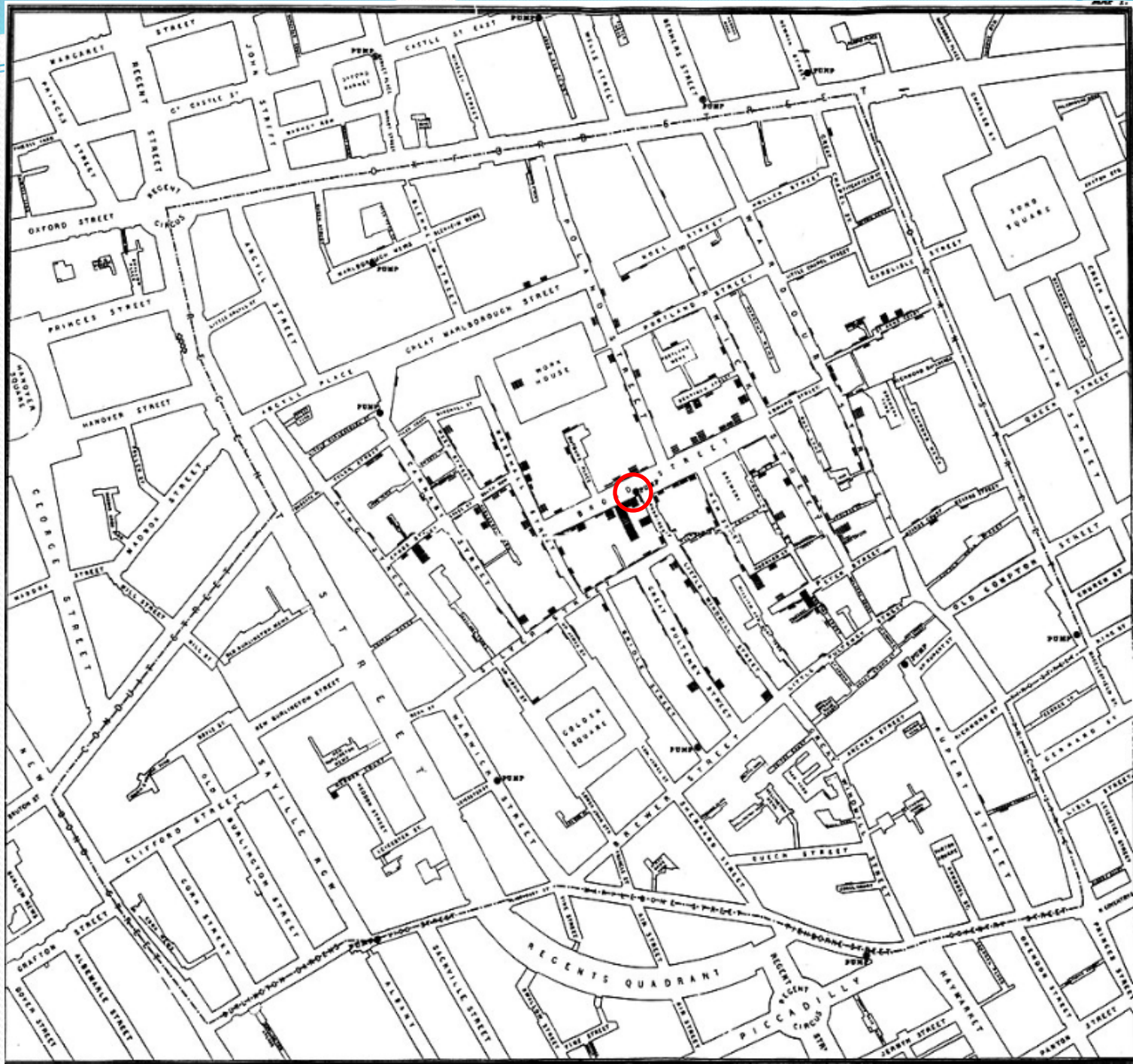


1854, Soho,  
Westminster  
London

616 died  
from  
cholera

Dr. Snow  
studied and  
found  
outbreak to  
be caused  
by the Broad  
St. well, not the  
“miasma”.



# GOALS OF A WATER TREATMENT PLANT

- CONTINUOUS SUPPLY
- HIGH QUALITY WATER
- AFFORDABLE COST

- **What is high quality water?**
  - **Safe** to drink, no viruses, bacteria, toxics
  - **Aesthetically** appealing
    - Clear appearance
    - Pleasing taste
    - No objectionable odor
    - Cool temperature
  - **Pressure** range (40 psi – 80 psi)
  - **Non-corrosive**, especially to lead
  - Moderate **hardness** (calcium and magnesium)
  - **Fluoride**, minerals, salt, radiation,

An enormous number of chemical compounds are possible through the chemical combination of the known chemical elements.

**“As of May 2011, about sixty million (60,000,000) chemical compounds are known.”**

Chemical substance – Wikipedia


**A total of 93 pharmaceuticals have been reported to occur in the surface water**, the most common being of the type **antibiotic** (total of 27) and **antidepressant** (total of 15). The pharmaceuticals that are assessed to be at high risk ( $RQ \geq 1.0$ ) include **acetaminophen** (analgesic); **caffeine** (stimulant); **sulfadimethoxine** (antibiotic); **triclocarban** (used in disinfectants); and **triclosan** (used in disinfectants). Given the high ecological risk, these pharmaceuticals require detailed evaluation, which means that their levels in surface water must be continuously monitored, and the risks for aquatic organisms must be carefully evaluated (both for **chronic** and **acute** toxicity), and any opportunities for their removal from the surface water and sustainable management opportunities must be explored.

