Introduction to the water sector: structure, economics, and regulation

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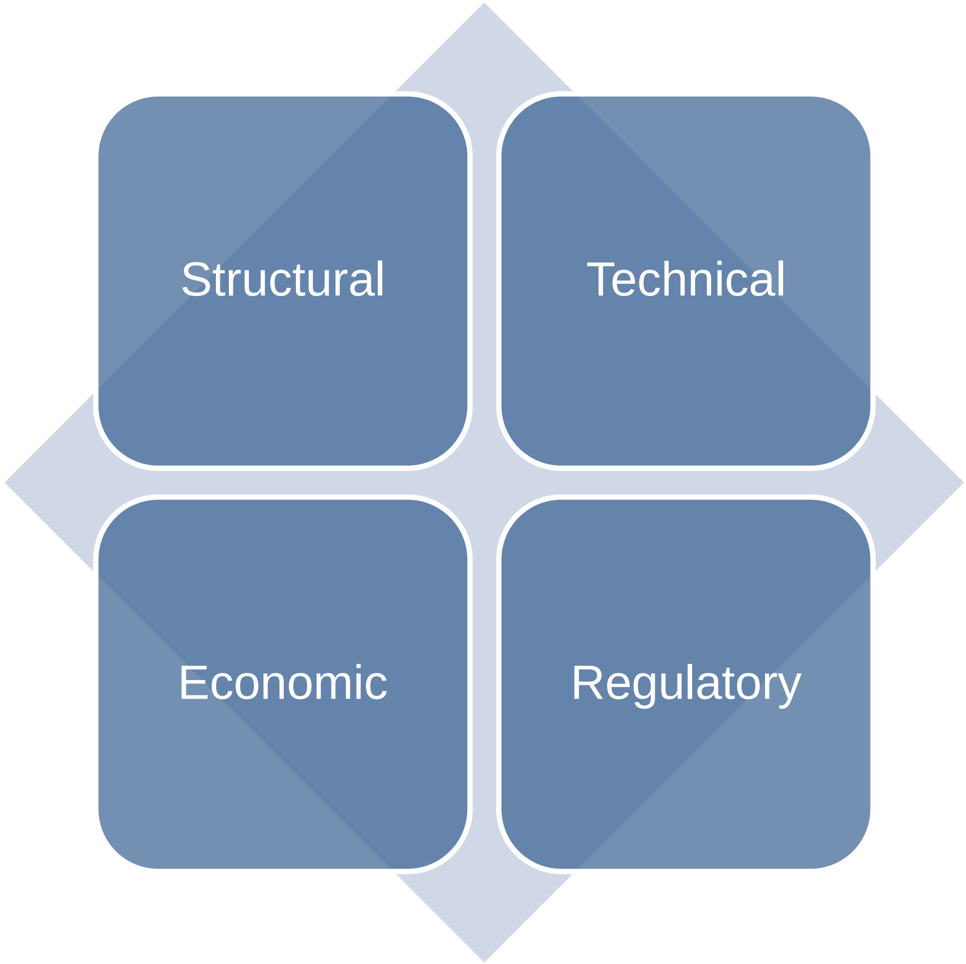
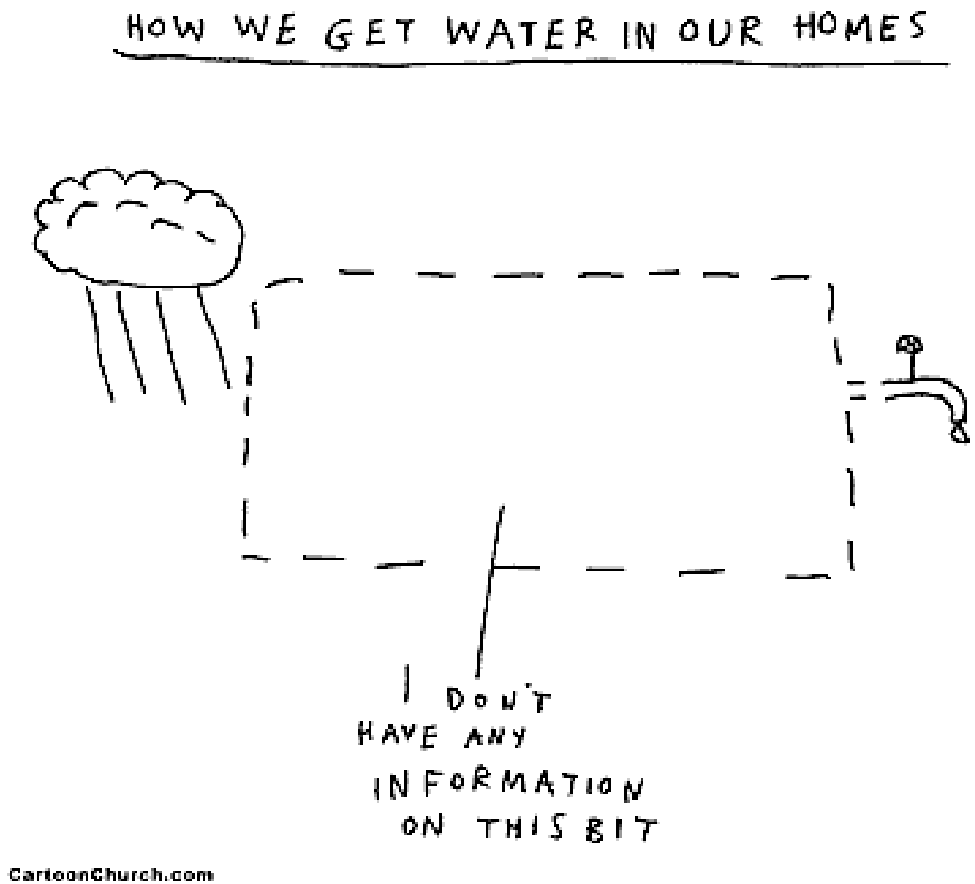
MICHIGAN STATE UNIVERSITY

