

A BRIEF HISTORY OF

WATER & WASTEWATER TREATMENT

• 3000 B.C. NIPPUR, SUMERIA

Wells, cisterns, supply culverts,
wastewater drains

• 2000 B.C. INDIA

Sanskrit Writings: How to purify water,

- BOILING IN COPPER VESSELS
- EXPOSURE TO SUNLIGHT
- FILTERING THRU CHARCOAL

• 1500 B.C. EGYPT

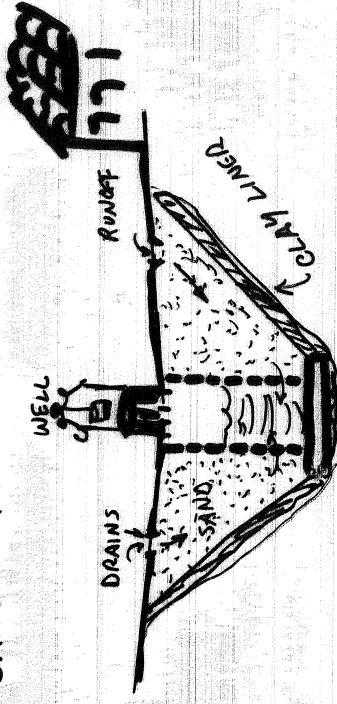
- SEDIMENTATION IN VESSELS + SIPHONING
- FILTRATION VIA A WICK

• ROMAN EMPIRE

- EXTRAORDINARY AQUEDUCTS & RESERVOIRS
- RESERVOIRS FOR SEDIMENTATION

• VENICE - 5th c. → 16th c.

- CISTERNS TO COLLECT RAINWATER
- SAND FILTERS FOR PURIFICATION



PROVIDED ~ 4 gpd/person which was quite adequate

• 1804 Paisley, Scotland

- First completely filtered city water supply
(Distributed by carts)

• 1807 Glasgow, Scotland

- Filtered water piped to consumers

• 1856 France + England

- Henry Darcy patents rapid sand filter

SEWERS & WASTEWATER TREATMENT

- ROME - Sewers for runoff, street washing. Human wastes collected & disposed in pots
- EXTENSIVE, IMPRESSIVE SEWERS BUT:
 - ♥ ~ NO DOMESTIC CONNECTIONS
 - ♥ NO TREATMENT OF WASTES

NO REAL PROGRESS FROM ~ 100 AD to 1842: Hamburg: Sewers

● DISEASE - Cholera

- 1849 LONDON: 14,600 deaths
1854 LONDON: 10,675 deaths

- Sewers in London, Paris (1855 →)
- Late 1890s: Early Sewage Treatment
- 1960s-70s: Modern Sewage Treatment

WATER QUALITY:

Why treat water & wastewater?
(ws) (ww)

- PATHOGENS (ws, ww)
- FACTORS RELATED TO PATHOGEN CONTROL (ws)
- OXYGEN DEPLETION (ww)
- TOXICITY TO HUMANS (ws, ww)
- TOXICITY TO ECOSYSTEM (ww)
- EXCESSIVE NUTRIENTS (Eutrophication) (ww)
- TASTE, ODOR, APPEARANCE (ws)
- UTILITY, CONVENIENCE (Hardness) (ws)

These are in approximate order of priority/importance.

- ▷ Waste treatment may be a form of preliminary water treatment
- ▷ Or, 2 may be decoupled.

Thumbnail Sketch of the History of Water Quality Regulation in the U.S.

