Infrastructure for a Livable Future

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July 12, 2017

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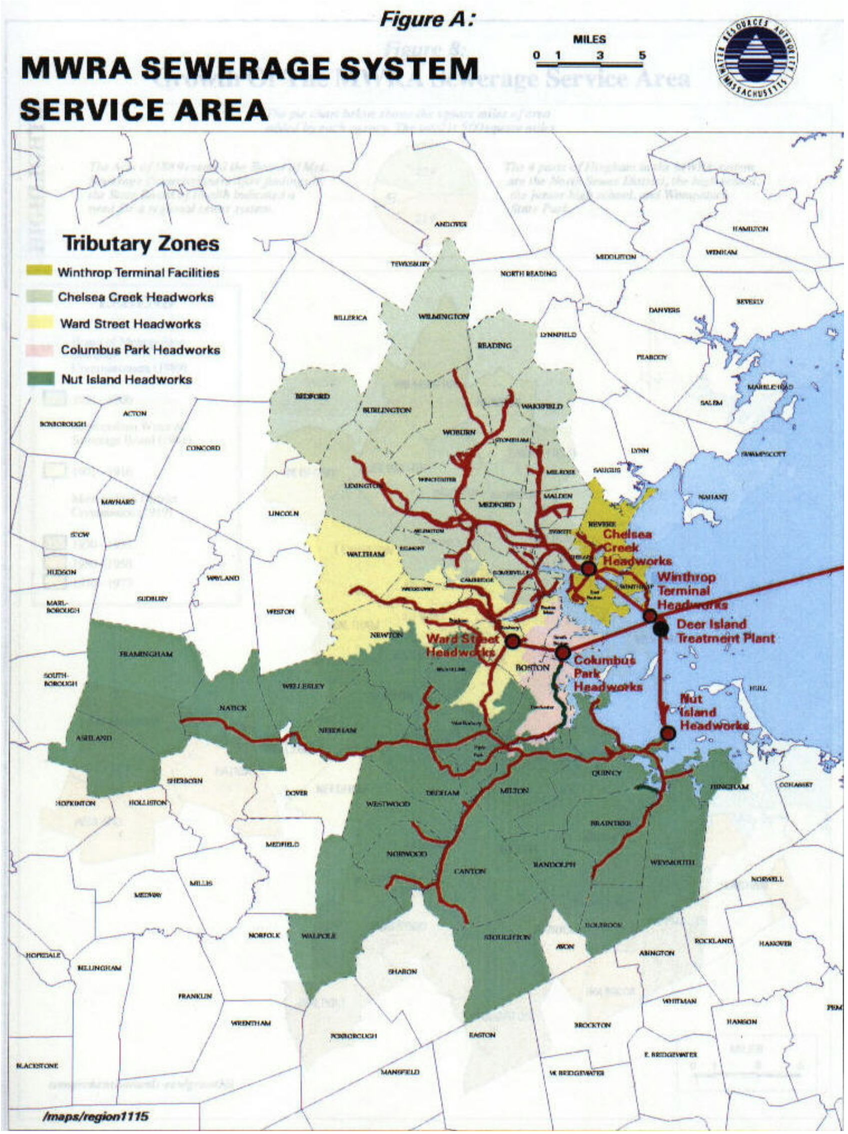
Resilience, water and energy recovery concept, and modeling overview

BACKGROUND

Massachusetts Water Resources Authority Wastewater System



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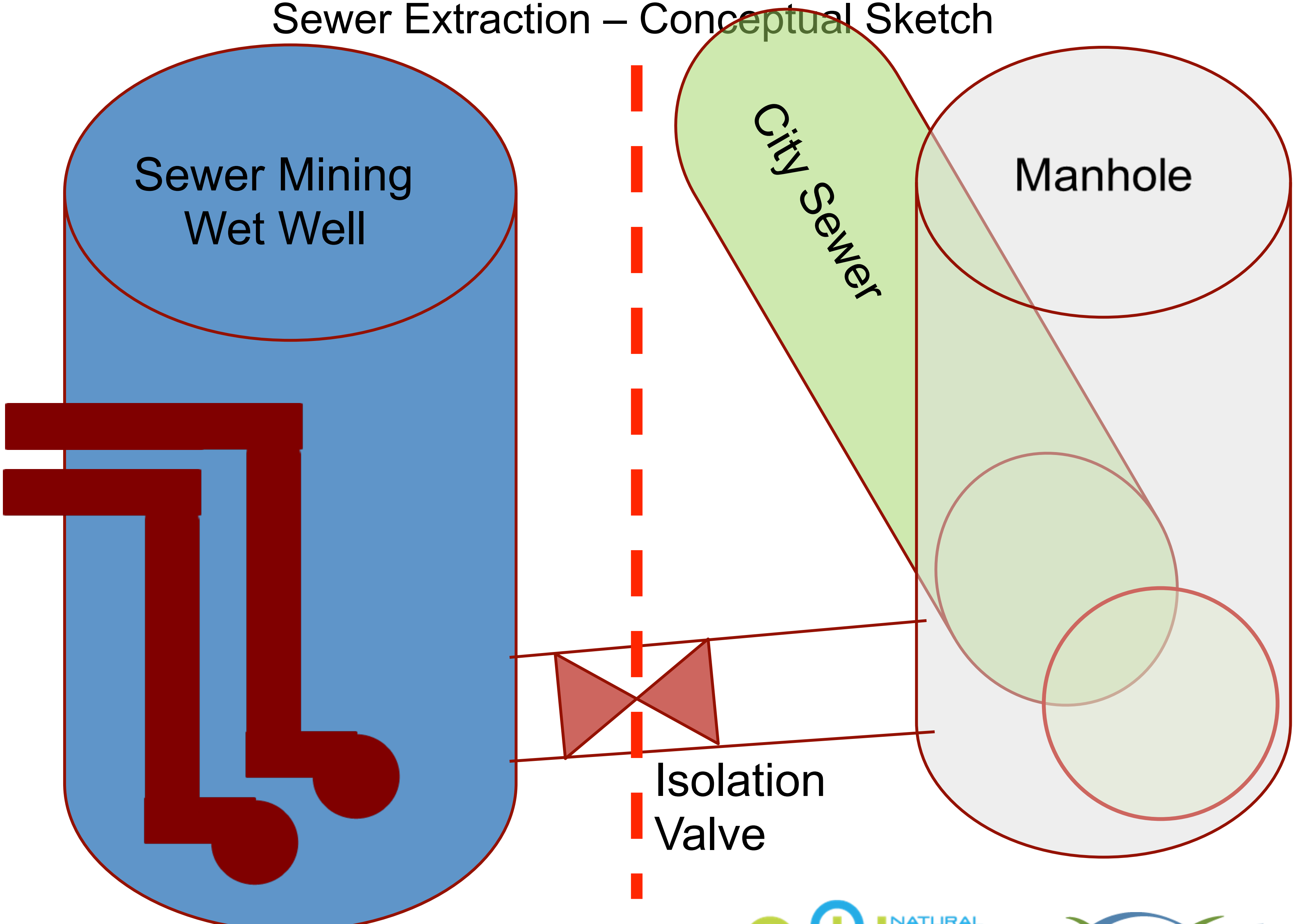
Sewer Extraction – Conceptual Sketch



Adapted from Barwon Water Sewer Mining Guidelines (2011)

