Once is Not Enough

A Guide to Water Reuse in Massachusetts

495/MetroWest Corridor Partnership
Metropolitan Area Planning Council
Outline

- Project Background
- Issue Background
- Types of Uses & Case Studies
  - Commercial Reuse
  - Industrial Reuse
  - Groundwater Recharge
  - Agricultural Reuse
  - Environmental and Recreational Reuse
- Technical Issues and Cost-Benefit Considerations
- Regulatory Overview
- Recommendations
Project Background

- **495/MetroWest Water Resources Strategy:**
  - Two-year project to address key water resource issues in the 495/MetroWest Corridor, 2004-2006
  - Funded by EPA through an appropriation secured by U.S. Rep. James McGovern
  - Conducted by MAPC in collaboration with the 495/MetroWest Corridor Partnership; with participation of US Geological Survey
  - Six major project components addressing water supply, wastewater, and stormwater issues
Massachusetts Water Use

Background

- With 44” of precipitation per year, why does Massachusetts need to worry about water?
  - Limited aquifer storage statewide
  - Impervious surfaces reduce aquifer recharge; piping of stormwater carries rainwater away
  - Seasonal demand prevents full aquifer recharge
  - Development on poor soils requires sewers and outside water sources
Water Supplies in Massachusetts: Stressed Basins

Massachusetts Basins: Flow Stress

Upstream Basins
- High Stress
- Medium Stress
- Low Stress
- No Data

Gaging Station
Watershed Boundary

0 10 20 30 Miles
Projected percent increase in water demand, 2000-2030
Potential Consequences

- If nothing is done to modify the projected water demand, negative consequences could include:
  - Longer, more contentious, more expensive water permitting processes
  - Higher water rates, affecting home owners and businesses
  - Limits on new connections could impede economic growth
  - Increasing impacts to rivers, streams, and wildlife
Water Use by Purpose

Do all uses require drinking-quality water?

Nationally:
- 32% agricultural, recreational, commercial, and industrial use
- 28% toilet flushing
- 23% bathing
- 14% for laundry and dishwashing
- 3% drinking and cooking
Water Reuse

- Water reuse means using treated wastewater, also known as recycled or reclaimed water, to satisfy certain water demands that do not require potable water.

- Benefits of water reuse include:
  - Non-potable water supply in stressed basins
  - Wastewater disposal option
  - Cost-effective supply for some high-demand industrial users
  - Reduced impacts of large developments
  - Less fresh water diversion from sensitive ecosystems
  - Less treated wastewater discharges into sensitive water bodies
  - Creation or enhancement of wetlands
Trends in Water Reuse

- **Water reuse increasing world-wide:**
  - Australia, the Middle East, parts of Latin America and the Caribbean, Japan, Europe

- **Uses internationally:**
  - Irrigation (most common)
  - Non-potable commercial & industrial uses
  - Indirect recharge of water supplies

- **In the US:**
  - Florida recycles 584 million gallons per day (mgd): 64% for irrigation
  - California recycles 358 mgd: 48% irrigation, 12% groundwater recharge
Allowable Uses in Massachusetts

- Golf courses – spray irrigation
- Landscaping – nurseries
- Toilet flushing in commercial applications
- Artificially recharging aquifers
Types of Uses

- Commercial Reuse
- Industrial Reuse
- Groundwater Recharge
- Agricultural Reuse
- Environmental and Recreational Reuse
Commercial Reuse

- Types of commercial reuse include:
  - Irrigation
  - Toilet flushing
  - Vehicle washing
  - Fountains, reflecting pools, waterfalls
  - Dust control & concrete production
  - Fire protection
Issues with Commercial Reuse:

- Additional treatment beyond standard wastewater treatment
- Possible on-site storage of recycled water
- Dual distribution system
- Demand evaluation
- Clear signs for above ground facilities
- Plant impacts from reclaimed water irrigation
Commercial Reuse, Massachusetts Case Study
Gillette Stadium - Foxborough, MA

- **Background:** New stadium in 2002 in Foxborough
- **Water issue:** Would have overwhelmed town with potable water demand and wastewater flow
- **Solution:**
  - 1 million gallon elevated holding tank for potable water
  - Wastewater treatment plant with subsurface disposal to recharge aquifers
  - 60% of treated wastewater used for toilet flushing in the facility
Commercial Reuse, Massachusetts Case Study
Wrentham Premium Outlet Mall – Wrentham, MA

