Executive Summary

Report to Congress on the Impacts and Control of CSOs and SSOs

The U.S. Environmental Protection Agency (EPA or "the Agency") is transmitting this Report to Congress on the extent of human health and environmental impacts caused by municipal combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs), including the location of discharges causing such impacts, the volume of pollutants discharged, the constituents discharged, the resources spent by municipalities to address these impacts, and the technologies used by municipalities to address these impacts.

Overview and Background

Why is EPA Preparing this Report?

In the Consolidated Appropriations Act for Fiscal Year 2001, P.L. 106-554 (or "2000 amendments to the Clean Water Act"), Congress requested two reports and the development of a technology clearinghouse. The first report was transmitted to Congress in December 2001 as *Report to Congress–Implementation and Enforcement of the Combined Sewer Overflow Control Policy* (EPA 2001a). This second Report to Congress fulfills the requirement that:

> *Not later than 3 years after the date of enactment of this Act, the Administrator of the Environmental Protection Agency shall transmit to Congress a report summarizing–*
>
> *(A) the extent of human health and environmental impacts caused by municipal combined sewer overflows and sanitary sewer overflows, including the location of discharges causing such impacts, the volume of pollutants discharged, and the constituents discharged;*
>
> *(B) the resources spent by municipalities to address these impacts; and*
>
> *(C) an evaluation of the technologies used by municipalities to address these impacts.*

Further, the technology information compiled for this Report to Congress will serve as a key element in developing the technology

SSOs include untreated discharges from SSSs that reach waters of the United States, as well as overflows out of manholes and onto city streets, sidewalks, and other terrestrial locations.

Photo: EPA

clearinghouse requested by P.L. 106-554.

What are CSOs and Why are They a Problem?

Two types of public sewer systems predominate in the United States: combined sewer systems (CSSs) and sanitary sewer systems (SSSs). CSSs were among the earliest sewer systems constructed in the United States and were built until the first part of the 20th century. As defined in the 1994 CSO Control Policy (EPA 1994a), a CSS is:

> *A wastewater collection system owned by a state of municipality (as defined by Section 502(4) of the Clean Water Act) that conveys domestic, commercial, and industrial wastewaters and storm water runoff through a single pipe system to a publicly-owned treatment works (POTW).*

During wet weather events (e.g., rainfall or snowmelt), the combined volume of wastewater and storm water runoff entering CSSs often exceeds conveyance capacity. Most CSSs are designed to discharge flows that exceed conveyance capacity directly to surface waters, such as rivers, streams, estuaries, and coastal waters. Such events are called CSOs.

A CSO is defined as:

> *The discharge from a CSS at a point prior to the POTW treatment plant.*

Some CSO outfalls discharge infrequently, while others discharge every time it rains. Overflow frequency and duration varies from system to system and from outfall to outfall within a single CSS. Because CSOs contain untreated wastewater and storm water, they contribute microbial pathogens and other pollutants to surface waters. CSOs can impact the environment and human health. Specifically, CSOs can cause or contribute to water quality impairments, beach closures, shellfish bed closures, contamination of drinking water supplies, and other environmental and human health problems.

What are SSOs and Why are They a Problem?

Since the first part of the 20th century, municipalities in the United States have generally constructed SSSs. For the purposes of this Report to Congress, an SSS is:

> *A municipal wastewater collection system that conveys domestic, commercial, and industrial wastewater, and limited amounts of infiltrated groundwater and storm water, to a POTW.*

SSSs are not designed to collect large amounts of storm water runoff from precipitation events. Areas served by SSSs often have a municipal separate storm sewer system (MS4) to collect and convey runoff from rainfall and snowmelt.

Untreated or partially treated discharges from SSSs are commonly referred to as SSOs. SSOs have a variety of causes including blockages, line breaks, sewer defects that allow excess storm water and groundwater to overload the system, lapses in sewer system operation and maintenance, inadequate sewer design and

construction, power failures, and vandalism. An SSO is defined as:

> *An untreated or partially treated sewage release from a SSS.*

The discussion of SSOs in this report, including national estimates of SSO volume and frequency, does not account for discharges from points after the headworks of the treatment plant, regardless of the level of treatment, or backups into buildings caused by problems in the publicly-owned portion of the SSS. EPA found that backups into buildings are not widely tracked by permitting authorities.