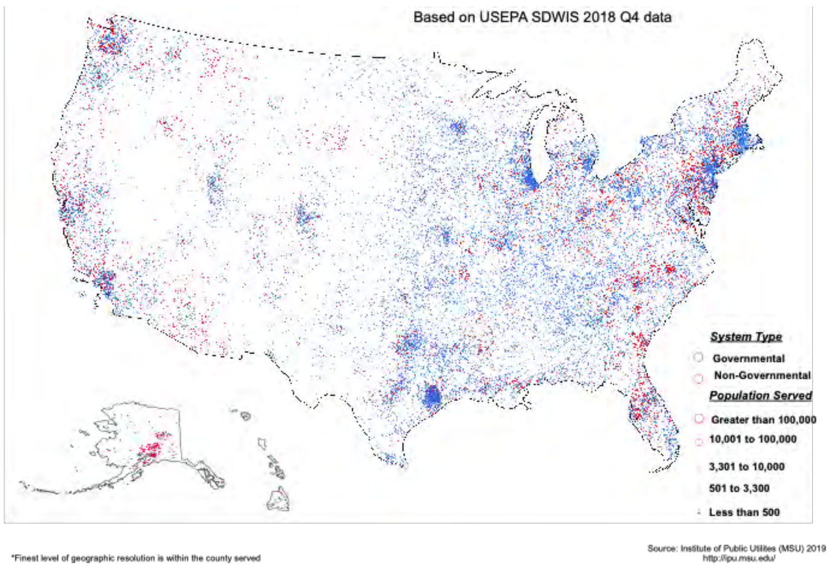
How public utilities compare

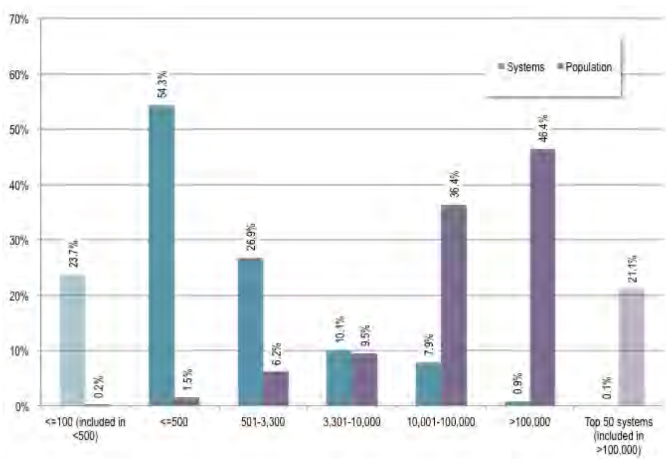


Introduction to water



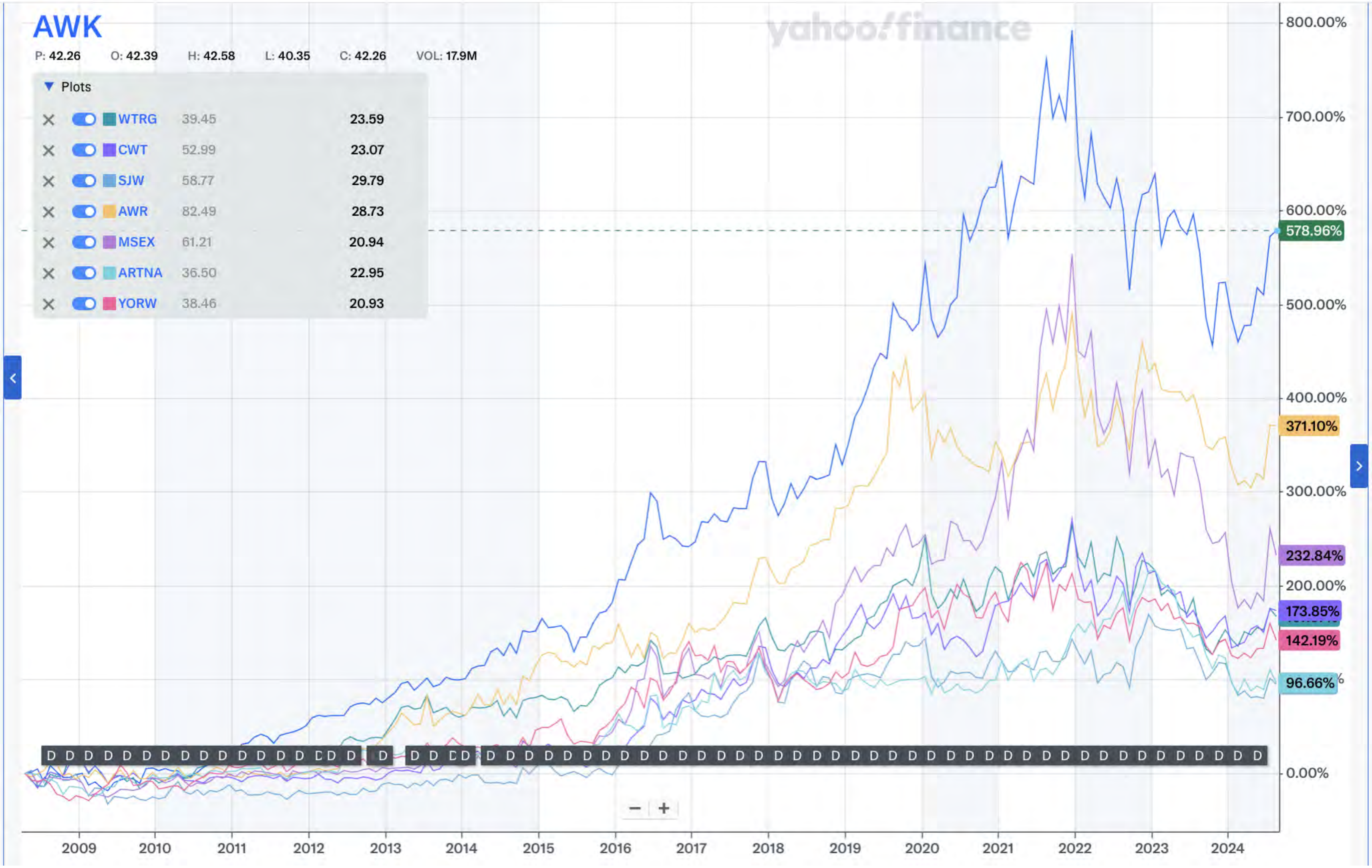
Structure of the U.S. water sector





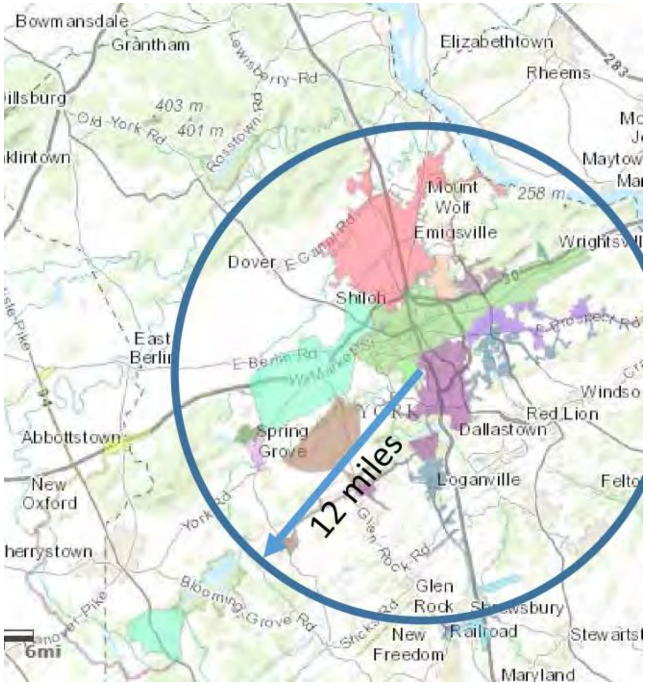
- U.S. regulates nearly **50,000 community water systems** for environmental and public health purposes
- Utilities (the administrative unit) may own and operate multiple water systems
- More than 90% of the U.S. population has community water service
- Industry is fragmented but bifurcated in terms of system size
- Majority of systems serve small populations, but most U.S. water customers are served by larger municipal systems
- Water systems are almost evenly divided in terms of governmental and nongovernmental ownership

