



# Drinking Water Research Program Update Science Advisory Board Meeting April 2009

## Strategic Directions and Anticipated Products



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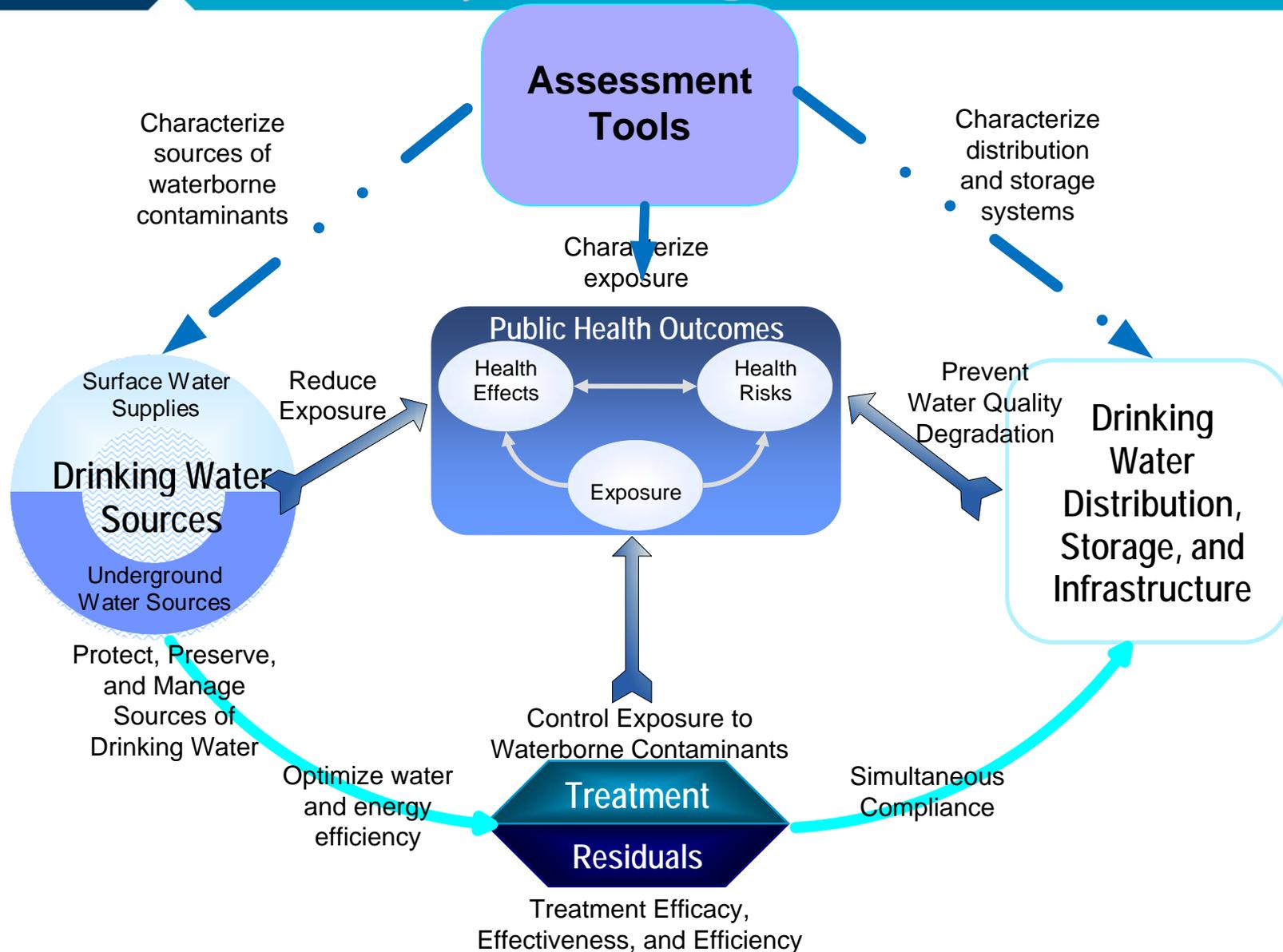
# ORD's Drinking Water Research Program