Generally speaking, SSOs can occur at any point in an SSS, during dry weather or wet weather. SSOs include overflows that reach waters of the United States. SSOs also include overflows out of manholes and onto city streets, sidewalks, and other terrestrial locations. A limited number of municipalities have SSOs that discharge from fixed points within their sewer system. SSSs can back up into buildings, including private residences. When sewage backups are caused by problems in the publicly-owned portion of an SSS, they are considered SSOs.

SSOs can range in volume from one gallon to millions of gallons. The microbial pathogens and other pollutants present in SSOs can cause or contribute to water quality impairments, beach closures, shellfish bed closures, contamination of drinking water supplies, and other environmental and human health problems.

What Statutory and Regulatory Framework Applies to CSOs and SSOs?

With extensive and documented stakeholder support, EPA issued its final CSO Control Policy on April 19, 1994 (59 FR 18688). The CSO Control Policy "represents a comprehensive national strategy to ensure that municipalities, permitting authorities, water quality standards authorities, and the public engage in a comprehensive and coordinated effort to achieve cost-effective CSO controls that ultimately meet appropriate health and environmental objectives."

When the CSO Control Policy was released, many stakeholders, key members of Congress, and EPA advocated for it to be endorsed in the Clean Water Act to ensure its full implementation. In the Consolidated Appropriations Act for Fiscal Year 2001, P.L. 106-554, Congress stated that:

> *...each permit, order, or decree issued pursuant to this Act after the date of enactment of this subsection for a discharge from a municipal combined storm and sanitary sewer shall conform to the CSO Control Policy signed by the Administrator on April 11, 1994.*

SSOs that reach waters of the United States are point source discharges, and, like other point source discharges from municipal SSSs, are prohibited unless authorized by an National Pollutant Discharge Elimination System (NPDES) permit. Moreover, SSOs, including those that do not reach waters of the United States, may be indicative of improper operation and maintenance of the sewer system,

CSO outfalls were constructed in a wide variety of shapes and sizes, including the large box culvert shown here. In general, CSO outfalls discharge directly to receiving waters.

Photo: City of Wilmington, DE

and thus may violate NPDES permit conditions.

What Methodology Did EPA Use for this Report to Congress?

The basic study approach for this report was to divide the congressional request into a series of discrete study questions, then to identify and collect existing data appropriate to each study question. This effort entailed:

- Reviewing existing data collected by EPA and other federal agencies, state and local governments, and non-governmental organizations;
- Searching the existing literature for environmental and human health impacts attributable to CSOs and SSOs, as well as the cost and technologies used to control CSOs and SSOs;
- Organizing forums to work with EPA and external experts and stakeholders on the specific questions addressed in this report;
- Updating, verifying, and establishing latitude and longitude coordinates for the inventory of CSO outfalls developed as part of EPA's 2001 *Report to Congress–Implementation and Enforcement of the Combined Sewer Overflow Control Policy*;
- Collecting SSO event information from those states that compile data on the volume, frequency, and cause of SSO events in electronic data management systems;
- Developing national estimates of the volume and frequency of CSOs and SSOs; and
- Developing simple models to estimate environmental and human health impacts where there was an absence of direct cause-and-effect data.

EPA emphasized the collection, compilation, and analysis of existing data for this report. This effort allowed the Agency to expand its knowledge about CSOs and SSOs, and to identify gaps in the existing data and in current systems that provide such data. This Report to Congress recognizes that EPA should and will continue to investigate the environmental and human health challenges posed by wet weather.

Response to Congress

EPA's response to the congressional request set forth in P.L. 106-554 is presented below, organized into five themes addressing both CSOs and SSOs:

- Characterization
- Environmental impacts
- Human health impacts
- Control technologies
- Resources spent

What are the Location, Volume of Pollutants, and Constituents of CSOs and SSOs?

Currently, 828 NPDES permits authorize discharges from 9,348 CSO outfalls in 32 states (including the District of Columbia). As shown in Figure ES.1, most CSSs are located in the Northeast and Great Lakes regions.

