FINAL
CSO CONCEPTUAL PLAN
AND SYSTEM MASTER PLAN

EXECUTIVE SUMMARY

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Massachusetts Water Resources Authority

Metcalf & Eddy
An Air & Water Technologies Company

EXECUTIVE SUMMARY

INTRODUCTION

This report presents the final conceptual plan for CSO control, completed by the Massachusetts Water Resources Authority (MWRA or Authority) in compliance with the Federal Court schedule of the Boston Harbor case. The $372 million conceptual plan was developed using a watershed-based approach and differs dramatically from the 1990 CSO Facilities Plan, which proposed a $1.3 billion deep rock storage tunnel for CSO control. The CSO conceptual plan is an integral part of the more comprehensive System Master Plan (SMP), which included the examination of interceptor and transport system needs, infiltration/inflow (I/I) control, and secondary treatment capacity needs to determine the impacts of these strategies on the development of the optimum plan for CSO control.

The overall goal of the SMP was to develop an integrated, system-wide approach to collection and treatment of wet weather flows that would maximize the effectiveness of existing facilities, including the MWRA's new Deer Island wastewater treatment plant, before construction of additional new facilities specifically for controlling or treating CSOs was undertaken. The SMP includes recommendations for CSO control, targeted I/I reductions, interceptor relief projects, required secondary treatment capacity, and other changes to the design and operation of existing and planned facilities in the collection system.

This Executive Summary provides a brief overview of the proposed conceptual plan for CSO control, including its rationale, its costs, and its implementation requirements. The summary of the CSO Conceptual Plan highlights some of the key factors resulting in the new watershed-based approach to CSO control. Summaries of the recommendations for the other strategy areas are also presented. Finally, a summary of the revisions made to the recommended plan, based on comments received on the draft report issued in September 1994, is provided.

The MWRA has made progressive system improvements since 1988, which have resulted in a significant reduction in CSO discharges. Further reductions will occur as the recommendations in the CSO conceptual plan are implemented. Figure ES-1 illustrates the decreasing trend in CSO volumes. Annual CSO volumes have decreased from about 3.3 billion gallons in 1988 to about 1.5 billion gallons in 1992, and are predicted to decrease further to about 1 billion gallons in 1997 and 0.5 billion gallons after full plan implementation in 2010. Along with these decreases, the portion of the CSO flow which is treated will rise to 96 percent.

SUMMARY OF THE CSO CONCEPTUAL PLAN

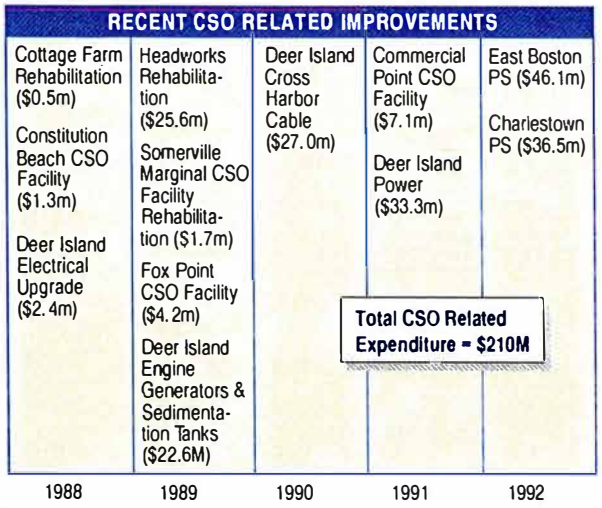
Major Factors Affecting Plan Development

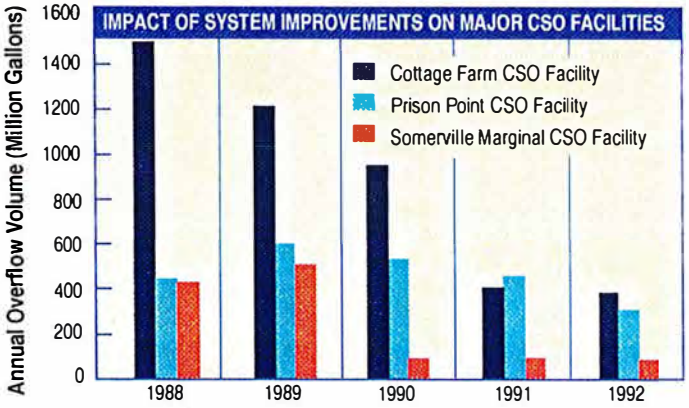
The major factors influencing the significant redirection of approach to CSO control embodied in this plan include:

- Substantially greater understanding of the sewer system
- On-going system improvements
- A watershed-based planning approach
- Evolution of the CSO regulatory framework
- Costs and affordability

Understanding of the Sewer System Operation. Over the last four years there has been remarkable advancement in the Authority's understanding of how wastewater flows in the 43-community system are transported, stored, treated and discharged during both wet and dry weather. In this period, almost 200 flow meters have been installed in the system, yielding a continuous record of the functioning of the transport system, pump stations, and treatment facilities along the MWRA interceptor system. In addition to providing valuable information

