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# Microbe Concentrations, Laser Particle Counts, and Stable Hydrogen and Oxygen Isotope Ratios in Samples from a Riverbank Filtration Study, Platte River, Nebraska, 2002 to 2004

Data Series 133

U.S. Department of the Interior
U.S. Geological Survey

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By J.R. Vogel, S.I. Harris, T.B. Coplen, E.W. Rice, and I.M. Verstraeten

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**U.S. Department of the Interior**
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# Conversion Factors and Datums

| Multiply | By | To obtain |
|---|---|---|
| | Length | |
| micrometer (µm) | 0.00003937 | inch (in.) |
| meter (m) | 3.281 | foot (ft) |
| kilometer (km) | 0.6214 | mile (mi) |
| | Volume | |
| liter (L) | 33.82 | ounce, fluid (fl. oz) |
| milliliter (mL) | 0.03382 | ounce, fluid (fl. oz) |
| microliter (µL) | 0.00003382 | ounce, fluid (fl. oz) |
| liter (L) | 2.113 | pint (pt) |
| liter (L) | 1.057 | quart (qt) |
| liter (L) | 0.2642 | gallon (gal) |
| | Flow rate | |
| cubic meter per second ($m^3/s$) | 35.31 | cubic foot per second ($ft^3/s$) |
| cubic meter per day ($m^3/d$) | 264.2 | gallon per day (gal/d) |
| million liters per day (ML/d) | 0.2642 | million gallons per day (Mgal/d) |
| cubic meter per second ($m^3/s$) | 22.83 | million gallons per day (Mgal/d) |
| | Mass | |
| nanogram (ng) | $3.527 \times 10^{-11}$ | ounce, avoirdupois (oz) |
| microgram (µg) | 0.00000003527 | ounce, avoirdupois (oz) |
| milligram (mg) | 0.00003527 | ounce, avoirdupois (oz) |
| gram (g) | 0.03527 | ounce, avoirdupois (oz) |

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F=(1.8\times°C)+32$$

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

# Microbe Concentrations, Laser Particle Counts, and Stable Hydrogen and Oxygen Isotope Ratios in Samples from a Riverbank Filtration Study, Platte River, Nebraska, 2002 to 2004

By J.R. Vogel, S.I. Harris, T.B. Coplen, E.W. Rice, and I.M. Verstraeten

## Abstract

Riverbank filtration is an important process for removal of microbes, such as *Cryptosporidium* and *Giardia*, from ground waters affected by surface water. Water supplies identified as being ground water under the direct influence of surface waters are required to meet the same treatment requirements as surface water under the Surface Water Treatment Rule. Source waters that undergo riverbank filtration are after classified as ground water under the direct influence of surface water. Under many circumstances, however, environmental conditions and analytical techniques preclude direct quantification of removal of microbes of concern (*Cryptosporidium* and *Giardia*) during riverbank filtration. Instead, microbial and physical surrogates of these two protozoa that occur in greater concentrations and are less difficult to analyze for than *Cryptosporidium* and *Giardia* can be measured in the surface and ground waters in an attempt to quantify removal by riverbank filtration. To evaluate the use of riverbank filtration as an effective means of drinking-water treatment, a study was conducted from 2002 to 2004 by the U.S. Geological Survey, in cooperation with the City of Lincoln, at an established riverbank-filtration well field with horizontal collector wells and vertical wells. This report presents analytical methods and data collected during the study. Data are presented as generalized statistics and in figures showing temporal variations.

Sites from which water-quality samples were collected for this study included one surface-water site (Platte River), one ground-water site (W90-1H collector well), and two drinking-water sites (raw and finished). Samples from these sites were analyzed for field water-quality properties, microbe concentrations, laser particle counts, and stable hydrogen and oxygen ratios. Samples from an additional vertical well (W49-9) were analyzed for stable hydrogen and oxygen isotope ratios.

*Cryptosporidium* was detected in 48 percent (13 of 27) of Platte River samples collected during the study, and *Giardia* was detected in 44 percent (12 of 27) of Platte River samples collected during the study. Both microbes, however were not always detected in the same sample. In general, detected *Cryptosporidium* concentrations were greater and more variable than *Giardia* concentrations. Neither *Cryptosporidium* nor *Giardia* was detected in any samples from well W90-1H, the raw water, or the finished water. Aerobic spores were detected in all samples collected from the Platte River and well W90-1H during this study. The mean concentration of aerobic spores in samples from the Platte River was 2.7 magnitudes greater than the mean concentration in samples from well W90-1H. Aerobic spores were detected in 95 percent of raw water samples and in 21 percent of finished water samples. Enterococci were detected in all samples from the Platte River, in one sample from well W90-1H, in one sample from the raw water, and in no samples from the finished water. During microscopic particulate analyses (MPAs), all non-diatomaceous algae were detected less frequently and at lower average concentrations in samples from well W90-1H than in samples from the Platte River except for *Phacus*. At least one type of diatom was detected in all samples from the Platte River. Unclassified diatoms were detected in 2 of 14 samples from well W90-1H, in 1 of 7 raw water samples, and in none of four finished water samples. Total coliforms were detected with decreasing frequency in samples from the Platte River, well W90-1H, and raw water, respectively, and not detected in finished water samples. *E. coli* were detected in most of the samples collected from the Platte River and in 9 percent of the samples collected from well W90-1H. *E. coli* were not detected in raw or finished water samples. In the Platte River, somatic coliphages were detected more often and generally in higher levels than male-specific coliphages. Somatic and male-specific coliphages were only detected at levels near the method detection limit in a few samples from well W90-1H, the raw water, and the finished water.

In general, mean laser particle counts in each size classification decreased as size increased. Mean laser particle counts in each size classification generally were greater in samples from the Platte River than in samples from well W90-1H and also generally were greater in the raw water than in the finished water.

In surface water, stable hydrogen isotope ratios showed seasonal variations ranging from -73.1 per mill (‰) to -48.7 ‰ relative to Vienna Standard Mean Ocean Water reference water, and stable oxygen isotope ratios varied from -9.86 ‰ to -6.04 ‰. In ground water, stable hydrogen isotope ratios showed seasonal variations ranging from -71.6 ‰ to -45.0 ‰ relative to Vienna Standard Mean Ocean Water reference water, and stable oxygen isotope ratios varied from -9.82 ‰ to -5.25 ‰.

# Introduction

Bank filtration has been used for centuries to purify surface water. In its simplest form, a well is drilled near a body of water such as a stream or a lake. Vertical wells can be dug or drilled at varying distances from the surface-water source, and horizontal wells (also called collector wells) can have their laterals extending under a stream or lake. Stream or lake water flows through the sediments before entering the well. Depending on the soil characteristics, hydrologic conditions, and the distance water travels, high levels of pathogen removal can be achieved. However, water treatment efficiency for bank filtration depends on the specific hydrogeology of each well field.

