Integrated Wet Weather Management in the Lower Charles River: Balancing CSO, Stormwater, Upstream Loads, and Water Quality Standards

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Agenda

Overview of MWRA CSO Program – Dave Kubiak

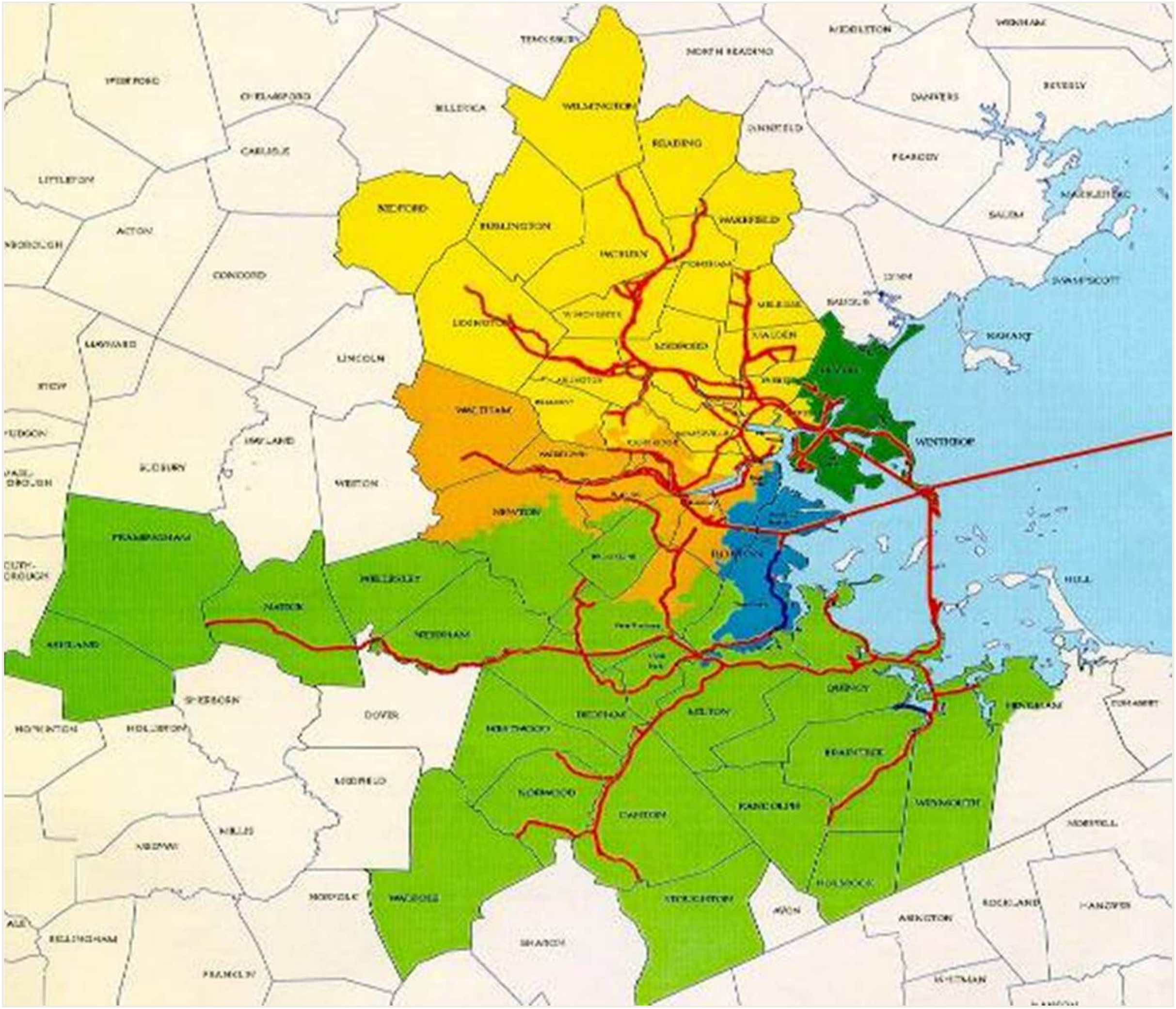
- MWRA collection system
- Early improvements
- CSO planning approach
- Approved LTCP

Challenges in the Lower Charles River Basin – Dan Donahue

- Background and benefits of early improvements
- Balanced approach for incremental CSO control
- Water quality variance process
- Conclusions

MWRA Sewer System

- Wholesale provider of water and sewer services
- 2.5 million served
- 43 sewer system communities
- Deer Island treatment plant – 1,270 mgd capacity
- 4 communities have CSOs – Boston, Cambridge, Somerville, Chelsea



Federal Court Order – Federal Clean Water Act

First CSO Stipulation: On February 27, 1987, MWRA assumed responsibility for LTCP for all outfalls hydraulically related to its system, including community outfalls

Second CSO Stipulation: On April 27, 2006, the Court accepted MWRA's final LTCP and limited MWRA's CSO obligations to the LTCP scope until 2020. If attainment verified, MWRA then responsible only for its own permitted outfalls

Schedule Seven: Adopted July 2006; includes approximately 150 milestones from 1987 to 2020 for planning, design and construction of long-term CSO control

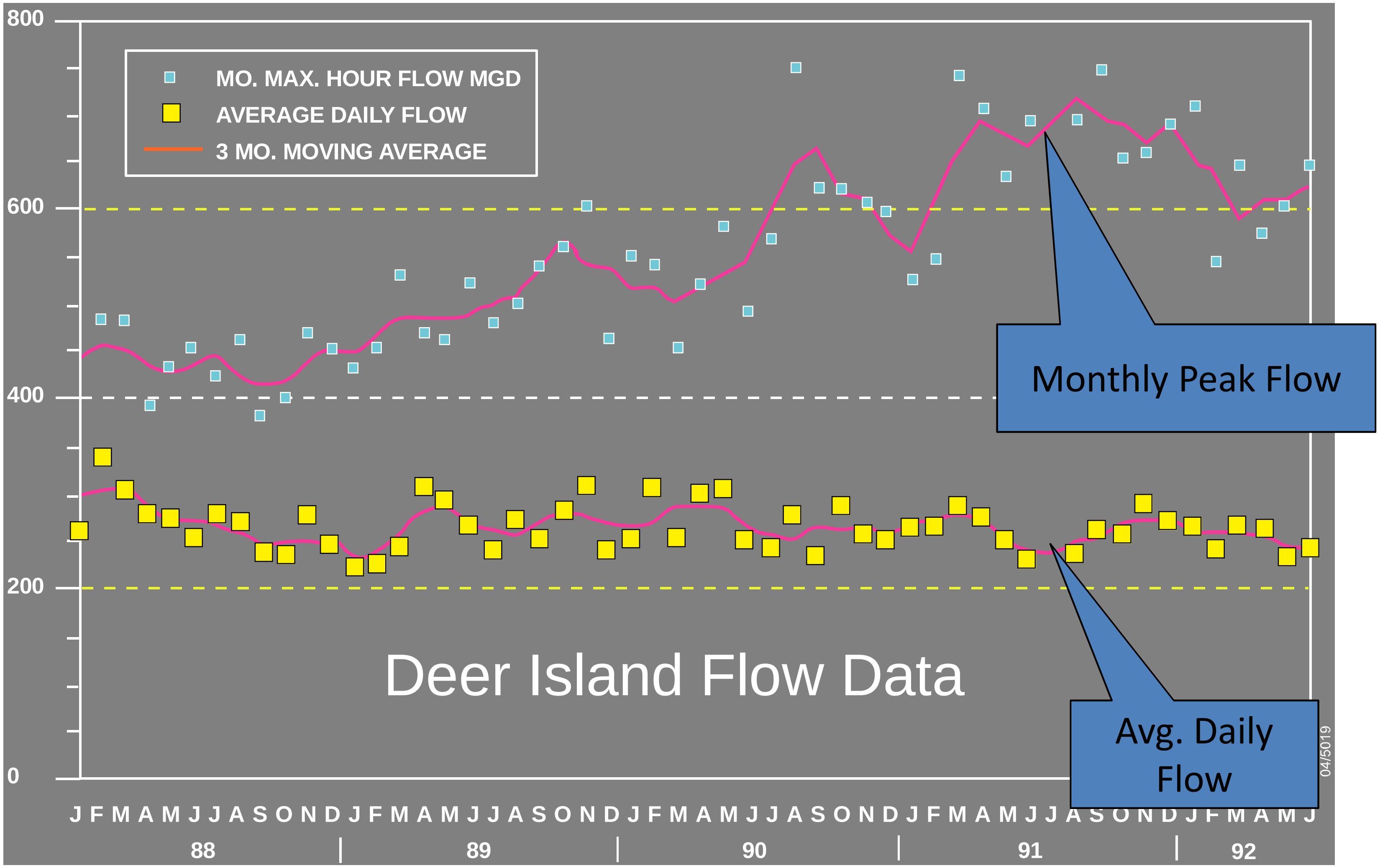
CSO Conditions 1987

- 84 permitted CSOs
- Thousands of discharges per year, including dry weather overflows
- Over 3 billion gallons of CSO discharge annually

