, salinity, and temperature. Turbidity is also collected using a field turbidity meter.

- *Public notification.* ADPH reviews all data and is responsible for issuing any advisories. All test results are posted on the ADEM Web site (www.adem.state.al.us/FieldOps/Monitoring/BeachMonitoring.htm), along with the in situ data, and advisories are publicized through press releases and posted on signs at each of the 25 sampling locations. Over 3,000 samples have been collected since the inception of the Beach Program, resulting in 52 advisories issued by the ADPH. During fiscal year 2004, over 800 samples were collected and analyzed, resulting in 15 beach advisories issued by ADPH.

Alaska

Alaska has 36,000 miles of coastal waters, which to a large extent are undeveloped, although a great deal of recreation occurs on Alaska's beaches throughout the year. The Alaska Department of Environmental Conservation, Division of Water, Water Quality Monitoring & Assessment Program, administers the BEACH Act grant program for the state. BEACH Act grant-funded work conducted since 2001 has established the statewide extent of beaches used for recreational purposes, the degree of use, and the proximity of pollution sources to the beaches. Visit www.dec.state.ak.us/water/wqsar/wqs/beachprogram.htm for more information.

Further work through the BEACH Act grants will result in the development of standardized monitoring and notification procedures for Alaska's coastal recreational waters where necessary, pilot and ongoing monitoring of high-risk beaches, parallel testing of fecal coliforms and enterococci, and analysis of results of testing for bacteria after various holding times.

- *Beach survey and risk-based beach ranking.* Alaska conducted a survey of coastal communities to identify where beaches were used for recreational purposes and what pollution sources might contribute to health issues at the beaches. The state used the survey results to develop a ranked list of identified beaches to prioritize where monitoring efforts should be focused.

Field sampling that occurred in summer 2005 revealed contamination issues at a beach near Juneau, but only during high tide. Source tracking commenced; local septic systems and an adjacent boat harbor were of particular interest.

- *Public notification.* Alaska developed a Notification and Risk Communication Plan that contains extensive guidelines for how to conduct a monitoring program, report the results to communities, and notify them if closings are necessary. The state conducted workshops in 2004 in communities with identified high-risk beaches, resulting in revisions to the notification procedures. Alaska will use the refined procedures during the coming season if monitoring results indicate the need for public notification.

American Samoa

American Samoa is surrounded by approximately 143 miles of beaches. Residents and tourists of American Samoa use all of the 143 miles of beaches for swimming and family subsistence fishing. The American Samoa Environmental Protection Agency (ASEPA) administers the Coastal Recreation Water Monitoring and Notification Program for the territory under the BEACH Act, and it conducts all monitoring and public notification for these beaches. Based on monitoring done in FY 2004, ASEPA determined that for swimming use support 56 miles are impaired, 27 miles fully support this designated use, and 60 miles are likely supporting this designated use but lack sufficient data.

- *Monitoring.* Since the monitoring and notification program was implemented in FY 2002, ASEPA has added 14 new beach sites to the program. ASEPA also increased the frequency of monitoring and public notification for 16 beach sites from once every 3 months to once a week.
- *Public notification.* Public advisories are issued each week in print, radio, and television media for all beach samples that exceed the American Samoa Water Quality Standards for enterococci. The number of public inquiries received by ASEPA from residents, tourists, and community groups (e.g., EnviroCamp Tifitifi, American Samoa Swimming Association, American Samoa National Olympic Committee) about weekly advisories has steadily increased since FY 2002, indicating the success of the public notification program in informing the community, raising awareness, and protecting public health.

California

California has one of the most extensive beach monitoring programs in the country. County health agencies in 18 different coastal counties, National Pollutant Discharge Elimination System (NPDES) permittees that discharge to the coastal zone, environmental groups, and numerous citizen monitoring groups perform beach monitoring. The BEACH program is helping California turn these programs into a coordinated statewide program.

- *Public notification.* EPA BEACH Act grant funds have been used to help develop and support electronic data submission from the coastal counties to the state's Beach Watch System and to EPA. The state's Beach Water Quality Work Group has worked with Heal-the-Bay, a Southern California environmental organization, to modify the grading system for the Beach Report Card, which provides weekly updates on the status of 430 beaches statewide (www.healthebay.org/brc/statemap.asp).
- *Pollution removal and future research.* California has invested $78 million in a Clean Beach Initiative to

clean up bacterial contamination throughout the state. The state has also funded research to develop more rapid detection of indicators, better methods for tracking contamination sources, and epidemiological studies to better understand the relationship between bacterial indicators and diseases.

Connecticut

Connecticut has state, municipal, and private beaches along its shoreline with Long Island Sound. Two of the most popular beaches are New London's Ocean Beach Park and Rocky Neck State Park, which are both EPA–New England-designated "Flagship Beaches." Visit the Web site http://dep.state.ct.us/updates/beach/wtrqual.asp for more information.

The Connecticut Department of Public Health (DPH) manages the BEACH Act grant, which funds courier service to deliver locally collected beach water samples to the DPH state laboratory in Hartford for analysis. The grant also funds other beach-related activities including hosting two annual technical meetings for municipal and state beach officials; collecting and managing laboratory test results for municipal beaches along the shoreline; managing the annual Beach Survey; and reporting monitoring and notification data to EPA. Connecticut has received $957,854 in BEACH Act grants since 2000. Visit the Web site http://dep.state.ct.us/updates/beach/wtrqual.asp for more information.

- *Risk-based beach ranking.* DPH uses a risk-based approach to monitor high-priority beaches. Through two annual meetings and ongoing consultation with municipal and state park beach contacts, the program is committed to communicating with the local communities along the shoreline.
- *Monitoring.* The DPH state laboratory analyzes more than 1,000 samples every summer for Connecticut's municipal and state park beaches along the shoreline. The laboratory quickly reports exceedances to the affected community.

  Local health authorities often preemptively close their beaches as a rapid response public health measure when historical data show there is a high likelihood of elevated bacteria counts after high rainfall events.

Delaware

More than 6.1 million beach-going tourist trips are made to Delaware each year. Delaware's swimming beaches have been sampled since 1979. The state implemented a revised and formalized Recreational Water Program in 1989. This program has grown further under the BEACH Act. Approximately 50 miles of coastline are now monitored, from Slaughter Beach, on the Delaware Bay, south to the State Line at Fenwick Island, Delaware/Ocean City, Maryland. In addition, a number of freshwater ponds are monitored.

Visit the Web site www.dnrec.state.de.us/dnreceis/Div_Water/Apps/RecWater/Asp/RecWaterPublic.asp for more information.

- *Monitoring.* Delaware uses the total enterococci standards recommended by EPA and employs a preemptive rainfall advisory system for the freshwater ponds covered under the program. Delaware conducts sampling at areas covered under the program from the second Monday in May to the second Monday in September. In addition, temperature, salinity, dissolved oxygen, and pH data are also collected weekly at marine sites.

Florida

Florida has numerous important beaches, including such popular destinations as Miami Beach, Fort Lauderdale, Daytona Beach, Key West, and Panama City Beach. The Florida Department of Health administers the Beach Monitoring Program in conjunction with the county health departments and they conduct and oversee monitoring and public notification on approximately 580 miles of beaches. They have received $1,674,348 in BEACH Act grants since 2000.

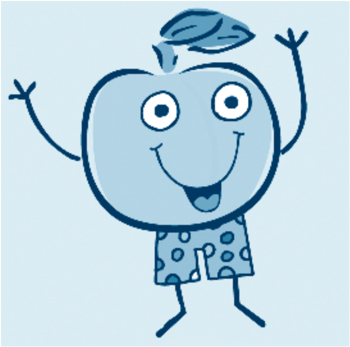
- *Monitoring.* In August 2000 the beach water sampling program included 34 of Florida's coastal counties through state legislation (Senate Bill 1412 and House Bill 2145) and funding. This funding allowed for biweekly sampling at just over 300 sites throughout the state. Testing under this program included fecal coliforms as well as enterococci bacteria. The choice of these two indicator bacteria was based on the water quality standards adopted by the Florida Department of Environmental Protection (DEP) for fecal coliforms and the recommended standards of EPA for enterococcus. In August 2002 DEP began collecting water samples weekly with additional funding from EPA. With the increased sampling frequency, the use of enterococcus geometric means became possible. Since that point, advisories have been based on bacteria levels that exceed either the single sample maximum standards for enterococcus or fecal coliforms or the geometric mean standard for enterococcus.

- *Public notification.* The state delegated authority to county health departments to conduct the sampling and issue health advisories for areas that exceed these standards. The public is then notified through a Web site (http://esetappsdoh/irm00beachwater/default.aspx), local media, and signs posted at the access points to the swimming area.

Georgia

Georgia has numerous important beaches, including such popular destinations as St. Simon's Island, Jekyll Island, and Tybee Island. The Georgia Department of Natural Resources administers the Beach Monitoring Program in conjunction with county and local governments, and they conduct and oversee monitoring and public notification on approximately 118 miles of beaches. They have received $922,745 in BEACH grants since 2000.

- *Public outreach.* The Georgia Department of Public Health and Department of Natural Resources developed a flier with frequently asked questions. The flier, featuring the "Peach on the Beach" character, is distributed to the public by the local health department and answers many of the questions related to beach advisories in a clear and concise manner.



- *Data management.* The Coastal Resources Division applied for and received an EPA National Environmental Information Exchange Network (NEIEN) grant to develop a method of transmitting the beach data into EPA WebSIM via the Georgia network node. The Division then contracted with Acclaim Systems to develop an Oracle database with a Web-based front end and data transport capabilities.

  The Oracle application automatically calculates the rolling 30-day geometric mean and automatically generates an e-mail and sends it to the laboratory manager and to the CRD manager notifying them when the EPA-recommended level has been exceeded. Programmed into the geometric mean application is a "what if" calculator that automatically displays the hypothetical value of the next sample needed to reach the EPA geometric mean threshold. This function is useful to beach managers for projecting what might happen with a particular beach in the near future.

Guam

The Guam Environmental Protection Agency (Guam EPA) administers the beach monitoring and notification program for the territory. Tourists, fishermen, and the public use the beaches and lagoons of Guam heavily every day. Guam has approximately 31.5 miles of beaches. The BEACH program has been instrumental in maintaining and enhancing the territory's water quality and marine monitoring programs over the past four years.

- *Monitoring.* Guam's Recreational Beach Monitoring Strategy focuses on the monitoring of "whole-body" (primary-use) and "limited whole body" (secondary-use) recreational marine waters for the presence of microbiological organisms. This program is important because consistent monitoring ensures the protection of the public from diseases such as gastroenteritis, hepatitis, and cholera caused by elevated levels of microbiological organisms. Guam EPA monitors 38 fixed stations weekly along Guam's most frequently used coastal beaches (Tier 1 beaches) for enterococci bacteria.

- *Public notification.* When samples exceed the single sample maximum or geometric mean criteria for enterococci bacteria, an advisory is released to notify the public that the beach is closed or to warn against swimming. These bacteria criteria were updated in

FY 2004 in the water quality regulations. Guam uses the local media (newspapers and TV) and its Web site to provide real-time results to the public. The Web site posts the weekly results and historical summaries to communicate potential risks to the public (www.guamepa.govguam.net/programs/emas/beach.html#REPORT). Furthermore, all reports listed above are accompanied by a press release making them available to any member of the public.

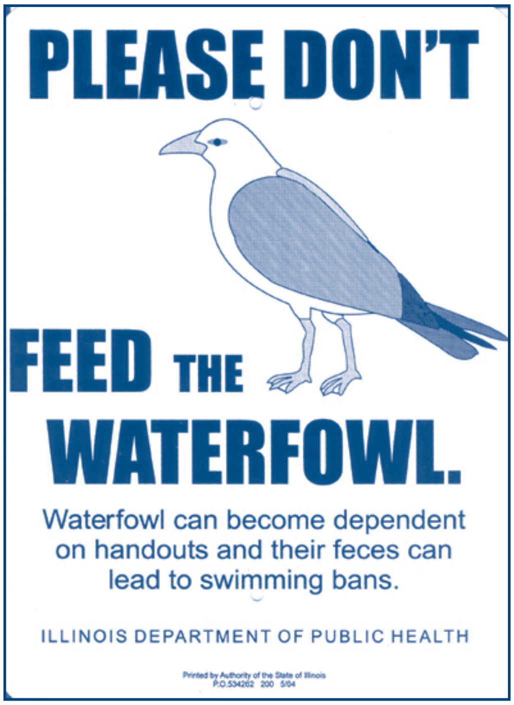
Hawaii

There are more than 400 beaches in Hawaii, including such well-known beaches as Waikiki and Lanikai. Although the Hawaii Department of Health (HDOH) had an established beach monitoring program prior to the first award of BEACH Act grant funds, the addition of these funds has enabled Hawaii to expand its monitoring efforts from a small group of highly visited beaches to a wider range of coastal beaches throughout Hawaii's 297 miles of beaches. These grant funds have also assisted Hawaii in developing its public notification system. Hawaii has received $1,030,971 in BEACH Act grant funds since 2001.

- *Risk-based beach ranking.* The HDOH developed a risk-based ranking system to classify beaches on the islands of Oahu, Maui, Kauai, and Hawaii. HDOH used this ranking system to determine the monitoring frequency of beaches in the state, allowing monitoring efforts to focus throughout the entire year on beaches with high visitation while also providing periodic monitoring surveillance of other beaches throughout the state. Ranks are revised as additional information becomes available.
- *Monitoring.* HDOH increased monitoring frequency from once a week to twice a week at high-use beaches and developed a rotating schedule for monitoring beaches with lower use on a periodic basis. Hawaii is in the process of increasing the monitoring frequency for high-use beaches to four times a week.

Illinois

The Illinois Department of Public Health (IDPH) has been responsible for licensing bathing beaches in Illinois since 1974. IDPH's BEACH Program goals are to improve public health and environmental protection programs for beachgoers and to provide the public with



information about Lake Michigan water quality at Illinois beaches.

- *Monitoring.* Illinois beaches along Lake Michigan are among the most frequently monitored beaches in the nation. All the coastal beaches in Lake County and suburban Cook County are monitored seven days a week during the swimming season. Chicago beaches are monitored 5 days a week. In addition, beach water quality monitoring is augmented through the use of *E. coli* predictive models at several Lake Michigan beaches.
- *Public notification.* IDPH provides beach water quality and program information to beachgoers through informational brochures, signs, and Web sites. An educational beach pamphlet titled *Why is the beach closed?* was developed and distributed to beach patrons. "Don't Feed the Waterfowl" signs have been posted at several Lake Michigan beaches to discourage visitors from feeding birds, which can contribute significant fecal loads to beach water.

Indiana

Indiana has approximately 23 miles of beaches along the Lake Michigan shoreline, including such important destinations as the Indiana Dunes National Lakeshore, which has 9 beaches, and the Indiana Dunes State

Park, with 2 main sections of beaches, along with 14 other county and city beaches. The Indiana Department of Environmental Management (IDEM) administers the Beach Monitoring and Notification Program in conjunction with the Lake County Parks and Recreation Department, the Hammond Health Department, the East Chicago Department of Public and Environmental Health, the Gary Sanitary District, the Town of Ogden Dunes, the Town of Dune Acres, and the LaPorte County Health Department. IDEM has received $676,000 in BEACH Act grants since 2000. Its goals are improving public health and environmental protection programs for beachgoers and informing the public of the water quality at their beaches.

- *Monitoring.* Prior to the BEACH Act grant, *E. coli* monitoring occurred only one day a week at Indiana's Lake Michigan beaches. Since receiving funding, Indiana has been able to increase the sampling frequency to five to seven days a week at most of its Lake Michigan beaches. In addition, in 2004 IDEM used grant dollars to fund two predictive model development projects with the goal of increasing the efficiency of the monitoring activities along the Lake Michigan shoreline in the future.
- *Public notification.* Indiana's Lake Michigan beach managers have requested that IDEM provide real-time information regarding CSO discharge events. In conjunction with the Earth911 data reporting system Web site (www.earth911.org/waterquality), IDEM is working to implement a pilot project designed to provide real-time information regarding CSO discharge events to local beach managers and the public. This project will be linked to Indiana's Beach Program Web site (www.in.gov/idem/beaches).

Louisiana

(Note: This highlight was revised after hurricanes Katrina and Rita to reflect current conditions.)

Louisiana has several beaches historically visited by the public, including the highly frequented Fountainebleau State Park, Grand Isle State Park, Cypremort Point State Park, Fourchon Beach, and Holly Beach. The Louisiana Department of Health and Hospitals (LDHH) administers the Beach Monitoring Program in the state and conducts, or contracts with other state and local governments to conduct on its behalf, monitoring and public notification. Prior to hurricanes Katrina and Rita, monitoring was conducted on approximately 23 miles of beaches.

LDHH completed a thorough, systematic review of available data and information to identify and rank Louisiana's beaches according to risk. LDHH uses the resulting beach classification scheme as a basis for monitoring the state's high-priority beaches. (See www.oph.dhh.state.la.us/sanitarianservices/beachmonitor/index.html and click on "Louisiana's BEACH Act Grant Report" for a description of the state's process for identifying priority beaches.) LDHH also has developed a high-quality public notification program that efficiently uses beach signs, the department's Web site, press releases, and direct contact of partner agencies and local officials to communicate to the public if beach advisories are warranted. Because of extensive damage to the state's beaches and associated infrastructure by Hurricanes Katrina and Rita, LDHH is reevaluating the state's existing List of Beaches to determine whether the list and associated monitoring schedules need to be revised.

Maine

Maine has 46 beaches, which are critical to the viability of its tourist industry. These include such popular places as Old Orchard Beach and Wells Beach in southern Maine and Mount Desert Island, home of Acadia National Park, bordering the downeast section of the 5,250-mile coast. The Maine Coastal Program/State Planning Office manages the Maine Healthy Coastal Beaches Program in cooperation with the University of Maine Cooperative Extension and Sea Grant (responsible for coordination of the program). Maine has received $1,090,713 in BEACH Act grants since 2001.

- *Monitoring.* With EPA BEACH Act grant funds, Maine has been able to develop a statewide monitoring and notification program, recruiting 19 towns and State Parks representing 42 beach management areas. This non-mandatory, local-jurisdiction program put in place an EPA-approved Quality Assurance Project Plan and developed a tiered monitoring approach with protocols, regional laboratories, training, and multiple resources for the program.
- *Public outreach and education.* This new and voluntary program employed a marketing plan, and resources were developed to reach a broad audience through radio, television, news media, posters, flyers, brochures, and a user-friendly and informative Web site, www.MaineHealthyBeaches.org. A public interface to Maine's on-line database was launched on the Web site May 2005, and it offers a wealth of information on the beach science, status, and data for the program.

Maryland

Each summer many state residents and visitors go to Maryland beaches for outdoor recreation and vacations. To protect the beach-going public, Maryland delegates a beach monitoring and public notification program to its local health departments. Beginning in the 1980s, each county had its own, independently developed program. From timing and frequency of sampling to methods of public notification, counties have had very different programs in terms of resources spent on beaches and priority given to public natural bathing areas. Maryland's goal, with the use of BEACH Act grant money and EPA guidance, was and is to maintain a standardized beach program for its coastal counties. Maryland has adopted the EPA-recommended indicators and criteria.

- *Monitoring.* Predictive models are being developed for high-use beaches in Maryland. Projects to monitor pollution sources affecting bathing areas have identified and remedied water quality problems at beaches.
- *Public notification.* Public notification, education, and outreach have increased awareness of the potential risks and hazards of bathing in natural waters, as well as providing public advisory information,

resulting in a better-educated and safer public. Additional information for the Maryland Beaches Program is available by calling 1-800-633-6101, x 3906 or by visiting the Web site http://www.mde.state.md.us/CitizensInfoCenter/Health/beaches.asp.

Massachusetts

Every year people head to bathing beaches in Massachusetts for vacation, relaxation, and recreation. The Massachusetts Department of Public Health (MDPH) is responsible for implementing of the bathing beach monitoring program at more than 500 coastal beaches in the state. The BEACH Act resulted in funding that MDPH has used to increase and implement consistent water quality monitoring throughout the state, increase public awareness of beach water quality issues, and identify areas of concern. Massachusetts has received $1,090,645 in BEACH Act grants since 2000.

- *Monitoring.* MDPH has achieved weekly monitoring at the state's public and semi-public marine beaches.
- *Public notification.* MDPH has developed a public notification Web site (www.mass.gov/dph/beha/tox/reports/beach/beaches.htm), where water quality information and beach open/closed status is shown in near-real time.

Michigan

Michigan has received a total of $1,134,966 in BEACH Act funding to support monitoring programs for 327 public beaches in 41 counties along the state's 3,200 miles of Great Lakes shoreline. Local health departments request an average of $380,000 of BEACH Act funds per year from the Michigan Department of Environmental Quality (MDEQ) for local beach monitoring programs for approximately 200 high-priority beaches. The BEACH Act allocation for Michigan provides funding to support monitoring once a week at 80 beaches for part of the summer and 100 beaches for most of the summer.

- *Monitoring.* All beach monitoring data are reported to and evaluated by the MDEQ. The MDEQ incorporates beach monitoring data into other water pollution prevention programs to encourage strategic improvements in water quality.
- *Public notification.* The Michigan Beach Monitoring Web site (http://www.michigan.gov/deq/0,1607,7-135-3313,00.html) immediately provides current and historical test results for *E. coli* and beach closings/advisories as they are reported from health departments for all public beaches in Michigan. All public beaches are required to post a sign indicating whether the beach is monitored and where the results can be found.

Minnesota

Minnesota has a number of important beaches, including the 5-mile-long Park Point beach within the city of Duluth and beaches in a number of state parks. The Minnesota Pollution Control Agency administers the Beach Monitoring Program in conjunction with Cook County, Lake County, St. Louis County, the City of Duluth, the Western Lake Superior Sanitary District, the Minnesota Department of Natural Resources, the Minnesota Department of Health, the University of Minnesota–Duluth, Sea Grant, Clean Water Action, the Natural Resources Research Institute, and local clubs such as the Park Point Community Club and the Duluth Boat Club. Minnesota conducts or oversees monitoring and public notification on approximately 58 miles of beaches. The state has received $467,815 in BEACH Act grants since 2000.