Water issues:
- No sewers, on-site wastewater treatment required
- Environmentally sensitive land

Solution:
- 100,000 gpd wastewater treatment plant next to parking area
- Wastewater recycling to reduce impacts of effluent disposal – 50% of effluent recycled:
- 75% of recycled effluent used for toilet flushing, 25% for groundwater recharge
Commercial Reuse, Massachusetts Case Study
Bayberry Hills – Yarmouth, MA

- **Background:** Golf course proposed on top of old landfill
- **Water issue:** Yarmouth water supply already stressed during peak summer use periods
- **Solution:**
  - Use treated wastewater to irrigate 7 holes of the golf course and to recharge groundwater
Industrial Reuse

- Types of industrial reuse:
  - Cooling water
  - Industrial processing water

- Main industrial users of recycled water:
  - Utility power plants
  - Metal working facilities
  - Paper mills
  - Textile industry
  - Tanneries
Industrial Reuse

- Issues with industrial reuse:
  - Potential for corrosion, biological growth, scaling due to higher concentrations of contaminants
  - Different industrial processes require different levels of water quality
Industrial Reuse, Massachusetts Case Study: EMC, Hopkinton

- **Background:** EMC planned to add two new large engineering facilities in Hopkinton.

- **Water issues:**
  - Water shortages in Hopkinton during summer months
  - EMC Hopkinton’s largest water user

- **Solution:**
  - Self-distributed wastewater treatment and recycling plant
  - Plant treats 32,000 gpd
  - 11,000 gpd reused

- **Reclaimed Water:** 95% toilets, 5% cooling
Industrial Reuse, Massachusetts Case Study: Intel, Hudson

- **Background:**
  - Intel semiconductor fabrication facility
  - High demand on town water supply and sewage treatment capacity

- **Water issue:**
  - Plant expansion limited by town’s sewer pipe capacity and ability to remove phosphorous from wastewater

- **Solution:**
  - Recycle clean spent rinse water for reuse as Ultra-Pure Water (UPW)
  - Use less treated water for lower water quality demands
Industrial Reuse, Massachusetts Case Study: Intel, Hudson

Outcomes:

- Intel saves 50+ million gallons per year in the UPW Recycle System
- Cost savings of $200 K/yr as water not purchased from Hudson
- Minimizes seasonal variability from municipal water supply
- Intel reduces wastewater and water supply needs
- Successful expansion:
  - Production increased 50%
  - Decreased wastewater discharge
Groundwater Recharge Reuse

- **Benefits:**
  - Prevents saltwater intrusion in coastal aquifers
  - Provides treatment and storage for future water reuse
  - Supplements existing potable or non-potable water supplies
  - Controls or prevents groundwater subsidence

- **Issues with groundwater recharge:**
  - Land requirements
  - Cost
  - Possible aquifer contamination
  - Groundwater law liability
Groundwater Recharge
Massachusetts Case Study: Kingston, MA

- **Background:** Development pressure increases with rail service to Boston
- **Water issues:**
  - Failing septic systems threaten water quality in Jones River and Kingston Bay
  - Town wells overdrawn in summer
  - Need wastewater treatment plan and sewers
- **Solution:**
  - Treated effluent for irrigation at proposed golf course
  - Subsurface leaching fields to recharge aquifers
Kingston System for Water Reuse

Wastewater Treatment Plant

Valve Control

Diversion Box

Diversion Valve

Storage Pond

Irrigation Pump

Driving Range Subsurface Disposal

Golf Course Irrigation

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Agricultural Water Reuse

- Irrigation for agriculture accounts for 75% of all water use worldwide
- Studies show reclaimed water safe for irrigation
- Crop yields increased by nutrients in reclaimed water
- Issues with agricultural reuse:
  - Crop damage from increased salinity, chlorine & trace elements
  - Runoff issues
  - Groundwater monitoring may be required
Example of Agricultural Reuse

- California’s San Joaquin Valley
  - Reclaimed water used on more salt-tolerant crops
  - Final discharge water to solar evaporators
Environmental and Recreational Reuse