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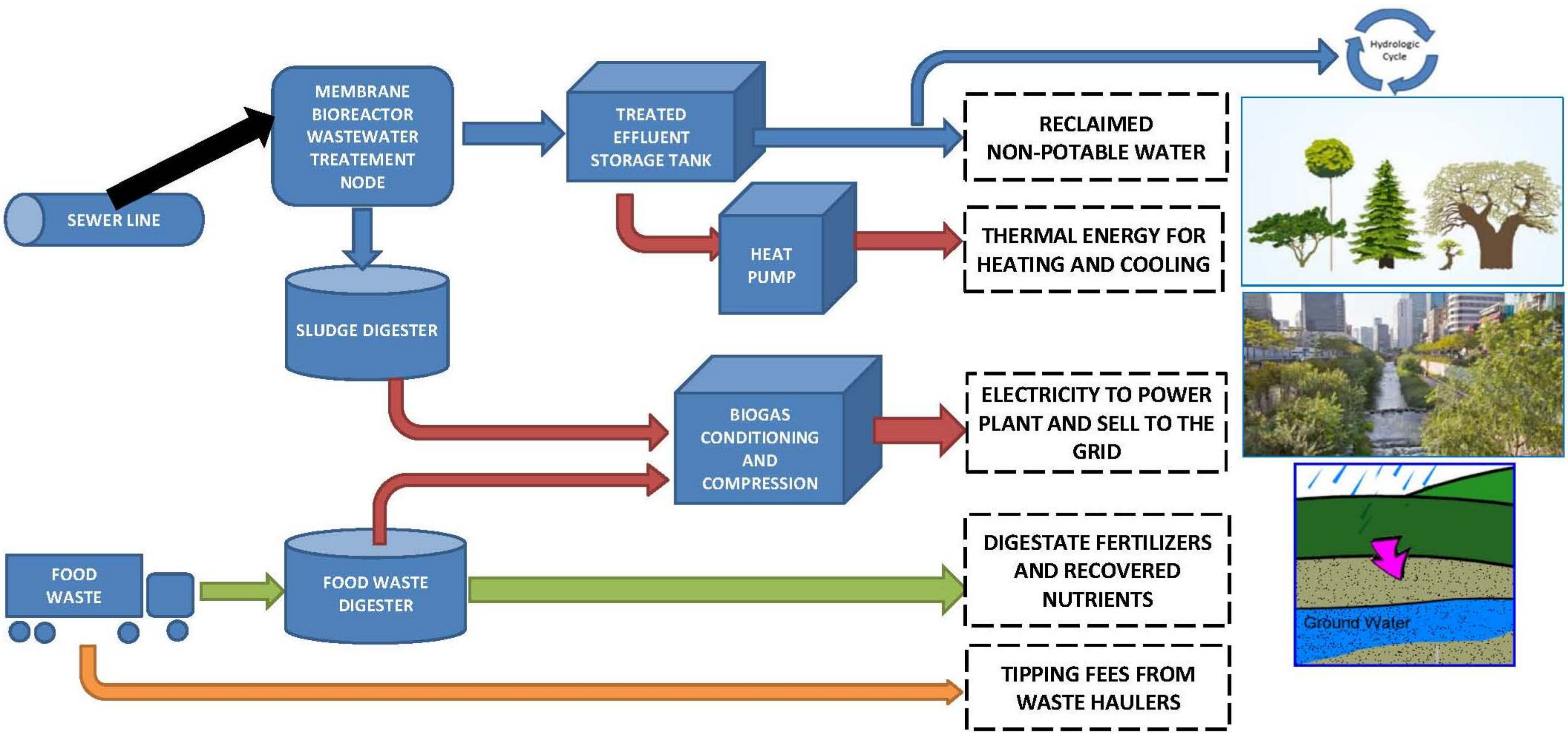
Community Water and Energy Resource Center = CWERC