- *Monitoring.* Since the Minnesota Pollution Control Agency started monitoring 35 beaches in 2002 (will be 39 in 2005), the level of awareness of bacterial pollution of recreational waters in the region, as well as in the state, has risen dramatically. The understanding that wastewater overflows and bypasses can have an effect on beach water quality has led to the demand for solutions to the inflow and infiltration problems in the region.
- *Public notification.* Minnesota has improved many aspects of its public notification process. The state has developed an exceptional interactive and informative Web site (www.MNBeaches.org) that summarizes key information about beach advisories and closings. E-mail notices are automatically sent to interested parties. A local phone message is continually updated with the latest advisories, and the public can call an 800 number to hear beach advisory information. Minnesota also has a good working relationship with the local media.

Mississippi

(Note: this highlight was not revised after hurricanes Katrina and Rita to reflect current conditions.)

Mississippi has numerous important beaches, including such popular destinations as Biloxi and Gulfport. The Mississippi Department of Environmental Quality administers the Beach Monitoring Program in conjunction with the State Beach Monitoring Task Force, and they conduct and oversee monitoring and public notification on approximately 40 miles of beaches. They have received $831,092 in BEACH grants since 2000.

- *Monitoring.* Under the BEACH Act, the Mississippi Beach Monitoring Program was expanded in 2005 to include 22 beaches, and the frequency of sampling was increased for 7 beaches. Sixteen of the 22 beaches were classified as Tier 1 beaches, and they are monitored 10 times a month during the recreational season (May through October). Six Tier II beaches are monitored 4 times a month. All beaches are monitored 4 times a month during the non-recreational season.
- *Public notification.* During 2000, MDEQ developed a Beach Monitoring Web site to notify the public of the water quality at Mississippi beaches and to provide historical beach monitoring bacteria data. The Web site is at http://www.usm.edu/gcrl/msbeach/indes. This Web site provides near real-time data from all the monitoring locations, current beach advisories, beach locations and pictures of all the monitored beaches, and maps locating the sampling sites. If bacteria levels reach unsafe levels, advisory notices are placed on the beach stating that swimming is not recommended until bacteria levels return to safe levels. The advisories remain in place until the monitoring data indicate that the water is safe for swimming and water contact.

New York

New York has 347 regulated beaches located on Lake Erie, Lake Ontario, the Atlantic Ocean, and Long Island Sound, including such well-known beaches as Jones Beach State Park, Rockaway Beach, Coney Island, and Robert Moses State Park. The New York State Department of Health administers the Beach Monitoring Program in conjunction with 11 subcontractors, including 8 organized county health departments; the New York City Department of Health and Mental Hygiene; the New York State Office of Parks, Recreation and Historical Preservation; and one State Health Department District Office, which conduct the monitoring and public notification program for the state's approximately 53 miles of coastal beaches. Since 2001 the New York State Department of Health has received $1,138,485 in grants from EPA to fund these monitoring and notification programs.

- *Monitoring.* Since the inception of the BEACH Act grant program, 35 new beaches have been added to the inventory of coastal beaches in New York State while 5 beaches originally listed have been dropped. The current list of 347 coastal beaches represents a net increase of 30 beaches.
- *Risk-based beach ranking.* The New York State Department of Health, through its subcontractors, thoroughly assesses all the coastal beaches and uses a risk-based approach to monitor all regulated beaches. Beaches assessed as high risk are monitored at least weekly during the bathing season, while those assessed as medium or low risk are monitored less frequently.

New Hampshire

New Hampshire administers a Public Beach Inspection Program, or Beach Program, that monitors, inspects, and provides public notification for 16 coastal public beaches. New Hampshire's coastal beaches are a valuable recreational and economic resource, and they include Hampton Beach State Park, New Hampshire's premier coastal beach attraction. New Hampshire has received $876,994 in BEACH Act grants since 2000.

- *Monitoring.* New Hampshire has increased the number of coastal beaches monitored from 9 in 2000 to 16 in 2005, and the program now includes weekly monitoring at 14 high-priority beaches. All beaches are subject to annual risk-based beach evaluations, which are the basis of New Hampshire's Tiered Monitoring Plan.
- *Public notification.* New Hampshire has developed a detailed Web site to inform the public of the health risks associated with beach recreational activities. The Web site includes features such as a current advisories page, an illness report form, a public comment section, and annual coastal beach reports. Other means of outreach include signage indicating beach monitoring status, numerous fact sheets, and a brochure.

New Jersey

Since 1974 the New Jersey Department of Environmental Protection (DEP) has administered the Cooperative Coastal Monitoring Program (CCMP), in which 10 local environmental health agencies participate. The CCMP assesses nearshore coastal water quality and investigates sources of water pollution. To date DEP has received $908,679 in EPA BEACH Act grants. DEP also received an EPA challenge grant to create a centralized database that will allow for the timely reporting of water quality conditions at New Jersey's beaches.

- *Monitoring and notification.* The local health agencies collect water samples each week and perform the water analyses for enterococci concentrations at 186 ocean and 139 bay monitoring stations. The CCMP enables local health agencies to respond to immediate public health concerns arising from contamination in coastal recreational areas. In addition, DEP performs aerial surveillance of nearshore coastal waters six days a week during the summer. This surveillance enables the routine evaluation of coastal water quality and the assessment of the nature and extent of public reports of ocean pollution. The information collected under the CCMP assists the DEP in developing coastal zone management strategies such as land use planning to control pollution from nonpoint sources.

North Carolina

North Carolina has numerous important beaches, including such popular destinations as Wrightsville Beach, Atlantic Beach, and the Outer Banks. The North

Carolina Department of Environment and Natural Resources administers the Beach Monitoring Program, and it conducts monitoring and public notification on approximately 330 miles of beaches. The Department has received $975,691 in BEACH Act grants since 2000. North Carolina has developed and implemented an extensive outreach and education program to educate local governments, the public, and state elected officials about the Beach Monitoring Program. This has led to increased credibility of the program and the investment of all parties in making the program successful. Also, at the beginning of 2004 the North Carolina Commission for Health Services passed new rules codifying the EPA beach guidance at the state level.

- *Public outreach:* North Carolina Recreational Water Quality (RWQ) staff developed an extensive outreach and education plan, targeted to different audiences both internal and external to state government. The audiences include state agency employees; state-level legislative representatives from coastal counties; local government officials and boards of health; interest groups, including tourism, environmental organizations, and pier and camp owners; and local business interests near sampling sites. They created brochures and fact sheets and the beginnings of a Web-based data system that would allow the public access to water quality data for their chosen beaches.

  The public can access beach water quality data that are updated weekly, as well as information about the program and downloadable brochures, on the program's Web site at http://www.deh.enr.state.nc.us/shellfish/Water_Monitoring/RWQweb/home.htm. In addition, the RWQ staff instigated a series of face-to-face talks and meetings, which has been their most valuable outreach tool.

Northern Mariana Islands

The Commonwealth of Northern Mariana Islands (CNMI) Division of Environmental Quality administers the beach monitoring and notification program for the territory. The beaches and lagoon waters of CNMI are used heavily daily by tourists, fishermen, and the public. CNMI has a little more than 28 miles of beaches. The BEACH program has been instrumental in maintaining and enhancing the territory's water quality and marine monitoring programs over the past four years. On the basis of beach monitoring, CNMI found that of the 28 miles of beaches, 8 miles are impaired, 6.5 miles are fully supporting their designated uses, and 13.8 miles are likely supporting their designated uses but lack sufficient data.

- *Monitoring.* Beach samples are monitored not only for enterococci bacteria, but also salinity, dissolved oxygen, phosphates, nitrates, temperature, pH, and turbidity. The beach monitoring complements CNMI's long-term coral reef ecosystem monitoring and biocriteria development efforts. Beaches that have a high potential risk for harmful pathogens and are heavily used by the public are all considered Tier 1 beaches.
- *Public notification/outreach.* When samples exceed the single sample or geometric mean enterococci bacteria limits in the water quality regulations, the beach is "red flagged," meaning a warning is provided to the public not to swim in these waters. DEQ uses the local media (two newspapers) and its Web site to provide real-time results to the public. The Web site (www.deq.gov.mp/beach%20monitoring%20web/Map%20Choice.htm) presents the weekly results and historical summaries to communicate potential risks to the public. Furthermore, all reports listed above are accompanied by a press release making them available to any member of the public. Signs are posted at six frequently used beaches regarding the most recent testing results, and CNMI is beginning to install signs at all other locations.

Ohio

Ohio regards its border with Lake Erie as a primary natural resource for commerce, tourism, and recreation. The Ohio Department of Health (ODH) has monitored many of the numerous public beaches along the lake since 1973. With the cooperation of its partners (the Ohio Department of Natural Resources, the Ohio Environmental Protection Agency, local health departments, and other interested agencies and organizations), ODH continues to conduct a beach monitoring program each year, generating needed data for allowing the public to make informed decisions about its aquatic recreation.

- *Monitoring.* Since 2002 ODH has used BEACH Act grant funding to increase the frequency of monitoring of Lake Erie beaches from twice per month to four times each week per beach. This frequency allows for swifter identification of bacteria problems and thus shortens the time involved in notifying the public of potential health hazards.
- *Public notification.* ODH provides beach water quality data, beach advisories, and information regarding its monitoring program on the department's Web site at www.odh.ohio.gov. Information on advisory status is also provided through a toll-free telephone line (1-866-OHIO-BCH) for people who lack access to the Internet. BEACH Act funding also has assisted in the development of informational pamphlets that are distributed throughout the Ohio/Lake Erie area. Future funding will allow for the development of bilingual signage and other written information.

Oregon

In Oregon the public is guaranteed free and uninterrupted use of all beaches along the coastline. Oregon's Parks and Recreation Department administers the ocean shore as a state recreation area. The state's Department of Human Services administers the Beach Monitoring Program and works in conjunction with the Department of Environmental Quality and the Parks and Recreation Department to implement the program. Since 2002 Oregon has received a total of $747,600 in BEACH Act grant funds.

- *Monitoring.* The Oregon Beach Monitoring Program conducts monitoring year-round and uses an adaptive sampling approach. The beaches sampled may change seasonally as use patterns and the presence of bacteria change. (http://oregon.gov/DHS/ph/beaches/beaches.shtml)
- *Public notification.* Oregon has significantly enhanced its information delivery system with the development of a new Web site, improved signage and news releases, and collaboration with the Oregon Coastal Atlas to display and broadcast monitoring data on its Web site at www.coastalatlas.net/learn/topics/waterquality/beach.

Pennsylvania

There are 12 permitted coastal recreational beaches on the southern shore of Lake Erie in Pennsylvania. All the beaches are in Erie County, which has the only coastal beaches in the Commonwealth. Annually, over 3 million people visit Presque Isle State Park, which has 11 beaches.

EPA awards a BEACH Act grant to the Erie County Department of Health (ECDH).

- *Monitoring.* Pennsylvania has adapted the *E. coli* standards recommended by EPA. A predictive model of recreational beach water quality based on weather, known sewage discharges, storm events, and water currents is being formulated. The information would be used to see if a correlation could be established with weather and high bacteria counts. If a predictive model were established, it would allow the beach managers to close beaches on a presumptive basis. This could prevent swimming in contaminated waters.
- *Public notification.* ECDH is developing a Web site to provide the public with updated information on the water quality of permitted Lake Erie beaches.

Puerto Rico

Puerto Rico, which includes two additional inhabited offshore islands (Vieques and Culebra) and various small uninhabited islands, provides more than 100 coastal segments that are used for bathing nearly all year long. Not all these coastal segments are designated beach areas. The various designated beach areas are operated by one of the following: the National Parks Company, the Department of Natural and Environmental Resources, or the specific municipalities where the beach is located. In all cases the Environmental Quality Board is responsible for ensuring that the water quality of the coastal segments complies with the applicable water quality standards through monitoring on alternate weeks and enforcement actions whenever noncompliance is discovered.

- *Monitoring.* In the Beach Monitoring Program, Puerto Rico has initially included the 22 major (most frequented) beaches throughout the coastal shoreline of the territory. The Environmental Quality Board monitors all 22 beaches for bacteriological and physical parameters on alternate weeks. Any noncompliance with respect to water quality is addressed immediately through a resampling sequence. The compliance status of each beach program is announced publicly in newspapers and on the Environmental Quality Board's Web site at www.jca.gobierno.pr.

Rhode Island

Rhode Island has 70 environmentally and economically important coastal beaches. The Rhode Island Department of Health (HEALTH) administers the Beach Monitoring Program, with the support of the Department of Environmental Management, the Department of Transportation, the University of Rhode Island, and the Office of the Governor. HEALTH conducts monitoring at approximately 25 miles of beaches and notifies the public whenever a beach is opened or closed. HEALTH has received $911,769 in BEACH Act grant funding since 2000.

- *Monitoring.* HEALTH has conducted sanitary surveys at all 70 licensed coastal beaches. A review of existing information, collection of geographic data, water quality monitoring, and extensive field surveys have allowed HEALTH to target resources, such as increased monitoring, to the beaches of greatest risk to public health.
- *Source identification.* HEALTH has worked to coordinate a multi-agency response to beach closings. The Governor of Rhode Island has charged HEALTH with not only monitoring beaches but also partnering with local, state, and federal agencies to identify and eliminate sources of pollution that cause the beaches to be closed.

South Carolina

South Carolina has numerous important beaches, including Myrtle Beach, Kiawah, and Hilton Head. The Department of Health and Environmental Control (DHEC) administers the Beach Monitoring Program in conjunction with some local authorities, and together they conduct and oversee monitoring and public notification on approximately 180 miles of beaches. They have received $986,868 in BEACH Act grants since 2000. As noted above, the state has worked with local authorities through the use of mini-grants to implement the program. This allows strong working relationships between state and local governments and gives local governments a greater commitment to seeing the beach monitoring program work.

- *Data management*. South Carolina's existing Environmental Facility Information System (EFIS) is used to manage monitoring and advisory data. All monitoring data are entered into EFIS through manual entry or uploaded from the Laboratory Information System (LIMS). The program coordinator enters advisory information is into EFIS.
- *Tiering of Beaches.* In August 2005 DHEC's Bureau of Water plans to issue a contract for continued surveying at sites identified previously as Tier 3. This contractor will verify the site locations, develop necessary survey forms if sampling is needed, document public access and use, and determine sources of pollution.

Texas

Texas has numerous popular beaches, including beaches in the vicinity of such important destinations as Galveston, Corpus Christi, and South Padre Island. The Texas General Land Office (GLO) administers the Texas Beach Watch Program in conjunction with various contracted entities, including local county health departments, universities, and municipalities. GLO oversees monitoring and public notification on approximately 144 miles of beaches in Texas. GLO has received $1.23 million in BEACH Act grants since 2000.

- *Tiering of beaches.* GLO thoroughly evaluated all of the state's beaches. The Office identified beach segments that are used most frequently by the public and determined where health risks to large swimming populations are greatest. Based on the results of this risk-based approach, GLO prioritized all defined beach segments for implementation of its monitoring and public notification program. Before passage of the BEACH Act of 2000, the state was sampling at 13 of the most popular beaches on the Texas coast using state funds. Using the BEACH Act grants, Texas has expanded its sampling program, and data collection now occurs at approximately 59 beaches in 7 counties. (See http://www.glo.state.tx.us/coastal/beachwatch/index.html for a description of GLO's classification of beaches and monitoring plan.)

Virgin Islands

The U.S. Virgin Islands (USVI) consists of four main islands—St. Thomas, St. John, Water Island, and St. Croix. These islands harbor some of the most fascinating and beautiful marine environments in the world. These aquatic resources have contributed to drawing an average of 2 million divers, beachcombers, and sightseers per year, spending nearly $100 million from 1997 to the present. The USVI also has a coastline greater than 185 nautical miles, allowing for public access at hundreds of locations during a year-round swimming season. These unique factors led to the development and implementation of the USVI BEACH Water Quality Monitoring Program, which is essential for the protection of both beachgoers and the marine resources.

- *Monitoring.* The 2001 BEACH Act grant was used to develop the program's Quality Assurance Project Plan. Second-year funds were used to implement the program. A total of 43 beaches were selected—20 on St. Croix, 15 on St. Thomas, and 8 on St. John. Sampling officially began in the St. Thomas/St. John district in July 2004 and in the St. Croix district in August 2004. The selected beaches are monitored weekly. Two state-approved labs were selected to perform the analysis, one on St. Croix and one on St. Thomas, and both use EPA method 1600 for enterococci analysis.
- *Public notification/outreach.* The USVI BEACH program is establishing a Web site and a toll-free number to ensure that the public has access to the data collected and the public advisory status of each beach. The program is using temporary beach water quality warning signs until the permanent signs are completely assembled. The program has conducted public outreach to several local public schools, and several interviews with the local media have been held.

Virginia

Virginia has been monitoring the bathing beaches at Norfolk and Virginia Beach since the 1970s. In 2001 Virginia received the first EPA BEACH Program grant to implement a Beach Monitoring and Public Notification Program for the 2002 swimming season at bathing beaches along the Atlantic coast and the Chesapeake Bay in Virginia. This grant was used to implement a state-level coordinated beach monitoring program at Norfolk and Virginia Beach. The Virginia Department of Health (VDH) coordinates the program, and state employees in the local health departments carry out weekly monitoring.

- *Monitoring.* In 2003 the Beach Monitoring Program was expanded to include additional beaches along the Virginia coast. The Beach Monitoring Program in Virginia provides seasonal water monitoring coverage of bathing beaches at Virginia Beach,

Norfolk, Newport News, Hampton, and Yorktown; the eastern shore of Virginia; and Gloucester and King George counties.

- *Public notification.* State employees in seven different Health Districts participate in the program by conducting sampling and posting signs at beaches when water samples exceed the state water quality standards for bacteria. The public is notified of a swimming advisory through press releases to local newspapers and notices on the Virginia Department of Health Web page (http://www.vdh.virginia.gov/whc/external_whc/BeachMonitoring.asp). In addition, two source-tracking techniques were used on Virginia's beaches during the 2004 swimming season. One method provided information on whether a human waste stream was present at the beaches; the other provided greater detail on the source of contamination by linking the bacteria to more specific sources such as pets, wildlife, human, or waterfowl sources.

Washington

Washington State has 3,066 miles of shoreline with over 2,000 miles in the west coast's largest estuary, Puget Sound. Washington has a variety of beach destinations, including coastal treasures like Westport, Ocean Shores, the city of Edmonds with its nationally recognized scuba diving sanctuary, and the city of Seattle, which has approximately 30 miles of shoreline.

The Washington State Department of Ecology (Ecology) and Department of Health (Health) administer the Beach Monitoring Program in conjunction with county environmental health departments. The monitoring takes place on approximately 60 miles of beaches at the local level, while public notification occurs through actions taken at the state and local levels. Washington has received $880,053 in BEACH Act grants.

The BEACH Act grants have enabled Washington to develop and implement a statewide monitoring and notification program for bacteria at the state's most popular marine recreational beaches. Prior to Washington State's BEACH Program being implemented in 2003, only a handful of marine beaches were monitored with the intent to reduce the risk of disease to users of the state's waters. County health departments monitored beaches independently, if at all, and developed threshold levels independent of other counties. Because of EPA's BEACH Act grants, Washington now has a uniform statewide monitoring program and an interactive mapping Web site that notifies people of advisories and closings.

Using CWA funding from the BEACH Act, Ecology and Health have developed the Washington State Beach Environmental Assessment, Communication and Health (BEACH) Program. Washington's statewide BEACH Program monitors marine recreational beaches to reduce the risk of disease and provide a notification program warning recreational users when there is an increased risk. As lead agencies for the beach monitoring and notification program, Ecology and Health formed an Inter-agency Advisory Committee made up of county, city, and state officials, nonprofit groups, and local park managers to develop the program. The committee chose to implement the BEACH Program by using state agencies to coordinate and county environmental health departments to voluntarily implement the monitoring plans. Public notification is conducted at both the county and state levels.

- *Monitoring.* In 2003, thanks to EPA's grants, Washington State was able to implement the first statewide monitoring and notification program for marine recreational beaches in a pilot project phase. Washington began full implementation of the BEACH Program by evaluating and ranking roughly 1,000 marine beaches in the state. Seventy-two beaches were identified as priority beaches and were monitored for bacteria during the 2004 summer swimming season. Washington State's BEACH Program will evaluate the results from 2003 and 2004 for chronically polluted beaches. Shoreline surveys and further investigation and remediation will follow for the beaches identified as problem beaches.

  The results from the BEACH Program demonstrate that Washington has relatively clean water and safe beaches: 100 percent of the state's marine recreational beaches fall below EPA's recommended geometric mean of 35 enterococcus colonies per 100 mL. However, the BEACH Program has identified roughly 20 percent of the monitored beaches as having bacteria levels above expected background levels. With the population in the Puget Sound region expected to grow by 1.2 million people by 2025, bacteria levels are expected to increase in Washington's recreational waters. Sample results were analyzed to see whether environmental factors like rainfall and sediment size could be correlated with an increase in bacteria levels. Further investigation is needed to determine whether the increased levels of bacteria are due to human impacts or natural causes and whether an increased risk of disease is present.

- *Public notification/outreach*. The BEACH Program also notifies the public when a sewer spill adjacent to a public beach has occurred. Prior to the BEACH Program, statewide notification did not exist. A new interactive, map-based Web site allows people to determine the condition of the beach they plan to visit before driving hours to get there only to find the beach unhealthy for use that day.

  Better public education is still needed to increase the awareness of the public as to the potential risks associated with swimming in polluted water. The BEACH Program developed a public education and outreach campaign for 2005.

Wisconsin

- *Beach assessment and identification*. The Wisconsin Department of Natural Resources collected geo-locational data on 193 beaches, along with their proximity to wastewater outfalls on the shoreline of Lake Michigan and Lake Superior. This information was used to develop state and county maps and to determine actual beach miles along the Great Lakes shores.
- *Public notification.* The Wisconsin Beach Health Web site, which is accessible to the public, stores up-to-date monitoring data and advisory information (www.wibeaches.us). An e-mail notification system allows beach users to sign up to be notified of the status of beaches of their choice. A toll-free phone line is also available for public use.