Bank filtration offers some advantages over the conventional filtration methods for surface water, including reliability and low cost of operation. However, local conditions can affect the effectiveness of bank filtration. For example, sediment characteristics can affect both the retention time as well as the efficiency of the sediments in removing or disinfecting pathogens. Although indicators of disinfection completeness or filtration efficiency have been used widely and are well understood, indicators of bank filtration performance (for example, coliforms, turbidity, and particle size distributions) are less understood. Because most bank-filtered water of medium to large drinking-water treatment plants will be disinfected, the occurrence of pathogens that are susceptible to the disinfectants is not of high concern. However, for parasites, such as *Cryptosporidium* and *Giardia*, the commonly used drinking-water disinfectants are not always effective.

Water supplies identified as being ground water under the direct influence (GWUDI) of surface waters are required to meet the same treatment requirements as surface water under the Surface Water Treatment Rule (SWTR) (U.S. Environmental Protection Agency, 2002). SWTR and subsequent surface-water regulations define GWUDI as “any water beneath the surface of the ground with (1) significant occurrence of insects or other macroorganisms, algae, or large diameter pathogens such as *Cryptosporidium* or *Giardia*, or (2) significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions.” State authorities determine GWUDI status using a combination of hydrogeologic criteria, sanitary surveys, well-construction logs, and analytical testing. In general, water from wells located near rivers and classified as GWUDI undergoes riverbank filtration. Two pathogens specifically regulated by the SWTR and subsequent surface water regulations are *Cryptosporidium* and *Giardia*. In Nebraska, precedent has been set at the Kearney, Nebraska, well field for the granting of removal credits for *Giardia* and *Cryptosporidium* if there is sufficient evidence of removal of these organisms by bank filtration processes (Elizabeth Esseks, Nebraska Department of Health and Human Services, oral commun., 2004).

Because *Cryptosporidium* oocysts and *Giardia* cysts commonly are present in river water, ineffective removal of these organisms by bank filtration could result in increased health risks. Historically, drinking-water quality is monitored by the presence or absence of indicator organisms (for example, coliforms and fecal coliform bacteria). Turbidity levels or particle counts are indicators of the efficacy of various filtration technologies in removing pathogens. Standard filtration performance can be studied by testing filter efficacy under laboratory, pilot plant, and field conditions. However, for bank filtration, each application has unique characteristics that may affect particle removal and pathogen disinfection. In theory, testing the drinking water for the presence of pathogens should be able to determine the safety of the water. However, methods to detect *Cryptosporidium* oocysts and *Giardia* cysts are particularly unreliable, generally recovering only a fraction of seeded oocysts/cysts (DiGiorgio and others, 2002). Limitations of the *Cryptosporidium* and *Giardia* tests indicate that failure to detect oocysts/cysts in drinking-water supplies does not ensure their absence in the water. Testing for various water-quality indicators may help to determine the presence of waterborne pathogens. However, comprehensive data are not yet available to determine which easily measured water-quality indicators can best assess either the presence of a pathogen or an increased health risk.

To understand the efficiency of riverbank filtration with respect to various microbes, more information is needed concerning the fate of contaminants as they move through the riverbed sediments into an aquifer and on to collector wells. A study was conducted from 2002 through 2004 at a riverbank filtration site on the Platte River in eastern Nebraska (fig. 1) by the U.S. Geological Survey (USGS), in cooperation with the City of Lincoln, to evaluate the use of riverbank filtration as an effective means of drinking-water treatment. During the study, water-quality samples were collected monthly or quarterly from the Platte River, a horizontal collector well, the influent (raw) water of a drinking-water treatment plant, and the finished water of a drinking-water treatment plant. The samples were analyzed for selected microbial concentrations, laser particle counts, and stable hydrogen and oxygen isotope ratios. Samples collected from a vertical well were also analyzed for stable hydrogen and oxygen isotope ratios. The objectives of this study were: (1) to evaluate the potential transport, attenuation, and inhibition of microorganisms of varying sizes during riverbank filtration into a public-water supply at varying flow regimes of the river during different times of the year, and (2) to evaluate the use of various microbiological and

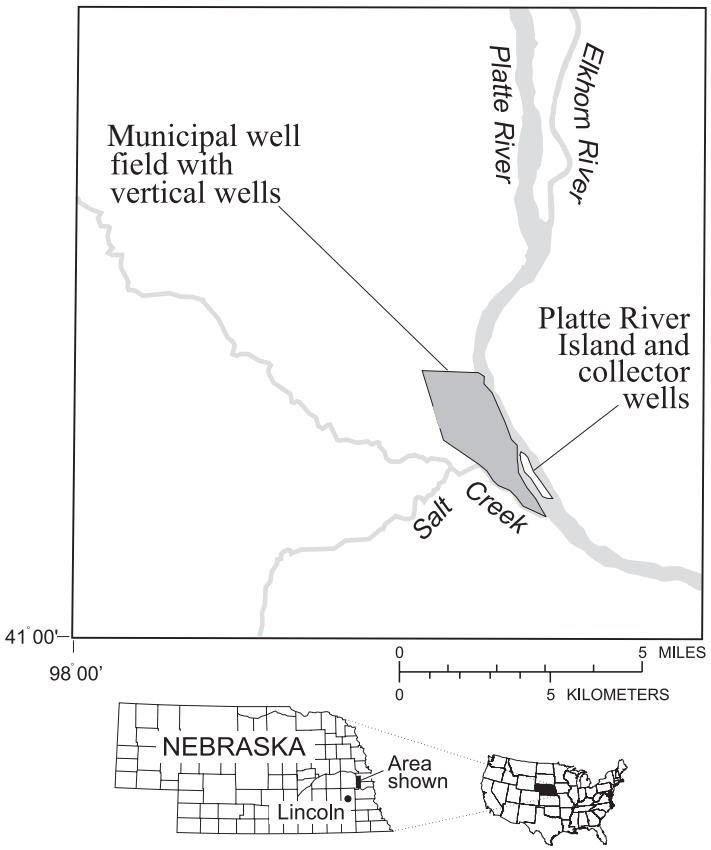


**Figure 1.** Location of the riverbank filtration study at a municipal well field along the Platte River in eastern Nebraska.

physical parameters as indicators of *Cryptosporidium* or *Giardia* contamination.

