

Massachusetts Beaches and Rivers: Where the People Meet the Water

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Abstract

MWRA's innovative, collaborative region-wide Long-Term Control Plan (LTCP) sought to reduce all CSOs within MWRA's tributary system, including those permitted to Boston Water and Sewer Commission and Brookline, Cambridge, Chelsea and Somerville. Through the implementation of 35 major construction projects, 40 of the original 86 CSO outfalls in the MWRA's system have been closed, with 30 of the remaining 46 CSOs meeting LTCP goals. 93% of the remaining combined sewage receives screening and disinfection. Of the remaining 16 outfalls, there are six outfalls that present significant challenges, potentially requiring substantial and costly system modifications to achieve LTCP goals. Even with these remaining challenges, the results of MWRA's and the CSO communities' efforts are an irrefutable success. In 2021, the water quality of the Charles River Lower Basin was rated as "B" and the freshwater reach of the Mystic River was rated "B+". The greater harbor has rejuvenated itself and is swimmable, even during rain events. The Boston area beaches are now considered the cleanest urban beaches in the country. It is truly an environmental success story.

Keywords: Boston Harbor, Charles River, Mystic River, Neponset River, CSO, overflow, sewer separation, water quality

1. Introduction/History

Over the course of the last three decades and beyond, MWRA and its member communities have undertaken various projects aimed at controlling the discharge of combined sewer overflow (CSO). These dedicated efforts have brought about a remarkable transformation in the conditions of Boston Harbor, its tributary rivers, and the beaches in the Boston area. Back in the 1980s and even earlier, combined sewer overflows used to occur regardless of the weather conditions, even during dry spells, leading to significant pollution of the harbor, rivers, and beaches. Figure 1 shows a typical CSO discharge from that time. At that time, Boston Harbor earned the unfortunate reputation of being labeled the "Dirtiest Harbor in the Country." Moreover, the beaches frequently failed to meet bathing standards for more than half of the swimming season. The Charles River's lower basin also received a disappointing Water Quality Report Card Grade of "D"

(Levy & Connor, 1992). However, the collective efforts over the years have brought about significant positive changes.

In 1982, the City of Quincy filed a civil lawsuit against the MDC (Massachusetts Department of Conservation and Recreation) and other state agencies, alleging violations of the Mass Clean Water act due to the discharge of untreated and partially treated sewage from Nut and Deer Islands. Following this, in 1983, the Conservation Law Foundation initiated an enforcement case, which was later taken up by the U.S. Environmental Protection Agency (EPA) in 1985. The case involves several parties, including the Commonwealth of Massachusetts, the Boston Water and Sewer Commission, and the Town of Winthrop.

The existing treatment facilities at that time were in a deteriorated and outdated state, leading to unreliable operations and non-compliance with the requirements of the EPA's Clean Water Act. As a consequence of these issues, the Massachusetts Water Resources Authority (MWRA) was established in 1985 (MWRA, 2023).

The Court's Orders outline the prescribed timelines for activities aimed at achieving legal compliance. Since 1985, MWRA has successfully met 420 milestones, including the construction of advanced wastewater treatment facilities at Deer Island. These facilities effectively treat wastewater from 43 communities in the Metropolitan Boston area. The obsolete treatment facility in Quincy has been replaced with a new headworks facility and tunnel system, redirecting wastewater to Deer Island, and managing sludge in Quincy. Additionally, the Orders have directed the planning, refinement, and implementation of 35 CSO construction control projects over the course of several decades.

MWRA's initiative to control CSOs commenced in 1987 as part of the Boston Harbor Case (U.S. v. M.D.C., et al., No. 85-0489 MA). Under the initial CSO stipulation (First CSO Stipulation), MWRA assumed responsibility for devising and executing a comprehensive plan to manage CSOs linked hydraulically to its wastewater system. This encompassed CSO discharges from MWRA's own outfalls as well as those permitted and managed by entities like the Boston Water and Sewer Commission (BWSC) and the cities of Cambridge, Chelsea, and Somerville. MWRA's CSO efforts encompassed projects to eliminate dry weather overflows and the formulation of a recommended CSO control plan, known as the Long-Term Control Plan (LTCP). The Court Order included a total of 184 CSO-related milestones as detailed in the AECOM Task Report 2021 (AECOM, 2021)

