

University of Nebraska - Lincoln

DigitalCommons@University of Nebraska - Lincoln

USGS Staff -- Published Research

US Geological Survey

2003

Ethylenediaminetetraacetic Acid Occurrence and Removal Through Bank Filtration in the Platte River, Nebraska

Jason R. Vogel

United States Geological Survey, jason.vogel@ou.edu

Larry B. Barber

United States Geological Survey

Tyler B. Coplen

United States Geological Survey

Ingrid M. Verstraeten

United States Geological Survey

Thomas F. Speth

United States Environmental Protection Agency

See next page for additional authors

Follow this and additional works at: <https://digitalcommons.unl.edu/usgsstaffpub>



Part of the [Earth Sciences Commons](#)

Vogel, Jason R.; Barber, Larry B.; Coplen, Tyler B.; Verstraeten, Ingrid M.; Speth, Thomas F.; Obrist, Jerry; and Butler, Win, "Ethylenediaminetetraacetic Acid Occurrence and Removal Through Bank Filtration in the Platte River, Nebraska" (2003). *USGS Staff -- Published Research*. 229.

<https://digitalcommons.unl.edu/usgsstaffpub/229>

This Article is brought to you for free and open access by the US Geological Survey at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in USGS Staff -- Published Research by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

Authors

Jason R. Vogel, Larry B. Barber, Tyler B. Coplen, Ingrid M. Verstraeten, Thomas F. Speth, Jerry Obrist, and Win Butler

Ethylenediaminetetraacetic Acid Occurrence and Removal Through Bank Filtration in the Platte River, Nebraska

Jason R. Vogel, Ph.D.
United States Geological Survey
Lincoln, Nebraska

Larry B. Barber, Ph.D.
United States Geological Survey
Boulder, Colorado

Tyler B. Coplen, Ph.D.
United States Geological Survey
Reston, Virginia

Ingrid M. Verstraeten, Ph.D.
United States Geological Survey
Baltimore, Maryland

Thomas F. Speth, Ph.D., P.E.
United States Environmental Protection Agency
Cincinnati, Ohio

Jerry Obrist, P.E.
City of Lincoln Water System
Lincoln, Nebraska

The USGS, USEPA, and City of Lincoln Water System (Nebraska) have conducted a study to determine the occurrence and removal of EDTA, NTA, and nonylphenol monoethoxycarboxylate to nonylphenol pentaethoxycarboxylate (NP1EC-NP5EC) in the hydrologic system at the City of Lincoln well field. The objective of the study is to evaluate the occurrence and removal of EDTA, NTA, and total nonylphenolpolyethoxycarboxylate (NPEC) by bank filtration at the City of Lincoln well field. This presentation will discuss removal during two sampling periods — May and August 2002 — based upon surface-water fractions in the collector well calculated using stable isotope ratios of hydrogen and oxygen.

The rationale for selecting compounds evaluated in this study was based on the hierarchical analytical approach and includes a range of compounds covering a spectrum of uses and effects. For example, EDTA is a low-toxicity, high-production volume chemical used in multiple domestic, commercial, and industrial applications to form stable, water-soluble complexes with trace metals. Because of its uses and chemical characteristics, EDTA occurs at relatively high concentrations and can persist in the aquatic environment (Barber et al., 1996; Barber et al., 2000; Leenheer et al., 2001; Barber et al., 2003).

Correspondence should be addressed to:

Jason R. Vogel, Ph.D.
Hydrologist
United States Geological Survey
Room 406, Federal Building • 100 Centennial Mall North • Lincoln, Nebraska 68508 USA
Phone: (402) 437-5129 • Fax: (402) 437-5139 • Email: jrvogel@usgs.gov

Site Description

There are 40 active production wells at the City of Lincoln well field. Two of these wells are horizontal collector wells screened in alluvial sand and gravel approximately 26-m below the Platte River; they provide approximately 50 percent of the municipal water during most times of the year. The remaining 38 wells are vertical production wells that are developed in alluvial sediments mainly consisting of sand and gravel. At this location, the quality of the river water has a large effect on the quality of the bank-filtered water obtained from the collector wells. Similarly, the water quality of the groundwater in the vertical production wells directly corresponds to the distances of the wells from the river. Because of the direct link between the collector wells and river, the collector well is usually turned off during the month of May and first part of June to avoid the flush of herbicides associated with spring planting in this agricultural area. After collection, well water is treated by ozonation, filtration, and chlorination before distribution.

Sampling

Representative surface-water samples were collected quarterly from the Platte River at the well-field site using equal width-increment, flow-weighted sampling. Groundwater samples were also collected quarterly from one of the collector wells and from two of the vertical groundwater wells. One groundwater well was located relatively close to the river (within 100 m), with another located away from the river (1,000 m). All samples were filtered through 0.7- μ m glass fiber filters and collected in pre-cleaned amber glass bottles. Samples for EDTA, NTA, and NPEC analyses were preserved with 2-percent by volume formalin. This presentation will discuss the results of samples from May and August 2002.

