1997-1998

The State of Boston Harbor

Massachusetts Water Resources Authority

BEYOND THE BOSTON HARBOR PROJECT

THE STATE OF BOSTON HARBOR 1997-1998

BEYOND THE BOSTON HARBOR PROJECT

FEBRUARY 2000

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TECHNICAL REPORT NO. 00-05

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Cover photo: Great blue heron at dawn in the Charles River, by Eric Endlich

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BEYOND THE BOSTON HARBOR PROJECT

With the Boston Harbor Project nearly complete, the new treatment plant is removing most solids and toxic chemicals from the effluent. The effluent is being properly disinfected; bacteria levels in Deer Island Treatment Plant effluent are usually better than standards set to protect water quality. Over the past five years, as MWRA projects have come on-line, there have been corresponding improvements in the harbor's water quality. Advisories against swimming at most Boston Harbor beaches have declined. Flounder liver disease and contamination in mussels have been dropping for a decade.

The waters at the former Nut Island sewage outfalls in Quincy Bay are dramatically cleaner since the Nut Island Treatment Plant was closed in July 1998 after 46 years in operation. South System sewage from 21 communities is now piped to Deer Island through the 5-mile Inter-Island Tunnel. Bacterial water quality in the Nut Island area is now excellent. In the long-term, seagrasses are expected to return to Quincy and Hingham Bays, a sign of a healthy ecosystem.

Although the Boston Harbor Project is MWRA's highest profile project, sewage treatment plants, old or new, have never been the only source of pollution to the area waters. Leaking and overburdened pipes overflow into rivers, ponds, and the harbor, especially during heavy rainstorms. MWRA's Combined Sewer Overflow Plan will eliminate, treat, or reduce combined sewer overflows (CSOs). In 2008 when the CSO Plan has been completed, more than one-third of the original 88 CSO outfalls will have been closed. MWRA is repairing and replacing critical parts of the aging sewer interceptor system with other construction projects throughout the metropolitan Boston area, alleviating sewer backups into streets and buildings, and minimizing overflows into rivers, streams, and wetlands.

Although these essential engineering and construction projects are being completed, major challenges remain: reducing stormwater pollution, which continues to be a significant source of contamination to our waterways, and alleviating sanitary sewer overflows (SSOs). An Infiltration and Inflow Task Force is developing regional goals and strategies to reduce groundwater and stormwater impacts on overburdened sewers. Communities will certainly have to continue to allocate resources to maintain and improve local storm drainage and sewer systems to ensure that our waterways are beautiful, safe for recreation, and healthy for aquatic life.

UPDATE ON

Boston Harbor

Over the past decade, MWRA has dramatically cut discharges of wastewater pollutants to Boston Harbor. This Harbor Update continues reporting from previous years by charting three pollutants in MWRA's wastewater discharges: bacteria, metals, and solids. The environmental effects of these pollutants are also tracked, using swimmers' advisory statistics, disease incidence in fish, and levels of contamination in fish and shellfish.

As pollution discharges to the harbor decrease, measures of the health of the harbor show its recovery. Figure 1 shows that the Deer Island Treatment Plant (DITP) has continued to maintain effective disinfection since 1994. There were only seven days in 1998 and nine days in 1997 when DITP effluent did not meet the water quality standard for bacteria counts, compared with 139 days in 1988.

One major concern about wastewater bacteria is the possibility that beaches will be contaminated, presenting health threats to swimmers. There are, however, multiple causes of bacterial beach contamination in the harbor, and the causes vary among beaches. Combined sewer overflows (CSOs) remain a problem at some beaches, but CSOs on beaches will be eliminated as part of MWRA's CSO Plan. Contaminated stormwater causes problems at Constitution, Wollaston, and Tenean Beaches.

The number of advisories against swimming at harbor beaches, which was high in the 1980's and decreased into the 1990's, generally reflects the varying performance of the local and regional sewer and stormwater systems during those years.

Figure 2 shows the percent of days that water samples failed to meet swimming standards at eight Boston Harbor beaches during four multi-year time periods. (Data from the Metropolitan District Commission beach monitoring program.) These time periods broadly reflect different phases of the modernization of greater Boston's sewage and stormwater infrastructure (Table 1). Contaminated stormwater (the responsibility of local communities), CSOs, neglected and malfunctioning treatment plants, and sludge discharges in past years have all affected the harbor's beaches to varying degrees.

Figure 3 shows that metals have

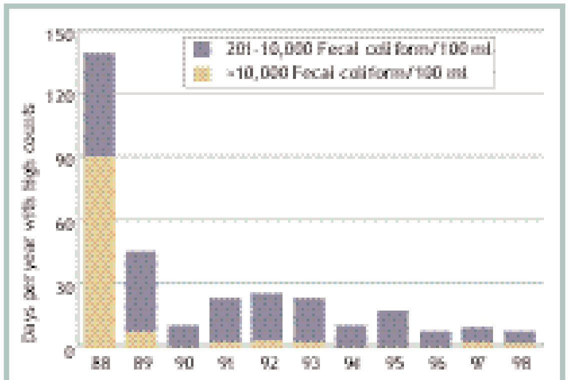


FIGURE 1. Bacteria levels in Deer Island effluent now rarely fail the water quality standard of 200 fecal coliform per/100 ml

A colony of harbor seals has returned to Calf Island in Boston's Outer Harbor.

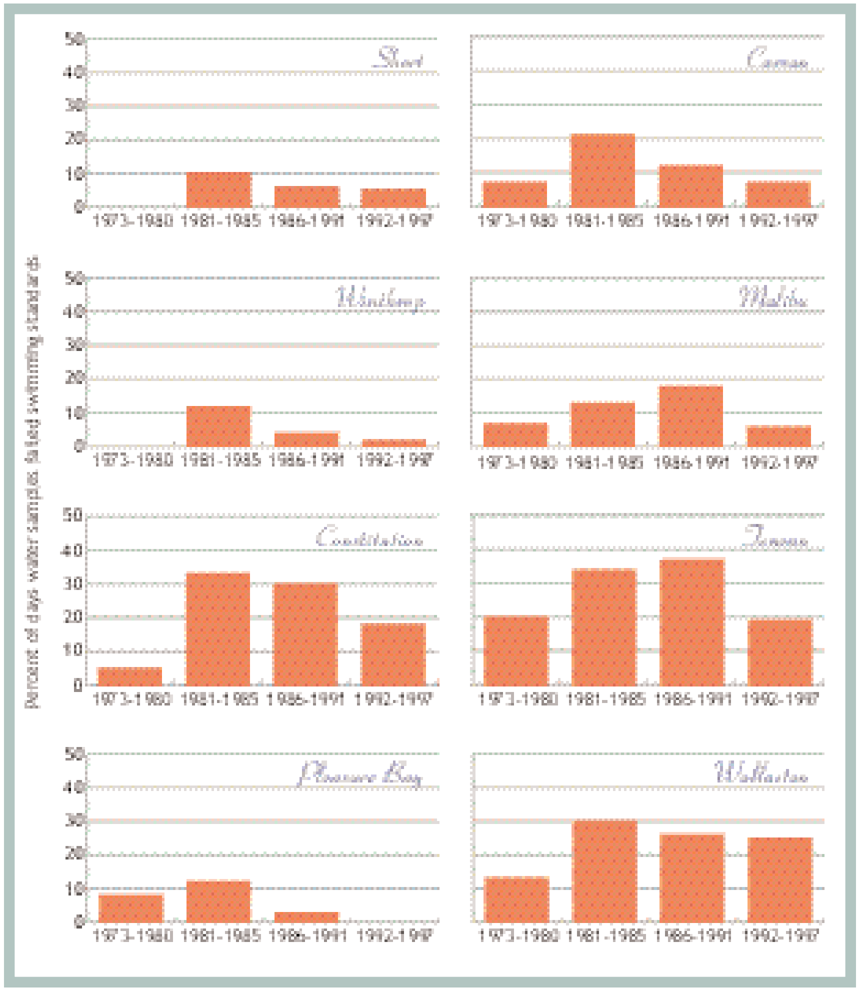
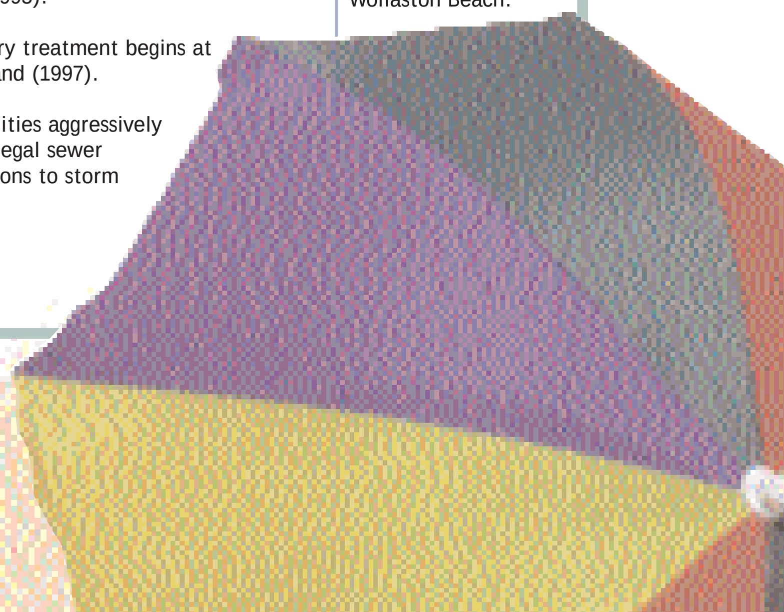


FIGURE 2. The percent of days advisories against swimming were posted at Boston Harbor beaches, averaged within four time periods. These time periods parallel phases of upgrades to MWRA's sewage infrastructure. After 1985, the effects of MWRA projects are reflected in fewer beach postings. A challenge to communities remains: addressing contaminated stormwater runoff to beaches, which is still a major source of beach pollution.

TABLE 1. Timeline of MWRA projects and changes in beach water quality.

Time Period	System Condition	Average % of Water Samples Failing Swim Standards
1973-1980	Treatment plant at Deer Island commissioned in 1968.	Generally less than 20%.
1981-1985	Sewage facilities deteriorated due to underfunding and neglect. MWRA created (1985).	More than 20% to 30% at several beaches.
1986-1991 	Early upgrades repair the old treatment plants so they function as designed. CSO treatment facilities completed in southern Dorchester Bay (1990). Improved maintenance of tidegates on CSOs. Sludge discharges from the treatment plants end (1991).	Swimmers' advisories still occur more than 20% to 30% of the time at several beaches. 
1992-1997 	New pumps at Deer island (1995). New primary treatment plant at Deer Island (1995). Secondary treatment begins at Deer Island (1997). Communities aggressively repair illegal sewer connections to storm drains.	Swimmers' advisories decline to less than 20%, except at Wollaston Beach.