## Purpose and Scope

The purpose of this report is to present field water-quality properties, microbe concentrations, laser particle counts, and stable hydrogen and oxygen isotope ratios in samples collected during a riverbank filtration study of the Platte River in eastern Nebraska during 2002 through 2004. This report includes descriptions of the sampling and analytical methods and data obtained during the study. Interpretations are limited to generalized statistics and figures containing temporal variations.

## Previous Investigations

Previous studies have provided hydrologic background information and reasonable estimations of traveltimes and chemical transport velocities for the municipal well field monitored during this study (Davis, 1992; Verstraeten and others, 1998; Verstraeten and others, 1999; Heberer and others, 2001; Verstraeten and Heberer, 2002; Verstraeten, Heberer, and others, 2002; Verstraeten, Thurman, and others, 2002; Verstraeten, Heberer, and others, 2003; Vogel and others, 2005). However, these studies focused on chemical compound occurrence and transport at the research site.

Indicators or indicator organisms of *Cryptosporidium* and *Giardia* that may originate from similar sources and that were considered in this study include turbidity, particle counts, dissolved organic carbon, and microbial indicators (table 1). However, the absence of any or all of these indicators does not guarantee that *Cryptosporidium* or *Giardia* is not present (Aboytes and others, 2004).

Turbidity is a measure of suspended particulates in a liquid and has been linked to fecal contamination of surface and ground water (LeChevallier and others, 1991a; Christensen and others, 2001). LeChevallier and others (1991b) and LeChevallier and Norton (1992) indicate a link between log removal of turbidity and log removal of *Cryptosporidium* and *Giardia*. However, Rose and others (1988) did not find a direct correlation between turbidity and the presence of *Cryptosporidium* or *Giardia* in a watershed in the western United States.

Particle counts in specific size ranges have been used as an indication of filtration efficiency of *Cryptosporidium* and *Giardia* for conventional water-treatment plants. Studies indicate that log removal of particles evaluated in size ranges coincidental to the size of *Cryptosporidium* (4-7 μm) and *Giardia* (7-11 μm) can be used as a surrogate for log reduction of these organisms (LeChevallier and others, 1991b, LeChevallier and Norton, 1992; Nieminski and Ongerth, 1995). However, other research also has shown that the technology used in laser particle counters generally undersizes the particles (Lewis and Manz, 1991; Hargesheimer and others, 1992; O'Shaughnessy and others, 1997). Therefore, particle counts for slightly smaller particle-size ranges than those of the corresponding protozoa diameters have been used as surrogates for removal of these organisms.

Many studies have been completed using total or fecal coliforms as an indicator of fecal contamination (for example, Crane and others, 1983; Baxter-Potter and Gilliland, 1988; Mau and Pope, 1999; Fujioka and Yoneyama, 2001). Correlation of total coliform concentrations to *Cryptosporidium* or *Giardia* concentrations, however, has had mixed results. LeChevallier and others (1991a) indicated a statistical correlation between total coliform concentrations and *Cryptosporidium* and *Giardia* concentrations, whereas Akin and Jakubowski (1986), Rose and others (1988), and Boyer and Kuczynska (2003) did not. LeChevallier and others (1991a) pointed out that the maximum total coliform concentrations measured in their study were much higher than in Akin and Jakubowski (1986) and Rose and others (1988), indicating that the higher concentrations of total coliforms may be responsible for the higher correlations. For a river study in the western United States, Rose and others (1988) determined that total coliform and fecal coliform were not reliable predictors for the presence or absence of *Cryptosporidium* or *Giardia*.

Francy and others (1994) and Edberg and others (1997) recommended using *E. coli* as an indicator of fecal contamination. Published literature reports the continued use of *E. coli* for this purpose (for example, Griffin and others, 1999; Fujioka and Yoneyama, 2001; Borst and Selvakumar, 2003; Haack and others, 2003). Thompson and Blatchley (2000) compared inactivation rates of *E. coli* and *Cryptosporidium parvum* by gamma irradiation, showing much larger levels of inactivation of *E. coli* than *Cryptosporidium parvum* at similar levels of gamma irradiation. *E. coli* has been shown to be unsuitable as a direct indicator of the presence of *Cryptosporidium* in streams because of faster die-off rates of *E. coli* than *Cryptosporidium.* Alm and others (2003) suggested that freshwater beach sand might also serve as a reservoir for fecal indicator bacteria such as *E. coli*.

Recent research has been completed using coliphages as an indicator of fecal contamination (International Association for Water Pollution Research and Control (IAWPRC) Study Group on Health Related Water Microbiology, 1991; Griffin and others, 1999; Fujioka and Yoneyama, 2001). Weiss and others (2003) indicated log reduction of various coliphages ranging from 1.9 to 3.3 at three drinking-water utilities in the midwestern United States during riverbank filtration. A male-specific coliphage (MS2) has been shown to have greater inactivation than *Cryptosporidium parvum* by similar levels of gamma irradiation during water treatment (Thompson and Blatchley, 2000). Chauret and others (1999) showed greater reduction of somatic coliphages than *Cryptosporidium* and *Giardia* during aerobic wastewater treatment (excluding the anaerobic sludge digestion). During the anaerobic sludge digestion, neither *Cryptosporidium* nor *Giardia* concentrations were reduced significantly, whereas the somatic coliphage concentration was reduced slightly.

Aerobic spores, specifically spores of the bacterium *Bacillus subtilis*, have been used as surrogates in evaluation of treatment processes with varying success (Facile and others, 2000; Chauret and others, 2001; Trimboli and others, 2001; Huck and others, 2002; Larson and Mariñas, 2003). Huck and others (2002) suggested that aerobic spores may be used in treatment plants as a conservative estimate of the capacity of the filter to remove *Cryptosporidium* under operating conditions based upon results from two treatment plants where removal of seeded *Bacillus subtilis* was lower than removal of seeded *Cryptosporidium parvum*. For disinfection purposes, Facile and others (2000) indicated that aerobic spores possibly could be used as a surrogate for inactivation of *Giardia lamblia* and *Cryptosporidium parvum* (oo)cysts during ozone activation. However, results from Larson and Mariñas (2003) and Craik and others (2002), indicated that *Bacillus subtilis* may not be a reliable surrogate of *Cryptosporidium parvum* inactivation for ozone disinfection. Aerobic spores have been found to be more sensitive than *Cryptosporidium parvum* to chlorine dioxide and chloramines and therefore may overestimate removal when used as a direct indicator of *Cryptosporidium parvum* inactivation in this process (Chauret and others, 2001; Larson and Mariñas, 2003).

