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[Return to Science Topics](#)**Safe Drinking Water:**

The challenge in delivering safe drinking water is one of balance. In protecting the public from health effects caused by microbial pathogens, public water supplies must achieve levels of disinfection that destroy the greatest number of pathogens while minimizing levels of disinfection byproducts that might themselves cause health effects. Providing safe drinking water involves meeting this challenge and simultaneously complying with federal and state standards that ensure protection from chemical contaminants. Tap water that meets all EPA and state standards is considered safe to drink for the general public.



However, there are occasional, rare incidents of disease outbreaks in U.S. populations served by Public Water Systems (PWSs), in some cases because standards have not been met, and in other cases apparently because the standards did not protect all exposed individuals. In particular, it has been found that some contaminants in even low concentrations pose special health risks to particular groups of people. These groups include infants, young children and the elderly. They also include people with compromised immune systems due to certain illnesses, or because they are undergoing chemotherapy. Drinking water standards are being strengthened to reduce the risk of outbreaks. However, some scientific uncertainty remains about the degree to which current standards and monitoring requirements protect all individuals from all possible effects of microbial pathogens or chemical pollutants.

EPA's Drinking Water Research Program:

Drinking water is one of EPA's high-priority research areas.

Threats to drinking

water is one of EPA's high-priority research areas. Threats to drinking water safety come from the occurrence of chemical contaminants or pathogens in drinking water. The 1996 Amendments to the Safe Drinking Water Act (SDWA) direct EPA to conduct research to strengthen the scientific foundation for standards that limit public exposure to drinking water contaminants. EPA is also charged to identify groups that may be at greater risk than the general population following exposure to contaminants in drinking water.

The 1996 Amendments contain specific requirements for research on waterborne pathogens such as *Cryptosporidium* and Norwalk virus, disinfection by-products (DBPs), arsenic, and other harmful substances in drinking water.

In response to these requirements, EPA has established an integrated, multi-disciplinary research program to provide scientific data and cost-effective technologies to improve the assessment and control of drinking water risks.

Long Term Goals:

The 2003 version of the [Drinking Water Research Program Multi-Year Plan](#) (PDF, 60pp., 1.1MB, [about PDF](#)), EPA drinking water research is captured by three long term goals:

- (1) By 2010, develop scientifically sound data and approaches to assess and manage risks to human health posed by exposure to specific regulated waterborne pathogens and chemicals, including those addressed by the Arsenic, M/DBP, and Six-Year Review Rules;
- (2) By 2010, develop new data, innovative tools and improved technologies to support decision making by the Office of Water on the Contaminant Candidate List and other regulatory issues, and implementation of rules by states, local authorities and water utilities;
- (3) By 2009, provide data, tools and technologies to support management decisions by the Office of Water, state, local authorities and utilities to protect source water and the

quality of water in the distribution system.

EPA's Drinking Water Research Multi-Year Plan

The Drinking Water Research Multi-Year Plan is being revised by EPA in 2005-2006.

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Previous Drinking Water Solicitations of Chemical Contaminants in Drinking Water

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Microbial Pathogens and Disinfection Byproducts

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Areas of Emphasis for STAR Extramural Research

What areas have our previous research solicitations covered?

NCER's drinking water research has covered a range of topics since the programs inception with the first drinking water solicitation in 1996. The STAR drinking water research program has evolved from a focus on disinfection byproducts to an emphasis on microbial contaminants. In more recent years, the STAR program has funded epidemiological investigations of drinking water systems. Future direction for the STAR drinking water program is on development of new, rapid detection methods for drinking water pathogens--both known and emerging.

To read abstracts, progress and final reports for any of the STAR grants, simply go to the NCER website at: <http://es.epa.gov/ncer/>

RFA topic areas and a general summary of awarded grants are provided in the following table.