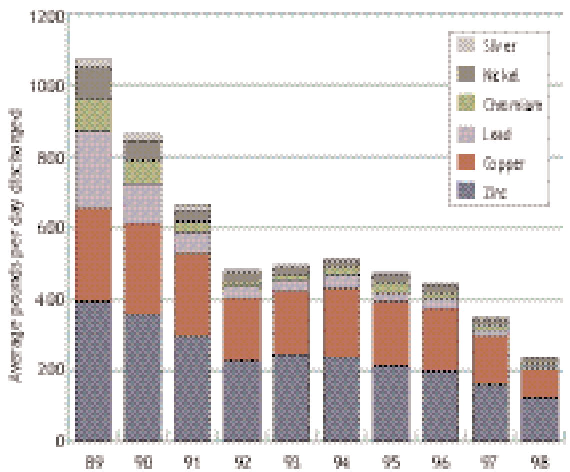


FIGURE 3. Metals in MWRA treatment plant discharges to Boston Harbor have declined dramatically since 1989.

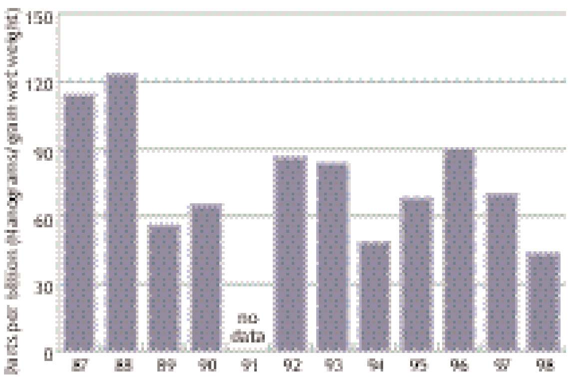


FIGURE 4. Mercury levels in the tissue of flounder caught near Deer Island have been well below the FDA limit of 1,000 parts per billion. Mercury levels have decreased significantly since the late 1980's.

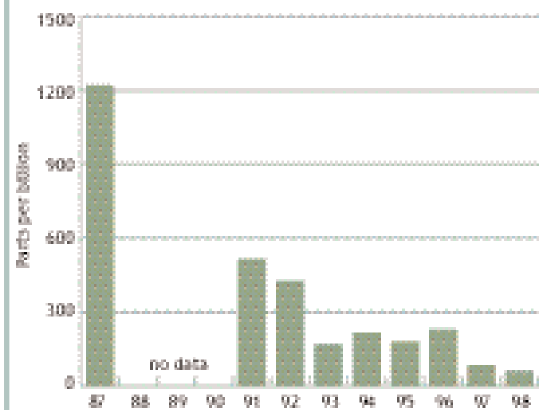


FIGURE 5. Levels of PAHs in mussels near Deer Island have remained low since 1993.

declined to less than half the levels discharged in 1989. Industries responding to MWRA's Toxic Reduction and Control Program (TRAC) have succeeded in significantly reducing inputs of toxic metals to the wastewater treatment system.

Secondary treatment since 1997 at the new DITP has been removing more toxic metals than did primary treatment alone. When the final battery of secondary treatment is completed in 2000, metals discharges will be reduced even more.

TRAC has also focused on reducing levels of mercury in wastewater, because a common reason for advisories against fish consumption is mercury levels found in fish tissue. Levels of mercury in flounder caught near Deer Island have consistently remained well under the FDA limit of 1,000 parts per billion (Figure 4). Mercury levels in flounder are less than half of what they were in 1996.

Discharges from the treatment plants of toxic organic chemicals like polynuclear aromatic hydrocarbons (PAHs) and polychlorinated bi-phenyls (PCBs) have also decreased. Levels of these toxic chemicals found in the tissue

Winter flounder live in close contact with the sea floor, and are exposed to contaminants that concentrate in sediments.

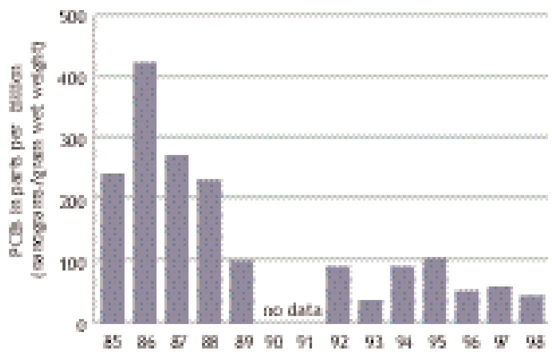


FIGURE 6. PCBs in winter flounder (fillet) caught near Deer Island. Levels have greatly decreased since the mid-to-late 1980's.

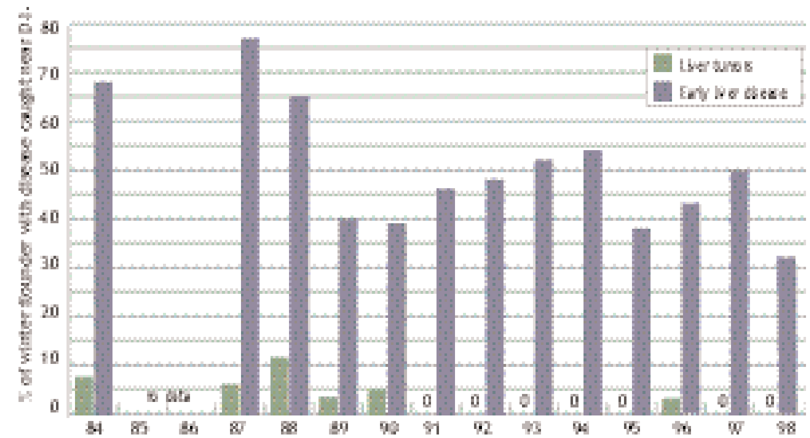
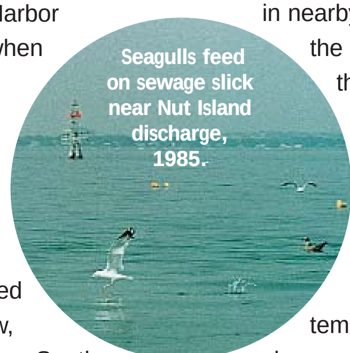


FIGURE 7. Decrease in flounder liver disease since the 1980's.

of two indicator species—blue mussels (Figure 5) and winter flounder (Figure 6)—have fallen since the late 1980's. Liver tumors and liver disease in winter flounder are also at relatively low levels compared with levels in the late 1980's (Figure 7).

A major milestone in the Boston Harbor Project was achieved in July 1998 when discharges from the Nut Island Treatment Plant (NITP) in Quincy ended. Until then, approximately 100 million gallons per day of sewage from MWRA's South System received only primary treatment at NITP before being discharged into Quincy and Hingham Bays. Now, sewage slicks in Quincy Bay are gone; South System flows pass through the Inter-Island Tunnel deep below the harbor floor to receive secondary treatment at DITP. Figure 8 shows the resulting dramatic decrease in treatment plant solids discharged to the harbor in 1998, continuing a 10-year trend.



Seagulls feed on sewage slick near Nut Island discharge, 1985.

Water quality improvements in the former NITP outfall area were immediate—the three visible effluent plumes and sewage odors disappeared. The risk of exposure to bacteria and viruses around the plumes is gone; Figure 9 shows that bacteria levels in nearby water have stayed very low since the discharge ended. Figure 10 shows that water clarity in the former discharge area, usually at its worst (about one to two meters deep) in mid-summer, continued to improve rapidly to three to four meters during the summer of 1998.

Ultimately, removal of the ecosystem stress caused by the NITP discharges will permit a healthier marine community to develop. Effects of the discharges near Nut Island of solids, nutrients, and toxic contaminants have developed over a century and will take years to reverse.

Although most of the solids discharged from NITP were flushed out of the harbor by tidal cur-

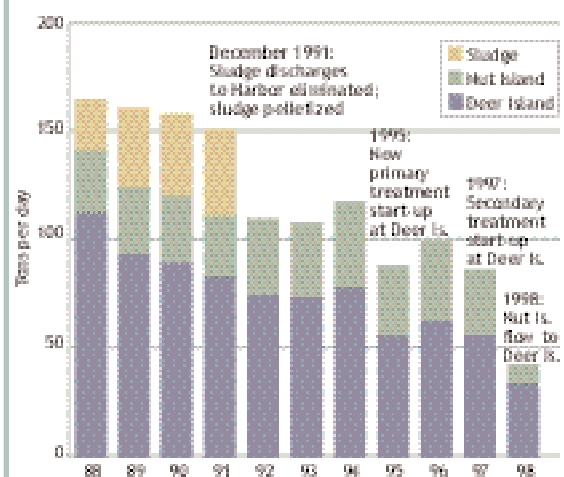
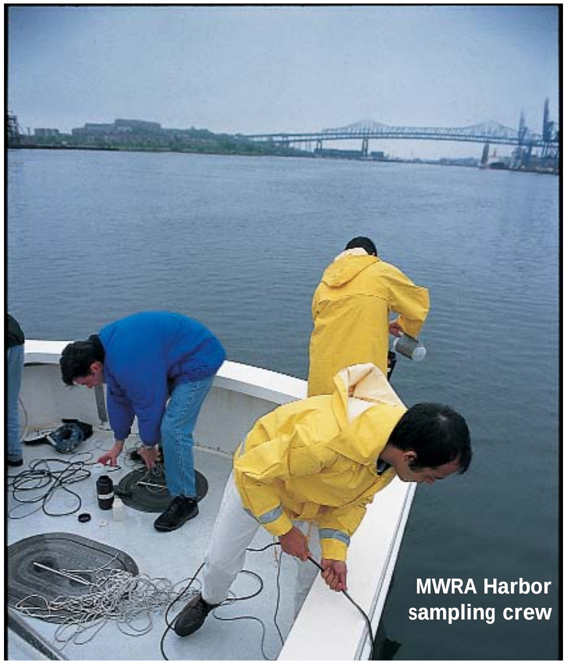


FIGURE 8. MWRA solids discharges to Boston Harbor.