The LTCP included performance goals for CSO activations and volumes, as well as goals for attainment with water quality standards. In 1998, when EPA and DEP issued their initial approvals of MWRA's 1997 recommended CSO plan, DEP also issued water quality standards determinations for some of the CSO affected water segments, and issued CSO variances for others. This brought the plan into compliance with state water quality standards. Table 1 below shows current water quality standards classifications established by DEP for the waters covered by the MWRA's LTCP. As indicated in the table below, the applicable water quality standards for the waters affected by the LTCP include Class B, Class SB, Class B_(CSO), Class SB_(CSO), and Class B (CSO Variance). Class B and Class SB waters are, respectively, inland and coastal/marine waters designated as a habitat for fish, other aquatic life, and wildlife, and for primary and secondary contact recreation. Water meeting Class B or SB standards indicate that the water is "fishable and swimmable." CSO discharges to Class B and Class SB waters are prohibited primarily to protect beaches and shellfish beds (AECOM, 2021).

DEP did not change the Class B designations for the Charles River and the Alewife Brook/Upper Mystic River at the time determinations were made for other receiving waters, but instead issued water quality standards variances to Class B standards for the impacts from CSO. DEP has since issued a series of multi-year CSO variances that allow MWRA and the CSO communities to continue to discharge CSO to these waters, while CSO control projects were underway through 2015 and continuing while the plan's performance was under evaluation and next steps are being determined. In accordance with agreements MWRA reached with EPA and DEP in 2006 and 2019, DEP reissued, and the EPA approved, the Charles River and Alewife Brook/Upper Mystic River CSO variances through August 2024 (MassDEP, 2019a; MassDEP, 2019b).

The variances apply only to the permitted CSO outfalls to the Alewife, Mystic, and Charles receiving waters and do not otherwise modify Class B water quality standards. The variances authorize limited CSO discharges to these receiving waters subject to conditions in the variances. Each variance extension, including the variances currently in effect, acknowledges that it would not be feasible to fully attain the Class B bacteria criteria and associated recreational uses for these receiving waters within the variance period.



Figure 1. Typical sewer overflow discharging to beach in 1980s (MWRA, 2004-2015)

Table 1. Water Quality Standards and Required Levels of CSO Control

Water Quality Standard Classification	Receiving Water Segment	Required Level of CSO Control
Class B	Neponset River	CSO prohibited (25-year storm control for the South Boston beaches in North Dorchester Bay)
Class SB	North Dorchester Bay South Dorchester Bay Constitution Beach	
Class B _(CSO)	Back Bay Fens	>95% compliance with Class B or SB (“fishable/swimmable”)
Class SB _(CSO)	Mystic/Chelsea Rivers Confluence Boston Inner Harbor Fort Point Channel Reserved Channel	Must meet level of control for CSO activation frequency and volume in the approved Long-Term Control Plan (LTCP)
Class B (CSO Variance)	Alewife Brook Upper Mystic River Charles River	Class B standards sustained with temporary authorizations for CSO discharges as the LTCP is implemented and verified. (1998-2024)

Source MA DEP 314 CMR:4.00 & AECOM (2021)

