

NATURE'S DESIGN

FOUR BILLION YEARS OF LAND AND WATER EVOLUTION

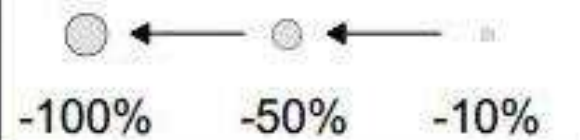
Bob Zimmerman

Charles River Watershed Association

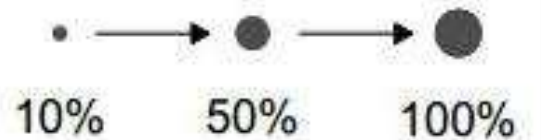
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Decrease in Frequency



Increase in Frequency







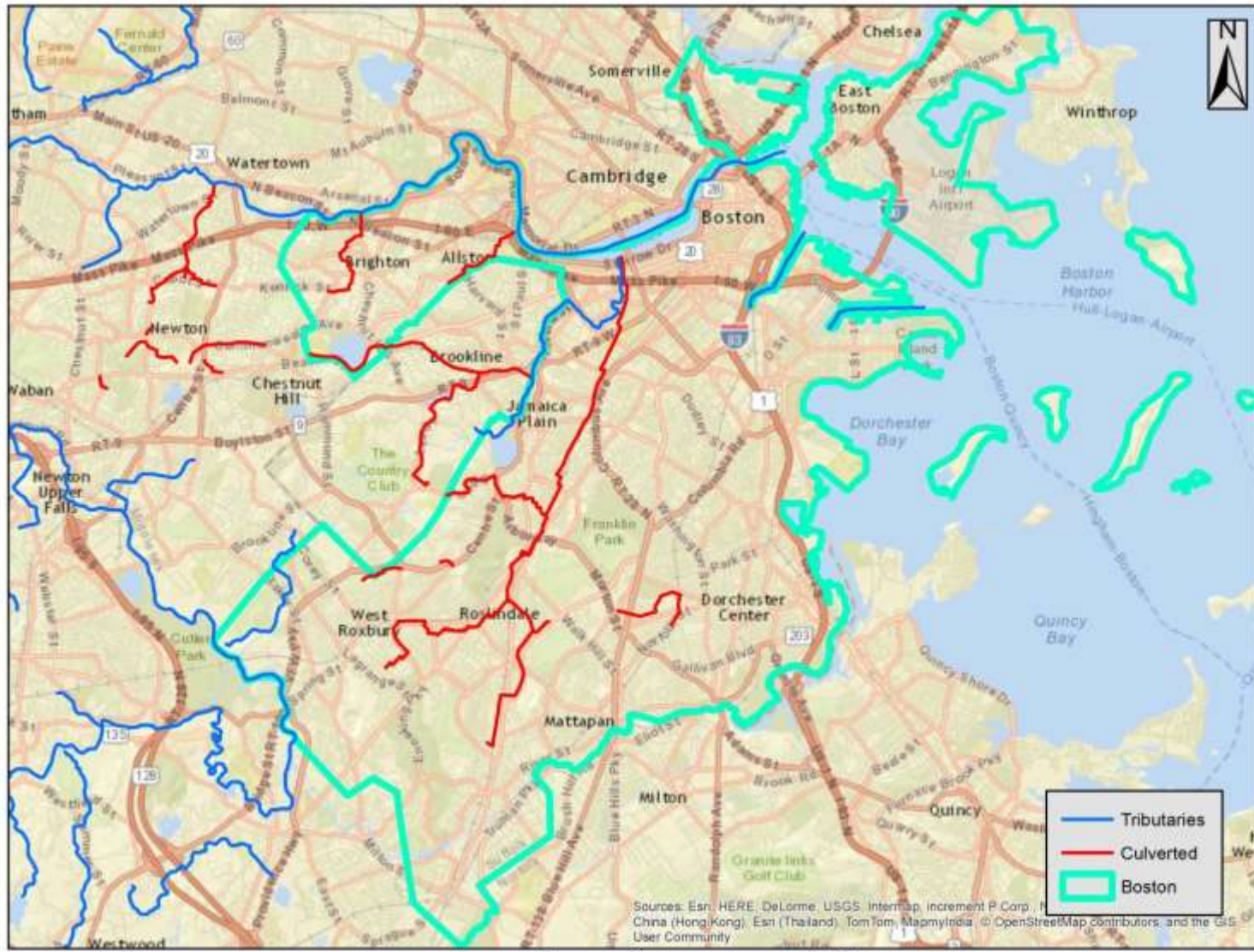


BLUE CITIES: SUBWATERSHED LANDSCAPE RESTORATION



KIRA SARGENT, LANDSCAPE DESIGN
HGSD, SASAKI ASSOCIATES

TRIBUTARY RESTORATION



Stream Daylighting-Visualization

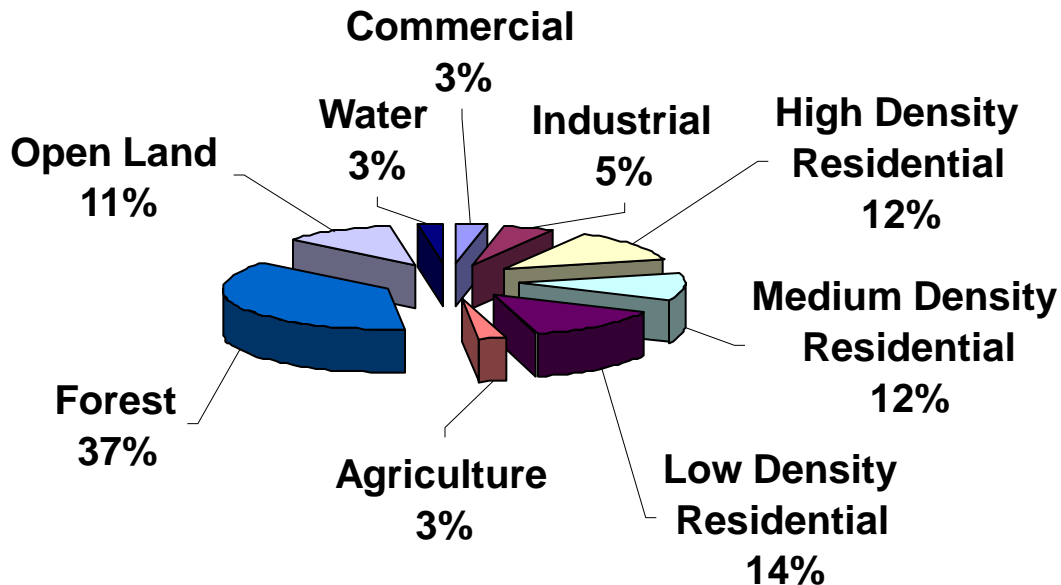


STREET STRATEGIES

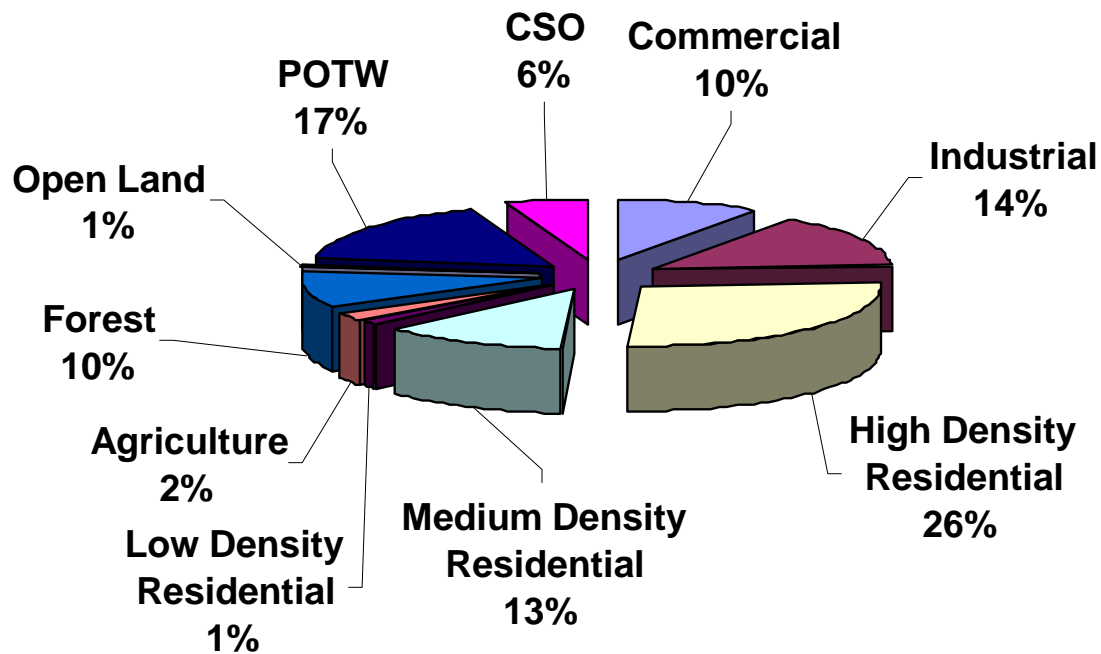


REGULATORY CHANGE: RESIDUAL DESIGNATION

Land Cover Distribution - Charles River Watershed



Distribution of Annual Phosphorus Load to the Charles River by Source Category (1998-2002)



PROPERTY VALUE BENEFITS OF STREET GREENING

- Residential property value enhancement based on survey of GI literature
 - Found 2% to 4% increase in value of properties on greened streets
- Identified towns with greening potential