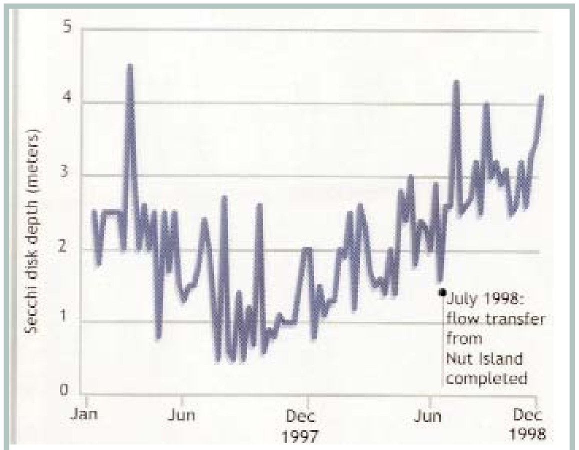
Although most of the solids discharged from NITP were flushed out of the harbor by tidal currents, about 1,100 tons of solids per year entered Hingham Bay and about 500 tons of solids per year entered Quincy Bay. Free from these pollutants in the future, Hingham Bay and Quincy Bay should be clearer in summer, with less green algal growth. Bottom-dwelling animal communities near the outfall areas should flourish as they recover from the effects of accumulated organic matter and toxic contaminants. Beds of tiny, shrimp-like *Ampelisca*, which naturally biofilter the water and increase the oxygen in the sediment, could spread into Quincy Bay, as they have recently expanded elsewhere in Boston Harbor.

Over the longer term, seagrasses, which once covered much of the harbor floor, will likely return to Quincy and Hingham Bays. Seagrasses serve as nurseries for many fish and other marine animals, and also stabilize the bottom sediments with their root systems and help keep the water clear. Seagrass beds are key indicators of a healthy harbor.

Although the volume of DITP effluent discharged to the North Harbor has increased temporarily until the new 9-mile effluent outfall tunnel is in use, most of the effluent is receiving secondary treatment. MWRA monitoring data indicate that the environmental benefits from closing NITP and providing secondary treatment for South System flows are greater than the effects from the temporary increase in discharges to the harbor near Deer Island.



MWRA Harbor sampling crew



GURE 10. Water clarity at Nut Island improved 84% after wastewater discharges there ended in July 1998. As measured by the depth at which a submerged white disk (secchi disk) is no longer visible, the average June-to-December water clarity at Nut Island was between one and two meters until July, when it increased to about three meters until year-end.

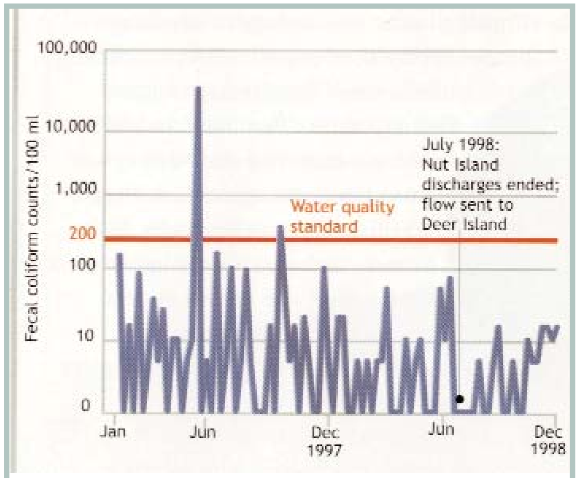
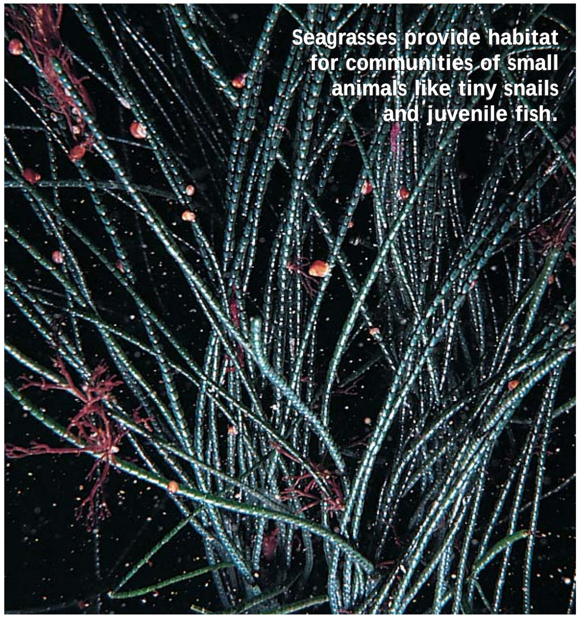


FIGURE 9. Fecal coliform levels at east Nut Island outfall. There were no violations of water quality standards in 1998 in the former Nut Island outfall area after discharges ended in July 1998.



Seagrasses provide habitat for communities of small animals like tiny snails and juvenile fish.

MWRA

Sewer System Overview

Over the course of 150 years, a large and complex sewage infrastructure has been built to transport and treat Greater Boston's wastewater.

MWRA'S REGIONAL WASTEWATER SYSTEM

The MWRA sewer system (Figure 11) is a network of large, regional sewers (interceptors) that collect sewage flows from local communities for conveyance to the Deer Island Treatment Plant (DITP) through MWRA-operated pump stations and headworks. The Fore River sludge-to-fertilizer plant then processes material removed from the sewage at DITP. Decades ago, before the regional system was built, local pipes discharged sewage into the nearest body of water. Rivers and streams became fouled as populations grew and the amount of waste increased. Beginning in the mid-nineteenth century, regional interceptors were built along the rivers to transport the sewage from local sewers for discharge to Boston Harbor. This regional system was taken over by MWRA in 1985.

MWRA's North System is built along the water courses of the Charles River and the Mystic River and its tributaries. The North System collects sewage from Boston, Cambridge, and 23 other cities and towns.

The South System follows the Charles, Neponset, Fore, and other river courses, collecting sewage from 21 communities including most of Boston.

Local sewer pipes and pumping stations are owned, maintained, and operated by individual cities and towns, not MWRA.

HOW SEWAGE GETS TO THE TREATMENT PLANT

Wastewater flows from local pipes through MWRA interceptors to MWRA headworks facilities. At the headworks, large objects are screened out and grit is removed. From the headworks, sewage flows under Boston Harbor to DITP through three main tunnels, and then is lifted by large pumps into the treatment plant for pollutant removal, disinfection, and discharge into the harbor.

The discharge to the harbor will stop when all flows are discharged through the new outfall and diffuser system into the deeper waters of Massachusetts Bay. (For detailed information on this outfall, see the 1996 State of Boston Harbor report).

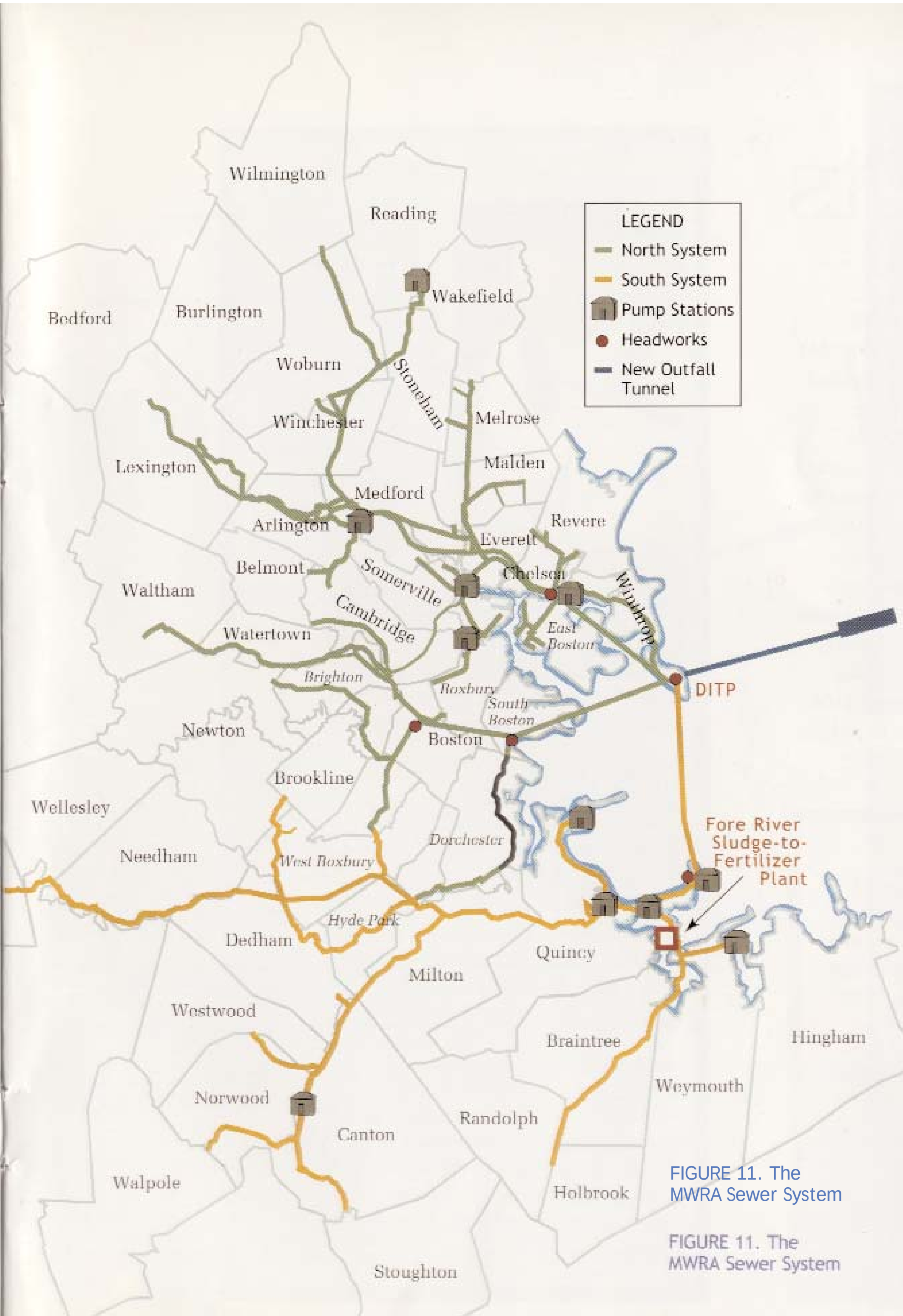


FIGURE 11. The MWRA Sewer System

FIGURE 11. The MWRA Sewer System

Sludge removed at DITP during treatment is barged to the Fore River Sludge-to-Fertilizer Plant to be converted to fertilizer.