- 1886 New York Harbor Navigation Act**
Prohibited dumping of impediments to navigation in NY Harbor
- 1899 Rivers & Harbors Act**
Prohibited dumping of solid wastes into navigable waters
- 1912 Public Health Service Act**
Included section on waterborne diseases
- 1924 Oil Pollution Act**
Prevented discharge of oil from vessels into coastal waters. First law to give pollution enforcement authority to the federal government if state or local efforts failed. Also first to use "carrot & stick" approach: Matching grants to local authorities for wastewater treatment (carrot) in addition to federal mandates on discharge prevention (stick).
- 1965 Water Quality Act**
First comprehensive federal attempt to improve water quality. Set water quality standards for interstate waterways. Did not deal with intrastate water bodies.
- 1966 Clean Rivers Restoration Act**
Major increase in authorization for federal funds to build wastewater treatment facilities, but not fully funded due to Vietnam War budget constraints.
- 1970 National Environmental Policy Act (NEPA)**
Landmark law: Led to formation of EPA, environmental impact statements, Council on Environmental Quality (CEQ), etc.
- 1970 EPA centralizes all water quality regulation and enforcement (both drinking water and receiving waters) but has no authority concerning water resources such as the management of supply, watershed management, reservoirs, etc.**
- 1972 Water Pollution Control Act Amendments (P.L. 92-500)**
Greatest single step in U.S. water quality history.
• New water quality standards, a goal to make all waters "fishable and swimmable"
• ultimate goal of eliminating all pollutant discharges into navigable waters
• introduction of the National Pollutant Discharge Elimination System (NPDES permits)
• prohibited discharge of toxic compounds in toxic amounts
• major R&D effort funded for innovative technologies
• uniform "technology based" effluent standards
• gave states opportunity to retain "primacy" in implementing these goals and standards
• huge (multi gigabuck) appropriations for building treatment facilities, infrastructure

1974 Safe Drinking Water Act (SDWA)

The moral equivalent of P.L. 92-500 for drinking water. Prior to SDWA all control was state or local; feds could only regulate interstate water systems.

- Set uniform nationwide standards for drinking water quality
- Primary regulations for protection of public health
- Secondary standards for taste, odor, appearance
- More R&D
- Health effects research
- More bags of money for local projects

1977 Clean Water Act (CWA) Amended FWPCA (P.L. 92-500).

- Mandated state primacy
- better enforcement and incentives for water quality improvement
- more dollars to local agencies
- realistic extensions of timelines for meeting goals

1986 SDWA Amendments

Post-Love Canal: New focus on toxics in drinking water, groundwater protection, well-head protection, sole-source aquifer designations, criminal liability and enforcement.

1987 Water Quality Act (reauthorization of CWA)

First major attempt to address role of nonpoint source of water pollution (runoff, etc). Also allowed more realistic flexibility in NPDES permitting.

1996 SWDA Amendments

Further refinement of drinking water regulations. New emphasis on source protection and on disinfection, especially with regard to dangerous non-bacterial organisms such as *Giardia* and *Cryptosporidium*. Has led to mandates for filtration or special watershed protections.