Analysis

EDTA, NTA, and NP1EC-NP5EC were measured using a modification (Barber et al., 2000) of the method of Schaffner and Giger (1984). Samples (100 milliliters) were evaporated to dryness, acidified with 5-milliliter 50-percent (volume per volume) formic acid/distilled water, and evaporated to dryness. Acetyl chloride/propanol (10-percent volume per volume) was added, the sample heated at 90-degrees Celsius for 1 hour to form the propyl-esters, and the propyl-esters were extracted into chloroform. The chloroform extracts were evaporated to dryness and re-dissolved in toluene for analysis by GC/MS, as described below.

The propyl-ester extracts were analyzed by electron-impact GC/MS in both the full-scan and select ion monitoring modes. The general GC conditions were:

- Hewlett Packard (HP) 6890 GC.
- Column-HP Ultra II (5-percent phenylmethyl silicone), 25 m \times 0.2 millimeters, 33-micrometer film thickness.
- Carrier gas, ultra-high purity helium, with a linear-flow velocity of 27 centimeters per second.
- Injection port temperature, 300-degrees Celsius.
- Initial oven temperature, 50-degrees Celsius.
- Split vent open, 0.75 minutes.
- Ramp rate, 6-degrees Celsius per minute to 300-degrees Celsius.
- Hold time, 15 minutes at 300-degrees Celsius.

The MS conditions were as follows:

- HP 5973 Mass Selective Detector.
- Tune with perfluorotributylamine.
- Ionization energy, 70 electron volt (eV).
- Source pressure, 1×10^{-5} torr.
- Source temperature, 250-degrees Celsius.
- Interface temperature, 280-degrees Celsius.
- Full scan, 40 to 550 atomic mass units at one scan per second.

Concentrations were calculated based on select ion monitoring data using diagnostic ions for each compound. Each compound was identified based on the matching of retention times (± 0.02 minutes) and ion ratios (± 20 percent) determined from the analysis of authentic standards. An eight-point calibration curve (typically ranging from 0.01 to 50 nanograms per microliter) and internal standard procedures were used for calculating concentrations. Surrogate standards were added to the samples prior to extraction and derivatization to evaluate compound recovery and whole method performance.

Results

In general, based upon results from May and August 2002, measured EDTA concentrations for surface-water samples were larger than for groundwater samples. In addition, EDTA concentrations decreased and total NPEC concentrations increased in the groundwater as the distance of the well from the river increased. NTA was only detected in one surface-water sample at very low levels and not at all in groundwater samples.

Using surface-water fractions in the collector well determined from deuterium and oxygen-18 ratios, the transport of EDTA was nearly conservative during these two sampling periods. Total NPEC concentrations were lower than predicted. Further analysis will be forthcoming in the presentation.

REFERENCES

Barber, L.B., G.K. Brown, and S.D. Zaugg (2000). "Potential endocrine disrupting organic chemicals in treated municipal wastewater and river water." *Analysis of Environmental Endocrine Disruptors*, L.H. Keith, T.L. Jones-Lepp, and L.L. Needham, eds., American Chemical Society Symposium Series 747, American Chemical Society, Washington, DC, p. 97-123.

Barber, L.B., E.T. Furlong, S.H. Keefe, G.K. Brown, and J.D. Cahill (2003). "Natural and Contaminant Organic Compounds in Boulder Creek, Colorado under High-Flow and Low-Flow Conditions, 2000." *Comprehensive water quality of the Boulder Creek Watershed, Colorado, under high-flow and low-flow conditions*, S.F. Murphy, L.B. Barber, and P.L. Verplanck, eds., U.S. Geological Survey Water Resources Investigations Report 03-4045.

Barber, L.B., J.A. Leenheer, W.E. Pereira, T.I. Noyes, G.A. Brown, C.F. Tabor, and J.H. Writer (1996). "Organic contamination of the Mississippi River from municipal and industrial wastewater." *U.S. Geological Survey, Circular 1133*, p. 114-135.

Leenheer, J.A., C.E. Rostad, L.B. Barber, R.A. Schroeder, R. Anders, and M.L. Davisson (2001). "Nature and chlorine reactivity of organic constituents from reclaimed water in groundwater, Los Angeles County, California." *Environmental Science and Technology*, 35: 3,869-3,876.

Schaffner, C., and W. Giger (1984). "Determination of nitrilotriacetic acid in water by high-resolution gas chromatography." *Journal of Chromatography*, 312: 413-421.



Hydrologist JASON VOGEL has been with the United States Geological Survey in Lincoln, Nebraska, for a little over a year. During that time, he has been the Project Chief for a bank-filtration study in cooperation with the United States Environmental Protection Agency and the City of Lincoln Water System, and is also Lead Scientist of the agricultural chemical transport team in the Nebraska District. Before joining the United States Geological Survey, Vogel was a research engineer in the Biosystems Engineering Department at Oklahoma State University for 5 years. He has published articles on a wide variety of topics, including geostatistics and stochastic design, vadose zone transport, and microbial transport in groundwater, and co-authored the chapter on Geostatistics in *Statistical Methods in Hydrology, Second Edition*, with C.T. Haan. Vogel received a B.S. in Biological Systems Engineering from the University of Nebraska, an M.S. in Agricultural Engineering from Texas A&M University, and Ph.D. in Biosystems Engineering from Oklahoma State University.