Synthetic Chemicals and Health (M Porta, Section Editor)

Published: 01 April 2014

Pharmaceuticals in the Surface Water of the USA: A Review

Randhir P. Deo

- 
- Household and Personal Care Products
  - Microplastics
  - Pesticides, Herbicides, Fungicides
  - PFAS and PFOS (per and poly fluoroalkyl substances)
  - Agricultural livestock hormones, medications
  - Agricultural surface runoff
  - Urban surface runoff

# How do we determine which contaminants to regulate and their limits?

- Toxicological research by researchers
- Determine minimum toxic levels
- Determine levels in raw and tap at water utilities
- Add a few safety factors (could be 10 x 10 x \_\_\_\_)
- Draft rules for review and comments
- Adopt rules

# Safety Factors for Toxicological Data to Regulations

Animal to human – x 10

Subchronic to chronic – x 10

LOAEL to NOAEL – x 10

Incomplete data base – x 10



# Common Processes Used to Treat Drinking Water

DISINFECTION

COAGULATION

FILTRATION

Rapid sand, slow sand,  
biologically active,  
pressure, riverbank

CHLORAMINATION

FLOCCULATION

ION  
EXCHANGE

OXIDATION

SEDIMENTATION

REVERSE  
OSMOSIS

MEMBRANE  
FILTERS

EVAPORATION

ULTRAVIOLET  
LIGHT

GRANULAR  
ACTIVATED  
CARBON

OZONATION

SOFTENING

POWDERED  
ACTIVATED CARBON

FLUORIDATION

DISSOLVED AIR  
FLOTATION

AERATION

UV PEROXIDE

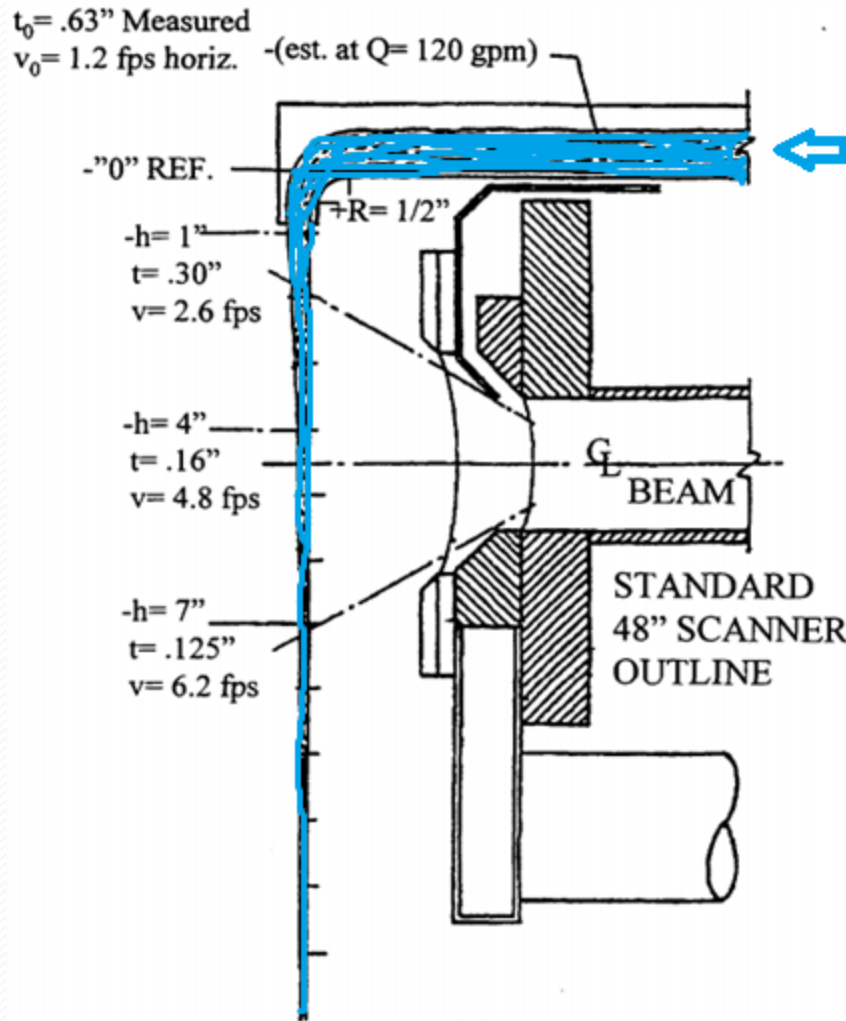
## A couple of uncommon treatment processes

- **Hydrocavitation** – no additional chemicals, but high energy demand
- **Sonic treatment** – no additional chemicals, but most effective to disrupt biological growth

# Membrane Filters



# Electron Beam Irradiation



FULL SCALE ELECTRON BEAM SYSTEMS FOR TREATMENT OF WATER, WASTEWATER AND MEDICAL WASTE T.D. WAITE, C.N. KURUCZ, WJ. COOPER\*, D. BROWN  
University of Miami, Coral Gables, Florida, United States of America

# Super-Oxidant by Eco-Soar Technology