FIGURE ES-1. OVERVIEW OF MWRA CSO PROGRAM





CSO CONTROL PROGRAM HIGHLIGHTS

Phase I - Recent CSO Related Improvements

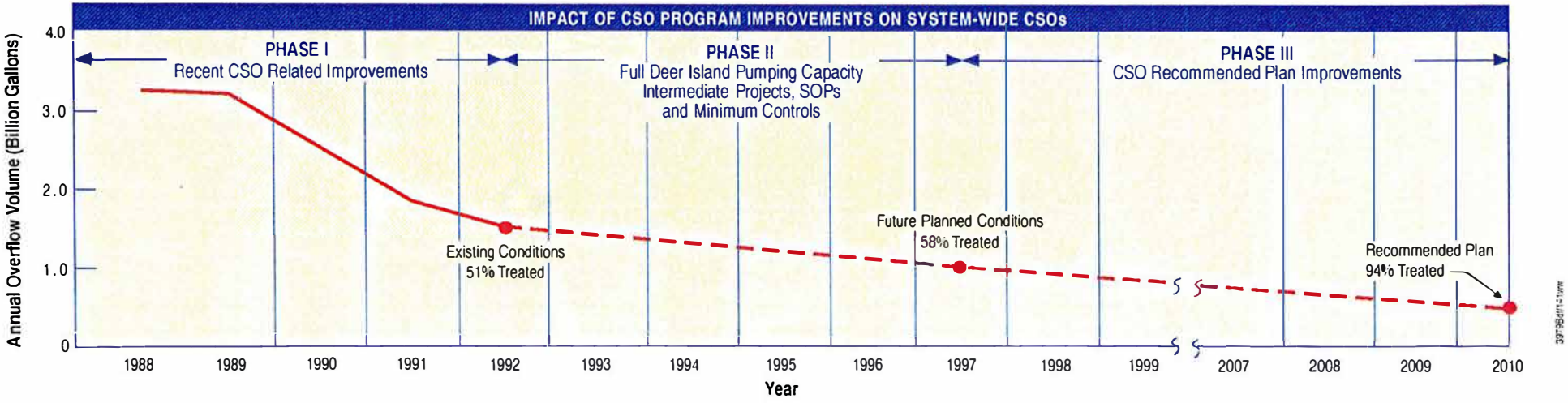
- Investment of over $200 million in CSO related improvements from 1988 to 1992.
- 55% reduction in annual CSO volume between 1988 and 1992 with at least screening and disinfection of over 50% of the CSO volume.

Phase II - Ongoing System Optimization and Improvements

- Due to SOPs, intermediate projects, minimum control implementation and further Deer Island improvements, by 1997 the CSO volume will have been reduced by 70% over 1988, with about 60% receiving at least screening and disinfection.

Phase III - Recommended CSO Control Facilities

- The CSO recommended plan will result in an 84% reduction in CSO volume over 1988 conditions, with 94% receiving at least screening and disinfection.
- Of the 80 CSO discharge locations, 21 will be closed; 16 will discharge treated flow; 28 will discharge untreated flow only 0 to 3 times per year; 13 will discharge untreated flow only 4 to 7 times per year; and 2 will discharge untreated flow only 8 to 10 times per year.



for optimizing system operations, the flow data have demonstrated that the volume of flow actually discharged through CSOs is much lower than previously estimated, and that the volume of flow stored in the interceptor and transport system during storms is much higher than previously estimated. The metering network has provided information on the effects of high tides, which block some outfalls and can substantially reduce overflows from the system during wet weather. It has also allowed quantification and location of the large amount of tidal inflow, which enters the system during high tides and may potentially be eliminated at relatively low expense.

In addition, extensive system inspections and mapping have resulted in an accurate delineation of the many areas of separated sewers. This information, along with the detailed computer model of the system, has been used to develop system optimization plans (SOPs) which alone will reduce total CSO volume by about 15 percent and untreated CSO volume by over 25 percent during the next few years.

On-going System Improvements. As a result of the system improvements already accomplished by the MWRA at total investment of over $200 million, there has been a substantial reduction of about 50 percent in CSO volume between 1988 and 1992, as shown of Figure ES-1. The most dramatic improvement, at the Cottage Farm facility on the Charles River, shows a reduction in CSO flows from 1,500 to about 400 million gallons per year, primarily due to the vastly improved reliability an capacity of the new pumps installed at the Deer Island treatment plant. This trend will continue through 1997, the time by which other on-going improvements will be completed, and when the implementation of this current conceptual plan begins. By 1997, over 50 percent of the CSO discharged to waterbodies will be treated with at least screening and disinfection at currently operational facilities. An overview of the MWRA's CSO program over the last five years and into the future, provides a context for the current planning effort. In developing the conceptual plan for CSO control, completed and on-going projects to maximize delivery of flow to Deer Island, including projects to optimize the storage and transport capacity of the collection system and to reduce infiltration and inflow of extraneous flows into the system were assumed in the definition of

future planned conditions. Future planned conditions were used as the CSO planning baseline, so that the recommended CSO controls would accurately reflect the reduction in CSO volume achieved by other projects.

A Watershed-Based Planning Approach. Nation-wide a recognition is growing that the approach to solving wet weather-induced pollution problems, such as those from stormwater and CSOs, must be generically different than that used over the last twenty years to control dry weather, point source problems. Effective treatment of very high peak, short-duration CSO flows can not be achieved with traditional primary or secondary treatment plants. In addition, wet weather pollution sources throughout the entire watershed, including urban and agricultural runoff, drainage from highways and other transportation facilities, drainage from construction sites, and a host of other sources, combine with CSOs to cause violations of water quality standards. In some cases, the CSO drainage area is a substantial percentage of the total watershed and full control of CSOs will result in significant improvement in water quality and attainment of beneficial uses. In other cases, the opposite is true. For watersheds in which CSO pollutant load is a small percentage of the total load, the high cost to control certain CSO pollutants may not result in measurable improvement in water quality or attainment of beneficial uses.

The MWRA has made a concerted effort to use a watershed-based approach in the present CSO control planning effort. A watershed approach allows integration of important factors into the planning process such as:

- Physical characteristics of the waterbody: access for swimming, shellfishing and boating; hydrodynamics (flushing, dispersion, depth, velocity, etc.); wet and dry weather flow conditions; other supporting or conflicting uses; riparian land uses; and aesthetics.

- Characteristics of the watershed: land uses and the proportion of pollution loads from various sources.

