NWRI

NATIONAL WATER RESEARCH INSTITUTE

Research Profile

CECs in Southern California Water Sources

Understanding the Presence of Constituents of Emerging Concern in Water

The National Water Research Institute (NWRI) published a project report on "Source, Fate, and Transport of Endocrine Disruptors, Pharmaceuticals, and Personal Care Products in Drinking Water Sources in California" in May 2010.

The report was prepared by researchers at the Metropolitan Water District of Southern California and Orange County Water District who conducted a project to better understand the presence and levels of constituents of emerging concern (CECs) in major Southern California drinking water sources.

Researchers detected very low (trace) levels of CECs in each water source that was studied. Based on the results of this project, we can now better assess any potential health and environmental impacts of CECs.

What Are Constituents of Emerging Concern?

"Constituents of emerging concern" is a term used to include a broad range of unregulated chemical components found at trace levels in many of our waters, including surface water, drinking water, wastewater, and recycled water. Other terms include "endocrine disrupting chemicals" or "pharmaceuticals and personal care products."

CECs include the pharmaceuticals that people use to treat illnesses and the components of personal care products, like shampoos and detergents, which people use every day. These constituents enter our water sources and wastewater by flushing unused medications, using personal care products and household cleaning products, excreting unabsorbed medications into the wastewater collection systems, and accidental spills into water or wastewater collection systems.

NWRI Final Project Report
Source, Fate, and Transport of Endocrine Disruptors, Pharmaceuticals, and Personal Care Products in Drinking Water Sources in California

Published: May 2010

Publisher: NWRI

Collaborators:

- Metropolitan Water District of Southern California (MWD)
- Orange County Water District (OCWD)

Principal Investigators:

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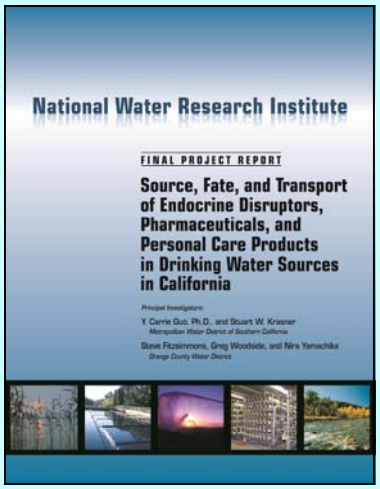


Availability: Download at www.NWRI-USA.org/CECs.htm

Overview of the NWRI Project

NWRI sponsored this project to assess the occurrence of CECs in three major drinking water sources in Southern California: State Water Project, Colorado River water, and Santa Ana River water.

The goal of the project was to better understand the presence and impact of CECs in these three sources of water.

As part of this project, water samples were taken from the three water sources at 32 locations, ranging from upstream of the City of Sacramento to down south in Orange County, California, as well as locations along the Colorado River in Arizona and Nevada.

Altogether, out of the 49 CECs that were evaluated in this project, researchers detected only 27 CECs in water samples from the three water sources.

These CECs were detected at very low levels — levels that are millions of times smaller than a pharmaceutical dose.

The Three Water Systems

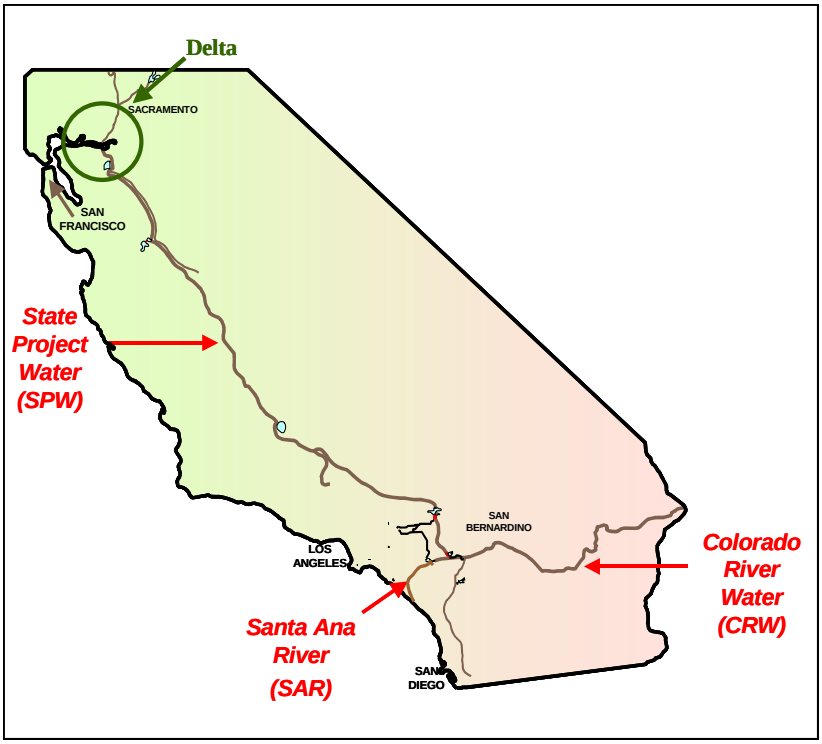
This project evaluated three of the major drinking water sources for over 25-million people in California. They include engineered and natural systems throughout the state, as shown in the map.