 - CRWA analysis identified towns with greater than 50% canopy cover → Excluded
 - Towns with less than 50% canopy cover range from Needham (48%) to Everett (5%)
- Estimated potential linear extent of greening in selected towns (5%-10% of residential street mileage)
- Multiply greening mileage by average property value per linear mile of residential street in each of the greened towns

PROPERTY VALUE BENEFITS OF STREET GREENING

PARAMETER	ESTIMATE	
	LOWER	UPPER
Linear Extent of Street Greening in Selected Towns (miles)	230	460
Baseline Residential Property Value on Greened Streets	\$16,428,400,000	\$32,856,700,000
Increment in Value Based on Literature Review	2%	4%
Aggregate Value Increase	\$328,600,000	\$1,314,300,000
Annualized Value Increase	\$23,800,000	\$95,200,000

AVOIDED STORMWATER BMP COSTS

- Annual savings relative to conventional BMPs
- Translate pilot site findings to savings per acre of GI
 - Literature review indicates savings of \$0.005 to \$0.01 per gallon of stormwater treated
 - Pilot studies estimated savings based on stormwater quantities treated
 - Divided annual BMP savings associated with each pilot site by acreage of GI installed at the site → savings per acre
- CRWA estimated total acreage of GI installations in study area
- Multiply GI acreage by avoided BMP cost per acre

PARAMETER	ESTIMATE	
	LOWER	UPPER
Annual Avoided Cost per Acre	\$41,367	\$262,942
Total Acreage of New GI in Study Area	1,972	
Annual Avoided BMP Costs	\$81,574,942	\$518,522,576



Property Address: ,

Impervious Area (acres): 0.00



Select Solution

Select Stormwater Control goals and type to determine the cost to meet the phosphorus reduction goal of 65% on your site.

Select Stormwater Control Goals

- Aesthetic High Medium Low
- TSS/Metals Reduction High Medium Low
- Phosphorus Reduction High Medium Low
- Nitrogen Reduction High Medium Low
- Bacteria Reduction High Medium Low
- Peak Flow Reduction High Medium Low
- Volume Reduction High Medium Low

Select Stormwater Control (percent ranking by the Exchange based on site and goals)



The Exchange Cost Analysis

Choose Design Criteria

Load Reduction (%)