- Basin-wide water quality, existing water uses, critical water uses, water quality standards and the compatibility of uses and standards from segment to segment.
- The number of towns and other governing institutions in the watershed.
- The actual water quality benefits and costs associated with CSO control options.

Consideration of these factors under a watershed approach has led to differing conclusions about appropriate CSO control for various receiving waters. In Dorchester Bay, critical uses, watershed characteristics, waterbody characteristics, and achievable water use benefits justify a very high level of CSO control. In contrast, in the Charles River, consideration of the same factors, including the multiplicity of governing institutions and the numerous sources of pollution in the large 350 square mile watershed, makes control of bacteria and floatables an appropriate recommendation for this waterbody at this time. The annual volume of CSO discharge from the Cottage Farm CSO treatment facility will be reduced to about 100 million gallons per year following implementation of the recommended plan. Higher levels of CSO reduction at very high costs are not supported, since no, or very little, water quality benefit would result.

Given the water quality conditions, uses and relative contribution of pollutants from CSO, the Authority believes that its recommended CSO plan for the Charles River Basin is the most appropriate plan. The Authority also believes, however, that long-term watershed planning efforts that encompass all pollution sources and responsible parties, together with the successful implementation of programs that achieve real reductions in non-CSO pollution, may in the future warrant further CSO control measures for the Charles River.

Evolution of the CSO Regulatory Framework. Coincident with the above factors has been the evolution of state, EPA Region I and national EPA CSO policies over the last four years. The 1989 EPA CSO Strategy provided a general impetus to CSO enforcement and planning efforts. Unfortunately, it had three shortcomings:

- It provided very little specific guidance to permit writers or permittees on critical issues related to wet weather pollution control, such as how to modify state water quality standards to allow for anything other than sewer separation as a viable CSO control alternative.

- It provided little flexibility in consideration of control alternatives.

- It provided no consideration of a community's financial capability.

Over the last three years, EPA developed the recently issued national CSO policy. The new EPA policy addresses the above shortcomings and provides a framework from which reasonable CSO control plans can be developed. As the MWRA undertook its CSO planning effort, the new federal policy provided very important confirmation of the method used for CSO alternatives evaluation and of the Commonwealth's process for review and revision of water quality standards to reflect wet weather factors in CSO control.

Costs and Affordability. It is clear that the cost of the recommended CSO plan proposed herein will result in substantial relief to MWRA ratepayers. Although new EPA guidance on financial capability is yet to be released, it appears evident that the CSO plan will be "affordable" based on the median household income for the service area. Projected sewer rates in communities served by the MWRA nevertheless remain among the highest in the country and, unlike more demographically homogeneous service areas, the range of incomes in the MWRA's 43 communities result in rates that are unaffordable for a large number of households.

These factors have led to serious and demonstrated concern by area ratepayers, as voiced by the MWRA Advisory Board, and a correspondingly serious consideration of water quality benefits in relation to cost for CSO control was required. The MWRA believes that the recommended CSO conceptual plan will achieve an aggressive level of CSO reduction that is consistent with realistically attainable improvements in water quality at an affordable level of capital expenditure.

Recommended Plan for CSO Control

The recommended plan is the result of technical and economic analyses, site investigations and a series of workshops that were held throughout the spring and summer of 1994. It results from CSO and system master planning efforts conducted by the Authority over the last two and one-half years, which are substantially documented in several reports prepared in support of the plan. Table ES-1 is a summary of the key features, cost and performance of the conceptual CSO control plan. Workshop participants included staff from the MWRA Advisory Board, the MWRA Wastewater Advisory Committee (WAC), the U.S. Environmental Protection Agency (EPA), the Massachusetts Executive Office of Environmental Affairs (EOEA), the Massachusetts Department of Environmental Protection (DEP), the Metropolitan Commission (MDC), the CSO communities (Boston, Cambridge, Somerville, Chelsea), watershed associations, and other groups, as well as staff from various departments within the Authority. At the workshops, participants used a number of criteria, including water quality improvement, hydraulic performance, environmental and construction impacts, and public acceptability to evaluate, rate and rank a series of system-wide alternatives and achieved general consensus on overall waterbody goals, CSO control levels, and methods of control. Cost, based on the MWRA's Life Cycle Cost Analysis policy, and siting requirements also were considered. Alternatives that included complete elimination of CSOs system-wide also were developed. Costs for the range of alternatives varied from $132 million to $1.7 billion.

With one exception, the recommended plan involves separate CSO controls for each receiving water segment, rather than a system-wide solution. The exception is a screening and disinfection facility on the Reserved Channel that would handle consolidated overflows from both the Reserved Channel and North Dorchester Bay. Otherwise, the plan includes a variety of controls, such as interceptor relief, upgrading of existing CSO storage and treatment facilities, sewer separation, and new screening and disinfection facilities. The recommended CSO control plan takes into account the effects of projected infiltration/inflow (I/I) reductions and recommended interceptor improvement projects, resulting from detailed