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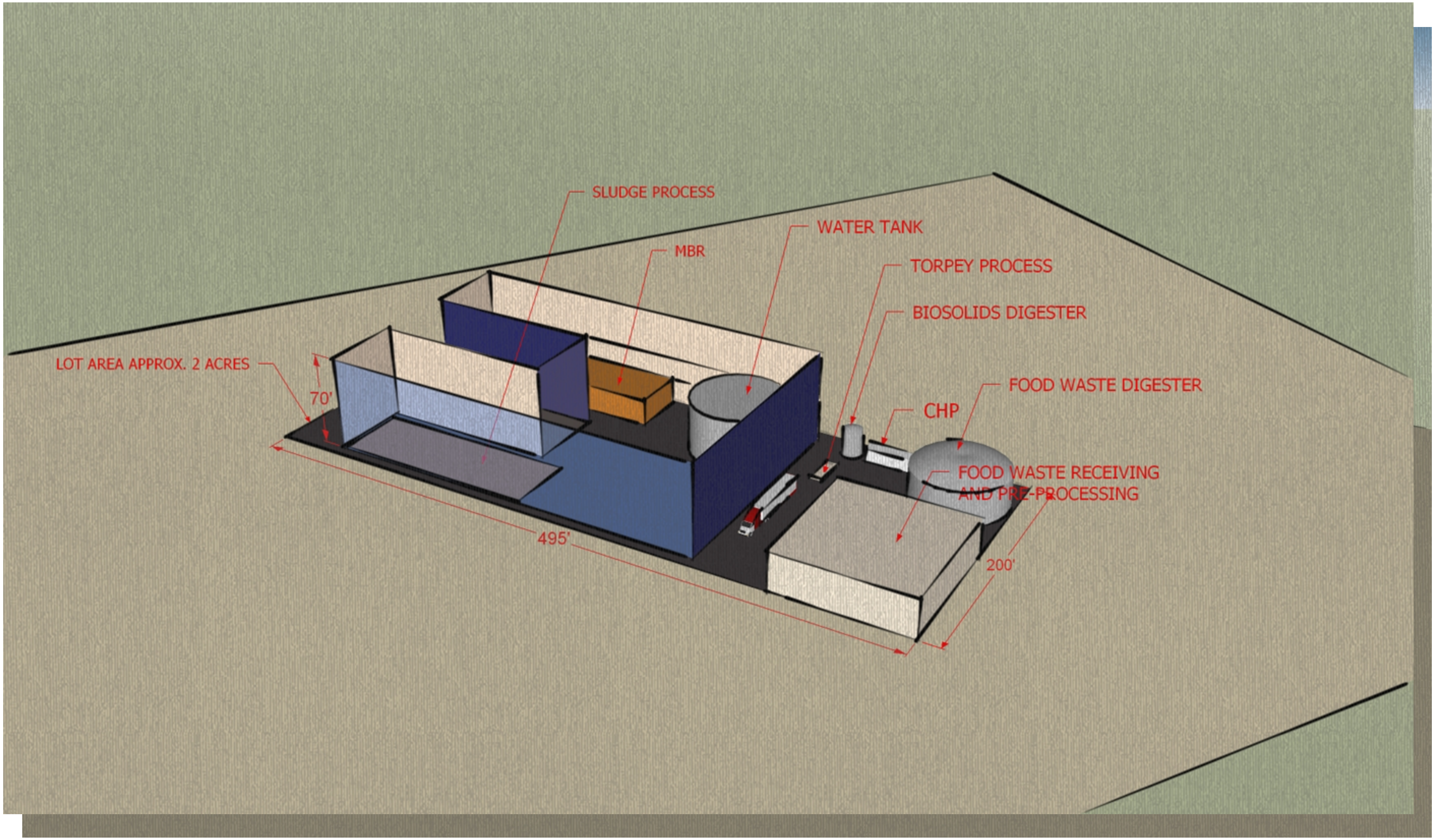
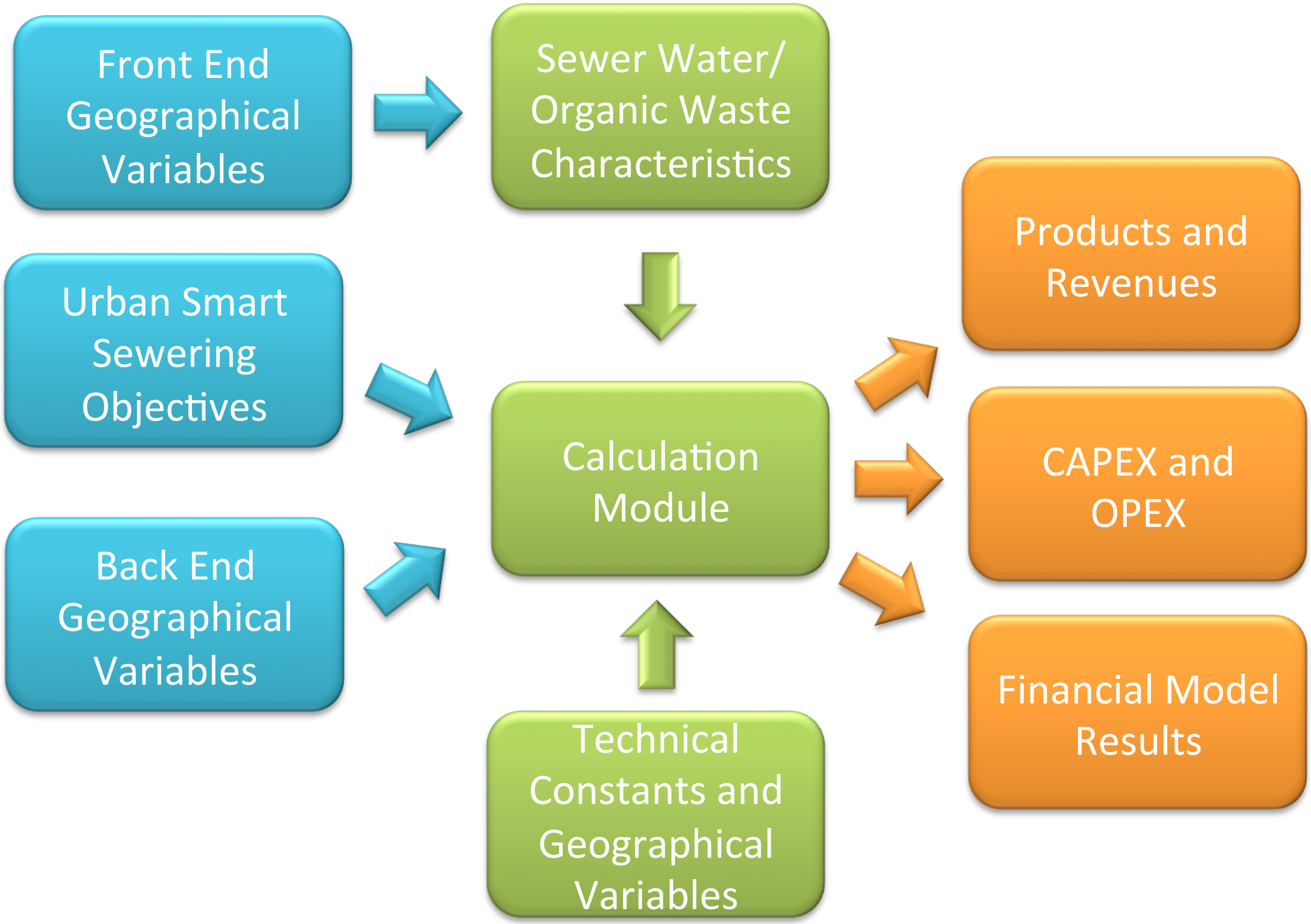
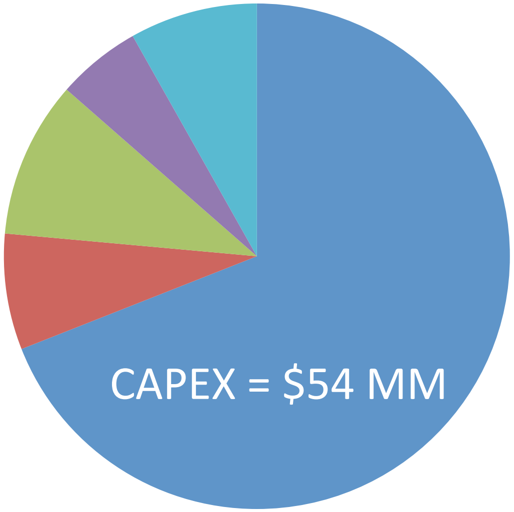
Integration into Institutional Building

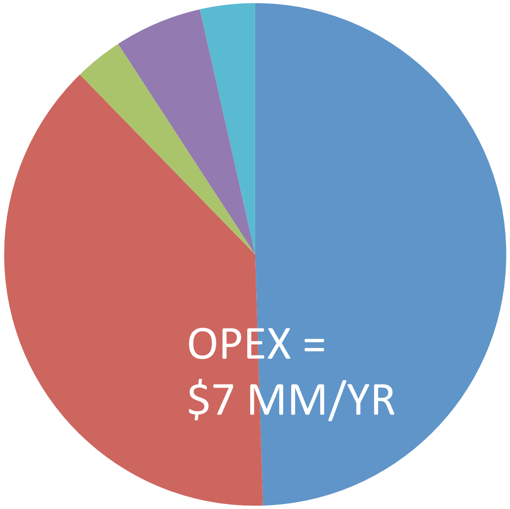


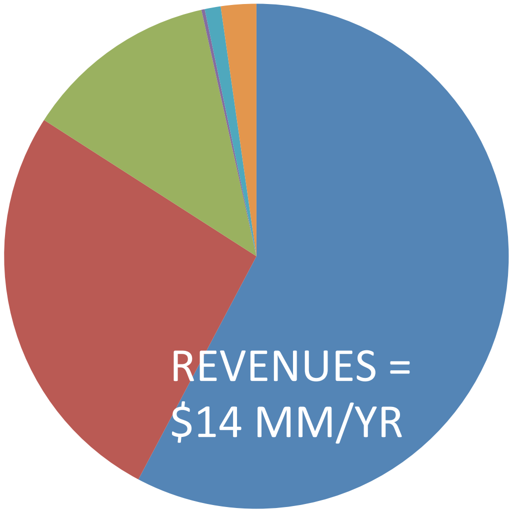
URBAN SMART SEWERING MODEL SUBMODULES



Neighborhood # 2 CWERC – Example of Model Outputs







- WASTEWATER TREATMENT W/WATER REUSE
- THERMAL ENERGY
- ANAEROBIC DIGESTION W/ENERGY RECOVERY
- BIOSOLIDS PROCESSING W/COMPOSTING
- FOOD WASTE SOLIDS PROCESSING W/ NUTRIENT RECOVERY
- REC/RIN