Transport and Treatment Upgrades

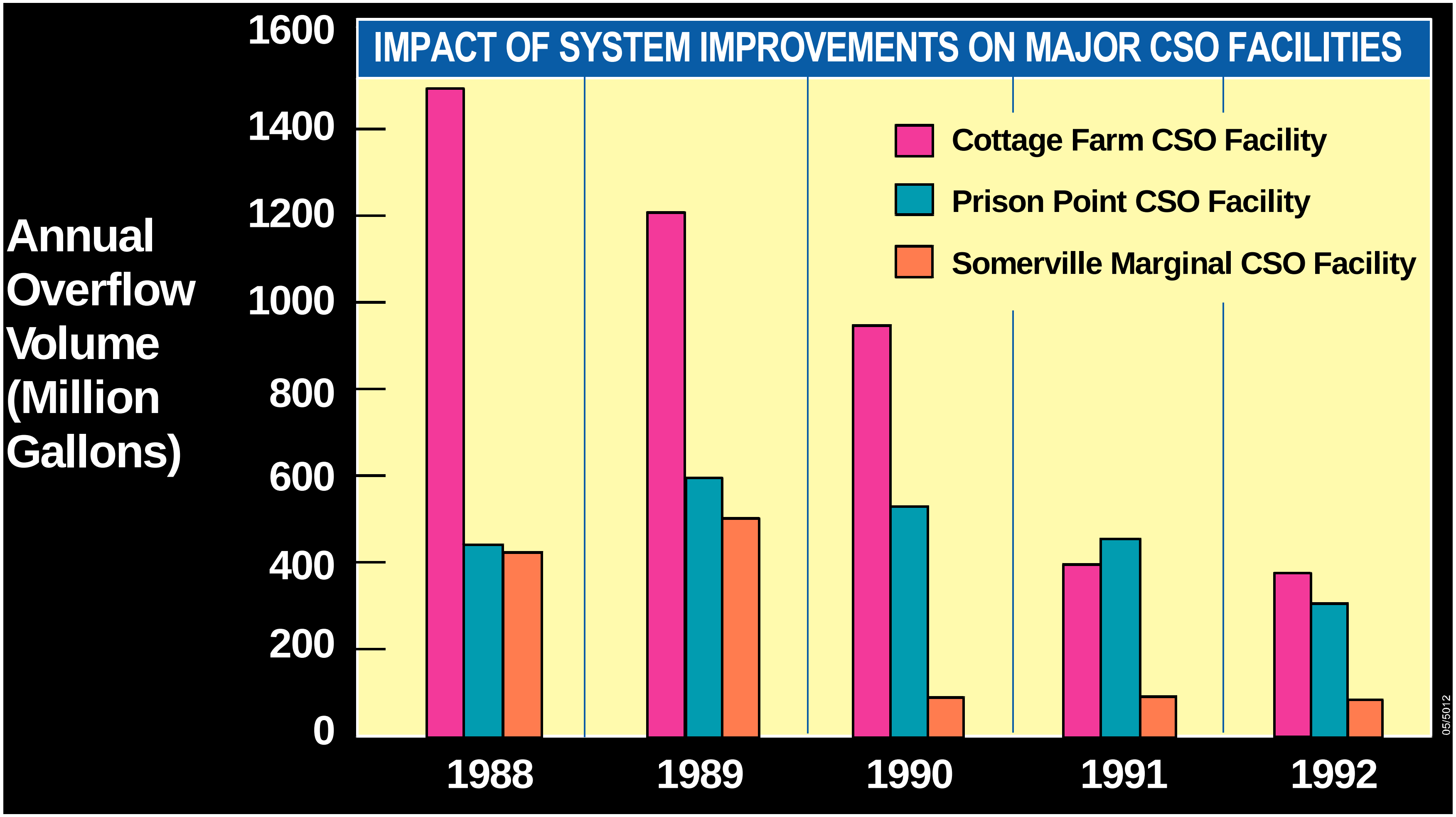
- Remote pumping station upgrades
- Headworks upgrades
- Treatment plant pumping upgrade
  - 84% capture of combined sewage

Deer Island Flow Data



Investment of over $250 million in system improvements from 1988 to 1992 maximized flow to Deer Island and achieved a 55% reduction in CSO volume

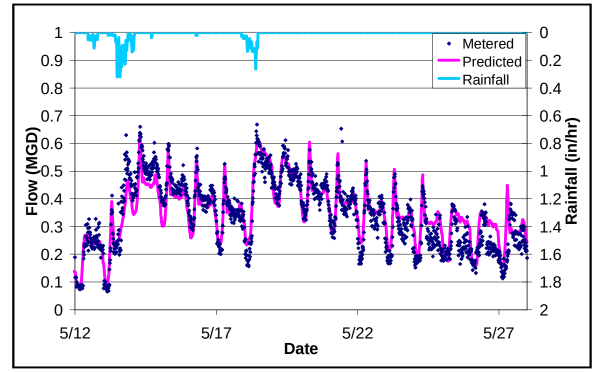
Impact of Maximizing Flow to Deer Island



System Characterization and Optimization

System characterization

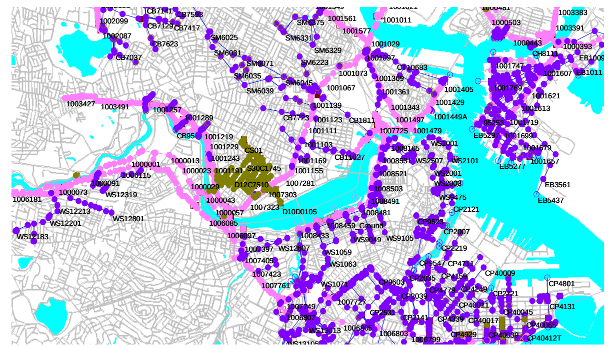
- Temporary meters
- Model calibration
- System performance



Collection system modeling

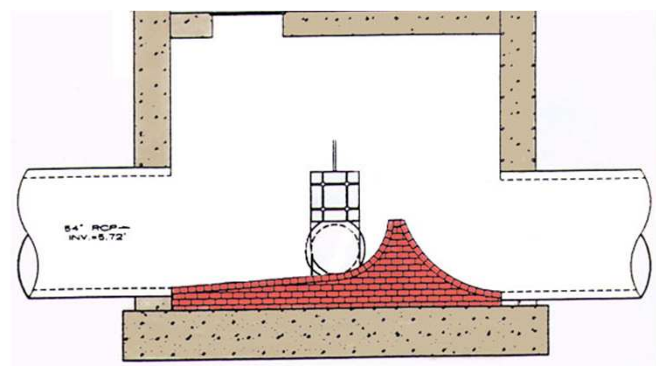
- Detailed, dynamic approach
- SWMM EXTRAN and Info Works

CSO and stormwater loadings



System optimization

- >100 measures implemented
- 25% CSO reduction



CROSS SECTION

Watershed-Based Approach

- 14 receiving water segments
- Baseline water quality assessment

Baseline Water Quality Conditions

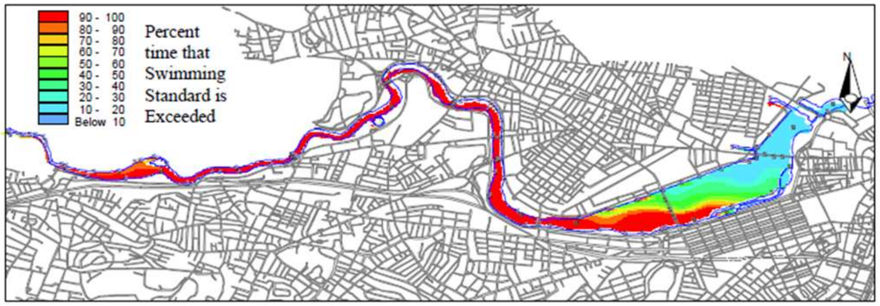
- Identify existing water quality standards / uses
- Assess existing water quality
- Characterize watershed
- Characterize CSO and non-CSO sources
- Determine and measure relative causes of non-attainment

Performance Measures

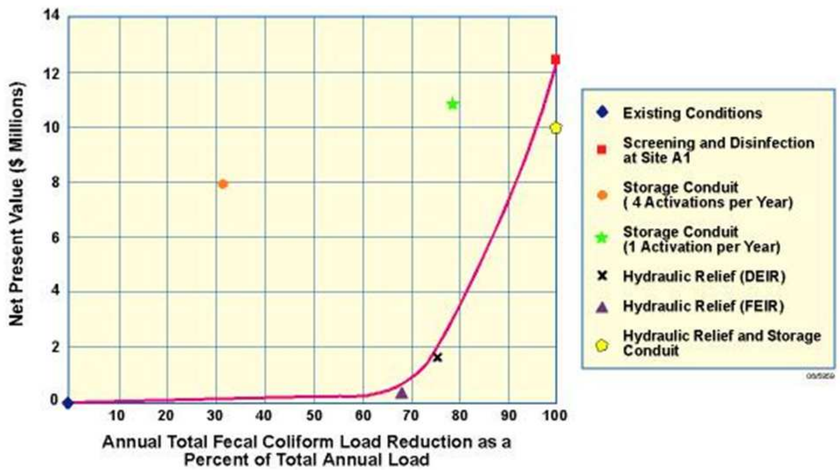
- Annual simulations using a typical rainfall year based on 40 years of rainfall records, approved by U.S. EPA and Mass. DEP, to predict average annual CSO frequency and volume

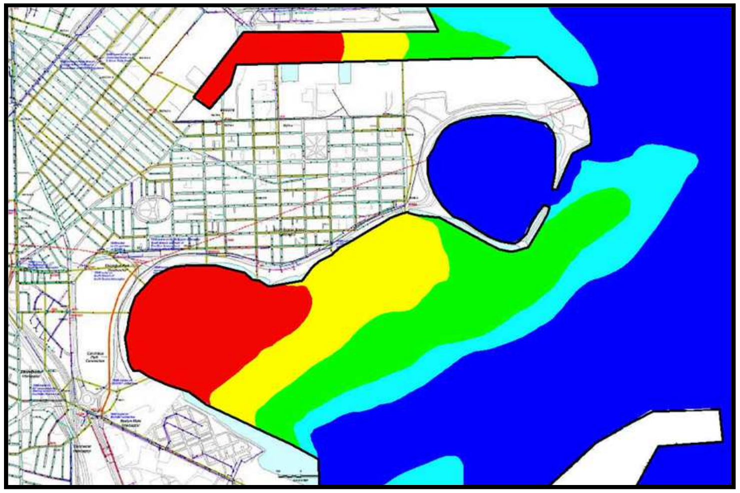
- Receiving water quality models to predict cumulative annual duration of water quality standards violations

Outfall	Baseline Condition		Updated Recommended Plan	
	Activations	Volume	Activations	Volume
BOS003	11	6.13	4	2.87
BOS004	18	5.34	5	1.84
BOS005	4	0.14	[illegible]	[illegible]



Technology Based and Water Quality Based Evaluations





Technology based evaluations

- Cost effectiveness
- Cost per unit load removed
- "Knee-of-the-curve"

