Contaminants of Emerging Concern in USA waters: Assessment and Prevention

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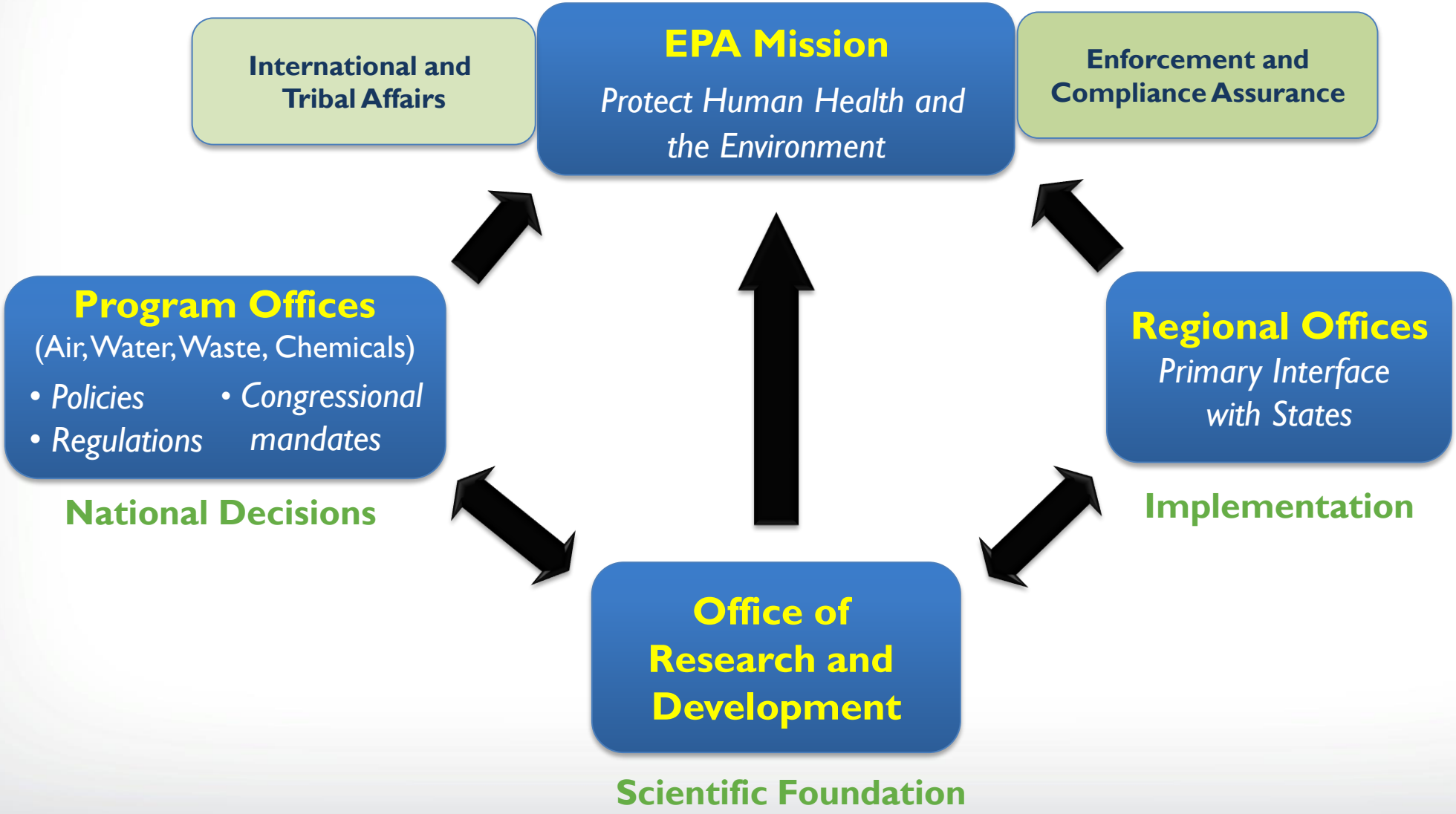
Science to Support EPA's Mission



What are Contaminants of Emerging Concern (CECs)?

- New chemicals entering the environment.
- Chemicals that may not necessarily be new, but their potential for risk to human health or the environment has been recently determined.
- Chemicals whose presence in the environment was previously unnoticed, but "discovered" more recently with improved detection methods.

