Water utility pricing and affordability

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Revised 7/25/19 – DRAFT
Household expenditures on utilities in the U.S.

Consumer expenditures on utilities for a four-person household in 2017 ($5,001 nd 6.2% of total household expenditures)

- Natural gas (.6% of exp.), $482, 9%
- Fuel oil and other fuels (.1% of exp.), $98, 2%
- Water and other public services (1% of exp.), $788, 16%
- Telephone (2.3% of exp.), $1,843, 37%
- Electricity (2.2% of exp.), $1,789, 36%

Consumer expenditures on utilities by household size (2017)

Source: IPUMS based on BLS data.
Household expenditures on utilities over time

Annual consumer expenditures on utilities for a four-person household ($)

- Water and other public services
- Fuel oil and other fuels
- Natural gas
- Telephone
- Electricity

Source: IPU-MSU based on BLS data

Consumer expenditures on utilities for a four-person household (% of total expenditures)

Source: IPU-MSU based on BLS data
Utilities expenditures by income level and regressivity

Note: ratepayer funding of any social program – including affordability assistance - is also regressive, meaning the near-poor will be asked to subsidize the poor.
Aggregate trends: electricity, gas, and water

Electricity usage in the U.S. (EIA 2015)

Natural gas consumption in the U.S. (EIA 2015)

Total water withdrawals in the U.S. (USGS, EIA)
CPI trends for utilities (US)

Trends in the Consumer Price Index (CPI) for public utilities

Source: IPU-MSU based on BLS data.
Expenditure and price trends combined

Household expenditures and CPI for electricity

- Electricity expenditures (nominal)
- Electricity expenditures ($2016)
- Electricity CPI

Household expenditures and CPI for natural gas

- Natural gas (nominal)
- Natural gas expenditures ($2016)
- Natural gas CPI

Household expenditures and CPI for water and sewer maintenance

- Water expenditures (nominal)
- Water expenditures ($2016)
- Water CPI

Source: IPUMSU based on BLS data.
Water infrastructure needs

**Bridging the Water Infrastructure Gap**

Investment by 2020 will improve economic results.

- **$147B** in increased costs to businesses
- **$59B** in increased costs to households

**And profits:**
- Almost 790,000 jobs
- $414B in personal income
- $416B in GDP
- $6B in U.S. exports

**IPU**

**MSU**

### Investment Gaps and Potential Sources of Funding

<table>
<thead>
<tr>
<th></th>
<th>Transportation</th>
<th>Water</th>
<th>Communications</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forecasted Annual Investment Gaps</strong></td>
<td>$2.7 billion</td>
<td>$1 billion</td>
<td>$70 million</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Forecasted Investment Gaps Over the Next 20 Years</strong></td>
<td>$40 billion</td>
<td>$19 billion*</td>
<td>$600 million</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**Potential Sources of Funding**

- Federal funding
- Mitigation-based user fee
- Gas tax increase
- Registration fee increase
- Local revenue options expansion
- Public and private partnerships
- Water rates aligned with investment needs
- Water infrastructure user fees
- Private investment
- Federal funding
- Provider rights-of-way fee increases
- Nonsubscriber surcharges
- Dedicated sales tax for infrastructure
- Dedicated statewide property tax

*This figure includes an estimated $800 million annual gap in water and sewer infrastructure needs. This is considered a conservative estimate using the best information available. As condition assessments are completed, this estimate is expected to increase.*
Inflationary pressure on water costs and prices

- Water system cost and price profiles vary substantially
  - By system type, age, and location
  - Water, wastewater, and stormwater costs may be combined
  - Prices of
  - Investor-owned systems are higher (taxes, returns, practices)

- Capital cost pressures
  - Combined infrastructure needs of $1 trillion need over the next 25 years
  - Asset valuation at fair value for acquisitions – a major threat

- Operating cost pressures
  - Labor, energy, chemicals, and purchased water
  - Quality standards and compliance costs
  - Lead service line replacement
  - New contamination threats
  - Water supply constraints
  - Population growth (locational)

- Flat or declining water usage (pricing, programs, population, recession)

- Move to full-cost pricing as a fiscal necessity for local government (vs. taxes)
  - Promoted by economists, consultants, and regulators (including EPA)
  - Investor-owned utilities invariably charge full cost, including overhead, taxes, & returns
Closing the funding gap

- Closing the funding gap from the top:
  - Efficiency practices
  - Technological innovation
  - Market-based approaches (bidding)
  - Industry restructuring
  - Integrated resource and asset management
  - System (re)optimization relative to demand