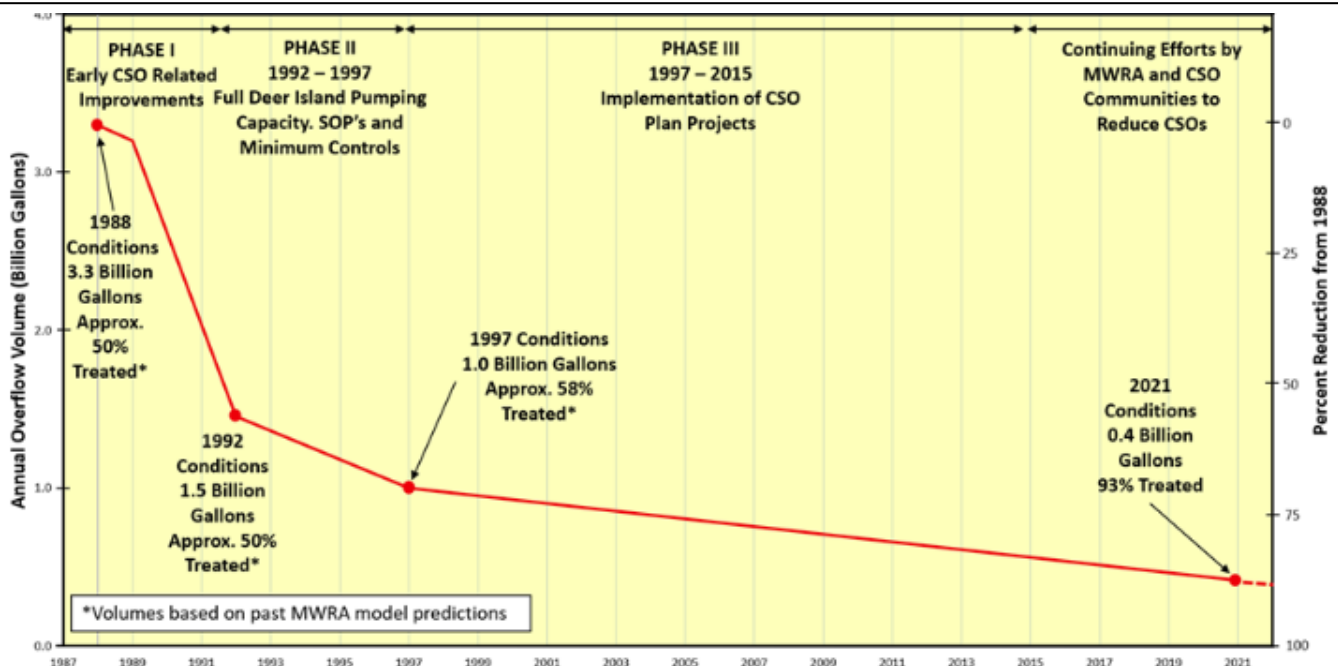


Figure 2. Impact of CSO Control Plan on System Wide CSOs (Somerville, 2023)

2. Accomplishments

2.1 CSO Projects

Since 1987, CSO discharges have been reduced from an estimated annual discharge of 3.3 billion gallons of Combined Sewer Overflows (CSOs) to the harbor and rivers in the late 1980s to 414 million gallons by the end of 2021, an 87% overall reduction with 93% of those remaining discharges treated (Figure 2). Further reductions continue through MWRA and CSO community work, with current CSO discharges estimated at 404 million gallons.

Most of the 35 projects were major undertakings involving the construction of new or improved CSO control and treatment facilities, interceptor relief, or extensive sewer separation, much of which was in historic, densely developed residential and commercial areas. In addition to the design and construction work, the projects also required extensive coordination with landowners, permitting agencies, transportation authorities and neighborhood residents. In some of the project areas, construction impacts were significant and unavoidable, and the collaboration, support and patience of residents and business owners should not be overlooked in understanding the effort borne by many parties to bring these projects to completion and achieve their benefits.

To accomplish the monumental task of designing and constructing 35 diverse projects within less than 20-year period (1996-2015), MWRA required a collaborative approach relying on assistance of its member communities. Memoranda of understanding (“MOUs”) and financial assistance agreements totalling \$412 million, with BWSC, the Cities of Cambridge, Somerville and Chelsea and Town of Brookline were established, where each municipality agreed to implement the projects within the Long-Term Control Plan involving facilities that would be owned and operated by each community, such as the new storm drain systems that would be constructed in sewer separation projects (Figure 3). MWRA agreed to fund the “eligible” costs, the costs of work to construct the facilities necessary to attain the long-term level of CSO control at each outfall. The MWRA and community CSO control efforts included the management of 125 contracts, including 82 construction contracts, 33 engineering contracts and 10 planning and technical support contracts.