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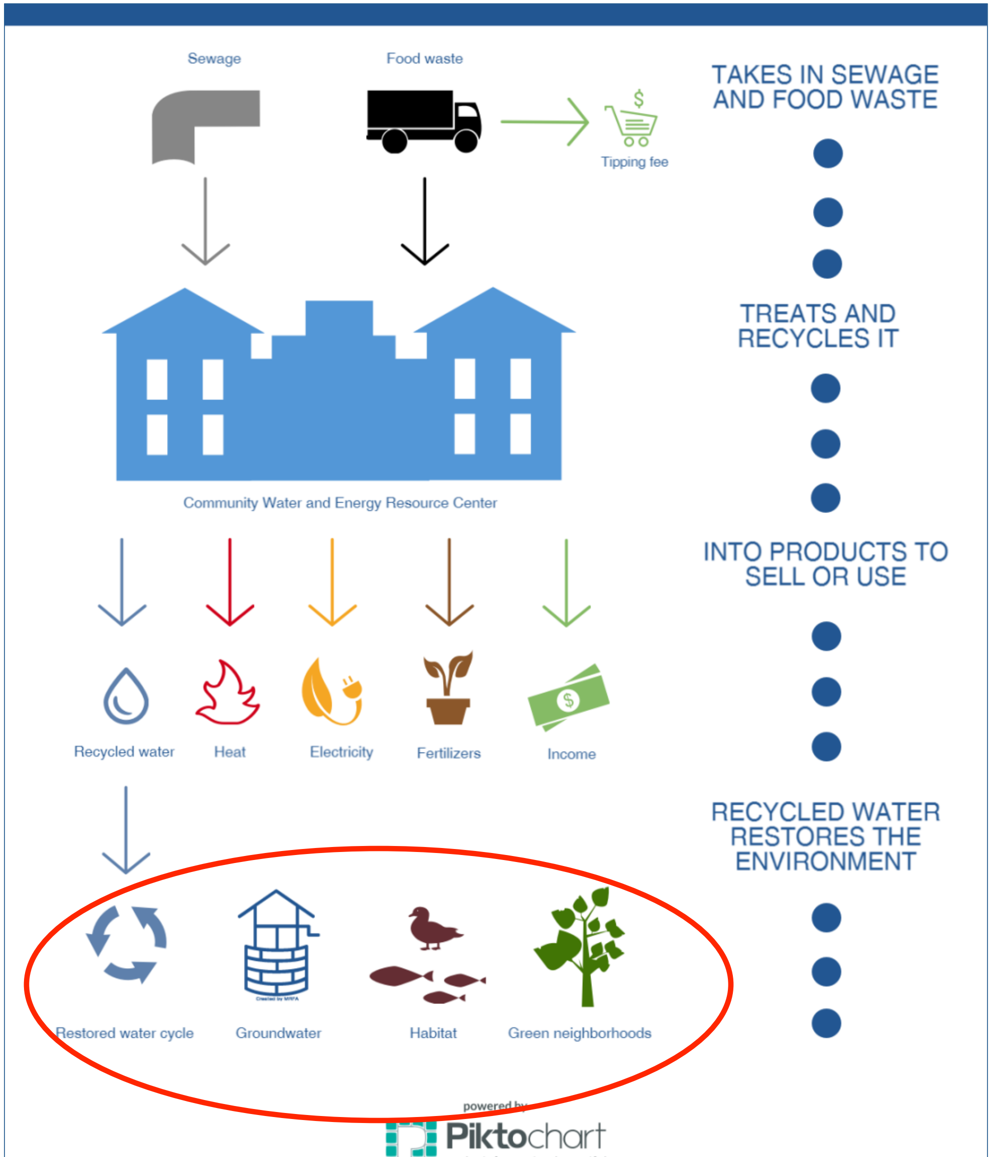
Marrying potable, storm-, waste-, surface and groundwater management to restore the natural water cycle

INTEGRATING STORMWATER MANAGEMENT

Resource to Waste to Resource

Community Water and Energy Resource Centers (or CWERCs) maximize resource recovery



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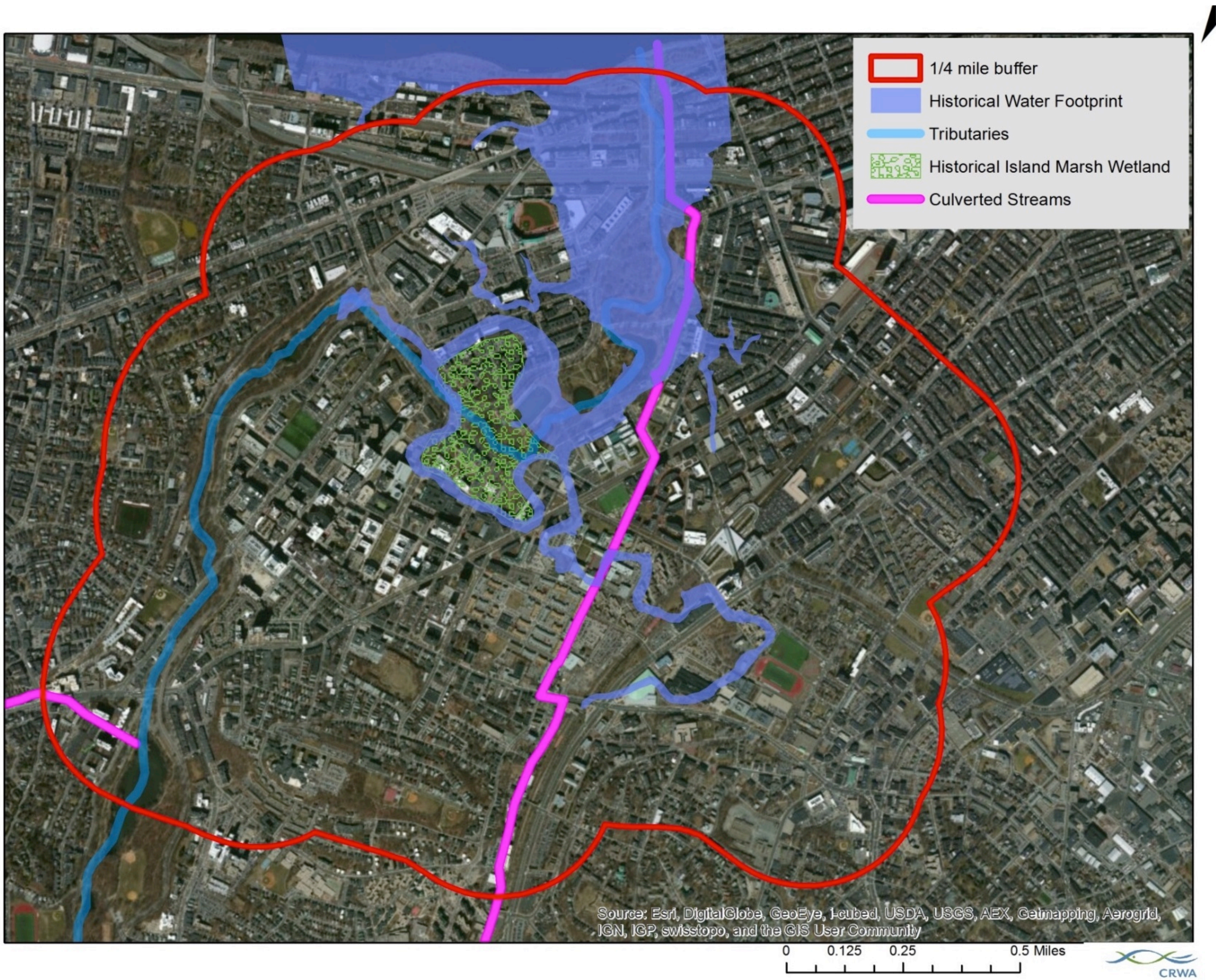
Historical Water Features in Present Day Context