TABLE ES-1. RECOMMENDED CONCEPTUAL CSO CONTROL PLAN

Critical Uses in Parentheses

Basins	Level of Control	Recommended Plan	Annual CSO Activation Frequency(1) Fut. Planned Conds. Total	Fut. Planned Conds. Untreated	Recommended Plan Total	Recommended Plan Untreated	Reasons/Comments	Capital Cost (million $) (2)
Dorchester Bay								
N. Dorchester Bay (Swimming/Shellfishing)	I	CSO relocation to Reserved Channel	78	78	0	0	1. Eliminates CSOs to North Dorchester Bay; potential for SA designation 2. Relocated flow to Reserved Channel to receive screening and disinfection	$86
S. Dorchester Bay (Swimming/Shellfishing)	I	Sewer separation	22	1	0	0	1. Eliminates CSOs; potential for SA designation 2. Interim upgrade of existing facilities 3. Potential for use of Fox and Commercial Point CSO facilities for stormwater treatment by others	$95
Neponset River (Shellfishing)	I	Sewer separation	17	17	0	0	1. Eliminates CSOs 2. Requires separation of South Dorchester area also	$11
							Subtotal -- Neponset River/Dorchester Bay Subareas:	$192
Constitution Beach (Swimming/Shellfishing)	I	Sewer Separation	16	0	0	0	1. Eliminates CSOs; potential for SA designation 2. Critical use area; potential for use of CSO Facility for stormwater treatment by others.	$9
							Subtotal -- Constitution Beach Subarea:	$9
Charles River								
Upper Charles River	II	Screening and disinfection at CAM005; relieve interceptor connection at BOS032; provide screens at five CSO outfalls in Boston and Cambridge.	12	12	10	4	1. High recreational uses; heavy stormwater impact on Charles River 2. Reconsider after watershed planning; separation cost of $60 million	$5
Lower Charles River -- Cottage Farm	II	Upgrade of Cottage Farm CSO Facility with fine screens, effluent diffuser, upgrade chlorination, provide dechlorination	22	0	18	0	1. High recreational use; heavy stormwater impact on Charles River	$7
-- Stony Brook	II	Screening and disinfection facility for Stony Brook Conduit flows	30	30	26	0	1. Heavy stormwater impacts on Charles River 2. Treats stormwater and CSO from Stony Brook basin 3. Reconsider after watershed planning with State	$24
-- Other Lower Charles	II	Provide screens at nine CSO outfalls; block regulators at BOS042 and MWR010	6	6	3	3	1. Minimum control; infrequent outfall activation	$1
Back Bay Fens	II	Provide screens at outfall	2	2	2	2	1. Consistent with water quality goal	
							Subtotal -- Charles River Subarea:	$37
Alewife/Upper Mystic								
Alewife Brook	II	Separate CAM002, CAM004, and SOM001; provide screens at eight CSO outfalls	16	16	4	4	1. Approximately four overflows per year; large stormwater impacts 2. Reevaluate in conjunction with watershed planning by state	$12
Upper Mystic River	II	Separation of baffle manholes at SOM006 and SOM007 Continue treatment at Somerville Marginal CSO Facility (SOM007A)	11	2	8	0	1. Large stormwater impacts 2. No WQ benefit for higher controls	$0.2
							Subtotal -- Alewife/Upper Mystic Subarea	$13
Boston Harbor								
Upper Inner Harbor	II	Relieve East Boston Branch Sewer; add dechlorination to existing Prison Point CSO Facility; screen and disinfect BOS019; provide screens at seven CSO outfalls	36	36	25	5	1. Approximately four overflows per year from E.Boston; Industrial/shipping water uses 2. Allows full use of Caruso Pump Station capacity 3. Large impacts from stormwater and Charles R. discharge	$23
Lower Inner Harbor	II	Relieve East Boston Branch Sewer; provide screens at five CSO outfalls	29	29	5	5	1. Approximately four overflows per year from E. Boston	$20
Mystic/Chelsea	II	Screening/disinfection at BOS017 and at relocated Somerville Marginal CSO Facility; interceptor relief for CHE002-CHE004; provide screens at five CSO outfalls; repair/replace CHE008 outfall	35	35	31	3	1. Industrial/shipping water uses and Mystic R. discharge impacts 2. Dissolved oxygen deficit near existing Som. Marginal facility outfall	$12
Reserved Channel	II	Consolidation to regional screening/disinfection facility (joint with North Dorchester Bay)	44	44	6	0	1. High commercial/industrial use 2. Receives relocated CSO from N. Dorchester Bay	$34
Fort Point Channel	II	Detention treatment facility at Union Park P.S.; Consolidation storage at 072/073; screens at six CSO outfalls, three regulators, and the DBC; In-line storage in Dorchester Brook Conduit	74	74	15	4	1. Separation infeasible; aesthetics important 2. High commercial / industrial use	$26
							Subtotal -- Boston Harbor Subareas:	$115
							Total -- All Subareas:	$368
							Facilities Planning:	$6
							Grand Total:	$372

(1) For receiving water segments with multiple CSO outfalls, activation frequency is for the most active outfall tributary to the receiving water segment.
(2) Capital cost includes engineering, construction and contingency.

hydraulic analyses of the entire MWRA sewerage system. Implementation of the recommended CSO plan, along with I/I and interceptor projects, will not significantly alter design flows and loads to the new Deer Island secondary treatment plant.

As shown in Table ES-1, the plan calls for partial sewer separation in the Alewife Brook receiving water segment. For the Charles River Basin, construction of a new screening and disinfection facility to treat CSO and stormwater flows in the Stony Brook Conduit and upgrading of the existing Cottage Farm CSO Facility are recommended. In these two areas, more extensive CSO controls were not warranted at this time because of the dominance of non-CSO sources of pollution, which would negate any real water quality improvement from higher levels of CSO control. Additional controls may be appropriate for these waterbodies in the future, if comprehensive watershed planning provides the impetus for substantial control of stormwater and other non-CSO pollution sources by other parties.

Watershed planning initiatives in river basins tributary to Boston Harbor, including the Charles River and the Neponset River, have been initiated by various parties. The Charles River planning effort is supported by EOEA, DEP, EPA, MWRA, and a broad range of environmental and business interests. The CSO Conceptual Plan could be revised in the future to re-evaluate the CSO control recommendations for the Charles River Basin, if watershed planning efforts can define if, how and when the control of other pollution sources will be achieved, and how funding, institutional and enforcement requirements can be met.

The following paragraphs summarize the re-evaluation of deep rock tunnel alternatives and describe the recommended plan and the CSO reduction/water quality improvement and siting requirements associated with it.