STAR Drinking Water Research Program

RFA Topic Areas and Summary of Awarded Grants

1996-2005

RFA Year	RFA Topic Areas and Grant Research Area
1996	<p>Microbial Pathogens in Drinking Water Systems (2 grants)</p> <ul style="list-style-type: none"> • <i>Cryptosporidium</i>: Infectivity assay and genomic database <p>Drinking Water Disinfection By-Products (3 grants)</p> <ul style="list-style-type: none"> • Exposure estimation methods for DBPs from different treatment processes; improved extraction procedures; and markers of effects and susceptibility
1997	<p>Microbial Pathogens in Drinking Water Systems (2 grants)</p> <ul style="list-style-type: none"> • Risks from human caliciviruses and <i>Crypto</i> as function of dose and host susceptibility <p>Drinking Water Disinfection By-Products (7 grants)</p> <ul style="list-style-type: none"> • Exposure estimation methods for DBPs from different treatment processes
1997	<p>Separate solicitation with American Water Works Association Research Foundation (AWWARF) and Association of California Water Agencies (ACWA)</p> <p>Arsenic Health Effects (3 grants)</p>

1998	<p>Microbial Pathogens (2 grants)</p> <ul style="list-style-type: none">• Detection and occurrence of viable MAC and caliciviruses <p>Disinfection By-Products (8 grants)</p> <ul style="list-style-type: none">• DBP identification, exposure, and formation modeling; DBP formation from alternative treatment approaches; treatment approach to minimize <i>Crypto</i> and DBP exposure
1999	<p>Method Development Research for CCL Microorganisms (7 grants)</p> <ul style="list-style-type: none">• Methods for detection and occurrence of CCL pathogens <i>Cryptosporidium parvum</i> (2 grants)• Infectivity and prevalence in feedlot cattle <p>Disinfection Byproducts (3 grants)</p> <ul style="list-style-type: none">• DBP exposure estimation and DBP formation from alternative treatment approaches
2000	<p>Research on Pathogen Infectivity and Treatment (6 grants)</p> <ul style="list-style-type: none">• Infectivity and virulence of <i>Cryptosporidium non-parvum</i> species; effectiveness of riverbank filtration for pathogen removal and UV treatment for pathogen inactivation <p>Pharmaceutical and Personal Care Products (PPCPs, 6 grants)</p> <ul style="list-style-type: none">• Occurrence and effects of antibiotics, hormones, and other chemicals in source waters and drinking water

2001	<p>Two concurrent RFAs: Health Effects of Chemical Contaminants in Drinking Water (3 grants)</p> <ul style="list-style-type: none">• Research addressing data gaps for CCL chemical contaminants <p>Microbial Risk in Drinking Water (3 grants)</p> <ul style="list-style-type: none">• Development of indices of relative risk from pathogens in drinking water; and epidemiological study of gastrointestinal health effects from conventionally treated groundwater
2003	<p>Microbial Risk in Drinking Water (5 grants)</p> <ul style="list-style-type: none">• Development of indices of relative risk from pathogens in drinking water; and epidemiological studies of gastrointestinal health effects from community water systems
2005	<p>Scheduled for release in February 2005</p> <ul style="list-style-type: none">• Development and Evaluation of Innovative Approaches for the Quantitative Assessment of Pathogens in Drinking Water

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Health Effects of Chemical Contaminants in Drinking Water



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Microbial Risk in Drinking Water

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SBIR Drinking Water Projects

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Drinking Water - Disinfection Byproducts

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Impact of STAR Drinking Water Research:

Since the 1996 Amendments were passed, NCER has funded research grants to provide information across a range of drinking water priorities. STAR grants have been instrumental in understanding waterborne pathogens such as Cryptosporidium and Norwalk virus, disinfection byproducts (DBPs) and other harmful substances in drinking water.

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Drinking Water - Microbial Pathogens

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STAR's drinking water program is working to identify and characterize the human populations that are most susceptible to contaminants in drinking water. In response to an emerging research area, STAR is now supporting research to evaluate the occurrence and effects of antibiotics, hormones and pharmaceuticals in water.

STAR research has helped to support regulatory and other activities to ensure safe drinking water. It has provided information to upgrade drinking water treatment approaches and improve our understanding of the risks posed by contaminants in drinking water. In the future, STAR's drinking water research program will be used to improve both our understanding of the risks posed by microorganisms in source and drinking waters along with developing innovative tools and improved technologies to support decisions on formerly unregulated contaminants.

