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from DHS

The Delta as a Drinking Water Source - Water Quality Issues

Issue

The Delta is the major source of drinking water in California. However, contaminants in Delta water have made it very expensive for water purveyors to comply with recent federal regulations and it is not clear how they will be able to comply with potential future drinking water standards.

The Delta as a Source of Drinking Water

Roughly two thirds of California's population obtains its drinking water from the Sacramento Delta which is formed by the confluence of the Sacramento and San Joaquin Rivers. Two major water projects draw supplies from the Delta: the State Water Project (SWP) and the federally operated Central Valley Project (CVP). A third entity, Contra Costa Water District, (CCWD) also draws its water supply from the Delta.

The SWP and the CVP both divert water in the southern part of the Delta near the City of Tracy. Although both projects divert from locations that are in close physical proximity to one another, the flow paths are such that the SWP diverts more water from the Sacramento River than does the CVP, which draws mostly from the San Joaquin River. Since the San Joaquin River has much poorer quality water, CVP is less suitable for use as a drinking water supply.

The SWP serves 30 public water agencies, which supply drinking water to communities in the North and South Bay Area as well as in Southern California. Roughly 60% of the exported water is used for municipal and industrial purposes, and the rest is used for agriculture. The State has contracts to supply 4.2 million acre-feet (MAF) per year to its member agencies, but can reliably supply only 2.4 MAF per year in its current configuration. This limitation is imposed both by the physical capacity of the system and by water quality considerations in the Delta. The SWP diverts water from two locations in the Delta. A small amount of water is taken from the north Delta, at a point near the City of Fairfield, for use by north Bay Area communities. A much larger amount is diverted from the south Delta for use by communities in Southern California, the central coastal area, the San Joaquin Valley, the south Bay Area, and the Livermore Valley.

The CVP was designed to provide irrigation water to growers in the Sacramento and San Joaquin valleys. The CVP has a south delta pumping capacity of some 2.8 MAF per year, which is used almost entirely to supply farms in the San Joaquin Valley. The CVP has a tremendous impact on the operation of the SWP, however, due to a Coordinated Operating Agreement designed to meet mutual water quality and supply objectives. In addition, the two systems share a common reservoir at a point roughly 50 miles south of the Delta diversions.

The CCWD diverts water from the south Delta for use by communities in Contra Costa County. The points of diversion CCWD uses are in areas that are less influenced by poor water from the San Joaquin River, but are more subject to seawater intrusion than either the SWP or the CVP.

Contaminants Affecting Delta Water Quality

Several water quality parameters have been identified as being of particular concern to water systems using the Delta as a source of supply. These include organic carbon, bromide, and disease-causing microorganisms (pathogens).

Total Organic Carbon (TOC) is produced by decaying vegetation and other organic detritus. Water flowing through the delta increases in TOC content as the result of the introduction of agricultural drainage, urban runoff, runoff from wetland areas, and treated sewage discharges. TOC reacts with chemicals (principally chlorine) used to disinfect drinking water supplies to form disinfection byproducts with potential health impacts.

Bromides are introduced into Delta water supplies primarily by intrusion of seawater (which is high in bromides) into the delta. The degree of this intrusion varies daily, seasonally, and from year to year, depending upon tidal fluctuations and the flow in the Sacramento and San Joaquin Rivers. Bromides can react with chlorine and TOC to form brominated byproducts, but are an even greater concern to water systems using ozone as the primary disinfectant. Ozone reacts with bromide to form bromate, which is considered a potent carcinogen. At this time, there is no economical means of removing either bromide or bromate from water. Bromate formation can be minimized, however, by foregoing the use of ozone as a disinfectant, or by using a water source with a lower concentration of bromide.

Pathogens can be introduced into the Delta water by drainage from animal enclosures and cattle grazing areas, urban runoff, and treated sewage discharges. Of principal concern are the protozoa *cryptosporidium* and *giardia*. These organisms, especially *cryptosporidium*, are very difficult to kill using chemical disinfectant. Although testing for them is very problematic due to the insensitivity of currently available analytical techniques, the presence of potential sources of cryptosporidium on delta watersheds makes it necessary to assume there is a potential problem with *cryptosporidium* and *giardia*. Water treatment systems deal with them by optimizing their removal by filtration and/or by using ozone, which is a much more powerful disinfectant than chlorine.

The Current Problem

The fundamental issue is whether drinking water suppliers using the Delta will be able to meet future drinking water standards, given the water quality problems inherent in the Delta. Unfortunately, current health effects research and treatment technology information do not now provide an adequate scientific basis from which to project what

the drinking water standards, or the treatment options to meet those standards, will be over the next five to ten years. Longer-range projections are even more uncertain.