Examples of CECs

Pharmaceuticals/Personal Care Products (PPCPs)

- **Sulfamethoxazole:** Pharmaceutical-antibiotic
- **Carbamazepine**: Pharmaceutical-anti seizure medication
- **Triclosan:** Personal care-soaps, toothpaste-antimicrobial

Disinfection Byproducts (DBPs)

- **Nitrosamines:** form from natural organic matter reactions with chloramines
- **Iodinated trihalomethanes and acetonitriles:** form from from natural organic matter reactions with chlorine

Industrial Chemicals

- **Perfluorooctanoic acid (PFOA):** waterproofing, fire fighting foams, Teflon
- **Perfluorooctanesulfonic acid (PFOS):** stain repellant, fire fighting foams

Engineered Nanomaterials

- **Metals/metal oxides:** silver, copper, cerium oxide
- **Carbon**: nanotubes, buckminsterfullerenes

How does EPA address Contaminants of Emerging Concern in drinking water?

Safe Drinking Water Act requires a 5-year review by EPA to:

- Publish the Contaminant Candidate List (CCL)
- Conduct the Unregulated Contaminant Monitoring Rule (UCMR) sampling survey

EPA's Contaminant Candidate List (CCL)

- CCL is a list of contaminants that are currently not subject to any proposed or promulgated national primary drinking water regulations, but are known or anticipated to occur in public water systems.
- CCL used to identify priority contaminants based on the best available health effects and occurrence data.
- CCL selection process includes a three-pronged approach:
  1) Carry forward previous CCL contaminants (except those with regulatory determinations)
  2) Nominations from the public for additional contaminants to be considered
  3) Evaluate any new available data for contaminants with previous negative regulatory determinations

➢ **Draft CCL 4** includes 100 chemicals or chemical groups and 12 microbial contaminants.

- Final CCL 4, EPA will determine whether or not to regulate at least five contaminants from the list in a separate process called Regulatory Determination.
- Regulatory Determination is a formal decision on whether EPA should initiate a process to develop a national primary drinking water regulation for a specific contaminant.
- CCL 3 to CCL 4:
  ADDED Manganese and Nonylphenol REMOVED Strontium (Oct 2014, RD3 for CCL3 to regulate)
  REMOVED 1,3-dinitrobenzene; dimethoate; terbufos and terbufos sulfone (Oct 2014, RD3 not to regulate)

Unregulated Contaminants Monitoring Rule (UCMR)

- UCMR provides EPA and other interested parties with scientifically valid data on contaminants in drinking water that do not have health-based standards. These data serve as a primary source of occurrence and exposure information that EPA uses to develop regulatory decisions.
- Limited to 30 contaminants. Current UCMR 3 includes 28 chemicals (CECs: PFOS, PFOA, EDC) and 2 viruses.
- Contaminants based on CCL 3 and additional info on CECs. Excludes contaminants in UCMR 1 and 2, or contaminants without reliable monitoring methods.
- Approximately 6,000 public water systems (PWS) are participating in UCMR 3 January 2013 through December 2015.

UCMR 3 requires public water systems (PWSs) to monitor for 30 contaminants under each of three lists:
Assessment Monitoring uses common analytical method technologies used by drinking water laboratories.
All PWS serving >10,000 people and 800 representative PWSs serving <10,000. Monitor for 21 List 1 contaminants
Screening Survey Monitoring uses specialized analytical method technologies not as commonly used by drinking water laboratories. All PWS serving >100,000 people, 320 representative PWS serving 10,001 to 100,000 people, and 480 representative PWSs serving <10,000 people. Monitor for 7 List 2 contaminants
Pre-Screen Testing uses newer method technologies not as commonly used by drinking water laboratories. 800 representative PWSs serving <1,000 people that do not disinfect. These PWS with wells that are located in areas of karst or fractured bedrock. Monitor for 2 List 3 viruses

EPA/USGS Collaboration on CEC's in Source and Treated Drinking Water

- Samples collected from 25 locations from September 2010 to March 2012
- Analyzed for:
  - 111 prescription and nonprescription pharmaceuticals and their metabolites
  - 17 perfluorinated compounds
  - 10 industrial chemicals
  - 5 household chemicals
  - 9 hormones
  - 8 pesticides
  - 10 fragrances
  - 7 detergent related chemicals
  - 3 phosphorous-based flame retardants
  - 9 PAHs
  - 5 viruses
  - 4 bacteria
  - 4 plant and animal sterols
  - 3 fungi
  - 2 protozoa
  - 40 metallic/non-metallic trace elements
- In addition to chemical analyses, samples underwent bioassays for estrogenic activity and assessments for human exposure and ecological risk

Commonly Detected in Source Water

Pharmaceuticals

- sulfamethoxazole
- lithium
- carbamazepine
- metoprolol
- estrone
- aciclovir
- metformin
- methocarbamol
- meprobamate
- caffeine
- tramadol

Perfluorinated Compounds

- PFOA
- PFBS
- PFOS
- PFHxA
- PFHpA
- PFNA
- PFBA
- PFPeA
- PFHxS
- PFDA
- PFUnDA

Anthropogenic Waste Indicators

- triclocarban
- triclosan
- benzotriazole methyl-1H
- DEET
- atrazine
- metolachlor
- galaxolide
- tri(2-butoxyethyl) phosphate
- tri(2-chloroethyl) phosphate