Examples of STAR research effecting rulemaking, monitoring methodology, and risk assessment:

Cryptosporidium: A Public Health Threat

In 1993, an estimated 400,000 people became ill in Milwaukee, Wisconsin, after drinking water contaminated with *Cryptosporidium parvum*, a waterborne pathogen that can contaminate drinking water supplies and is highly resistant to traditional disinfection processes. Infection results in diarrhea in healthy people but has more severe consequences for the very young, elderly and those with compromised immune systems. STAR researchers at the University of Texas Health Science Center looked at different types of *Cryptosporidium* to better understand its ability to infect and cause diarrhea in healthy people. They found that these different types varied widely in their abilities to both infect and cause diarrhea, and that only partial immunity was gained against reinfection. The results of this research are proving essential to EPA's Office of Water for estimating the benefits of additional regulations to prevent future outbreaks from water contaminated with *Cryptosporidium*.

A New Technique for DNA "Fingerprinting"

How can we tell if harmful microbes are in our drinking water? STAR researchers at Battelle Memorial Institute developed a new, rapid and low-cost technology to detect microbial pathogens in various water sources. They designed a DNA array that "fingerprints" different types of *Cryptosporidium parvum*, detecting differences at the genetic level. The ability of this technique to discriminate between live and dead pathogens in water means it can indicate if a water source is contaminated with *Cryptosporidium* that could actually cause disease. The technology can potentially be adapted to fingerprint other disease-causing organisms in water or air—whether they are naturally occurring or intentionally placed. Therefore, one extremely important possibility for this technology is to serve as an early warning system to identify pathogens related to bioterrorism incidents in water supplies.

Minimizing Risks From Disinfection Byproducts

One of the major public health advances of the 20th century is the chemical disinfection of drinking water to prevent microbial contamination. But while disinfectants effectively control many harmful microorganisms, they can also react with natural materials in the water to form disinfection byproducts (DBPs). Some DBPs pose health risks of their own, and one of the most complex questions facing water suppliers is how to provide safe drinking water while reducing the risks from toxic DBPs. STAR researchers at Arizona State University have developed computer models to help predict DBP formation using various disinfectants under different water conditions. Currently, these models are being validated as part of the EPA's Water Treatment Simulation Model, which is used to evaluate control strategies for DBPs. Once validated, these models will enable treatment plant operators to consider many specific characteristics of their source waters and essentially "try out" different treatment processes on the computer to find the best approach for minimizing DBPs while still ensuring safe water. Because treatment can be tailored to specific water conditions, applying these models will also help reduce the costs of chemicals used to treat water.

Development of Biomarkers for Haloacetonitrile-Induced Cell Injury

Treated drinking water commonly contains a mixture of halogenated hydrocarbons (disinfection byproducts, or DBPs) that form when residual chlorine reacts with natural organic substances. Among these disinfection by-products are the halogenated acetonitriles (HANs), which have been shown to be toxic and mutagenic in vitro and in vivo assays, and carcinogenic in exposed laboratory animals. The overall goal of this research project was to develop unique biomarkers in a readily accessible compartment such as peripheral (i.e., circulating) blood, for HAN exposure and HAN-induced cellular injury. The development and validation of biomarkers for use in human risk assessment can significantly improve the quality and reduce uncertainty in risk estimates associated with exposure to HANs in drinking water. [more information](#) (PDF, 4pp., 50KB, [about PDF](#))

Evaluation a Novel Secondary Disinfectant Formulation that Reduces Disinfection By-products