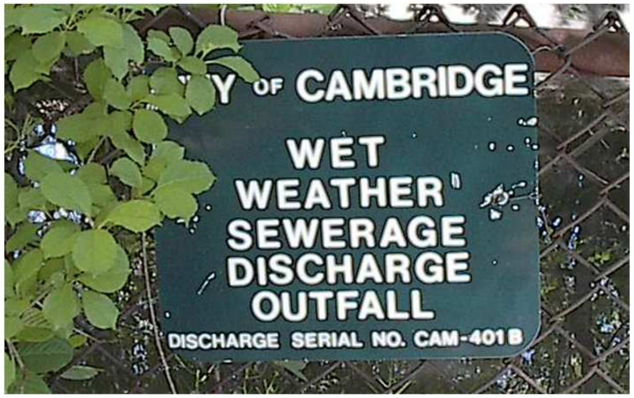
Water quality based evaluations

- Benefit in terms of attainment of water quality standards
- Validate position on knee-of-the-curve

Regulatory Coordination

Regulatory compliance issues

- Level of CSO control
- Water quality standards
- Affordability

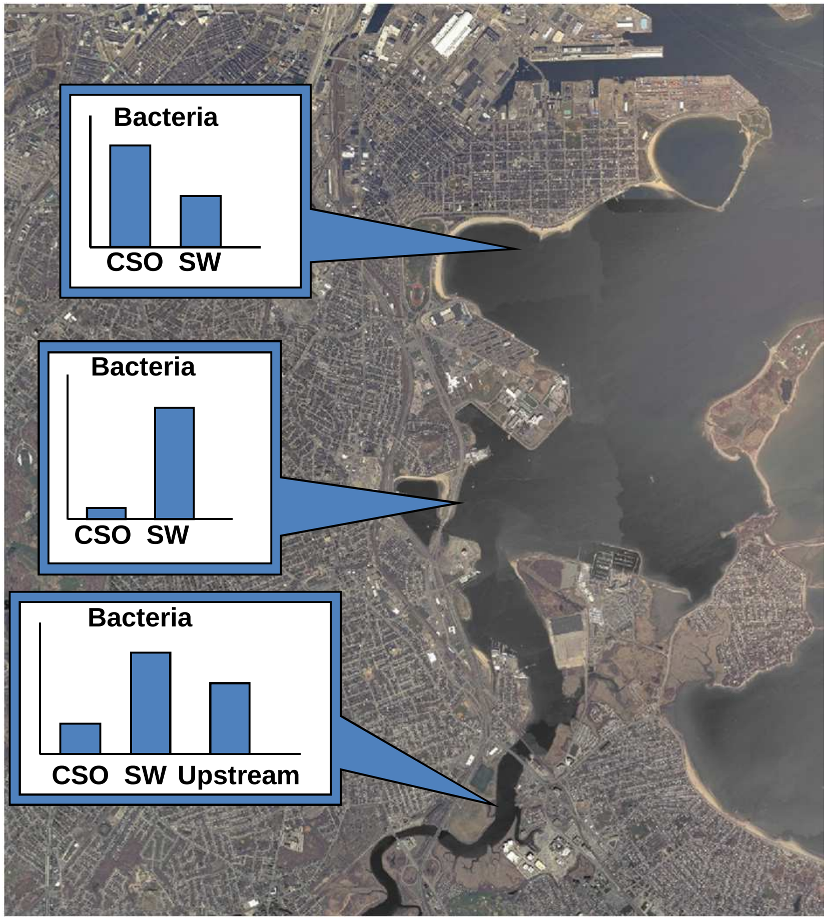


Approach

- Early and continued engagement of agencies and other stakeholders in key workshops
- Detailed and defensible technical information

Result: First LTCP nationwide approved in coordination with changes to water quality standards

CSO Facilities Plan (LTCP)



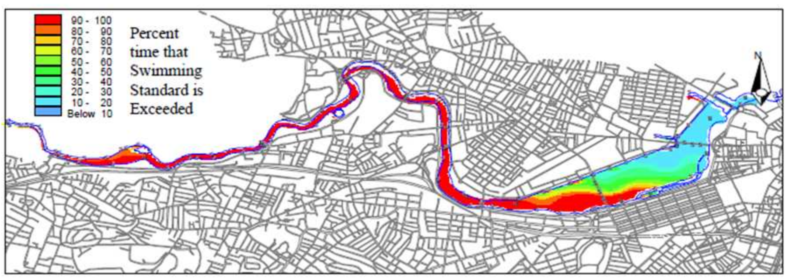
- Defined site-specific projects and technologies
- Provided cost-effective CSO control; protected sensitive use areas
- Established implementation schedule
- Achieved regulatory approval through the demonstration approach
- Formed basis for Use Attainability Analysis

Provided basis for changes to water quality standards

Water Quality Standards Revisions

B_{CSO} / SB_{CSO}

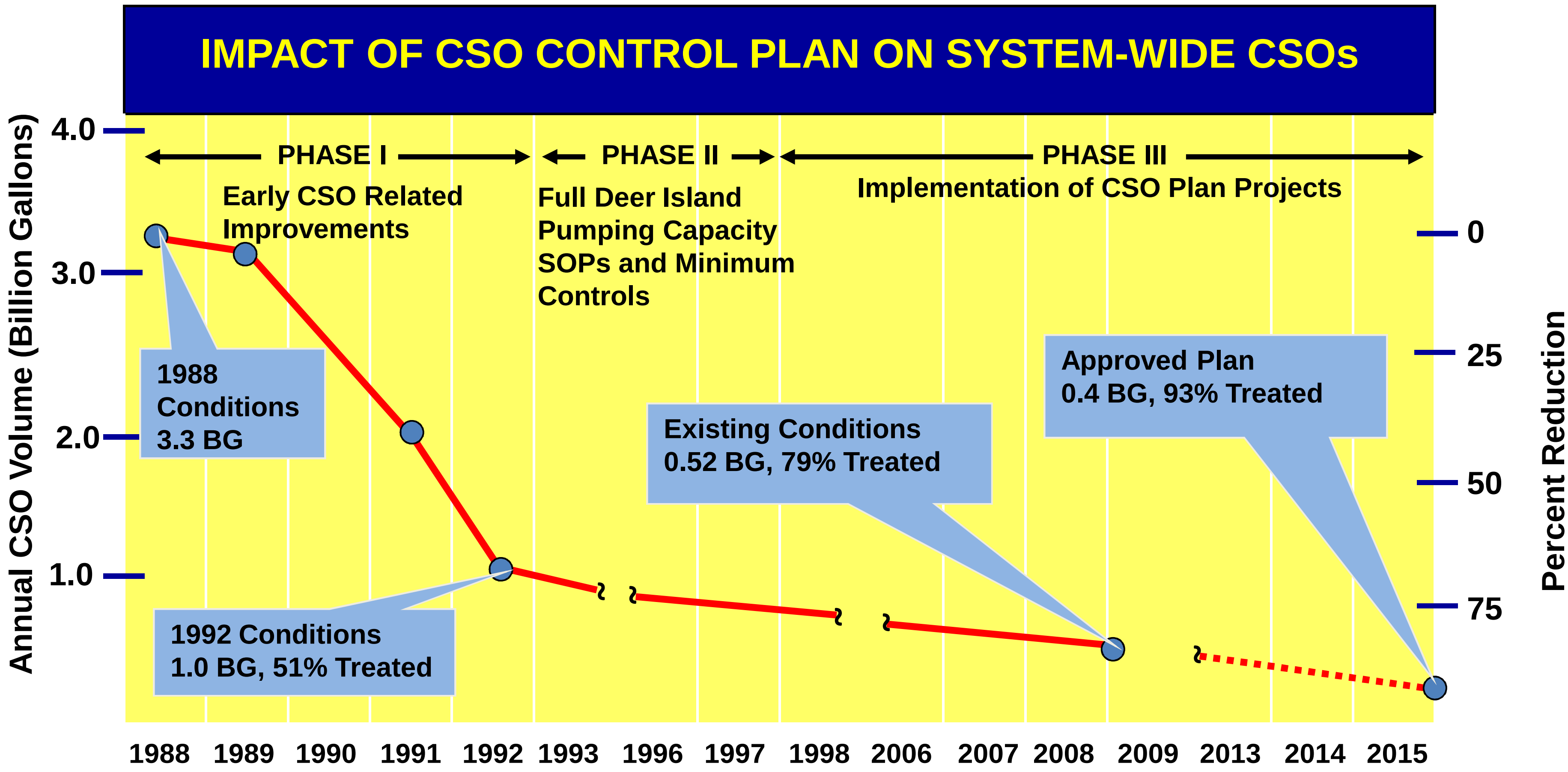
- Allows short-term excursions from Class B / SB due to CSO
- Meet Class B / SB criteria at least 95% of the time
- Meet level of control in approved LTCP (MWRA LTCP >98% compliance)



Variance

- Short-term modification to water quality standards
- Long-term attainment of standards uncertain

MWRA CSO Program: Proven Results



MWRA LTCP Implementation

Approved plan

- 35 projects
- $868 million construction cost (Dec 11 dollars)
- 20-year construction (1996 – 2015)

Current status

- 27 projects completed
- 5 projects in construction
- 2 projects in design
- 1 project design start 2012

Measured performance

- All constructed projects are meeting or exceeding their CSO performance objectives

MWRA CSO Program Objectives

Eliminate CSOs to sensitive waters (swimming / shellfishing)