MWRA SEWER IMPROVEMENT PROJECTS

In 1994, MWRA prepared a System Master Plan which included an integrated, system-wide approach to wastewater treatment, wastewater conveyance through the interceptors, and combined sewer overflow management and remediation. The System Master Plan considered all manner of system improvements, including the benefits of increased pumping at DITP, in order to determine the best ways to reduce overflow and address other sewer capacity and efficiency issues. The next two sections of this report describe major engineering and construction efforts on the part of MWRA and its sewer communities to modernize the sewer system.

Drainage & Sewerage:

DRAINAGE SYSTEMS divert rainfall and snowmelt that would otherwise create flooding in streets and buildings. Gutters, catchment basins, storm drain pipes, and culverts serve to carry stormwater runoff to a nearby body of water.

As more people moved into the Boston area, land that normally drained into wetlands and streams was developed and paved over, resulting in local flooding problems. Communities had to create a system of artificial drainage to meet the needs of a growing population and changing land use.

SEWER SYSTEMS transport residential and industrial wastewater to treatment facilities. More than a century ago, Boston became one of the first American cities to build regional sewer systems to dispose of residential and industrial waste.

Today, MWRA owns and manages regional sewage transport and treatment facilities that connect to local systems. Local municipalities are responsible for providing effective drainage systems in their areas, and operating local sewage collection systems.

MWRA
Interceptor Projects
IN FOUR RIVER BASINS

Interceptors are MWRA's large, regional sewers that receive sewage from smaller, local systems. MWRA owns 240 miles of interceptors and several pumping stations that collect and transport wastewater from local sewer systems to the Deer Island Treatment Plant. Some interceptors were built more than a century ago, and are deteriorating because of age. Increased land development in the suburbs of Boston over the past decade has created more demands on the interceptor system. In extremely wet weather, sewage can back up into streets and buildings. Because most interceptors are located in river valleys, overflows can contaminate rivers and streams. Leaking pipes and illegal storm drain connections to the sewer system contribute to the problem. To minimize sewer overflows, MWRA is increasing the capacity of its interceptor system; between 1990 and 2002, more than $400 million is being invested to construct, enlarge, and rehabilitate interceptors and pumping stations throughout the service area. Approximately 56 miles of interceptors will be either newly constructed or rehabilitated, improving water quality throughout the Boston Harbor watershed (Figure 12). An additional $100 million is being invested in rehabilitation of locally owned collection systems to reduce Infiltration and Inflow (see page 22).

In the Neponset River Basin

The New Neponset Valley Relief Sewer: Structural and hydraulic deficiencies in the old interceptor caused sewer overflows into Fowl Meadow (in Canton, Norwood, and parts of Milton) and threatened the water supply for Canton, Dedham, and Westwood. A new sewer and a pumping station were constructed to alleviate these problems. The increased capacity will enable MWRA to serve an increasing population as many people now using septic systems will convert to sewer service.

The Neponset Valley Sewer Project: This project is in the planning stage, where the need for new construction or rehabilitation of the interceptor—which in some places is more than 100 years old—is being evaluated.

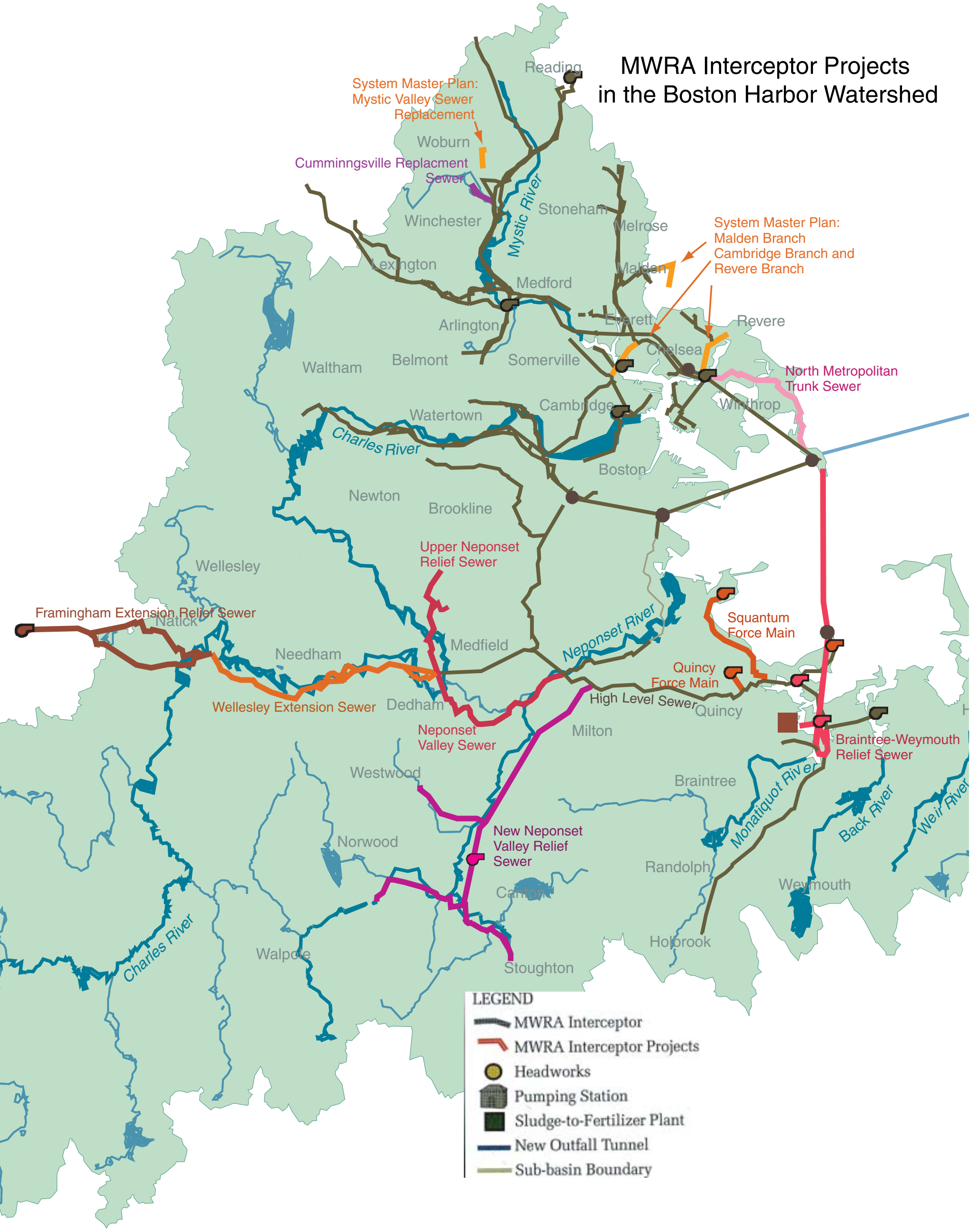
In the Charles River Basin

Charles River Watershed Association volunteer Bill Tedoldi samples in the Charles River.

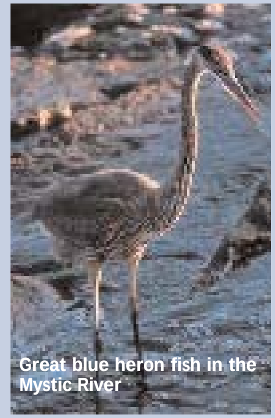
Framingham Extension Relief Sewer: The 40-year-old Framingham Extension Sewer (FES) receives flow from Framingham, Ashland, and Natick. This interceptor did not have the capacity to contain the volume of flow it received during heavy storms, or to serve future sewage needs. The $52 million Framingham Extension Relief Sewer project included construction of additional pipeline and a new pump station, providing additional capacity for the FES system.

Wellesley Extension Sewer Replacement: The existing interceptors, more than 75 years old, run along the Charles River, serving the towns of Needham, Wellesley, and Dedham. Overflows into the river endangered Needham's drinking water supply and the Elm Bank Aquifer in Dover. This $72 million project, nearly complete, replaces part of the system and rehabilitates and relines the remaining old sewer.

Upper Neponset Valley Relief Sewer Project: As the northernmost portion of the aging sewer lies within the Charles Watershed, backups and overflows to the Charles River do occur. Construction of a new relief interceptor will reduce backups and overflows.



In the Mystic River Basin


Great blue heron fish in the Mystic River

North Metropolitan Trunk Sewer Rehabilitation. This large 100-year-old brick interceptor carries sewage from East Boston, Chelsea, Revere, and Winthrop to the Deer Island Treatment Plant. Because the inside of the pipe had deteriorated, the entire sewer has been patched and relined. These pipe repairs will prevent leaking and ensure reliable flow of wastewater to Deer Island.

Cummingsville Replacement Sewer. The Cummingsville Branch Sewer is a 100-year-old interceptor system in Winchester. Insufficient capacity in the old system may be the cause of upstream sewer overflows into the local drinking water supply—Horn Pond in Woburn. The $4 million project includes construction of a new sewer and rehabilitation of an existing sewer.

System Master Plan Interceptor Projects. Five interceptor projects are planned to increase the capacity of the system during wet weather; four of these projects are in the Mystic Basin. The projects will increase the size and/or add additional sewer pipes to parts of the system that contribute to sewer overflows: the Mystic Valley Sewer, the Malden Branch Sewer, the Revere Branch Sewer and the Cambridge Branch Sewer.

In the Fore River Basin: Braintree-Weymouth Relief Facilities

Braintree-Weymouth Interceptor: Together, the Braintree-Weymouth Interceptor, Relief Sewers, and Relief Tunnel will have the capacity and additional flexibility to handle peak wet-weather flows, alleviating surcharging and overflows into Smelt Brook.

Two New Pumping Stations: The new Intermediate Pump Station and Headworks in North Weymouth will pump sewage to the Inter-Island Tunnel. The existing Braintree-Weymouth pump station will be replaced by a smaller, modern station. The combined capacity of the two new stations will be 50% greater than that of the existing station.

Relief Sewers: New sewers will be constructed from the Idlewell section of North Weymouth to the Intermediate Pump Station.