This research addressed two critical issues associated with the use of a new secondary disinfectant formulation composed of hydrogen peroxide (H_2O_2) and silver ion (Ag^+): (1) the efficacy of long-term residual disinfection, including the control of coliform bacteria, bacterial regrowth, and slime/biofilm control; and (2) the identification and quantification of disinfection by-products (DBPs) that may result from interactions with conventional chlorine- and oxidant-based primary disinfectants. The H_2O_2/Ag^+ disinfectant formulation is commercially available and designed for use after a strong primary disinfectant. It has been approved as a drinking water disinfectant in Switzerland, Germany, and Australia. By combining two or more disinfectants, it may be possible to lower concentrations of each component, reduce exposures, minimize the formation of toxic and undesirable DBPs, and thus minimize health risks associated with disinfection. In addition to reduced DBPs, when compared to chlorine as a secondary disinfectant, the combined H_2O_2/Ag^+ . [more information](#)(PDF, 4pp., 37KB, [about PDF](#))

Giardia and Cryptosporidium Transport and Fate in Groundwater Systems

The potential exposure of humans to pathogens in potable water supplies is of significant and ongoing regulatory concern. One of the major factors affecting the likelihood and magnitude of human exposure is the transport and fate behavior of the pathogens in subsurface (groundwater) systems. Despite their known public health significance, only limited research has been performed on the subsurface transport and fate behavior of *Cryptosporidium parvum* oocysts, *Giardia muris* cysts, and microsporidium *Encephalitozoon intestinales* spores. Several current and proposed EPA regulations and guidance documents address waterborne *Cryptosporidium* and *Giardia*, while microsporidia (*Enterocytozoon* and *Septata* genera) are included on the 2005 Drinking Water Contaminant Candidate List (CCL). Additionally, *Cryptosporidium* and microsporidia have been shown to be resistant to chlorination, which is the primary water treatment method used throughout the United States. Thus, although these pathogens are often found in the aquatic environment and are of regulatory concern, the processes that control their transport and fate in soil groundwater systems remain poorly understood. [more information](#)(PDF, 4pp., 37KB, [about PDF](#))

Meaningful Detection of Known and Emerging Pathogens in Drinking Water

The provision of safe, treated drinking water requires the control of microbial contamination while minimizing health risks associated with the generation of disinfection by-products (DBPs). Essential to balancing these needs is the availability of microbiological monitoring methods that are practical, meaningful, and adaptable for both established and newly-discovered or emerging pathogens. Often, conventional methods are not sufficiently sensitive to detect small numbers of pathogens that may present risks to water consumers. Many common pathogens are difficult or impossible to cultivate in laboratory media, and polymerase chain reaction (PCR) detection of their genetic material in water, while very sensitive, is often of uncertain significance because of "falsepositive" results due to the presence of dead cells or their components. The overall goal of this research project was to develop and validate molecular methods for detecting viable bacteria in water using two nonstandard nucleic acid analytes. The first analyte, ribosomal RNA precursors (prerRNA), are intermediates in rRNA synthesis, which are abundant in growing bacterial cells but rare in nongrowing or nonviable cells. [more information](#) (PDF, 4pp., 51KB, [about PDF](#))

Development of a Quantitative Cell Culture-based Infectivity Assay for *Cryptosporidium parvum*

Development of a Quantitative Cell Culture-based Infectivity Assay for *Cryptosporidium parvum* Project Scope Oocysts of the enteric protozoa *Cryptosporidium parvum* are ubiquitous in surface waters; have a low infectious dose, even in healthy individuals; and are resistant to conventional water treatment practices. For these reasons, documented waterborne outbreaks of cryptosporidiosis associated with contaminated drinking water or recreational water occur every year in the United States. Therefore, waterborne *C. parvum* oocysts have been of steadily increasing public health and regulatory concern in the past decade. For example, improved control of *C. parvum* is a key component in the proposed Long-Term 2 Enhanced Surface Water Treatment Rule. At the time the research conducted under this grant was being planned, important limitations of the widely used immunofluorescent assay (IFA) for *Cryptosporidium* detection had been identified. [more information](#) (PDF, 6pp., 68KB, [about PDF](#))

Characterizing Disinfection By-product Formation Potential with UV Absorbance Techniques