10

Site Constraint

Partly developed area

Stormwater Control Costs

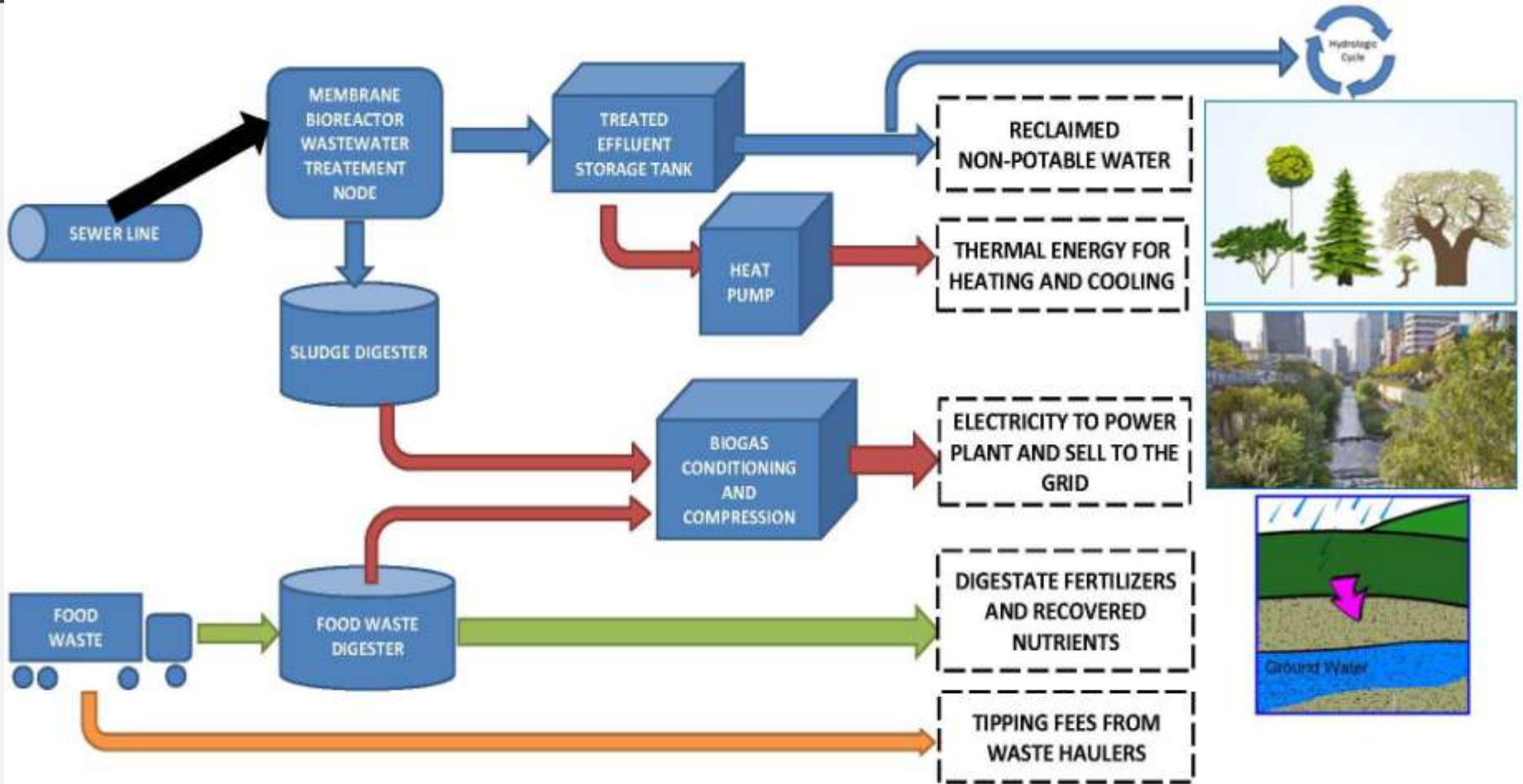




Expensive stormwater management –
due to space constraints, poor soils,
contamination



COMMUNITY WATER AND ENERGY RESOURCE CENTER (CWERC) GENERATE REVENUE, RESTORE MORE NATURAL HYDROLOGY



COMMUNITY WATER AND ENERGY RESOURCE CENTERS (CWERCs)