The estimated volume of CSO discharged nationwide is 850 billion gallons per year. The number of CSSs and CSO permits has decreased slightly since publication of EPA's 2001 *Report to Congress–Implementation and Enforcement of the Combined Sewer Overflow Control Policy*. Further, the percentage of CSO long-term control plans (LTCPs) that have been submitted to permitting authorities has increased from 34 to 59 percent. This represents progress in controlling CSOs in the United States.

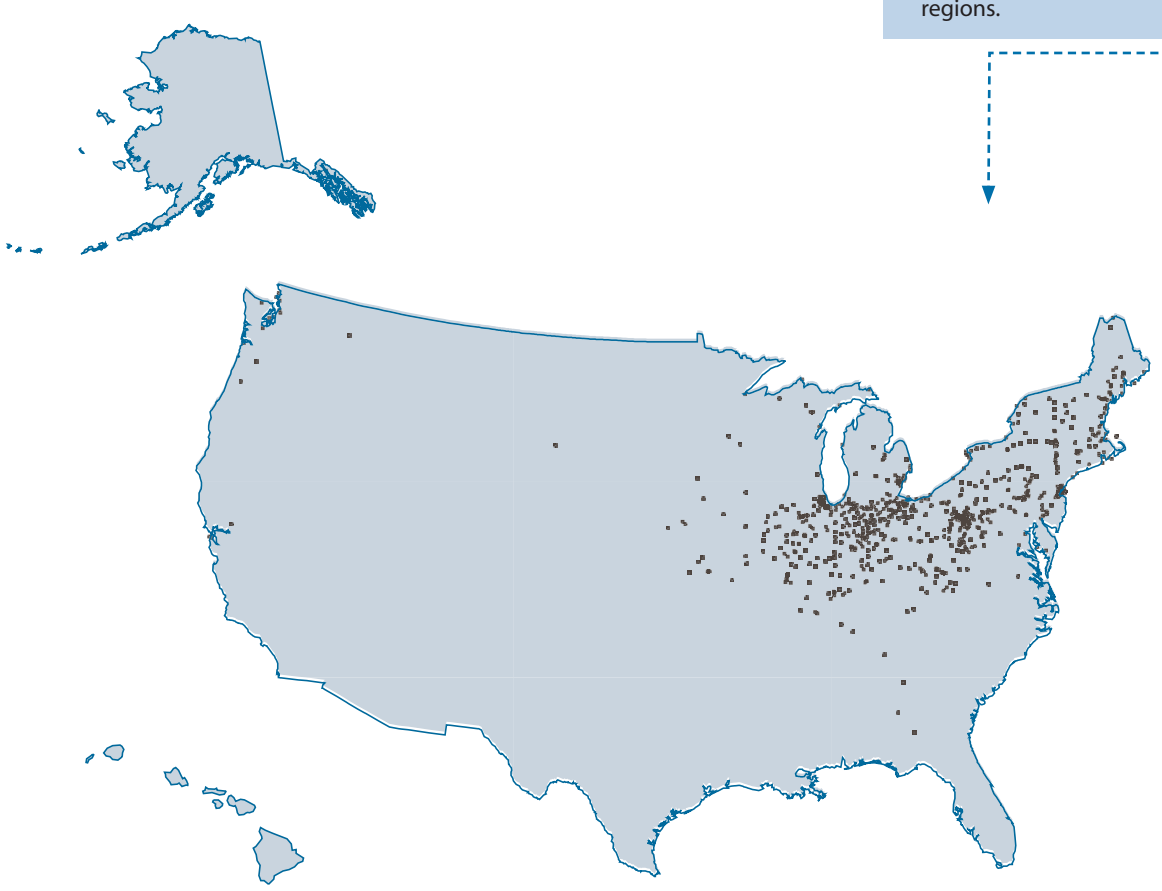
As shown in Figure ES.2, SSSs are located across the country. EPA's 2000 *Clean Watersheds Needs Survey (CWNS) Report to Congress* reported 15,582 municipal SSSs with wastewater treatment facilities; an additional 4,846 satellite SSSs collect and transport wastewater flows to regional wastewater treatment facilities. SSOs have the potential to occur in any of these SSSs.