4.4 What have tribal governments done?

Section 518(e) of the CWA authorizes EPA to treat eligible Indian tribes in the same manner as states for the purpose of receiving CWA section 406 grant funding. To be eligible for a CWA section 406 development grant, a tribe must have coastal recreation waters adjacent to beaches or similar points of access that are used by the public. In addition, a tribe must meet the requirements in CWA section 518 for treatment in a manner similar to a state for purposes of receiving a CWA section 406 grant. At this time, no eligible tribe has applied for a BEACH Act grant.

4.5 What have local governments done?

The BEACH Act authorizes EPA to make a grant to a local government for implementation of a monitoring and notification program only if, after the 1-year period beginning on the date of publication of the performance criteria (which was July 19, 2002), EPA determines that the state within which the local government has jurisdiction is not implementing a program that meets the requirements of section 406(b) of the CWA, as amended by the BEACH Act. On April 26, 2006, EPA made this determination for Pennsylvania and transferred the state's grant to Erie County.

4.6 References

USEPA (U.S. Environmental Protection Agency). 2002a. *National Beach Guidance and Required Performance Criteria for Grants*. EPA 823-B-02-004. U.S. Environmental Protection Agency, Office of Water, Washington, DC. June.

USEPA (U.S. Environmental Protection Agency). 2002b. *Assessing and Monitoring Floatable Debris*. EPA 842-B-02-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC. August.

USEPA (U.S. Environmental Protection Agency). 2004. *National List of Beaches*. EPA 823-R-04-004. U.S. Environmental Protection Agency, Office of Water, Washington, DC. March.

Chapter 5

Improvements to Methodologies and Techniques for Monitoring Coastal Recreation Waters

EPA has also been working to improve the science and integration of monitoring and modeling for pathogens in coastal recreation waters. Chapter 3 describes some of EPA's efforts in this area. This chapter describes other EPA efforts to improve monitoring and recommends improvements to methodologies and techniques for monitoring coastal recreation waters.

5.1 What monitoring research has EPA conducted?

EPA's Office of Research and Development (ORD), in coordination with the Office of Water, conducted a study to identify the characteristics of a beach environment that have a significant impact on monitoring in coastal recreation waters. This project examined five beach environments to determine the factors that most influence the measurement of beach water quality. Two ocean beaches, an estuarine beach, a Great Lakes beach, and a riverine beach were selected to provide as broad a representation of beach environments as possible. The following sites participated in this study (Figure 5.1):

- West Beach, Indiana Dunes National Lakeshore, Ogden Dunes, Indiana, a freshwater beach on the shores of Lake Michigan
- Belle Isle Park, Detroit, Michigan, a freshwater beach on the Detroit River between Lake St. Clair and Lake Erie
- Wollaston Beach, Quincy, Massachusetts, a marine beach in Quincy Bay
- Imperial Beach, Imperial Beach, California, a marine beach on the Pacific Ocean
- Miami Beach Park, Bowley's Quarters, Maryland, an estuarine beach on Chesapeake Bay near Middle River

EPA published the report titled *Environmental Monitoring for Public Access and Community Tracking (EMPACT) Beaches Project* in August 2005. EPA will initiate a formal review process to evaluate the study results. The Agency plans to use the results of the study, along with other recent research studies, to determine how its monitoring guidance for beach monitoring programs might be improved.

There is, for example, a range of technical and policy issues that EPA might review. These could include the depth at which samples should be collected; the time and location at which samples should be collected; other considerations, such as sampling "hot spots," the use of composite sampling, and combining sampling with site-specific predictive modeling; and other monitoring factors that states and localities should consider.

5.2 What modeling work has been conducted?

EPA has been investigating means to improve the monitoring of beach water quality and to develop strategies, including modeling, for timely notification of the public when bacterial contamination poses a risk to bathers. A few models for predicting bacteria concentrations on beaches have been

Figure 5.1. **EMPACT study beaches**

developed in recent years. They include statistical models that rely on readily available parameters, such as rainfall, turbidity, wind direction, and wave height.

The United States Geological Survey (USGS) has also conducted research related to beach water quality. For example, USGS has been refining monitoring methods, and conducting field sampling studies. USGS and EPA have been working to improve models to better predict water quality at beaches.

USGS has developed empirical models for beaches in Ohio and Indiana. In Ohio, USGS researchers developed beach-specific models for five Lake Erie beaches (Francy and others, 2003). At Huntington Beach, Bay Village, Ohio, predictions based on the model are being presented to the public through an Internet-based “nowcasting” system in 2006 (see http://www.ohionowcast.info/); the models for the other beaches will be presented through the nowcasting system after they are validated. In 2005, USGS scientists studied beaches in Porter and Lake Counties in Indiana and developed a mathematical model dubbed “Project SAFE” (Swim Advisory Forecast Estimate, see http://www.glsc.usgs.gov). In these types of models, sources are usually not defined explicitly because rainfall or other variables serve as surrogate source functions. Project SAFE and Nowcasting uses measurements such as rainfall, wave height, and lake turbidity to estimate *E. coli* counts and to determine when counts are high enough to threaten the health of swimmers. Because of the 24-hour time lag associated with the current technique of collecting water samples and culturing for *E. coli*, there are limitations for beach public notification decisions. Therefore, Project SAFE and Nowcasting seeks to decrease the waiting time for results by incorporating real-time information into its model prediction.

USGS began using the Project SAFE models at beaches in Gary, Indiana, during the summer of 2005. According to the SAFE protocol, each morning USGS scientists downloaded data from weather- and water-monitoring stations near or around the Burns Ditch outfall and beaches to the west. Scientists incorporated the data into the mathematical model, determined the likelihood of elevated bacteria levels, and distributed the result to beach managers in time for them to make an educated decision about keeping a beach open to swimmers, issuing an advisory that *E. coli* counts were likely elevated, or closing the beach. Similar procedures are being followed as part of the Nowcasting system in Ohio in 2006. USGS has proposed using this method for other Great Lakes beaches as well.

Less developed, at least in the area of beach bacteria predictive models, are comparatively complex hydrodynamic approaches. Based on initial and boundary conditions, these models are designed to solve the equations of motion numerically, thus predicting the fate and transport of pollutants. Although fundamentally physics-based, they also often have important empirical components to bridge gaps in knowledge or to simplify the mathematics. Such models are currently used mostly for other purposes, such as predicting the transport and fate of hydrocarbons after an oil spill. Sources are usually modeled explicitly.

Nowhere in this spectrum of existing approaches are there models that are readily applicable to new sites. Empirical models apply to specific sites, and complex numerical models generally require the services of experts and consultants to implement them.

New software called "Virtual Beach" is intended to overcome these limitations by supporting both empirical and physical approaches in an integrated application. In collaboration with USGS, EPA is designing Virtual Beach to automate the statistical analytical techniques developed by USGS. Upon collecting and compiling similar ambient data, well-motivated laypersons will be able to use Visual Beach to derive predictive statistical models for their own sites. A prototype is under development at the EPA Ecosystems Research Division in Athens, Georgia. A beta version of the Virtual Beach statistical model was distributed to selected reviewers in June 2005. Parts of the interface and statistical models were presented at the AllPI conference on Oceans and Human Health in Lansing, Michigan, April 19–20, 2005 (Ge 2005).

The goal is to develop a user-friendly application that directly or indirectly includes point and nonpoint sources of contamination, the latest bacterial decay mechanisms, real-time and Web-based ambient and atmospheric and aquatic input, and a predictive capability of up to three days to help avert potential beach closings. Upon successful completion of the first phase, similar development approaches will be used to start the second phase, the hydrodynamic modeling approach. After both the statistical and hydrodynamic approaches become available, end users will be able to select the approach most compatible with their resources and capabilities.

The suite of predictive capabilities for this software application can enhance the utility of new methodologies for analyzing indicator pathogens by identifying times that represent the highest probability of bacterial contamination. Successful use of this model will provide a means to direct timely collection of monitoring samples, strengthening the value of the short turnaround time for sampling. In addition, in some cases of known point sources of bacteria, such as wastewater treatment plant discharges, the model can be applied to help guide operational controls to help prevent resulting beach closings.

5.3 References

Francy, D.S., A.M. Gifford, R.A. Darner. 2003. Escherichia coli *at Ohio bathing beaches: distribution, sources, wastewater indicators, and predictive modeling*. Water-Resources Investigations Report 02-4285. U.S. Geological Survey, Reston, Virginia.

Ge, Z. 2005. The development of an empirical bacteria model for Visual Beach. Presented at the AllPI conference on Oceans and Human Health in Lansing, Michigan, April 19–20, 2005.

USEPA. 2005. *The EMPACT Beaches Project: Results From a Study on Microbiological Monitoring in Recreational Waters*. EPA 600/R-04/023, U.S. Environmental Protection Agency, Cincinnati, Ohio.

Appendix A
BEACH Act

SECTION 1. SHORT TITLE.
This Act may be cited as the "Beaches Environmental Assessment and Coastal Health Act of 2000".
SEC. 2. ADOPTION OF COASTAL RECREATION WATER QUALITY CRITERIA AND STANDARDS BY STATES.
Section 303 of the Federal Water Pollution Control Act (33U.S.C. 1313) is amended by adding at the end the following:
"(i) COASTAL RECREATION WATER QUALITY CRITERIA.—
"(1) ADOPTION BY STATES.—
"(A) INITIAL CRITERIA AND STANDARDS.—Not later than 42 months after the date of the enactment of this sub-section, each State having coastal recreation waters shall adopt and submit to the Administrator water quality criteria and standards for the coastal recreation waters of the State for those pathogens and pathogen indicators for which the Administrator has published criteria under section 304(a).
"(B) NEW OR REVISED CRITERIA AND STANDARDS.—Not later than 36 months after the date of publication by the Administrator of new or revised water quality criteria under section 304(a)(9), each State having coastal recreation waters shall adopt and submit to the Administrator new or revised water quality standards for the coastal recreation waters of the State for all pathogens and pathogen indicators to which the new or revised water quality criteria are applicable.
"(2) FAILURE OF STATES TO ADOPT.—
"(A) IN GENERAL.—If a State fails to adopt water quality criteria and standards in accordance with paragraph (1)(A) that are as protective of human health as the criteria for pathogens and pathogen indicators for coastal recreation waters published by the Administrator, the Administrator shall promptly propose regulations for the State setting forth revised or new water quality standards for pathogens and pathogen indicators described in paragraph (1)(A) for coastal recreation waters of the State.
"(B) EXCEPTION.—If the Administrator proposes regulations for a State described in subparagraph (A) under subsection (c)(4)(B), the Administrator shall publish any revised or new standard under this subsection not later than 42 months after the date of the enactment of this
subsection.
"(3) APPLICABILITY.—Except as expressly provided by this subsection, the requirements and procedures of subsection (c) apply to this subsection, including the requirement in subsection (c)(2)(A) that the criteria protect public health and welfare.".

SEC. 3. REVISIONS TO WATER QUALITY CRITERIA.
(a) STUDIES CONCERNING PATHOGEN INDICATORS IN COASTAL RECREATION WATERS.—Section 104 of the Federal Water Pollution Control Act (33 U.S.C. 1254) is amended by adding at the end the following:
"(v) STUDIES CONCERNING PATHOGEN INDICATORS IN COASTAL RECREATION WATERS.—Not later than 18 months after the date of the enactment of this subsection, after consultation and in cooperation with appropriate Federal, State, tribal, and local officials (including local health officials), the Administrator shall initiate, and, not later than 3 years after the date of the enactment of this subsection, shall complete, in cooperation

with the heads of other Federal agencies, studies to provide additional information for use in developing—
"(1) an assessment of potential human health risks resulting from exposure to pathogens in coastal recreation waters, including nongastrointestinal effects;
"(2) appropriate and effective indicators for improving detection in a timely manner in coastal recreation waters of the presence of pathogens that are harmful to human health;
"(3) appropriate, accurate, expeditious, and cost-effective methods (including predictive models) for detecting in a timely manner in coastal recreation waters the presence of pathogens that are harmful to human health; and
"(4) guidance for State application of the criteria for pathogens and pathogen indicators to be published under section 304(a)(9) to account for the diversity of geographic and aquatic conditions.".
(b) REVISED CRITERIA.—Section 304(a) of the Federal Water Pollution Control Act (33 U.S.C. 1314(a)) is amended by adding at the end the following:
"(9) REVISED CRITERIA FOR COASTAL RECREATION WATERS.—
"(A) IN GENERAL.—Not later than 5 years after the date of the enactment of this paragraph, after consultation and in cooperation with appropriate Federal, State, tribal, and local officials (including local health officials), the Administrator shall publish new or revised water quality criteria for pathogens and pathogen indicators (including a revised list of testing methods, as appropriate), based on the results of the studies conducted under section 104(v), for the purpose of protecting human health in coastal recreation waters.
"(B) REVIEWS.—Not later than the date that is 5 years after the date of publication of water quality criteria under this paragraph, and at least once every 5 years thereafter, the Administrator shall review and, as necessary, revise the water quality criteria.".

SEC. 4. COASTAL RECREATION WATER QUALITY MONITORING AND NOTIFICATION.

Title IV of the Federal Water Pollution Control Act (33 U.S.C. 1341 et seq.) is amended by adding at the end the following:
"SEC. 406. COASTAL RECREATION WATER QUALITY MONITORING AND NOTIFICATION.
"(a) MONITORING AND NOTIFICATION.—
"(1) IN GENERAL.—Not later than 18 months after the date of the enactment of this section, after consultation and in cooperation with appropriate Federal, State, tribal, and local officials (including local health officials), and after providing public notice and an opportunity for comment, the Administrator shall publish performance criteria for—
"(A) monitoring and assessment (including specifying available methods for monitoring) of coastal recreation waters adjacent to beaches or similar points of access that are used by the public for attainment of applicable water quality standards for pathogens and pathogen indicators; and
"(B) the prompt notification of the public, local governments, and the Administrator of any exceeding of or likelihood of exceeding applicable water quality standards for coastal recreation waters described in subparagraph (A).
"(2) LEVEL OF PROTECTION.—The performance criteria referred to in paragraph (1) shall provide that the activities described in subparagraphs (A) and (B) of that paragraph shall be carried out as necessary for the protection of public health and safety.
"(b) PROGRAM DEVELOPMENT AND IMPLEMENTATION GRANTS.—
"(1) IN GENERAL.—The Administrator may make grants to States and local governments to develop and implement programs for monitoring and notification for coastal recreation waters adjacent to beaches or similar points of access that are used by the public.
"(2) LIMITATIONS.—
"(A) IN GENERAL.—The Administrator may award a grant to a State or a local government to implement a monitoring and notification program if—
"(i) the program is consistent with the performance criteria published by the Administrator under subsection (a);

"(ii) the State or local government prioritizes the use of grant funds for particular coastal recreation waters based on the use of the water and the risk to human health presented by pathogens or pathogen indicators;
"(iii) the State or local government makes available to the Administrator the factors used to prioritize the use of funds under clause (ii);
"(iv) the State or local government provides a list of discrete areas of coastal recreation waters that are subject to the program for monitoring and notification for which the grant is provided that specifies any coastal recreation waters for which fiscal constraints will prevent consistency with the performance criteria under subsection (a); and
"(v) the public is provided an opportunity to review the program through a process that provides for public notice and an opportunity for comment.
"(B) GRANTS TO LOCAL GOVERNMENTS.—The Administrator may make a grant to a local government under this subsection for implementation of a monitoring and notification program only if, after the 1-year period beginning on the date of publication of performance criteria under subsection (a)(1), the Administrator determines that the State is not implementing a program that meets the requirements of this subsection, regardless of whether the State has received a grant under this subsection.
"(3) OTHER REQUIREMENTS.—
"(A) REPORT.—A State recipient of a grant under this subsection shall submit to the Administrator, in such format and at such intervals as the Administrator determines to be appropriate, a report that describes—
"(i) data collected as part of the program for monitoring and notification as described in subsection (c); and
"(ii) actions taken to notify the public when water quality standards are exceeded.
"(B) DELEGATION.—A State recipient of a grant under this subsection shall identify each local government to which the State has delegated or intends to delegate responsibility for implementing a monitoring and notification program consistent with the performance criteria published under subsection (a) (including any coastal recreation waters for which the authority to implement a monitoring and notification program would be subject to the delegation).
"(4) FEDERAL SHARE.—
"(A) IN GENERAL.—The Administrator, through grants awarded under this section, may pay up to 100 percent of the costs of developing and implementing a program for monitoring and notification under this subsection.
"(B) NON-FEDERAL SHARE.—The non-Federal share of the costs of developing and implementing a monitoring and notification program may be—
"(i) in an amount not to exceed 50 percent, as determined by the Administrator in consultation with State, tribal, and local government representatives; and
"(ii) provided in cash or in kind.
"(c) CONTENT OF STATE AND LOCAL GOVERNMENT PROGRAMS.—
As a condition of receipt of a grant under subsection (b), a State or local government program for monitoring and notification under this section shall identify—
"(1) lists of coastal recreation waters in the State, including coastal recreation waters adjacent to beaches or similar points of access that are used by the public;
"(2) in the case of a State program for monitoring and notification, the process by which the State may delegate to local governments responsibility for implementing the monitoring and notification program;
"(3) the frequency and location of monitoring and assessment of coastal recreation waters based on—
"(A) the periods of recreational use of the waters;
"(B) the nature and extent of use during certain periods;
"(C) the proximity of the waters to known point sources and nonpoint sources of pollution; and
"(D) any effect of storm events on the waters;
"(4)(A) the methods to be used for detecting levels of pathogens and pathogen indicators that are harmful to human health; and
"(B) the assessment procedures for identifying short-term increases in pathogens and pathogen indicators that are

harmful to human health in coastal recreation waters (including increases in relation to storm events);
"(5) measures for prompt communication of the occurrence, nature, location, pollutants involved, and extent of any exceeding of, or likelihood of exceeding, applicable water quality standards for pathogens and pathogen indicators to—
"(A) the Administrator, in such form as the Administrator determines to be appropriate; and
"(B) a designated official of a local government having jurisdiction over land adjoining the coastal recreation waters for which the failure to meet applicable standards is identified;
"(6) measures for the posting of signs at beaches or similar points of access, or functionally equivalent communication measures that are sufficient to give notice to the public that the coastal recreation waters are not meeting or are not expected to meet applicable water quality standards for pathogens and pathogen indicators; and
"(7) measures that inform the public of the potential risks associated with water contact activities in the coastal recreation waters that do not meet applicable water quality standards.
"(d) FEDERAL AGENCY PROGRAMS.—Not later than 3 years after the date of the enactment of this section, each Federal agency that has jurisdiction over coastal recreation waters adjacent to beaches or similar points of access that are used by the public shall develop and implement, through a process that provides for public notice and an opportunity for comment, a monitoring and notification program for the coastal recreation waters that—
"(1) protects the public health and safety;
"(2) is consistent with the performance criteria published under subsection (a);
"(3) includes a completed report on the information specified in subsection (b)(3)(A), to be submitted to the Administrator; and
"(4) addresses the matters specified in subsection (c) .
"(e) DATABASE.—The Administrator shall establish, maintain, and make available to the public by electronic and other means a national coastal recreation water pollution occurrence database that provides—
"(1) the data reported to the Administrator under sub-sections (b)(3)(A)(i) and (d)(3); and
"(2) other information concerning pathogens and pathogen indicators in coastal recreation waters that—
"(A) is made available to the Administrator by a State or local government, from a coastal water quality monitoring program of the State or local government; and
"(B) the Administrator determines should be included.
"(f) TECHNICAL ASSISTANCE FOR MONITORING FLOATABLE MATERIAL.—
The Administrator shall provide technical assistance to States and local governments for the development of assessment and monitoring procedures for floatable material to protect public health and safety in coastal recreation waters.
"(g) LIST OF WATERS.—
"(1) IN GENERAL.—Beginning not later than 18 months after the date of publication of performance criteria under subsection (a), based on information made available to the Administrator, the Administrator shall identify, and maintain a list of, discrete coastal recreation waters adjacent to beaches or similar points of access that are used by the public that—
"(A) specifies any waters described in this paragraph that are subject to a monitoring and notification program consistent with the performance criteria established under subsection (a); and
"(B) specifies any waters described in this paragraph for which there is no monitoring and notification program (including waters for which fiscal constraints will prevent the State or the Administrator from performing monitoring and notification consistent with the performance criteria established under subsection (a)).
"(2) AVAILABILITY.—The Administrator shall make the list described in paragraph (1) available to the public through—
"(A) publication in the Federal Register; and
"(B) electronic media.
"(3) UPDATES.—The Administrator shall update the list described in paragraph (1) periodically as new

information becomes available.
"(h) EPA IMPLEMENTATION.—In the case of a State that has no program for monitoring and notification that is consistent with the performance criteria published under subsection (a) after the last day of the 3-year period beginning on the date on which the Administrator lists waters in the State under subsection (g)(1)(B), the Administrator shall conduct a monitoring and notification program for the listed waters based on a priority ranking established by the Administrator using funds appropriated for grants under subsection (i)—
"(1) to conduct monitoring and notification; and
"(2) for related salaries, expenses, and travel.
"(i) AUTHORIZATION OF APPROPRIATIONS.—There is authorized to be appropriated for making grants under subsection (b), including implementation of monitoring and notification programs by the Administrator under subsection (h), $30,000,000 for each of fiscal years 2001 through 2005.".

SEC. 5. DEFINITIONS.

Section 502 of the Federal Water Pollution Control Act (33 U.S.C. 1362) is amended by adding at the end the following:
"(21) COASTAL RECREATION WATERS.—
"(A) IN GENERAL.—The term 'coastal recreation waters' means—
"(i) the Great Lakes; and
"(ii) marine coastal waters (including coastal estuaries) that are designated under section 303(c) by a State for use for swimming, bathing, surfing, or similar water contact activities.
"(B) EXCLUSIONS.—The term 'coastal recreation waters' does not include—
"(i) inland waters; or
"(ii) waters upstream of the mouth of a river or stream having an unimpaired natural connection with the open sea.
"(22) FLOATABLE MATERIAL.—
"(A) IN GENERAL.—The term 'floatable material' means any foreign matter that may float or remain suspended in the water column.
"(B) INCLUSIONS.—The term 'floatable material' includes—
"(i) plastic;
"(ii) aluminum cans;
"(iii) wood products;
"(iv) bottles; and
"(v) paper products.
"(23) PATHOGEN INDICATOR.—The term 'pathogen indicator' means a substance that indicates the potential for human infectious disease.".