Inorganics

- strontium
- barium
- calcium
- sodium
- sulfur
- magnesium
- silicon
- potassium
- total dissolved nitrogen
- flouride
- nitrate
- aluminum
- zinc
- sulfate
- chloride
- iron
- manganese
- phosphorus
- copper
- phosphate
- bromide
- lead
- uranium
- ammonia
- arsenic
- nitrite
- nickel
- vanadium
- tin

Microorganisms

- *Aspergillus fumigatus*
- Giardia
- Adenovirus
- *Aspergillus terreus*

Commonly Detected in Treated Water

Pharmaceuticals	Perfluorinated Compounds	Anthropogenic Waste Indicators	Inorganics	Microorganisms
• lithium • metoprolol	• PFOA • PFBS • PFHxA • PFPeA • PFOS • PFHpA • PFNA • PFBA • PFHxS • PFDA • PFUnDA	• bromoform • triclosan • benzotriazole methyl-1H • isophorone • atrazine • metolachlor • tri(2-chloroethyl) phosphate	• strontium • barium • calcium • sodium • sulfur • magnesium • silicon • potassium • total dissolved nitrogen • flouride • nitrate • aluminum • zinc • sulfate • chloride • iron • manganese • phosphorus • copper • phosphate • bromide • chlorate • uranium • ammonia • arsenic • selenium • nickel • tin	

USGS-EPA Monitoring Results

- Source Water: The frequency of detection for analytes were higher in source water (relative to drinking water), and ranged from approximately 40 detections (from one DWTP) to 100 detections (in another DWTP).

- Drinking Water: Detections in treated DW ranged from approximately 30 to 75 (total positive detections from two individual DWTP)

- Flowing source waters (rivers/streams) tended to have higher frequencies of detection than lake/reservoir and groundwater sources

Preventing CEC's in the Environment: Pharmaceuticals/Personal Care Products

EPA Pharmaceutical Waste disposal guidance

Until a new rule is finalized and adopted by authorized states, healthcare facilities and other business entities that generate pharmaceutical hazardous waste must manage these wastes in accordance with the hazardous waste generator requirements.
http://www2.epa.gov/hwgenerators/management-pharmaceutical-hazardous-waste

EPA Pharmaceutical take-back collection guidance

EPA encourages the public to take advantage of pharmaceutical take-back collection programs that accept prescription or over-the-counter drugs, as these programs offer a safe and environmentally-conscious way to dispose of unwanted medicines. This may be at a location such as a local enforcement agency, retail pharmacy, hospital or clinic. To find any available collection programs in your community, contact your city or county government's household trash agency.
http://www2.epa.gov/hwgenerators/collecting-and-disposing-unwanted-medicines

Preventing CEC's in the Drinking Water: Disinfection Byproducts & PFOA/PFOS

Focus on precursor (e.g., organic matter, halogens such as iodine, bromide) removal in drinking water treatment systems

- Advanced oxidation processes (ozone, UV, H2O2) for removal of organic matter ($$$)
- Ion exchange pre-treatment for halogens ($$$ not commonly used)
- Minimize problematic halogen precursors from point sources (esp. wastewater from coal-fired power plants and industrial wastewater treatment facilities). EPA Regions considering inclusion of halogens in discharge permits in addition to salinity (TDS) requirements.

EPA research on green alternatives to perfluorinated compounds since PFOA/PFOS are ubiquitous, recalcitrant and difficult to remove with conventional WW treatment processes.

Preventing CEC's in the Environment: Engineered Nanomaterials

Manufactured nanomaterials are in more than 1,300 commercial products including medical equipment, textiles, fuel additives, cosmetics, plastics and more.

Nanomaterials Research Areas

- Mapping environmental fate of nanomaterials
- Nanomaterial effects on ecosystems and wildlife health
- Developing sustainable nanomaterials

- EPA scientists research the most prevalent nanomaterials that may have human and environmental health implications.
- EPA research is developing a scientific foundation to better understand, predict and manage the challenges posed by nanomaterials.
- Previous research by EPA and others show high removal by conventional wastewater treatment plant processes for metals/metal oxides

Summary

EPA-ORD works closely with Office of Water to focus research on CECs of highest priority to minimize release into the environment

- Research emphasizes prevention of CEC release to the environment (e.g., pharmaceutical management programs, green alternatives)

However…

If release to the environment cannot be prevented for some compounds (e.g.. PFOA, PFOS) current research focuses on

- Ecological and human exposure and toxicity
- Treatment methods for drinking water and wastewater

Questions?