Water infrastructure, engineering, economics and regulation

- Three trivia questions
  - Where does it rain more, Dallas or Detroit?
  - What key factor drives water infrastructure design?
  - Why should water-rich regions care about efficiency?
The water infrastructure challenge

- Water utilities are capital-intensive, with high fixed costs and long-life assets
- Water infrastructure is invisible, aging, leaky, oversized, and taken for granted
- Water usage is falling, especially in legacy cities (lost population, industry)
- Lower flows jeopardize operations, water quality, and public health
- Lower sales add to the pressure on water costs and prices
- Efficiency saves operating costs (short term) and capital costs (long term)
- Local control can come at a cost of scale and scope economies
- Infrastructure optimization and coordination are needed
- Infrastructure choices should be prudent and in the public interest
- Public health priorities call for compliance, barriers, and precaution
- A new paradigm for water infrastructure and rate design may be needed
- Economic regulatory jurisdiction, standards, and methods could be applied

U.S. industry structure in 2011: 51,356 community water systems served almost 300 mil. people
Community water systems in Michigan (USEPA, 2015)

Global and national infrastructure needs

- Growing funding needs
- Growing funding gaps

Rising Infrastructure Funding Needs...

More Than $57 Trillion Needed For Infrastructure Through 2030

INVESTING IN INFRASTRUCTURE - OUR NATION’S ECONOMIC ENGINE

We can prevent:

- $3.1 Trillion
- $3,100 per year
- $2.4 Trillion
- 3.5 Million jobs
Drinking water infrastructure needs

- Are we (politically) willing?
  - To invest in infrastructure
  - To charge at cost
  - To minimize transfers
  - To pay as consumers
  - To manage assets
  - To regulate effectively

- Are we mainly crisis driven and reactive?

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Drinking water infrastructure needs (AWWA, 2011)

**Figure 6: Aggregate Needs for Investment in Water Mains Through 2035 and 2050, by Region**

<table>
<thead>
<tr>
<th>Region</th>
<th>2011-2035 Totals</th>
<th>2011-2050 Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(2010 $M)</td>
<td>Replacement</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northeast</td>
<td>$92,218</td>
<td>$16,525</td>
</tr>
<tr>
<td>Midwest</td>
<td>$146,997</td>
<td>$25,222</td>
</tr>
<tr>
<td>South</td>
<td>$204,357</td>
<td>$302,782</td>
</tr>
<tr>
<td>West</td>
<td>$82,866</td>
<td>$153,756</td>
</tr>
<tr>
<td>Total</td>
<td>$526,438</td>
<td>$498,285</td>
</tr>
<tr>
<td></td>
<td>(2010 $M)</td>
<td>Replacement</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northeast</td>
<td>$155,101</td>
<td>$23,200</td>
</tr>
<tr>
<td>Midwest</td>
<td>$242,487</td>
<td>$36,755</td>
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<tr>
<td>South</td>
<td>$394,219</td>
<td>$492,493</td>
</tr>
<tr>
<td>West</td>
<td>$159,476</td>
<td>$249,794</td>
</tr>
<tr>
<td>Total</td>
<td>$951,283</td>
<td>$802,242</td>
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</tbody>
</table>
Water infrastructure needs (USEPA for 2011)

- National need = $376 billion
- Michigan need = $13.8 billion

Wastewater infrastructure needs (USEPA for 2012)

- National need = $271 billion
- Michigan need = $2 billion
Lead service lines (AWWA, 2016)

- Michigan has a high level of lead lines
- Note that vertical axis is logged

![Graph showing lead service lines](image)

Financing lead service-line replacement

- Environmental remediation funds (“superfund”)
- Federal or state tax credits
- City or utility financed with low-cost loans
- Customers on their own or shared
- Transfer ownership to utility (ratepayers)
- Finance and recover in utility revenue requirements

![Map showing percent of connections by state](image)
Declining withdrawals in the U.S. (USGS, 2014)

Declining water usage in U.S. cities

- Water usage is declining everywhere due to efficiency, prices, other factors
- Legacy cities have also lost economic activity and population
- Falling usage and sales add pressure to water rates to cover fixed costs
Water prices and expenditures (BLS, 2016)

- Utility bills have regressive impacts and jeopardize home ownership
- Water prices are rising much faster than inflation
- Water affordability and universal service are growing concerns

Water systems: five products, one set of pipes

- Systems are designed to meet average-day, max-day (daily peak), and max-hour (hourly peak) demand – the latter is defined by fire-flow requirements
- Pricing in many ways is disconnected from supply and demand realities
Sustainable water systems

- Sustainable systems live within ecological, economic, and equity tolerances
- Optimal service level is constrained by compliance with mandates and standards

<table>
<thead>
<tr>
<th>Price revenues relative to expenditures</th>
<th>&lt; 1 expenditures are below optimum (“cost avoidance”)</th>
<th>= 1 expenditures are optimal</th>
<th>&gt; 1 expenditures are above optimum (“gold plating”)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 price revenues are below expenditures (“price avoidance”)</td>
<td>Deficient system</td>
<td>Subsidized system</td>
<td>Budget-deficit system</td>
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<tr>
<td>= 1 price revenues are equal to expenditures</td>
<td>Underinvesting system</td>
<td>SUSTAINABLE SYSTEM</td>
<td>Overinvesting system</td>
</tr>
<tr>
<td>&gt; 1 price revenues are above expenditures (“profit seeking”)</td>
<td>Revenue-diverting system</td>
<td>Surplus system</td>
<td>Excessive system</td>
</tr>
</tbody>
</table>

Building tomorrow’s infrastructure

- Infrastructure at an inflection point
  - Don’t build tomorrow’s infrastructure to meet yesterday’s demand (i.e., in kind)
  - Optimization modeling tools are available
  - Infrastructure can be more intelligent, flexible, adaptable, modular, and distributed

- Strategies for sustainability
  - Optimize systems in the course of infrastructure renovation
  - Leverage investment resources across infrastructure types
  - Modernize the infrastructure with available technologies
  - Integrate infrastructure planning and projects
  - Coordinate infrastructure oversight across agencies