Re-evaluation of Tunnel Alternatives. Using more accurate flow information, a re-evaluation of a system-wide tunnel comparable to the 1990 plan concluded that a system-wide tunnel is not justified because it would provide very minor, if any, additional water quality benefits compared to the recommended plan, yet would carry a very high cost ($1,050

million). A smaller tunnel to serve only the Charles River also is not justified, because of the small contribution of CSOs relative to other pollution sources in the watershed and the high cost ($770 million). Such an option could be reconsidered in the future when, and if, major basin-wide reductions in other pollution sources are made.

An evaluation also showed that increasing tunnel storage capacity to provide peak-shaving flow storage and to allow a reduction of secondary treatment capacity at Deer Island would not be cost-effective, even if a tunnel for CSO control were to be recommended. The incremental cost of a larger CSO tunnel for peak-shaving would be about $200 million more than the cost of comparable secondary treatment capacity, or the cost of using chemically enhanced primary treatment.

CSO Reduction/Water Quality Improvement. In general, the recommended plan focuses on the control of bacteria and floatables to increase swimming, shellfishing, and aesthetic/recreational uses of waterbodies. Improvement of these uses through control of bacteria and floatables is measured by reduction in the annual frequency of untreated combined sewer overflow events, as well as the reduction in loading of these parameters. The plan includes limited near-surface storage of CSO at two of the existing CSO treatment facilities and new storage facilities in certain other basins where CSO flows are a major percentage of the total flow to the waterbody. The recommended plan involves:

- Elimination (closure) of CSOs discharging to critical use (swimming and shellfishing) water (Dorchester Bay, Neponset River estuary, and Constitution Beach).
- Reduction of untreated overflows (about 4 per year remaining) in other waterbodies.
- Upgrade of three existing CSO treatment facilities (Cottage Farm, Prison Point and Somerville Marginal). The other three existing CSO facilities (Commercial Point, Fox Point and Constitution Beach) will be decommissioned.

In most waterbodies, it was found that pollutants other than bacteria and floatables, such as biochemical oxygen demand (BOD), total suspended solids (TSS), and nutrients, were not the major cause of CSO-related water quality problems. For most of the waterbodies where these pollutants may cause water quality problems, it was determined that non-CSO sources, such as stormwater and upstream river flows, were the dominant contributors of these pollutants. The Fort Point Channel and the Reserved Channel are exceptions to this finding.

State water quality standards require a "partial use" designation for waterbodies with any remaining CSO discharge. Under the recommended plan, the Dorchester Bay, Neponset River, and Constitution Beach receiving water segments will not require a partial use designation because of the elimination of CSOs to these receiving waters. In the remaining receiving water segments, partial use designations will be required. If the plan is accepted, the state regulatory process necessary to change water quality standards to add partial use designations will be initiated in early 1995.

Facility Site Requirements. Much of the plan involves sewer separation and upgrading of existing CSO treatment facilities, and therefore, involves minimal new site requirements. Requirements for new sites include the following locations, where new screening and disinfection facilities and one detention/treatment facility are recommended.

- For Stony Brook overflows, use of the existing MDC Fens Gatehouse at Storrow Drive and Charlesgate East or an alternative site in the vicinity of the Ward Street Headworks.
- For Reserved Channel overflows, acquire a site in the industrial area along East First Street.
- For Fort Point Channel overflows, use of part of the Union Park Pump Station site or acquire a site in that vicinity for a detention/treatment facility.
- For an overflow to the Little Mystic Channel (BOS 019), acquire a small site on the west side of the channel.

- For overflows to the Charles River, acquire a site in Cambridge along Memorial Drive near Mt. Auburn Hospital.

- For a Lower Mystic River overflow, a site for relocation of the Somerville Marginal CSO facility is required. The relocation is necessary because of the planned re-construction of I-93. Selection of a new site will be done in conjunction with the highway relocation.

- For overflows to the Mystic/Chelsea Confluence, acquire a small site in Charlestown near outfall BOS017.

Proposed Implementation Schedule. A proposed implementation schedule for the recommended CSO plan has been developed. In summary, the plan will require approximately 15 years for full implementation. Key factors affecting the schedule include:

- Site selection and acquisition. In some cases, legislative transfers under Article 97 of the Massachusetts Constitution may be required.

- Requirements for amending the Massachusetts water quality standards to obtain partial use designations.

- Requirements for facilities planning and environmental review through the Massachusetts Environmental Policy Act (MEPA) process, and permitting for various construction activities.

- Phasing of extensive neighborhood projects, such as sewer separation in Dorchester and the Neponset River area.

- Constraints and uncertainties imposed by the Central Artery project in South Boston and the Fort Point Channel area; and the construction of I-93/Exit 29 improvements in Somerville affecting the Somerville Marginal CSO facility.

- Discussions with the CSO communities regarding implementation responsibilities, coordination of efforts and construction phasing.

Because the current recommendations are at a conceptual level, there remain numerous assumptions upon which the schedule is based. Following further discussions with the Court parties, the final implementation schedule may include a provision to allow full review and

modification of the schedule, as necessary, following facilities planning and environmental review, in order to reflect appropriate changes resulting from those efforts.

SUMMARY OF I/I REDUCTION PROJECTIONS

The I/I reductions identified in the SMP are based on the review and analysis of extensive data and on various assumptions regarding the effectiveness of I/I rehabilitation measures. The I/I evaluation process assumed that I/I projects currently planned under the MWRA's Local Financial Assistance Program would be implemented, and the levels of I/I control evaluated as part of the SMP represented reductions above and beyond those anticipated to be achieved by the current projects.