Big water: publicly traded investor-owned water utilities



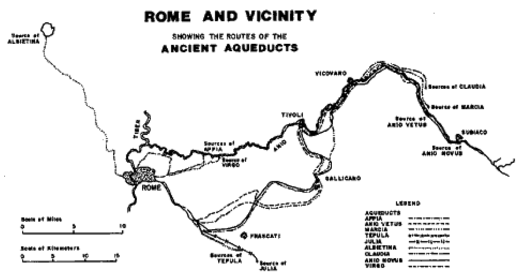
Economic characteristics

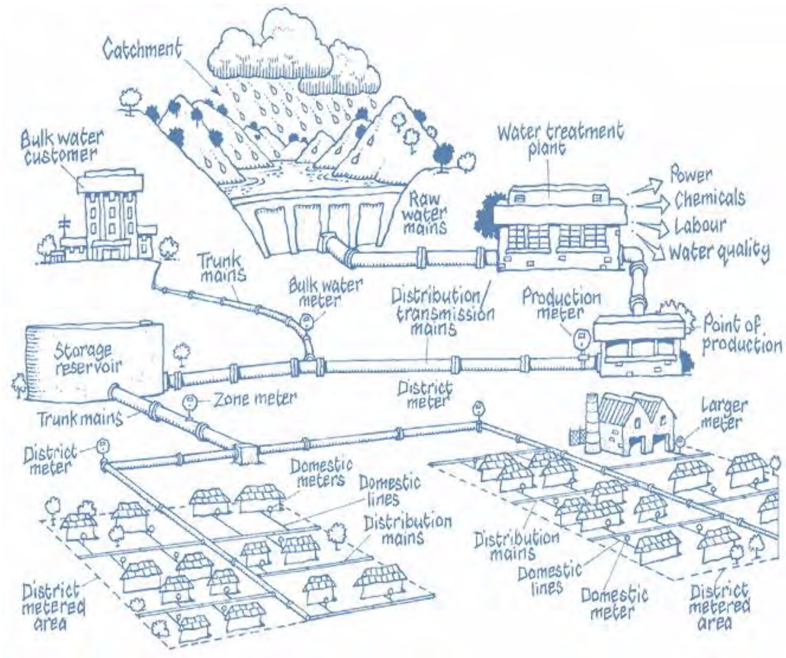
- Most water utilities are vertically integrated – production, transmission, storage, and distribution – although many smaller systems purchase wholesale water
- Water utility monopolies are particularly capital intensive with long-life assets
- Scale economies in production and treatment are offset by the cost of piped networks
- For small systems, structural and nonstructural solutions can help improve capacity, regulatory compliance, and financial sustainability
- Economics do not favor restructuring, competitive markets, and some forms of corporate consolidation
- Systems should be reoptimized and regionalized based on beneficial outcomes