Relief Tunnel: Twelve feet in diameter, this new tunnel will be bored through bedrock 250 feet underground. It will run from the Fore River Sludge-to-Fertilizer ("pelletizing") Plant, under the Fore River to the Intermediate Pump Station in North Weymouth. This new tunnel will carry wastewater to the Inter-Island Tunnel for treatment at Deer Island. Inside the Inter-Island Tunnel and the Braintree Relief Tunnel, two smaller pipes will carry sludge from Deer Island to the pelletizing plant.

CONTROLLING

Combined Sewer Overflows

Combined Sewer Overflow (CSO):

1. Outfall in a combined sewer system that by design releases stormwater and sewage into receiving waters during storms in order to avoid sewage backups into homes and streets.
2. The combined stormwater and sewage discharged from a CSO outfall.

Like many other older areas in cities across America, large parts of Boston, Cambridge, Somerville, and Chelsea have combined sewer systems. Combined sewers were engineered to merge drainage and sewage pipes in a single system. The pipes that normally carry sewage every day also convey stormwater runoff in wet and rainy weather. During heavy rains, because of the limited capacities of the interceptors and tunnels, combined sewers can become filled with more stormwater and sewage than can be carried all the way to the Deer Island Treatment Plant (DITP) for treatment and discharge. Therefore, to prevent combined sewage from backing up into streets and buildings, combined sewer systems were designed to discharge overflow volumes to the Neponset River, Charles River, Mystic River, Alewife Brook, and Boston Harbor through 88 CSO outfalls. Throughout the 1970's and early 1980's, discharges of these contaminated flows from CSOs posed a potential health threat to swimmers and recreational boaters, as well as to consumers of locally caught shellfish. Indeed, because of system neglect and deterioration, there were times and locations where combined sewers overflowed even in dry weather!

A DECADE OF SEWER SYSTEM UPGRADES REDUCED OVERFLOWS 70%

In 1987, MWRA agreed to plan and build projects to control CSOs in its sewer communities. While planning for the larger CSO construction projects was underway, MWRA and the communities with combined sewers implemented many smaller projects, emphasizing better maintenance and optimizing the sewer system. These projects helped to reduce CSO volumes and activations by directing more flow to Deer Island for treatment. Many of these so-called "System Optimization Projects" mirrored the requirements of the U.S EPA's Nine Minimum Controls contained in the National CSO Control Policy shown in Table 2 (EPA, 1994).

Routine maintenance activities like making sure tidegates are working properly or sweeping streets to prevent trash from entering the sewer system also proved to be effective and inexpensive ways to reduce frequencies and volumes of overflows and their impacts. Furthermore, improved pumping at DITP and increases in sewage transport capacity resulted in significant CSO reduction (Figure 13).

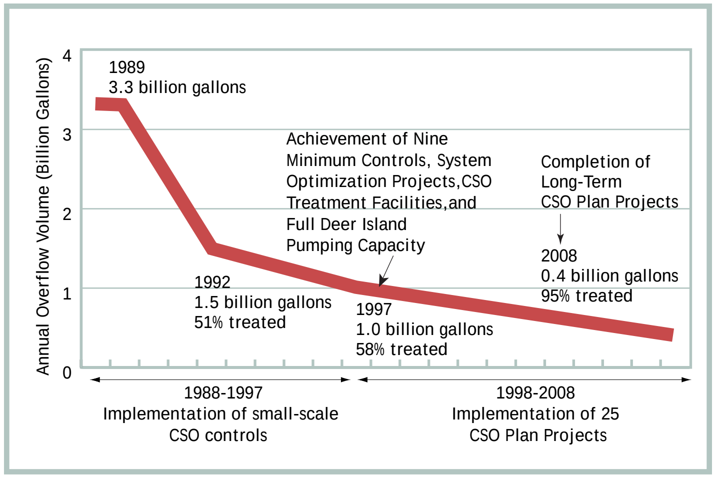


FIGURE 13. CSO control efforts reduce overflows dramatically, as shown by a computer model; most remaining CSO flow will be treated by 2008.

TABLE 2. NINE MINIMUM CONTROLS: NATIONAL CSO POLICY

MWRA has fully complied with EPA's nine minimum controls.

1- Proper operation and regular maintenance programs

2- Maximization of storage in the collection system

3- Review and modification of pretreatment requirements

4- Maximization of flow to the treatment plant

5- Elimination of CSOs in dry weather

6- Control of solid and floatable materials in CSOs

7- Pollution prevention program to reduce contaminants in CSOs

8- Public Notification

9- Monitoring to characterize CSO impacts and the efficacy of CSO controls

Examples of projects that optimized the sewer system

- The single most important improvement that reduced CSOs was the installation of new sewage pumps at the Deer Island Treatment Plant. Because more sewage can be pumped to the plant for treatment, CSO volume has been reduced by more than 50 percent.
- Some CSOs that rarely overflowed were simply blocked off and eliminated.
- The pre-flow capacities of many individual sewer lines were increased by raising the height of weirs — small dams inside the sewer pipes — that assure diversion of flow toward a plant and away from the overflow pipes.
- Small sewer separation projects eliminated several CSOs.
- New tidegates were installed to keep seawater from backing into the sewers and drains at high tide. The excess water was reducing the sewers' capacity for handling sewage.

Another approach to CSO control is to provide facilities that screen and disinfect overflows that occur relatively frequently. The oldest CSO treatment facility now owned by MWRA, at Cottage Farm near the B.U. Bridge on the Charles River, was originally constructed in 1971. Five other facilities (see Table 3) were placed in operation in the 1980-1990 period. Upgrades have been completed or planned for five CSO facilities including a $5.8 million project at Cottage Farm to improve disinfection and to dechlorinate the discharge before it enters the river. However, three of the five facilities will eventually be decommissioned when separate sewers and storm drains are constructed.

To date, the cumulative effect of improvements resulting in increased pumping at Deer Island, physical and management changes to the CSOs themselves, and upgrades of the CSO treatment facilities, is that the volume of CSO decreased from 3.3 billion gallons per year in 1987 to one billion gallons per year in 1997, and more than half of the discharges are now treated. The water quality of Boston Harbor and its tributary rivers has improved as a result: fecal coliform bacteria levels in the water are about 35% lower than before these CSO projects were implemented (Figure 14).

MWRA'S LONG-TERM CSO CONTROL PLAN

The CSO improvements made thus far are significant, but they are only the beginning. Figure 15 illustrates the 25 projects that make up MWRA's CSO Plan. The Plan includes upgrading existing CSO treatment facilities, building new treatment facilities, and constructing large conduits to store and transport combined sewage. In some areas, new, separate sewers and storm drains will be built so that the sewage can be carried to Deer Island and storm runoff can flow to the rivers or harbor. After implementation, 36 of the original 88 CSOs will have been eliminated, including all CSOs near beaches or shellfish beds. The remaining CSO discharges will be minimized to four or fewer per year, or treated. If other sources of pollution—especially contaminated stormwater runoff are controlled, the harbor and rivers will be able to meet water quality standards virtually all the time.

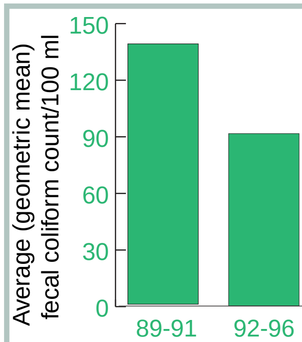
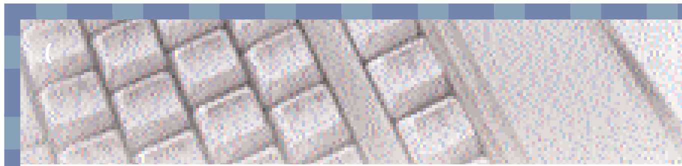


FIGURE 14. Overall fecal coliform levels in Boston Harbor and tributary rivers over the past five years are 35% lower than in the period 1989-91. The statistical analysis accounts for differences in rainfall. (Gong et al, 1998).



Computer modeling the effects of Combined Sewer Overflows (CSOs)

MWRA has used computer models to evaluate methods of CSO control. The sewer systems in communities with CSOs were modeled; the water quality of the river and harbor locations to which CSOs discharge (the "receiving water") were also modeled. The sewer model used system characteristics and land use data to calculate how different amounts of rain affect CSO flow. The water quality model used information about the shape, depth, tides, and currents of the harbor and rivers to calculate the effects of CSOs on water quality.

The impact on receiving waters of a moderate storm (1.89 inches of rain in 21 hours) and a severe storm (2.79 inches of rain in 22 hours) were simulated.

By running the models with different CSO control measures, MWRA can compare the water quality benefits of various CSO-control approaches to determine the most cost-beneficial solution.

TABLE 3. MWRA CSO Treatment Facilities

LOCATION OF DISCHARGE	FACILITY	BUILT	CSO PLAN
South Dorchester Bay	Commercial Point	1990	Upgrade 2001 Decommission 2008
South Dorchester Bay, Savin Hill Cove	Fox Point	1988	Upgrade 2001 Decommission 2008
Inner Harbor at Charles River confluence	Prison Point	1988	Upgrade 2000
Winthrop Bay, Constitution Beach	Constitution Beach	1986	Decommission 2000
Inner Harbor at Mystic River confluence	Somerville Marginal	1980	Upgrade 2001
Charles River	Cottage Farm	1971	Upgrade 1999

FIGURE 15.
MWRA LONG TERM PLAN FOR CSO CONTROL TO IMPROVE WATER QUALITY

The goal of the CSO Plan is to eliminate CSOs at Boston Harbor beaches.

THE CSO PLANNING PROCESS

Rather than using a single engineering solution to CSO control, MWRA's CSO Plan is an example of watershed-based planning. This approach tailors CSO control strategies to the uses of each waterbody and the sources and types of pollution it receives. Water quality goals, available technologies, costs, and siting constraints were all considered (Figure 16). As part of the planning process, a series of workshops evaluated different strategies for controlling CSOs. Workshop participants included MWRA and its engineering consultant, public works professionals from the CSO communities, interested citizens, state and federal regulatory agencies, environmental organizations, MWRA's Wastewater Advisory Committee, and the MWRA Advisory Board.

Neighborhood groups including local residents, environmentalists, and elected officials commented on specific CSO alternatives. Community meetings at major milestones in the planning process helped shape the decision-making for the Plan. Recommendations for CSO control in three types of water bodies, South Dorchester Bay, Fort Point Channel, and the Charles River show how watershed-based planning is tailored for different locations.