An I/I control plan was developed which represented an aggressive level of system-wide I/I reduction (20 percent infiltration reduction and 51 percent inflow reduction), but hydraulic assessments showed that even a high level of I/I removal did not significantly impact the cost or sizing of CSO, interceptor, or treatment options.

Based on these results, community specific, cost-benefit relationships were developed to attempt to discern a cost-beneficial level of I/I control. These relationships generally did not exhibit a clear cost-beneficial point and suggested that even if I/I rehabilitation was prioritized to address the more extreme areas first, costs would increase relatively uniformly as higher levels of control were pursued.

Based on the results of both evaluations, it did not appear that there would be a cost trade-off between I/I control and other strategy areas, and a clearly cost-effective level of I/I control could not be determined. However, a level of I/I reduction was assumed and included in the hydraulic analyses of CSO, interceptor, and secondary treatment strategies, since factors such as aging community sewer trunk lines and laterals, and increasing community costs (both in

terms of MWRA flow-based charges and local costs for transporting wastewater) will continue to motivate communities to take steps to control I/I. More aggressive I/I reductions are anticipated to occur in those portions of each community's collection system that have higher infiltration and inflow rates, although most of the systems can be characterized as having only moderately high infiltration and inflow rates.

The anticipated I/I reductions consist of a 9.8 mgd reduction in peak infiltration, which represents four percent of the 247 mgd peak infiltration total. A similar percentage reduction applied to average annual infiltration of 181 mgd represents a reduction of 7.2 mgd. The estimated cost of this infiltration reduction is $97 million.

Inflow reductions were assessed based on the one-year, 6-hour storm prescribed for use in I/I evaluations by DEP. Reductions in direct inflow volume on the order of 9.1 mg, or five percent of the 168 mg four-day inflow volume associated with the one-year, 6-hour storm are predicted. The estimated cost of this inflow reduction is $15 million. In addition, 4.3 mg reduction in indirect inflow would occur as a result of the pipeline rehabilitation performed to achieve the 9.8 mgd peak infiltration reduction.

The infiltration and inflow reductions outlined, at a total cost of $112 million, will impact CSO volumes, interceptor surcharging, and treatment plant flows, as presented below. This information confirms that the level of I/I control expected to be implemented will not impact the cost or sizing of CSO, interceptor, or treatment plant options.

Parameter	Future Planned Conditions	I/I Reduction in SMP	Percent Reduction
CSO Volume, mg	151	150	1
Surcharged Interceptor Junctions[1]	1,246	1,244	0
Predicted Overflow Volume, mg[2]	14	13	7

(1) This parameter reflects the number of nodes (junctions) within the hydraulic model at which interceptor surcharging occurred. It provides a relative measure of the extent of surcharging throughout the system under future planned versus aggressive I/I reduction conditions.

(2) Predicted overflow volume represents the volume of wastewater predicted to overflow from manholes within the MWRA interceptor system at non-CSO locations.

SUMMARY OF INTERCEPTOR RECOMMENDATIONS

The interceptor improvements recommended in the SMP are based on analyses of the hydraulic operating characteristics of the interceptor network for future planned condition flows and system configuration, including reductions in I/I and interceptor network changes currently planned to be completed. The basis of flow for these assessments included peak sanitary flow, peak infiltration, and inflow corresponding to a one-year, 6-hour storm event. A test storm used in the hydraulic model was timed so its peak rainfall intensity would coincide with maximum hour sanitary flow.

Hydraulic gradients and system configuration were assessed to determine interceptor reaches that require relief, had potential for in-system storage during peak flow conditions, or might be conducive to the transfer of flow from hydraulically overloaded to under-utilized segments. Cost and non-monetary considerations also were identified and assessed.

A total of 15 interceptor relief projects are included in the recommended plan. Two of the recommended projects (Cummingsville Branch Sewer and Upper Neponset Valley Sewer) are

INTERCEPTOR RELIEF PROJECTS

Interceptor Designation	Priority of Relief	Improvement Description
Mystic Valley Sewer Section 160	A	Replace 4,250 ft. of existing 1.25 ft. dia. sewer with new 2 ft. dia. sewer. (Upper end of Mystic Valley Sewer into Woburn.)
Wakefield Trunk Sewer Sections 49, 50	A	Replace 11,886 ft. of existing 1 ft., 1.25 ft and 1.5 ft. dia. sewer with new 2 ft. dia. sewer. (Through Melrose Center to Wakefield line.)
Millbrook Valley Sewer Section 84	A	Replace existing 110 ft. siphons (one 12 in. dia. and two 21 in. dia.) with two 24 in. dia. siphons under Mill Brook near Arlington Reservoir.
Revere Branch Sewer Sections 61 & 62	A	Install 3,112 ft. of 4.5 ft. dia. relief sewer parallel to existing 4 ft. dia. sewer. Install 3,500 ft. of 4 ft. dia. sewer parallel to existing 4 ft. dia. sewer. (Sewer extends from Chelsea Screen House along Eastern Ave. and Crescent Ave., essentially to Mill Creek.)
Chelsea Branch Sewer Sections 11, 56 & 57	A	Replace 3,040 ft. of 2.08 x 3 ft. sewer and 1,175 ft. of 3.5 ft. dia. sewer with 4.5 ft. dia. sewer. Replace 1,500 ft. of 3.5 ft. dia. sewer with 4 ft. dia. sewer and 2,715 ft. of 2.75 ft. dia. sewer with 3.5 ft. dia. sewer. (Sewer extends along Eastern Avenue, Cabot St., under Northeast Expressway to Everett.)
Somerville/Medford Branch Sewer Section 35	A	Replace 6,250 ft. of 32 in. x 28 in., 36 in. and 42 in. dia. sewer with new 48 in. sewer. Parallel 2,700 ft. of existing 40 in. x 48 in. sewer with new 54 in. dia. sewer. (This sewer extends from Sullivan Square area just west of I-93 along Mystic Ave. to Medford.)