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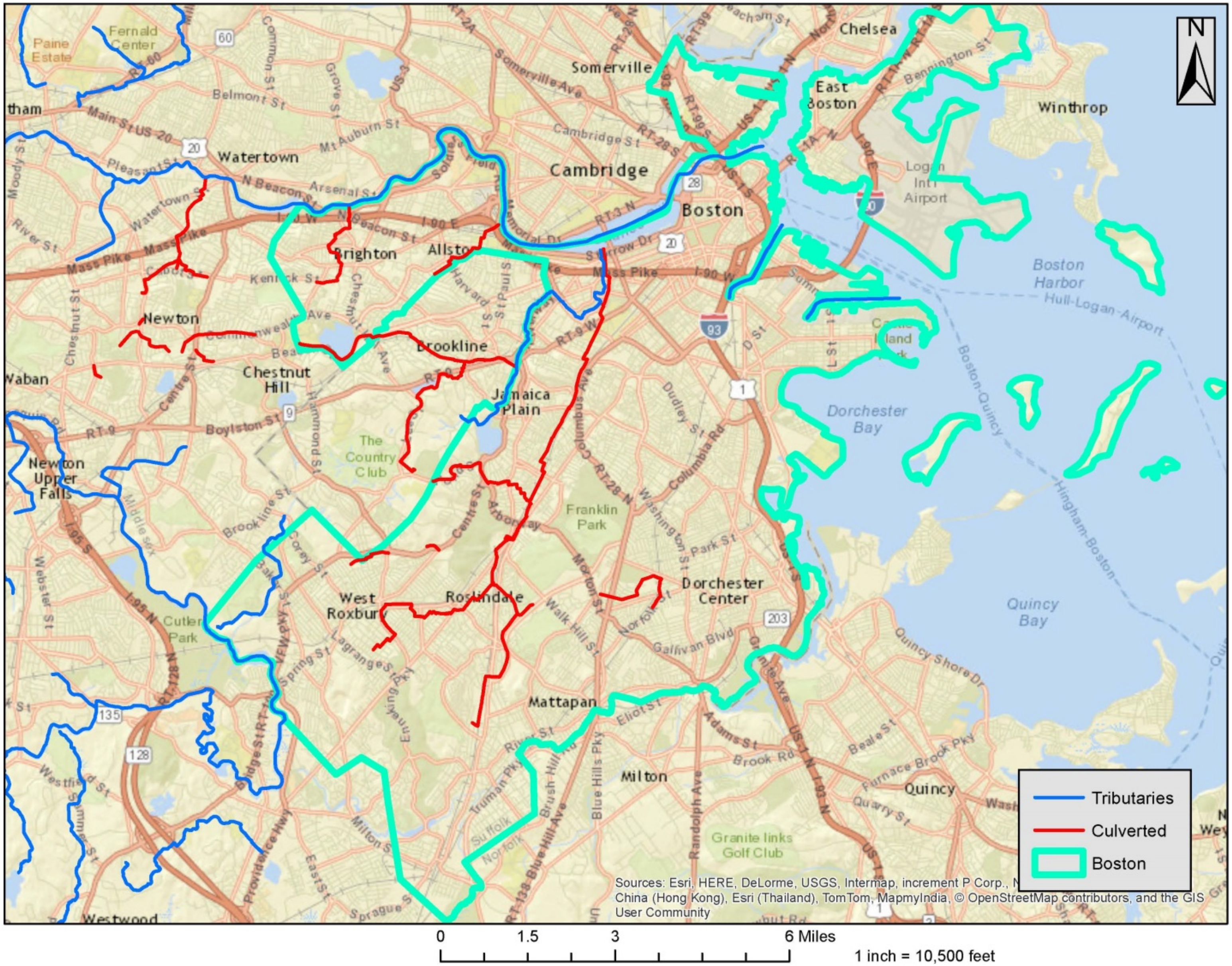
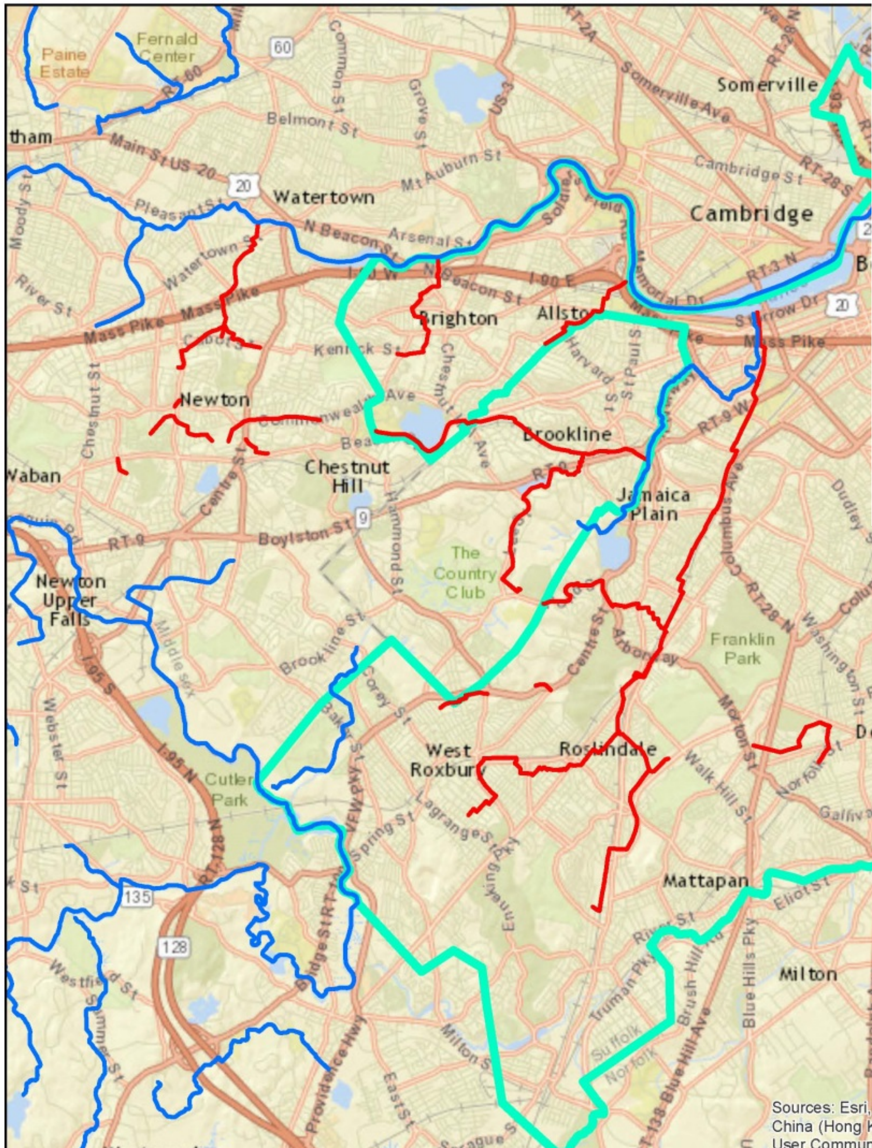
Historical Water Features in Present Day Context