Functional integration

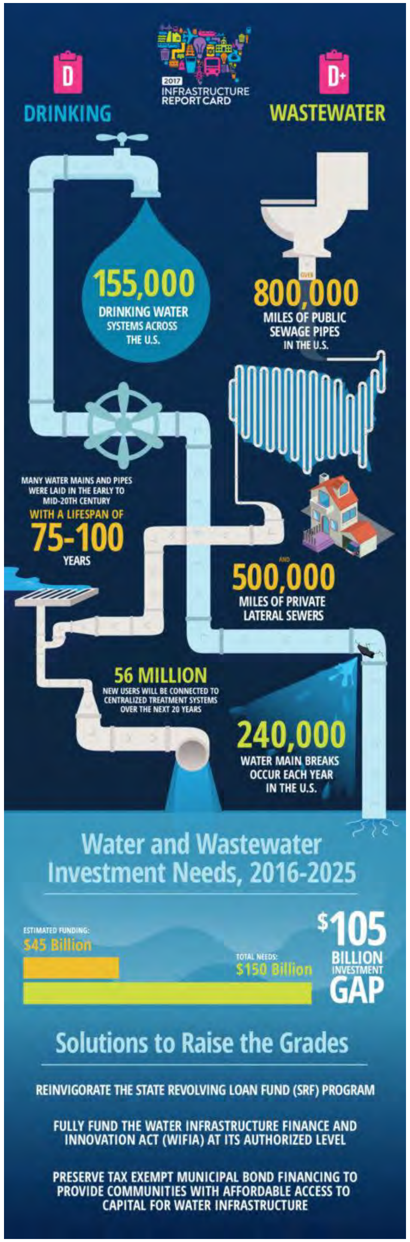
- Production
  - Surface and ground withdrawal; a locally renewable natural resource
- Raw water storage
  - Raw water storage in surface reservoirs and underground well fields
- Transmission
  - Mains and pumping stations; relatively expensive to transport
- Treatment
  - For meeting drinking water standards
- Distribution
  - Local distribution systems, including treated water storage – designed for fire protection and “service on demand
- “One Water”
  - Water, wastewater, stormwater (drainage), ecological and recreational water





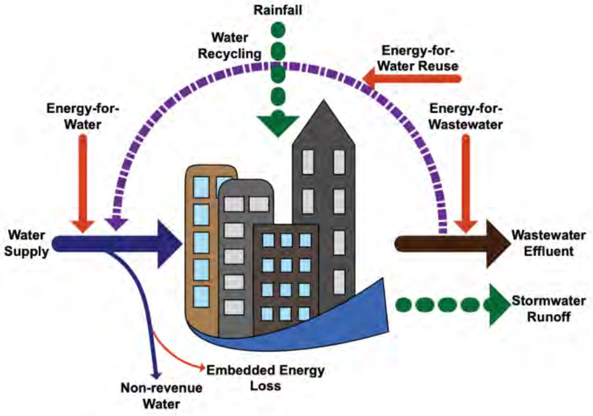
Water infrastructure

- Water utilities are particularly capital intensive (assets to revenues)
  - Long-life assets and scale economies in production – though not unlimited
  - Water infrastructure is mostly invisible and aging or failing to varying degrees based on materials and conditions (main breaks, water losses, infiltration) – especially legacy cities
- Infrastructure needs are estimated at $1 trillion over the next 25 years
  - Need estimates appear to presume in-kind replacement – pipe for pipe
  - Suboptimal in the context of rising prices, falling usage, and excess capacity
  - Planning should be guided by public-health priorities
  - Not all infrastructure is "crumbling"



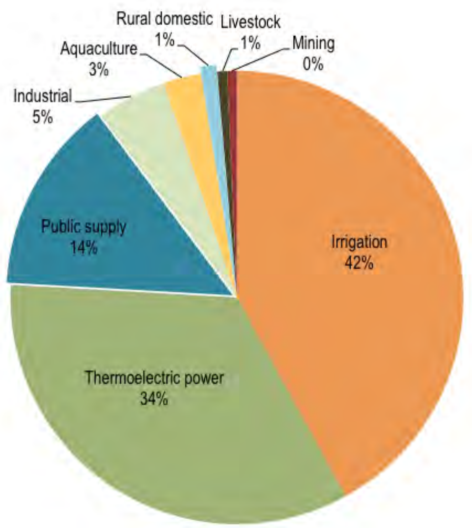
Water and energy

- Water has properties we wish energy had – abundant, renewable, storable
  - Water systems are organized as micro-grids
  - Policy for 50 years favors putting households on grids
  - Off-grid means wells, septic systems, and in-home treatment (POE, POU)
- The water-energy nexus – some add food and land
  - Energy production and usage are water intensive
  - Water production and usage are energy intensive
  - Water can generate energy – gravity fed hydro and piped power
  - Water can also store energy as a large "battery" – pumped (reservoirs) and elevated (towers)
- Water lost is energy lost – and water saved is energy saved
  - Water systems should be on dynamic electricity rates (pumping)
  - Smart water meters may be useful for monitoring and information than pricing
- Technological disruption for water is less likely
  - Multiple social benefits of water grids
  - Scale, scope and network economies
  - Service interdependencies
  - Indoor usage is relatively inelastic
  - Technical limits to substitution
  - Community fire protection



Water supply and public use (USGS)

- Water withdrawals in the U.S. have fallen dramatically relative to population
  - More water is withdrawn for irrigation and thermoelectric cooling than for public supply
  - Aggregate water withdrawals and usage are falling with increasing end-use efficiency and broader shifts in the economy