Although meaningful and effective investments were made in CSO reductions throughout MWRA’s tributary systems, larger projects were targeted to eliminate CSO discharges and improving water quality where the most recreating and environmental benefit could be realized. The work completed has eliminated CSO discharges to sensitive receiving waters (swimming and shellfishing), including the beaches of South Dorchester Bay and Neponset River (Savin Hill, Malibu and Tenean beaches) and Constitution Beach. For the South Boston beaches (North Dorchester Bay), MWRA’s CSO storage tunnel provided a 25-year storm level of CSO control and a 5-year storm level of separate stormwater control. The most expensive project in the LTCP at a total cost of \$270 million, the North Dorchester Bay CSO Storage Tunnel/South Boston CSO Storage Tunnel included

a 17 MG storage tunnel, odor control facilities, pump station and sewer separation. Figure 4 highlights the CSO construction activities in North Dorchester Bay and South Boston.

For decades, combined sewer overflows discharged about 21 times a year at six outfalls along South Boston beaches. This project eliminated CSOs to these beaches, except in a catastrophic storm event. Stormwater drains also discharged to the South Boston beaches every time it rained - about 95 times a year. No CSO discharges and only 5 stormwater releases have occurred since the facility’s commissioning in 2011. Now, these beaches meet water quality standards most days, and are considered some of the cleanest urban beaches in the country. Figure 5 highlights the improvements to water quality at Carson Beach in South Boston.

MWRA, BWSC, the City of Cambridge and the Town of Brookline installed over 100 miles of new storm drain and sewer pipe mostly as part of separating 4,300 acres of combined area, substantially reducing the volume of stormwater requiring collection and treatment. Figure 6 shows a typical sewer separation area for the City of Cambridge.

Cambridge undertook the construction of a remarkable storm drain system designed to transport nearly 280 acres of separated stormwater to a newly created 3.4-acre wetland within the Alewife Brook Reservation (Figure 7). This impressive green infrastructure project offers 10.3 acre-feet of storage capacity, effectively mitigating the impact of heightened stormwater flow rates on the Little River and Alewife Brook. The innovative Alewife stormwater wetland project received esteemed recognition, winning the National Recognition Award in the 2014 Engineering Excellence Awards competition organized by the American Council of Engineering Companies.

The individual project capital costs, covering both design and construction expenses, varied significantly, ranging from under \$100,000 for the Prison Point CSO Facility Optimization to a substantial \$228.4 million for the South Boston CSO Storage Tunnel. When considering community costs, the overall expenditure surpassed \$1 billion.

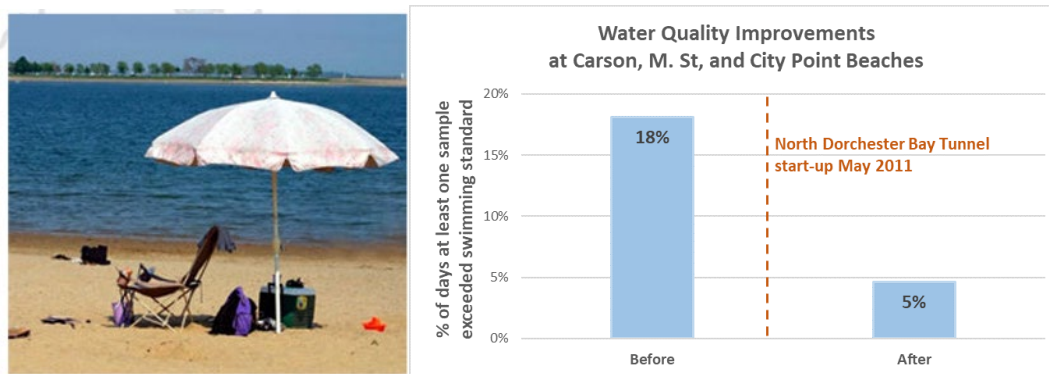
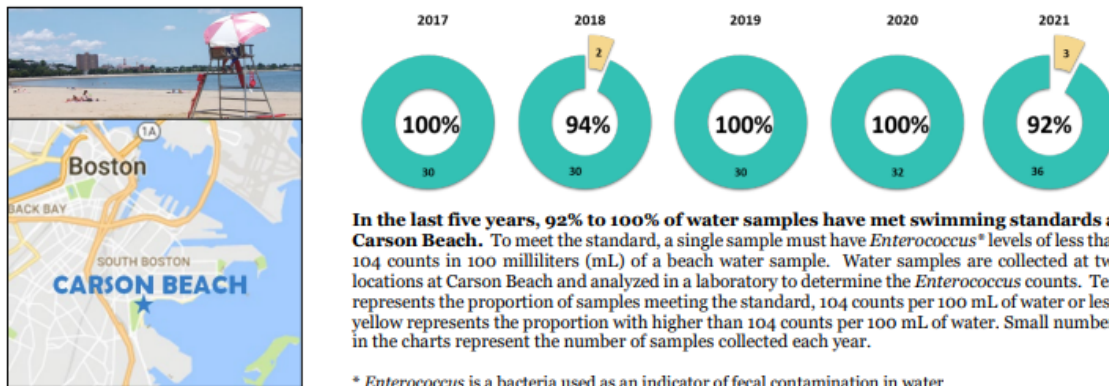