Historical Water Features in

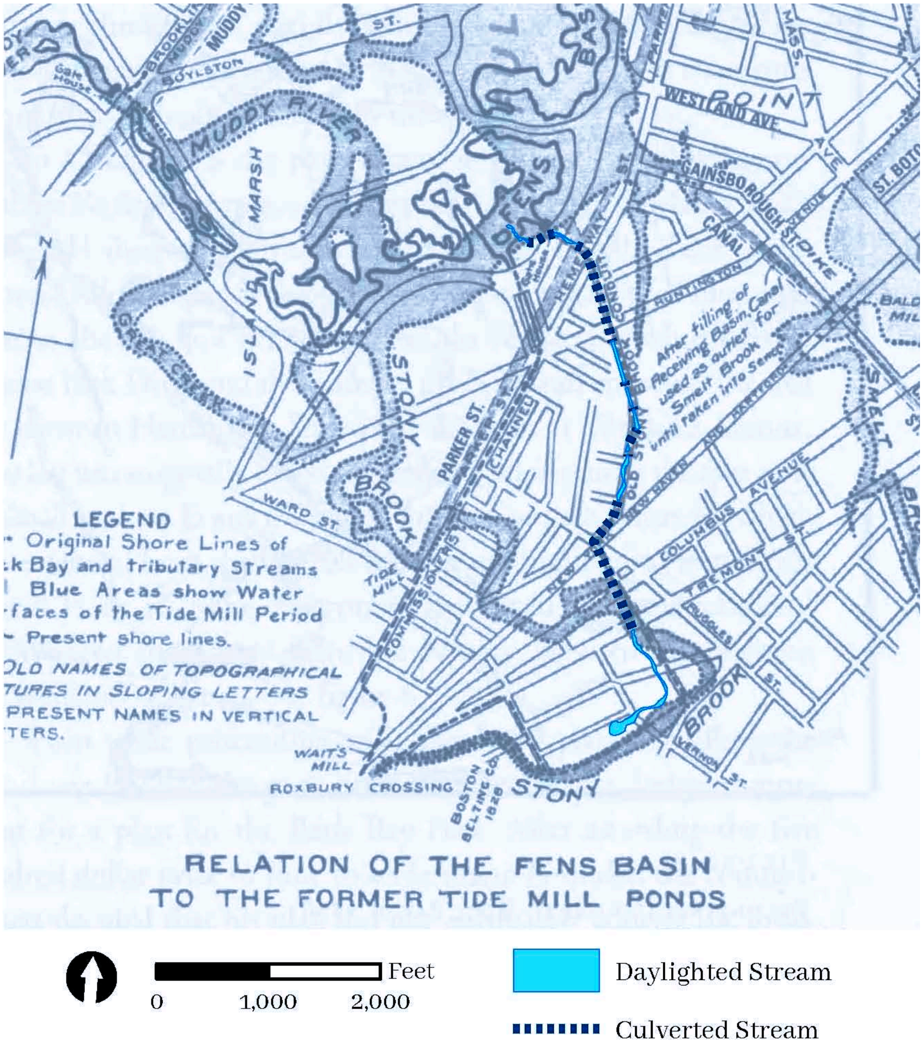


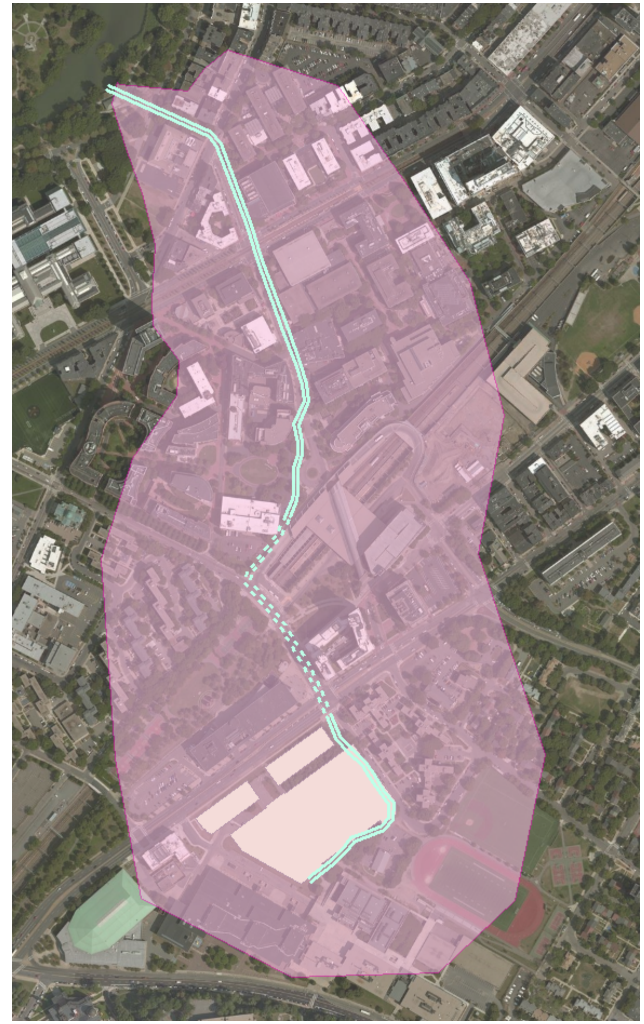
0 1.5 3 6 Miles

1 inch = 10,500 feet

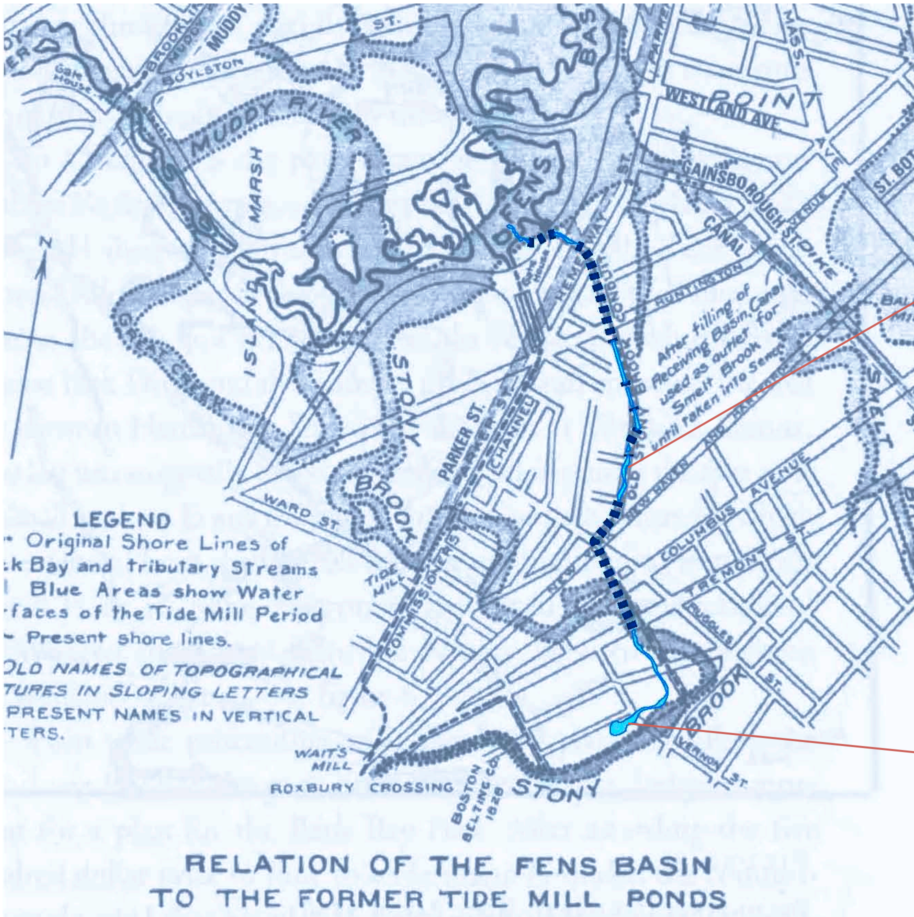
Figure 11. The culverting of Stony Brook at Forest Hills, about 1905.

Restoring Historical Water Features in Present Day Context





Restoring Historical Water Features in Present Day Context



Feet
0 1,000 2,000

Daylighted Stream

Culverted Stream

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Stream Daylighting-Visualization

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Neighborhood Scale Green Infrastructure Integration