- Treat and resell a portion of the water (MBR)
- Capture and use/sell thermal energy (heat pump/exchange)
- Produce and use/sell biogas through co-digestion (CHP)
- Capture nutrients (N) for resale
- Produce compost for resale (2 tiers, separating sludge and SSO streams)

RESOURCE RECOVERY CWERC MODELING NEIGHBORHOOD #1 TECHNICAL RESULTS

	Unit Cost/Fee Assumed	Total Volume Produced	Total Value Produced	Volume Used Onsite
Reuse Water Sales	\$2.20/1000 gallons	1.5 MGD	\$1,201,000/yr	None
Thermal Energy Capture	\$9.77/MMBTU	292,981 MMBTU/yr*	\$2,494,000/yr** (\$715,000 net)	188,466 MMBTU/yr**
Biogas Conditioning and CHP	\$89/MWh (\$0.089/KWh) (sale)	7,480 MWh/yr	\$665,700/yr	3,870 MWh/yr <i>(\$121/MWh rate for usage)</i>
Sludge Digester Compost	\$25/cu. yds.	770 cu. yds./yr	\$19,200/yr	None
Food waste Digester Compost	\$12/cu. yds.	12,650 cu. yds./yr	\$151,800/yr	None
Nitrogen Recovery	\$0.70/lb N	85,100 lbs-N/yr	\$59,600/yr	None
Food Waste Tipping Fees	\$80/wet ton (\$0.025/lb)	80 ton/day accepted	\$1,440,000/yr	All
Renewable Energy Credits	\$65.27/MWh		\$439,400	