SEC. 6. INDIAN TRIBES.

Section 518(e) of the Federal Water Pollution Control Act (33 U.S.C. 1377(e)) is amended by striking "and 404" and inserting "404, and 406".

SEC. 7. REPORT.

(a) IN GENERAL.—Not later than 4 years after the date of the enactment of this Act, and every 4 years thereafter, the Administrator of the Environmental Protection Agency shall submit to Congress a report that includes—
(1) recommendations concerning the need for additional water quality criteria for pathogens and pathogen indicators and other actions that should be taken to improve the quality of coastal recreation waters;
(2) an evaluation of Federal, State, and local efforts to implement this Act, including the amendments made by this Act; and
(3) recommendations on improvements to methodologies and techniques for monitoring of coastal recreation waters.

(b) COORDINATION.—The Administrator of the Environmental Protection Agency may coordinate the report under this section with other reporting requirements under the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq.).

SEC. 8. AUTHORIZATION OF APPROPRIATIONS.

There are authorized to be appropriated to carry out the provisions of this Act, including the amendments made by this Act, for which amounts are not otherwise specifically authorized to be appropriated, such sums as are necessary for each of fiscal years 2001 through 2005.

Speaker of the House of Representatives.
Vice President of the United States and
President of the Senate.

Appendix B

State and Territory Highlights

The following sections were written by each state or territory to highlight the key accomplishments of beach programs in coastal states and territories. EPA has not verified and validated these data. These program descriptions describe recent activities and might include some actions not funded by BEACH Act funds. Readers should note that the summaries for the Gulf Coast area were written before hurricanes Katrina and Rita. These devastating events, which occurred in August and September 2005, will likely have a profound effect on the beach programs administered by the affected states in the short term. In the coming months, EPA and the states will work to reestablish program activities so that the health and safety of beachgoers remain protected.

Alabama

In June 1999, the Alabama Department of Environmental Management (ADEM), in cooperation with the Alabama Department of Public Health (ADPH), initiated a program to routinely monitor bacteria levels at five public recreational beaches along the Gulf Coast. The effort was later expanded to include six additional sites along the Gulf Coast and Mobile Bay. ADEM was designated as the state's lead agency and was awarded grant money by EPA through the BEACH Act to carry out this program. Through the BEACH Act, ADEM and ADPH expanded and enhanced monitoring and notification efforts for Alabama's public recreational waters. The goal of this program is to increase public awareness and provide water quality information to help the public make more informed decisions concerning their recreational use of Alabama's natural coastal waters.

Monitoring and Public Notification

The monitoring program now involves the routine collection of water samples from 25 high-use and/or potentially high-risk public recreational sites from Perdido Bay to Dauphin Island. The selection of sites and the frequency of sampling have been determined using a risk-based evaluation and ranking process. This process considers a number of factors for a given site, the most important being the amount of use and the amount of risk. Depending on the site rankings, samples are collected twice a week, once a week, or once every other week during the swimming season (June through September) and once a month during the cooler months (October through May). Samples are analyzed for the indicator bacteria enterococci. The indicator bacteria used and the threshold concentration, which triggers an advisory, are based on recommendations provided by EPA in the documents *Ambient Water Quality Criteria for Bacteria* (1986) and *Water Quality Standards Handbook, second edition* (1983). All enterococci analysis is performed by ADPH Laboratory using EPA Standard Method 1600. EPA Method 1600 provides a direct count of bacteria in the water based on the development of colonies on the surface of the membrane filter. The ADPH and EPA whole body water contact standard for enterococci is 104 col/100 mL (single sample maximum).

Trained ADEM and ADPH staff collect samples from the sites, and the ADPH Mobile Laboratory performs enterococcus analyses. ADPH reviews all data and is responsible for issuing advisories. All test results are posted on the ADEM Web site and advisories are publicized through press releases and posted on signs at each of the 25 sampling locations. More than 3,000 samples have been collected since the inception of the Beach Program, resulting in 52 advisories issued. During fiscal year 2004, over 800 samples were collected and analyzed, resulting in 15 beach advisories. Currently ADPH is using YSI Environmental Monitoring Systems, which are multiparameter, water quality measurement and data collection systems used to collect in situ data. These data are also reported on the ADEM Web site. The in situ data collected includes dissolved oxygen, pH, specific conductivity, salinity, and temperature. Turbidity data are also collected using a field turbidity meter.

American Samoa

Overview of progress

All 143 miles of beaches and lagoon waters surrounding American Samoa are used daily by residents and tourists both for swimming and for family subsistence fishing. Thus, protection of public health by reducing the risk of disease acquired from swimming and recreating in contaminated waters is a great concern for the local community. Prior to 2002, the existing methods for monitoring recreational waters in the territory did not adequately protect public health. Following the receipt of BEACH grant funds in FY 2001, American Samoa EPA (ASEPA) successfully developed a beach monitoring and public notification program by the end of FY 2002. Since that time, ASEPA has continued with full implementation and enhancement of this program.

Background

Prior to receiving BEACH Act grant funds in FY 2001, limited assessment was made of beaches (embayments and open coastal waters). Each week, ASEPA monitored only 12 beach sites spanning 30 beach miles. Although beach samples were analyzed for the detection and quantification of enterococci, no statistical reference work was performed, nor was any attempt made to utilize the information for public notification.

FY 2002 Progress

In FY 2002, ASEPA used grant funds to develop a program consistent with EPA's nine performance criteria for the implementation of monitoring, assessment and notification. The primary objective of the project was continued development of an enhanced coastal recreation water monitoring program for American Samoa. Samples were routinely collected and analyzed from 14 beach sites weekly (Tier 1), 7 beaches monthly (Tier 2), and 14 remote beaches quarterly (Tier 3). Public advisories were issued in print, radio, and television media for all beach samples that exceeded the American Samoa Water Quality Standards.

FY 2003 Progress

In FY 2003, ASEPA continued with full implementation of the beach monitoring and notification program. ASEPA also submitted an annual performance report, financial report, and monitoring and notification report for each fiscal year. Two Tier 3 beach sites were shifted to a more regular sampling frequency of Tier 1, increasing the number of beaches monitored weekly from 14 to 16 beaches. An additional beach site was added to Tier 3 for monitoring and public notification, bringing the total number of beaches sampled each quarter to 15. The total number of beach miles monitored and assessed for public notification at the end of FY 2003 was 83 miles.

FY 2004 Progress

Increased BEACH Act grant funding awarded in FY 2004 enabled ASEPA to continue with full implementation and to enhance its beach monitoring and notification program. Specifically, ASEPA increased the monitoring frequency for Tier 3 waters from quarterly to weekly monitoring; bringing the total number of beach sites sampled each week from 16 to 31. In addition to increased monitoring, advisories of water quality exceedances at Tier 3 waters were issued weekly for public notification. These data have enabled ASEPA to focus its nonpoint source efforts for improving water quality at beach sites. A fourth tier of 21 new beach sites spanning 60 miles was evaluated and classified using a risk-based approach, increasing the total number of beach miles considered for monitoring and public notification to 143 miles.

California

California has one of the most extensive beach monitoring programs in the country. Monitoring is performed by county health agencies in 18 coastal counties by NPDES permittees that discharge to the coastal zone, environmental groups, and numerous citizen monitoring groups. The BEACH program is helping California turn these programs into a coordinated statewide program.

Monitoring

BEACH Act grant funds have been used to augment beach monitoring in California. The State Department of Health Services (DHS) requires weekly monitoring for three bacterial indicators (total coliform bacteria, fecal coliform bacteria, and enterococcus) during the summer dry-weather period (April 1 to October 31) at all beaches having more than 50,000 visitors each year and near storm drains. Some local governments, especially in southern California, monitor their beaches year-round. Counties have used the BEACH Act grant funds to increase the number of stations sampled at beaches, increase the frequency of sampling, and, where appropriate, extend sampling to year-round.

The State Water Resources Control Board (State Board) has an ongoing Beach Water Quality Task Force consisting of health officials, regulatory agencies, discharge agencies, and environmental groups. The task force developed a three-tiered monitoring framework. Tier 1 beaches are high-use beaches with potential sources of contamination. These are monitored at least weekly; many are monitored daily or five days a week. Tier 2 beaches have moderate usage. These beaches may be monitored less than weekly or not at all during the period from November 1 through March 31 at the discretion of the local health officer. Tier 3 beaches are low-use beaches with little or no known source of contamination. The local health officer and water quality agencies may have monitoring conducted to determine whether these waters should be classified as Tier 1 or 2. Otherwise, the Tier 3 beaches are not monitored.

Quality assurance

The local health agencies collecting data have their own individual Quality Assurance Plans. DHS used the BEACH Act grant funds to develop a Quality Assurance Management Plan for all beach monitoring activities under the BEACH program. The plan describes how the program will develop, implement, and determine the effectiveness of its quality assurance and quality control policies and procedures. Perhaps unique to California, organizations participate in inter-laboratory calibration studies to ensure that results being generated by multiple laboratories are comparable.

Public notification and outreach

The state regulations prescribe bacterial thresholds and procedures for posting advisories and closing beaches. California makes a clear distinction between advisories and closings. Advisories provide the beachgoer with information to make an informed decision. The thresholds for posting an advisory in California are lower than those in other states. In California, beach advisories are mandated when any single sample exceeds a threshold for any one of three indicators. In addition, advisories are routinely posted for beaches 72 hours after a rainstorm. These differences need to be taken into consideration when making state-by-state comparisons.

Coastal counties are required by statute to report monthly to the state the number of beach advisories and closings. EPA BEACH Act grant funds have been used to help develop and support electronic data submittal. In Southern California, the county health agencies have data systems in place that allow them to transmit the water quality and advisory data to the State Board's Beach Watch System. In Northern California, counties are able to submit data to the Beach Watch System through a Web-based interface. The data from the Beach Watch System is used to submit data to EPA.

The Beach Water Quality Work Group refined the Heal-the-Bay Report Card system for consistent statewide application. The beach report card provides information on 430 beaches in California and is updated weekly (www.healthebay.org/brc/statemap.asp). The use of letter grades effectively communicates complex water quality data in a way that most people can understand and allows them to make informed decisions about where they want to swim.

Other highlights

California is a leader in beach monitoring. The state has invested $78 million in a Clean Beach Initiative to clean up bacterial contamination throughout the state. The state also has invested in the development of techniques for rapid indicators to allow for quicker notification and methods for source tracking to accurately and rapidly identify causes of bacterial impairments. There have been two epidemiological studies in California (Santa Monica Bay, 1994, and Mission Bay, 2004) to evaluate the relationship between bacterial indicators and incidence of disease. The Mission Bay study is unique in that it provides information on the risks associated with nonpoint sources of bacteria that are not of human origin.

Connecticut

Monitoring and public notification

The 67 regulated coastal bathing areas along the shoreline of Connecticut in contact with the Long Island Sound Estuary fall into two groups. Sixty-three of these beaches are sampled and monitored by 22 municipal local health departments, while the remaining 4 are state park beaches monitored by the Connecticut Department of Environmental Protection (CTDEP). These 67 beaches are monitored and closed in accordance with the *State of Connecticut's Guidelines for Monitoring Bathing Water and Closure Protocol*. From Memorial Day to Labor Day, the shoreline local health departments and CTDEP notify the public when they issue closings or advisories for these beaches.

The Connecticut Department of Public Health (CTDPH) is currently building Web pages for the public beaches in Connecticut. The pages will be accessed through the department's home page, and will include beach lists; a tiered beach monitoring list; the *State of Connecticut's Guidelines for Monitoring Bathing Water and Closure Protocol*; links to Connecticut local health departments and CTDEP for beach closure information, the Centers for Disease Control and Prevention, and EPA; and references to state regulations governing public beaches.

Beach mapping and data management

CTDPH has traversed the entire length of each of the 67 regulated coastal bathing areas along the shoreline adjoining the Long Island Sound Estuary. This survey yielded the latitude and longitude of the beach end points, the beach lengths, and the latitude and longitude of each of the 144 sampling sites at these beaches. The geographic data from this survey have been rendered through geographic information system (GIS) software to create one colored and scaled map for each of the regulated coastal bathing areas. These maps, along with notification and monitoring data, are contained in an integrated custom relational database reserved for office use. Notification and monitoring data can be displayed on beach maps to quickly visualize seasonal data sets for selected beaches.

This custom database not only tracks notification and monitoring data but also is used to produce a yearly Beach Summary report and the annual Beach Survey that is completed by CTDEP and the local health departments. Sample results produced by CTDPH state laboratory for these beaches are reported seasonally to CTDPH where they are entered into and managed by custom relational database software. Monitoring and notification data collected with the annual Beach Survey is stored in the database and forwarded to EPA as part of a BEACH Act grant requirement.

Laboratory services

The CTDPH state laboratory is an active partner with CTDEP and the local health departments that elect to use the laboratory service for beach monitoring. During a typical bathing season, the state laboratory routinely processes more than 1,000 water samples collected at selected regulated coastal bathing areas. Samples that test positive for elevated levels of enterococcus trigger a telephone call directly to the submitting local health department or CTDEP as soon as the test results are learned. Beach monitoring test results are mailed to the local health departments and to CTDEP.

Training

CTDPH administers the BEACH Act grant in Connecticut and provides two meetings annually at the beginning and end of the bathing season for local health departments, CTDEP, and other interested parties. These workshops review the current status of the BEACH Act grant, laboratory methods used to test for the indicator organism enterococcus, sample collection and handling protocol, the courier service provided by CTDPH to collect coastal water samples along the shoreline, and notification and monitoring data collection during and after the bathing season.

Press event

EPA and CTDPH have participated in several press events announcing the award of the BEACH Act grant. In 2004, the city of New London participated in the Connecticut BEACH Act grant announcement at Ocean Beach. Following the announcement and speaker comments, EPA demonstrated water collection sampling and testing techniques in front of several camera crews and a live audience of swimmers.

Delaware

Delaware's swimming beaches have been sampled since 1979. As part of an ongoing commitment to provide assurances for the state's residents and visitors regarding swimming water quality, Delaware implemented a revised, formalized Recreational Water Program in 1989. It is one of the most comprehensive programs of its kind in the United States. Approximately 50 miles of coastline, from Slaughter Beach to the state line at Ocean City, Maryland, are sampled for enterococcus bacteria levels, monitored for rainfall, and observed for other factors known to impact water quality, including spills and potentially toxic phytoplankton blooms. Delaware has a total of 25 miles of Atlantic Ocean coast, 50 miles of Delaware Bay Coast, and 115 miles of coastal bay (Inland Bays) shoreline, including Rehoboth Bay, Indian River Bay, and Little Assawoman Bay.

The Delaware Department of Natural Resources and Environmental Control developed the *State of Delaware Guidelines for Monitoring and Assessing the Human Health Risk of Swimming Activities in Fresh and Marine Recreational Waters*. These guidelines were set forth to protect people from incurring an unacceptable health risk due to swimming (primary-contact recreation) in the natural waters of Delaware. These health risks may include, but are not limited to, infections of the ears, nose, eyes, of throat, or gastrointestinal distress.

The principles in the guidelines were developed using health effects relationships determined by the EPA through 10 years of study in the United States and other countries. The guidelines contain a list of definitions, details on the statutory authority, specifications and a discussion on health risks, monitoring parameters, water quality standards, laboratory analytical methodology, and a description of their tiered monitoring plan, site selection criteria, and their public notification policy.

Swimming advisories are issued to recreational water area administrators and are managed collaboratively with the Delaware Department of Natural Resources and Environmental Control. Continuous notification to the public regarding the advisory status of swimming areas is maintained via a toll-free number (1-800-922-WAVE). Information is also available through the Web site www.dnrec.state.de.us.

Florida

In 1998, five of Florida's coastal counties began monitoring for enterococci bacteria under a grant-funded pilot program. By the beginning of 2000, 11 Florida counties were participating in the program, which continued through July 2000.

In August 2000, the beach water sampling program was extended to 34 of Florida's coastal counties through state legislation (Senate Bill 1412 and House Bill 2145) and funding. This funding allowed for biweekly sampling at just over 300 sites throughout the state. In addition, testing under the new program included fecal coliform as well as enterococci. The choice to use these two indicator bacteria was made on the basis of adopted water quality standards of the Florida Department of Environmental Protection for fecal coliform, and recommended standards of EPA for enterococcus. The state delegated authority to county health departments to conduct the sampling and issue health advisories for areas that exceed these standards. The public is notified through an online Web site, local media, and signs posted at the access points to the swimming areas.

In August 2002, the beach water sampling program began collecting water samples weekly with additional funding from EPA. With the increased sampling frequency, the use of enterococcus geometric means became possible. Since then, advisories have been issued if bacteria levels exceed either the single sample standards for enterococcus or fecal coliforms or the geometric mean standard for enterococcus.

The Florida Healthy Beaches Web site (http://esetappsdoh/irm00beachwater/default.aspx) continues to be a valuable asset in notifying the public. The ability for the public to access the information on all beaches in their area allows them to make informed decisions without tying up county or state staff. Sample locations and risk classifications for beaches in the program are being reviewed to ensure they remain in step with development along the coast of Florida.

Georgia

The Coastal Resources Division (CRD) of the Georgia Department of Natural Resources uses the Web to meet both the monitoring and notification portions of the BEACH Act grant. Beach water quality monitoring data are easily accessible and transferable in the Web-based Coastal Water Quality Database. For public notification, Georgia has partnered with Earth911 to allow easy access to current beach status information.

Water quality database

CDR collects water quality data in the rivers, estuaries, and ocean waters, including beach sites, along the Georgia coast. These data had been stored in a single Water Quality Database housed within CRD. Upon implementation of the beach data reporting requirements, CRD found that the existing database was insufficient for storing and reporting the beach data required by EPA. CRD applied for, and received, an EPA National Environmental Information Exchange Network (NEIEN) grant to develop a method of transmitting the beach data into EPA WebSIM via the Georgia network node. CRD then contracted with Acclaim Systems to develop an Oracle database with a Web-based interface and data transport capabilities.

Prior to the development of the Oracle database, laboratory data were reported to CRD electronically in an Excel spreadsheet. CRD staff would then copy and paste the data into an Access database (a time-consuming and error-prone method). With the new Beach Water Quality Database, the laboratory staff log in to the database using a Web browser, such as Internet Explorer, to access a data input form. Data in this form are held separately in the database until checked for quality assurance and quality control (QA/QC) by CRD. After approval, the data are stored in the main Oracle database, where they can be queried or exported into an XML format for transmission to EPA WebSIM. For bacterial data, the laboratory enters the bacteria count from each single sample.

The Oracle application automatically calculates the rolling 30-day geometric mean. The application highlights the data fields in red when the single sample value or the geometric mean value exceeds the EPA recommended levels. When the EPA-recommended level has been exceeded, the application generates and sends an e-mail to the laboratory manager and to the CRD manager. A “what if” calculator that automatically displays the hypothetical value of the next sample needed to reach the EPA geometric mean threshold is programmed into the geometric mean application. This is useful to beach managers for projecting what might happen with a beach in the near future. If the numbers show that a relatively low single sample value will push the geometric mean above the threshold, the beach manager can do a little advance planning and perhaps conduct a preventive sanitary survey. If a beach is already under a geometric mean-based advisory, the manager can project how much longer the beach might remain under advisory and perhaps increase public notification outreach efforts.

Beach notification

To ensure the widest outreach of public notification, CRD partners with Earth911 to reach the Web-using public. As soon as laboratory results are received, CRD staff log in to an Earth911 Web interface to update the status on each Georgia beach. Changes in status are instantly reflected on the public Earth911 Web site. After clicking the “Beach Water Quality” category, users see a map of the United States. Clicking the “Georgia” portion of the United States map zooms in to Georgia. Users can then select their beach area of interest to see information about it, and the date and time of the last update.

An added benefit to Earth911 users is that they can subscribe to receive e-mail notifications regarding their beach of interest. When the status of that beach is revised, a notification is triggered.

Public outreach

The Georgia Department of Natural Resources (GDNR) and the Georgia Division of Public Health (GDPH) are working together to implement a public outreach component of the Beach Monitoring Notification program. To give cohesion to the message coming from both agencies, they created an easily identifiable graphic. Because Georgia is known as the "Peach State," the "Peach on the Beach" was created. This character is used in flyers, ads, and promotional items. The "Peach on the Beach" literature is designed to direct people to the GDNR Web site for additional information. Once there, users can easily find a link to the Earth911 Web site.

FAQ flyer

GDPH and GDNR developed a flyer with frequently asked questions. The flyer, featuring the "Peach on the Beach" character, is distributed to the public by the local Health Department. The flyer also contains contact information directing the public to the GDNR Web site and to the local health department telephone information line.

In addition, permanent metal folding signs were installed at beach access points. The signs are the primary way for visitors to the beach to stay informed of the current beach status. However, GDPH and GDNR wanted to make the information available in various formats, especially for people who want to see the beach status before their beach trip.

Newspaper ads and hotel information sheets

When GDNR began testing for enterococcus bacteria in early 2004, one local beach community began to have short-term advisories occur at one or more of their beaches seemingly on a weekly basis. When GDPH issued a press release issuing a beach swimming advisory, within days another press release was issued lifting the advisory. Eventually, GDNR and GDPH began running a weekly ad in the local newspaper. The ad, entitled "Your Weekly Beach Report," featured the "Peach on the Beach" and listed which beaches in that county were currently under advisory. The ad also pointed readers to the GDNR Web site for the most current beach advisory information. The newspaper ad ran weekly throughout the swimming season.

In addition to the newspaper ad, the local health department worked with the local visitors bureau to create a customized information sheet for hotels to display or distribute to their guests. The date-stamped flyer is faxed weekly to a distribution list maintained and updated by the visitor's bureau.

Promotional items

GDNR holds an annual coastal environment festival, Coastfest, every year in October. The one-day event is very popular, drawing more than 7,000 visitors last year. GDPH set up a booth at Coastfest with information about the Beach Water Quality Monitoring and Notification Program. At the booth, beach buckets imprinted with the "Peach on the Beach" and Web directions were given to the children. Coloring sheets were handed out as well. Pencils imprinted with the Web address were given out to adults. The promotional items remind people to check the Web site before going to the beach.