- **Long-term goals**
  - Characterize risks: chemical and microbial contaminants, infrastructure, water availability
  - Manage risks: Source water protection, treatment, distribution and storage
- **Thematic areas—Relate to hydrologic cycle**
  - Assessment tools
  - Exposure/health effects
  - Source water/Water Resources
  - Treatment and residuals
  - Distribution and storage





# DRINKING WATER RESEARCH PROGRAM *Interrelationships among Thematic Areas*



# Regulatory Research Drivers

## Assessment tools

- Unregulated Contaminant Monitoring Rule (UCMR)
- CCL3 contaminants
- Distribution Systems
  - Lead and copper
  - Biofilms
  - Microbial indicators
  - Solids Accumulation
  - "Smart" monitoring

## Exposure/ Health Effects

- CCL3 and emerging contaminants
- 6-year review: lead, DBPs

## Source Water/Water Resources

- Surface water
  - Source Water Protection
  - Surface Water Treatment Rule (LT2)
- Underground sources of drinking water
  - Underground Injection Control (UIC),
  - Ground water Rule (GWR)

## Treatment

- CCL3 contaminants
- Simultaneous Compliance
  - Corrosion control (LCR)
  - Disinfection byproducts (D/DBPs)
  - Nitrite/nitrate
  - Total Coliform Rule (TCR)

## Distribution Systems

- Total Coliform Rule (TCR)
- Lead and Copper Rule (LCR)
- Disinfection Byproduct Rule (DBP)
- Surface Water Treatment Rule (LT2)
- Simultaneous Compliance

# Current and Emerging Research Drivers

- **Public health protection**
  - Are current approaches adequate under changing water quality, water availability, and water use patterns?
  - Role of water infrastructure: Current inventory  
Migration towards alternative water delivery/collection/reuse systems  
Green Infrastructure, Low Impact Development,  
Integration of centralized and decentralized systems
  - Prioritization of waterborne contaminants  
(health end-points, exposure pathways, mixtures, cumulative risks, sensitive populations)
- **Water scarcity/availability**
  - Impacts of drought/intense storms/snowpack variability on water quality and availability
  - Integrated water management and role of water reuse on regulatory construct for protecting public health
  - Increased rates of evaporation and variability in water sources (impacts on salinity, solubility, microbiology, pathogen diversity)
  - Nutrient and contaminant loadings:  
Organic and inorganic disinfection byproduct precursors
- **Energy and economic impacts on treatment reliability**
  - Availability of chemicals (phosphates for corrosion control)
  - Energy needs to convey water (supply drinking water and collect wastewater)
  - Transportation costs—chemicals, residuals
  - Water-energy interdependencies--Carbon footprint of water and water footprint of energy production and delivery
  - Impacts of energy decisions on water quality and availability (e.g. biofuels, thermo-electric power generation, geologic sequestration, etc.)
  - Water economics—true costs of providing water, costs of waterborne disease outbreaks