- Types of Environmental and Recreational Reuse
  - Wetlands restoration
  - Constructed wetlands
  - Stream augmentation
  - Water features
  - Water impoundments for boating, wading, and swimming

- Issues with constructed wetlands reuse:
  - Significant land use requirements
  - Limited application in urban settings
Water Reuse Technical Issues and Cost Considerations

- **Issues to consider in planning:**
  - Identify demand for reclaimed water
  - Determine existing sources of reclaimed water
  - Investigate level of treatment necessary for intended use
  - Estimate storage capacity to meet seasonal demand
  - Determine needed supplemental facilities
  - Evaluate environmental impacts
  - Incorporate operation & maintenance skills
Suggested Uses by Treatment Level

Wastewater Collection System

Primary Treatment: Sedimentation
- No uses
  Recommended at this level

Secondary Treatment: Biological Oxidation, Disinfection
- Surface irrigation of orchards and vineyards
- Non-food crop irrigation
- Restricted landscape impoundments
- Groundwater recharge of nonpotable aquifer**
- Wetlands, wildlife habitat, stream augmentation**
- Industrial cooling processes**

Increasing level of treatment

Tertiary/Advanced Treatment: Chemical Coagulation, Filtration, Disinfection
- Landscape and golf course irrigation
- Toilet flushing
- Vehicle washing
- Food crop irrigation
- Unrestricted recreational impoundment
- Indirect potable reuse: Groundwater recharge of potable aquifer and surface water reservoir augmentation**

Increasing level of human exposure

* Suggested uses based on Guidelines for Water Reuse, developed by U.S. EPA.
** Recommended level of treatment is site-specific
The Benefits vs. Challenges

**Benefits**
- Provides a safe and affordable alternative water source
- Reduces demand on potable water supplies

**Challenges**
- Added capital costs
  - Additional treatment
  - Reuse water storage
  - Distribution system
- Added O&M costs
- Public perception
Water Reuse Costs

- Water reuse cost issues:
  - Capital improvements at wastewater treatment plant
  - Installation of reclaimed water transmission lines
  - O&M costs for power, water quality monitoring, and administration
  - Cross-connections prevention program
  - Revenue loss for potable water supplier
Cost-Effectiveness & Cost-Benefit Analysis

Evaluation process:

- **Cost-Effectiveness Analysis:**
  - Compare alternative ways to address the same issue

- **Cost-Benefit Analysis:**
  - Determine economic impacts of each alternative on various groups, including each type of user
  - Evaluate price of water & cost of action for each alternative
Regulatory Overview

- **Federal Regulations:**
  - No current regulations (2005) on reuse of treated wastewater

- **Other States:**
  - By the end of 2002:
    - 25 states had adopted water reuse regulations
    - 16 states had guidelines to aid in developing reuse programs
    - 9 had no regulations or guidelines – sometimes permitted case-by-case
Massachusetts Regulatory Approach

- DEP guidelines developed in 1999
- Hybrid of other state programs
- Task Force promotes reuse at:
  - Specific recreation sites
  - New large developments
- DEP evaluating use of reclaimed water for:
  - Public park & playground irrigation
  - Non-residential, highway & cemetery landscaping
  - Cooling water for industrial uses
Constraints & Barriers

- MA plumbing code
- Lack of coordinated local water/wastewater planning
- Regulatory inconsistency at municipal level
- Local zoning not required to comply with community development plans
- No-growth advocates may oppose any additional water supply
- Lack of public education for town officials & residents
Suggested New Uses

- Irrigation
  - Parks
  - Ball Fields
  - Cemeteries
  - Developments
  - Crops
  - Residential irrigation
Suggested New Uses

- Toilet reuse
  - Condos
  - Apartments
- Fire protection
- Powerplants
- Industrial uses
- Automated car wash
Recommendations

- State should work with communities to promote reclaimed water projects
- Minimum water reuse thresholds for developments on state property or using state funds
- Public education campaign
- Technical assistance for communities
- Formation of regional water use districts
- Reuse standards & cost-benefit analysis in MEPA review
A Guide to Water Reuse in Massachusetts

Copies are available from MAPC and the 495/MetroWest Corridor Partnership

Available online at:

www.mapc.org/waterreuse and

www.arc-of-innovation.org
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