Regulatory Situation

In November of 1998, the U.S. Environmental Protection Agency (USEPA) will promulgate new regulations that will make more stringent drinking water standards for disinfection byproducts (known as Stage 1 DBP) while tightening requirements on the treatment of surface water for larger water systems (systems with greater than 10,000 population).

The new standards for disinfection byproducts address three types of byproducts that may be produced when chlorine and/or ozone are used as the primary water disinfecting agent. They are as follows:

Byproduct	**New Standard, micrograms per liter (ug/l)**	**(Old) Standard**
Total trihalomethanes (TTHMs)	80	100
Total haloaceticacids (HAAs) (includes five haloaceticacids)	60	N/A
Bromate	10	N/A

The new disinfection byproducts regulation will affect all community water systems. The previous regulation was specific to TTHMs and only affected community water systems serving greater than 10,000 population.

The new surface water treatment requirements (Interim Enhanced Surface Water Treatment Rule) is intended to address the concerns associated with the transmission of *cryptosporidium*. Larger water systems will be required to meet more stringent performance standards and improve on the operation of their treatment facilities.

Currently most water systems using Delta water are able to meet the requirements of these two new regulations. They have accomplished this by: 1) changing from chlorine disinfection to the use of chloramines to reduce disinfection byproducts; and 2) optimizing their treatment operations and using ozone as a primary disinfectant in combination with chloramines.

Future Regulations

USEPA has established a regulatory schedule that will require two future revisions of both the disinfection byproducts regulation (DBP) and the surface water treatment rule (SWTR). The DBP rule is scheduled to be revised in mid 2002 and then again in 2007. The SWTR is scheduled for revision in late 2000 and again in 2002.

USEPA has indicated that discussions on the first DBP rule revision (known as Stage 2 DBP) will begin in December, 1998. The process will follow the Regulatory Negotiation framework that USEPA has employed in the past.

The outcome of the Stage 2 DBP rule could have a profound effect on water systems using Delta water. Any tightening of the requirements could result in serious compliance problems for water systems. For example, a study commissioned in 1997 by the California Urban Water Association found that if the bromate standard were set at 5 ug/l, water systems using ozone as a primary disinfectant would be unable to comply. In addition, the study found that if the TTHM standard was reduced to 40 ug/l and the THAA standard reduced to 30 ug/l, water systems using chlorine as a primary disinfectant could not comply without extensive capital improvements.

Research Affecting Future Regulations

To support the future DBP rules, USEPA is undertaking a significant research effort on the health effects of disinfection byproducts. In February, 1998, a USEPA expert panel was convened to review recent toxicological and epidemiological studies of reproductive and developmental effects associated with DBPs and to consider whether additional epidemiological studies of reproductive and developmental effects would likely yield information to help USEPA develop drinking water standards or strategies for reducing the formation of DBPs of health concern. To date USEPA's focus has been on the cancer causing properties of DBPs. The report contains a number of recommendations for studies that are intended to provide USEPA with information on reproductive and developmental effects for use in establishing the Stage 2 DBP rule.

The panel also reviewed the recent report by the Department of Health Services that found an association between spontaneous abortions and certain levels of trihalomethanes in drinking water. The panel found the study to be well-designed and recommended that: 1) additional work be done to refine the study results; and 2) a similar study be conducted in another location. USEPA agreed with the panel's recommendations and has committed funds to carry them out. A schedule of the DBP Reproductive Epidemiology studies is attached.

USEPA has also committed significant funds to studying the cancer and reproductive toxicology of disinfection byproducts. These studies are scheduled for completion between 1999 and 2004 (schedule of studies attached).

Conclusion

Delta water quality will continue to affect the ability of water systems to comply with federal and state drinking water standards. The most significant Delta water quality concern presently is bromide since many larger water systems are converting to ozone as the primary disinfectant to meet the new rule for surface water treatment and still must control bromate production. Any further tightening of federal standards for disinfection

byproducts beyond the Stage 1 DBP rule has the potential for causing serious compliance problems for water systems of all sizes. Therefore, the water systems that use the SWP generally support the construction of a diversion point in the Delta upstream (peripheral canal) of the areas where TOC and bromide cause problems. The diversion point is consistent with the industry principle of providing the highest quality product possible at a reasonable cost and eliminates issues relating to treatment technologies to remove TOC and bromide. Environmental impacts on the Delta and other parts of California would also need to be factored into the public policy decisions.