Disinfection of drinking water with chlorine may produce undesirable, potentially toxic chemical byproducts. These disinfection byproducts (DBPs) are organic and inorganic compounds formed by reactions between chemical oxidants, including chlorine and bromide, and dissolved organic matter (DOM) in the source water. EPA's recent multistaged Disinfectant and Disinfection Byproducts Rule sets standards for the allowable levels of DBPs in drinking water, posing a challenge for public water utilities. Understanding the characteristics of natural waters that contribute to the formation of DBPs is necessary to develop cost-effective strategies to comply with the new standards. [more information](#) (PDF, 3pp., 33KB, [about PDF](#))

Riverbank Filtration Effectiveness in an Arid Environment

Riverbank filtration is a relatively simple and low-cost means for removing particulates and microorganisms from surface water by placing pumping wells in alluvial sediments of the river or stream banks. The sediments act as a filter that traps and attenuates microorganisms and some organic pollutants. During riverbank filtration, waters with different chemical and microbial compositions mix, resulting in complex interactions between soil, microorganisms, pollutants, and dissolved solids. For example, organic solids can be concentrated in the alluvial sediments, and subsequent microbial reduction can create an anaerobic zone where heavy metals are mobilized. Beyond the anaerobic zone, however, there may be an aerobic zone where trace elements and heavy metals are immobilized. [more information](#) (PDF, 4pp., 35KB, [about PDF](#))

An Integrated Approach for the Control of *Cryptosporidium parvum* Oocysts and Disinfection By-products in Drinking Water

Oocysts of the enteric protozoa *Cryptosporidium parvum* are often prevalent in surface waters used to produce drinking water. Unfortunately, these oocysts have a high resistance to inactivation with commonly used disinfectants such as free chlorine and monochloramine. Consequently, waterborne outbreaks of cryptosporidiosis resulting from ingestion of inadequately treated drinking water occur throughout the world, including the United States. Due to ineffectiveness of common disinfectants, many U.S. drinking water utilities have begun to use or are considering the use of ozone and chlorine dioxide to improve control of *C. parvum*, which is a central requirement of the proposed Long-Term 2 Enhanced Surface Water Treatment Rule. However, both of these strong oxidizing agents degrade rapidly by reacting with organic compounds commonly found in surface waters. [more information](#)(PDF, 5pp., 121KB, [about PDF](#))

Pilot Studies of a Novel Ozonation/Fluidized Bed Treatment Process for Disinfection By-product Control

Natural organic matter (NOM) is a complex mixture of organic materials normally present in source waters. During drinking water treatment, chlorine comes in contact with NOM which causes the formation of trihalomethanes (THMs) and other halogenated compounds. The formation of THMs and other disinfection byproducts (DBPs) during the disinfection of drinking waters may pose a public health risk as a number of DBPs, including chloroform and dichloroacetic acid, have been shown to be either carcinogenic or potentially carcinogenic. A number of DBPs, including dichloroacetic acid, have also been shown to have substantial toxicity. Many drinking water utilities worldwide are currently using ozonation followed by biological filtration (biodegradation of organic matter by microorganisms). [more information](#)(PDF, 4pp., 41KB, [about PDF](#))

Studies of the Infectivity of Norwalk and Norwalk-Like Viruses

Norwalk virus (NV) is representative of a large group of related enteric viruses (human caliciviruses) that are the predominant cause of acute gastroenteritis outbreaks in the United States. They are typically transmitted through ingestion of feces-contaminated water and food, exposure to aerosolized feces and vomitus, contaminated surfaces, and through direct person-to-person contact. In previous taxonomic classifications, Norwalk-like viruses (NLVs) were one of four genera of the family Caliciviridae and included two genotypes. Genotype I of the NLVs included the prototype NV and related viruses and genotype II included Snow Mountain Virus (SMV). [more information](#)(PDF, 4pp., 65KB, [about PDF](#))

Occurrence and Fate of Pharmaceuticals and Antiseptics in Drinking and Surface Waters