EPA estimates that between 23,000 and 75,000 SSO events occur per year in the United States, discharging a total volume of three to 10 billion gallons per year. This estimate does not account for discharges occurring after the headworks of the treatment plant or backups into buildings caused by problems in the publicly-owned portion of an SSS. The majority of SSO events are caused by sewer blockages that can occur at any time. The majority of SSO volume appears to be related to events caused by wet weather and excessive inflow and infiltration.

Figure ES.1

National Distribution of CSSs

The majority of CSO permits are held by communities located in the Northeast and Great Lakes regions.



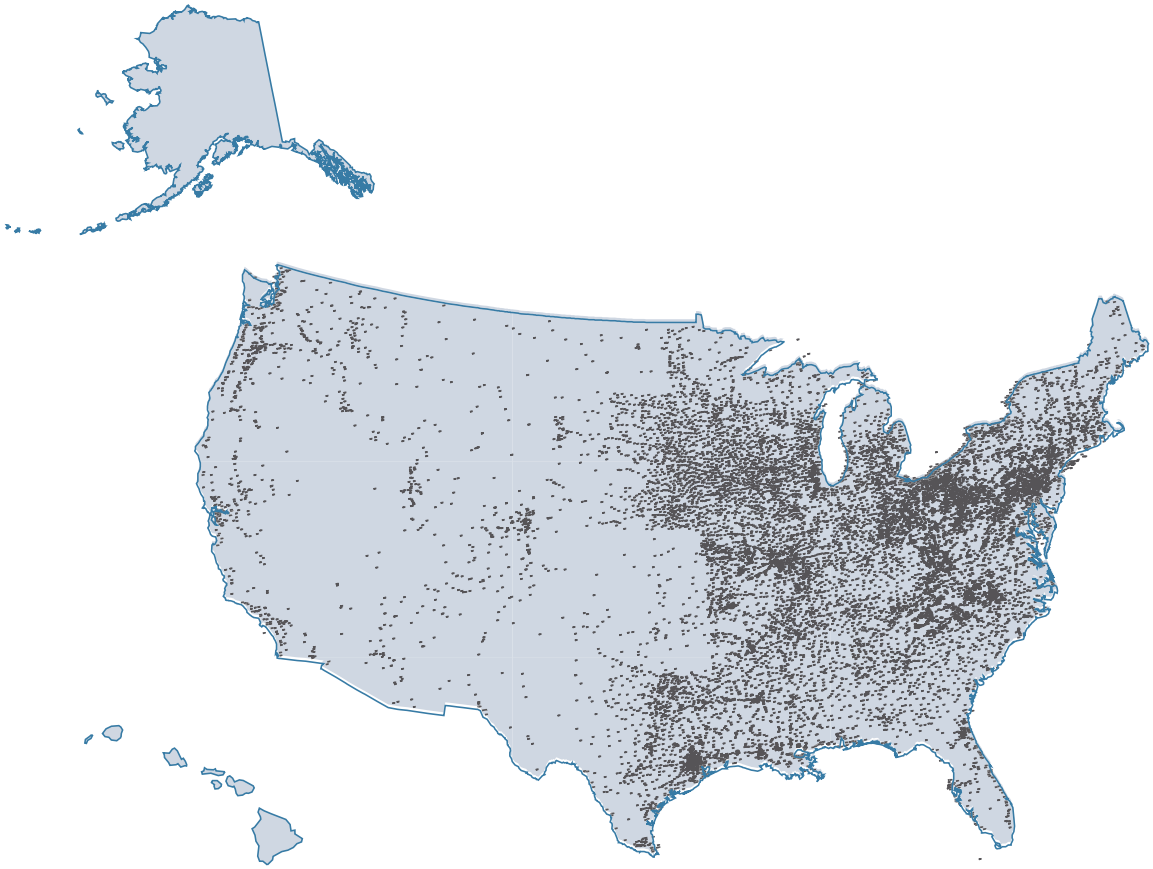


Figure ES.2

National Distribution of SSSs

SSSs are widely distributed across the United States, serving municipalities in all 50 states. Approximately 75 percent of SSSs are shown, where location data (latitude/longitude) were available from EPA's Permits Compliance System.