State Water Project (SWP) - An engineered water storage and delivery system of reservoirs, aqueducts, and pumping plants that delivers water throughout California, including Southern California.

Colorado River Water (CRW) - This river flows from Colorado through Utah, Nevada, and Arizona; water is imported to Southern California via the Colorado River Aqueduct.

Santa Ana River (SAR) - The river flows from the San Bernardino Mountains to the ocean through three counties. Flow from the SAR is diverted and used for groundwater recharge in Orange County, California.

Each of these sources is impacted in varying degrees by treated wastewater discharges, agricultural runoff, recreation, and other activities that may account for the presence of CECs.



The three water systems, as located in a partial map of California.

Laboratories Used in This Study to Analyze Constituents of Emerging Concern

The following laboratories were used to analyze the water samples for CECs in this project:

- **Metropolitan Water District of Southern California (MWD)** - Located in La Verne, CA, MWD's Water Quality Laboratory is a state-of the-art facility dedicated to ensuring that the drinking water served to nearly 18 million Californians is safe, of the highest quality, and complies with water quality regulations.
- **Orange County Water District (OCWD)** - Located in Fountain Valley, CA, the OCWD Water Quality Laboratory supports water quality testing for Orange County's groundwater basin and the Groundwater Replenishment System, the largest water purification project of its kind in the world.
- **Southern Nevada Water Authority (SNWA)** - Located in Henderson, NV, the SNWA Water Quality Laboratory and Applied Research & Development Center houses one of the most sophisticated municipal water quality laboratory complexes in the world.

Analytical Methods for Detecting Constituents of Emerging Concern

Multiple analytical methods have been developed for the detection of CECs. However, these methods are not standard methods (that is, methods approved for regulatory purposes), which means that the methods may vary from laboratory to laboratory.

All three laboratories that participated in this project used analytical methods that were either previously published or slightly modified versions. To ensure high-quality data, an inter-laboratory comparison of the analytical methods among the three laboratories was conducted before sample collection began in April 2008.

Extensive quality assurance/quality control (QA/QC) protocols for the three laboratories were also implemented for this project. These protocols included field blanks, method blanks, duplicate samples, matrix-spiked samples, and matrix-spiked duplicate samples.

How Small Is "Nanograms Per Liter"?

The ability to detect CECs at very low levels in water is a relatively new breakthrough in science.

CECs are detected at trace levels in water (for instance, detected concentrations of pharmaceutical CECs are millions of times smaller than a pharmaceutical dose).

Therefore, CEC detections are reported in "nanograms per liter" (ng/L). A nanogram is one one-billionth of a gram, and nanograms per liter are equal to "parts per trillion" (ppt).

For reference, one ppt is one drop of dye in about 13 million gallons of water, or about one second in 32,000 years.

Sampling Procedures

Water sampling took place quarterly at 32 sampling sites from April 2008 to April 2009. Specifically:

- Eleven locations in the SWP system were sampled, with a total of 43 samples taken.
- Eight locations in the CRW system were sampled, with a total of 31 samples taken.
- Thirteen locations in the SAR system were sampled, with a total of 52 samples taken.

The samples included:

- River samples with low impact from wastewater treatment plant discharges.
- River samples dominated by tertiary-treated wastewater discharges.
- Wastewater treatment plant effluents, collected from the CRW and SAR systems.

Sampling Results

Out of the 49 CECs that were evaluated in this project, researchers detected 27 CECs in water samples from the three water sources, while 22 CECs were not detected in any of the sources. Both the detected and non-detected CECs are listed in the adjacent table.

Some CECs were detected in all but one of the 32 sampling sites used for this project. The concentration levels of all detected CECs were very low, on a nanogram-per-liter level.

State Water Project (SWP)

Twenty-one CECs were detected in the SWP samples, typically at levels below 30 ng/L.

Colorado River Water (CRW)

Twelve CECs were detected in CRW surface water samples, typically at levels below 20 ng/L.

Sixteen CECs were detected in the wastewater treatment plant effluent samples, with average levels on the order of a hundred to several hundred nanograms per liter.

Santa Ana River (SAR) Water

Twenty-two CECs were detected in the SAR river and tributary samples. Typical concentrations varied from 2 to 200 ng/L, though they were generally lower than those for treated wastewater effluent samples.

Twenty CECs were detected in the wastewater treatment plant effluent samples, with average levels on the order of a hundred to several hundred nanograms per liter.

Further Details about the Results

More details about the sampling results are included in the NWRI final project report, "Source, Fate, and Transport of Endocrine Disruptors, Pharmaceuticals, and Personal Care Products in Drinking Water Sources in California."