- Closing the funding gap from the bottom:
  - Public funding for infrastructure
  - Cost-based rates for water service
  - Comprehensive economic regulation by PUCs address costs and rates
  - EPA’s four pillars: management, efficiency, pricing, watershed protection
Infrastructure funding vs. financing

- Funding for infrastructure is from taxpayers (federal, state, or local) or ratepayers (user fees, charges) – increasing emphasis on ratepayers
  - Rates are more regressive and taxes can be less regressive
  - Capital financing comes from debt or higher cost private debt and equity
  - Funding & financing options can be combined - privatization is not a source of “funding”

- Utility enterprise model and full-cost pricing are strongly favored over taxes
  - Regardless of economic or social basis – compare to historical experience
  - Institutional constraints undermine investment and pricing (MI’s Headlee and Bolt)

<table>
<thead>
<tr>
<th>Capital funding</th>
<th>User fees</th>
<th>Public enterprise</th>
<th>Private enterprise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public (debt)</td>
<td>Public service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private (debt and equity)</td>
<td>Private partnership</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Differential effects of utility rates and taxes

Consumer expenditure on utilities and taxes by quintile (2017%)

Source: IPU-MSU based on BLS data.
Publicly owned utilities: local finances

Local government finances for utilities in 2015 ($billions)

- Gas
- Electricity
- Sewer
- Solid waste
- Water
- Transit

Revenues
Expenditure
Difference

U.S. local government finances for water and sewer through 2015 ($bil.)

Water revenues
Sewer revenues
Water expenditures
Sewer expenditures


Beecher – afford2019
# Sustainable utility enterprises

<table>
<thead>
<tr>
<th>System revenues relative to expenditures</th>
<th>System expenditures relative to optimized compliant service level</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 revenues are below expenditures (&quot;price avoidance&quot;)</td>
<td>&lt; 1 expenditures are below optimum (&quot;cost avoidance&quot;)</td>
</tr>
<tr>
<td>Deficient system</td>
<td>Subsidized system</td>
</tr>
<tr>
<td>= 1 revenues are equal to expenditures</td>
<td>Underinvesting system</td>
</tr>
<tr>
<td>&gt; 1 revenues are above expenditures (&quot;profit seeking&quot;)</td>
<td>Revenue-diverting system</td>
</tr>
</tbody>
</table>
## Cost of service and its recovery

<table>
<thead>
<tr>
<th>Societal level</th>
<th>System level</th>
<th>Ratepayer level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full social cost</td>
<td>Full economic cost</td>
<td>Full-cost accounting</td>
</tr>
<tr>
<td>Environmental, economic, social externalities (spillovers)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opportunity and avoided costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accounting costs</td>
<td>• Capex (debt and equity)</td>
<td>• Federal and state grants</td>
</tr>
<tr>
<td></td>
<td>• Opex</td>
<td>• Lease and other income</td>
</tr>
<tr>
<td></td>
<td>• Depreciation</td>
<td>• Property taxes</td>
</tr>
<tr>
<td></td>
<td>• Taxes</td>
<td>• General fund transfers</td>
</tr>
</tbody>
</table>
Economics of price signals and welfare effects

Prices too high
- Extracts rents from essential usage (Ramsey pricing)
- Regressive deprivation and endangerment
- Drag on the local economy (income effect)
- Excess capacity and stranded investment
- High reserves and transfers from system
- Foregone revenues (lost sales, theft, bypass, defection)

Prices too low
- Weakens price signals for discretionary usage
- Excessive and wasteful use of resources
- Inadequate infrastructure investment
- Poor capacity utilization and congestion
- Low reserves and subsidies to system
- Financial effects of revenue inadequacy
Modern criteria for evaluating utility rates*

- **Criteria**
  - Financial viability
  - Economic efficiency
  - Equitable allocation
  - Operational performance
  - Network optimization
  - Environmental stewardship (social equity)
  - Distributive justice (social equity)

- **Constraints and considerations**
  - Understandable, unambiguous, and transparent
  - Technically feasible and cost effective
  - Legally defensible and politically acceptable

*Building on Bonbright (1961)
Michigan is one of six U.S. jurisdictions that has no economic regulatory jurisdiction for the water sector.

Regulation “in the public interest”
- substitutes both for competitive market and governmental provision of the monopolies providing essential services at just and reasonable rates
- Regulation is protective of both utilities and ratepayers

Source: Surveys by IPU and Wisconsin PSC.
Defining affordability for water (AWWA, M1)

- Affordability may be defined in terms of the ability of
  - Poorest households in the service area to afford their water and wastewater bills.
  - Average or median household in the service area to afford its water and wastewater bill.
  - An unconnected household or business to afford connection.
  - Community to bear the total costs of providing water infrastructure and services.
  - Community to afford these costs as measured by the USEPA or other relevant entities.