* Includes heat capture from CHP unit

**Includes energy to run heat pump which is available as output but is a cost to the plant

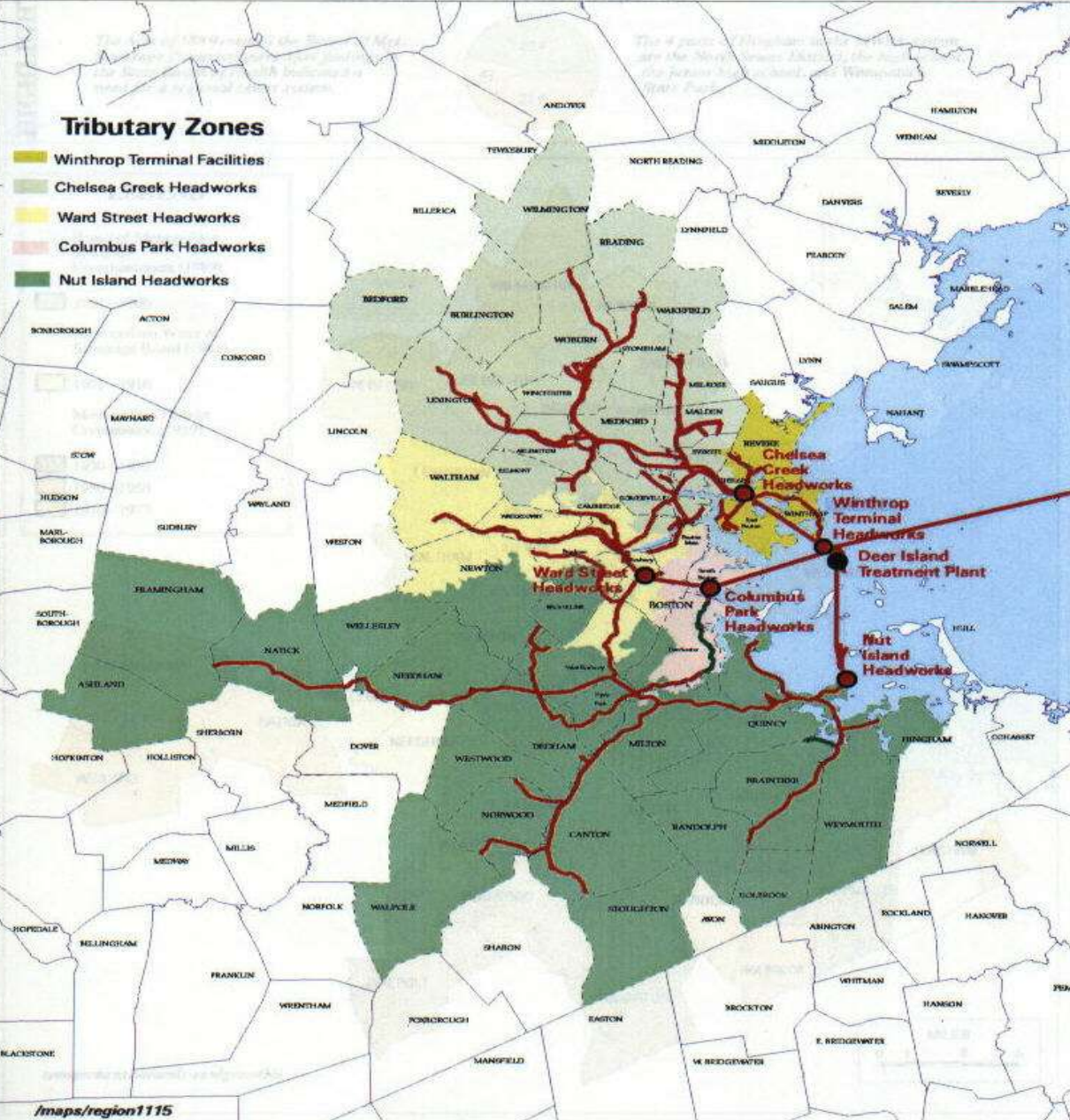
SUMMARY OF ANNUAL BENEFITS

	BENEFIT CATEGORY	VALUE	
		LOWER	UPPER
Additive	Energy Recovery and Energy Savings	\$3,727,535	\$3,982,105
	Reduced Carbon Emissions	\$334,635	\$1,722,388
	Reduced Criteria Pollutant Emissions	\$55,909	\$139,392
	Carbon Sequestration from GI	\$3,991	\$20,679
	Air Quality Benefits from Greening	\$6,755	\$16,889
	Avoided Stormwater BMP Costs	\$1,572,345	\$3,144,689
	Avoided Underpinning Costs	\$8,600,000	\$22,900,000
	Stream Daylighting Benefits	\$139,442	\$1,426,351
	TOTAL	\$14,440,612	\$33,352,494
Areas of Significant Overlap	Property Value (Street Greening)	\$1,522,778	\$3,045,556

Figure A:

MWRA SEWERAGE SYSTEM SERVICE AREA

MILES
0 1 3 5



SUMMARY OF ANNUAL BENEFITS: EXPANSION SCENARIO I

	BENEFIT CATEGORY	ESTIMATE	
		LOWER	UPPER
Scaled	Energy Recovery – Electricity	\$20,600,000	\$21,200,000
	Energy Recovery – Heat	\$136,400,000	\$136,400,000
	Emissions Reduction – Electricity	\$10,400,000	\$25,700,000
	Emissions Reduction – Heat	\$12,600,000	\$73,300,000
	Avoided Stormwater BMP Costs	\$81,600,000	\$518,500,000
	Property Value Enhancement (Greening)	\$23,800,000	\$95,200,000
	Avoided Underpinning Costs	\$29,500,000	\$198,300,000
	SUBTOTAL	\$315,000,000	\$1,068,700,000
Threshold	Charles River Flow Enhancement	\$4,200,000	\$8,700,000
	Swift River Flow Enhancement	\$2,700,000	\$3,300,000
	Avoided Cost of Water Deliveries	\$8,300,000	\$8,300,000
	Annualized Capital Investment Avoided	\$52,700,000	\$135,000,000
	SUBTOTAL	\$67,900,000	\$155,300,000
GRAND TOTAL		\$382,900,000	\$1,224,000,000
CWERC TOTAL		\$270,600,000	\$598,200,000

*TRANSFORMATION:
WATER INFRASTRUCTURE FOR
A SUSTAINABLE FUTURE*

AVAILABLE ON AMAZON FOR THE
KINDLE APP

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