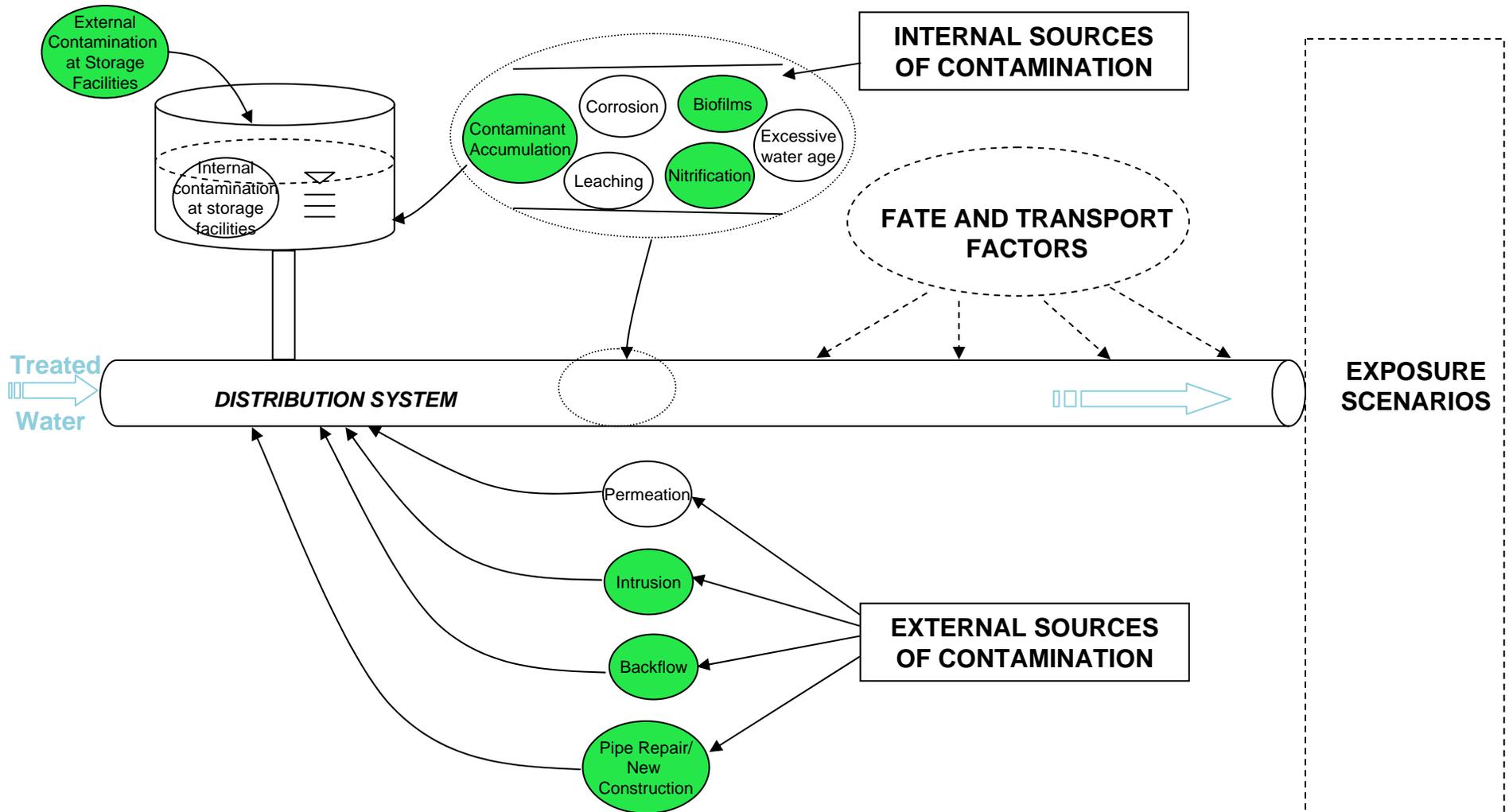




# Research Inputs for CCL Regulatory Decisions

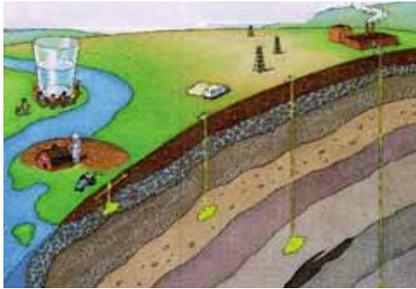
Criteria	Research Inputs
Human health effects? Chemicals Pathogens	Screening studies, models, laboratory studies
	Epidemiological data
Occurrence in public water supplies? UCMR2, UCMR3	Analytical methods, monitoring
	Exposure evaluation, Data analysis and interpretation
	Treatment efficacy
Meaningful opportunity for health risk reduction?	Treatability, Costs, Simultaneous compliance
Implementation Challenges and performance measures	Treatment, simultaneous compliance
	Health outcomes, Small systems, Performance, Energy, Water efficiency