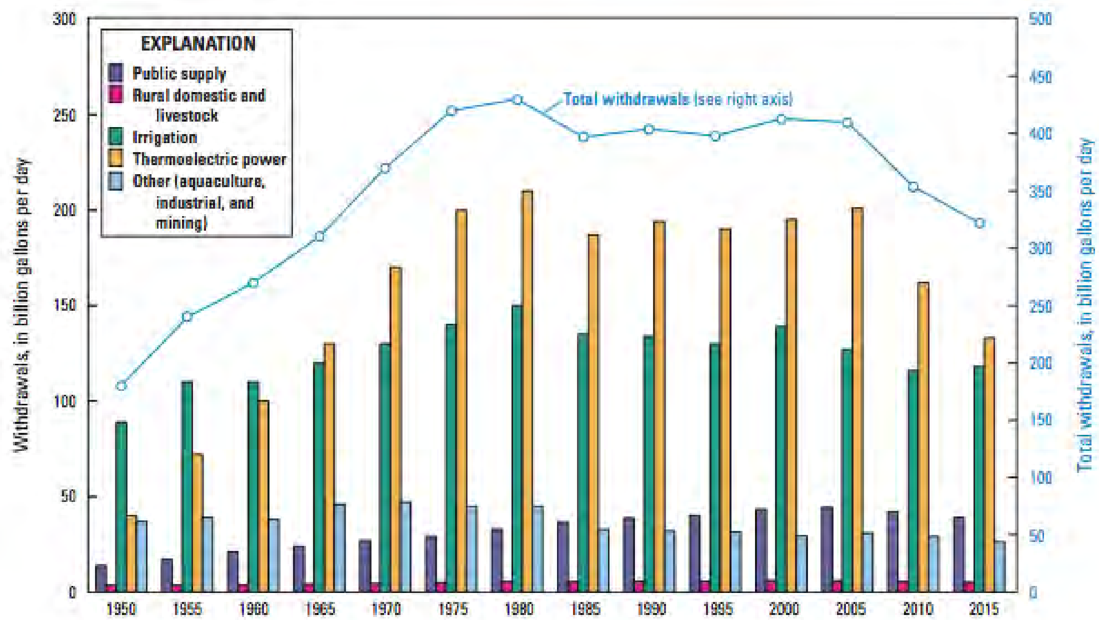


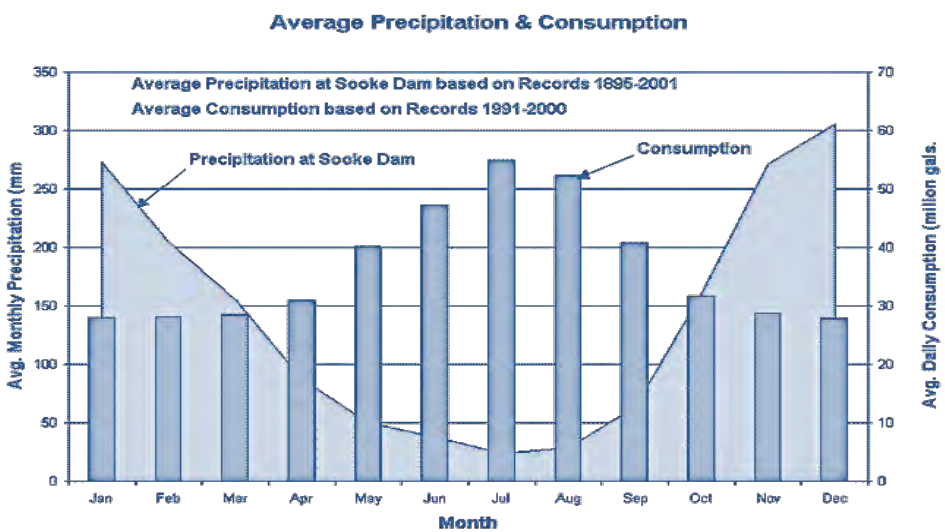
Figure 16. Trends in total water withdrawals by water-use category, 1950–2015.

Water demand and system design

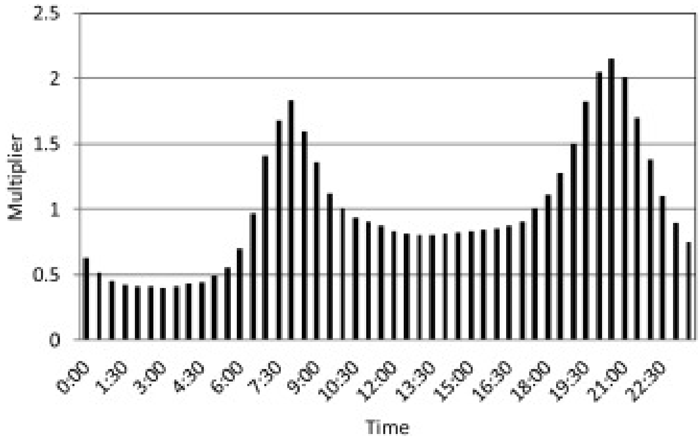
Maximum-hour (hourly peak) demand*
- Distribution mains, pumping stations, treated water storage

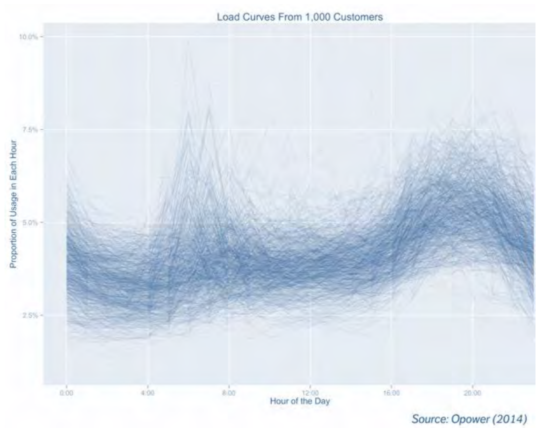
Maximum-day (daily peak) demand*
- Transmission lines, water treatment plants