INTERCEPTOR RELIEF PROJECTS (Continued)

Interceptor Designation	Priority of Relief	Improvement Description
Cummingsville Branch Sewer Section 47	A	Replace 4,500 ft. of existing 15 in., 18 in. and 20 in. dia. sewer with new 30 in. dia. sewer. Drop upstream invert to balance flow with Cummingsville Branch Relief Sewer. (The sewer extends along Sylvester Ave. onto Middlesex St. and through a wetland, onto Linden St. and Lake St.)
Reading Extension Sewer Section 72	A	Replace 1,162 ft. of existing 1.67 ft. dia. sewer with new 2.5 ft. dia. sewer. (Existing sewer runs along river and crosses Hill St.)
Upper Neponset Valley Sewer Section 28, 29 and 30	A	Replace 17,500 ft. of existing 15 in. thru 45 in. x 46 in. sewer with new 30 in. to 42 in. sewer. (Existing Sewer runs through Baker St. Cemetery, crosses Baker St.; St. Joseph Cemetery, MBTA Commuter Rail tracks and continues along the Charles River).
Upper Neponset Valley Sewer and Neponset Valley Sewer Section 15-21	A	Replace 17,300 ft of existing 48 in. x 50 in. thru 54 in. x 56 in. with new 54 in., 60 in. and 66 in. dia. sewer, including Upper Neponset Valley Sewer improvements. (Neponset Valley Sewer runs along River St. to Business St. crosses RR tracks, parallels Neponset River back onto River St.).
Cambridge Branch Sewer Section 23, 24, & 25	B	Install 4,935 ft. of 6 ft. dia. relief sewer parallel to existing 6.76 ft. diameter sewer. (Interceptor branches out from North Metropolitan Sewer, extends along Broadway (Route 99) to Charlestown Pump Station).
Edgeworth Branch Sewer Section 20A	B	Replace 1,530 ft. of existing 2 ft. dia. sewer with new 3 ft. dia. sewer. (Sewer branches off North Metropolitan Sewer west of the Malden River).

INTERCEPTOR RELIEF PROJECTS (Continued)

Interceptor Designation	Priority of Relief	Improvement Description
Malden Branch Sewer Sections 65 & 66	B	Replace 2,630 ft. of existing 1.5 ft. dia. sewer with new 2 ft. dia. sewer. (Existing sewer runs along Broadway between Taylor and Salem St.).
Lexington Branch Sewer Section 52	B	Replace 2,200 ft. of existing 1.5 ft. dia. sewer with 2 ft. dia. sewer. (Sewer runs along Lewis Ave onto Franklin to Hamlet to Mystic Valley Parkway to Decatur St.).
North Metropolitan Trunk Sewer Sections 44, 45, & 46	B	Replace 2,300 ft. of existing 1.25 ft. dia. sewer with new 2 ft. dia. sewer. Replace 4,384 ft. of existing 2.46 ft. dia. sewer with new 3.5 ft. dia. sewer.

currently in facilities planning, so an estimated cost for these projects was not included in the total cost. The estimated capital cost for the other 13 recommended interceptor relief projects is $35 million.

Certain interceptor relief projects are designated as having implementation priority A, which is the highest priority based on potentially serious surcharging predicted during the one-year, 6-hour storm and peak flow conditions. For gravity flow pipelines, surcharging is an indication that the pipeline, or a pipeline downstream of it, likely has insufficient capacity to convey the flow which is tributary to it. This could result in back-ups into community sewers.

Interceptor relief projects designated as priority B are predicted to surcharge under the peak flow conditions, but to a lesser degree than priority A projects. Based on the MWRA's criteria that interceptors should be capable of handling the flow from a one-year, 6-hour

storm under peak flow conditions without surcharging, these interceptors still require relief. Some other interceptor relief projects located within the CSO area of the MWRA system, upstream of pump stations or headworks that function as choke points under wet weather conditions were identified. Surcharging in these interceptors is generally related more to the downstream choke points than to insufficient pipeline capacity. Even if these interceptors were relieved, the downstream choke points would likely still result in surcharging. These interceptor relief projects were assigned priority C and are not recommended as part of the SMP.

The SMP also does not include recommendations for interceptor storage or flow transfer projects. A detailed analysis of the interceptor network indicated that significant in-system storage potential existed only in the South System or downstream of CSOs in the North System, so that no potential for cost-effective reduction of CSO flows through interceptor storage or flow transfer was identified. Analyses also showed that the available storage volume was not great enough to reduce secondary treatment capacity. Evaluation of two potential flow transfer projects to transfer flow during wet weather conditions from the North System to the South System, upstream of the Ward Street Headworks indicated that the flow transfers would not be cost effective compared to other CSO control alternatives.

SUMMARY OF SECONDARY TREATMENT RECOMMENDATIONS

SMP planning included a critical review of the secondary treatment capacity required at the Deer Island treatment plant in the context of the CSO control, I/I reduction, and interceptor improvements. This review was coordinated with the on-going reassessment of secondary treatment capacity being conducted under contract DP-29 by MWRA's Program Management Division. Key evaluation factors and criteria in the review included updated flows and loads, impacts of CSO, I/I, and interceptor strategies, review of process design criteria and estimates of effluent quality.

Annual average flows and loads were used to size various treatment processes and to assess typical plant performance. Maximum 30-day and 7-day flow values were used for sizing certain processes and to assess whether the effluent quality resulting from these flows and loads and alternative process configurations would meet permit limits for the effluent discharge. The annual average flow was derived from a year-long model simulation of a typical rainfall year. The maximum flows were derived by simulating the severe hydrologic conditions that occurred during the spring of 1993, which represents a critical design period. Annual average and maximum loads were developed by adding load associated with increased flow to historical annual loadings.