Enterococci also have been used as an indicator of fecal contamination (Griffin and others, 1999; Vilanova and others, 2002; Haack and others, 2003). Enterococci generally seem to be more persistent than either bacterial pathogens or fecal coliforms (Cohen and Shuval, 1973; Davies-Colley and others, 1994; Sinton and others, 1994). Enterococci, however, may not be a good indicator of *Cryptosporidium* presence in river water because of higher die-off rates of enterococci compared to *Cryptosporidium* (Medema and others, 1997). Freshwater beach sands also may serve as a reservoir of enterococci and other fecal indicator bacteria (Alm and others, 2003). Results from Chauret and others (1999) showed greater reduction of enterococci than *Cryptosporidium* or *Giardia* during aerobic wastewater treatment (excluding the anaerobic sludge digestion). During the anaerobic sludge digestion, none of these three microbes were reduced significantly.

Microscopic particulate analysis (MPA) was developed by the U.S. Environmental Protection Agency (USEPA) to be used in determining whether an existing ground-water source should be classified as being under the influence of surface water (U.S. Environmental Protection Agency, 1992). MPAs have been used as a method to estimate the threat of ground-water contamination by *Cryptosporidium* and/or *Giardia* (Schulmeyer, 1994; Nnadi and Fulkerson, 2002). However, some studies caution about the overdependence on using the MPA as the only criteria for designating GWUDI without taking into account the absolute risk of illness from the water (Gollnitz and others, 1997; Chin and Qi, 2000). Quantitative MPA techniques also have been used to quantify concentrations of various indicator microbes including several types of non-diatomaceous algae, diatoms, rotifers, amoebae, nematodes, flagellates, and pollen (Schulmeyer, 1994).

## Environmental Setting

The Platte River and its tributaries receive municipal waste from most cities along its course, except the City of Omaha, which releases its wastewater into the Missouri River above its confluence with the Platte River. Along the Platte River and its tributaries, an estimated 200 sewage treatment plants (STPs) release treated or untreated wastewater into the rivers with flows varying from about 0.4 ML/d (million liters per day) to about 200 ML/d (Ronald Ash, Nebraska Department of Environmental Quality, oral commun., 2001). In addition, more than an estimated 7,000 animal feeding operations (AFOs) exist in Nebraska, of which less than 1,000 are confined animal feeding operations (CAFOs). A CAFO is defined by the State of Nebraska as having at least 1,000 animal units (Dennis Heitmann, Nebraska Department of Environmental Quality, oral commun., 2001). The AFOs vary in size from more than 1 unit to almost 100,000 units of cattle and pigs. During runoff events or chronic wet periods (several rainfalls within 1 month leaving the soils saturated and standing water high in collection pits), unregulated and regulated

discharges occur from these AFOs into nearby streams. Nebraska was ranked third on January 1, 2004, in inventory of cattle and calves in the United States with 6.25M (million) head, or about 6.6 percent of the national inventory (National Agricultural Statistics Service, 2004). Moreover, Nebraska was ranked seventh in the United States on December 1, 2003, in inventory of hogs and pigs with about 2.9M head, or 4.8 percent of the national production (National Agricultural Statistics Service, 2004).

**Table 1.** Description of microbes for which samples were analyzed during riverbank filtration study, Platte River, Nebraska.

[µm, micrometers; diam, diameter; °C, degrees Celsius; --, not applicable]

| Microbe | Common species | Size (µm) | Shape | Description |
|---|---|---|---|---|
| *Cryptosporidium* | *Cryptosporidium parvum* | [1]3-7 | Spherical or oval | Members of the genus *Cryptosporidium* are parasites of the intestinal tracts of fishes, reptiles, birds, and mammals. Members of this genus do not appear to display a high degree of host specificity, so the number of species in this genus is not known. *Cryptosporidium* isolated from humans is now referred to as *C. parvum*. *Cryptosporidium* lives on (or just under) the surface of the cells lining the small intestine, reproduces asexually, and oocysts are passed in the feces. Transmission of the infection occurs through the oocysts. |
| *Giardia* | *Giardia lamblia* | [2]8-12 | Oval | *Giardia lamblia* trophozoites live in the small intestine of the host. Cysts, which are resistant to adverse environmental conditions, are passed in the feces of an infected host, and the next host is infected when it ingests cysts in food or water contaminated with feces. The trophozoites contain a dark transverse rod, the axostyle, which seems to be a supportive element. The cysts are oval, and contain two nuclei and remnants of the axostyle. |
| Total coliform | Includes the genera *Escherichia*, *Citrobacter*, *Klebsiella*, and *Enterobacter* | [3]*Citrobacter*: 1 x 2-6<br>[3]*Klebsiella*: 0.3-1.0 x 0.6-6.0<br>[3]*Enterobacter*: 0.6-1.0 x 1.2-3.0 | Rod-shaped | A particular group of bacteria that are used as indicators of possible sewage pollution. This group includes coliforms that inhabit the intestine of warmblooded animals and those that inhabit soils. They are characterized as aerobic or facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria that ferment lactose with gas formation within 48 hours at 35°C. |
| *E. coli* | *Escherichia coli* | [3]1.1-1.5 x 2.0-6.0 | Rod-shaped | Bacteria present in the intestine and feces of warm-blooded animals. *E. coli* are a member species of the fecal coliform group of indicator bacteria. |
| Coliphage | [4]Male-specific: *E. Leviviridae*, (MS2); *F. Inoviridae*, (fd)<br>[4]Somatic: *A. Myoviridae*, (T2); *B. Stylovirida*, (λ); *C. Povoviridae*, (T7); *D. Microviridae* (ϕX-174) | Male-specific: 0.03-0.10<br>Somatic: 0.006-0.8 | Variable | Coliphage are recognized to be representative of the transport and survival of viruses in the environment. They are found in high numbers in sewage and are thought to be reliable indicators of sewage contamination of waters. Two main groups of coliphage are used as viral indicators. Somatic coliphage infect coliform bacteria by attachment to the outer cell membrane or cell wall. They are widely distributed in both fecal-contaminated and uncontaminated waters[5]. Male-specific coliphage attach only to the F-pilus of coliforms that carry the F+ plasmid: F-pili are made only by bacteria grown at higher temperatures. Thus, male-specific coliphage presumably come from warm-blooded animals or sewage. |
| Aerobic spores | *Bacillus subtilis* | [6]0.5 x 1.0 x 2.0 | Rod-shaped or spherical[6] | Species of *Bacillus* found in soil and decomposing organic matter. |