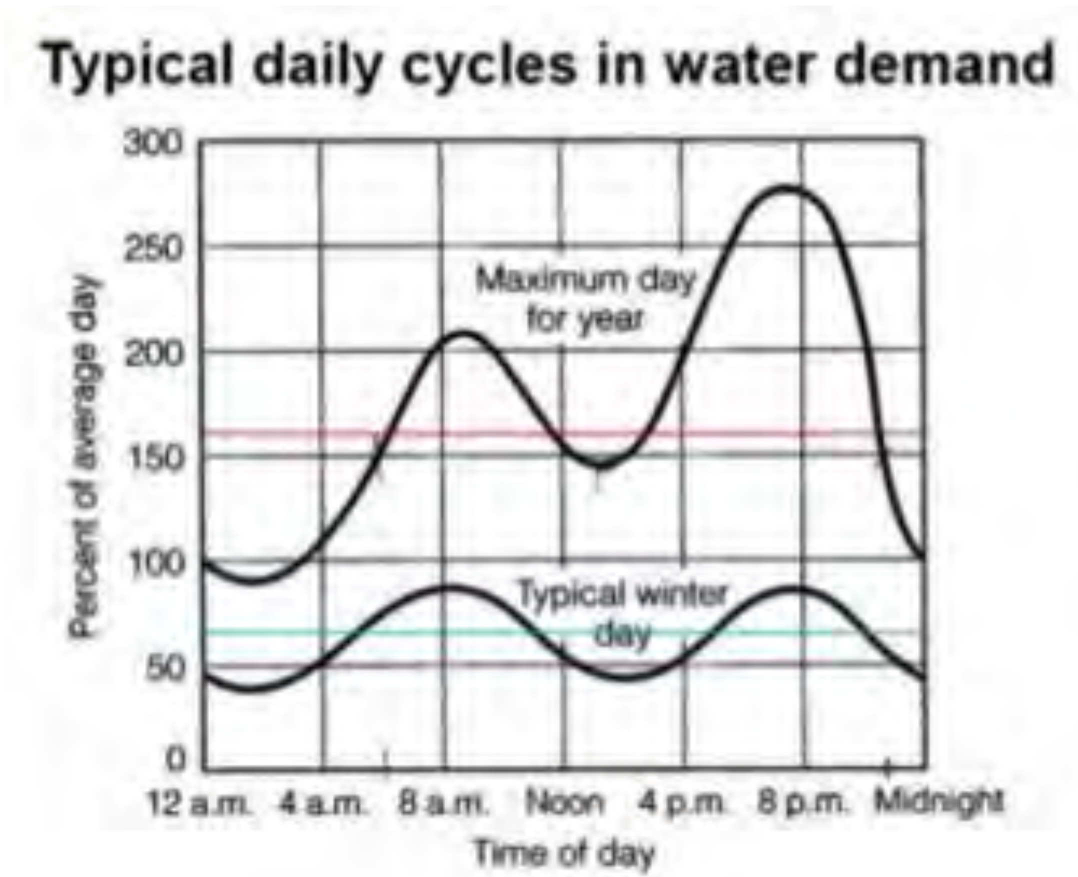
Average-day demand (annual/365)
- Source-of-supply facilities, raw water storage (reservoirs)