- How EPA measures affordability for regulatory purposes (currently debated)
  - Water at 2.5% of MHI and wastewater: 2% of MHI (4.5% total)
  - Infers a combined annual water and wastewater bill of 4.5%
  - AWWA and others have also adopted similar metrics.
Alternative metrics (Teodoro, 2018)

- Convention methods are flawed and may be misleading
- Proposed method
  - Measures household-level affordability (rather than the entire utility’s financial capability)
  - provides for basic water needs (rather than average consumption)
  - Focuses on low-income households (not average- or median-income customers)
  - Accounts for essential costs other than water and sewer
- Two complementary metrics
  - $AR = \text{affordability ratio}$
  - $AR_{20} = \text{at the 20th income percentile}$
  - $HM = \text{hours of labor at minimum wage}$

### TABLE 2: Affordability metrics for Dallas, Tex.

<table>
<thead>
<tr>
<th></th>
<th>$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Basic monthly water and sewer cost</td>
<td>$59.82</td>
</tr>
<tr>
<td>AR</td>
<td></td>
</tr>
<tr>
<td>B. $AR_{20}$ annual income</td>
<td>$18,585.00</td>
</tr>
<tr>
<td>C. Monthly income ($B \div 12$)</td>
<td>$1,548.75</td>
</tr>
<tr>
<td>D. Estimated monthly essential expenses$^b$</td>
<td>$864.11</td>
</tr>
<tr>
<td>E. Monthly disposable income ($C - D$)</td>
<td>$684.64</td>
</tr>
<tr>
<td>AR$_{20}$ ($A + E$)</td>
<td>8.74%</td>
</tr>
<tr>
<td>HM</td>
<td></td>
</tr>
<tr>
<td>F. Minimum wage per hour</td>
<td>$7.25</td>
</tr>
<tr>
<td>HM ($A + F$)</td>
<td>8.25</td>
</tr>
</tbody>
</table>

$AR = \text{affordability ratio}, AR_{20} = \text{affordability at the 20th income percentile}, HM = \text{hours of labor at minimum wage}$

$^a$Based on 2017 rates
$^b$Estimates based on regression analysis of 2015 Consumer Expenditure Survey. See appendix.
Affordability policy options

- Payment credits or assistance (including voluntary funding)
- Tax exemption for water bills
- Arrearage forgiveness
- Budget billing
- Bill timing (monthly)
- Payment convenience (kiosks)
- Lifeline and other rate structures
- Smart meters (tamper resistant)
- Service limiters (time or flow limited)
- Coordinated outreach and counseling
- Disconnection policies (including prohibition)
- Prepaid meters (self-rationing, self-disconnection)
- Tailored efficiency programs and dynamic pricing
- Fixed charges calibrated to property values with usage allowance (water)
Options identified for Michigan (Detroit and Flint)

Detroit’s Water Affordability Program: Practical, implementable solutions
Presented by Gary Brown, DWSD Director, and Eric Rothstein, BRPA Chair
February 8, 2016
The rationale for customer assistance programs

- **Utility funded customer assistance programs**
  - Emphasize an enterprise model based on full-cost recovery and pricing without subsidy
  - Presume public tax support will be prohibited by law, unavailable, or insufficient
  - Easier for larger systems with a diverse customer base, lower costs, and lower poverty

- **Business case**
  - “Frequent service shut-offs and resolving bad debt from customers who cannot afford their rates can be more expensive for a utility than instituting a CAP and assisting customers in paying their bills.”
  - “Utilities might use this argument that differences in rates based on income are justified, not only because it is socially responsible but because it helps the utility operate more efficiently.”
  - “The benefit to the utility of having discounts or lower rates for low-income customers is the increased likelihood of collecting payment from these customers; the subsidy makes it possible for these customers to pay more of their bills more regularly and promptly” (Curley 2014).” (Mehan and Gansler, 2017)

- **Regulatory issues**
  - Cost recovery from ratepayers is also regressive and will impact the near poor
  - Program audits to ensure proper use of funds and program effectiveness (metrics)
  - Expansion, enhancement, and consolidation of existing programs (i.e., LIHEAP)
Basic rate design options

Note: rate blocks can be understood like income taxes, that is, rates usually are incremental or marginal and the customer’s bill reflects cumulative calculations.
Progressive design depends on details and perspectives

Tuscon and Phoenix water bills

- Tuscon:
  - 1 month: $16.87
  - 5 months: $24.35
  - 10 months: $38.77
  - 16 months: $64.52
  - 32 months: $192.57