Guam

Tourists, fishermen, and the public use the beaches of Guam heavily every day. Increased development over the years continues to threaten beach water quality. Improper or failing sewage delivery systems, septic tanks, urban runoff, non-permitted upland clearing, and reverse osmosis discharges are the largest contributors to surface water pollution.

Monitoring

The microbiological and chemical parameters that the Guam EPA currently monitors include: pH, total suspended solids, total dissolved solids, temperature, turbidity, nitrite-nitrogen, nitrate-nitrogen, dissolved oxygen, salinity, total phosphorous, ortho-phosphorous, and enterococci bacteria. Guam EPA conducts weekly monitoring at 38 fixed stations along its most frequently used coastal beaches (Tier 1 beaches) for enterococci bacteria.

Beaches classified as Tier 1 are beaches that are highly frequented have a high number of possible pollution sources, are easily accessible, and require frequent monitoring. Tier 2 beaches are less frequented with restricted accessibility, have few pollution sources, and require less frequent monitoring. Tier 3 beaches are classified as very infrequently visited, remote, or very inaccessible, and are not monitored routinely. Of the 73 beaches, 39 were further classified as Tier 1 beaches and the remaining 34 were classified as Tier 3.

Public notification and outreach

When samples exceed the single sample or geometric mean enterococci bacteria (cfu/100mL) an advisory is released to notify the public that the beach is closed or warn against swimming. These bacteria criteria were updated in FY 2004 in the water quality regulations. Guam uses the local media (newspapers and TV) and their Web site (http://www.guamepa.govguam.net/programs/emas/beach.html#REPORT) to provide real time results to the public. The Web site posts the weekly results and historical summaries to communicate potential risks to the public. Further, all reports are accompanied with a press release making them available to the public.

Hawaii

Hawaii's BEACH Act grant, which is managed by the Hawaii Department of Health (HDOH), assists the state in its efforts to monitor a portion of more than 400 beaches, scattered along 297 miles of its coastline, and notify the public when monitoring reveals exceedances of water quality criteria for bacteria. HDOH already had established and maintained a monitoring program for their coastal waters prior to initiation of the BEACH grant program. HDOH's further development of the established beach monitoring program, in response to requirements of EPA's BEACH Act grant, began with identification of all beaches scattered throughout the four major islands of Hawaii (Oahu, Maui, Hawaii, and Kauai). These beaches were identified by name and associated with longitude and latitude coordinates. HDOH then developed and implemented a risk-based evaluation and classification plan for their list of coastal marine waters and prioritized their monitoring schedule using this information.

HDOH categorized the list of beaches into tiers on the basis of potential risk of illness to swimmers and frequency of use. Monitoring frequency is done according to tier level. Tier 1 beaches are composed of coastal recreational waters with a high frequency of primary contact recreation use, including waters with a potential for contamination by pollution. Presently, 50 Tier 1 beaches are monitored twice a week throughout the year. Tier 2 beaches are used less frequently and, therefore, are monitored once a week on a rotating schedule for six months at a time. Thirty-four Tier 2 beaches are being monitored once a week for a six-month period. Tier 3 beaches are designated by very low visitation and are monitored as needed. HDOH compiled data about beach locations and sources of potential contamination into a GIS map, which identifies beaches by name, latitude and longitude coordinates, and indicates the locations and types of potential sources of microbial contamination.

All beaches are resampled when water quality standards for bacteria are exceeded. In 2003, HDOH refined its decision rule for resampling and posting advisories on beaches where adjacent coastal waters exceeded water quality criteria for bacteria. By 2004, Hawaii's practice of posting advisories was well established and extended to add advisories for possible contamination from storm water after rain events. In addition to posting advisories at beaches, HDOH also alerts the public of high bacterial indicator counts or sewage spills through announcements on radio stations and in newspapers. HDOH is in the final stages of developing its own Web site for reporting data to the public. They have established a practice of sharing monitoring data with a local chapter of the Surfrider Foundation, an environmental organization. Surfrider displays HDOH's monitoring data on its own Web site. HDOH also sends monitoring data to EPA quarterly and reports a summary of notifications to EPA annually.

HDOH keeps the public informed of the beach program by attending meetings of community environmental organizations, hosting public presentations of grant awards, and encouraging comments about the monitoring and notification program from the public, local agencies, recreational clubs, and environmental organizations.

Illinois

Monitoring

Illinois' Lake Michigan beaches are monitored five to seven times a week during the swimming season. They are among the most frequently monitored beaches in the country. To augment beach water quality monitoring conducted at coastal beaches, the Illinois Department of Public Health (IDPH) continues to validate and implement working models to predict *E. coli* levels in Lake Michigan because health warnings are generally issued on the basis of *E. coli* concentrations from samples taken the previous day. Predictive models created using continuously measured hydro-meteorological variables provide a good alternative to monitoring because they can predict, with a good degree of accuracy, when bacteria levels will be high. For example, in the summer of 2004, predictive modeling equipment was installed by the Lake County Health Department to predict *E. coli* levels at two Lake Michigan beaches: Illinois Beach State Park–South Beach in Zion, Illinois, and Forest Park Beach in Lake Forest, Illinois. The models, which measure a number of variables, such as wind speed and direction, sunlight, rainfall, air and water temperature, humidity, wave height, dissolved solids, clarity, and acidity, accurately predicted whether *E. coli* concentrations were above or below the 235 cfu/100 mL threshold for full body contact 85 percent and 86 percent of the time, respectively, during the 2004 swimming season.

Public notification and outreach

All of the Lake Michigan beaches in Illinois use standard postings at the beach indicating that swimming is prohibited when *E. coli* levels are above 235 cfu/100 mL. IDPH continues to develop and distribute educational resources to the public on the potential risks associated with swimming in contaminated water. "Don't Feed the Waterfowl" signs have been posted at Lake Michigan beaches to discourage visitors from feeding birds, which has the potential to contribute significant fecal loads to beach water, leading to beach closings. To obtain beach closure information, the public can visit IDPH's bathing beaches Web site at www.idph.state.il.us/envhealth/beachhome.htm or the Chicago Park District's Swim Report at www.chicagoparkdistrict.com/index.cfm/fuseaction/swim_report.home.cfm. Information on keeping the beaches clean is available at www.lakemichigan.org. The Lake County Health Department, Wilmette Park District, Winnetka beaches, and the City of Evanston post their beach closure information at the EARTH911 beach notification Web site at www.earth911.org/WaterQuality/default.asp?cluster=17.

Indiana

Under the BEACH Act, Indiana has used grant dollars to develop the Lake Michigan Beaches Program. Indiana's 45 miles of Lake Michigan shoreline is on the northern edge of Lake, Porter, and LaPorte counties. Funding has helped to increase the frequency of *E. coli* monitoring at Indiana's Lake Michigan beaches.

Before the development of the Lake Michigan Beaches Program, Indiana's coastal beaches were monitored one or two days a week. The funding has allowed partner communities to increase the frequency of sampling and analysis of water samples for *E. coli* to five to seven days a week. IDEM has also used a portion of the resources to keep the public informed. Beach managers, the park department, or both now notify the public by posting beach advisory and beach water closure signs. In the spring of 2005, IDEM will have fixed signage or kiosks installed at several coastal beaches for the 2005 beach season. The kiosks will provide beachgoers with current information about the status of beach waters and additional information about the possible sources and causes of *E. coli* contamination. Recommendations will also be provided as to how beachgoers and watercraft owners and operators can reduce the likelihood of causing an *E. coli* release.

In 2002, IDEM began developing the Beach Monitoring and Notification Plan (BMNP) as required by EPA for Indiana's portion of the Lake Michigan shoreline. This work was completed in 2003, and the plan has met the performance criteria established by the BEACH Act.

The summer of 2004 was the first beach season in which IDEM was able to provide funds to coastal communities to increase the frequency of monitoring. The funding provided multiple resources to local communities, which were able to upgrade equipment, purchase supplies, and pay for additional summer staff to collect and analyze samples.

As part of Indiana's efforts to fulfill the requirement of the BEACH Act performance criteria, four pilot projects were funded and implemented during the 2004 beach season:

1. Indiana University: Developing a prototypical model of *E. coli*-induced closings at Indiana's Lake Michigan beaches in close proximity to the outfall of Dunes Creek into Lake Michigan

2. Gary Sanitary District: Characterizing the *E. coli* distribution of beaches down-current from Burns Ditch, which flows into Lake Michigan
3. LaPorte County Health Department: Working with state and local stakeholders to enhance public notification of Lake Michigan beach closings in LaPorte County
4. Indiana University: Assessing and evaluating communication about Lake Michigan beach closings and health information provided to Lake and Porter County stakeholders

In addition, IDEM has funded 3 pilot projects for the 2005 beach season:

1. Environment, Law, and Economics Institute (ELEI): Protecting the health of our coastal communities through education by developing and distributing an educational brochure on "beach health"
2. Gary Sanitary District: Developing a 'SwimCast' predictive model system for Buffington Harbor Beach in the City of Gary, Indiana
3. Gary Sanitary District: Validating and operationally testing predictive model for *E. coli* concentrations on swimming beaches of Ogden Dunes, Wells Street, Marquette, and Lake Street

Time-relevant water quality data for Indiana's beaches are posted on the Earth911 Web site. The site also includes pollution information, project information, and links to other water quality sites. During 2004, a partnership between IDEM and Earth911 facilitated the development of the submittal, reporting, and notification system for Indiana's Lake Michigan Beaches Program. The information posted on the Earth911 Web site allows partner communities, beachgoers, and other interested parties to access the current status of the beaches that have been monitored for *E. coli*.

Louisiana

(Note: This information was updated after Hurricanes Katrina and Rita hit the Gulf Coast in 2005)

Risk-based beach classification system

Since initial Beach Act grants were awarded in 2001, the Louisiana Beach Monitoring Program has been developed and successfully implemented under the guidance of the Center for Environmental Health Services within the Office of Public Health (OPH). Before the implementation of the Louisiana Beach Monitoring Program, OPH and its contractor completed a systematic process to identify and rank Louisiana's beaches according to risk. The analysis process consisted of four major steps:

1. Identifying and defining coastal recreation waters
2. Identifying beaches or similar points of access used by the public for swimming, bathing, surfing, or similar water contact activities
3. Reviewing available information on levels of potential fecal contamination at beaches and their intensity of use
4. Ranking beaches to decide which beaches would be included in Louisiana's BEACH program

The results of this evaluation are presented in *Louisiana's BEACH Act grant Report, Grant Year 200*1 and are available online at www.ophbeachmonitoring.com. They reflect a model approach for identifying and prioritizing beaches in a state for monitoring under the BEACH program.

OPH initiated the process by defining coastal recreation waters within the state. Waterbodies designated as "estuarine" or designated for oyster propagation in the state's surface water quality standards and water quality assessments, waters adjacent to estuarine waters containing at least one sample station with a mean salinity of 3 parts per trillion (ppt), and waters lying between an isolated estuarine waterbody and the estuarine water's connection to the Gulf of Mexico were identified as coastal recreation waters.

Next, coastal recreation waters were examined to determine whether beaches or similar points of access used by the public for swimming, bathing, surfing, or similar water contact activities were present. Parish sheriff's offices were contacted to identify the areas meeting OPH's definition of a beach in each parish where coastal recreation waters occur. Using the resulting list of beaches, OPH delineated each beach on digital aerial photography in a GIS and began the process of evaluating exposure risk at each beach using two factors: the relative densities of pathogen indicators in beach waters and the number of people using each beach.

OPH used fecal coliform data collected under the state's Molluscan Shellfish Program to identify areas where the state's fecal coliform criteria were being exceeded. They also evaluated general information gleaned from the state's existing fish consumption and swimming advisories, water quality inventory, and impaired waters list. To obtain estimates of beach use, OPH surveyed local parish officials. The officials provided estimates of the number of beach visitors on a typical weekday, weekend, and holiday during the peak swimming season, along with the percentage of beach users entering the water. Estimates were then generalized into broad categories for relative comparison.

Using fecal coliform levels and levels of beach use, a qualitative ranking scheme was devised and used to assign each beach to a monitoring tier. Because water quality was good for the majority of beaches considered, the level of beach use was the primary criterion used to assign beaches to monitoring tiers. Beaches classified as having very high, high, or moderate to high use were assigned to Tier 1 and received the most monitoring attention. Beaches classified as having moderate use were assigned to Tier 2. Beaches with low or very low use and a water quality ranking based on fecal coliform data that were not collected in close proximity to the beach were assigned to Tier 3 and targeted for additional bacterial indicator monitoring to better characterize risk. Beaches on private land or with existing swimming advisories posted by the state and with very low public use were excluded from further consideration.

Prior to the landfall of Hurricanes Katrina and Rita in 2005, OPH was implementing its beach monitoring program at high-priority beaches consistent with its beach classification scheme. OPH had developed a high-quality public notification program that efficiently used beach signs, the department's Web site, press releases, and direct contact of partner agencies and local officials to communicate to the public when beach advisories were warranted by the monitoring data collected at these beaches. Due to extensive damage to the state's beaches and associated infrastructure by Hurricanes Katrina and Rita, LDHH expects to reevaluate the state's existing list of beaches to determine whether adjustments to the list and associated monitoring schedule are necessary.

Maine

Background

Although beach monitoring was not a priority in Maine in the past, there is growing interest in monitoring ocean beaches to protect public health. Although relatively few people swim in the cold water in the eastern part of the state, the sandy beach areas in the mid-coast and southern regions experience a high volume of visitors and intense recreational usage during the 3-month beach season.

With EPA funding through the BEACH Act grants, Maine's Healthy Coastal Beaches Program was established in 2002 as part of the larger statewide Healthy Beaches Program. Prior to then, the state monitored a few state parks monthly and the Maine Department of Environmental Protection (DEP) focused on ensuring that licensed discharges did not threaten swimmers' health. Monitoring and public notification for public beaches was (and still is) primarily under the jurisdiction of the municipalities, and private beaches are responsible for monitoring their own beaches (although most do not). With three towns recruited in 2004, 37 beaches in 18 towns are currently monitored weekly, Memorial Day through Labor Day, as part of the Program.

The Program is a community-based, voluntary program with no current legislation and none proposed. Although this approach has its challenges, the communities have accept it, and they are supportive of the assessment and remediation of pollution sources that impair water quality at coastal beaches. The Program is advised by an Advisory Committee composed of representatives from the University of Maine Cooperative Extension and Sea Grant; Maine

Coastal Program/Maine State Planning Office; Maine Departments of Environmental Protection, Marine Resources, Human Services, and Conservation and Bureau of Health; Casco Bay Estuary Project; Wells National Estuarine Research Reserve; Mount Desert Island Water Quality Coalition; Northern New England Chapter of the Surfrider Foundation, local municipalities, and water districts. The Advisory Committee has developed and implemented a pilot program including:

1. Surveys of towns and beach users
2. Outreach and education to community groups, municipal officials, data managers and citizens
3. Development and implementation of standards and protocols for swimming beach monitoring
4. Notification of the public of water quality conditions at public beaches

Assessment

The program created and updated a risk assessment matrix to classify beaches into tiers as required by the BEACH Act. Using results of the assessment and monitoring, recent additional investigations and sanitary surveys have been conducted to identify sources of pathogens at Lincolnville Beach and the neighboring Frohock Brook; Goosefare Brook in Saco, where a study of coastal currents was conducted; and Goose Rocks Beach in Kennebunkport.

Training and public notification

In 2004, program staff trained all town and state park beach personnel, and personnel from three regional labs. Microbac Laboratories provided analysis to 12 towns and state parks, including the scheduling and transportation for the samples. The lab worked closely with several towns when water quality exceedances occurred. The program received a fair amount of media attention this past year, including television, newspapers, radio, and newsletters. Advisory signs were placed at all participating beaches in 2004.

Database management and Web site

The program has been working steadily on improving the online database. It functioned very well in 2004 as an in-house tool; the latest functions include automatic e-mail alert to managers when a water quality value is in exceedance, geometric mean, and simple graphing capability. The public interface to the data portion of the program's Web site (developed by the program's database consultant, Relyon Media) is at http://www.mainecoastdata.org/public/ and went live in March 2005.

GIS maps have been developed for all beaches and have been verified for accuracy. Beach monitoring and notification data for 2003 and 2004 were submitted to EPA in 2005.

In addition to protecting public health, beach monitoring data collected by the program have been used by scientists investigating harbor seal mortality, by a student preparing a master's thesis, and by journalists for articles for the local press.

Education, outreach, and public involvement

The program developed a 2-year marketing plan, using professional marketing expertise to develop educational and outreach materials such as print materials (brochure, posters, community resource guide, and advisory signs), a Web site (www.mainehealthybeaches.org), radio commercials and public service announcements, and television weather sponsorship. The state conducted a direct user survey to determine the extent of the outreach for the Maine Healthy Beach campaign. The goal of this effort was to inform visitors to Maine beaches of the monitoring program, the risks of waterborne illness, and the measures being taken to ensure a safe experience in the form of written and visual materials.

Community examples of partnerships

The Health Coastal Beaches Program has created successful partnerships in Maine. This was evident in 2004 in Mount Desert Island and southern Maine after the Natural Resources Defense Council annual *Testing the Waters Report* singled out the two communities in Maine (out of four nationally) as "Beach Bums." Although the report and ensuing articles may have accelerated the process of recruiting one of the "Bums," much time was spent redirecting the attitudes created by the bad press. In the other "bum" community, the report had the opposite effect, though monitoring has continued. Maine believed that its Healthy Coastal

Beaches Program was still in the developing and recruiting phase and that this was simply a detour for the work that needed to be done in soliciting towns' participation. It was a test of the community-based process, reaffirming the importance of community support in protecting public health.

The community partnerships are exemplified by the Mount Desert Island Water Quality Coalition (MDIWQC), which monitors, with the high school, water quality at Seal Harbor Beach, a popular swimming spot. The MDIWQC confirmed that at times swimmers were at risk at Seal Harbor Beach, given the enterococci counts. In fact, two outbreaks of swimming illness were reported to the MDIWQC during the pilot project. The town of Mount Desert Island has been proactive in posting swimming advisories, has closed the beach on two occasions, set up its own laboratory, and continues to work closely with the MDIWQC to solve the pollution problem at Seal Harbor Beach. In addition, a group of Seal Harbor residents raised funds to conduct a shoreline and watershed survey to track down potential pollution sources, which will be conducted in 2005. The combined data of the town and the MDIWQC have helped to develop a more complete picture of when and where pollution events are occurring. Healthy Coastal Beaches Program staff has provided the training and resources necessary to implement the monitoring, data entry, and notification for Mount Desert Island beaches.

Maryland

The Maryland Department of the Environment (MDE) adopted revised beach regulations for all of Maryland's beaches. Key points include:

- Adoption of *E. coli* and enterococci as the only bacteriological indicators for beach monitoring and public notification purposes
- Tiered monitoring design, prioritizing beaches based on risk
- All beaches, permitted or not, receive the same protection (in the past, only permitted beaches required monitoring)
- New amendments reflecting EPA's comments and concerns to the beach regulations (adopted by Maryland in July 2004) are in the final promulgation stages

Sixteen of the 23 counties in Maryland have recognized beaches and monitoring programs. Seven counties claim to have no beaches. Each year, memorandums of understanding (MOUs) with Maryland Department of Health and Mental Hygiene (DHMH) have provided the Laboratories Administration with the personnel, equipment, and materials to evaluate the increase in samples.

Working closely with St. Mary's County, and providing grant money to them, has helped a poorly managed beach program that was nearly defunct to become the most improved county program in Maryland. Increased monitoring has exposed potential fecal contamination sources. The county has developed its own Web site to convey each beach's status. Thorough sanitary surveys and increased monitoring have resulted in a better-protected public.

MOUs with several other counties have provided a much needed benefit to the beach monitoring and public notification efforts of those counties. Along with St. Mary's County, Kent, Cecil, and Anne Arundel Counties have used grant money to upgrade their programs. Many projects revolve around source identification. Anne Arundel County is working on developing a predictive model. (See below for Sandy Point project description).

The number of samples taken by the counties has more than tripled in the past two years due to the following factors:

- Replicate sampling is required for quality assurance purposes
- The number of beaches monitored has increased by more than 50 percent
- The frequency of monitoring has increased from most beaches being monitored monthly to the higher priority beaches now being monitored weekly or biweekly

Data submission to EPA and the methods for data transfer are still evolving. MDE and sister agencies in other states are working closely with EPA in data sharing. MDE was one of the first states to transmit the 2003 beach monitoring data. This was mainly due to MDE's use of STORET, which greatly simplified the process. As more efficient means of data sharing have become possible, EPA's STORET group has provided the technical assistance to the Beach Program. Beach advisory data (a.k.a. "Notification Data") sharing has been more challenging due to the requirement to use EPA's Central Data Exchange (CDX) node. In the near future, MDE hopes to use its node to transfer all of the required data to EPA.

"Digital Health Department"

MDE chose to acquire a Web-based product that can manage all aspects of the beach program. MDE contracted with Garrison Enterprises, Inc. to develop a customized version of the Digital Health Department application for Maryland's Beach program. This Web-based product allows them to:

- Record data collected in the field directly into an online database
- Receive results directly from the lab as the lab personnel enter data and test results directly into the online database
- Analyze and track data, including water sample results, illness data, or any search or report of data as needed
- Notify the public and all interested parties automatically via e-mail, phone center, blast fax, and Web site
- Export data to EPA in compliance with BEACH Act grant performance criteria

Field samplers will use laptop or tablet PC instead of a paper form when collecting samples. Scheduling of field sampling and preparing labels for bottles will be done online using the application. In the field, all the information and data that the sampler wishes to collect (time, station, salinity, temp, etc.) will be entered directly into the device, real time via a wireless Web connection. The labs will enter the bacterial indicator sample result directly into the database. Transcription errors will be eliminated or minimized, creating higher quality data. Results will be available to the local health department immediately, without having to fax, mail, or phone, allowing more timely public notifications if necessary. All the local health departments who monitor beaches will have access to this data via the Web. They will be able to download data, run queries and reports, among other things. This application also comes with a state beach Web site and a variety of methods for notifying the public of water quality results and exceedences (fax, e-mail, phone, Web page). MDE planned to fully implement the system prior to the 2005 beach season.