SOURCES OF MUNICIPAL WATER

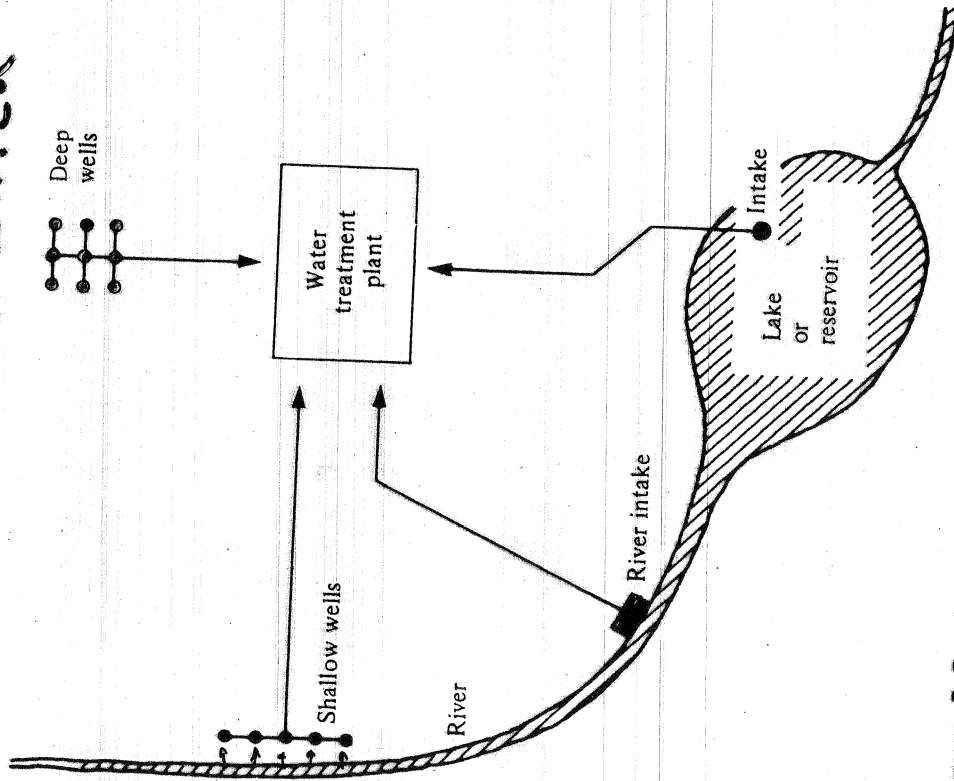


Figure 9.9 Common municipal water sources.

TOWER INTAKE

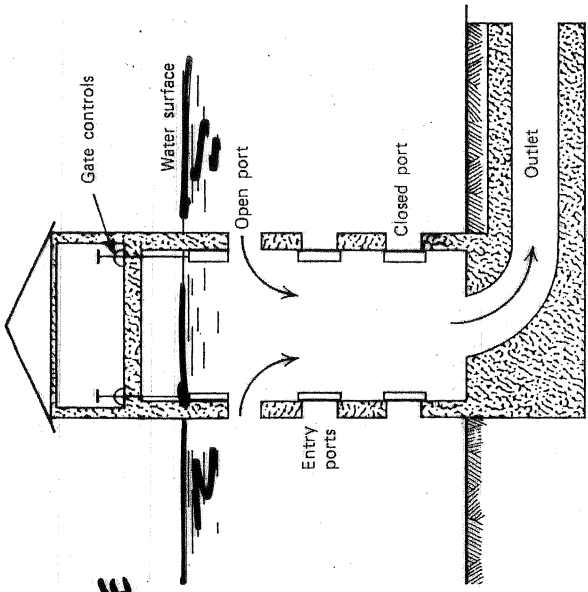
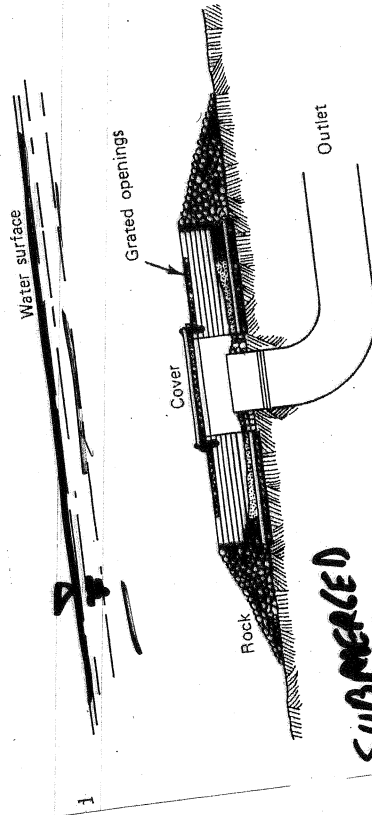


Figure 6-4 Tower water intake for a lake or reservoir supply.