**Table 1.** Description of microbes for which samples were analyzed during riverbank filtration study, Platte River, Nebraska.—Continued

| Microbe | Common species | Size (µm) | Shape | Description |
|---|---|---|---|---|
| Enterococci | *Streptococcus faecalis*, *Streptococcus faecium*, *Streptococcus avium*, and their variants. | 0.5-1.0 | Oval | Enterococci commonly is found in the feces of humans and other warmblooded animals. Although some strains are ubiquitous and not related to fecal pollution, the presence of enterococci in water is generally considered an indication of fecal pollution and the possible presence of enteric pathogens. |
| *Scenedesmus* | *Sc. abundans, Sc. bijuga, Sc. dimorphus, Sc. obliquus, Sc. quadricauda* | [7, 8]Usually 2, 4, or 8 cells wide; each cell approx. 5-15 x 10-30 | Cells are ellipsoidal, oblong, fusiform, acicular, or ovoid. Coenobia are flat and consist of 2, 4 (most common), 8, 16, or 32 cells[7] | *Scenedesmus* is an algae found everywhere as a constituent of the fresh-water plankton. It is more abundant in stagnant, organically enriched water. The genus is widely distributed in the euplankton, tychoplankton, and periphyton. Great numbers of this algae, so as to color the water green, may occur in small pools. |
| *Selenastrum* | *S. Bibraianum, S. capricornutum, S.gracile, S. minutum,* and *S. Westii* | [9]22-42 x 2-4 | Crescent or hook-shaped; Convex surfaces of 4, 8, or 16 cells are apposed; a colony may be as many as 100 or more cells[7] | *Selenastrum capricornutum* is a green alga used as a biological indicator of toxins. Because it is a freshwater species, it can be used as a salinity indicator. This genus is widely distributed in the euplankton and is found sparingly intermingled with other free-floating algae in pools and other quiet waters, including sewage ponds. Some species occur in soft, acidic waters. |
| *Pediastrum* | *P. biradiatum, P. Boryanum, P. duplex, P. simplex* | [7]May be as large as 450 | Plate shaped with 4, 8, 16, 32, 64, 128, or 256 cells[7] | This genus is widely distributed in the euplankton and tychoplankton. *P. simplex* is indicative of oligotrophic waters. *P. duplex* and *P. Boryanum* are indicative of eutrophic waters. |
| *Phacus* | *Phacus acuminatus, Phacus curvicauda, Phacus longicauda, Phacus pleuronectes, Phacus pyrum, Phacus triqueter* | [10]16-106 x 8-84; tail 26-45 | Nearly round or fusiform in front view; disc-like, flattened, or triangular from the side; may be spirally twisted[11] | This genus often is found around ponds and sloughs, particularly in the sand, but rarely in abundance. It is solitary, free-swimming, and has a rigid shape. |
| *Agmellum* | *Agmenellum quadriduplicatum* | [7]3-6 | Spherical; regularly arranged in parallel vertical and transverse rows; colony is one cell in thickness[7] | This genus is widely distributed and generally indicative of soft-water and acidic conditions. |
| *Stichococcus* | *Stichococcus bacillaris* | [12]4-11 x 3 | Cell body cylindrical in shape, both ends rounded[12] | Eleven species are found in the United States, with most found on the back of trees, old boards, or damp soil. |

**Table 1.** Description of microbes for which samples were analyzed during riverbank filtration study, Platte River, Nebraska.—Continued

| Microbe | Common species | Size (µm) | Shape | Description |
|---|---|---|---|---|
| *Fragilaria* | *F. brevistriata, F. constuens, F. capucina, F. crotonensis, F. leptostauron, F. pinnata, F. vaucheriae, F. virescens* | [13]7-35 x 3-10 | Linear to fusiform, bilaterally symmetrical, commonly attenuated at the poles, and often medially inflated[7] | Periphytic and tychoplanktonic in lakes, ponds, springs, and rivers. This diatom is considered an indicator of well-oxygenated waters. They also are generally indicative of alkaline waters of moderate conductivity. *Fragilaria* cells unite into free-floating or sessile colonies that generally are zigzag chains[7]. |
| *Tabellaria* | *T. binalis, T. fenestrata, T. floculosa* | [14]49-175 x 8-15 | Rectangular in girdle view, with truncate poles that have rounded corners[11] | Widespread in the euplankton and tychoplankton. *T. fenestrate* is indicative of mesotrophic to eutrophic conditions. The genus generally occurs in circumneutral, shallow waters. Cells attach at the corners to one another, forming zigzag chains or filamentous arrangements[11]. |
| *Asterionella* | *A. formosa, A. gracillima, A. inflate, A. Ralfsii* | [7]130 x 1-2 | Rod-like cells joined together to form spoke-like colonies[7] | A commonly occurring diatom in the euplankton that is indicative of mesotrophic to eutrophic conditions. They may occur in such abundance as to impart a fishy taste to the water. Some species may form a bloom in favorable habitats that could cause water spoilage. The common species are usually found in hard-water lakes. |
| *Navicula* | Many including *N. accomoda, N. canalis, N. cryptotenella, N. incomposita, N. lanceolata, N. pelliculosa, N. petersenii, N. tripunctata, N. viridula* | [13]10-55 x 3-12 | Oblong, cigar-shaped, elliptical[13] | Periphytic in lakes and ponds, prefers eutrophic waters, many prefer slightly alkalinic to alkalinic waters. The disappearance of *Navicula cryptotenella* from waters is considered a good indication of high pollution. Other species are able to tolerate high pollution levels. Many species may be associated with thermal sources with high mineral content. |
| Rotifers | More than 2,500 species, of which >2,375 species are restricted to fresh waters | [8]100-500 | Varied, may be spherical, oval, or elongated[8] | Rotifers are associated with small puddles, damp soils, vegetable debris, and mosses. The vast majority of rotifers encountered are females. |
| Free-living amoeba | Include the amoeboid, flagellated and cyst stages of such *Sarcodina* as *Naegleria, Amoeba, Acanthamoeba,* and *Difflugia* | [15]15-1,200 | Varied, may be spherical, cylindroid[16] | The external surfaces of these amoebas are usually very thin. They are very common in healthy surface waters, especially eastern lakes during summer months. In western surface waters, they may be present in low numbers. |
| Nematodes | More than 2,000 known free-living species in fresh water | [7]Organism, as much as 1,500; [7]Egg, 50 | Worm-like; anterior is truncate or bluntly rounded, and the posterior end tapers to a point[7] | Some nematode species thrive in aquatic habitats under a wide range of ecological conditions. Nematodes and/or their eggs are common in healthy water sources and in spring boxes containing plant material and other detritus. They occur in widely differing habitats. Most are colorless. Some feed on dead plant material, whereas others feed on dead animal material. |