A comparison of the estimated annual CSO and SSO discharge volume with treated wastewater is presented in Table ES.1.

CSOs and SSOs contain untreated wastewater, and therefore the pollutant concentration depends on the service population, the characteristics of the sewer system, weather conditions, any treatment provided, and other factors. The principal pollutants present in CSOs and SSOs are:

- Microbial pathogens
- Oxygen depleting substances
- Total suspended solids (TSS)
- Toxics
- Nutrients
- Floatables and trash

Pollutant concentrations in CSOs and SSOs vary substantially, not only from community to community and event to event, but also within a given event. CSOs and SSOs contribute pollutant loadings to waterbodies where discharges occur. It is important to note that waterbodies also receive pollutants of the types found in CSOs and SSOs from other sources such as storm water runoff.

Source	Annual Discharge Volume (billion gallons)
Treated wastewater[a]	11,425
CSO[b]	850
SSO[c]	3 - 10

[a] EPA 2000a
[b] GPRACSO model, Section 4.5.1 of this report
[c] Section 4.7.4 of this report

Table ES.1

Estimated Annual Discharge Volumes

On an annual basis, the volume of CSO and SSO discharged is a proportionally small amount compared to the total flow processed at municipal treatment facilities.

What is the Extent of Environmental Impacts Caused by CSOs and SSOs?

Pollutant concentrations in CSOs and SSOs may be sufficient to cause a violation of water quality standards, precluding the attainment of one or more of the designated uses (e.g., swimming, boating, fishing) for the waterbody.

CSOs and wet weather SSOs discharge simultaneously with storm water runoff and other nonpoint sources of pollution. EPA recognizes that this can make it difficult to identify and assign specific cause-and-effect relationships between CSOs, SSOs, and observed water quality problems. In addition, EPA found that the identification and quantification of environmental impacts caused by CSOs and SSOs at the national level is difficult because there is no comprehensive national data system for tracking the occurrence and impacts of CSOs and SSOs.

Nevertheless, CSOs and SSOs can by themselves affect the attainment of designated uses and cause water quality standards violations. Average bacteria concentrations in CSOs and SSOs may be several thousand times greater than water quality standard criteria, and waterbodies that receive CSO and SSO discharges may lack sufficient dilution or assimilative capacity. Based on modeling analysis conducted by EPA and summarized in Table 5.6 of this report, water quality standards are projected to be violated frequently, even in the absence of other sources of fecal coliform pollution, where discharges from SSO events include more concentrated wastewater (e.g., SSOs with limited I/I) or when SSOs discharge to smaller receiving waters such as a stream or small tributary.

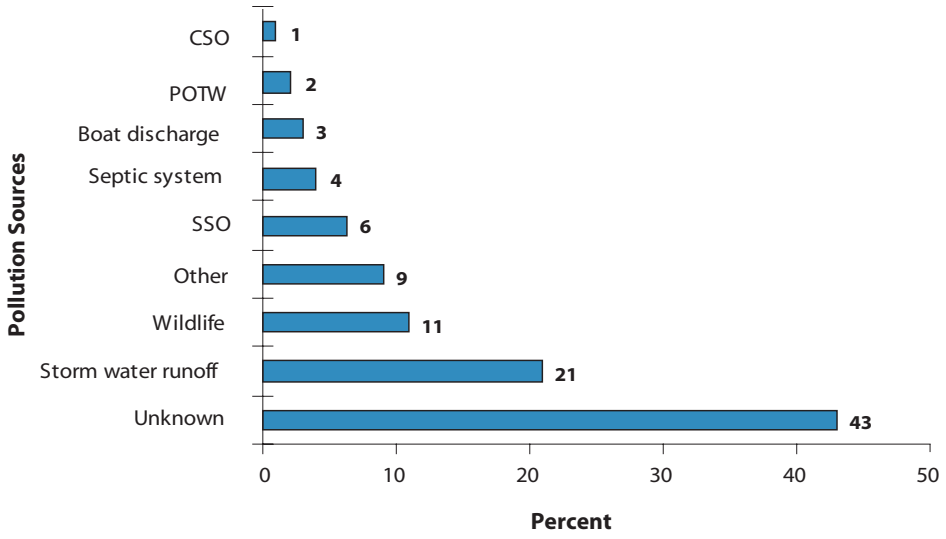
As shown in Figure ES.3, CSOs were responsible for 1 percent of reported advisories and closings, and 2 percent of advisories and closings that had a known cause during the 2002 swimming season. SSOs were reported to be responsible for 6 percent of reported advisories and closings, and 12 percent of advisories and closings having a known cause. Studies also identify CSOs and SSOs as a cause of shellfish harvesting prohibitions and restrictions in classified shellfish growing areas.

