Overview of Drinking Water Quality Management

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1. Introduction

The provision and management of drinking water is based upon the multi-barrier concept; that is, (1) selecting the best available source and protecting it from contamination, (2) using water treatment to control contaminants, and (3) preventing water quality deterioration in the distribution systems. An added component is now the prevention, detection, and decontamination of deliberate attacks on drinking water infrastructure. Although such practices have resulted in the virtual elimination of traditional waterborne threats such as cholera and typhoid, public health concerns remain.

2. Problem Overview

The continued occurrence of waterborne disease outbreaks demonstrate that the safety of drinking water can still be threatened by pathogenic microorganisms if treatment is inadequate or the distribution system is compromised. New concerns have also been raised about emerging pollutants of concern with natural (arsenic) and man-made (endocrine disrupting chemicals) substances. The disinfection process itself leads to the formation of a number of potentially toxic organic and inorganic chemical by-products. Human subpopulations such as infants, children, pregnant women, and those with weakened immune systems are also of concern.

3. Program Description

The Safe Drinking Water Act (SDWA) requires EPA to set national drinking water standards to ensure the safety of water consumed by the millions of people who consume water from public water systems. The SDWA regulatory requirements require research on disinfection by-products, the Arsenic Rule, the Groundwater Rule, the Long Term 2 Enhanced Surface Water Treatment Rule, as well as future unregulated waterborne pathogens and chemicals on the Contaminant Candidate List (CCL). Source water protection, as well as maintaining the quality of drinking water in distribution systems is also priorities of the SDWA. Research is also associated with a subset of the contaminants subject to the Six-Year Review where regulations can be modified based upon new information. The most recent change was

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the reduction of the Arsenic MCL from 50 ug/L to 10/ug/L which involves nearly 4,000 small systems. The EPA Office of Research & Development (ORD) has established an integrated, multidisciplinary research program that is closely linked to Office of Water's regulatory activities. The ORD program also works closely with the EPA Regions helping to implement the regulations. Recently, the Drinking Water Multi-Year plan has undergone revisions that will carry the research program through the next several years. A major change in the plan is the increased emphasis on aging infrastructure and source water protection. This also includes research on maintaining water quality in the distribution system and real-time monitoring. Another aspect of the new plan is the web-based Treatability Data Base that will be a repository on control of contaminants in drinking water. It will be interactive and portions of it will be available in 2007. There will ultimately be hundreds of contaminants.

The Drinking Water Research Program also includes efforts from other national laboratories and centers: The National Exposure Research Laboratory (NERL), the National Health and Environmental Effects Research Laboratory, the National Center for Environmental Assessment, the National Center for Environmental Research, the National Center for Computational Toxicology, and the National Homeland Security Research Center.

Sustainable Water Resources

Challenges

- Population growth
- Urbanization
- Water scarcity
- Climate change

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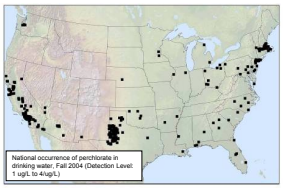
Drinking Water Challenges

- More stringent regulations
- Emerging contaminants
- Water security
- Aging infrastructure
- Coordinating regulations



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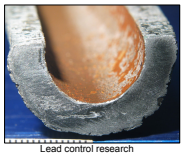
Ongoing Drinking Water Research

Arsenic compliance training and demonstration program

Simulated drinking water distribution system

Microbial disinfection



Lead control research

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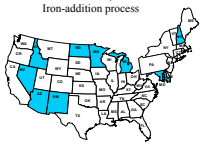
Arsenic Removal Demonstration Program

- **$20 million targeted to a two year program ($20M EPA; $12M Congress)**
- **Small systems, full-scale, long-term (1 year) evaluation studies**
- **Focused on commercially-ready technologies or engineering approaches**
- **Three phases with the third beginning in 2006**

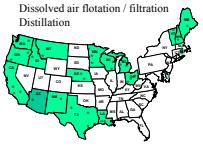
Round 1: 12 Sites / 9 States

Iron media
- Iron-based media
- Anion exchange
- Modified activated alumina
- Iron-removal system
- Iron-addition process



Round 2: 28 Sites / 18 States

- Oxidation / filtration
- Iron Coagulation / filtration
- Reverse osmosis
- Anion exchange
- Process modification
- Dissolved air flotation / filtration
- Distillation



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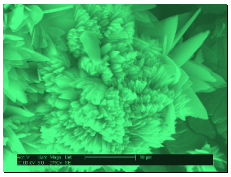
Emerging Research Areas

- Perchlorate
- EDCs
- Cyanobacteria toxins
- Nanotechnology



Nanoflowers synthesized using vitamin B_1

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Perchlorate Research

1) **EPA Funded a series of projects through AwwaRF**
   - Ion Exchange
   - Biological treatment
   - Membranes
   - Tailored GAC
   - Electrochemical
2) **New research**
   - Small-system cost modeling for perchlorate
   - Ion exchange brine treatment with biological systems
   - Adsorbents for multiple contaminants: arsenic & perchlorate
   - Biological treatment of EDR concentrate streams with wastewater augmentation
   - Biotreatment of perchlorate – post treatment needs
   - Effect of nitrate competition on ion exchange treatment of perchlorate

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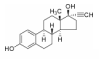
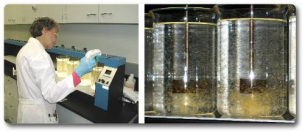
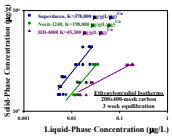
EDC Treatment Research