- Meet Class B

Minimize CSOs in less sensitive waters

Provide treatment at larger remaining CSOs

>98% compliance with water quality standards

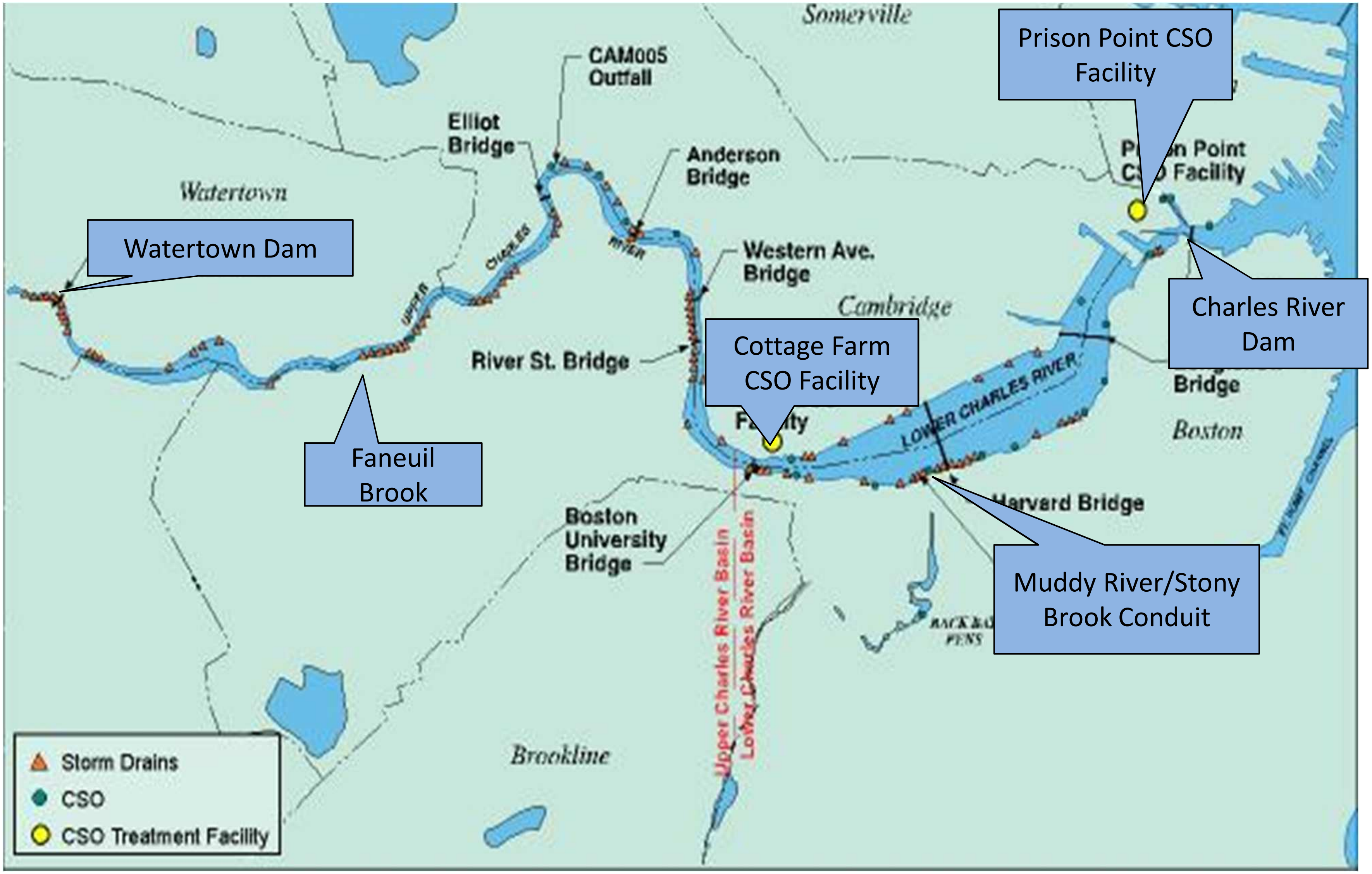
- Meet Class B_{CSO}

Cost-Effective Projects Achieve Site-Specific CSO and Waterbody Goals

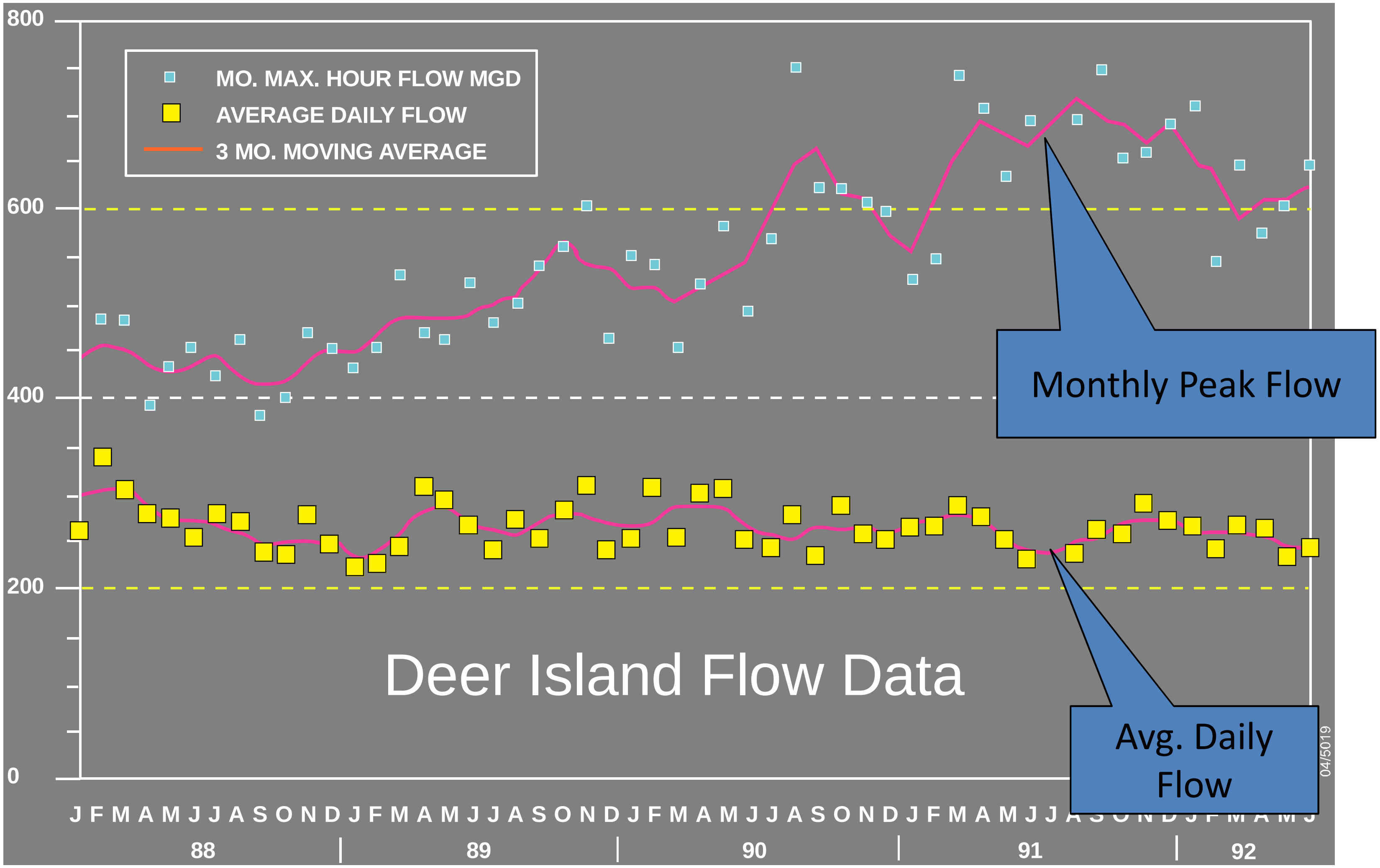
Recommendations from MWRA Experience

- Gain a solid understanding of the system and its performance.
- Account for already planned conditions.
- Develop and maintain a collection system model to evaluate options, build confidence, and track and verify performance.
- Maximize use of existing facilities and new facilities through system optimization.
- Use watershed approach.
- Create best negotiating position by building consensus from the start.
- Track performance before and during implementation.
- Always be looking for and be open to opportunities to reassess and optimize.
- Don’t be afraid to make changes.