Water usage throughout the day

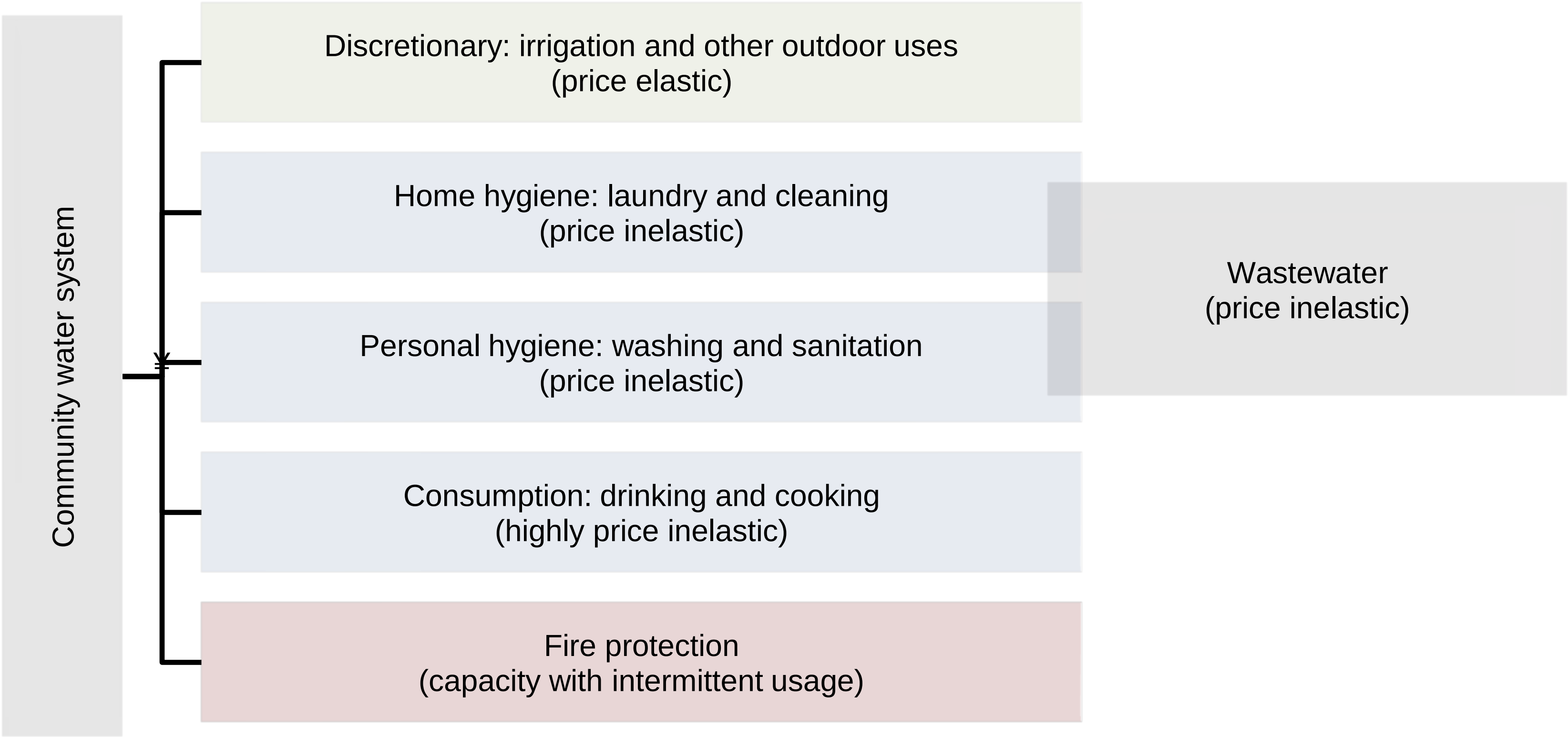




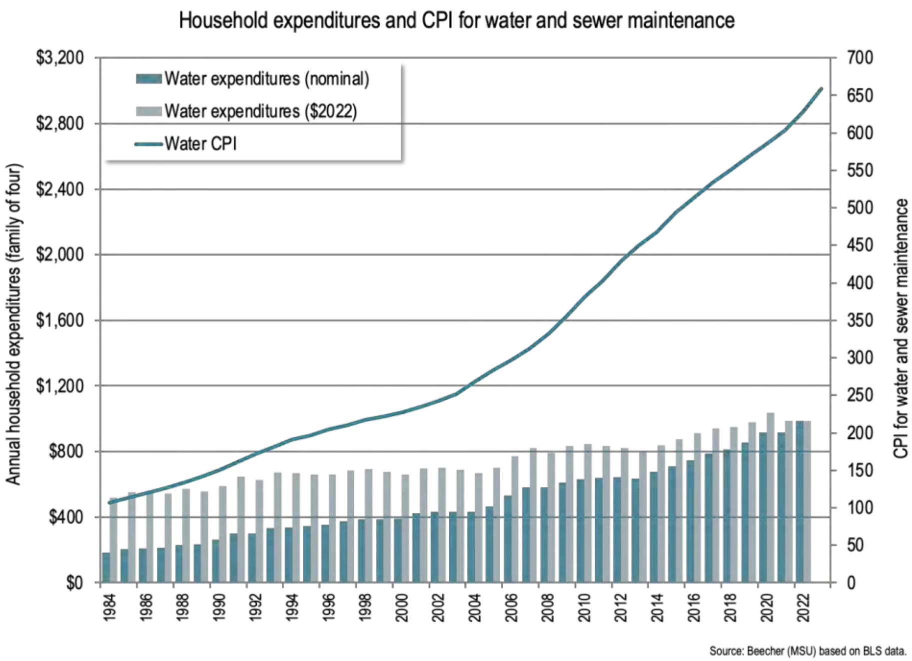


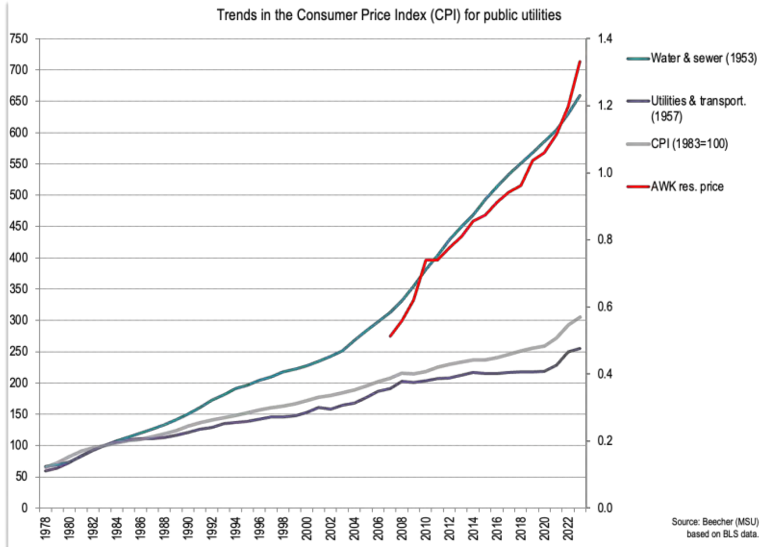
Water demand: five products, one set of pipes