# Distribution System/Infrastructure Research Focus

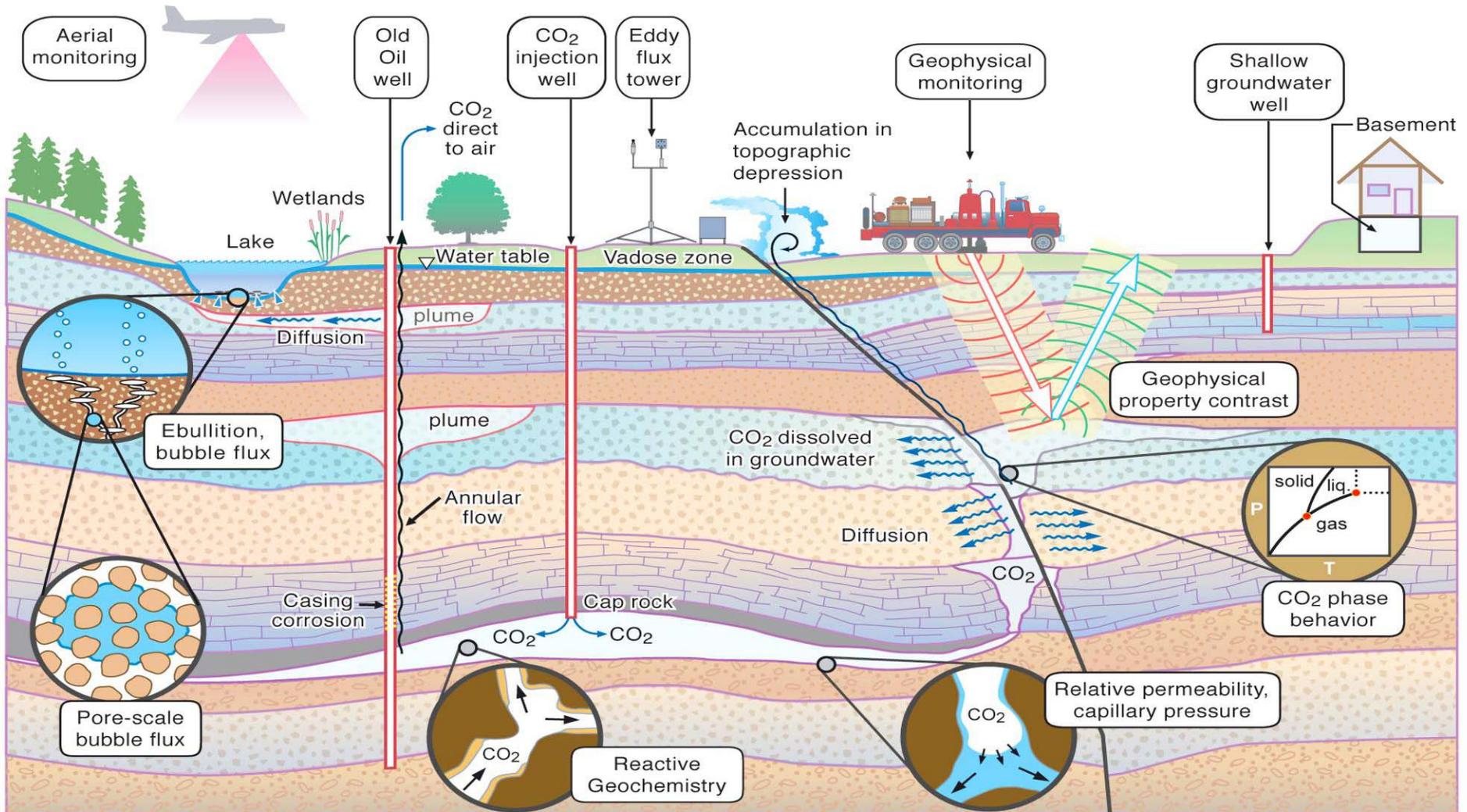


4/23/2009  
 = contamination pathway

\*Aging of distribution systems contribute to several issues



# Overview of Geological Sequestration of CO<sub>2</sub>



# Research Directions

## Assessment tools

- Pathogen detection and viability/infectivity assessment
- Exposure metrics and links to occurrence
- CCL3 contaminants

## Exposure/ Health Effects

- CCL3 and emerging contaminants
- Concurrent exposure to multiple contaminants
- Microbial Risk Characterization