Scientists to be Contacted on Health Effects Issues And their Areas of Expertise

Contact	Area of Expertise
Ann Aschengrau Associate Professor School of Public Health Services Boston University 715 Albany Street Boston, MA 02118	Epidemiology
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Allen Wilcox, Director Division of Epidemiology and Biostatistics National Institute of Environmental Health Sciences Research Triangle Park, NC 27709	Epidemiology
Fred Hauchman Assistant Director for Water National Health and Environmental Effects Research Laboratory U.S. Environmental Protection Agency Research Triangle Park, NC 27711	Toxicology and Epidemiology
Diane Pettiti, M.D., M.P.H. Kaiser Permanente Research South	Epidemiology and Reproductive Effects
Kenneth Rothman, Editor Epidemiology	Epidemiology
Richard Bull, Ph.D. Batlelle Pacific Northwest National Laboratory	Toxicology

USEPA Schedule of Studies

DBP REPRODUCTIVE EPIDEMIOLOGY

Project	Status	Completion Date
Expert panel report on future DBP repro epi research	Complete	4/98
Improve exposure assessment in California study cohort	1. Low birthweight paper in progress 2. GIS analysis (SAB, LBW) in progress 3. Improve THM, add HA, redo SAB analysis, add male repro and delayed conception	1. 1998 2. 1999 3. 2000 - 2001
Study of DBP exposures and birth weight in Colorado	1. Pilot study on LBW, paper submitted 2. Distribution system model, paper submitted 3. Expanded study on LBW in progress	1. 1998 2. 1999 3. 1999
Collaborative study with CDC on birth defects	Protocol in development	2000
Evaluate methods for conducting male reproductive studies	1. Container development 2. Pilot container	1. 1998 2. 1999
M/DBP Council: Evaluation of geographic areas for future studies	Analysis of available health and exposure information throughout the U.S. is progressing satisfactorily	1998
California-type study in another location	Funds earmarked; Solicitation toward end of year; study begins 1999	2002

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USEPA Schedule of Studies

DBP CANCER TOXICOLOGY

Project	Status	Completion Date
2-Year Cancer Bioassays (NTP)		
Bromodichloromethane	Most of these are in the initial stages of planning and chemistry analysis.	2002 - 2003
Dibromoacetic acid		2002 - 2003
Bromochloroacetic acid		2003 - 2004
Dichloroacetic acid		2003 - 2004
Dibromoacetonitrile		2003 - 2004
Chlorate		2002 - 2003
MX		2003 - 2004
EPA mechanistic research		
Dichloroacetic acid	Mechanistic studies underway in support of a BBDR[1] model	
Bromate	Mechanistic studies underway	
Bromodichloromethane	Pharmacokinetic studies underway in support of PBPK[2] models	1998 (rodent model) 2000 (human model)
	Mechanistic studies underway in support of a BBDR model	2000
Dibromochloromethane and bromoform	Mechanistic and pharmacokinetic studies underway	1999-2000
Dibromoacetic acid	Screening/mechanistic studies (Bull)	Early 1999
Bromodichloroacetic acid	Screening/mechanistic studies (Bull)	Early 1999
Bromochloroacetic acid	Screening/mechanistic studies (Bull)	Early 1999
DBP mixtures studies		
Mechanism-based (Wolf *et al.*)	In planning stage	2000 ?
THM toxicity (Simmons et al.)	Assessment of additivity assumption; Chlorination/ozonation mixture comparison	1997-1999 2000

[1] BBDR = biologically based dose-response

[2] PBPK = physiologically based pharmacokinetic

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USEPA Schedule of Studies

DBP REPRODUCTIVE TOXICOLOGY

Project	Status	Completion Date
35-day screening studies (NTP)		
Bromodichloromethane	Just completed - negative	Pending
Chlorodibromomethane	Completed - negative	Report available
Bromochloroacetic acid	Just completed - positive	Pending
Chlorodibromoacetic acid	Not yet initiated	1999
Dibromoacetonitrile	Completed - negative	Pending
Bromoacetonitrile	Completed - high dose effect	Pending
Bromate	Completed - high dose effect	Report available
Hexachloropropanone	Completed - high dose effect	Pending
Haloacetic acid mixture	Initiated	1999
Embryotoxicity studies		
Effects of haloacetic acids, bromate, and chlorate in embryo culture	Completed	1999
Haloacetic acid effects on protein kinases	Underway	2000
Developmental toxicity studies		
In vivo screens of DCA, BCA and bromate in pregnant mouse	Underway (oxidative damage, effect on kinase activity)	2000
Reproductive toxicity studies		
Dibromoacetic acid (rabbits)	Award pending (CSU)	2001
Effects of BDCM and BCA on reproduction in female rats	Underway (in-house)	2000
BCA studies in adult male	Underway (in-house)	2000
Long-term DBP study 2-generation study	In planning stages	>2000

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