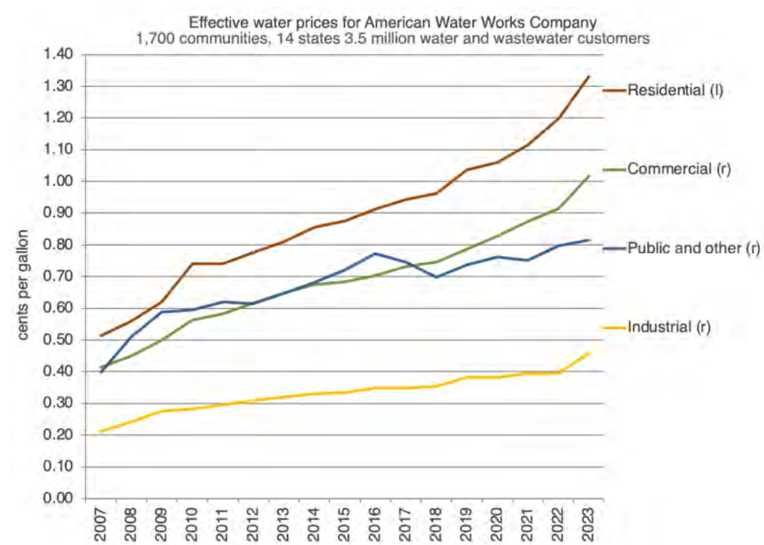
- Water pricing does not differentiate based on the cost or value of these services
  - Essential water usage is nondiscretionary – consumer agency is limited
  - Water systems co-produce water, wastewater, and fire protection
  - Wastewater is a byproduct resource (water, energy, nutrients)



Expenditure and price trends combined and rates by class







Pressure on water utility costs, prices, and affordability

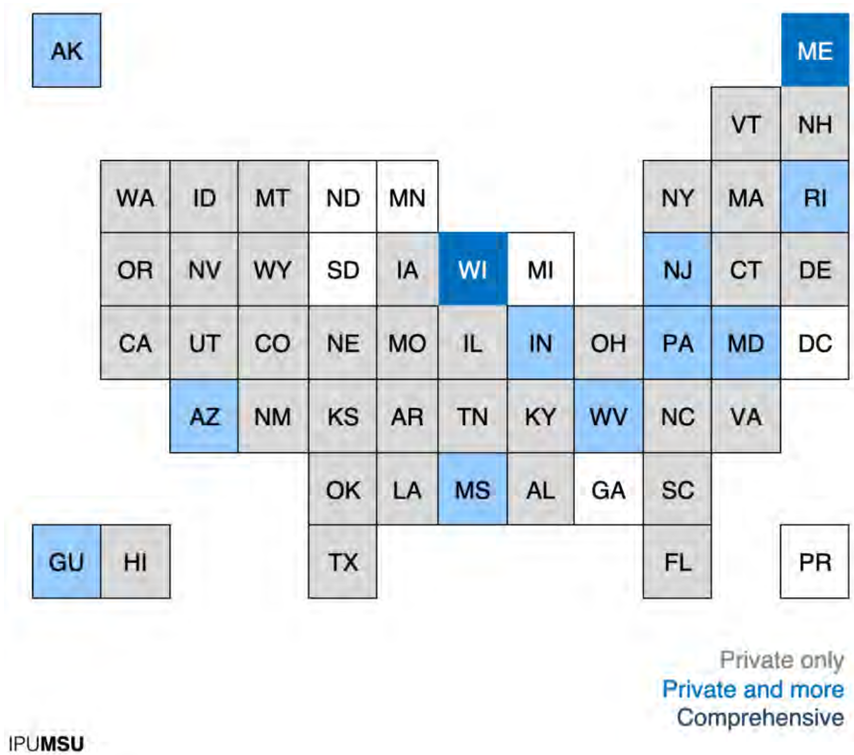
- Capital-cost pressures
  - Combined water, wastewater, and stormwater infrastructure needs (rate base)
  - Legacy costs (e.g., lead service lines), deferrals, and modernization
  - Asset valuation at fair value and private capital investment
- Operating-cost pressures
  - Labor, energy, chemicals, and purchased water
  - Quality standards and compliance costs
  - New threats (PFAS, cyanotoxins, toxic algae, climate change)
- Resource pressures
  - Water supply constraints, including climate-related
  - Economic or population growth (locational)
- Demand pressures
  - Flat or declining usage due to efficiency standards, programs, and practices
  - Economic or population loss (locational)
- Structural pressures
  - Enterprise models and full-cost pricing, often as a fiscal necessity
  - Suboptimal and inefficient sizing and operations given structural change
  - Spending propensities and ineffectual regulatory oversight

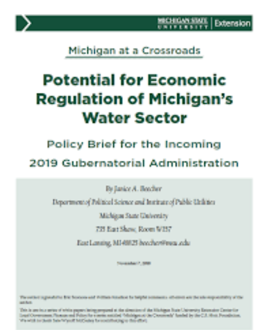
Water federalism in the U.S.: states have primacy

	Water quality	Water quantity	Water funding	Water prices
Federal	Congress and EPA	Court review as applicable	Congress and EPA	Judicial review
Interstate	Basin commissions	Basin commissions	n/a	n/a
States	**Primacy agencies (health & environmental)**	**Resource agencies**	**Revolving loan funds (SRF)**	**PUCs and/or judicial review**
Substate	Management districts (varies)	Management districts (varies)	n/a	n/a
Local	Local health departments	Local zoning and fire officials (pressure)	Local financing (bonds)	Municipal and other local boards

Economic regulation

- Economic regulation is mostly focused on private utility monopolies
  - No federal economic jurisdiction and no state regulation in DC, GA, MI, MN, ND, SD
  - Jurisdiction varies by state and system type, size, and structure
  - Publicly owned systems are subject to local control and regulation
  - Comprehensive jurisdiction in Wisconsin for municipal systems
  - Economic regulatory jurisdiction or tools are needed in the sector





Water as a human right

- Social and environmental justice call for treating essential services as rights
  - World Health Organization recommends minimal provision of 25 gal. (100 liters) per person per day (2,000 gal. per average-sized family of 2.6 per month)
  - U.S. has not established a universal service policy for water or sanitation service, only the obligation to deliver water that meets federal standards
  - Utility model emphasizes financialization, commodification, and full-cost pricing over public health and welfare – despite social impacts of having or not having water
  - New funding and pricing models may be needed (see Beecher, 2020)