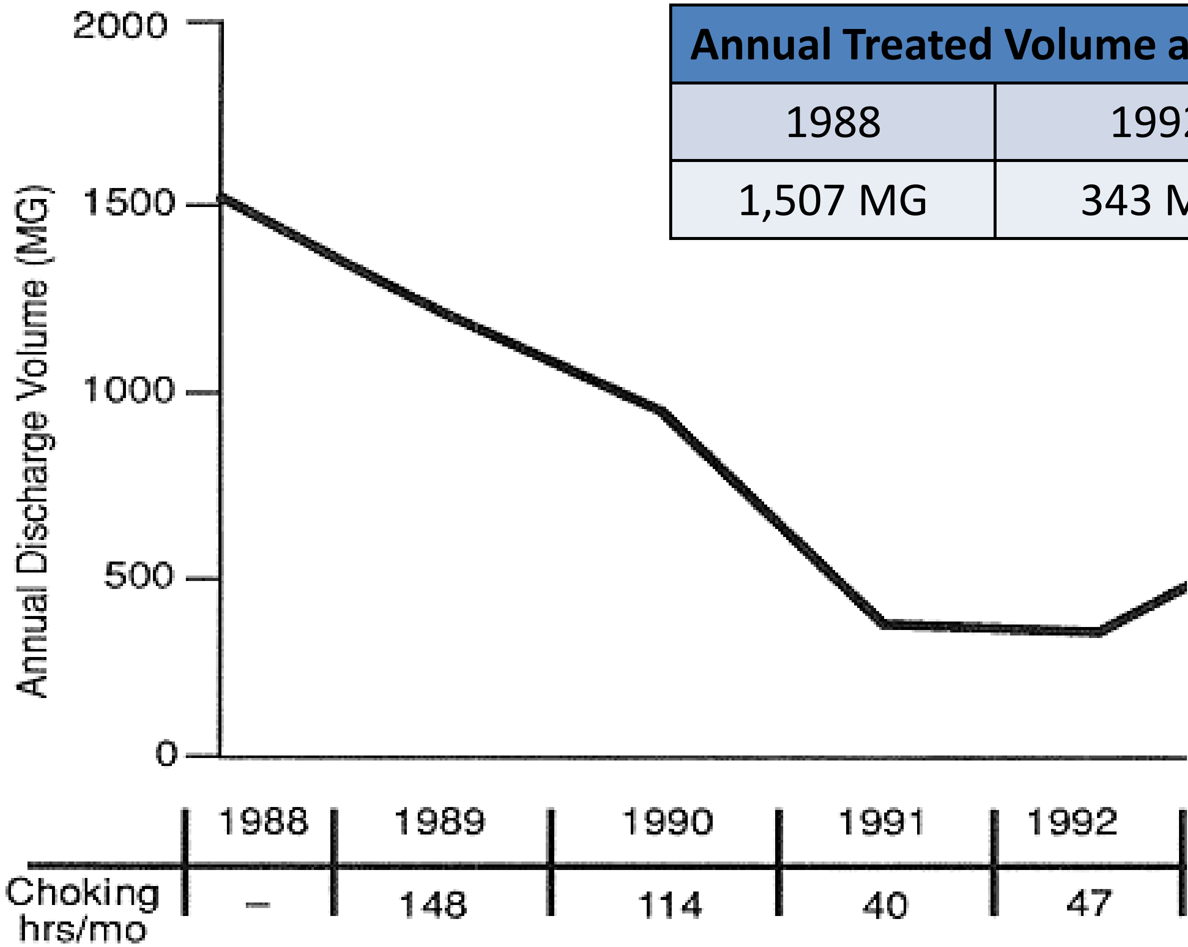
Lower Charles River Basin



Deer Island Flow Data



More Peak Flow to Deer Island = Less CSO to Charles



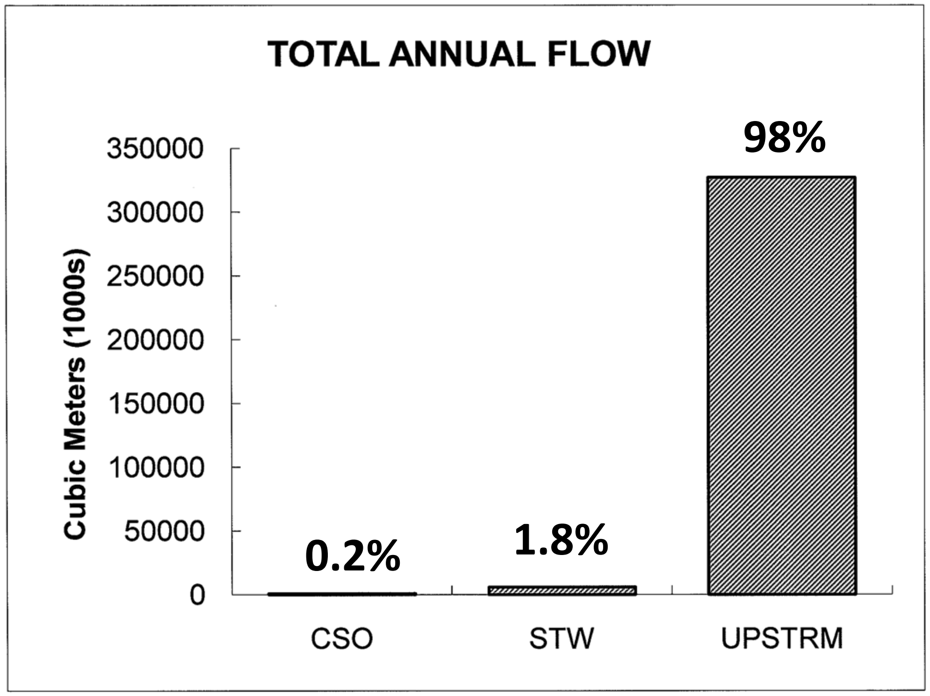
Annual Treated Volume at Cottage Farm		
1988	1992	% Reduction
1,507 MG	343 MG	77 %

After Reducing CSOs by 77% What is Next Step?

- How to focus limited resources on projects that will do the most good
- Identify the pollutants causing remaining water quality standards violations
- Identify the sources of those pollutants
- Quantify the pollutant loads and impacts
- Identify projects to address pollutants and sources causing greatest impact

Causes of Non-Attainment of Water Quality Standards

- Bacteria identified as primary source of non-attainment
- Quantified relative contributions from CSO, stormwater, and upstream flow (over Watertown Dam)
    - Based on sampling and collection system modeling



LTCP Approach for Lower Charles River CSO Control

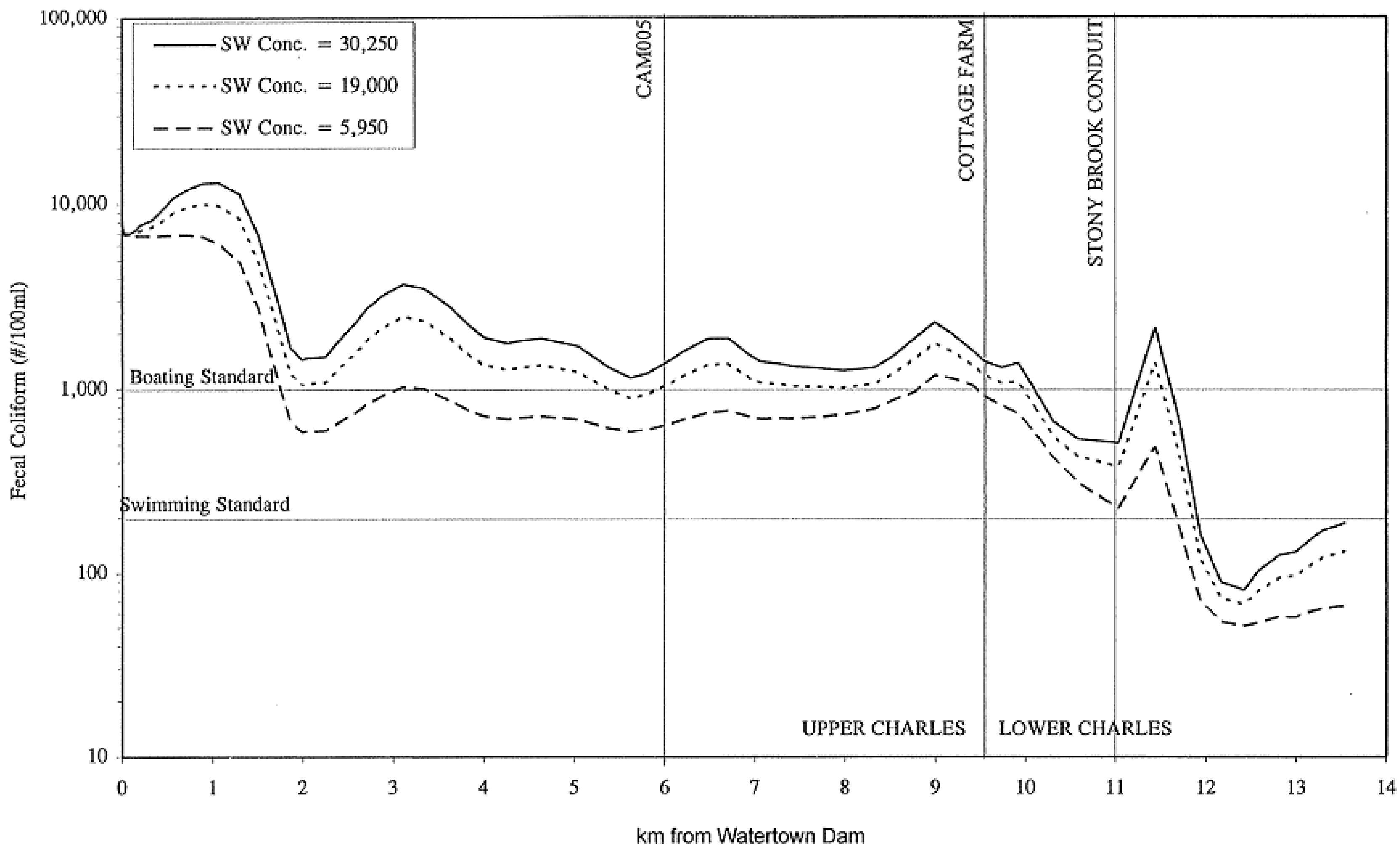
Upgraded water quality model

- Better quantification of impacts of variable flows on pollutant concentrations

Additional WQ sampling

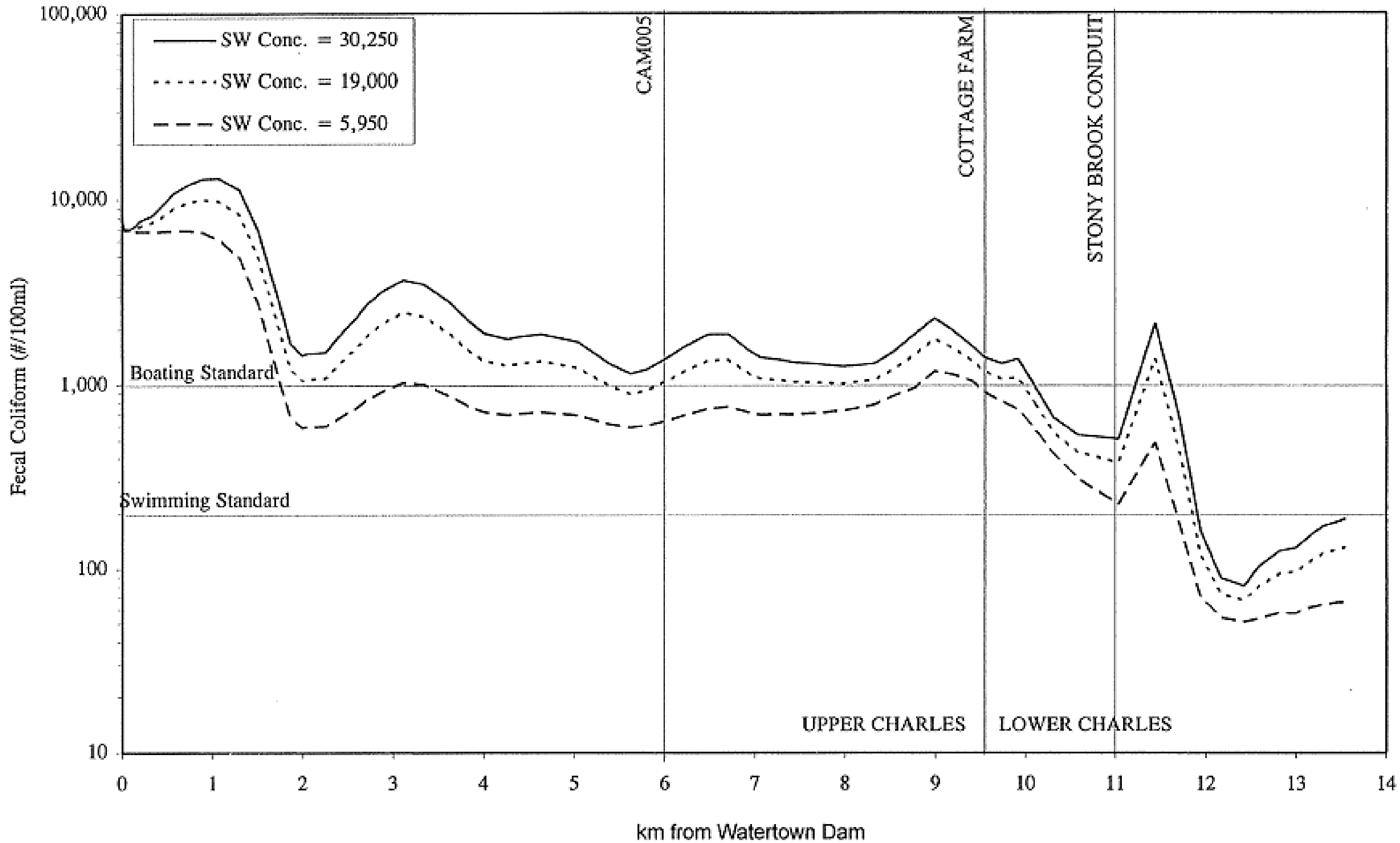
- Refined dry weather FC concentration at boundary dam
- Confirmed stormwater bacteria concentrations
- Assessed sensitivity of findings to changes in stormwater bacteria concentrations

