Some Historical Aspects of Urban Water Systems

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Dead Sea and Jordan

Ancient springs at Delphi, Greece (site of Oracle) (bronze age center of the universe)

Modern springs at Delphi, Greece

Ancient temple drains at Knossos, Crete (Minoan 2600 to 1000 BC)
Ancient stone pipe from reservoir at Knossos, Crete (Minoan 2600 to 1000 BC)

Kamiros, Rhodes (ancient Greece, 7th century BC)

Ancient clay pipe at Kamiros, Rhodes (ancient Greece, 7th century BC)

Ancient temple site at top of hill that had roof runoff cistern, Kamiros, Rhodes (ancient Greece, 7th century BC)
Cistern tank, Kamiros, Rhodes (ancient Greece, 7th century BC)

Steps alongside cistern, Kamiros, Rhodes (ancient Greece)

The Agora, Athens, Greece (from the Acropolis to modern Athens) (1st to 4th century BC)

The Agora, Athens, Greece
Storm drainage channels at the Agora, Athens, Greece

House drain at the Agora, Athens, Greece

Waterwheel at the Agora, Athens, Greece

Child potty, ancient Greece (Agora Museum)
Pipe at Pompeii, Italy (before 79 AD)  J. Harper photo

Roof drain at Pompeii, Italy (destroyed Aug 24-26, 79 A.D.)  J. Harper photo

Water storage jugs at Pompeii, Italy (prior to 79 AD)  J. Harper photo

Impluvium (indoor pool and cistern for rain water storage), Pompeii, Italy (before 79 AD)  J. Harper photo
Swimming pool at the Baths, Pompeii, Italy (prior to 79 AD)
J. Harper photo

Roman community toilet, Athens, Greece (100 BC)

Coliseum sewage ditch, Rome (completed in 80 AD)
J. Harper photo

Coliseum sewage ditch, Rome
J. Harper photo
Ancient gutter still in use, Rome (about 100 AD)

Excavation of ancient Roman pipes, Rome (about 100 AD)

Excavation of ancient Roman pipes, Rome (about 100 AD)

Bill James reading 1600s hydraulic manuscript at the library of the Institute of Civil Engineers, London
Clay pipe, Roman London, 43-410 AD (Key Bridge Steam Museum)

Lead pipe, Medieval London, 1000 to 1400 (Key Bridge Steam Museum)

Stone pipe, Tudor London, 1500s (Key Bridge Steam Museum)

Wood log pipe, Georgian London, 1710 - 1830 (Key Bridge Steam Museum)
Cast iron pipe, Victorian London, 1840 - 1900 (Key Bridge Steam Museum)

Wooden water pipe, Seattle, WA (Underground Seattle Museum)

Hamilton, Ontario, Historical Pumphouse

Wastewater treatment has only been around since the late 1800s. People dumped wastes into gutters, ditches, and out open windows.

Sewer if from the old English for sea-ward.
More people were able to have a flush toilet, not just the rich. First US treatment plant built in NYC in 1886 to protect Coney Island beaches from vast increases in wastewater volume.
Elevated toilet to keep above hydraulic grade line during high tides, Seattle, WA (Underground Seattle Museum)

After years of a bad sewage system and several fires, Seattle finally decided to build a new sewage system where the streets were raised anywhere from 8 to 36 feet. However, it was years before they actually raised the sidewalks, requiring climbing up a ladder (sometimes 36 feet high) to cross the street and then climbing back down on the other side.

**Major Receiving Water Beneficial Uses**

- Stormwater Conveyance (flood prevention)
- Recreation (non-water contact) Uses
- Biological Uses (Warm water fishery, aquatic life use, biological integrity, etc.)
- Human Health Related Uses (Swimming, Fishing, and Water Supply)

Urbanization causes extremes in flows; extended dry periods and short periods of higher flows
Increased high flows have lead to unusual solutions

Urbanization has also caused increased pollutant discharges

Numerous beach closures at community swimming beaches due to bacteria from urban runoff discharges

Beach Closings in the US in 1994

<table>
<thead>
<tr>
<th>Cause of Closure</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanitary Sewer Overflows (SSOs)</td>
<td>584</td>
<td>43%</td>
</tr>
<tr>
<td>Stormwater Runoff</td>
<td>345</td>
<td>25%</td>
</tr>
<tr>
<td>Combined Sewer Overflows (CSOs)</td>
<td>194</td>
<td>14%</td>
</tr>
<tr>
<td>Agricultural Runoff</td>
<td>136</td>
<td>10%</td>
</tr>
<tr>
<td>Wastewater Treatment Plant Malfunctions</td>
<td>106</td>
<td>7.8%</td>
</tr>
</tbody>
</table>
However, kids still play in urban creeks and swim near outfalls.

Many also enjoy fishing along urban creeks.

Cuyahoga River in Cleveland often Caught on Fire Between 1952 and 1969

Fire from 200,000 gallons of spilled gasoline into an urban creek, Bellingham, Washington, 2000.
Sanitary Sewer Overflow, 5-Mile Creek, Birmingham, AL

Continuous, low volume sanitary sewage leakage at 5-Mile Creek study area, Birmingham

Upwelling sewage from broken sewer in backyard, Birmingham

Discharge of sanitary sewage leak into Village Creek, Birmingham
Captured floatable debris from combined sewer outfalls at Brooklyn, NY, study area.

October 10, 2000

U.S. Drought Monitor

October 10, 2000

U.S. Drought Monitor

“IT'S A CLASS OF CUSTOMER THAT STRETCHED OUR MINDS ABOUT WHAT PEOPLE CAN CONSUME.”

Randy Chafin  
Assistant general manager of the Water Works

WATER CRISIS

Groups urge no new water, sewer hookups

WATER CRISIS

Water Works looks at tapping other systems

URBAN STREAMS STUDY 1992-93

Bacteria in Lincoln Creek

Storm Sewers

Storm Events

Base Flow

Criteria

Count/100 ml

0 2,000 4,000 6,000 8,000 10,000 12,000

6,130 11,200

1,150 400
Spray Irrigation of Treated Wastewater at Golf Course

Basic Wastewater Conveyance in Sanitary Condition not Always Achieved

One City’s Wastewater is Another City’s Water Supply

Point and nonpoint sources

McKinney and Schoch

McKinney and Schoch
Percent Water Consumption

- Toilet Leaks (5%)
- Dishwasher (3%)
- Baths (9%)
- Toilet Flush (28%)
- Faucet (12%)
- Showers (21%)
- Washing Machine (22%)

Aqueduct in Havana, Cuba, 1565

Private Water Delivery in Havana, Cuba, 2003

What is the infrastructure like in developing countries?
What will cities be like in the future?
What type of infrastructure will be used for water and wastes?
Can we continue to use the same systems as we use now?