**Table 1.** Description of microbes for which samples were analyzed during riverbank filtration study, Platte River, Nebraska.—Continued

| Microbe | Common species | Size (µm) | Shape | Description |
|---|---|---|---|---|
| Flagellates | Genera include *Chlorogonium, Euglena,* and *Lepocinclis* | *Chlorogonium*: [17]10-100 x 3-1<br>*Euglena*: [18]29-180 x 7.5-36<br>*Lepocinclis*: [16]9-16 x 5-8 | *Chlorogonium*: Cells usually fusiform; two equal-length flagella, about 1/2 as long as cell[15]<br>*Euglena*: Spindle, cylindrical or band-form[19]<br>*Lepocinclis*: more or less ovo-cylindrical[19] | Many flagellates are plant-like, possessing chlorophyll and chromatophores. Although many flagellates are photo-trophic, numerous species grow in the absence of light if sufficient dissolved nutrients are available. |
| Pollen | -- | [8]Variable, around 70 | Spherical; surface may have golf-ball appearance[8] | All microspores produced by seed plants. In the spring and fall, pollen is everywhere, both airborne and water borne. |

[1]Arrowood, 1997

[2]Akin and Jakubowski, 1986

[3]Holt and others, 1994

[4]International Association for Water Pollution Research and Control Study Group on Health Related Water Microbiology, 1991

[5]Sobsey and others, 1995

[6]Rice and others, 1996

[7]Greeson, 1993

[8]Berk and Gunderson, 1993

[9]Protist Information Server, 2005a

[10]Protist Information Server, 2005b

[11]Prescott, 1978

[12]Hirose and Yamagishi, 1977

[13]Ehrlich, 1995

[14]Protist Information Server, 2005c

[15]Page, 1976

[16]Lee and others, 1985

[17]Protist Information Server, 2005d

[18]Protist Information Server, 2005e

[19]Kudo, 1966

The alluvial sediments deposited by the Platte River, consisting mainly of sand and gravel and some silt and clay, increasingly have been developed for drinking-water supply by cities along the Platte River. At the same time, river and ground-water quality are being influenced by releases of wastewater and runoff from fields along the river. The municipal water supply from the well field along the river generally is affected by the quality of water from the local streams and the main channel (Verstraeten and others, 1999). The well field consists of 2 horizontal and 36 vertical wells completed in the alluvial sediments, generally at depths of less than 40 m (meters). Water obtained from the well field is used for a population of more than 230,000 people, which is growing at a rapid rate that may require development of additional large capacity wells at the well field.

# Methods

This section of the report describes the sampling and analytical methods used in the study. The quality-assurance samples collected for this study are also described.

## Sampling Methods

During this study, representative water samples were collected monthly or quarterly according to a pre-determined schedule from four sites: surface water from the Platte River near Ashland, Nebraska, ground water from well W90-1H, raw water, and finished water. Well 90-1H is a horizontal collector well that is located on an island in the middle of the Platte River. Raw water is influent to the drinking-water treatment plant that uses water from the site as source water. In general, the raw water is approximately 50 percent vertical-well water and 50 percent horizontal-well water. This ratio varies throughout the year based on management of the well field. Finished water is the effluent of the drinking-water treatment plant after treatment by rapid sand filtration, ozonation, and chloramines. Additional samples collected from a fifth site (well W49-9) were analyzed only for stable hydrogen and isotope ratios. All water samples were collected using approved sampling protocols (U.S. Geological Survey, 1997-2004). Because Kistemann and others (2002) suggested that substantial shares of the total microbial loads in watercourses result from rainfall and extreme events, samples also were collected during a spring-runoff event and two summer-runoff

events. Other regularly scheduled samples also were collected during runoff events if the event occurred on the day scheduled for sampling. Boyer and Kuczynska (2003), however, reported that *Cryptosporidium* oocyst densities were not correlated to storm-dependent flow in an agriculturally influenced karst spring.

## Analytical Methods

Water samples were analyzed in the field for pH, temperature, specific conductance, dissolved oxygen (DO), and turbidity using USGS procedures for collecting field measurements (U.S. Geological Survey, 1997-2004). Dissolved organic carbon (DOC), microbial concentrations (*Cryptosporidium, Giardia,* male-specific and somatic coliphages, total coliform, *E. coli*, aerobic spores, enterococci, and MPA), laser particle counts, and stable hydrogen and oxygen isotope ratios were determined by analytical laboratory methods. DOC analysis was completed at the USGS National Water Quality Laboratory (NWQL) using the methods of Brenton and Arnett (1993). The NWQL is certified by the National Environmental Laboratory Accreditation Program, which is the only program that accredits environmental laboratories on a national basis for drinking-water analyses. Coliphage analysis was completed in the USGS Ohio Water Science Center Microbiology Laboratory. Other laboratory analyses described in this report were completed at other USGS or USEPA-approved laboratories. The USGS National Water Information System (NWIS) database permanently stores water-quality information collected by the USGS. However, some analytical data were not entered into the NWIS database, such as values for constituents that were obtained using non-approved methods (screening or research methods). These data were entered into a project water-quality database that was archived by the USGS Nebraska Water Science Center.

### Microbes

Samples collected for this study were analyzed for microbes including *Cryptosporidium*, *Giardia*, male-specific (F+) and somatic coliphages, total coliform, *E. coli*, aerobic spores, and enterococci (table 1). MPA techniques were used to quantify concentrations of algae, diatoms, rotifers, amoeba, nematodes, flagellates, and pollen (table 1).

#### *Cryptosporidium* and *Giardia*

For analysis of *Cryptosporidium* and *Giardia* concentrations, USEPA method 1623 was utilized (U.S. Environmental Protection Agency, 2001a). An absolute porosity filter (*Whatman Cryptest*®) was used to collect debris from 10 L (liters) of water. If the water was too turbid to allow filtration of 10 L, a lesser volume was filtered. The filter was eluted through backflushing and the debris was collected and centrifuged to concentrate it. The concentrate was subjected to immunomagnetic separation (IMS) that specifically retains the *Cryptosporidium* oocysts and *Giardia* cysts and allows the background debris to be removed. The IMS part of the sample was placed on a well slide and stained with fluorescein-tagged antibodies to *Cryptosporidium* and *Giardia* and a vital dye stain (DAPI) that specifically delineates the nuclei within the organisms. The slides were examined microscopically, and organisms that were identified as *Cryptosporidium* and *Giardia* were counted.