LTCP Recommended Plan – All Pollutant Sources



Fecal Coliform Densities 12 Hours after Start of 3-Month, 24-Hour Storm

LTCP Recommended Plan – Non-CSO Sources, Only

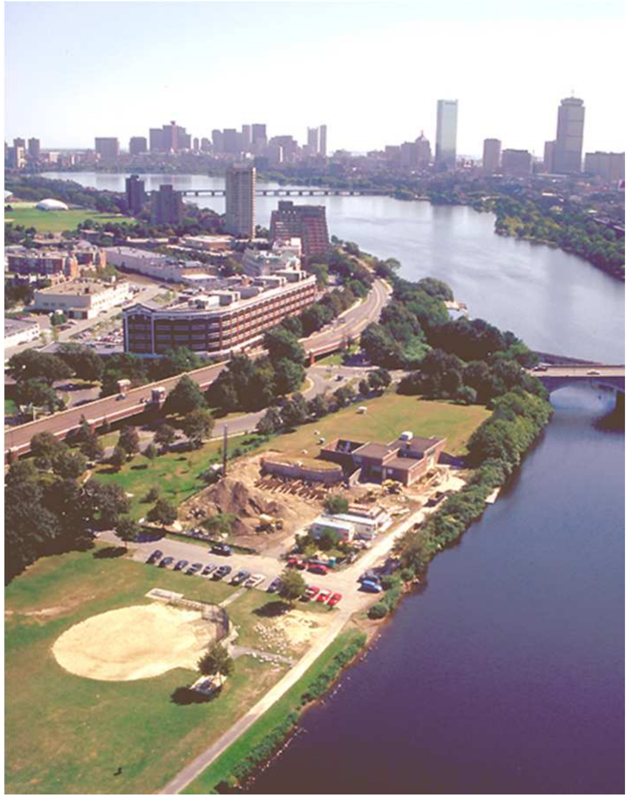


Fecal Coliform Densities 12 Hours after Start of 3-Month, 24-Hour Storm

LTCP Recommended Plan for Lower Charles CSOs

Plan Components

- Interceptor relief (CAM 005)
- Sewer separation (Stony Brook system)
- Cottage Farm disinfection upgrade
- Four outfalls closed
- Floatables control at remaining outfalls



Estimated cost: $49 Million (1997 dollars)

Performance:

- 3 MG/yr untreated CSO
- 27 MG/yr treated CSO (Cottage Farm)

Water Quality Variance Requirements

Class B_{CSO} standard

- Allows short-term excursions from Class B (fishable/swimmable) criteria
- Achieve criteria at least 95% of time
- Approved facilities plan justifies remaining CSOs

DEP: Appropriate level of CSO control in context of other pollutant sources still not clear

Variance

- Short-term modification to water quality standards
- Long-term attainment of standards uncertain

Charles River Water Quality Variance Conditions

- Evaluate additional stormwater BMPs
- Evaluate additional storage at Cottage Farm
- Develop 2-dimensional water quality model

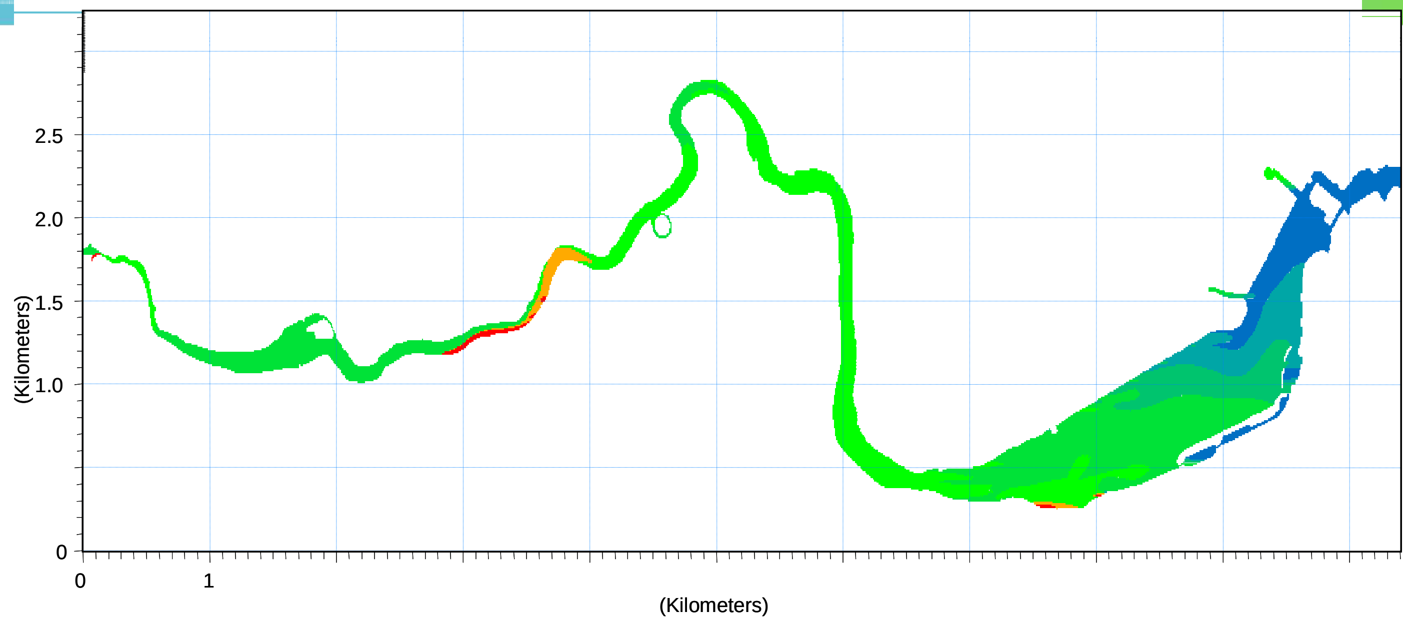
Development of MIKE 21 Model

- Model variables derived from available information / estimated
- Model calibrated using data from USGS, EPA, and MWRA
- Model applications:
  - Evaluate impact of BMPs on water quality
  - Evaluate impact of providing additional storage at Cottage Farm

Evaluate Impact of BMPs on Water Quality

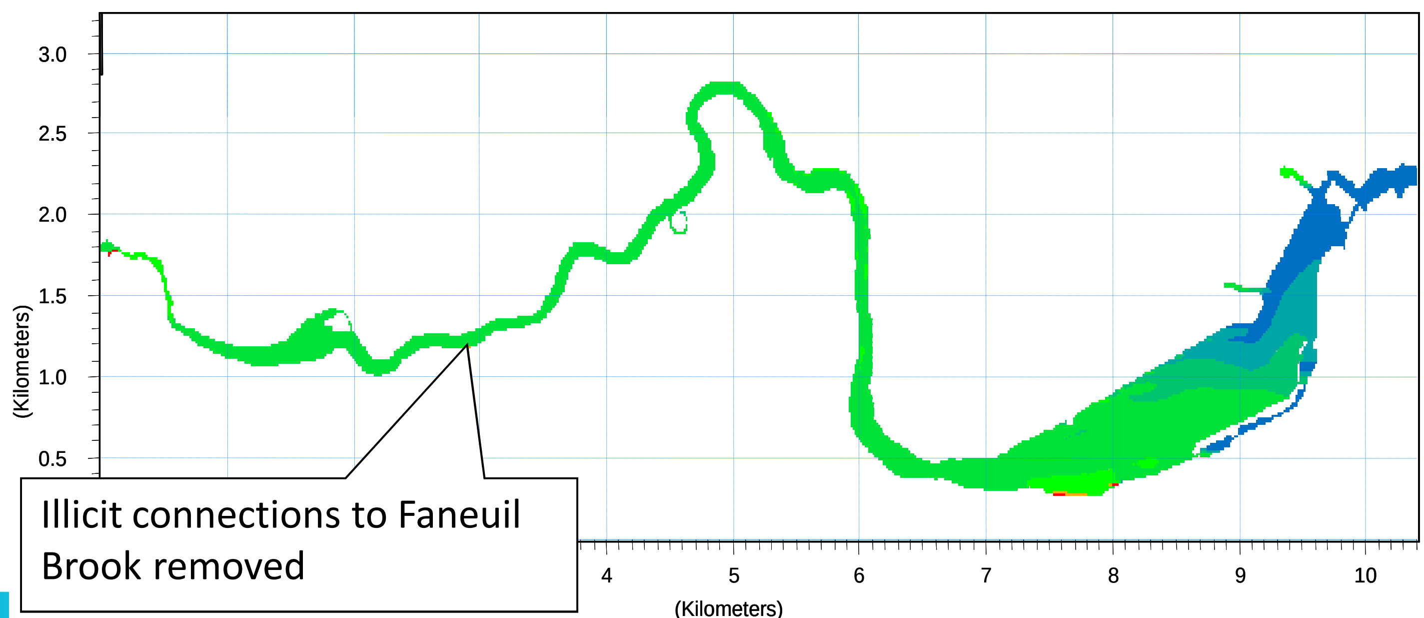
- USGS study refined stormwater concentration data
  - USGS baseline concentrations not substantially different from those used in LTCP
- USGS estimated bacteria removal by BMPs in range of 8-18%
- MIKE 21 model provided effective means for presentation of findings