The NWRI final project report includes information about the specific CECs that were analyzed and the concentration levels of detected CECs in each water system, as well as discussions on the impact of seasonal variation on the occurrence of CECs in wastewater effluents and surface water samples.

The NWRI final project report can be downloaded at our website at **www.NWRI-USA.org/CECs.htm**.

CECs Analyzed in the Study

Detected	
Compound	**Use**
4-n-Nonylphenol	Detergent metabolite
4-n- and 4-t Octylphenol	Detergent metabolite
Acetaminophen	Analgesic medicine
Atrazine	Herbicide
Atrazine-Desisopropyl	Atrazine metabolite
Azithromycin	Antibiotic
Benzo(a)pyrene	Industrial compound
Bisphenol A	Plastics manufacturing
Caffeine	Stimulant
Carbamazepine	Anti-convulsant
Ciprofloxacin	Antibiotic
DEET	Insect repellant
Diclofenac	Anti-inflammatory
Dilantin	Anti-convulsant
Diuron	Herbicide
Gemfibrozil	Anti-cholesterol
Ibuprofen	Analgesic medicine
Linuron	Herbicide
Methoxychlor	Pesticide
Methylparaben	Preservative and antibacterial
o,p-DDD	DDT metabolite
Primidone	Anti-convulsant
Propylparaben	Preservative and antibacterial
Simazine	Herbicide
Sulfamethoxazole	Antibiotic
Tris(2-chloro-ethyl) phosphate (TCEP)	Flame retardant
Triclosan	Antibacterial

Not Detected	
Compound	**Use**
2,4,6-Trichlorophenol	Pesticide, fungicide
4-Phenylphenol	Fungicide
17a-Estradiol	Hormone
17b-Estradiol	Hormone
Anthracene	Industrial compound
Atrazine-Desethyl	Atrazine metabolite
Butylparaben	Antibacterial
Cyanazine	Herbicide
Cyprazine	Herbicide
Diethylstilbestrol	Hormone
Epitestosterone	Hormone
Estriol	Hormone
Estrone	Hormone
Ethylparaben	Preservative and antibacterial
Ethynylestradiol	Synthetic birth control
Lindane	Pesticide
Nonylphenol ethoxy-lates (total)	Detergent metabolite
Pentachlorophenol	Fungicide, fumigant
Progesterone	Hormone
Propazine	Herbicide
Testosterone	Hormone
Tetrabromobis-phenol A	Flame retardant

Fate and Transport of Constituents of Emerging Concern

The term "fate and transport" refers to what happens to a CEC as a result of its potential to be transported, transformed, or destroyed in a watershed.

The project's research team found that CECs were attenuated (or reduced) in the natural environment. A possible cause for the attenuation of some CECs (such as carbamazepine and primidone) was dilution with other source waters, whereas for other CECs (such as gemfibrozil and sulfamethoxazole), the cause was natural degradation processes, such as biodegradation, photolysis, and sorption.

In addition, researchers concluded that the use of wetlands to remove nitrate from the water also appears to be an effective means to remove some CECs to varying extents. For example, the antibiotic azithromycin was completely attenuated from water sampled at the Prado Wetlands (part of the SAR system), while caffeine, gemfibrozil, ibuprofen, sulfamethoxazole, and acetaminophen were often highly attenuated (42 to 100 percent).

Where Do We Go From Here?

Significant information was obtained from this project on the occurrence, fate, and transport of CECs in three water sources in California.

However, this project is among the first of such efforts currently being undertaken by the water and wastewater community to better understand the presence of CECs in our water sources.

Future Research Needs

To move forward on developing a better understanding of CECs, the NWRI project report recommends that future research be directed toward the following areas:

- Develop standardized analytical methods to better evaluate water quality data on CECs.
- Collect and analyze water samples from treated wastewater effluents in the SWP system.
- Develop a sampling design that follows a plug of water to allow a more in-depth fate and transport analysis.
- Better characterize the hydrology of certain locations in the three water systems.
- Include monitoring wells in future sampling plans to understand the occurrence of CECs in groundwater.
- Continue toxicological assessments on CECs in drinking water to determine possible health risks.
- Collaborate on developing public communications tools regarding CECs in water supplies to address public concerns.

Our Commitment

The water and wastewater community is committed to protecting public health and the environment.

Utilities and research organizations, as well as state and federal public health agencies, are working to identify further research and conduct more studies to characterize the occurrence and determine whether CECs pose human health and environmental risks and, if so, what additional measures will need to be implemented.

For more information about CECs in our water supplies, including current reports, please visit the NWRI website at **www.NWRI-USA.org/CECs.htm** or contact Jeff Mosher, NWRI Executive Director, at jmosher@nwri-usa.org or (714) 378-3278.

The National Water Research Institute (NWRI) is a nonprofit organization formed in 1991 by water and wastewater agencies in Southern California to improve water quality, protect public health and the environment, and create safe, new sources of water for our communities. NWRI focuses on research and outreach activities in the areas of drinking water, wastewater, and recycled water.

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