These flows and loads were used to assess the performance of four secondary treatment alternatives:

- Two Battery Secondary (540 mgd secondary treatment capacity)
- Two Battery Secondary plus Chemically Enhanced Primary Treatment (CEPT) (540 mgd secondary treatment capacity)
- Two and two-thirds Battery Secondary (720 mgd secondary treatment capacity)
- Three Battery Secondary (810 mgd secondary treatment capacity)

A series of analyses were performed for each alternative to assess the operational characteristics of the primary and secondary process, sizing of residuals facilities, anticipated effluent quality and a comparison to potential permit limits, and to estimate each alternative's cost savings potential.

The SMP analysis concluded that from 720 to 810 mgd of secondary treatment capacity would be needed. This corresponds to between two and two-thirds batteries and three batteries, based on the present plant design. Preliminary estimates of potential costs savings for the required capacity range from $120 million to $147 million.

The "Final Draft Recommended Plan for Completion of the Deer Island Facilities," prepared by the DP-29 consultant, recommends a minimum secondary treatment capacity of 710 mgd in order to meet all permit standards. This conclusion was reached by performing a statistical flow blending analysis that predicted effluent quality during time periods when the secondary treatment unit capacity is exceeded. To provide for plant symmetry and provide an additional layer of operating safety, DP-29 recommended construction of the complete third battery for a capacity rating of 780 mgd, 70 mgd above the base recommendation.

The potential for a minor TSS violation was predicted for the 3 battery alternative in the SMP analysis. The DP-29 study included provision of a polymer system to aid the settling process during high flow periods and to provide a level of safety to avoid permit violations for TSS in particular. With the provision of the polymer system for use during peak events, the SMP analysis and the DP-29 study both predict no permit violation with a 3-battery secondary treatment plant.

SUMMARY OF REVISIONS TO THE DRAFT CSO CONCEPTUAL PLAN AND SYSTEM MASTER PLAN

The draft CSO Conceptual Plan and System Master Plan was submitted to the Court parties and available for public review on September 30, 1994. The Authority received numerous comments on the draft report and conducted further technical evaluations of the recommended CSO alternatives. This section summarizes the changes and refinements made to the recommendations, as well as other enhancements made to the report in response to the comments received.

Changes to Recommended Facilities and Project Costs

South Dorchester Bay

Backwater from the Columbus Park Headworks was identified as a potential source of continued regulator activation in the BOS088 and BOS090 systems following sewer

separation. It may be necessary to hydraulically isolate the southern Dorchester Interceptor area from the Columbus Park Headworks to allow closure of all BOS088 and BOS090 regulators without risk of flooding during extreme storm events. This issue will be further evaluated in facilities planning.

Upper Charles

The previously proposed screening/disinfection facility at CAM009 will be replaced with manually cleaned screens, since CAM009 is predicted to activate only once in the typical year.

The previously proposed screening/disinfection facility at BOS032 will be replaced by a project to enlarge the interceptor connection. With the larger interceptor connection, BOS032 is not predicted to activate during the one-year storm.

Lower Charles

An alternative site for the screening/disinfection facility for the Stony Brook Conduit flows was identified in the vicinity of the Ward Street Headworks. Locating the facility upstream of BOS046 will provide treatment for the overflows at BOS046, as well as allowing more contact time for disinfection of flows before discharge at MWR023.

Alewife Brook

The following projects will be added to the previously recommended sewer separation work at CAM004:

- Sewer separation upstream of CAM002. This work is necessary to reduce the annual activation frequency of CAM002 from nine overflows per year to about four.

- Separation of common manholes upstream of SOM001. The relatively low-cost project will allow the elimination of SOM001 as a CSO outfall.

Upper Mystic

Outfall SOM006 has been identified as a potentially active CSO outfall. The scope of work in the Upper Mystic area has been expanded to include locating this outfall, and separating common manholes upstream of the outfall, if necessary.

Upper Inner Harbor

The previously proposed storage facility at BOS019 has been replaced by a screening/disinfection facility. The incremental change in water quality between

screening/disinfection and storage did not justify the increase in cost. In addition, the screening/disinfection facility would require less space, and would be easier to site.

Mystic/Chelsea Confluence

The previously recommended screening/disinfection facilities at BOS014 and CHE008 will be replaced by screens only, as the activation frequency of these outfalls will be about four overflows per year.

The previously recommended replacement of the Somerville Marginal CSO facility with a storage facility has been changed to replacement with a screening/disinfection facility, which would include dechlorination. (The facility must be relocated due to the relocation of I-93). The potential water quality benefits of a storage facility did not justify the additional costs.

A project to repair/replace the CHE008 outfall pipe has been added, based on comments received regarding the poor condition of the existing outfall.

System-Wide

Manually cleaned bar screens will be added at all outfalls that will remain, but where more extensive CSO controls are not required.

Summary of Cost Changes

	ESTIMATED COST (Millions)	
	Draft	Revised
Dorchester Bay	$185	$192
Constitution Beach	9	9
Charles River	36	37
Alewife/Upper Mystic	3	13
Boston Harbor	141	115
Facilities Planning	--	6
	$374	$372

A cost of $6 million has been added to the program costs to account for facilities planning.

General Text Revision/Additions

The Final CSO Conceptual Plan and System Master Plan has improved upon the draft report with the following additions to the text.

- The discussion of water quality benefits of the recommended plan by receiving water segment has been expanded.
- The discussion of watershed planning has been expanded, and now includes recent information from the EOEA and the Charles River Watershed Association.
- An outline of the requirements and process for obtaining partial use designation and a summary of information within the CCP/SMP document which supports the application for a partial use designation is included.
- The implementation plan and schedule has been revised based on comments received and subsequent discussions with MWRA.