MIKE 21 Output – Days of FC > 200 CFU/100 ml



Rec. Plan
No BMPs

6 -7
5 -6
4 -5
3 -4
2 -3
1 -2
Below1



Rec. Plan
Faneuil Brook
Illicit Conns.
Removed

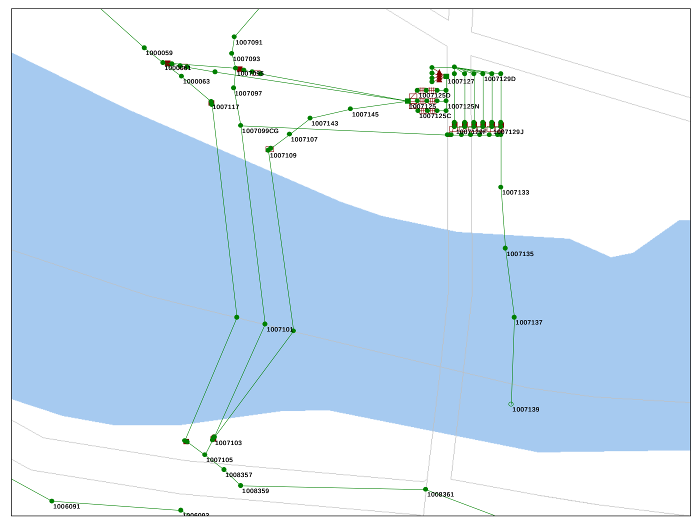
6 - 7
5 - 6
4 - 5
3 - 4
2 - 3
1 - 2
Below 1

Evaluate Benefits of Additional Storage at Cottage Farm

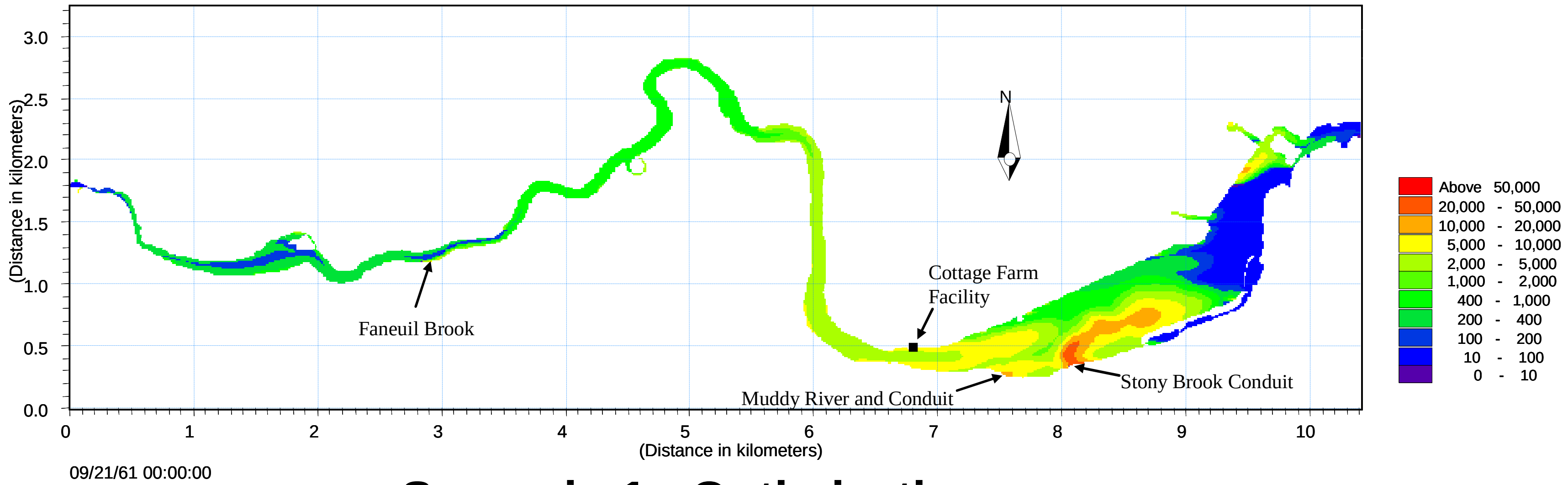
Scenario 1: Further optimization of Cottage Farm operation

- 6.3 MG of treated discharge per year

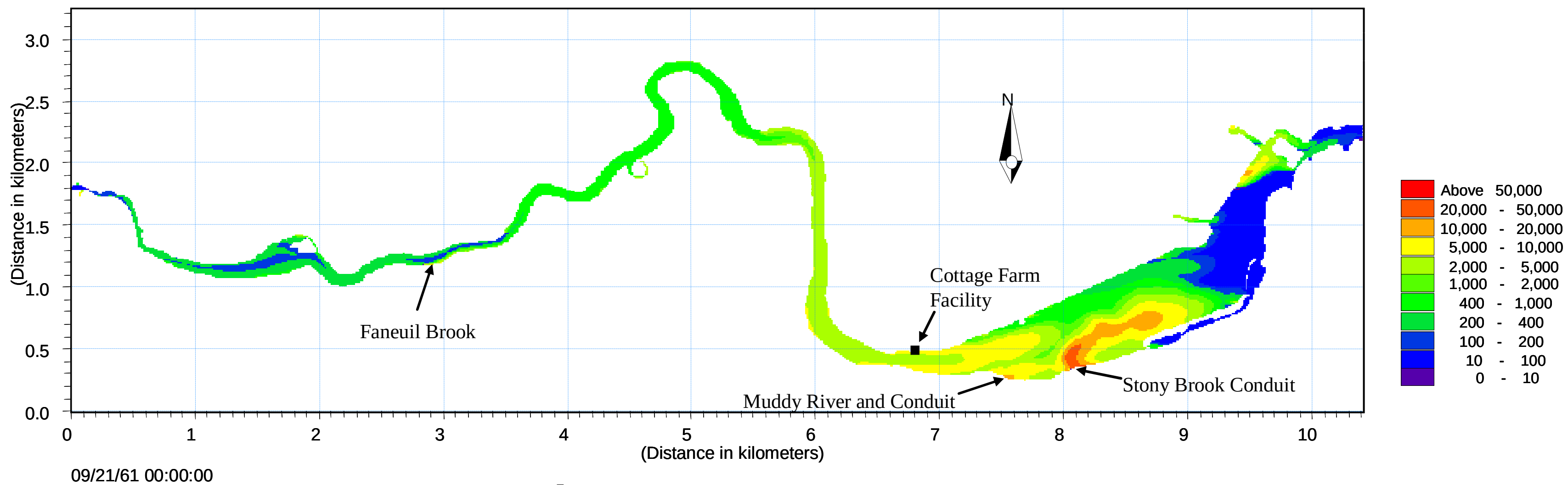
Scenario 2: Storage for up to 1-year, 24-hour storm



Fecal Coliform 24 Hours After Start of 1-Year Storm



Scenario 1: Optimization



Scenario 2: Storage

Significant CSO Reduction Achieved at Cottage Farm

Annual Performance – Cottage Farm

	Annual CSO Volume	Annual Activation Frequency
Baseline Conditions	110 MG	19
1997 Recommended Plan	23 MG	7
Current Plan	6.3 MG	2