SUBMERGED CRIB INTAKE

TYPICAL TREATMENT SEQUENCE FOR SURFACE WATER

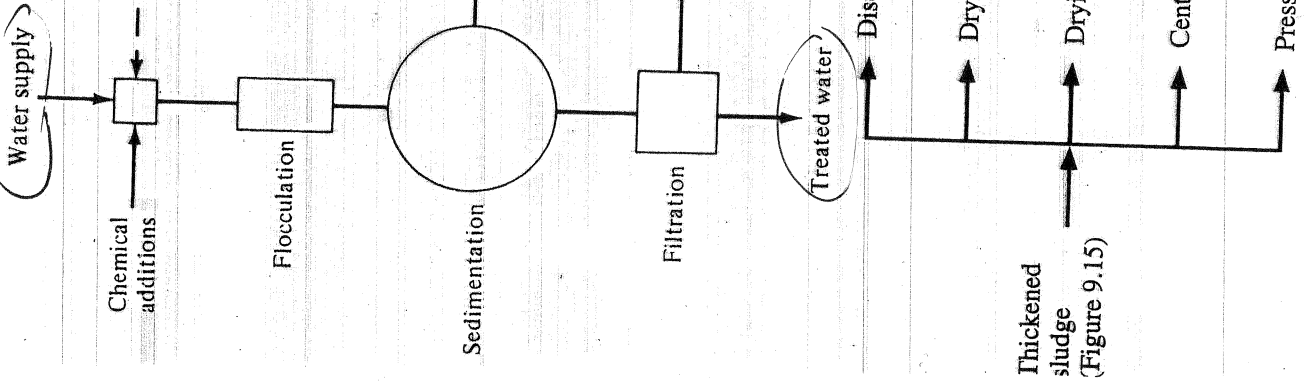
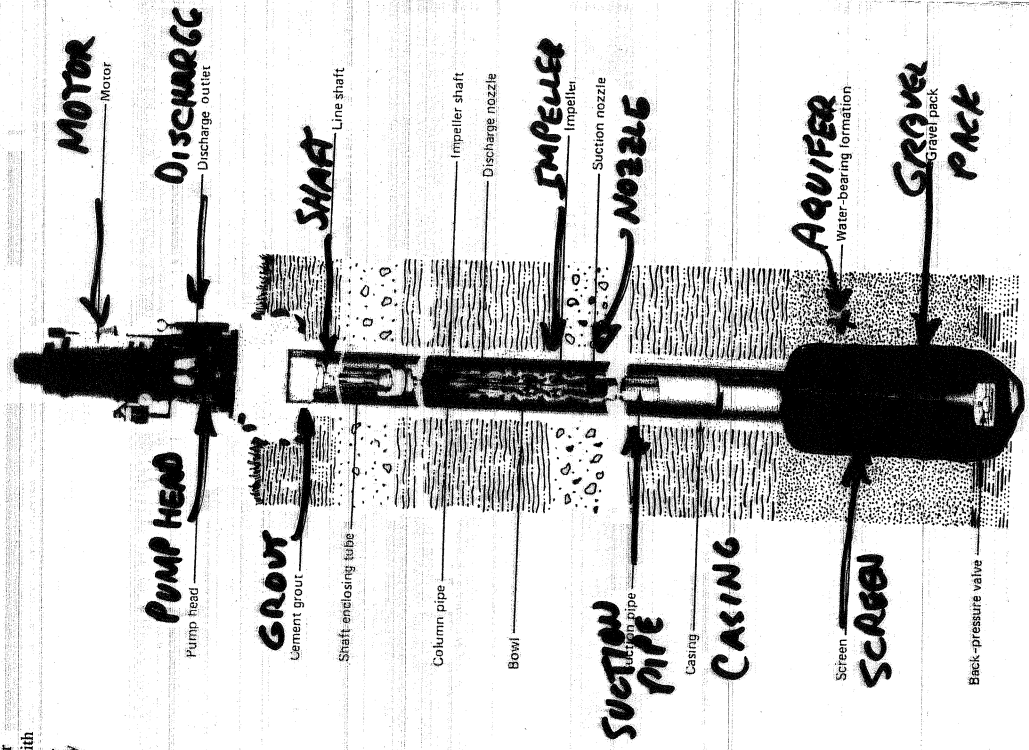


Figure 6-2 Gravel-packed water well in a sand aquifer equipped with a two-stage vertical turbine pump. [Courtesy of Layne, Inc. (formerly Layne-Western Company, Inc.)]