PERFORM BASELINE WATER QUALITY ASSESSMENTS
Identify water quality standards.
Identify and assess beneficial uses.
Identify causes of non-attainment and determine relative contribution of CSOs.
Define CSO flows, loads, and outfall activations.
ESTABLISH GOALS
Develop a range of water quality goals.
Define CSO control goals.
DEVELOP & SCREEN CSO CONTROL ALTERNATIVES
Develop CSO control alternatives to achieve CSO control goals.
Use computer modeling to evaluate performance.
Screen alternatives using rating criteria for cost, benefit, construction and environmental impacts, and public acceptance.
DEVELOP & EVALUATE SYSTEM-WIDE STRATEGIES
Develop combinations of CSO control alternatives for the entire system.
Define cost, performance, water quality impacts, and siting issues.
Evaluate CSO alternatives using numerical rating criteria for cost, water quality improvement, and siting constraints.
RECOMMEND CSO CONTROL PLAN
Select CSO control alternatives for each receiving water segment.
Combine alternatives into a system-wide control plan.

FIGURE 16. Schematic of CSO Planning Process

1. South Dorchester Bay plan: elimination of CSOs

This bay is a very important recreational area, with three beaches (Malibu, Savin Hill, and Tenean). Soft-shell clams are abundant here, but are too contaminated with bacteria to harvest. Recreational boating is also popular; several yacht clubs are located in the area.

Four CSO outfalls and several large stormwater drains rim the shoreline (see Figure 15). Stormwater, contamination from the Neponset River, and CSOs are the main sources of bacterial contamination to this bay during heavy rainstorms. However, water quality is generally good during dry weather.

The CSO Plan includes elimination of CSOs in this sensitive shellfishing and swimming area. Two existing CSO treatment facilities (Fox Point and Commercial Point) are being upgraded. Then, extensive work to construct separate storm drainage and sewer systems will eliminate all CSOs to this area. To fully benefit from this construction, it will be important for communities to address the problem of contaminated stormwater, where most bacterial contamination comes from. (Figure 17).

CSO improvements to heavily industrialized Fort Point Channel will include a new treatment facility.

2. Fort Point Channel: treatment of CSOs

Fort Point Channel in the Inner Harbor is a long, narrow, artificially channelized embayment with granite walls. Surrounding the channel is a heavily urbanized area. Restaurants, offices, and the Children's Museum are nearby. So are a major highway interchange now under construction, a railway yard, the world's largest razor blade factory, the new federal courthouse, a large hotel, and a ferry pier. Walkways and bridges serve pedestrian traffic to the waterfront, where people enjoy the open space and harbor views. Small recreational boats use the channel.

The channel is severely polluted by the largest amount of untreated CSO in the entire system; more than eight million gallons are discharged from a large outfall at the head of the channel in a moderate storm, and 26 million gallons during a severe storm. Six smaller CSOs line the channel. After rainstorms, it is common for bacteria levels to exceed the boating standard; unsightly sewage-related floating materials sometimes can be seen in the channel.

Plans to protect Fort Point Channel from CSOs include construction of the Union Park Detention and Treatment Facility and the Fort Point Channel Storage Conduit. Together, these projects will decrease the volume of CSO and treat most of the remaining discharge. During a moderate storm, no untreated CSO will be discharged; for a severe storm, 94% of the discharge will be screened and disinfected. Thus, the worst effects of CSO on Fort Point Channel—bacterial contamination and floating trash and sewage—will be largely corrected.

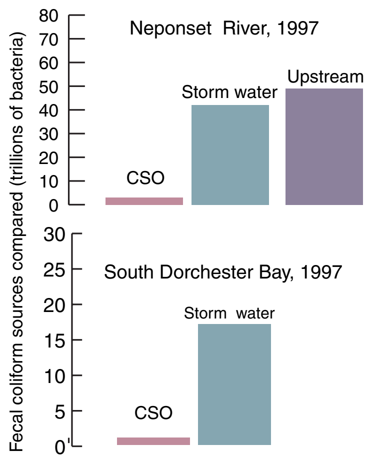


FIGURE 17. Sources of bacteria to the Neponset River and South Dorchester Bay after a 3-month storm. Stormwater and upstream flows are the main source of bacteria. There will be no CSO after the CSO Plan is completed.

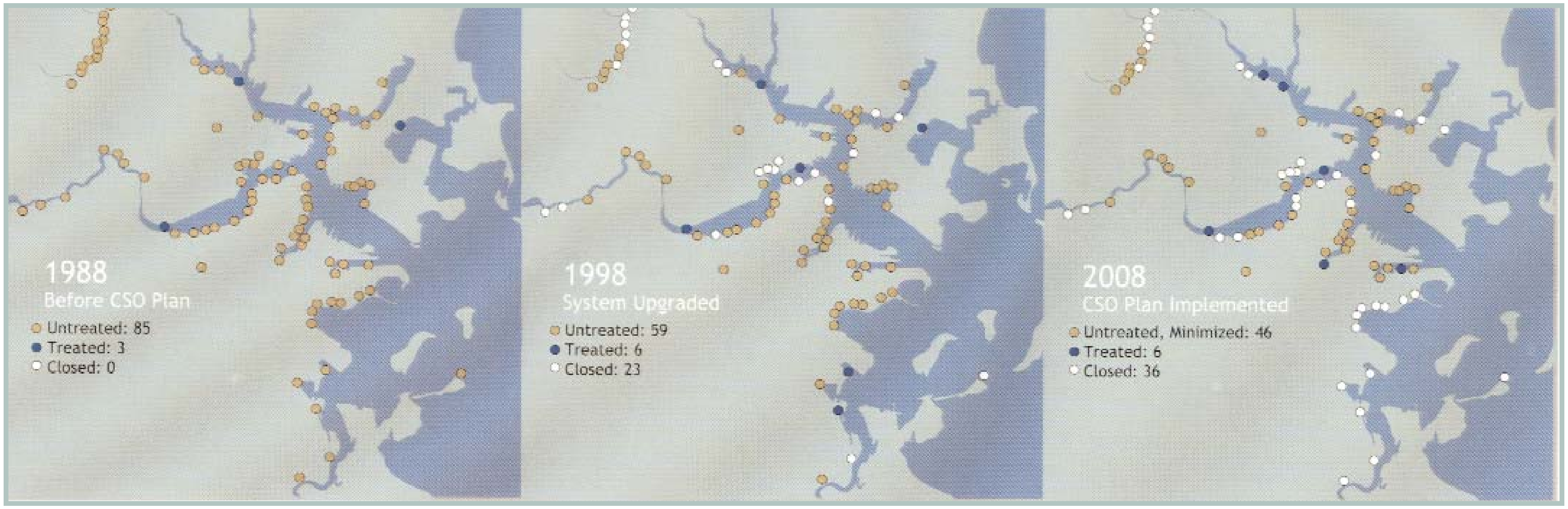


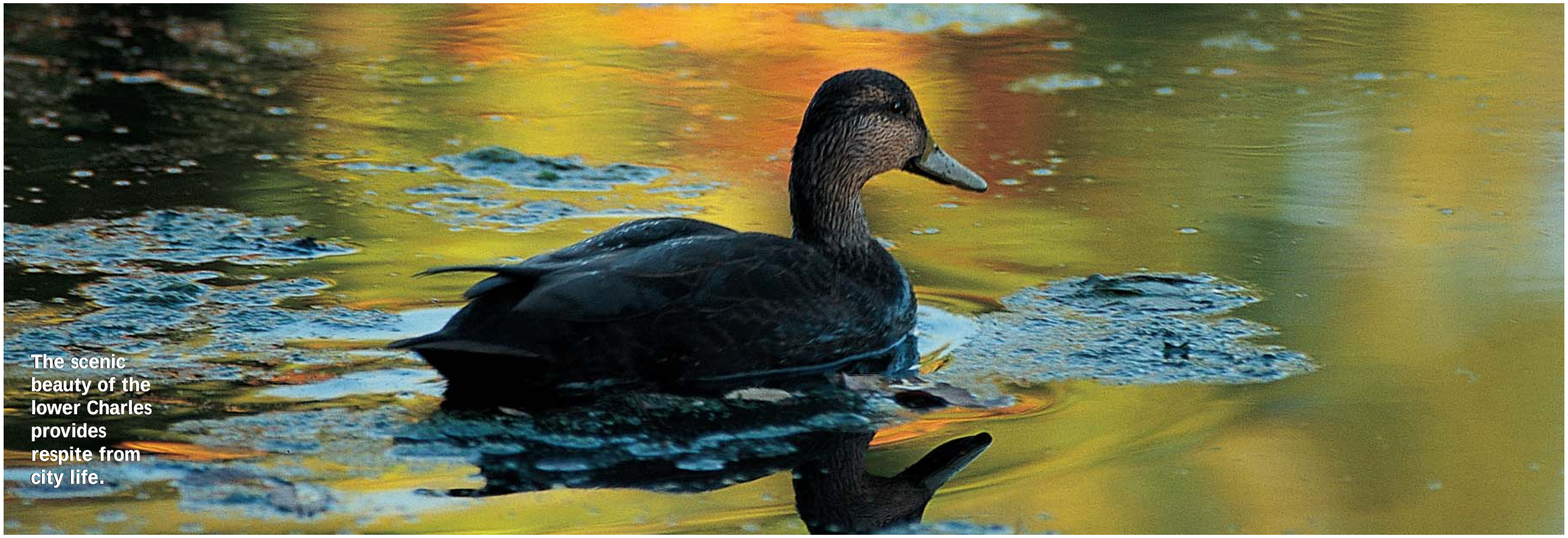
FIGURE 18. The reduction of active CSO outfalls between 1988 and 2008.

3. The Charles River: controlling CSOs

Because of MWRA improvements in pumping, sewage transport, and system maintenance, the number and volume of CSOs in the Charles River have dramatically decreased since 1987. Now, the largest CSO source of fecal coliform bacteria to the lower Charles is the Stony Brook outfall, and the largest treated source of CSO is MWRA's Cottage Farm CSO Treatment Facility (see Figure 15).

Projects to protect the Charles outlined in the MWRA CSO Plan (1) dramatically reduce CSOs to the Stony Brook through separating storm and sanitary sewers; (2) improve treatment of combined sewage discharged at Cottage Farm; and (3) dramatically decrease the total number of CSO discharges. After the Plan is completed, untreated CSO discharges to the Charles will be rare and small in volume. Nevertheless, bacterial water quality is still predicted to violate boating and swimming standards after heavy rainstorms, mainly due to contaminated stormwater that enters the river. Unless stormwater runoff is cleaned up, the Lower Charles will still fail to meet the boating standard after a severe storm.