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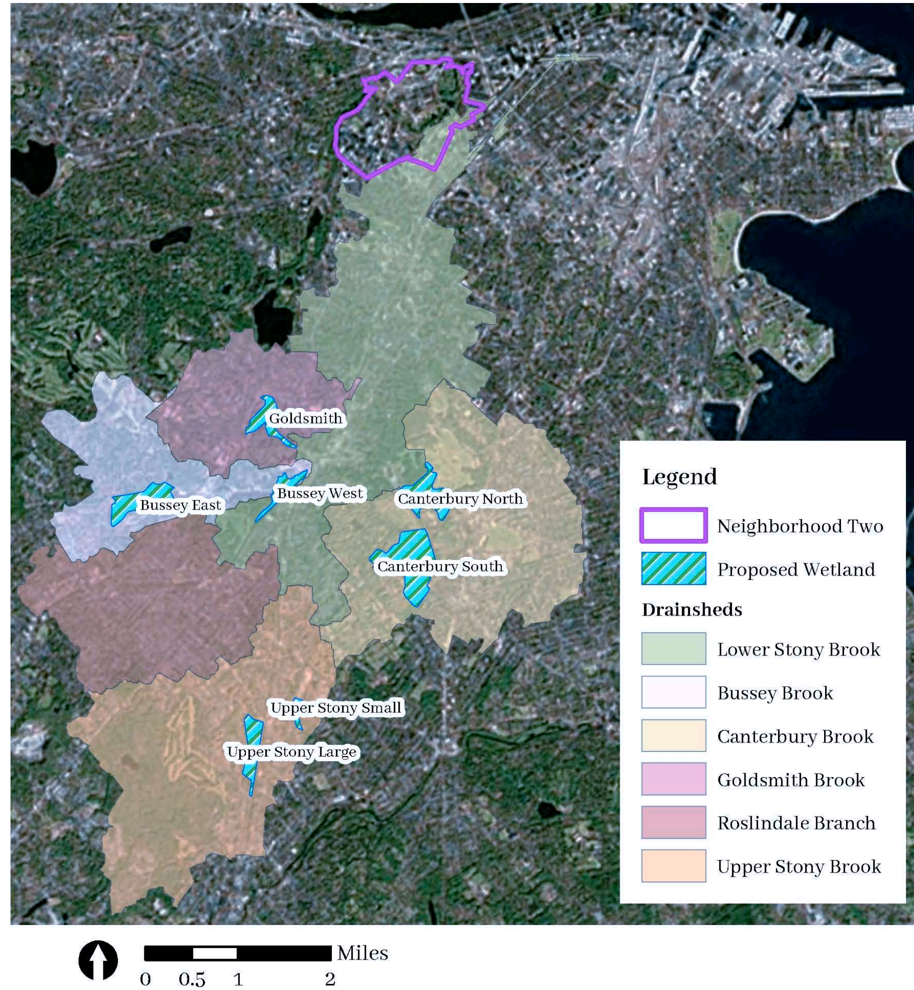
Urban Wetlands



Stormwater Wetland	Drainage Area(s) Treated	Design Storm+	Wetland Area (acres)
Goldsmith	Goldsmith Brook	10 inches (100 year +10%)	32
Bussey West	Bussey Brook	10 inches (100 year +10%)	51
Bussey East	Bussey Brook/Upper Stony	5.5 inches (10 year +10%)	22
Canterbury North	Canterbury Brook	>10 inches (100 year +10%)	49
Canterbury South	Canterbury Brook	10 inches (100 year +10%)	101
Upper Stony Large	Upper Stony	5.5 inches (10 year +10%)	34
Upper Stony Small	Upper Stony	5.5 inches (10 year +10%)	8

Replacing a centralized system with a distributed network of CWERCs and extensive green infrastructure implementation

EXPANSION AND REPLICATION

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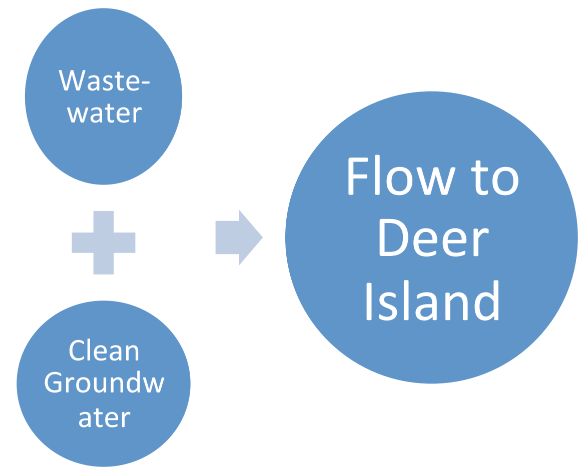
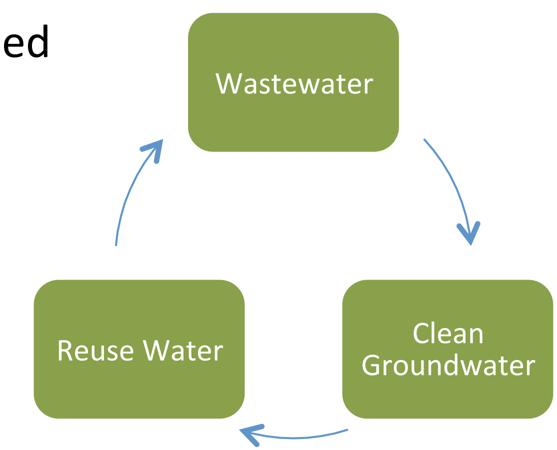
Lessons from Nature: Keep Water Local

- Offset the impacts of infiltration and inflow: about 40% of flow to Deer Island is relatively clean groundwater or rainwater
- Reduce potable water demand from Quabbin or local sources

Existing



Proposed



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Lessons from Nature: Flexible, Adaptable, Interconnected

- A decentralized or distributed network of CWERCs to serve our water and energy needs
  - Resilient and redundant
  - Equitable
  - Efficient
- Integrated stormwater management using green infrastructure, wetland restoration and stream daylighting