Figure 3. Stormwater drain construction to support sewer separation (MWRA 2004-2015)



Figure 4. North Dorchester Bay / South Boston CSO tunnel construction and facilities (MWRA 2004-2015)

Water quality at South Boston's Carson Beach meets swimming standards nearly all of the time.



Results from DCR swimming season sampling at Carson, M. St, and City Point beaches collected 10-years before and after tunnel commissioning. Any day with at least one sample exceeding 104 *Enterococcus*/100mL is counted for the figure.

Figure 5. Beach water quality improvements resulting from tunnel construction (MWRA 2004-2015)

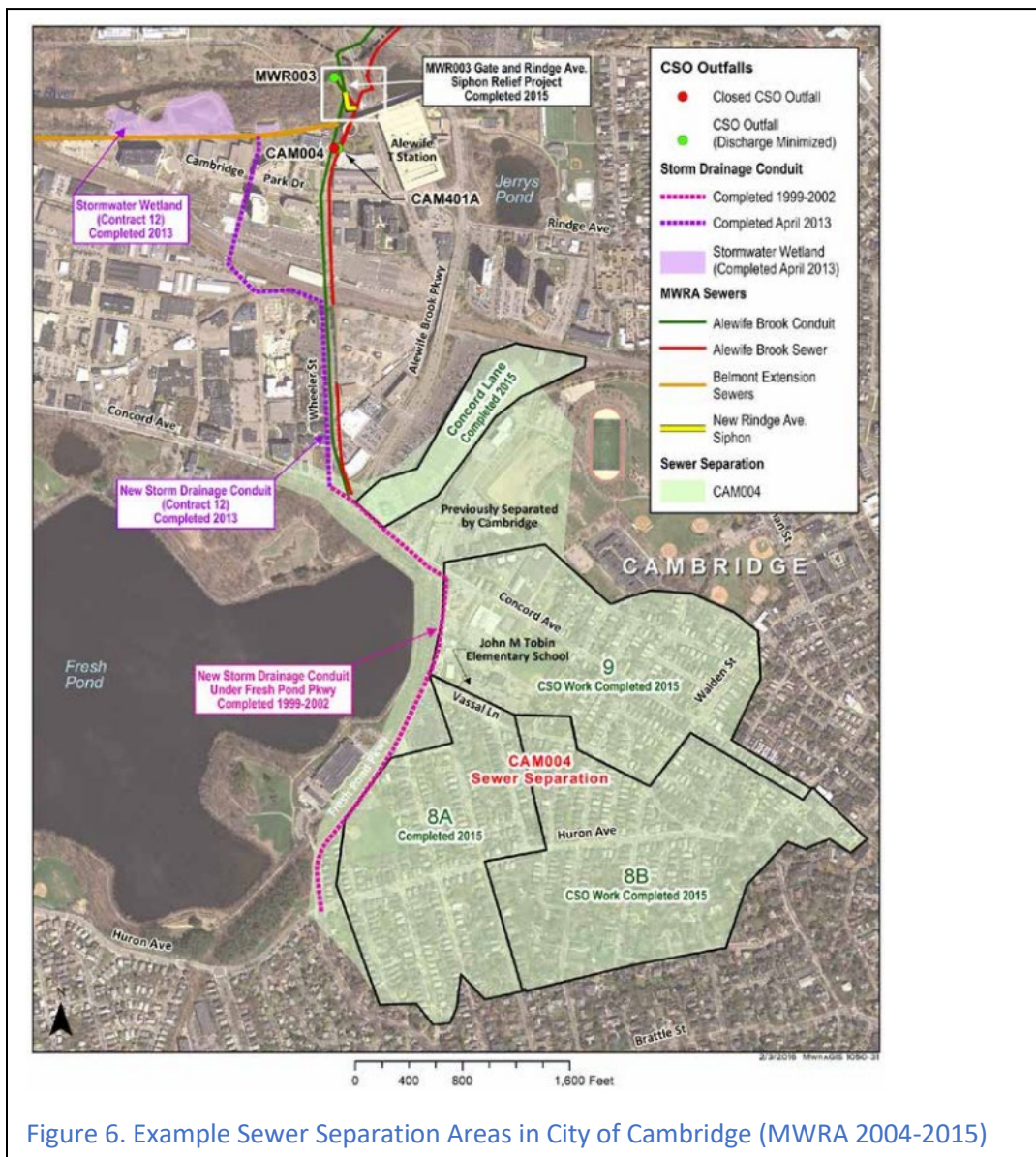


Figure 6. Example Sewer Separation Areas in City of Cambridge (MWRA 2004-2015)



Figure 7. Alewife Brook Reservation constructed wetland (MWRA 2004-2015)

Substantive improvements and upgrades were made to existing CSO treatment facilities that would remain in operation, including improvements to disinfection and dechlorination capabilities.

These 35 projects contributed to the following CSO control accomplishments:

- Permanent closure of 35 of the 86 CSO outfalls that were active in the late 1980s;
- Elimination of CSOs to South Dorchester Bay, the Neponset River, and Constitution Beach through sewer separation;
- Effective elimination (i.e., up to a 25-year storm) of CSOs along the South Boston beaches in North Dorchester Bay and capture of separate stormwater discharges in up to the 5-year storm by the South Boston CSO Storage Tunnel; this project also included re-routing of stormwater outfalls away from Pleasure Bay to the Reserved Channel;