North Beach–Calvert County, Maryland

North Beach is a high use beach on the Chesapeake Bay in northern Calvert County Maryland. The Town of North Beach invested millions of dollars in creating a boardwalk, building a fishing pier, and attracting businesses and vendors. The boardwalk and pier is a centerpiece in the town's plan to attract more visitors and help the town's economy by increasing tourism dollars. Overlooked in the town's planning were the possible effects of a stormwater outfall, which is in the center of the swimming area. The town assumed that any runoff would be rainfall alone and impacts would be minimal.

With Beach Act grant money, MDE implemented a tiered sampling design, and required more frequent monitoring by the local health departments of the state's higher use beaches. During the summer of 2003, the increased monitoring at North Beach revealed poor water quality results during the bathing season, resulting, ultimately, in beach advisories. A thorough sanitary review of the area and discussions between MDE, the Calvert County Health Department, and the North Beach town engineer revealed the likely source of high fecal counts to be the storm water outfall. The town engineer provided blueprints that showed that the stormwater system shared a common conduit with the aging, terra cotta sanitary sewer system. During periods of drought, a minimal flow still was evident from the stormwater outfall.

A sampling plan was developed to identify the area(s) of the sewer system that may be damaged and to follow up with camera inspections of the pipes. One week later, Hurricane Isabel disrupted those plans, damaging much of the boardwalk, pier, and the stormwater outfall. However, one very positive result of the storm occurred. The town, when rebuilding the pier and boardwalk area, decided to extend the stormwater outfall past the end of the pier and outside of the bathing area. The 2004 beach season sampling, during a similarly rainy summer as 2003, revealed significantly better water quality in the beach area with no advisories or closings required. The town still plans to investigate and repair, if necessary, the suspect sewer system. Without the BEACH Act and Beach Act grant funding, the more proactive monitoring and public notification effort by the State may not have occurred, thus, perhaps not revealing a potential public health risk to the bathers at North Beach.

Sandy Point State Park Project

A major problem in determining whether a swim area is safe for human contact is the lag time between water sampling and receipt of water quality monitoring results. Under current practices, decisions concerning swim advisories and beach closings are made using results that are between one and four days old, depending on communication with the labs. Consequently, bathers may be exposed to fecal-contaminated water and may be at increased risk of contracting gastroenteritis and other swimming related illnesses.

The Anne Arundel County Department of Health, in partnership with the Maryland Department of Natural Resources and MDE, are using Beach Grant funds to assess water quality conditions at Sandy Point State Park and to more appropriately determine beach advisories using real time water quality data. Daily fecal indicator sampling, along with real time measurements of wind speed, wind direction, rainfall, temperature, solar radiation, as well as nutrient and other water quality parameters are being collected during this project. Two shallow-water monitoring sites and a weather station are strategically placed at public swim areas within Sandy Point State Park. Over 1 million visitors bathe, recreate or attend special event activities each year at Sandy Point State Park. At the completion of the project, decisions concerning beach advisories and management of swim and recreational areas will be enhanced so that a bather's exposure to fecal contaminated water and risk of contracting gastroenteritis and other swimming related illnesses is reduced.

Real time and near real time data from Sandy Point can be seen at the following Web site: http://mddnr.chesapeakebay.net/newmontech/contmoneotb_results_graphs.cfm?station=SandyPointSouth.

A proposal to develop a regression or predictive model under a future grant application will be made to closely correlate physical, nutrient, and meteorological data with bacterial concentrations in bathing and recreational waters. The outcome of this project will help to further MDE's efforts in better protection of the public who bathe in natural areas by giving more timely notifications of possible increased risk due to fecal contamination impacts.

Ongoing and near-future efforts

- Statewide public outreach and information campaign to better educate the public regarding beaches, water quality, risk, etc. Beach Web site, brochures are planned. This may include enhancing our notification methods with Earth911.org cooperation—Spring and Summer 2005.
- Continue to select and fund local programs and projects.
- Develop predictive model for Sandy Point State Park.
- Continue urging counties to perform post rain-event sampling to allow for more protective preemptive advisories where appropriate.
- Continue to upgrade and improve data management techniques, quality, sharing, etc. between state and county agencies and EPA.
- Explore the use of NOAA radar rainfall data for predicting water quality and for developing preemptive advisory protocols.

Massachusetts

Public notification and outreach

In 2001, the Massachusetts Department of Public Health (MDPH) initiated the development of a system that would enable the public to see which beaches were open or closed on specific day or week, to see the reason behind any closure, and to keep track of a beach's water quality history. A working electronic, Web-based system for public notification of marine beach postings and water quality monitoring data went online in 2003. It was developed by MDPH in conjunction with Garrison Enterprises. The Web site was developed with funding support from the EPA BEACH Act grant and can be reached from the home page of the MDPH Web site (www.mass.gov/dph) or directly at www.mass.gov/dph/beha/tox/reports/beach/beaches.htm.

The Web site supports reporting routine water quality monitoring data through a series of password-protected data entry pages. The Web-based system allows MDPH contract laboratories to enter sampling test results directly to the site. These laboratories are required under contract to enter field sampling data and laboratory results into the MDPH public notification Web site as results become available. Data entered on the site provide as near real time public notification as possible, after which the Web site automatically generates postings for those samples that exceed single-sample or geometric mean regulatory limits. Display of postings on the public pages occurs twice a day, at 9:30 AM and 12:30 PM. Additional enhancements allow for local health officials to view postings shortly before public notification to give them an opportunity to post advisories at beaches and prepare for public inquiries.

Beach mapping

A detailed GIS layer for Massachusetts's marine bathing beaches was developed by MDPH with assistance from Applied Geographics, Inc. (AGI), and with considerable information from local health officials. AGI prepared detailed color aerial photomaps for all 60 coastal communities with marine bathing beach polygons highlighted. AGI also calculated the miles of sandy coastline (approximately 727 miles) in Massachusetts. State health officials worked with local health officials to identify the locations and specific boundaries of each known beach, the designation of each beach—public or semi-public (and private, if known), the location or locations where the water samples are taken for routine monitoring, the location at each beach where posting (i.e., posting/closure due to bathing water quality violation) would occur if it is necessary, and the locations of normal access points and parking lots. MDPH staff validated all information by site visits to all marine beaches. The completed Massachusetts marine bathing beach GIS point layers were added to the state Web site (www.mass.gov/mgis/). These layers represent the linear extent of each beach and points marking their boundaries and access, sampling, and other locations. The beach layers display information for 510 marine bathing beaches, including 419 public beaches and 91 semi-public beaches, as well as the estimated mileage of public (153.1 miles), semi-public (50.7 miles), and private beaches (522.4 miles) in Massachusetts.

Monitoring

MDPH has been successful at monitoring every marine and semi-public beach in Massachusetts weekly during the past three beach seasons. This includes 578 sampling locations at more than 500 beaches. The bathing beach season in Massachusetts usually runs from as early as Memorial Day, in some areas, through Labor Day.

The Public Health-Based Beach Evaluation, Classification, and Tiered Monitoring Plan has been developed to ultimately direct water quality monitoring resources to the beaches that pose the greatest health concern. The plan is intended to facilitate the identification and cleanup of pollution problems, while those beaches with more pristine records can be monitored less often than the required weekly routine monitoring through a variance process pursuant to both the Massachusetts and federal beach acts. In this system, every beach was classified into three "tiers." Tier 1 includes heavily used beaches that have pollution problems. EPA believes that these beaches should be tested at least twice a week. Because of the ongoing pollution concerns and violations, these beaches are generally sampled more than once a week. Tier 2 includes beaches with some pollution. These beaches must be tested once a week. Tier 3 includes beaches with no known pollution problems. These beaches are required to be tested once every 2 weeks or sometimes less, as determined by MDPH through the variance process.

Training and sanitary surveys

MDPH has held numerous training sessions for local health officials during the life of the BEACH Act grant. Topics discussed have included health concerns related to polluted bathing water, sampling methodology and use of standardized field sampling forms, current federal and state regulations, MDPH's new public notification Web site, and an overview of MDPH's global positioning system (GPS) survey of marine beaches in Massachusetts. MDPH training sessions have also presented information on identifying actual or potential sources of contamination and use of the MDPH standardized sanitary survey form. Additional technical guidance has been provided in subsequent mailings to local health officials.

MDPH developed a sanitary survey form for beaches. The development of this form allows communities to apply for sampling variances according to Massachusetts regulations (105 CMR 445.100) and will help MDPH comply with EPA BEACH Act grant requirements for a tiered monitoring approach to sampling. In addition, MDPH conducted three sanitary survey training sessions for local health officials to further these goals.

Laboratory programs and quality assurance

MDPH used the federal beach funds to provide partial contract laboratory support for routine water quality compliance and monitoring for marine beaches required under federal and Massachusetts regulations to local communities that qualified. These laboratories have analyzed more than 12,000 samples from 48 marine beach communities that took part in the contract laboratory program. The laboratories will be audited in 2005 to ensure compliance with the quality assurance project plan (QAPP) and standard operating procedures.

The QAPP for routine monitoring activities and related beach project implementation was submitted to, and approved, by EPA. The QAPP describes quality assurance, quality control, and related activities, including enforcement aspects that are in place to ensure that the results of the project meet EPA's published performance criteria. The state finalized a Quality Management Plan (QMP) for all activities under the EPA BEACH Act grant and other activities specific to bathing beach regulations. The QMP is a required document that describes how the program will develop, implement, and determine the effectiveness of its quality assurance and quality control policies and procedures.

Database management

The Data Submission Plan for Routine Monitoring under the BEACH Act grant and other activities specific to bathing beach regulations was developed, submitted to, and approved by EPA. The Plan is a required document that describes Massachusetts' plan for submitting the beach data it collects from coastal municipalities to EPA. Massachusetts submitted all its monitoring and notification data for 2003 and 2004 to EPA in 2004.

Michigan

The Michigan Department of Environmental Quality's (MDEQ) beach monitoring program is summarized below, and more details can be found at www.deq.state.mi.us/documents/deq-wb-beach-2003annualreport.pdf.

MDEQ's beach monitoring program is a part of the surface water quality monitoring program summarized in the January 1997 report titled *A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters*. The objectives of the beach monitoring component of the Strategy are listed below:

1. Assist local health departments to implement and strengthen beach monitoring programs
2. Determine whether waters of the state are safe for total body contact recreation
3. Create and maintain a statewide database
4. Compile data to determine overall water quality
5. Evaluate the effectiveness of MDEQ programs in attaining water quality standards (WQS) for pathogen indicators

The following examples from the report contain detailed information about the beach monitoring program, as well as water quality data for 2003.

Beach monitoring

The monitoring of beaches in Michigan is voluntary and is conducted by the local health departments. Health departments are required to comply with Michigan's water quality standards according to R 333.12544 of the Public Health Code, 1978 PA 368, which states,

Funding for beach monitoring

Prior to 2000, health departments relied on local funding to conduct beach monitoring programs. Local funding is often not sufficient to execute a comprehensive monitoring program. MDEQ now provides Clean Michigan Initiative-Clean Water Fund (CMI-CWF) and BEACH Act grants to local health departments to aid in the implementation or enhancement of their beach monitoring programs.

MDEQ awards CMI-CWF and BEACH Act grant monies to local units of government and nonprofit entities. Eligible entities include county, city, township, and village agencies; watershed and environmental action councils; universities; regional planning agencies; and incorporated nonprofit organizations. The majority of grants are awarded to local health departments. If a group other than a local health department is awarded a grant, MDEQ requires the group to work closely with the local health department. The CMI-CWF and BEACH Act grants are designed to fund proposals that determine and report levels of *E. coli* in the swimming areas of public beaches. In selecting recipients for grant awards, MDEQ considers the following:

- Location and frequency of beach use
- History of beach monitoring and bacterial contamination
- Ability to communicate results to the public efficiently
- Ability to respond and take appropriate action in the event of beach contamination

In 1998, only 20 counties monitored their beaches. Since MDEQ began providing grants for beach monitoring, the number of counties with a beach monitoring program has risen steadily. Twenty-four counties monitored at least one of their beaches in 2000, 36 counties monitored in 2001, and 38 counties monitored in 2003 and 2004. Although no grant funding was available in 2002, monitoring was conducted in 26 counties.

Minnesota

The Minnesota Pollution Control Agency (MPCA) operates Minnesota's Beach Monitoring Program. The program addresses fecal contamination of Lake Superior's recreational waters by implementing a comprehensive beach monitoring and public notification plan for beaches adjacent to Lake Superior.

Collaboration of beach program with external parties to identify source problems

MPCA is working to identify beach pollution sources so that measures can be taken to reduce beach water pollution. For example, the City of Duluth and the Western Lake Superior Sanitary District (the District) have conducted die testing in the sewer lines and stormwater pump tanks and have been able to eliminate them as potential sources of bacteria at the New Duluth Boat Club site. The District has also been pursuing DNA fingerprinting to try to determine whether the source of the bacteria is animal or human waste.

MPCA is also working toward eliminating sewer overflows. In many areas of Duluth, the sanitary sewers that carry sewage also receive rainwater or groundwater that does not normally require treatment. Much of this "clear" water enters the sewers from roof drains and from footing drains that remove groundwater from around houses. The connection of these sources to the sanitary sewers over the years has led to overloading of the sewers during wet weather. As a result, the sewers sometimes overflow during rainy weather, and untreated sewage flows into Lake Superior. Because of the heavy precipitation in the summer of 2003, there were over 40 overflows from 10 different locations. EPA has been working with MPCA, the City of Duluth, and the District to resolve the problem. Each organization submitted a Plan of Action describing its proposed actions to eliminate the overflows. Among other things, these plans propose preventing excessive amounts of rainwater and groundwater from entering the sewers, by such means as construction of storage basins to hold some of the water during wet weather until it can be sent to the wastewater treatment plant for proper treatments.

Monitoring

All the beaches along Lake Superior within state jurisdiction are monitored for *E. coli* regularly during the swimming season. If a beach has unsafe levels of bacteria, it is posted with a "Water Contact Not Recommended" sign until the bacteria levels decrease. The Beach Monitoring Program's goal is to ensure a safe and healthy aquatic recreational environment by informing the public about the risk of contracting waterborne diseases from exposure to contaminated waters. It will work toward this goal during 2005 by:

- Collecting samples from 39 Lake Superior beaches
- Analyzing those samples for waterborne diseases and human health risks
- Working with researchers to try to determine the source of contamination at beaches with continuous advisories
- Actively promoting safe water- and beach-related recreation
- Encouraging the beachgoing public to become more active stewards of the state's precious water resources

The 2004 monitoring season brought windier and rainier days than 2003's pilot monitoring season and precipitated more advisories along Minnesota's North Shore. During 2004, 38 beaches were monitored for *E. coli* and fecal coliform bacteria; 26 advisories were posted at 17 of the sites. Of the 17 beaches with advisories, 5 were repeats from the 2003 monitoring season.

Public notification and outreach

MPCA developed beach advisory and closure signs that show when risk is present to swimmers. The signs contain a "no-swim" icon, information about causes of water contamination, advice on what the public can do to help reduce beach water pollution, and contact information. MPCA also developed an informational brochure and beach health fact sheets for distribution to the public. It has also partnered with local mass media outlets to communicate beach health risk information to the public through newspapers, radio, and television. MPCA Beach Monitoring Program staff developed a user-friendly Web page that offers specific beach information and has an easy-to-remember URL—MNBeaches.org. The Minnesota program also has a local phone number (218-725-7724) with a beach advisory voice message and access to advisory information via the MPCA 800 number (1-800-657-3864).

Mississippi

(Note: This information was not updated after Hurricanes Katrina and Rita hit the Gulf Coast in 2005)

Monitoring

Mississippi's Department of Environmental Quality (MDEQ) implemented an intensive beach water quality monitoring and public notification program in 1998 through its inter-agency Beach Monitoring Task Force. From 1998 through 2004 water samples were collected from twenty-one beaches and tested for fecal coliform and enterococci along with several chemical parameters. If bacteria levels reached unsafe levels, advisories were placed on the beach stating that swimming was not recommended until bacterial levels returned to safe levels. The advisories remained in place until the monitoring data indicated that the water was safe for swimming and water contact.

Under the BEACH Act, the Mississippi Beach Monitoring Program was expanded in 2005 to include 22 beaches, and the frequency of sampling was increased for seven beaches. Sixteen of the 22 beaches were classified as Tier 1 Beaches and they are monitored 10 times per month during the recreational season, which is from May through October. The six Tier II beaches are monitored four times per month. All beaches are monitored four times per month during the non-recreational season.

Water samples from the beaches are tested for enterococci bacteria, and if the bacteria levels exceed

EPA recommended levels, a no swimming advisory sign is posted on the beach section. Additional water samples are tested from the site, and the no-swim advisory remains posted at the site until bacteria levels return to safe levels. In addition to signage, MDEQ provides public notification of beach water quality conditions through press releases and by posting near real time information on the state's Beach Monitoring Web site

Public Notification

During 2000, MDEQ developed a Beach Monitoring Web page to provide public notification of the water quality at the Mississippi beaches and to provide historical beach monitoring bacteria data. The public can view the Web site at http://www.usm.edu/gcrl/msbeach/indes. This Web site provides near real time data from all the monitoring locations, current beach advisories, beach locations, pictures, and maps locating the sampling sites. Also, information is provided about the history of beach advisories for all beach locations. Data from Mississippi's Beach Monitoring Program is routinely uploaded to EPA's Beach Monitoring STORET database. EPA uploads these data to the EPA National STORET database.

New Hampshire

Monitoring

The New Hampshire Department of Environmental Services (NHDES) manages New Hampshire's Beach Program. The Beach Program monitors and inspects 16 coastal public beaches weekly or twice a month based on their status. Currently, 11 beaches are monitored weekly and 5 beaches are monitored twice a month. In addition, potential pollution sources are monitored regularly during the swim season to identify potential public health threats. Monitoring and assessment reports are available on the program's Web site at www.des.state.nh.us/beaches/beach_reports/index.html.

Assessment

The assessment of all beaches and designation of tiers were completed in 2003. On the basis of these assessments, NHDES performed microbial source tracking studies to better identify the host source species that contribute to elevated bacteria observations in coastal streams that discharge to or near three coastal beaches. The sites included Little River, North Hampton, which discharges to State Beach; Chapel Brook, Rye, which discharges to Bass Beach; and Parson's Creek, Rye, which discharges to Pirate's Cove Beach. The study found that wildlife and humans were the most prevalent source species identified at each site. Wild animals present included coyote, deer, fox, otter, raccoon, and sparrow. At two sites, the state has plans for remediation of human fecal contamination, including repair of failed septic systems. At another site, they will study restoring a salt marsh by removing tidal restrictions.

Public notification

On the beach program Web site at www.des.state.nh.us/beaches/index.html, NHDES has provided the public with information about coastal beach water quality status. NHDES has also published a brochure informing the public about the program. In addition, NHDES has produced signage for the public when advisories are posted.

Data management

NHDES developed a beach database to allow for ease of data transfer between the state and federal levels. NHDES's Environmental Monitoring Database houses the department's environmental data. All New Hampshire beach stations, activities, and sampling results can be found in the database. The database also houses a beach-specific module for the program that went live in December 2003. Beach-specific information, such as beach contacts, inspections, and beach advisory data are accessible through this module.

The objective of the module is to enhance current beach data and make the data reportable to EPA via XML. Data are reported to EPA via uploads to the National STORET database for the water quality database and via XML to the PRAWN database for beach advisory and contact information. New Hampshire met the BEACH Act grant requirements on March 12, 2004, and was the second state in the nation to submit notification data via XML. To date, both coastal and freshwater beach data dating back to 1985 have been uploaded into the national version of STORET.

New Jersey

Beginning in May 2004, the New Jersey Department of Health and Senior Services and the New Jersey Department of Environmental Protection's (NJDEP) Cooperative Coastal Monitoring Program required that the sanitary quality of its marine bathing beach waters be determined using EPA Method 1600 enterococcus test (September 2002 version.) In this test, all bacterial colonies with a blue halo, regardless of colony size, are counted as enterococcus. The method states that there is a 6 percent false-positive rate and a 6.5 percent false-negative rate.

New Jersey coastal county and local health departments sample 325 ocean and bay bathing beach locations weekly and test the samples for enterococcus organisms. The concentration of enterococcus may not exceed 104 per 100 mL. Exceeding this value requires immediate resampling of the beach water and a sanitary survey of the sampled area. Two consecutive violations result in closure of the beach to primary contact recreational activities. Daily monitoring is continued until an acceptable enterococcus value and sanitary survey result is obtained, and the beach is then reopened.

In June 2004, enterococcus concentrations in samples from several ocean and bay bathing beaches were unusually high (>1000 per 100 mL), often in the absence of high concentrations at adjacent or nearby beaches and, in at least one case, in the absence of fecal coliform and *E. coli* bacteria. These results were unusual and unexpected because there are no known sources of bacteria to those beaches, and years of past fecal coliform data have been well within the standard for bathing beaches.

NJDEP's Water Monitoring and Standards marine water laboratory began work to isolate and identify the bacteria. Ten colonies isolated from one of these high-concentration sample petri plates were subjected to enterococcus confirmatory testing as specified in the method. None of these colonies were *Enterococcus spp*. All colonies on this plate appeared near the end of the 24 h incubation period, were less than 0.5 mm in diameter, and created lighter-blue halos than colonies that confirm as *Enterococcus spp*.

Nine similar colonies (< 0.5 mm diameter, excluding halo) were randomly selected from high-concentration sample plates from four bathing beach sites from two counties and subjected to identification procedures ("API 20 Strep" test, bioMerieux, Inc., Durham, NC). Six colonies were identified as *Aerococcus viridans* and three could not be classified.

Aerococcus viridans and a few other non-enterococcus lactic acid bacteria are known to possess the enzyme that causes the blue color halo in the enterococcus test and interference by *A. viridans* has been observed by researchers in commercial enterococcus detection tests that rely on the presence of this enzyme.

Aerococcus viridans was first described in 1953. It is a well-known pathogen of lobsters and other crustaceans and is an occasional opportunistic pathogen in humans and animals. *A. viridans* has been observed in many non-fecal environments and is "by no means common in [human] faeces" (Williams et al. 1953. J. Gen. Microbiol. 8: 475). Thus, the presence of *A. viridans* in marine water appears to have little sanitary significance.