The environmental impacts of CSOs and SSOs are most apparent at the local level, and as the result of large or recurrent discharges. Examples of localized impacts due to CSOs and SSOs include:

Figure ES.3

Sources of Pollution Resulting in Swimming Beach Advisories and Closings (EPA 2003a)

EPA's Beaches Environmental Assessment and Coastal (BEACH) Program conducts an annual survey of the nation's swimming beaches. During the 2002 swimming season, CSOs and SSOs (including sewer line blockages and breaks) were responsible for 1 and 6 percent of reported closings and advisories, respectively.



- The City of Indianapolis assessed receiving waters in the city and ranked CSOs high in importance relative to other sources of pollution.
- The State of North Carolina has documented fish kills attributed to SSOs since 1997.
- The State of New Jersey closed over 30,000 acres of classified shellfish growing areas in the Raritan Bay area due to a large SSO in 2003.

What is the Extent of Human Health Impacts Caused by CSOs and SSOs?

Microbial pathogens and toxics can be present in CSOs and SSOs at levels that pose risks to human health. Human health impacts occur when people become ill due to contact with water or ingestion of water or shellfish that have been contaminated by CSO or SSO discharges. In addition, CSSs and SSSs can back up into buildings, including private residences. These discharges provide a direct pathway for human contact with untreated wastewater. Exposure to land-based SSOs typically occurs through the skin via direct contact. The resulting diseases are often similar to those associated with exposure through drinking water and swimming (e.g., gastroenteritis), but may also include illness caused by inhaling microbial pathogens.

Although it is clear that CSOs and SSOs contain disease-causing pathogens and other pollutants, EPA has limited information on actual human health impacts occurring as a result of CSO and SSO events. Further, CSOs and wet weather SSOs also tend to occur at times (e.g., storm events) when exposure potential may be lower.

Identification and quantification of human health impacts caused by CSOs and SSOs at the national

level is difficult due to a number of factors, including under-reporting and incomplete tracking of waterborne illness, contributions of pollutants from other sources, and the lack of a comprehensive national data system for tracking the occurrence and impacts of CSOs and SSOs. As an alternative to direct data on human health impacts, EPA modeled the annual number of gastroenteritis cases potentially occurring as a result of exposure to water contaminated by CSOs and SSOs at BEACH survey beaches. As shown in Table 6.6, EPA found that CSOs and SSOs are estimated to cause between 3,448 and 5,576 illnesses annually at the subset of recreational areas included in the analysis.

What Technologies Have Municipalities Used to Reduce the Impacts of CSOs and SSOs?

Municipalities have many options in selecting technologies to reduce the impacts of CSOs and SSOs. These technologies range from large-scale structural projects (e.g., wet weather storage facilities) to operation and maintenance practices (e.g., sewer cleaning). Technology selection is determined by characteristics of the sewer system, problems identified in the sewer system, performance goals established for the sewer system, resources available, and other site-specific considerations.