The Charles River



The scenic beauty of the lower Charles provides respite from city life.

The 25 projects in the CSO Plan are now scheduled to be completed by 2008. Thirty-six outfalls will be closed (Figure 18), completely eliminating overflows at the most sensitive areas—beaches and shellfish beds. Elsewhere, CSOs will be reduced and treated so that water quality standards will be met.

WATER QUALITY IMPROVEMENTS

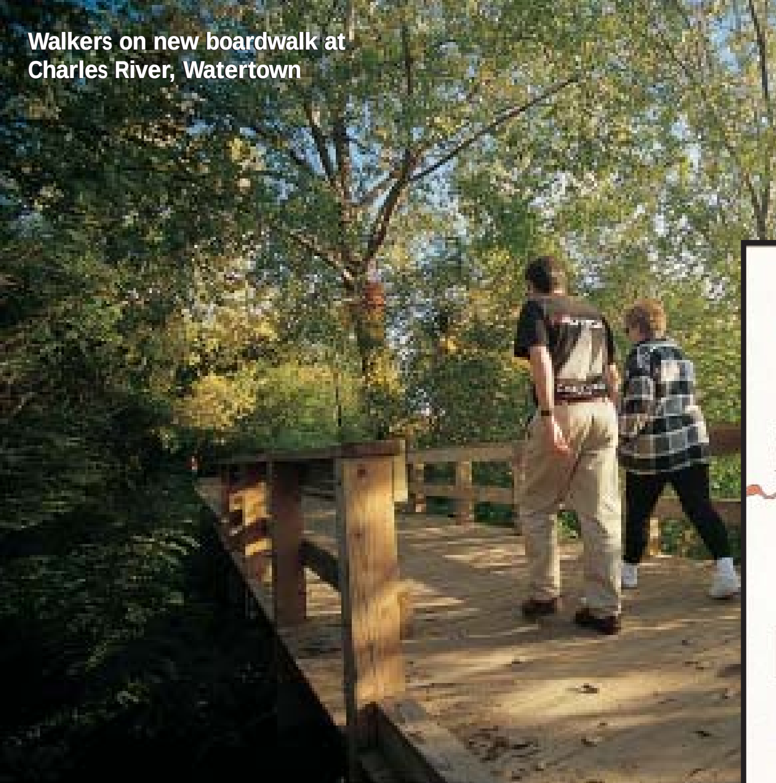
Figures 19A and 19B show the results of computer modeling of fecal coliform bacteria levels in Boston Harbor and its tributary rivers after rainstorms for the present and future. Fecal coliform levels are shown one day after the rainstorm, and both stormwater and CSO sources of bacteria are included in the model. The fecal coliform levels in the water indicated by each color are described in the legend. The red/yellow areas indicate poorer water quality, where fecal coliform levels are higher than allowed by state swimming standards, and blue/green areas show good water quality, within swimming standards.

River herring

Stormwater Pollution:

A CHALLENGE FOR THE CHARLES

A two-year government study sponsored by MWRA, EPA, and the Massachusetts Department of Environmental Protection is measuring and modeling the relative contributions of stormwater sources to the Charles to help guide future pollution control efforts. Urban stormwater is not clean, and is very difficult to control. Because of its high volume, stormwater can have a big impact on water quality, even with low concentrations of pollutants. Use of best management practices such as street sweeping, catch-basin cleaning, and enforcing “pooper scooper” laws are ways to help reduce stormwater pollution. The effectiveness of these programs in helping to meet water quality standards is yet to be determined.



Walkers on new boardwalk at Charles River, Watertown

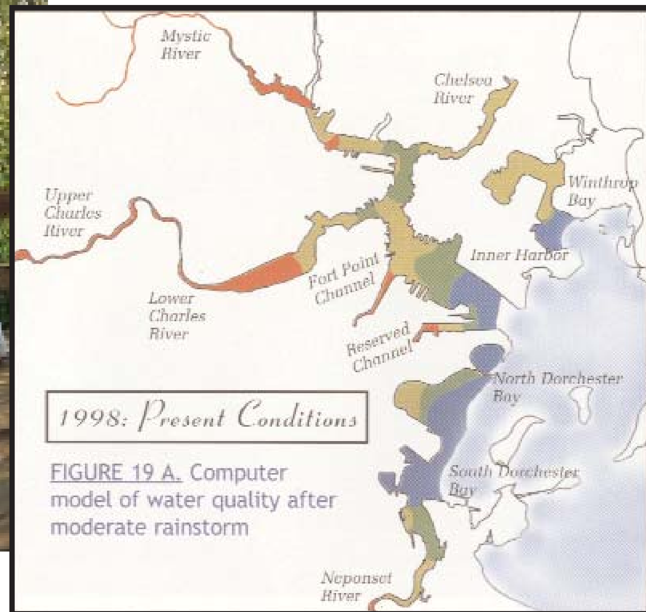


FIGURE 19 A. Computer model of water quality after moderate rainstorm

Legend

Fecal coliform count per 100 ml water	Interpretation
>1,000	Fails swimming and boating water quality standards
201-1,000	Meets boating standards but fails swimming standards
89-200	Meets swimming standards but fails shellfishing standards
14-88	Meets conditionally restricted shellfishing and swimming standards, but fails unrestricted open shellfishing standards
<14	Meets all bacteria standards

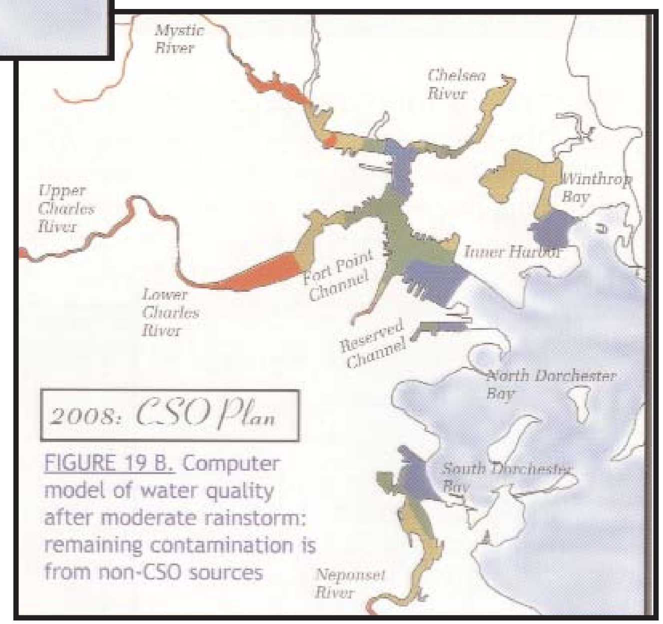


FIGURE 19 B. Computer model of water quality after moderate rainstorm: remaining contamination is from non-CSO sources

Present (1998) conditions: Figure 19A shows modeled water quality after a moderate storm. The three rivers (Charles, Mystic, and Neponset) all fail to meet boating or swimming standards, as do areas of the Inner Harbor, especially Fort Point Channel. Near the shoreline, North Dorchester Bay and Winthrop Bay fail to meet the swimming standard.

Future (2008) conditions: Figure 19B shows model results for the moderate storm conditions after the CSO Plan is fully implemented. The model assumes no changes in the bacteria inputs from current non-CSO sources such as stormwater. The most dramatic change will be in North Dorchester Bay, where the water quality will meet the highest standards. Most of South Dorchester Bay and the Inner Harbor will be within swimming standards, except for small areas of Fort Point Channel and the Chelsea River. However, other areas show little change compared to 1998. In the areas that show relatively little change, most of the bacterial contamination is from stormwater discharges to the area or from upstream (river water flowing downstream into the study area).

Despite the highly controlled CSO discharges called for in MWRA's CSO Plan, river water quality is still predicted to be poor after rainstorms because of stormwater input. Although stormwater is somewhat cleaner than CSO flow, the large volume of stormwater entering rivers significantly degrades water quality.

Future Challenges

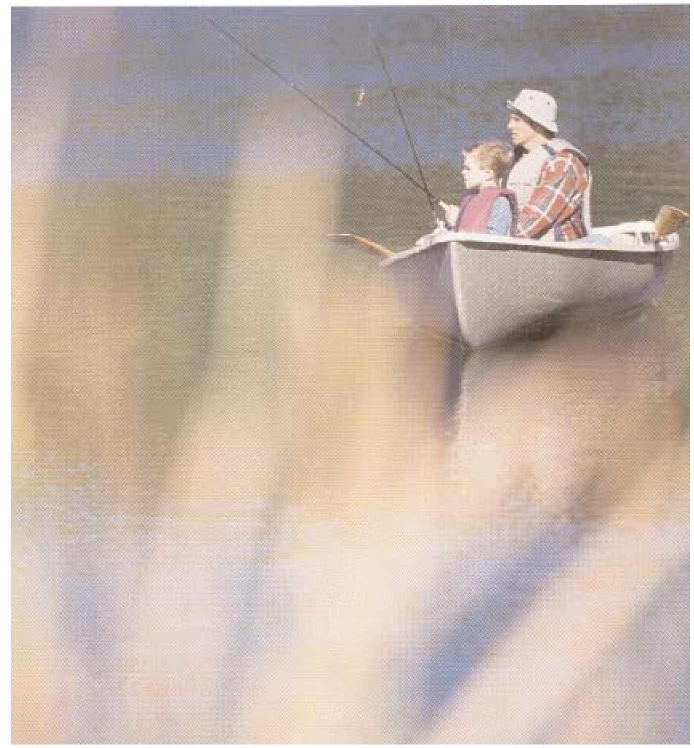
This report has focused on MWRA's engineering and construction projects to control combined sewer overflows and to expand and repair MWRA's regional system of interceptors and pumping stations. Although less widely known than the Boston Harbor Project, these improvements will provide substantial benefits to water quality throughout the river basins in greater Boston and in the harbor. However, even after these projects are complete, significant challenges will remain if the region is to realize all the potential water quality benefits of these investments.

Since the Federal Clean Water Act of 1972, major efforts to control water pollution have focused on regulation, engineering, and construction to prevent or treat municipal and industrial wastewater discharges. These solutions have worked well: water bodies like Boston Harbor are showing the benefits of such investments. However, as these sources have been controlled, other sources of pollution have been revealed. These include contaminated stormwater runoff—urban, rural, and residential; sewage overflows in extreme wet weather called "sanitary sewer overflows" (SSOs); and deposition of airborne pollutants into water bodies.