In early July 2004, the NJDEP requested guidance from EPA regarding the counting of small-diameter colonies. The NJDEP received written guidance from EPA recommending that colonies less than 0.5 mm diameter no longer be counted as enterococcus, further stating their intention to revise Method 1600 to this effect by the end of 2005. The NJDEP immediately instituted the revised counting procedure resulting in a reduction of some sample counts and the need for closures at several beach locations. (Note: occasional high-concentration "true" enterococcus samples continue to be observed at some beach sampling locations, typically associated with wet-weather conditions.)

For more detailed information on New Jersey's Cooperative Coastal Monitoring Program, visit the NJDEP beach Web site: www.njbeaches.org.

North Carolina

North Carolina's recreational water quality monitoring program began as a state-funded mandate in 1997. The program tests both ocean and estuarine waters in deference to North Carolina's barrier island system, which offers recreational areas on both the ocean and sound sides. North Carolina boasts 320 miles of ocean shoreline and another approximately 4,000 miles of estuarine shore. The program had previously tested between 275 and 300 sites for *E. coli* and fecal coliform bacteria and posted swimming advisories on the basis of a running monthly average or geometric mean.

The changes to beach water quality monitoring dictated by the BEACH Act guidance led North Carolina Recreational Water Quality (RWQ) staff to expect a higher number of swimming advisories for the 2003 season. The new single-sample advisory requirement would increase the number of advisories because previously, the single-count "spikes" were moderated in the geometric mean calculation. However, it was questionable whether the number of beach days sites were under advisory would also increase. This is a more accurate indicator of overall water quality, and if people did not clearly understand this difference, a potential public perception problem could develop. The state sought to address the issue before it occurred.

RWQ staff developed an extensive outreach and education plan, targeted to different audiences both internal and external to state government. Their audiences included state agency employees; state-level legislative representatives from coastal counties; local government officials and boards of health; interest groups, including tourism, environmental, pier, and camp owners; and local business interests near sampling sites. They created brochures and fact sheets and the beginnings of a Web-based data system that would allow the public to access water quality data for their chosen beaches. The public can access beach water quality data that is updated weekly, as well as information about the program and downloadable brochures on the program's Web site, www.deh.enr.state.nc.us/shellfish/Water_Monitoring/RWQweb/home.htm. They also entered into a partnership with a national environmental nonprofit to display their swimming advisories on the nonprofit's Web site while they developed their own capacity. Most importantly, they instigated a series of face-to-face talks and meetings—their most valuable outreach tool.

The personal contact facet of the plan was critical, especially for introducing the state and local government officials. The Recreational Water Quality Program is not housed within the state Division of Water Quality, which, to the public, might seem a logical place for it. Because the program is focused on public health protection, it falls under the auspices of the state's Division of Environmental Health, along with the Shellfish Sanitation Program.

State and local government employees receive high volumes of notices, e-mails, and other information, so the likelihood of their closely reading the material received from an unknown agency representative, much less retaining any of it, was slim. With personal contact, however, a face is connected to a name and a program. Although people might not retain all the information they receive at a meeting, they have a contact and back-up material with memories attached to them.

With the goal of reaching as many concerned parties as they could, the program staff also performed a snowball sample for the first round of a total of 49 meetings, ending the discussion by asking those present who else they thought they should contact. This yielded other groups and individuals, which were also approached.

Another key component of the outreach program involved eliciting the concerns of officials and citizens about aspects of the program, and feedback about how those concerns might be addressed. One of the most common issues raised by officials was the media's handling of swimming advisories, especially in light of the likely increase. Early in the program, reporters had mistakenly stated that an entire county's beaches were "closed." The state program does not have the statutory authority to close beaches; they issue swimming advisories that recommend against swimming in a specific area within 200 feet in any direction of a sampling site. This caused considerable concern about misperceptions regarding an area's waters and possible loss of tourism revenues.

As a result, the program offered a modified version of its educational program to key environmental media representatives. Again, the most important component of the program involved personal contact, and this was augmented by presentations and the other informational materials. Several prominent reporters were given tours of the program and supplied with data and background, resulting in three positive front page stories in major newspapers in Raleigh, Charlotte, and Wilmington. Throughout the season, media coverage was consistently strong and accurate, and no "closings" were reported. This approach gave the program increased credibility and showed that state and local governments can work together, which has led to increased cooperation.

Outreach efforts continue on a smaller scale—refresher talks are offered for local government and health officials and citizen groups, as well as orientation for newly elected or appointed members. The program checks in with interested parties before the new season begins to determine whether they are the notification contact for the coming season and whether they would like anyone else added to the notification list for their areas. The program has received substantial positive feedback for its responsiveness and hopes to continue to improve outreach in the coming seasons.

Northern Mariana Islands

The beaches and lagoon waters of the Commonwealth of Northern Mariana Islands (CNMI) are heavily used daily by tourists, fishermen, and the public. Increased development over the years continues to threaten beach water quality. Improper or failing sewage delivery systems, septic tanks, urban runoff, non-permitted upland clearing, and reverse osmosis discharges are the largest contributors to waterbody pollution.

Monitoring

The microbiological and chemical parameters that the CNMI Division of Environmental Surveillance Laboratory currently monitors are salinity, dissolved oxygen, phosphates, nitrates, temperature, pH, turbidity, and enterococci bacteria. The Department of Environmental Quality (DEQ) monitors 38 fixed stations along Saipan's most frequently used west coast beaches for microbiological and chemical parameters weekly (Tier 1 beaches). On Managaha Island (11 sites), Tinian (11 sites), and Rota (12 sites), beaches are monitored at least twice a year for 8-week continuous periods during the rainy and dry seasons (Tier 2 beaches). At all Tier 2 beaches, after the 8-week continuous monitoring periods, monthly sampling is continued.

Beaches that have a high potential risk for harmful pathogens and are heavily used by the public are all considered Tier 1 beaches. Beaches that do not have a high potential risk for harmful pathogens but may or may not be heavily used by the public are considered Tier 2 beaches. Tier 2 beaches also include the most isolated beaches, which cannot feasibly be sampled on a weekly basis. Tier 1 beaches are easily accessible, commonly used by the public, and represent the majority of impaired waters throughout CNMI. Tier 2 beaches are less accessible and represented more supportive waterbodies. In the case of Managaha Island, Tier 2 classification is used because historical data sets show few violations despite a growing tourist population visiting the island.

Public notification and outreach

When samples exceed the single sample or geometric mean enterococci bacteria limits in the water quality regulations, the beach is "red flagged," meaning a warning is provided to the public not to swim there. These bacteria criteria were updated in FY 20004 in the water quality regulations. DEQ uses the local media (two newspapers) and their Web site to provide real time results to the public. The Web site posts the weekly results and historical summaries to communicate potential risks to the public (www.deq.gov.mp/beach%20monitoring%20web/Map%20Choice.htm). Further, all reports are accompanied with a press release making them available to any member of the public. Additionally, signs are posted at six frequently used beaches regarding the most recent testing results, and are being installed at all other locations.

Ohio

Ohio has developed and continues to conduct a program for monitoring the bacteria content at the majority of recreational waters that are designated for swimming, bathing, scuba diving, or similar water contact activities. The partnership effort between the Ohio Department of Health (ODH), the Ohio Department of Natural Resources, local health departments with public bathing beaches within their jurisdictions, and private or public organizations along the Lake Erie border provides the citizens of Ohio with specific information regarding the most recent water quality conditions at most public beach areas throughout the state.

Monitoring

The monitoring program analyzes water from selected public beaches along the Lake Erie border during the summer, generating data for evaluating the risks of adverse health effects to bathers. The program provides for prompt notification whenever the water at public beaches becomes contaminated, thereby helping to better inform the bathing public and ultimately prevent illness. The program also highly encourages the development of localized beach water monitoring efforts, predictive models for assessing recreational water quality, preemptive warning systems to inform the public more effectively, and aquatic sanitation programs for identifying and eliminating potential pollution sources.

Collaboration of beach program with external parties to identify source problems

In Ohio, much work is being done along the Lake Erie shoreline to ensure biologically safe swimming areas. Many agencies and organizations (both public and private) are involved in identifying factors that adversely affect beach water. Some local health departments have instituted programs to locate and eliminate failed septic systems that might contribute to high bacteria counts at public beaches. Other organizations are concentrating on controlling the migratory habits of numerous waterfowl to minimize their effects on beach water quality. Two projects funded by Ohio's Lake Erie Commission, one at Maumee Bay State Park in the western Lake Erie basin and one in the Cleveland area, are working to identify and eliminate sources of potentially harmful pathogens. By employing intense sampling surveys and sophisticated DNA fingerprinting technologies, researchers are seeking the sources of illness-causing bacteria on Lake Erie beaches.

Public notification and outreach

In recent years, high levels of *E. coli* bacteria have resulted in Lake Erie beach postings, warning the public of the potential health hazards. ODH will use BEACH Act grant funds to improve advisory signs for use at monitored beaches, offering the public credible data for making informed decisions about their aquatic activity. Monitoring results are distributed to all monitored beaches, all local health departments along the lake, and various major newspaper and media outlets in the Lake Erie basin.

Oregon

Monitoring

Using an EPA BEACH Act grant, the Oregon Beach Monitoring Program (OBMP) began developing its monitoring and notification program in 2002 by prioritizing and selecting an initial list of beaches for sampling. During the first sampling season in 2003, the program sampled 99 sites at 52 beaches in all 7 counties along the Oregon coast. Six percent of these sites were monitored weekly, 44 percent were monitored every two weeks, and 50 percent were monitored monthly.

In 2004, Oregon reduced the number of sites and beaches monitored to 60 and 19, respectively. Using EPA's recommendation for adaptive sampling, Oregon targeted those beaches that had the highest use and bacteria levels as indicated by the monitoring data collected the preceding year. While reducing the number of sites monitored, Oregon nearly doubled its sampling frequency from the previous season—in 2004, 16 percent of the sites were monitored weekly, 74 percent were monitored every 2 weeks, and 10 percent were monitored monthly.

For the 2005 sampling season, Oregon again used an adaptive approach to prioritize its list and identified more than 70 sites at 21 beaches for sampling. This way, the program can ensure that each season it is using federal BEACH dollars to monitor the most important Oregon beaches from a public health perspective.

In addition, Oregon is one of the few states to monitor beach waters during the winter, when surfers are the primary beach users. To identify the beaches where surfing occurs most frequently, the OBMP has worked with the Oregon chapter of the Surfrider Foundation and local surf shops. At the time of this writing, Oregon monitors 42 winter sampling sites at 12 beaches in 6 counties along the coast. The program has doubled its sampling frequency from last winter, from once per month to every other week, and will try to maintain this frequency for subsequent monitoring seasons.

Public notification and outreach

As of January 2005, Oregon has issued 20 beach advisories at 12 beaches along the coast. Until recently, the process for notifying the public of these water quality advisories consisted of e-mail messages to stakeholders and local government officials, press releases to media outlets throughout the state, and signage at beach access points. Although this system continues to be effective, Oregon has taken important steps to improve and expand public access to advisory information and monitoring data.

To expand the reach of public notifications and to make data accessible to the public, Oregon focused its notification system improvements on Internet resources. For example, Oregon partnered with Earth911 to disseminate beach advisory information online. The Earth911 system maps all monitored beaches and allows program staff to enter advisory information as it is retrieved from the field. The public can then access this information for any monitored beach in real time from both the OBMP Web site (http://oregon.gov/DHS/ph/beaches/beaches.shtml) and the Earth911 Web site (www.earth911.org/waterquality/default.asp?cluster=41).

To provide the public with access to monitoring results, the program is collaborating with the Oregon Ocean-Coastal Management Program's Coastal Atlas. The Coastal Atlas is one of the nation's most comprehensive coastal-area information systems, and it provides the public with access to interactive maps and data sets related to the Oregon coast. The program's partnership with the Coastal Atlas will enable users to view monitoring data by beach or by sampling station and will provide photographs and maps for each station. That system is expected to be available on both the Coastal Atlas and OBMP Web sites by May 2005.

For more information, contact the Oregon Beach Monitoring Program at 503-731-4012 or visit http://egov.oregon.gov/DHS/ph/beaches/.

Rhode Island

Monitoring and assessment

Through routine water quality monitoring, supported through the BEACH Act grant and conducted by the Rhode Island Department of Health (HEALTH) in 2003 and 2004, three beaches were identified for additional attention because of high bacteria densities and frequent closings. Sanitary surveys at these beaches Warren Town Beach, Easton Beach, and Scarborough State Beach helped to reveal problems with storm drains, sewer lines, and septic systems.

At Warren Town Beach, through sampling and inspections conducted by HEALTH, the Rhode Island Department of Environmental Management (RIDEM), and the Warren Department of Public works, it was shown that sewage from a broken sewer line was penetrating a brick stormwater catch basin and being discharged into the bathing area. The town repaired the sewer line, and routine sampling during the 2004 bathing season showed bacteria levels well below the standard; no closings were necessary. HEALTH will conduct additional wet weather sampling to ensure that all local pollution sources have been addressed

In Newport, HEALTH, RIDEM, Rhode Island Department of Transportation (RIDOT), EPA, the City of Newport, and the Town of Middletown have been working to identify sources of pollution causing closings at Easton's Beach. More than 350 water quality samples have been collected in the area surrounding the beach. Test results were modeled using GIS techniques. This information was used to investigate and eliminate pollution sources in the drainage system. Smoke testing has revealed several possible cross-connections between the sewer and stormwater system. It was discovered that a pump station approximately 500 feet from the bathing area, in Middletown, Rhode Island, was discharging untreated sewage during high-flow events. RIDEM issued a Notice of Violation (NOV) to the municipality. Short-term measures were put into place to avoid discharge, except in the case of extreme rainfall. Residents passed a $2.5 million bond, which will fund the mandated reconstruction of the defective pump station, as well as aid in correcting the structural integrity of faulty segments of the wastewater infrastructure. In addition, Middletown has an ongoing inflow and infiltration abatement project that will reduce pump station volumes and lower the risk to public health.

At Scarborough State Beach, routine monitoring in the summer of 2003 identified high bacteria counts following rain events. Through sanitary surveys, HEALTH identified three stormwater discharges at this beach. The stormwater outfalls drain surface runoff from high-density residential development and several wetland areas. HEALTH, RIDEM, and EPA conducted extensive water quality sampling and inspected private septic systems in the surrounding area. Intensive sampling did not reveal a direct cause for the bacterial contamination, but several septic system violations were identified. RIDEM has issued citations to several facilities, including a vacation campground with more than 100 units and an inadequate sewage disposal system. Short-term corrections are in place at the campground; the owner has entered into a consent decree and will install sewers in the facility by the 2007 bathing season. RIDOT contracted with a private engineering firm to develop and construct a treatment system for the three outfalls. The engineering firm decided to use new, innovative media technology to filter out bacteria before they are discharged into the bathing area.

HEALTH will continue to monitor for bacteria at all these sites to monitor improvements and notify the public if unsafe conditions exist.

Public notification and outreach

HEALTH's active and visible role in mitigating public health risks at beaches through the reduction of pollutants has spurred much interest. Media channels are reporting beach-related environmental and health concerns; the public has focused on beach closings; and, most important, there is the political will to correct these problems. Local communities have formed committees, municipalities have passed bonds, and nongovernmental organizations have turned a watchful eye to Rhode Island's beaches. The governor has formed a commission to reduce beach closings and fish kills, the legislature has authorized a permanent commission to provide recommendations for correcting the problem, and a $19 million bond fund was just passed to help clean up Narragansett bay.

Data management

HEALTH has worked with a vendor, Garrison Enterprises, Inc., to develop a Web-based beach monitoring and public notification database. The database will allow for the improved collection of data and transmission to EPA. It will also give HEALTH the ability to more effectively and quickly notify the public when opening or closing a bathing beach. A listing of all of Rhode Island's beaches, sample stations, facility information, facility contacts, monitoring data, open/closed information, season reports, and other environmental information can be accessed through this database from any Web connection. Much of this data is also available through a public portal available on HEALTH's Beach Monitoring Web site at www.ribeaches.org. This real time access to data better equips managers and the public to make informed decisions about their recreational opportunities. HEALTH met the BEACH Act grant requirements in 2004 when it electronically submitted to EPA (via XML) the 2003 and 2004 monitoring and notification data for the national beach database.

South Carolina

Data management

Grant funds provided to the South Carolina Department of Health and Environmental Control (DHEC) through the BEACH Act have allowed for many upgrades and improvements to the state's beach monitoring and notification program. One of the largest of these accomplishments is electronic storage and management of monitoring and advisory data. Previously, all records were maintained as paper copies. These records were quickly reviewed and then filed. The data were not used in any constructive way, other than to issue and rescind advisories. With the need for electronic data arising from the requirements of the BEACH Act grant, this system was changed dramatically. South Carolina's existing Environmental Facility Information System (EFIS) is used to manage monitoring and advisory data. All monitoring data is manually entered into EFIS or uploaded from the Laboratory Information System (LIMS). The program coordinator enters advisory information into EFIS. This improvement has allowed for easy dissemination of monitoring and advisory data to interested individuals through e-mail or printed reports. The electronic format also makes it possible to analyze monitoring data. In past years, gathering data for analysis or to respond to a citizen's request was a tedious process requiring a lot of time; now it is much simpler.

Mini-grant program

The award of BEACH Act grant funds has allowed South Carolina to establish a mini-grant program. A portion of South Carolina's total grant award is set aside to award monitoring and notification grants to coastal municipalities. Municipalities apply for grant awards through a competitive process. A committee reviews and ranks grant applications. The grants are then awarded on the basis of ranking and available funding. For the 2003 and 2004 cycles, all municipalities that applied were awarded grant funds. These monies can be used for collecting and analyzing samples, purchasing advisory signs, and employing staff to post and remove advisory signs.

The benefits of this program are multifaceted. The municipalities benefit by becoming more involved in a program that greatly affects their community. The local state university benefits because currently, all funded municipalities employ a local university to perform sampling and analysis. This gives the university an opportunity for student involvement and instruction, as well as monetary support of the laboratory. The state benefits from this process by building stronger working relationships with the communities involved in the beach monitoring program. Municipalities' involvement also assists the state in rapid public notification of advisories. Local municipal employees are able to post and remove advisory signs more quickly than a state employee, who must travel to the site. The state plans to continue the mini-grant program as grant funds are available. In coming years, the state hopes to expand the program by encouraging more local governments to apply for grant funding.

GPS data

Before receiving the BEACH Act grant, South Carolina had very little locational information regarding sampling sites. Descriptions of site locations used only nearby streets or landmarks. The length of each beach was also imprecise and was estimated using maps. Through the grant, South Carolina has collected GPS data for each beach monitoring site. Use of these data, in conjunction with GIS capabilities, has allowed South Carolina to:

- Determine the location of each site with respect to county lines
- More accurately determine beach lengths
- View beach monitoring stations in relation to other information layers, such as shellfish monitoring stations
- Create location-specific maps for display in public areas, such as community information kiosks or state park camping areas

Compilation of locational data also allowed South Carolina to participate in Earth911's beach advisory notification Web site. Earth911 works in conjunction with coastal states to provide advisory information on the Internet. The Web site provides maps of the state's beaches with the sample sites, marked by green dots that become red when an advisory is issued for the area. This Web site has added another avenue for dissemination of advisory information.

Tier III project

In August 2005, DHEC's Bureau of Water will issue a contract for continued surveying at sites identified previously as Tier III. This contractor will verify the site locations, develop necessary survey forms, document public access and use, and determine sources of pollution.

Texas

The Texas General Land Office (GLO) administers the Texas Beach Watch Program in conjunction with various contracted entities, including county health and parks departments, universities, state parks, and municipalities. GLO oversees monitoring and public notification on approximately 144 miles of beaches in Texas. GLO has received $1.23 million in BEACH Act grants since 2000 to develop and implement its program.

Beach segment classification

During the development phase of the Texas Beach Watch Program, GLO used information from its own *Texas Beach & Bay Access Guide* to identify beaches within each of the coastal counties that may be eligible for implementation of a beach monitoring program. Beach segments were initially evaluated to determine whether swimming activities occurred at each beach. For those beaches at which swimming activities were occurring, the level of beach use was evaluated using GLO's observations and those provided by local entities with intimate knowledge about local beach usage. Beach segments identified with the highest frequency of use were then ranked and prioritized for monitoring under the BEACH Act. This classification system has provided a useful framework in which to prioritize funds for the implementation of the Beach Watch Program.

Monitoring

Prior to the passage of the BEACH Act, Texas was sampling at 13 of the most popular beaches on the Texas Gulf coast using National Oceanic and Atmospheric Administration Coastal Management Program funds. Using the BEACH Act grants, Texas expanded sampling to approximately 59 beaches in 7 counties. Sampling using the BEACH Act funds began in 2003 following a 2-year period of program development. From January 1, 2003, through October 31, 2004, GLO performed more than 7,000 sampling events at 59 coastal beaches in Texas.

Public notification and outreach

When beach water quality samples exceed the applicable water quality criteria for enterococcus, officials with jurisdiction over local beaches, as well as other interested citizens and citizens' groups, are immediately notified by e-mail. In most areas, local officials have agreed to post beach advisory signs to notify the public of potentially unsafe swimming conditions. Additionally, GLO maintains an interactive mapping tool on its Web site that allows the public to select individual beaches or stations and get information about current bacteria levels and recommended beach advisories. This GIS mapping tool provides real time water quality updates using the information entered into the Texas Beach Watch database. For a link to this interactive mapping tool see www.glo.state.tx.us/coastal/beachwatch/index.html. From January 1, 2003, through October 31, 2004, 392 criterion exceedances were noted out of approximately 7,000 sampling events. Local governments were notified, and advisories were posted at local beaches at their discretion.

Since the Beach Act was passed, the Texas Beach Watch Program has greatly expanded its monitoring and notification capabilities and the number of partners with which it works to implement the program. This has resulted in a much more visible beach monitoring program and an increased level of interest in beach water quality by the public.

Virginia

A new component to the program in 2004 included collaboration with Virginia Tech researcher Dr. Charles Hagedorn to conduct source tracking at beaches that exceeded the standard for bacteria. Two source-tracking techniques were used on Virginia's beaches during the 2004 swimming season. One method provided information on whether a human waste stream was present at the beaches; the second method provided greater detail into the source of contamination as identification of the bacteria were linked to more specific sources such as pets, wildlife, human, or waterfowl. The source tracking techniques have proved valuable to the cities of Hampton and Newport News in providing information to help them identify where to target mitigation efforts in an attempt to control wastewater contamination of beaches in their localities.