## Source Water/Water Resources

- Surface Water Protection
  - Emerging contaminants, Algal toxins, Pathogens (invasive species, antibiotic resistance, changing microbial ecology), Source tracking/attribution
  - Water reuse, Biofuels, water availability, quality/quantity, decentralized systems
- Ground water protection
  - Underground Injection Control (UIC): Geologic sequestration of carbon dioxide, groundwater recharge, aquifer storage and recovery,
  - Monitoring for public health indicators : microbes, emerging contaminant
  - Modeling: coupled hydrology and water quality

## Treatment

- Treatment efficacy for CCL3 contaminants
- Small systems
- Corrosion control
- Residuals/Brine management

## Distribution Systems

- Sustainable Infrastructure
- Research support for Total Coliform and Distribution System Research Partnership
  - Biofilms, Nitrification, Solids Accumulation
- Integrated corrosion control
  - Linkage with disinfection chemistry
  - Resilience to water quality variations (sources, precipitation impacts)
  - Secondary water quality impacts (biofilms, water discoloration, DBPs)
  - Impacts on wastewater treatment and water reuse (phosphate/nitrogen loading, metals release, sludge/biosolids)
- Sampling, Monitoring and Modeling
- Quantitative Microbial Risk Assessment Tools

# DRINKING WATER RESEARCH PROGRAM

## Major Accomplishments

- **Where we've been: Major recent program accomplishments**
  - Analytical methods for microbial pathogens and emerging chemical contaminants, arsenic bioavailability
  - Characterization of role of water quality (organic carbon, dissolved solids) in disinfection byproduct (DBP) formation and health effects (cancer and non-cancer) attributable to DBP mixtures (regulated and unregulated contaminants)
  - Treatment technologies for control of arsenic, particularly for small systems
  - Water distribution systems/infrastructure
- **Where we're going: Major program accomplishments anticipated in the near-term**
  - Biomarkers of exposure, Virulence Factor Activity Relationships (VFARs), analytical methods for sampling and analysis of multiple pathogens
  - Health effects: integration of screening tools, CCL3 high priority contaminants (strontium, molybdenum, nitrosamines, 1,1-dichloroethane)
  - Improved characterization of underground sources of drinking water—microbial risks, risk management, underground injection
  - Geologic sequestration of carbon dioxide: models, monitoring, geochemistry
  - Simultaneous compliance—lead and copper corrosion control; disinfectants and their byproducts, NPDWR
  - Water distribution systems—biofilms, solids accumulation, nitrification; integration/coordination with water infrastructure program
  - Water efficiency and water-energy nexus

### Acronyms:

**CCL:** Contaminant Candidate List

**DBP:** Disinfection byproducts

Office of Research and Development

**GWR:** Groundwater Rule

**LCR:** Lead and Copper Rule

**NPDWR:** National Primary Drinking  
Water Regulations

**SWTR:** Surface Water Treatment Rule

**TCR:** Total Coliform Rule

**UCMR:** Unregulated Contaminant  
Monitoring Rule

**UIC:** Underground Injection Control

## **DRINKING WATER RESEARCH PROGRAM 2010 - 2014 Strategic Directions**

- ***Assessment tools***—Integrated approaches for monitoring drinking water sources, treatment systems, and distribution systems
- ***Exposure/Health Effects***—Health effects attributable to mixtures relevant to drinking water including DBPs, PPCPs, environmental and treatment “degradates”, microbial metabolites, oxidation/reduction byproducts; emerging contaminants—tools for prioritizing health effects research
- ***Source Water Protection***—Underground injection control with an emphasis on geologic sequestration; aquifer storage and recovery; water availability and quality; water reuse
- ***Treatment and Distribution Systems***—support for regulatory agenda including TCR, LCR, D/DBP, GWR, SWTR, 6-year review; support for Research and Information Collection Partnership (RICP), water infrastructure, Residuals management
- **Increased emphasis/visibility across thematic areas** — Water efficiency and water-energy nexus (includes source water protection, water reuse, water infrastructure, treatment and distribution systems); Environmental Justice