- Decommissioning of three CSO treatment facilities (CSO elimination); treatment and reliability upgrades to three other

- CSO facilities; and construction of the Union Park Detention/Treatment Facility;
- A 98% reduction of CSO to the Little Mystic Channel in Charlestown with the BOS019 Storage Conduit;
 - A 77% reduction of CSO to Alewife Brook through system optimization and hydraulic relief project, as well as a major sewer separation program that included a constructed wetland for stormwater detention and treatment and habitat restoration;
 - Interceptor and hydraulic relief projects that reduced untreated CSOs to the Upper and Lower Inner Harbor by 90% and Mystic/Chelsea Confluence, including Chelsea Creek by 94%;
 - A 97% reduction of CSO to the Charles River through separation projects, hydraulic relief and system optimization measures.
 - A 99% reduction of CSO to the Reserved Channel through major sewer separation efforts.

2.2 Water Quality Improvements

MWRA's environmental monitoring documents the benefits of these significant achievements in CSO control, and the monitoring along with receiving water quality modeling demonstrates that water quality impacts from CSO discharges are small relative to other sources of pollution (Figure 8).

Improvements in the public perception of regional water quality is evident in the renewed focus on water-centric activities and development along Boston Harbor and its tributary waters. The water quality of Boston Harbor, the Charles, Mystic and Neponset Rivers and Alewife Brook has steadily improved as MWRA and the CSO communities completed the CSO projects and as communities along these waters have implemented programs to control pollutant loadings from storm drains.