The Virginia Department of Health Beach Monitoring Program has the potential to prevent public exposure to waterborne pathogens when they are at levels that pose a greater than normal risk at the locations in Virginia where the greatest number of people may be affected.

Virgin Islands

The United States Virgin Islands (USVI) consists of four main islands—St. Thomas, St. John, Water Island, and St. Croix. These islands harbor some of the most fascinating and beautiful marine environments in the world. These aquatic resources have contributed to drawing an average of two million divers, beachcombers and sightseers per year spending nearly $100 million since 1997. The USVI also has a coastline greater than 185 nautical miles, allowing for public access at hundreds of locations during a year-round swimming season. These unique factors led to the development and implementation of the United States Virgin Islands Beach Water Quality Monitoring Program (the Program), which is essential for the protection of both beachgoers and the marine resources.

Before the implementation of the Program, the Department of Planning and Natural Resources (DPNR), Division of Environmental Protection (DEP) sampled only a fixed network of coastal and offshore waters quarterly through the Ambient Monitoring Program. The frequency and sampling locations did not sufficiently inform the community of the potential health hazards in nearshore waters. This promoted DPNR-DEP to apply for its first year of BEACH Act grant funds in 2001. First-year funds were used to develop the program's Quality Assurance Project Plan (QAPP). Second-year funds were directed to implementation of the program. A total of 43 beaches were selected—20 on St. Croix, 15 on St. Thomas and 8 on St. John. The selected beaches are monitored weekly. Two state-approved labs were selected to perform the analysis, one on St. Croix and one on St. Thomas, and both use EPA method 1600 for enterococci analysis. A Web site and a toll-free number are being established to ensure that the public has access to the data collected and the public advisory status of each beach. Temporary beach water quality warning signs are being used until the permanent signs are completely assembled. The Program has conducted public outreach to several local public schools, and several interviews with the local media have been held.

The Program officially began sampling in the St. Thomas and St. John districts in July 2004 and in the St. Croix district in August 2004. Since the program began, several press releases have been issued. Using field research, DPNR-DEP has found that the common sources of bacterial contamination in the nearshore waters at the designated beaches are soil runoff after heavy rain events and occasional municipal sewer overflows. However, other suspected contributing factors are the garbage dumpsters that have been placed in close proximity to the shoreline.

The Program, one of the newest programs within DPNR-DEP, is also one of the most popular. Future plans include conducting additional pollution source investigations throughout the territory and continuing public education sessions.

Wisconsin

Monitoring

The Wisconsin Department of Natural Resources (WDNR) operates Wisconsin's Beach Program. Under this program, WDNR gives grants to communities along Lake Michigan and Lake Superior to monitor beach water for elevated bacteria levels. To design its beach monitoring and notification program, WDNR formed a workgroup composed of state-level environmental and public health officials, local health officials, and other interested parties. They identified 190 beaches along Lake Michigan and Lake Superior using GPS technologies. This allowed WDNR to create additional GPS data layers that included the location of all wastewater treatment outfalls along with their proximity to the beaches. WDNR collected additional information for each beach, evaluating the potential for impacts from stormwater runoff, bather and waterfowl loads, and the location of outfalls and farms. WDNR used this information to rank and classify beaches as "high," "medium" or "low" priority. These rankings indicate how often the beaches should be monitored to ensure that water quality conditions are safe for swimming. Passage of the BEACH Act has enabled WDNR to substantially increase the number of beaches it monitors, from 6 to 110 coastal beaches.

Public notification and outreach

WDNR's public notification and risk communication measures were developed in collaboration with the workgroup and other stakeholders, including the public. These efforts included developing signs at beaches to give notice to the public that the coastal recreational waters are not meeting, or are not expected to meet, water quality standards. These signs, which are also in Spanish and Hmong, were designed using feedback from a beach user survey and public meetings held around the state. Other products that were developed include:

- A statewide toll-free telephone service to make beach condition information available to the public
- An automatic e-mail service to which the public can subscribe to receive daily updates on beach conditions
- A statewide informational brochure, approximately 70,000 copies of which were distributed at local beaches, parks, and health departments
- A statewide Beach Health Web page (www.wibeaches.us) for collecting monitoring and advisory data and reporting up-to-date conditions at all coastal beaches
- An internal Web site for local health departments to report their daily advisory and monitoring data in the format required for EPA reporting at the end of the beach season

Collaboration of beach program with external parties to identify source problems

Phytoremediation project in Racine, Wisconsin

The Racine County Health Department collaborated with staff from federal, state, and local health and environmental agencies; nongovernmental organizations; academia; and students to plant native indigenous wetland plants upland of a beach to filter stormwater runoff and thereby reduce nonpoint source pollution into Lake Michigan. The plan is to reroute the flow of water from a stormwater outfall to infiltration beds upland of the beach using the native plants to filter the flow and reduce beach water pollution. The project should improve water quality, reduce the number of beach closings, and increase protection of public health.

Microbial source tracking in Door County, Wisconsin

Door County has more than 250 miles of shoreline and a large number of public beaches that are frequented by many tourists during the summer season. The BEACH Act grant was used to monitor 27 Great Lakes beaches in the county in the summer of 2004. Although there was not enough funding to allow for identification of sources of detected microbial contamination, steps had to be taken to find out where the contamination source was and whether it was safe to swim at the beach. The Door County Soil and Water Conservation Department acquired funding to pay samplers and analysts to monitor *E. coli* concentrations at selected beaches, near outfalls, and after rain events. Funds were also used to monitor avian waste concentrations; to isolate *E. coli* from beach water, avian waste, and human waste in Door County; and to conduct DNA fingerprinting and antibiotic sensitivity profiling of these isolates. These data are to be used to further characterize the indicator organism used to monitor beach water quality and help to identify the source of contamination. Approximately 1,000 *E. coli* isolates from water and waste, and the majority has been DNA fingerprinted and tested for antibiotic sensitivity.

Appendix C

Beach-related References

1. National Beach Conference Proceedings (October 2004)

The first national conference for EPA's National Beach Program, since passage of the BEACH Act, was held October 13–15, 2004, in San Diego, California. The conference was designed to help state and local beach managers and public health officials from across the country share information on implementing a successful recreational beach program. Representatives attended from all but 3 of the 36 Beach Act states and territories, at least 2 inland states, Canada, Mexico, and the United Kingdom. Attendees recognized the progress made in developing state beach programs four years after passage of the BEACH Act in 2000. They also recognized the significant technological advances in developing rapid methods for microbial analysis and microbial source tracking techniques. Several examples presented at the conference confirmed innovative program development in states where beach programs had not existed before Congress passed the BEACH Act.

A panel discussion on the second day of the conference was designed to promote frank and open discussion of beach monitoring and beach program issues. Panel members with different areas of expertise and experience related to federal and state environmental policy, beach water quality, health, and monitoring each addressed two main questions. After the panel members addressed the questions, the questions were then put out to conference attendees for discussion and questions.

The proceedings of the National Beaches Conference are available at this Web address: www.epa.gov/waterscience/beaches/meetings/2004/index.htm.

2. Tropical Indicators Workshop (March 2001)

A 2-day workshop titled "Tropical Water Quality Indicator Workshop" was held at the Waikiki Beach Marriott Resort in Honolulu on March 1–2, 2001. The primary funding agency for this workshop was the EPA's Office of Water, with matching funds provided by the Department of Health, State of Hawaii, and by the Water Resources Research Center, University of Hawaii. Mr. Rick Hoffmann of EPA was the project officer, and Dr. Roger Fujioka of the Water Resources Research Center served as the workshop coordinator. The overall goal of this workshop was to address issues identified under the "Tropical Indicators" section of the *EPA Action Plan for Beaches and Recreational Waters* (EPA/600/R-98/079), which is restated below:

Tropical indicators

Currently recommended fecal indicators may not be suitable for assessing human health risks in the tropics. Studies have suggested that at tropical locales such as Puerto Rico, Hawaii, and Guam, *E. coli* and enterococci can be detected in waters where there is no apparent warm-blooded animal source of contamination. Whether or not current indicator bacteria proliferate naturally in soil and water under tropical conditions must be determined. If so, the range of conditions (such as nutrients, temperature, pH and salinity) under which the bacteria proliferate will be characterized and their geographical boundaries defined. If the phenomenon is widespread under tropical conditions, additional research will be conducted to modify approaches for monitoring, or to develop new tropics-specific indicators. Further evaluation of Clostridium perfringens and other microbial indicators (including coliphages) that do not flourish naturally in the tropics will be conducted to determine their usefulness as alternative indicators.

To address the above problem, 18 national and international experts, as well as other "observers" defined as those with relevant experience from a regulatory or environmental perspective, were selected to participate in the workshop. Selection of the experts was based on their established professional reputation and expertise in water quality microbiology and some applicable working knowledge of water quality problems in tropical areas.

The full report from this workshop is available at this Web address:
www.wrrc.hawaii.edu/tropindworkshop.html.

Appendix D

Other Research

EPA has a number of grant programs that support research in areas of special significance to the Agency's mission. EPA's National Center for Environmental Research in the Office of Research and Development runs competitions for Science to Achieve Results, or STAR grants, in numerous environmental science and engineering disciplines through a competitive solicitation process and independent peer review. The program engages scientists and engineers in targeted research that complements EPA's own intramural research program.

The Regional Applied Research Effort (RARE) provides the Regions with a mechanism to address near term research needs through an ORD Laboratory/Center. Applied research projects are funded to meet information needs that a Region identifies as necessary and that an ORD laboratory has the expertise to carry out.

The EPA is also one of 11 federal agencies that participate in the Small Business Innovation Research Program established by the Small Business Innovation Development Act of 1982. The purpose of this Act was to strengthen the role of small businesses in federally funded R&D and help develop a stronger national base for technical innovation. Through the SBIR Program, EPA makes awards to small, high-tech firms to help develop and commercialize cutting-edge environmental technologies.

Science to Achieve Results (STAR) Grants

Data Collection and Modeling of Enteric Pathogens, Fecal Indicators and Real-Time Environmental Data at Madison, WI (EPA Grant Number: R829339)

The City of Madison, Wisconsin contains three recreational lakes with over 20 miles of shoreline within the city limits. The lakes are heavily used for recreational activities including sail boating, power boating, wind surfing, water skiing, swimming, scuba diving, canoeing, kayaking, fishing and jet skiing. The Madison Department of Public Health (MDPH) developed beach-closing criteria using testing results, combined with physical observations at the beach sites. There was a concern that the criteria might not reflect the actual risk to swimmers because the occurrence of pathogenic microorganisms during periods of high indicator levels had never been determined.

The objectives of this research are to:

1. Expand the current city beach monitoring program to include use of improved indicators that index changes in the microbial quality of the beach water including sensitive gene probe technologies to discriminate between human and animal sources of fecal pollution.

2. Determine the correlations between microbial indicator data, occurrence of pathogens, and meteorological, physical and water quality data collected by remote monitoring stations.

3. Consider mathematical constructs for modeling pathogen occurrence.

4. Create innovative partnerships with community groups and agencies to facilitate dissemination of water quality data and beach closure decisions, including development of a water quality web-based database with dynamic query capacity for the public.

For more information visit: http://cfpub.epa.gov/ncer_abstracts/index.cfmfuseaction/display.abstractDetail/abstract/5843/report/0

Real-Time Water Quality Monitoring and Modeling for Equitable Recreation on the Mystic River (EPA Grant Number: R829338)

The city of Somerville, Massachusetts, in collaboration with Tufts University and the Mystic River Watershed Association, proposed a project that combines advanced technology for real-time water quality and meteorological monitoring with sampling of bacterial levels to develop a model that anticipates river conditions, especially after heavy rains. The real-time data, water quality indices, and model-generated water quality predictions will be made available to the public via the Internet as well as color-coded flags at riverfront sites. The predictive model will enhance standard water quality monitoring by providing a way to anticipate bacterial levels that ordinarily require 24 hours to assess, leaving citizens in this dense and heavily polluted river basin with inadequate information about water safety.

The project objectives include collection of water quality indicator data (e.g., fecal coliform, enterococcus, DO, turbidity) along with data on depth, temperature, pH, conductivity, and meteorological conditions in real-time to develop an "early warning" water quality forecasting model. The data presentations will interpret the data into indices useful for everyday decisions about contact with the water.

For more information visit: http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/5858/report/0

Prevalence and Survival of Microorganisms in Shoreline Interstitial Waters: A Search for Indicators of Health Risks (EPA Grant Number: R828830)

Researchers felt there was some suggestion in the literature that the microbiological quality of beach sand may constitute a health risk to bathers, particularly children who spend time in the "swash zone." Sand could act as a filter to trap and concentrate bacteria, spores, and cysts because it has a large surface area for microbial attachment, ample oxygen levels, higher temperatures, and a constant resupply of nutrients through wave action and tides. Pathogenic organisms could potentially accumulate in interstitial space. Organisms could then be periodically swept from surfaces and transported to the surf zone where they pose a health risk aggravated by the abrasive nature of sand, the ingestion of contaminated waters, and the inhalation of aerosols rich in microbes. Thus, individuals exposed to the surf zone of populated beaches may show a higher incidence of illnesses from either enteric or nonenteric pathogens.

The study will document the number of "classic" fecal indicators in sand (*E. coli*, enterococci, and fecal coliforms), paying attention to whether they are free in interstitial space or attached to sand particles. Consideration will be given to the possibility that some of these organisms are lofted into the air. Other non-indigenous microorganisms in sand including non-enterics, coliphage and several eukaryotic microbes will be enumerated. A laboratory-based microcosm will be enumerated to study the survival (and growth) of indicator organisms in sand relative to overlying open water. Additionally, correlations of microbial abundance data to incidences of beach-related indicators will be compiled.

For more information visit:http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/1009/report/0

Near-Real Time Monitoring of Inland Suburban Waterways: Application to Three Critical Environmental Issues Facing the North Shore/Metro Boston (EPA Grant Number: R828582)

Local citizen groups are engaged in environmental monitoring of two major tributaries that empty into Plum Island Sound estuary, the Ipswich and Parker Rivers. In addition, commonwealth, federal agency and research/academic groups have carried out focused studies on these watersheds.

The proposed work assembles a consortium of eleven partner groups drawn from the public, academic, and private sectors. Through this partnership the group wants to link several, ongoing, but currently uncoordinated, environmental monitoring efforts. The existing environmental data sets will serve as a historical benchmark by which to assess future change detected by the near real-time monitoring system that will be installed. Pooled data will be evaluated with models and Web tools to observe the changing character of the Ipswich and Parker watersheds. Although the focus is on monitoring, the consortium also has technical expertise to interpret and draw scientifically sound conclusions from the emerging data sets. An active public outreach program is included in the proposal.

The focal point for this work will be a geospatial Web-based information system, the Ipswich/Parker Suburban Watershed Channel (I/PS-WATCH), akin to the "Weather Channel" but reporting on suburban watershed environmental variables. The interface will represent extension of an existing system (see: http://www.gm-wics.sr.unh.edu/ for prototype). I/PS-WATCH will be applied to three sub-projects, already identified by the partners as of high public relevance, cast in near real-time.

For more information visit: http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/408/report/0

Molecular Detection of Anaerobic Bacteria as Indicator Species for Fecal Pollution in Water (EPA Grant Number: R827639)

Fecal contamination of aquatic environments is a continuing problem. Yet some of the standard indicators for fecal pollution do not distinguish between human and animal sources. A novel indicator system was developed based on the anaerobic gut bacterial group Bacteroides/Prevotella. Molecular markers, amplified from bacteria filtered from the water, are measured. This method can already distinguish human from cow fecal pollution in both estuarine and river waters. The proposed study will focus on a small, nutrient-rich, fecally polluted estuary, Tillamook Bay, Oregon, and its tributary rivers.

The objectives of this proposal are:

1. To develop additional markers from other biologically important polluting species, such as waterfowl.
2. Identify the indicator strains or species that are host-specific.
3. To allow quantitative estimation of both the amount of total pollution in the water and the proportions of different sources of fecal pollution.

For more information visit: http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/279/report/0

Community Recreational Water Risk Assessment and Public Outreach (EPA Grant Number: R827063)

A consortium was formed with several scientific and community organizations for the purpose of more effectively collecting and disseminating to the public recreational water quality data from several beaches in Milwaukee and Racine. This project is focusing on reporting E. *coli* levels to the public in a time-relevant and meaningful format.

Project objectives include:

* To improve documentation and dissemination of environmental data specifically related to health risk associated with the recreational use of public beaches.
* To improve the type, quantity and quality of environmental data collected at and around public beaches in both Milwaukee and Racine Counties in development of a public health risk model.
* To improve coordination and collaboration of environmental data collected between Local Public Health Agencies (LPHAs), other organizations and community stakeholders, and standardize data collection.

For more information visit: http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/427/report/0

Regional Applied Research Effort (RARE) Grants

Development of Guidance on Decision-Making When Using Microbial Source Tracking Methods

Molecular biology methods (e.g., DNA fingerprinting) are now commonplace in public health monitoring programs. One of the more common uses is microbial source tracking (MST), i.e., identifying the sources of pathogens in water. The potential value of these methods is illustrated in a recent report published by the Natural Resources Defense Council. The report noted that 87 percent of the 13,000 beach closings and water advisories in 2001 were due to high levels of bacteria associated with fecal contamination, but in 54 percent of the cases, the exact source of the contamination could not be identified.

The methods that have been used include genotypic (e.g., ribotyping, rep-PCR, and pulsed-field gel electrophoresis) and phenotypic (antibiotic resistance testing and carbon utilization) approaches. These methods have already been used in recreational water and shellfish bed closure programs, TMDLs, and source water protection for both surface water and ground water in several coastal states in the United States. Although already in use by state and local governments, these methods have not been fully validated, and no single best method for all situations has been discovered. Integration of the vast array of information on these methods and publishing of this guidance as an EPA document will support the Regions in the appropriate use of these methods and inform potential users of issues that need to be considered when selecting a method.

For more information visit: http://intranet.ord.epa.gov:9876/OSP/RARE.nsf/7523fef8d5be8b05852569fa00619181/0540a0d5a97be2fa85256f6600589621?OpenDocument

Proof of Concept Demonstration for Near Real-Time In Situ Detection of Fecal Contamination in Fresh and Marine Waters

A key component of monitoring is the detection and timely reporting of concentrations of bacteria that are associated with human gastroenteritis and indicate fecal contamination. Current monitoring methods require incubation periods between 24 hours and 3 days before public health decisions can be made. The development of new in situ instruments with the capability for rapid, near real-time, quantification of bacterial densities would provide a more effective and better warning system for both environmental managers and the public.

For more information visit: http://intranet.ord.epa.gov:9876/OSP/RARE.nsf/7523fef8d5be8b05852569fa00619181/a0c21dbd217c5e6485256c83006cdae3?OpenDocument

Small Business Innovation Research (SBIR) Program

Portable Pathogenic Predictor for Storm water (EPA Contract Number: 68D99028)

The key objective of this phase of the project is to develop a novel dual-wavelength radiometric fluorescence method and sensor for the detection of coliform bacteria in water samples. The radiometric technology will be rapid, robust, and suitable for the development of online sensors for monitoring the effluents of urban storm water and sewage treatment plants. This novel approach, unlike previous single-wavelength intensity-based methods, will be highly immune to light source and detector instabilities, temperature effects, optical density, and turbidity variability in the sample, spurious quenching, and photobleaching. In contrast to current methods that take 24 hours or more to generate results, the proposed technology will provide reliable results in minutes to hours, depending on bacterial concentration.

The overall potential market for coliform testing of water encompasses several segments: drinking water, municipal sewage, coastal fisheries, shellfish aquaculture, and beach and recreational waters. Products will include a portable instrument, reagent kits, and online sensors.

For more information visit: http://cfpu b.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/1267/report/0

A New Biosensor for Rapid Identification of Bacterial Pathogens (EPA Contract Number: 68D02051)

Rapid, handheld, or portable instrumentation for determining the quality of natural waters, recreational waters, and distributed and treated supplies does not currently exist. Echo Technologies, Inc., completed a Phase I project that demonstrated a new approach for identifying bacteria in aqueous systems. The approach uses bacteriophage as the molecular recognition element. Bacteriophage are virus particles that generally attach to, and infect, a narrow range of host cells. Biosensors based on this molecular recognition offer a rapid, selective, and potentially very sensitive method to detect bacteria and bacterial pathogens in potable and recreational waters.

Several experiments were conducted with a customized detection system to demonstrate the feasibility of making a small in-line instrument capable of high-sensitivity detection.

Application of the fabricating fluorescently labeled virus probes (FLVP) technology to solid-state optical sensing represents a new approach to real-time detection of bacterial pathogens. This approach will minimize the need for culturing to identify pathogens and is an important departure from immunoassay- or DNA-based sensing concepts. The miniature probes are perfectly suited for incorporation in a sensor array for the simultaneous detection of many bacterial pathogens.

For more information visit: http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/5182/report/0

Automated Human Fecal Pollution Detection (EPA Contract Number: EPD05036)

Public health departments have set strict standards for the quantity of coliform bacteria allowed in the water. Because of the requirement to detect very low levels of these bacteria, rapid automated detection is very difficult. Culture techniques take 24 hours, and the more rapid DNA amplification techniques still require DNA purification and the use of unstable enzymes and nucleotides as well as elaborate instrumentation, all of which are difficult and expensive to automate. In this research project, an automated biosensor capable of detecting low levels of fecal microorganisms without the need for bacterial culture or DNA amplification techniques will be developed. The biosensor should be sensitive enough to detect fecal microorganisms at a level of 1 coliform cell per 100 mL of water within 30 minutes. The sensing element will be reusable to allow for long-term, unattended, cost-effective analysis. The sensor also should distinguish human from farm livestock sources of fecal pollution.

The final product is envisioned as an automated buoy placed in drinking water inlet sources, swimming waters, and shellfish or other aquaculture growing waters. The buoy will report fecal microorganism levels at set time intervals by remote telemetry communication. A portable version of the instrument also will be developed.

For more information visit: http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/7485/report/0