ADDRESSING OTHER SOURCES OF POLLUTION

MWRA is active in several cooperative initiatives among government agencies, community sewer utilities, and environmental advocacy groups to identify and address other sources of water pollution.

Contaminated stormwater runoff: Stormwater is a major source



of toxic chemicals and bacteria to waterways including the harbor and the Mystic, Charles, Neponset, and Fore Rivers. Stormwater can be contaminated by leaking sewers, as well as by dirt and animal waste, or by illegal dumping of oil or other pollutants into storm drains. Failing septic systems in the suburbs and rural areas can contribute bacteria and excess nutrients to the upstream areas of these rivers. Fertilizers and pesticides from lawns, golf courses, and farms leach into groundwater or are washed into rivers and wetlands. Leaking oil and gas from boat motors and illegal discharge of wastewater from sinks and toilets on boats are problems throughout the watershed.

Massachusetts' Clean State Initiative is targeting state facilities to implement stormwater controls; MWRA has implemented these policies in all of its own facilities. Stormwater studies in the Charles, Neponset, Mystic, and Fore Rivers, and at Wollaston Beach, aim to identify and measure the sources and quantities of pollutants in stormwater entering the rivers and the harbor. Such studies provide essential information to help communities target cleanup efforts where they are most needed.

Sanitary sewer overflows (SSOs): In separate sewer systems, overflows of sewage from manholes or underground sewerage structures can occur. Unlike combined systems (see page 12), separate systems are designed with the intention of keeping sewage and stormwater separate: sewage is transported to wastewater treatment facilities, while stormwater is discharged to nearby rivers, streams, and wetlands.

However, no separate systems are truly separate. Although the discharge of stormwater to sanitary sewers is illegal, sump pumps, roof drains, and basement and foundation drains from homes often connect directly to sewers instead of drainage systems. This inflow adds significant volumes of stormwater to already overtaxed sewer systems. Another large source of water to sewers is infiltration of groundwater into leaky pipes during wet weather. In some communities, approximately half the annual volume of flow through sewer pipes comes from infiltration and inflow (I/I).

In wet weather, if enough stormwater and groundwater enters a separate sewer system, the sewers fill up and inevitably overflow through the manholes where the top of the sewer pipe is closest to the ground surface. Figure 20 illustrates how an interceptor overflows during a major storm.

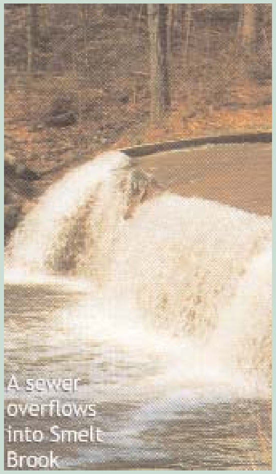
Fortunately, widespread SSOs occur only rarely, during severe (50- to 100-year) storms. In those few locations where SSOs occur repeatedly, MWRA is planning, designing, or constructing sewer relief projects (see pages 10-11) which will eliminate SSOs except during the most extreme storm events. MWRA is also leading an Infiltration and Inflow (I/I) Task Force (see text box) to develop effective ways to address SSOs.

Sewer improvements and regulations alone are not enough. SSOs must be addressed at many levels. MWRA and communities must work to develop cost-effective programs to control SSOs. The CSO program is one model for tailoring cost-effective solutions to particular areas. Significant factors contributing to SSOs are denser development, development in formerly "unbuildable" low-lying areas and flood plains, increased impervious surfaces, wetlands loss, and inadequate or improperly designed or maintained drainage systems. All these factors have led to failures of drainage systems, often sending water into sewer systems and resulting in SSOs. Impervious surfaces must be reduced, zoning laws changed, and drainage systems improved to decrease the amount of storm runoff and overflows.

I/I Task Force

Mission Statement:

"The I/I Task Force will develop goals and implementation strategies that will reduce Infiltration/Inflow to optimize local regional sewer service. The Task Force will make recommendations for cooperative implementation of the goals and strategies by local communities, MWRA, DEP, EPA, and others."



A sewer overflows into Smelt Brook

An I/I Task Force has been formed to address I/I issues. Representatives from local communities, state and municipal agencies, and environmental groups hold open monthly meetings to work on strategies for implementing the group's goals,which are to:

- eliminate all sewage backups into homes;
- minimize health/environmental impacts of sewage overflows;
- remove all inflow sources (and prevent new ones);
- minimize infiltration;
- educate and involve the public; and
- develop minimum operation and maintenance standards.

The Task Force will make policy recommendations to MWRA in the year 2000, which will be used in part to form the basis of a new MWRA I/I reduction strategy.

AIR POLLUTION

Atmospheric deposition is a significant source of many contaminants in rivers, lakes, and estuaries. For example, most of the mercury contamination found in water comes from the air. There is increasing evidence that a large portion of pesticides, toxic organic chemicals, and nutrients ending up in water comes from the air.

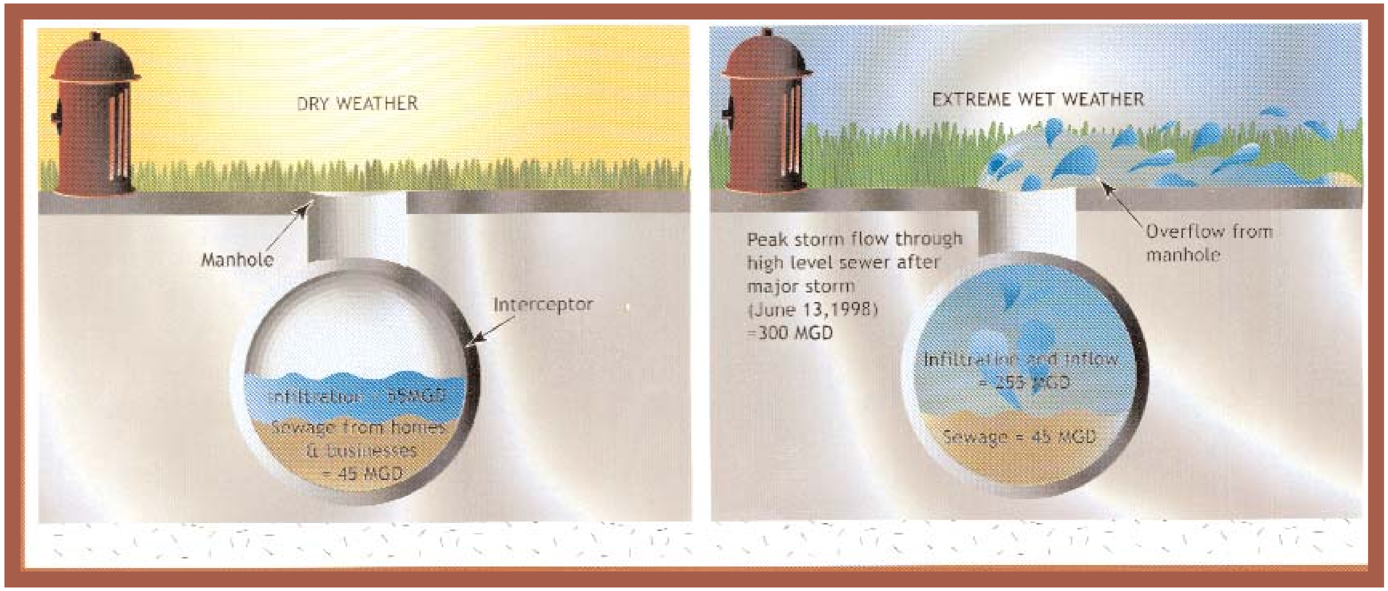


FIGURE 20. A sanitary sewer overflow (SSO): An interceptor overflows in extremely wet weather

Pollutants in air directly settle out into waterbodies during dry weather; rainfall and snowfall can also bring pollution. The effects of air pollution on water quality must be better understood and managed at all levels. Most airborne pollutants are products of combustion from industries, vehicles, and residences, but some pollutants, like pesticides, have a very complex land-water-atmospheric cycle. More research and monitoring are needed to better understand which contaminants and what proportion of water pollutants come from the air. We also need to identify the sources and learn whether they are local or from other regions of the world.

WATER USE AND WATER BALANCE PROBLEMS

Water quality problems are compounded when withdrawals of water from wells, rivers, and lakes for drinking and other uses lead to water quantity problems. For example, as waterways begin to dry up, concentrations of pollutants increase. In MWRA's service area, some communities withdraw local water supplies from local water sources but discharge wastewater to the regional sewer system (and ultimately to the ocean). This "interbasin transfer" may result in a net loss of water within a river basin.

More scientific research is needed to increase our knowledge of how human activities on the land and air affect water quality, water quantity, and the ecosystem. Better data, including better measurements of river flow, are needed to help answer questions such as, "What is the relative impact of interbasin transfer of water compared to excess water withdrawal and increasing development?"

To complement regional projects, residents and businesses must support community efforts to improve local infrastructure and encourage sustainable development practices that reduce harmful runoff. Decreasing runoff and permitting more water to absorb into wetlands and groundwater are critical steps in addressing water balance problems.

A willingness to incorporate an integrated understanding of the relationships between water resources, human communities, and the natural ecosystem is necessary to ensure that our health will be better protected when we swim, fish, or eat shellfish; that our waters will support natural, diverse wildlife; that we will have plenty of pure water for drinking, and that the beauty of our rivers, wetlands, ponds, and harbors will be preserved.

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Rex, A. C. and M. S. Connor. 1997. The State of Boston Harbor 1996: questions and answers about the new outfall. Boston: Massachusetts Water Resources Authority. Report ENQUAD 97-05. 28 p.

Related Web Sites

MASSACHUSETTS WATER RESOURCES AUTHORITY

www.mwra.com

STATE & FEDERAL

Mass. Executive Office of Environmental Affairs (EOEA)
www.magnet.state.ma.us/envir

MDC beach water quality
www.magnet.state.ma.us/mdc/harbor
or www.shore.net/shore/beach/quality

EPA Office of Water
Atmospheric deposition
www.epa.gov/owow/oceans/airdep

EPA Region 1
www.epa.gov/region1

USGS Stormwater Study of Charles River
ma.water.usgs.gov/charles_river/loads

ADVOCACY GROUPS

The Boston Harbor Association
www.tbha.org

Charles River Watershed Association
www.crwa.org

Mystic River
www.cee.tufts.edu/mystic

Neponset River Watershed Association
www.neponset.org

Save the Harbor/Save the Bay
www.tiac.net/users/shsb