Implementation of the LTCP has resulted in the elimination of CSO discharges to sensitive receiving waters, for example,

- For the South Boston beaches, MWRA's South Boston CSO Storage Tunnel provides a 25-year storm level of CSO control and a 5-year storm level of separate stormwater control. As a result, beach closings due to high bacteria are infrequent, allowing for swimming on most summer days at all beaches. The tunnel has captured and therefore prevented more than 2 billion gallons of CSO and stormwater from discharging to the beaches since May 2011. In May 2015, The Boston Globe reported South Boston beaches now "boast some of the cleanest waters of any urban beach in America." (Boston Globe, 2023)
- Improvement in the quality of Boston Inner Harbor waters is also seen in the changes to *Enterococcus* bacteria counts from the time period before improvements (1989-1991) to data collected after most improvements described above were completed.

Today, the results of MWRA's and the CSO communities' efforts are an irrefutable success. In 2021, the water quality of the Charles River Lower Basin was rated as "B" and the freshwater reach of the Mystic River was rated "B+." In fact, swimming races

are held in the Charles River and efforts are afoot to reopen a bathing beach. The greater harbor has rejuvenated itself and is swimmable, even during rain events. The Boston area beaches are now considered the cleanest urban beaches in the country. It is truly an environmental success story, and the CSO program has played a critical role.

3. Next Steps

Water quality monitoring data indicates significant improvements in bacteria levels across all weather conditions in the Charles, Alewife, and Mystic Rivers. However, updated receiving water modeling reveals that water quality impacts primarily arise from non-CSO sources, suggesting that CSOs contribute to the E. coli criterion non-attainment less than 0.1% of the time for the Charles River and approximately 2% of the time for the Alewife Brook/Upper Mystic River. These percentages align with the targets set in previous CSO planning efforts.

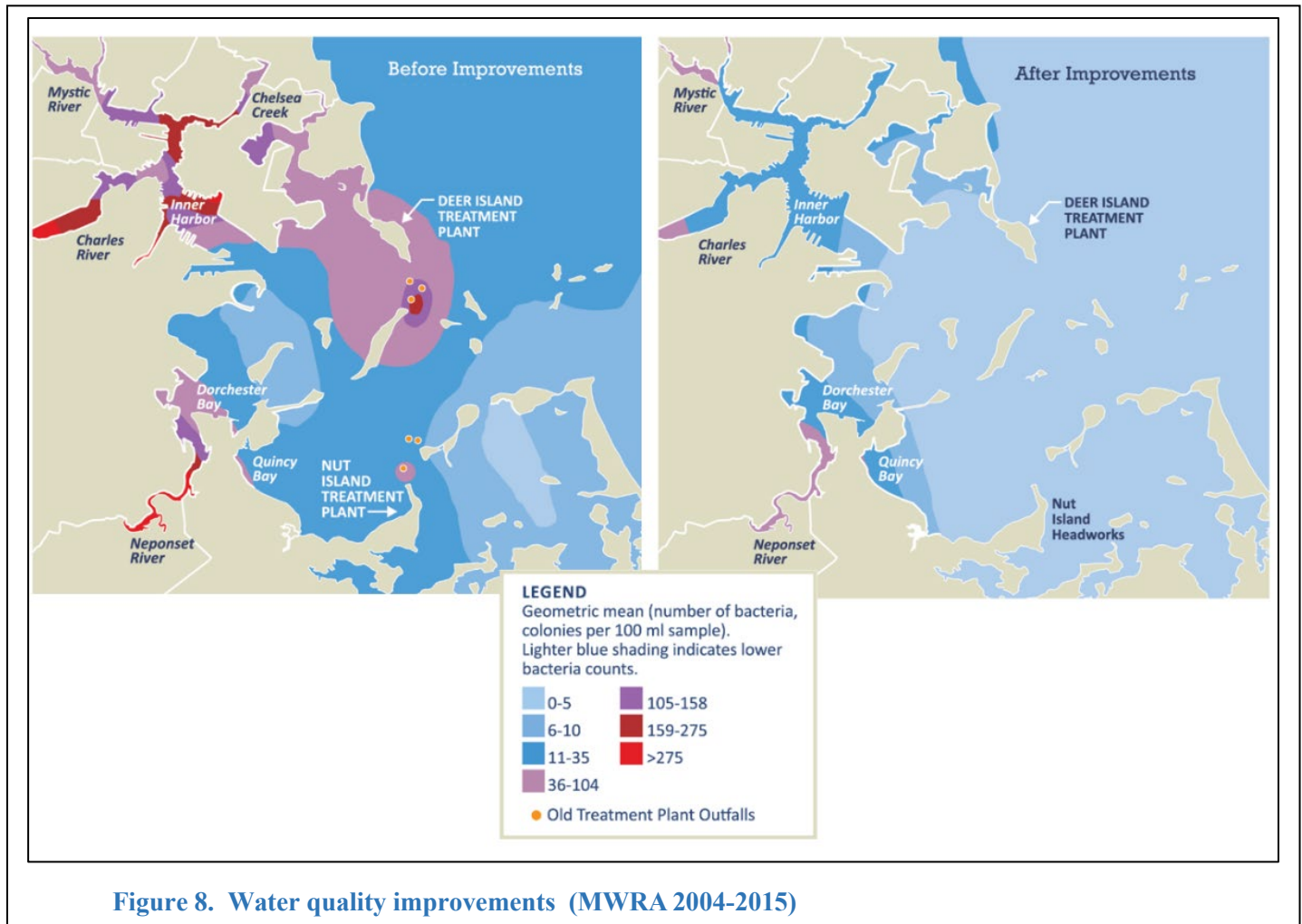
Considerable progress has been made in reducing CSOs, with 40 out of the initial 86 outfalls being closed or effectively managed. Still, there are 46 active CSO outfalls in the MWRA's system, out of which 30 meet the LTCP goals. The remaining 16 outfalls present challenges and may require substantial and costly modifications to achieve compliance with the LTCP goals.