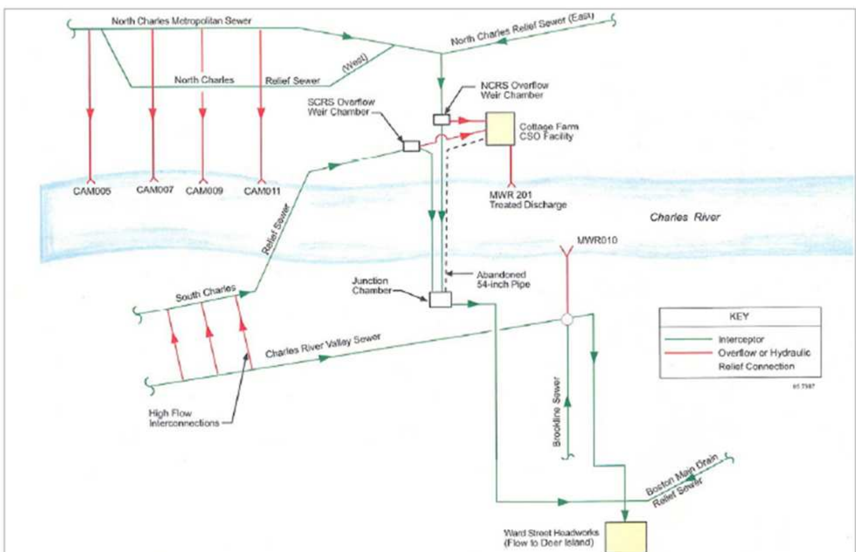


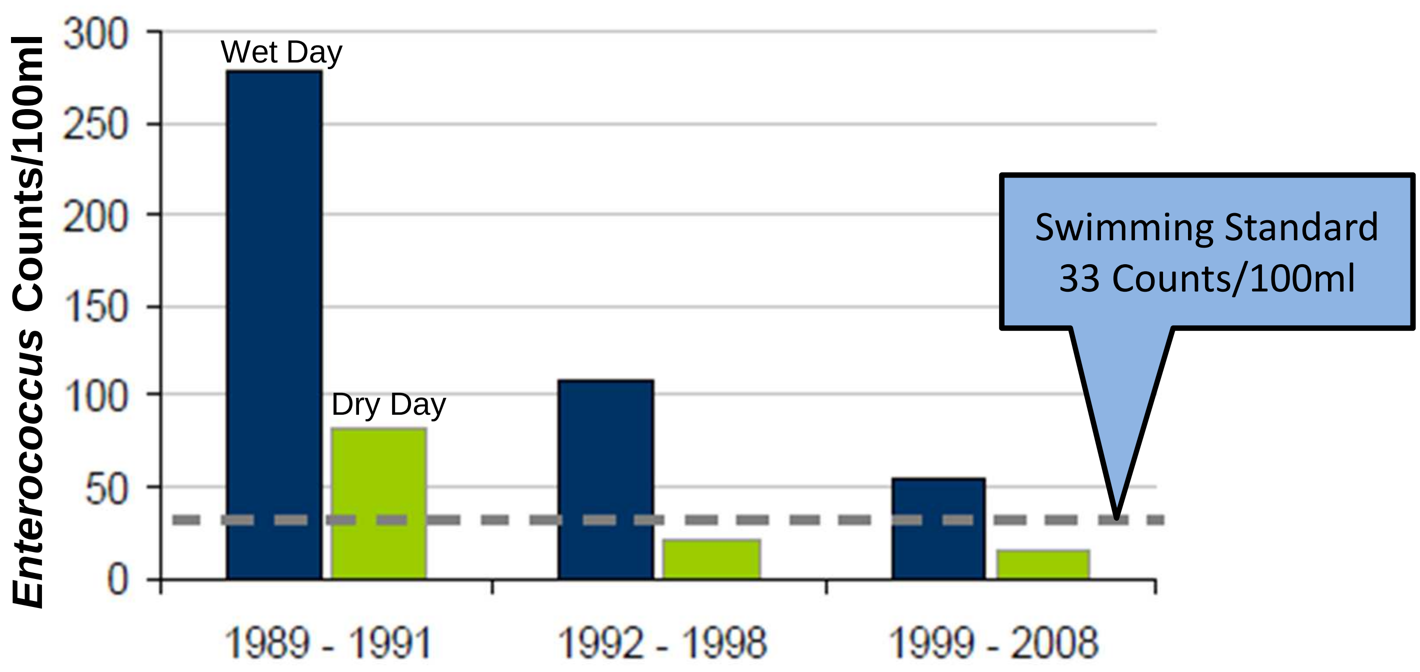
FIGURE 6-1. SCHEMATIC OF INTERCEPTORS AND REGULATORS IN VICINITY OF COTTAGE FARM CSO FACILITY

Snapshot of Progress on Charles River Water Quality

Year	Avg. CSO Volume
1988	1,740 MG
2008	39 MG

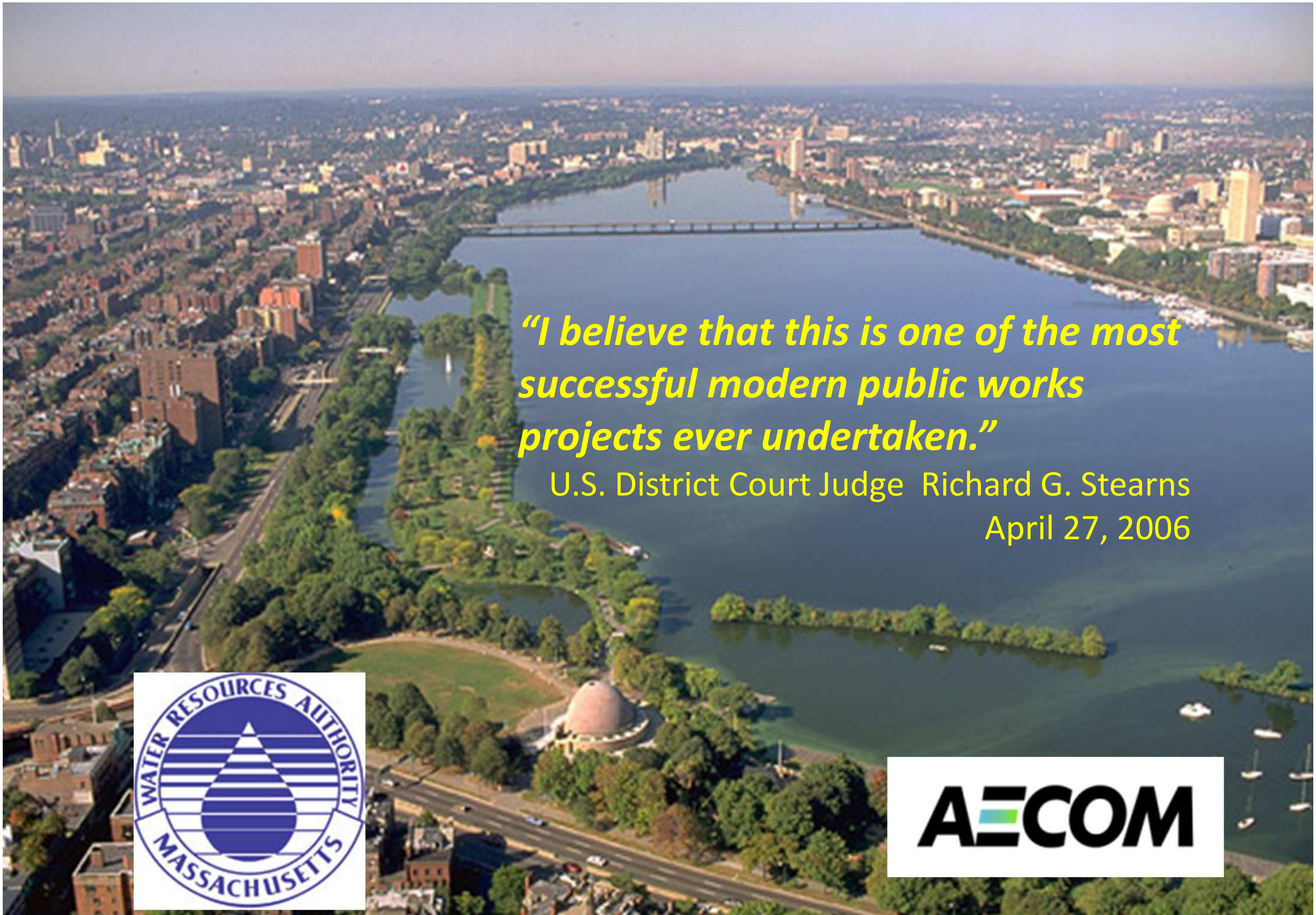
Mid-Basin

(Cottage Farm to Science Museum)

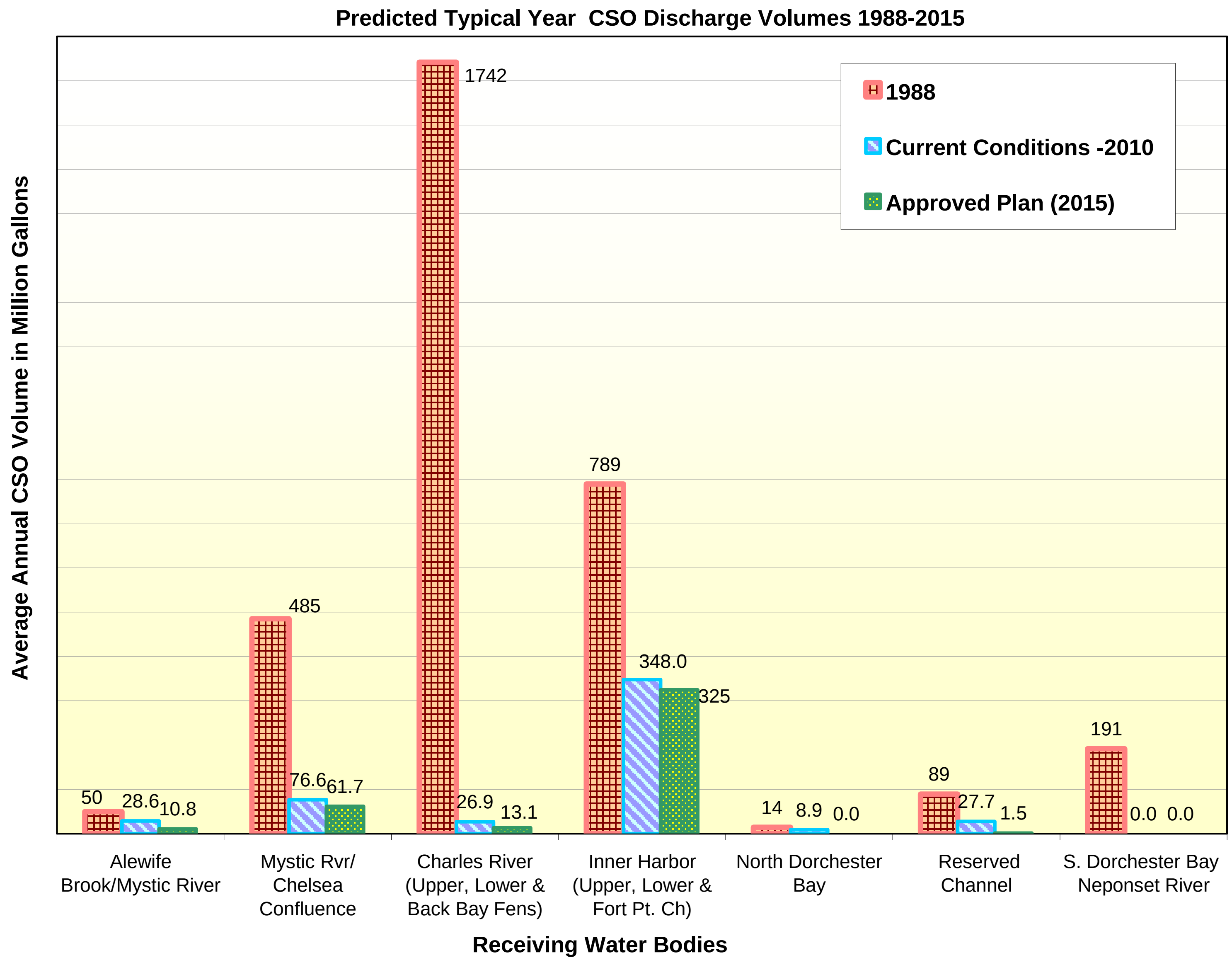


Conclusions

- Water quality in Charles River has come a long way
- A big step was taken with the improvements at Deer Island
- Resolving remaining CSO was an iterative process involving sequentially more detailed evaluations, including system optimization
- 2-dimensional water quality model played a key role in understanding impacts of pollutant loads, and in presenting those impacts to stakeholders
  - Focused stakeholders on sources contributing to water quality impacts


"I believe that this is one of the most successful modern public works projects ever undertaken."
U.S. District Court Judge Richard G. Stearns
April 27, 2006
WATER RESOURCES AUTHORITY MASSACHUSETTS
AECOM

MWRA CSO Program: Results By Receiving Water



MWRA CSO Program: Investment By Receiving Water