- Phoenix in Low Season:
  - 1 month: $4.25
  - 5 months: $4.25
  - 10 months: $16.45
  - 16 months: $34.75
  - 32 months: $83.55

- Phoenix in Medium Season:
  - 1 month: $4.25
  - 5 months: $4.25
  - 10 months: $18.49
  - 16 months: $39.85
  - 32 months: $96.81

- Phoenix in High Season:
  - 1 month: $4.25
  - 5 months: $4.25
  - 10 months: $4.25
  - 16 months: $27.65
  - 32 months: $90.05

Legend:
- Blue: Monthly Service Charge
- Orange: Usage Charge
# Fixed vs. variable charges: tradeoffs

<table>
<thead>
<tr>
<th>Recovering more costs from fixed charges</th>
<th>Recovering more costs from variable charges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static view of infrastructure</td>
<td>Dynamic view of infrastructure</td>
</tr>
<tr>
<td>(more sunk costs)</td>
<td>(less sunk costs)</td>
</tr>
<tr>
<td>Enhances revenue stability</td>
<td>Reduces revenue stability</td>
</tr>
<tr>
<td>(less sales revenue risk to utility)</td>
<td>(more sales revenue risk to utility)</td>
</tr>
<tr>
<td>Weakens price signals</td>
<td>Strengthens price signals</td>
</tr>
<tr>
<td>(less resource efficiency)</td>
<td>(more resource efficiency)</td>
</tr>
<tr>
<td>Familiar &amp; understandable but less acceptable</td>
<td>Familiar &amp; understandable but more acceptable</td>
</tr>
<tr>
<td>(more predictable and less controllable)</td>
<td>(less predictable and more controllable)</td>
</tr>
<tr>
<td>Less affordable for low-income households</td>
<td>More affordable for low-income households</td>
</tr>
<tr>
<td>(more regressive)</td>
<td>(less regressive)</td>
</tr>
<tr>
<td>Encourages self supply and grid defection</td>
<td>Preserves grid supply and participation</td>
</tr>
<tr>
<td>(may raise some costs)</td>
<td>(may lower some costs)</td>
</tr>
<tr>
<td>Possible advantage for combined households</td>
<td>Possible stability from first blocks</td>
</tr>
<tr>
<td>(one fixed customer charge)</td>
<td>(relatively inelastic usage)</td>
</tr>
</tbody>
</table>
Pricing to promote access and affordability

- **Pricing and affordability**
  - First usage block is highly price-inelastic: use standards, programs, assistance, lifelines
  - Additional blocks of usage are price-elastic: set prices to encourage efficiency

- **Lifeline rates**
  - Limited by policies and practices related to price discrimination and subsidies
  - Programmatic discounts to qualified customers (low-income, seniors)
  - Low-priced first block, sometimes including a quantity allowance

- **Income-based rates and rates based on family size**
  - Does not comport with legal and practice frameworks (discrimination not based on cost)
  - Intuitive but complicated and expensive to administer and not necessarily equitable
Water usage by income level

- Low income does not always mean low usage
- Low-income customers are unlikely to drive peak demand and related costs
- Low-income customers can be price sensitive, even for essential usage

![Graph showing water usage by income level](image)

**Fig. 7 Average DWU per capita with personal income and education**


![Graph showing frequency distribution of DWU among 50 houses](image)

**Fig. 8 Frequency distribution of DWU among 50 houses**
Why not income-based rates?

- Communities should have discretion to design their rates and address equity
  - Income-based and “lifeline” rates have intuitive appeal – e.g., Philadelphia Water Dept.

- Implementation issues
  - Depart from prevailing legal and practice frameworks (cost-based pricing, efficiency)
  - Resistance from consultants, utilities, ratepayers, regulators, politicians
  - Subject to legal challenge based on undue discrimination (based on cost of service)
  - Complicated and expensive to administer and consumer privacy issues (income data)
  - Income is an imperfect measure – can be distorted, gamed, and does not reflect wealth
  - Averages and medians for costs and income mask wide variations
  - Thresholds are arbitrary and at any level (e.g., 2%), the near-poor will subsidize the poor
  - Price signals remain relevant for discretionary water usage

- An inclusive progressive rate structure can ensure affordability for essential use
  - Can be reconciled with cost-of-service principles
  - Lower cost of implementation and less distortion
  - May be perceived as more fair and equitable (vs. “targeting”)

- Considering family size in rate design
  - Family size raises issues of choice affecting cost of service
  - Assistance programs take both income and children into account
  - Also imperfect and administratively complicated
  - Utilities can also provide medical exceptions
Water systems: five products, one set of pipes