#### Total Coliform and *E. Coli*

Total coliform and *E. coli* concentrations were determined using the most-probable number (MPN) method from Colilert™ at the Nebraska Health and Human Services Laboratory. Colilert™ is a commercially available liquid medium (Idexx Corporation, Westbrook, Maine) that allows the simultaneous detection of total coliforms and *E. coli*. The MPN method is facilitated by use of a specially designed disposable incubation tray called the Quantitray. To perform the analysis, two enzyme substrates are reacted in Colilert™—a chromogen that reacts with the enzyme found in total coliforms (galactosidase), and a fluorogen that reacts with an enzyme found in *E. coli* (glucuronidase). After 24 hours of incubation at 35°C (degrees Celsius), a total-coliform-positive reaction turns the medium yellow, while an *E. coli*-positive reaction causes the medium to fluoresce under a long-wave ultraviolet light (366 nanometers). A dilution step was added to the procedure on November 10, 2003, effectively raising the maximum detectable concentration of the method from 201 MPN/100 mL to 2,420 MPN/100 mL.

#### Coliphages

Male-specific (F+) and somatic coliphages in water were analyzed using the single agar layer (SAL) procedure (USEPA Method 1602; U.S. Environmental Protection Agency, 2001b). Antibiotic-resistant host-culture strains *E. coli* F-amp (resistant to streptomycin and ampicillin) and *E. coli* CN-13 (resistant to nalidixic acid) were used as hosts for male-specific and somatic coliphages, respectively. A 100-mL (milliliter) sample was combined with magnesium chloride, log-phase host bacteria, and tryptic soy agar. The sample mixture was poured into plates and incubated overnight. If phage particles are present in the sample, they infect an *E. coli* cell and reproduce, causing death of the cell and cell lysis. This continues until a plaque is visible; a plaque is a circular clearing in the bacterial lawn. The plaques were counted and summed for all plates from a single sample and expressed as plaques per 100 mL.

#### Aerobic Spores

Aerobic spores were analyzed in the laboratory of Dr. Gene Rice at the USEPA in Cincinnati, Ohio using the procedures of Rice and others (1996). During analysis, the samples were placed in a sterile flask, agitated, and heated to 80°C. After 12 minutes at 80°C, the flasks were cooled in an

ice bath. Dilutions of the sample were filtered onto a 0.45-µm-porosity membrane filter. The membranes were then placed on nutrient agar medium containing the dye trypan blue, inverted, and incubated for 20-22 hours at 35°C. After incubation, all colonies on the plates were counted using a binocular dissecting microscope. All colonies in this procedure were considered to be derived from bacterial spores that were present in the sample and capable of surviving the heat treatment. Petri dishes with loose-fitting lids were used to facilitate growth of the strictly aerobic spore-formers during medium preparation.

### Enterococci

Enterococci concentrations were determined using the MPN method from Enterolert™ at the USEPA labor oratory of Dr. Gene Rice in Cincinnati, Ohio. The MPN method is facilitated by use of the Quantitray. Enterolert™ detects enterococci such as *E. faecium* and *E. faecalis* in fresh and marine water because when enterococci use their ß-glucosidase enzyme to metabolize the nutrient-indicator, 4-methyl-umbelliferyl ß-D-glucoside, found in Enterolert™, the sample fluoresces. Enterococci are detected within 24 hours with a method detection limit of 1 colony forming unit (cfu) per 100 mL sample.

### Microscopic Particulate Analysis

For MPAs, a yarn-wound depth filter was used to collect debris from either 100 L (surface water, ground water, and raw water) or 1,000 L (finished water). The particulates were eluted from the filter, and the washing was concentrated using centrifugation. In the case of raw water, centrifugation often was not necessary because enough particulates were present to examine the sample directly. Appropriate dilutions of the sample were made to provide adequate dispersion of particulates on a 100-microliter (µL) Palmer Maloney chamber. The particulates were counted and categorized by organism type (algae, diatom, nematode). Genus categorization was then attempted for algae and diatoms.

## Laser Particle Counts

Laser particle counts (LPC) were determined by Analytical Services, Inc., in Williston, Vermont, using a Hiac/Royco Laser Particle Counter. For analysis, the machine pulls the water sample through a syringe, where a sensor uses "light scatter and light extinction technology" for determining particle size and concentration. The machine automatically calculates the averages of three sample runs for the same sample and reports this average as the result. The laser particle counter is calibrated every 12 months.

## Stable Hydrogen and Oxygen Isotope Ratios

Samples from the Platte River and from two wells (W90-1H and W49-9) were analyzed for stable hydrogen and oxygen isotope ratios. Samples were collected monthly from well 49-9, which is approximately 300 meters from the Platte River at the study site.

Variations in stable isotope abundance ratios typically are small. Stable isotope ratios commonly are determined as relative difference in the ratio of the less abundant isotope (usually heavy) to the more abundant isotope (usually light) of the sample with respect to the reference. This difference is designated $\delta(^{i}\mathrm{E})$ notation (pronounced delta) and it is defined according to the relation in equation 1:

$$\delta\left(^{i}\mathrm{E}\right) = \left[\frac{n_{\mathrm{X}}\left(^{i}\mathrm{E}\right)/n_{\mathrm{X}}\left(^{j}\mathrm{E}\right)}{n_{\mathrm{ref}}\left(^{i}\mathrm{E}\right)/n_{\mathrm{ref}}\left(^{j}\mathrm{E}\right)} - 1\right] \quad (1)$$

where $\delta(^{i}\mathrm{E})$ refers to the delta value of isotope number *i* of element E of sample X relative to the reference (ref), and $n_{\mathrm{X}}(^{i}\mathrm{E})/n_{\mathrm{X}}(^{j}\mathrm{E})$ and $n_{\mathrm{ref}}(^{i}\mathrm{E})/n_{\mathrm{ref}}(^{j}\mathrm{E})$ are the ratios of the isotope amounts in unknown X and a reference (ref). A positive $\delta(^{i}\mathrm{E})$ value indicates that the unknown is more enriched in the heavy isotope than the reference. A negative $\delta(^{i}\mathrm{E})$ value indicates that the unknown is depleted in the heavy isotope relative to the reference. The $\delta(^{i}\mathrm{E})$ is commonly shortened to $\delta^{i}\mathrm{E}$ and has been reported in parts per hundred (% or percent), parts per thousand (‰ or per mill), and parts per ten thousand. In this report, $\delta(^{i}\mathrm{E})$ values are given in ‰.