While significant strides have been taken to comply with the court-ordered requirements established decades ago, work remains to be done. Compliance with the Clean Water Act necessitates variances to the Class B waters of the Charles River, Alewife Brook, and Upper Mystic River, as CSOs are otherwise illegal. Updated CSO Control Plans are being developed by MWRA, Cambridge, and Somerville to explore alternatives and further reduce the 16 remaining CSOs. Creative engineering solutions are being sought to address the infrequent CSOs, as traditional methods may prove expensive with limited water quality benefits.

Receiving water modeling highlights that stormwater is the main challenge to bacterial water quality, and the impact of remaining CSOs is relatively small. Additionally, the changing climate, characterized by more intense rain events, requires innovative solutions for CSO and stormwater control to avoid adverse impacts such as flooding and increased pollutant loads from direct stormwater discharges. Future plans aim to analyze both historical rainfall data and climate models to assess rainfall changes in the coming decades, thereby evaluating alternative approaches in terms of their resilience to such changes.

The "easy" fixes (relatively speaking) have been implemented. The challenges ahead require consideration of:

- Green infrastructure, which presents significant challenges in the highly urbanized communities in and around Boston. The balance between parklands, recreational needs, and green infrastructure may be in conflict.



- Climate change and infrastructure resiliency adds additional requirements and costs for CSO control projects. Which climate models and how future projections are incorporated into planning will impact design, space needs, and costs.
- Costs and benefits of additional control may be exceeding the “knee of the curve”, both in terms of cost, and also environmental benefit. Consideration of the goals of the program are needed to better address those concerns and ensure the best use of limited public funds.
- Call to engineering community for innovative solutions.

MWRA is committed to maintaining the reliability of its collection and treatment systems, allocating approximately \$50 million annually to various facility and collection system projects beyond CSO control. Moreover, the four CSO communities continue their efforts to invest in system improvements, contributing to further reductions in CSO discharges in the upcoming years.

Boston Water and Sewer Commission is actively involved in sewer separation work in East and South Boston, while Chelsea continues its sewer separation efforts as part of its master plan. Somerville is engaged in sewer separation and flood control

projects, such as the Union Square and Poplar Street Pump Station project, which will decrease flows to MWRA's system. Cambridge is also undertaking sewer separation projects and flood control improvements.

While striving for maximum water quality improvements, the challenges and costs of further CSO reductions, which have minimal water quality benefit, need to be carefully considered. MWRA's ratepayers across the sewer service area have already invested significantly, totalling over \$1 billion, to eliminate or control CSO discharges, with the objective of safeguarding the environment and public health.

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