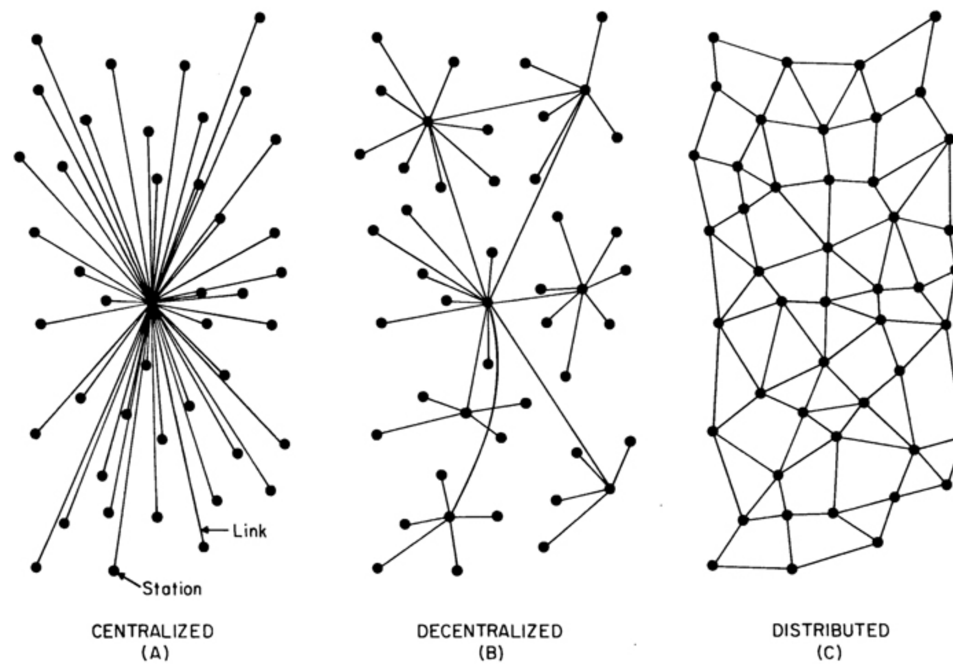

FIG. I — Centralized, Decentralized and Distributed Networks

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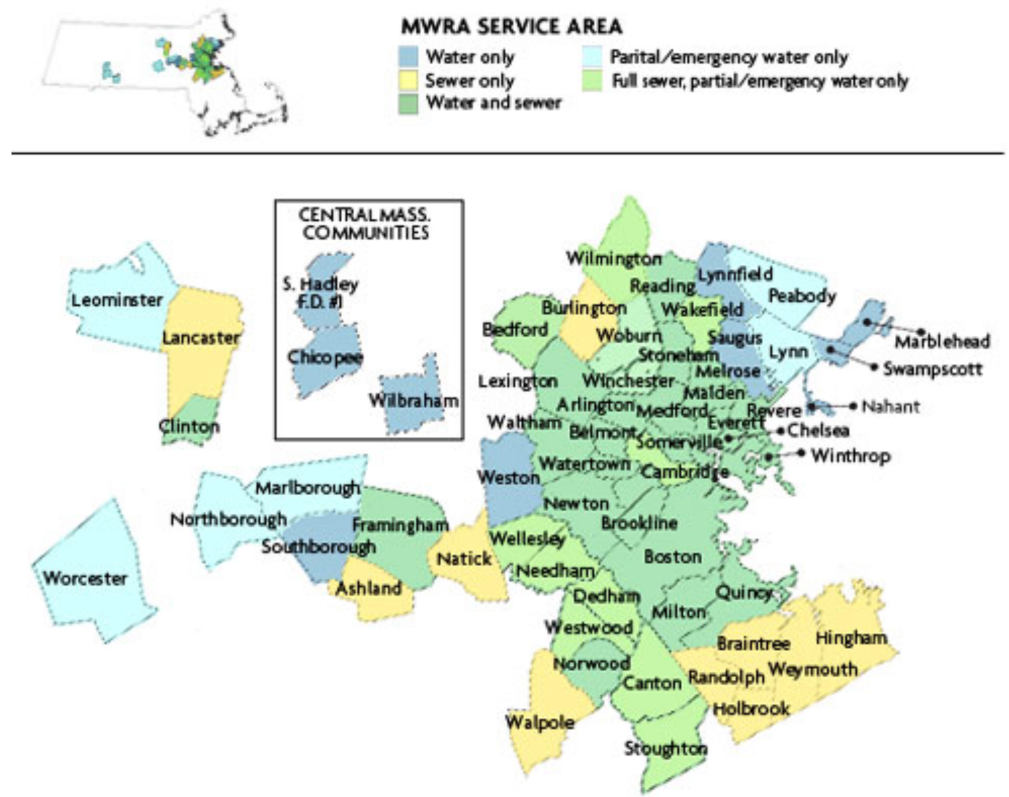
CWERC Expansion Model

- Goal: Model replacing centralized system with CWERCs
- Methodology
  - Developed “unit multipliers” based on pilot scale plants (i.e. energy produced / gallon ww treated, etc.)
  - Modeling done on municipal scale
  - Developed multiple scenarios for varying conditions



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CWERC Expansion Model

	Storage (% current daily flow)	**Water Resale Value (% 2014 rates)**	**Wastewater Fee (% 2014 rates)**
Scenario A: Max Storage	500%	57%	0%
Scenario B: Low Rates w/fees	300%	60%	37%
Scenario C: Thermal Credits in APS (Alternative Energy Credit Added for Thermal Energy)	300%	60%	37%

Modeling Results Summary

Scenario	A	B	C
Total capital cost	$6,678,992,512 (~125-175 CWERCs)	$6,061,272,512 (~125-175 CWERCs)	$6,061,272,512 (~125-175 CWERCs)
Net annualized cost (5%)	$(394,680,023)	$(85,897,238)	$(32,529,246)
Net annualized cost (4%)	$(347,927,075)	$(43,468,330)	$9,899,662
Net annualized cost (3%)	$(301,174,127)	$(1,039,422)	$52,328,570

Potential avoided costs for O&M and capital upgrades for centralized system:
$118-200 million annually

1.8 billion lbs of CO_2 reduced annually

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Thank you for your time!

Special thanks to our other co-authors: Nigel Pickering, (formerly) CRWA, Bob Zimmerman, CRWA; Barbara Wingler, (formerly) NSU; Robert Black, Industrial Economics, Inc.; and Chris Smith, Industrial Economics, Inc.

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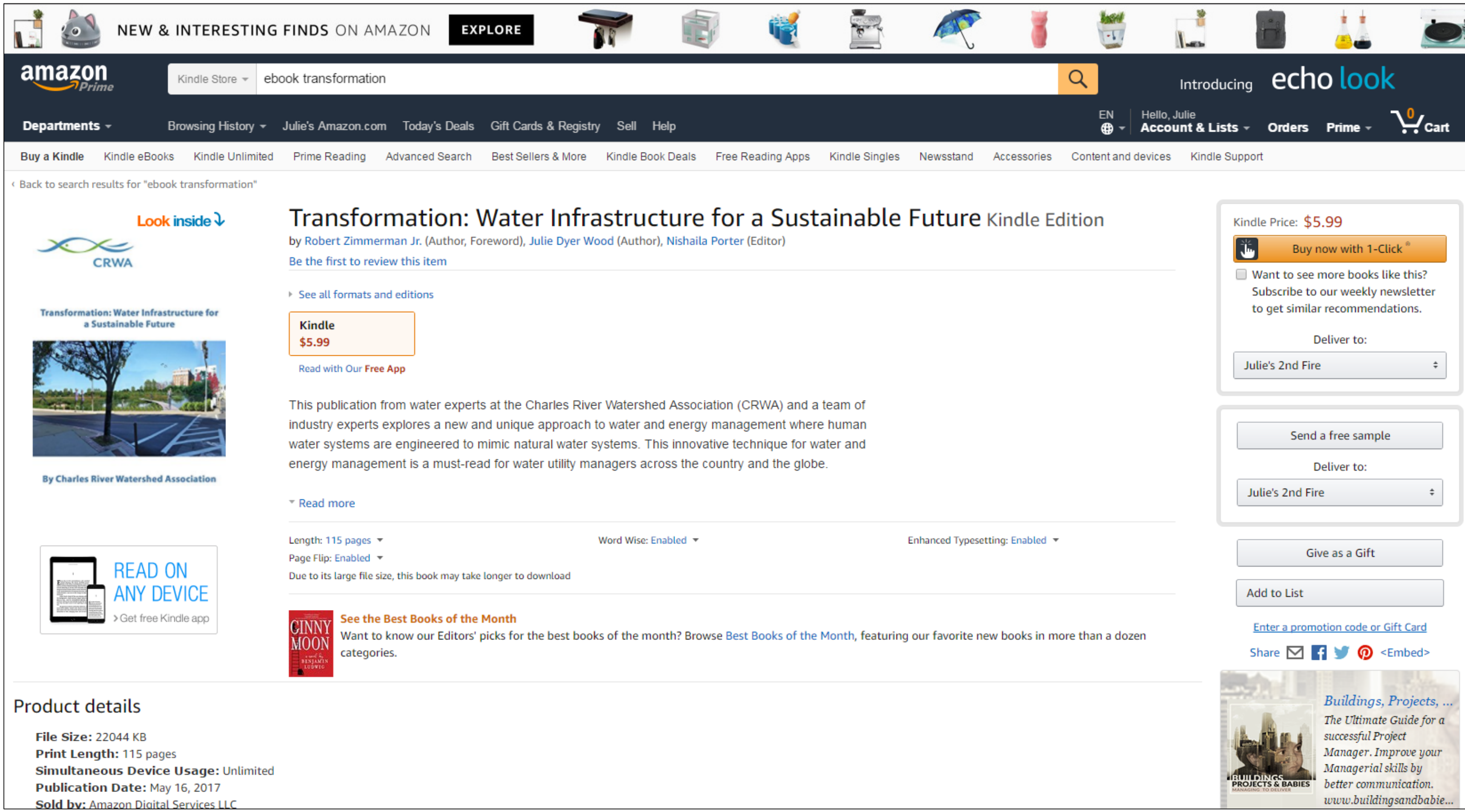
Transformation: Water Infrastructure for a Sustainable Future



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