Municipalities employ a wide variety of technologies and operating practices to maintain existing infrastructure, minimize the introduction of unnecessary waste and flow into the sewer system, increase capture and treatment of wet weather flow reaching the sewer system, and minimize the impact of any subsequent discharges on the environment and human health. For this Report to Congress, technologies used to address CSOs and SSOs have been grouped into five broad categories:

- Operation and maintenance practices
- Collection system controls
- Storage facilities
- Treatment technologies
- Low-impact development techniques

EPA, states, and municipalities have made progress in developing tools and strategies for reducing the frequency and volume of CSOs and SSOs. Much remains to be done, however, to fully realize the objectives of the Clean Water Act and the CSO Control Policy. Municipalities have suggested that limited resources prevent them from acquiring and implementing technologies as quickly as they and regulatory agencies would prefer.

What Resources Have Municipalities Spent to Address the Impacts of CSOs and SSOs?

Municipal resources used to address CSOs and SSOs are documented in different ways. EPA's estimates of municipal CSO expenditures rely on requests for Clean Water State Revolving Loan Fund (CWSRF) loans and on documents submitted

to EPA's CWNS, which include CSO LTCPs and other facility planning documents. In addition, EPA uses a cost curve methodology to estimate costs for communities with CSSs that do not submit documentation. In communities served by SSSs, SSO control expenditures are generally a combination of general operation and maintenance (O&M) and capital expenditures. In total, EPA documented expenditures of more than $6 billion on CSO control (through 2002) and at least $4 billion on SSO control (1998-2002). EPA's 2000 CWNS estimated that at least an additional $50.6 billion is required to capture no less than 85 percent of the CSO by volume, and an additional $88.8 billion is required to control SSOs over the next 20 years (EPA 2003b).

What Actions Should be Taken to Reduce the Impacts of CSOs and SSOs?

In its preparation of this report, EPA found that:

Maintaining and improving the integrity of the nation's wastewater infrastructure will protect the high level of environmental quality and public health enjoyed in the United States. Proper O&M of the nation's sewers is integral to ensuring that wastewater is collected, transported, and treated at POTWs; and to reducing the volume and frequency of CSO and SSO discharges. Many existing structural and non-structural technologies are well suited for CSO and SSO control. Emerging technologies and innovative practices hold promise for even greater reductions in pollution. Municipal owners and operators of sewer systems and wastewater treatment facilities need to manage their assets effectively and implement new controls, where necessary, as this infrastructure continues to age.

The impacts of CSOs and SSOs are a concern at the local watershed level. CSOs and SSOs are two among many sources of pollutants that contribute to urban water quality problems. The watershed approach is central to water quality assessments and the identification of control strategies must include all sources of pollution affecting water quality. The presence of sewer systems in most developed watersheds nationwide underscores the importance of considering potential SSOs impacts on water quality. Similarly, the presence of CSOs in 32 states places them in many watersheds across the country. EPA, states, and municipalities should strive toward better integration of wet weather programs with other NPDES, compliance assistance, and enforcement activities. Better integration of programs and activities at the watershed level will provide economies of scale with respect to monitoring and reporting, protecting water quality, and reducing the impacts of CSOs and SSOs.

Improved monitoring and reporting programs would provide better data for decision-makers on CSO and SSO control. Better tracking of environmental impacts and the incidence of waterborne disease would increase national understanding of the environmental and human health impacts associated with CSOs, SSOs,

and other sources of pollution. Use of standardized reporting formats for information on the occurrence and control of CSOs and SSOs would enable EPA, states, and others to track pollutant loads and the performance of controls. Recent EPA efforts such as WATERS (Watershed Assessment, Tracking, and Environmental ResultS) work to unite national water quality information that was previously available only from several independent and unconnected databases. EPA will continue to work to improve the information available.

The success that the nation has achieved in improving water quality since passage of the Clean Water Act is due to the collective efforts of federal and state agencies, municipalities, industry, non-governmental organizations, and citizens. Continued cooperation among these groups is essential to meet the challenges to clean water that lie ahead. As described in this Report to Congress, numerous pollutant sources threaten the environment and human health, but establishing direct cause-and-effect relationships is often difficult. The information necessary to manage water quality problems comes from many sources. EPA recognizes the value of working with stakeholders and has pursued a strategy of extensive stakeholder participation in its policy-making on CSO and SSO issues. Likewise, as communities continue to implement CSO and SSO controls, further cooperation with municipal, industry, and environmental organizations is essential to ensure successful development and implementation of environmental programs.