- Water systems are actually service “co-generators” of differentiated products
  - Essential water usage is nondiscretionary – not conducive to private model price signals
  - Water and wastewater services are symbiotic and can be bundled
  - Wastewater is a byproduct and a resource – water, energy, and nutrients

![Diagram showing five products of a water system: Discretionary: irrigation and other outdoor uses (price elastic), Home hygiene: laundry and cleaning (less price inelastic), Personal hygiene: washing and sanitation (price inelastic), Consumption: drinking and cooking (highly price inelastic), Fire protection (capacity with intermittent usage).]
Public fire protection costs (Wisconsin study)

Figure 10. Public Service Commission Cost-of-Service Model

Table 3. Average PFP Cost-of-Service as a Percentage of Total Cost-of-Service (n=218)

<table>
<thead>
<tr>
<th>Utility Class</th>
<th>Average PFP Cost-of-Service as Percentage of Total Cost-of-Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB</td>
<td>18%</td>
</tr>
<tr>
<td>C</td>
<td>29%</td>
</tr>
<tr>
<td>D</td>
<td>34%</td>
</tr>
</tbody>
</table>
A new paradigm: universal equity-efficiency rate (Beecher)

- Universal, principled, and defensible – applicable to all water customers
  - May become more relevant for network-intensive industries
  - Theoretical, practical, and normative support – possible stakeholder appeal
- Minimum bill (tax-exempt) calibrated to assessed property value
  - Constitutes a demand-correlated network capacity charge
  - Includes an essential usage allowance for all households
  - Additional customer assistance may be needed
- Three water usage blocks
  - First: essential usage based on public health criteria (included in minimum bill)
  - Second: basic usage priced with a uniform volumetric rate
  - Third: discretionary usage priced for efficiency based on marginal cost
- Prohibit water service disconnection
  - Disconnection is not good business, governmental, or social practice
  - Implement service (flow) limiter instead of disconnection (shutoff)
  - Flow, volume, or time-limiting (tamper-proof valves, meters)
A new paradigm: rationale (Beecher)

- **Theoretical rationale**
  - Reconciles theory and conceptions of efficiency and equity (cost of service)
  - Consistent with full-cost recovery and enterprise model for utilities
  - Provides a mechanism for supporting network capacity based on demand
  - Maintains economic price signals for discretionary usage (where they matter)
  - Recognizes non-allocable cost and value of public fire protection
  - Added theoretical support: insurance, taxation, social-good, historical pricing models

- **Practical rationale**
  - Co-benefits of “base” capacity for system health, public health, fire protection
  - Mitigates effects of rising costs and declining usage on low-income & low-volume users
  - Cost-effectiveness and implementation ease (vs. disconnection, income-based rates)
  - Provides revenue and rate stability to maintain the distribution network
  - Makes use of tax information but is still a user fee and not a tax
  - Adaptable as to details (allowance based on family size, block pricing, prepayment)

- **Normative rationale**
  - Consistent with broad principles of social equity and fairness
  - Human right to water and sanitation (security) and protection of innocents (children)
  - Not just a business case for compassion – but a compassion case for compassion
Usage allowance

- Inclusion of a usage allowance in a fixed tax-exempt minimum bill
  - Useful in satisfying preference for universal equity (fairness)
  - Distorts end-use efficiency incentives only if usage is discretionary
  - May be more appropriate for water given storability, renewability, and externalities

- World Health Organization recommendations
  - Minimal provision of 50-100 liters per person per day for human health
  - Consider default at 25 gpcd (100 liters) or about 3,000 gal. per family per month
  - Indoor household usage in the U.S. varies but generally exceeds this amount

- Timely metered consumption data would facilitate self-rationing
Flow restriction
Universal equity-efficiency rate (Beecher)

Universal equity-efficiency rate: uniform design

- Charge for usage above base of 6000 gal. ($0.01)
- Base usage charge ($0.01) for next 3000 gal.
- Fixed property-value charge ($0.01) includes 3000 gal. allowance
- Customer charge

Universal equity-efficiency rate: block design

- Charge for usage above base of 6000 gal. ($0.019)
- Base usage charge ($0.075) for next 3000 gal.
- Fixed property-value charge ($0.01) includes 3000 gal. allowance
- Customer charge
IPU’s Ratemaking Course

- Focusing on the financials for a high-performing regulated water utility
  - University sponsored and professionally designed and delivered
  - Comprehensive but concise (2.5 days)

- Topics covered
  - Foundations of Public Utility Ratemaking
  - Capital Expenditures (Capex)
  - Operating Expenditures (Opex)
  - Financing Utility Infrastructure
  - Cost Allocation and Rate Design