Although several European studies have revealed a number of pharmaceuticals present in surface waters, sewage treatment plant effluents, and drinking water, information concerning the occurrence, fate, and ecological risk of selected pharmaceuticals and antiseptics in the United States is extremely limited. The research conducted under this grant is designed to address these data gaps by providing an assessment of the prevalence of common pharmaceuticals in drinking water, sewage treatment plant influents and effluents, and receiving waters in the United States. [more information](#)(PDF, 4pp., 37KB, [about PDF](#))

Molecular Detection and Environmental Survey of *Helicobacter pylori*

Helicobacter pylori is a ubiquitous gram-negative bacterium present in the gastrointestinal systems of more than half of the population worldwide. It is a leading cause of peptic ulcers and contributes to a variety of other illnesses, ranging from childhood malnutrition to gastric cancer. It is also known to increase susceptibility to other water- and food-borne pathogens. Although its primary mode(s) of its transmission remains unknown, some epidemiological data suggest contaminated water as a possible transmission route, especially in developing countries. [more information](#)(PDF, 3pp., 35KB, [about PDF](#))

Development of Detection Methods for Waterborne Microsporidia

Microsporidia are a diverse group (1,200 species belonging to 143 genera) of obligate intracellular protozoa that are pathogenic to a broad range of vertebrate and invertebrate hosts. At least 13 microsporidia, including members of the genera *Encephalitozoon* and *Enterocytozoon*, cause disease (e.g., gastroenteritis, encephalitis) in humans—especially among those with compromised immune systems. The infectious form of microsporidia is a small (~2 μm diameter) spore which is resistant to environmental conditions and conventional water treatment practices. [more information](#)(PDF, 5pp., 57KB, [about PDF](#))

Developing Biomarkers of Arsenic Exposure and Toxicity

Arsenic is a highly toxic element that occurs naturally in the environment and is also released by human activities. The most important human exposure source is contaminated drinking water. An important toxic mechanism of inorganic arsenic (iAs) is the interaction of trivalent iAs, (arsenite or iAs^{III}), with thiol-containing residues of peptides and proteins. (See also Exhibit 1 for a list of arsenic-related acronyms used in this report.) This interaction can result in the inhibition of a number of enzymes and the inactivation of critical cellular receptors. Glutathione reductase (GR) has been identified as a key enzyme that is sensitive to inhibition by iAs^{III} . [more information](#)(PDF, 4pp., 40KB, [about PDF](#))

Modeling Monochloramine Loss and Disinfection Byproduct Formation in Drinking Water

Monochloramine is the major chloramine produced in a commonly used drinking water disinfection process. Monochloramine, although a weaker disinfectant than chlorine, can be used when free chlorine residuals are difficult to maintain, or when they lead to excessive disinfection by-product (DBP) formation. The fate of chloramines in drinking water distribution systems and the nature of the reactions and byproducts, as well as factors that influence these, are not well-characterized. Several common reactive water contaminants, such as natural organic matter (NOM), play an important role in determining disinfectant stability and the DBP formation. In addition to reacting with organic materials, monochloramine is known to slowly decompose via auto oxidation. [more information](#)(PDF, 4pp., 56KB, [about PDF](#))

Understanding Risk Factors for Cryptosporidiosis

Oocysts of the enteric protozoa *Cryptosporidium parvum* are ubiquitous in the aquatic environment. Previous taxonomic classification of *C. parvum* included two genotypes of public health concern: Genotype 1 that only infects humans, and Genotype 2 that occurs in a wide variety of animals, including humans. Although small numbers of *C. parvum* oocysts are frequently detected in treated drinking water, it is not known whether they constitute a sufficient dose to cause disease (cryptosporidiosis) in exposed humans. There is a need to assess and determine the actual public health risk associated with consumption of drinking water contaminated with small numbers of *C. parvum* oocysts. [more information](#) (PDF, 5pp., 56KB, [about PDF](#))

Development of an Innovative Procedure for the Analysis of Bromate and Other Oxy-halides in Drinking Water