— GROUND WATER —

Often NO treatment need other than Chemical disinfection (Chlorine)

Lime: for softening reaction
Alum: for coagulation, if needed

HARDNESS ($Ca^{2+} + Mg^{2+}$) REMOVAL

Mixing, flocculation, and sedimentation using excess lime for hardness; Fe and Mn removal

Potassium permanganate: to oxidize Fe and Mn, if needed

Mixing, flocculation, and sedimentation: to neutralize excess lime in softened water with raw water, and oxidation of remaining Fe and Mn

Fluosilicic acid: for fluoridation

Removal of unsettled hardness precipitate and oxidized Fe and Mn floc

Chlorine: to establish a free chlorine residual in distribution system

shallow wells

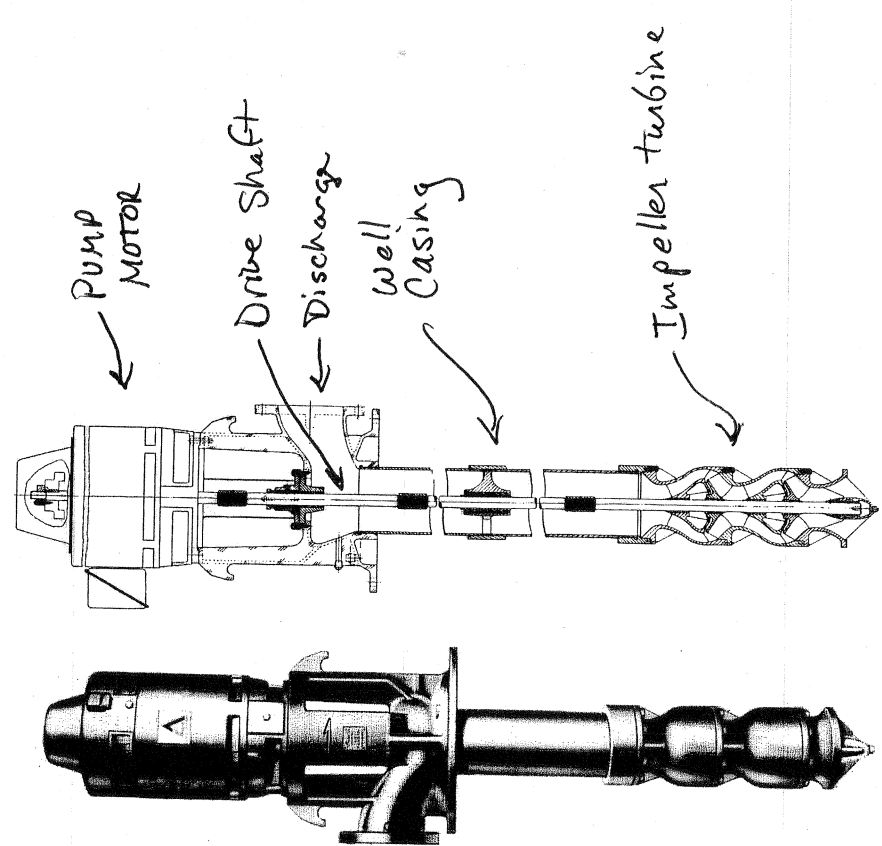
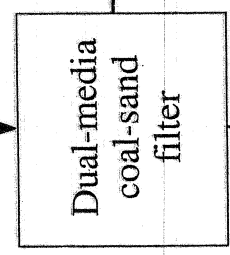
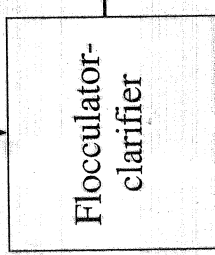
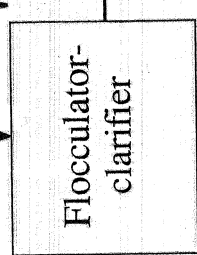


Figure 6-7 Vertical turbine pump. (Courtesy of Allis-Chalmers Corp.)

re 9.11 Plant using split treatment for partial softening and iron and