- Bench-scale conventional, PAC, GAC, and oxidation research for estrogens, androgens, and progesterone







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Cyanobacteria Research

Microcystis aeruginosa bloom

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Cyanobacteria Research

EPA Mini-pilot Plant

Filter Gallery

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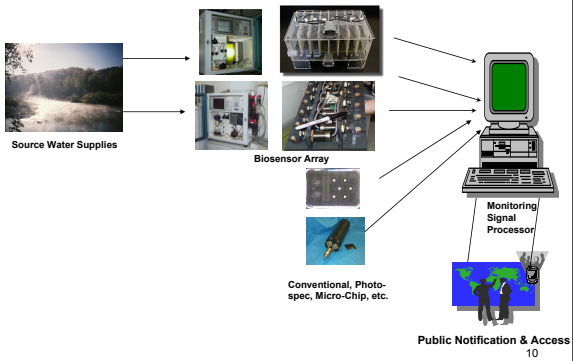
Water Security: Early Warning & Monitoring



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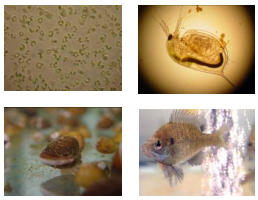
Toxicity Monitor Research

- "Canary in the coal mine"
- Only an organism in its own environment can integrate all factors that contribute to stress



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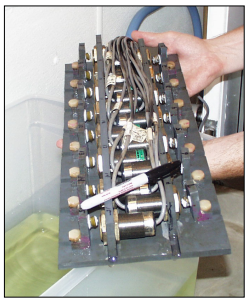
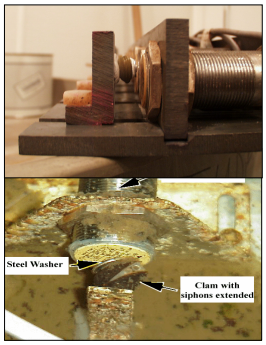
Clam Monitor - Biosentinel





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Coordinating Regulations

- Simultaneous compliance for drinking water regulation
- Complementing CWA with the SDWA

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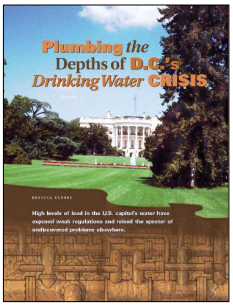
Lead Corrosion in Distribution Systems



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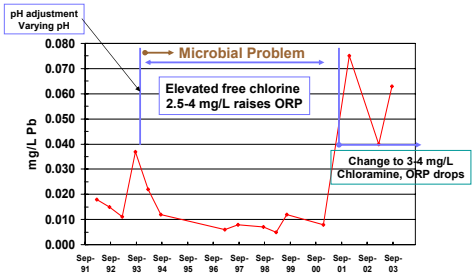
Holistic View of Drinking Water Treatment



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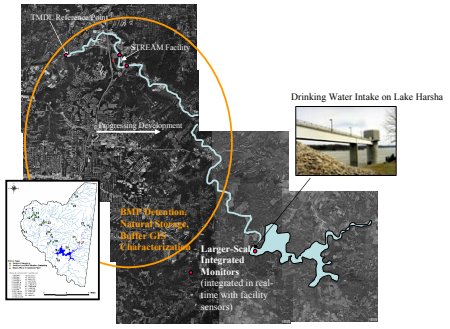
Watershed Management



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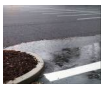
Stormwater BMPs


Retention pond


Porous pavement


Swale used for roadway drainage


Constructed wetland


Detention pond


Rain garden


Bioinfiltration in traffic island

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EPA Swales Research Facility

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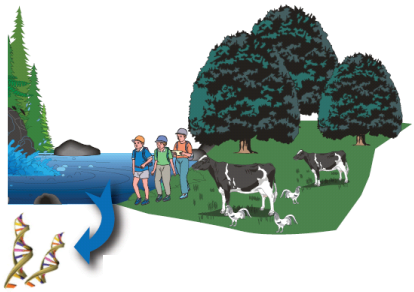
EPA's Source Tracking Research

Match microbe from a polluted site and an animal source to suggest the origin of fecal pollution



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EPA's Source Tracking Research

- Development of animal-specific molecular assays
- TMDL preparation
- Evaluation of Best Management Practices

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Activity of Microbes in Water Distribution Systems

Problem: Traditional culture-based methods significantly underestimate density/diversity

Goal: DNA-based and RNA-based clone libraries to characterize non-culturable microbial communities and active populations in water distribution systems.

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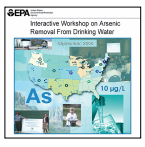
Outreach

- Presentations, publications, multimedia
- EPA workshops
- Brochures, posters, etc.
- Collaborations
- Website: **http://www.epa.gov/ORD/NRMRL/wswrd/**



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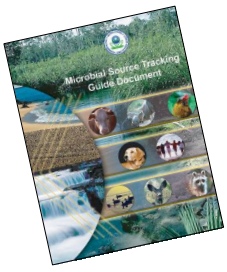
Key Products for Water Utilities



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Treatability Database

Project
- Repository of referenced information on control of contaminants in drinking water
- Interactive database on EPA website in 2007

Contaminants
- Regulated
- Unregulated

Long-Term Commitment
- Expanding to hundreds of contaminants
- Updated over time

Impact
- Potentially the largest single compilation of referenced drinking water treatment data in one place

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Research to Protect the Environment




www.epa.gov/ORD/NRMRL/
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