Drinking water treated by chlorine commonly contains a mixture of disinfection byproducts (DBPs). One important class of DBPs is inorganic oxyhalides, which form when residual disinfectant reacts with natural organic substances present in the source water. Bromate is an important inorganic oxyhalide DBP that has mostly been associated with ozonation of drinking waters containing background bromide. Ozonation requires a secondary disinfectant to maintain a residual in the distribution system. Bromate has also been identified as a contaminant in liquid hypochlorite, a commonly used disinfectant. Bromate is classified as a Group B2 carcinogen (probable carcinogen) by the U.S. EPA and is regulated under the 1998 Stage 1 Disinfectants and Disinfection Byproducts Rule with a Maximum. [more information](#) (PDF, 3pp., 33KB, [about PDF](#))

Measuring Inhalation and Dermal Exposures to Disinfection By-products

Disinfection by-products (DBPs) have been a public health concern since the 1970s, when chloroform and other trihalomethanes (THMs) were identified in chlorine-treated drinking water. DBPs are produced during chlorination of surface and groundwater, and over 100 DBPs have been identified. People can be exposed to DBPs by ingestion, inhalation, and dermal contact with treated drinking water. To estimate the health risks associated with DBPs in drinking water, it is important to be able to estimate dose associated with each potential exposure route. However, the only DBP for which multi-pathway doses have been well characterized to date is chloroform. [more information](#)(PDF, 4pp., 38KB, [about PDF](#))

Development of Mechanistic-based Models of Disinfectant and Disinfectant By-product Formation

The water industry faces new challenges in understanding and controlling disinfection byproduct (DBP) formation as additional information becomes available regarding the health concerns associated with exposures to these compounds. Accurate predictive models for DBP formation will facilitate the evaluation of treatment alternatives for disinfection and DBPs. For this reason, EPA developed a water treatment plant simulation model (*Journal of the American Water Works Association* 1992; 84[11]:78) that incorporates the then-current state of knowledge for predicting DBP formation based upon the water quality entering a treatment plant, chemical dosages applied at various locations within the treatment process, and the retention times in these processes. EPA used this model. [more information](#)(PDF, 5pp., 69KB, [about PDF](#))

Removal of Pathogenic Microorganisms during Riverbank Filtration

Riverbank filtration holds promise as a relatively simple and low-cost way to remove particulates and microorganisms from surface water and make subsequent disinfection treatment easier. In this method, extraction wells are placed deep within riverbank (alluvial) sediments, where they collect river water that filters through the sediments. The effectiveness of this method—i.e., the degree to which microbial pathogens are removed from the collected water—depends greatly on physical processes and aquifer sediment properties (e.g., grain size and distribution) which varies greatly among sites. [more information](#) (PDF, 4pp., 179KB, [about PDF](#))

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[The U.S. Environmental Protection Agency / U.S. Geological Survey Meeting on Cryptosporidium Removal by Bank Filtration](#)
- August 5 - 7, 2003
2003 Research on Microorganisms in Drinking Water Workshop
| [Proceedings](#) | (PDF, 150pp., 3.64MB, [about PDF](#))
- February 22 - 23, 2001
2001 STAR Drinking Water Progress Review Workshop
| [Proceedings](#) | (PDF, 94pp., 6.3MB, [about PDF](#))
- [Bibliometric Analysis of Publications from EPA/ORD's Drinking Water Research Program](#)

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ORD Research Plans

- [Research Plan for Arsenic in Drinking Water
\(February 1998\)](#) (PDF, 63pp., 192KB, [about PDF](#))
- [Microbial Pathogens and Disinfection By-Products
in Drinking Water \(November 1997\)](#) (PDF, 173pp.,
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DRINK: Drinking Water Research Information Network

The Drinking Water Research Information Network (DRINK) is a portal to information on projects funded or performed by water research organizations, government agencies in the U.S., international research organizations, and academic institutions focused on drinking water issues. It is a compilation of drinking water project information from partner organizations that creates a single source of information on ongoing research.

EPA has developed the Drinking Water Research Information Network (DRINK) as a publicly accessible, web-based system that contains searchable information on more than 1,000 research projects funded by leading domestic and international partner organizations. DRINK can be used as a tool for assessing future research priorities to support regulatory development and implementation.

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