For stable hydrogen isotope ratios

$$\delta^{2}\mathrm{H} = \left[\frac{n_{\mathrm{X}}\left(^{2}\mathrm{H}\right)/n_{\mathrm{X}}\left(^{1}\mathrm{H}\right)}{n_{\mathrm{VSMOW}}\left(^{2}\mathrm{H}\right)/n_{\mathrm{VSMOW}}\left(^{1}\mathrm{H}\right)} - 1\right] \quad (2)$$

where the isotope ratios are expressed relative to Vienna Standard Mean Ocean Water (VSMOW) reference water and they are normalized such that $\delta^{2}\mathrm{H}$ of Standard Light Antarctic Precipitation (SLAP) reference water is –428 ‰ (Coplen, 1996). Hydrogen isotope ratios were determined by $H_2$-$H_2O$ equilibration and analysis by isotope ratio mass spectrometry (Coplen and others, 1991). About 25 percent of analyses each day were reference samples and samples were analyzed in replicate. The 2-sigma uncertainty of hydrogen isotopic results is 2 ‰. This means that if a sample was resubmitted for analysis at a later date, there is a 95-percent probability that the hydrogen isotopic result reported will be within 2 ‰ of the result originally reported.

For oxygen isotope ratios

$$\delta^{18}\mathrm{O} = \left[\frac{n_{\mathrm{X}}\left(^{18}\mathrm{O}\right)/n_{\mathrm{X}}\left(^{16}\mathrm{O}\right)}{n_{\mathrm{VSMOW}}\left(^{18}\mathrm{HO}\right)/n_{\mathrm{VSMOW}}\left(^{16}\mathrm{O}\right)} - 1\right] \quad (3)$$

where the isotope ratios are expressed relative to VSMOW reference water, and they are normalized such that $\bullet^{18}\mathrm{O}$ of SLAP reference water is –55.5 ‰ (Coplen, 1996). Oxygen isotope ratios are determined by the $CO_2$-$H_2O$ equilibration method of Epstein and Mayeda (1953). About 20 percent of analyses each day were isotopic reference water, and about 35 percent of samples were analyzed in replicate. The 2-sigma

uncertainty of oxygen isotopic results is 0.2 ‰. This means that if a sample is resubmitted for analysis at a later date, there is a 95-percent probability that the isotopic result reported will be within 0.2 ‰ of the result originally reported.

## Quality Assurance/Quality Control

Various quality-assurance (QA) samples were collected for this study. Duplicate samples consist of splits from the same sample aliquot that are collected in such a manner that the samples are assumed to be essentially identical in composition. Duplicate samples for *Cryptosporidium* and *Giardia* analysis were collected from the Platte River on March 17, 2003, and from well W90-1H on June 30, 2003. Duplicate samples for somatic and male-specific coliphages were collected from the Platte River on October 20, 2003; from well W90-1H on April 15, 2003, and March 16, 2004; from the raw water on May 13, 2003, and January 13, 2004; and from the finished water on September 16, 2003. Duplicate MPA samples were collected from well W90-1H on March 18, 2003, and from the raw water on May 13, 2003. Duplicate LPC samples were collected from the Platte River on December 9, 2002, and November 15, 2003; from well W90-1H on December 16, 2003; from the raw water on January 21, 2003, and June 30, 2003; and from the finished water on May 27, 2003, and January 13, 2004.

Equipment blanks, which are samples of ultrapure deionized water that have been processed with the same sample collection equipment used to collect the surface-water environmental samples, also were collected and analyzed for various microbes. An equipment blank was collected on April 1, 2003, and analyzed for *Cryptosporidium* and *Giardia.* A second equipment blank was also collected on June 18, 2003, and analyzed for male-specific and somatic coliphages. A third equipment-blank for MPA was collected on January 21, 2003. Additional quality-assurance and quality-control (QC) measures inherent to the laboratory methods and consistent with each laboratory QA plan also were taken. In addition, a three-tiered approach of QC divided into method performance (instrument and method), data review and blind sample programs, and performance evaluation studies were applied at the NWQL (Pirkey and Glodt, 1998).

# Streamflow and Well Pumpage

Streamflow during the period of study of riverbank filtration at the established well field was compared to the natural variability in the hydrologic system through use of long-term streamflow information. Historical median streamflow data used for comparisons are available at *http://nwis.waterdata.usgs.gov/ne/nwis/sw* for the Platte River near Ashland (station 0681000) for water years 1929 to 2004. Daily mean streamflow during the study period was compared to the historical mean daily streamflow in the Platte River (fig. 2). Flow conditions were tracked for several days around each sample date at the Platte River sampling site (fig. 3). Streamflow conditions denoted as being impacted by "Ice" in figure 3 will not reflect accurate flow conditions because of changes in the stage-discharge relation caused by ice in the channel. In addition, well field management caused varied pumping rates during different times of the year in the collector well W90-1H (fig. 4), total flow into the treatment plant, and total well field pumpage during the study period.

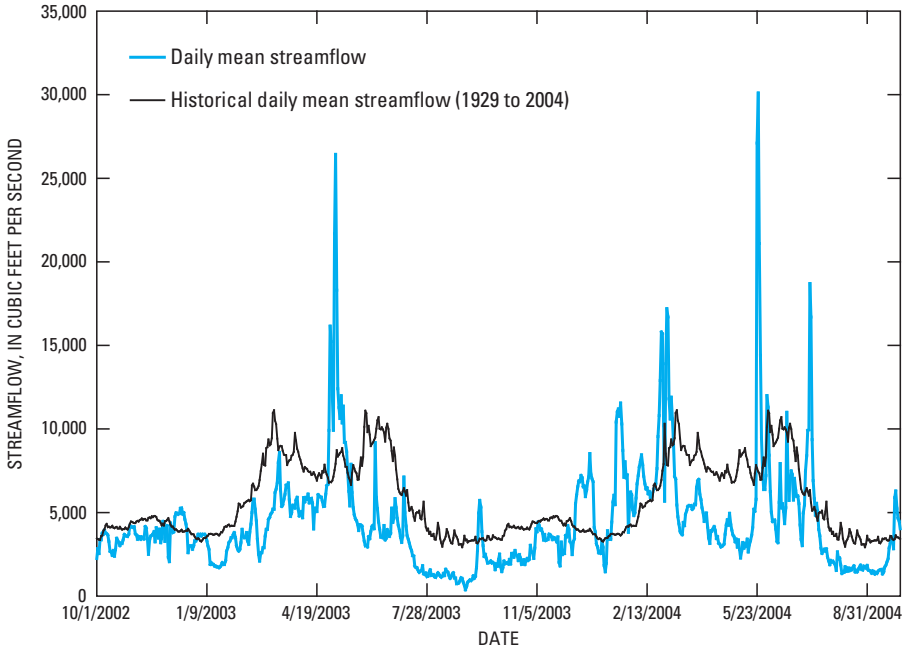


**Figure 2.** Comparison of average daily streamflow and historical mean daily streamflow at the Platte River near Ashland gaging station (06801000).

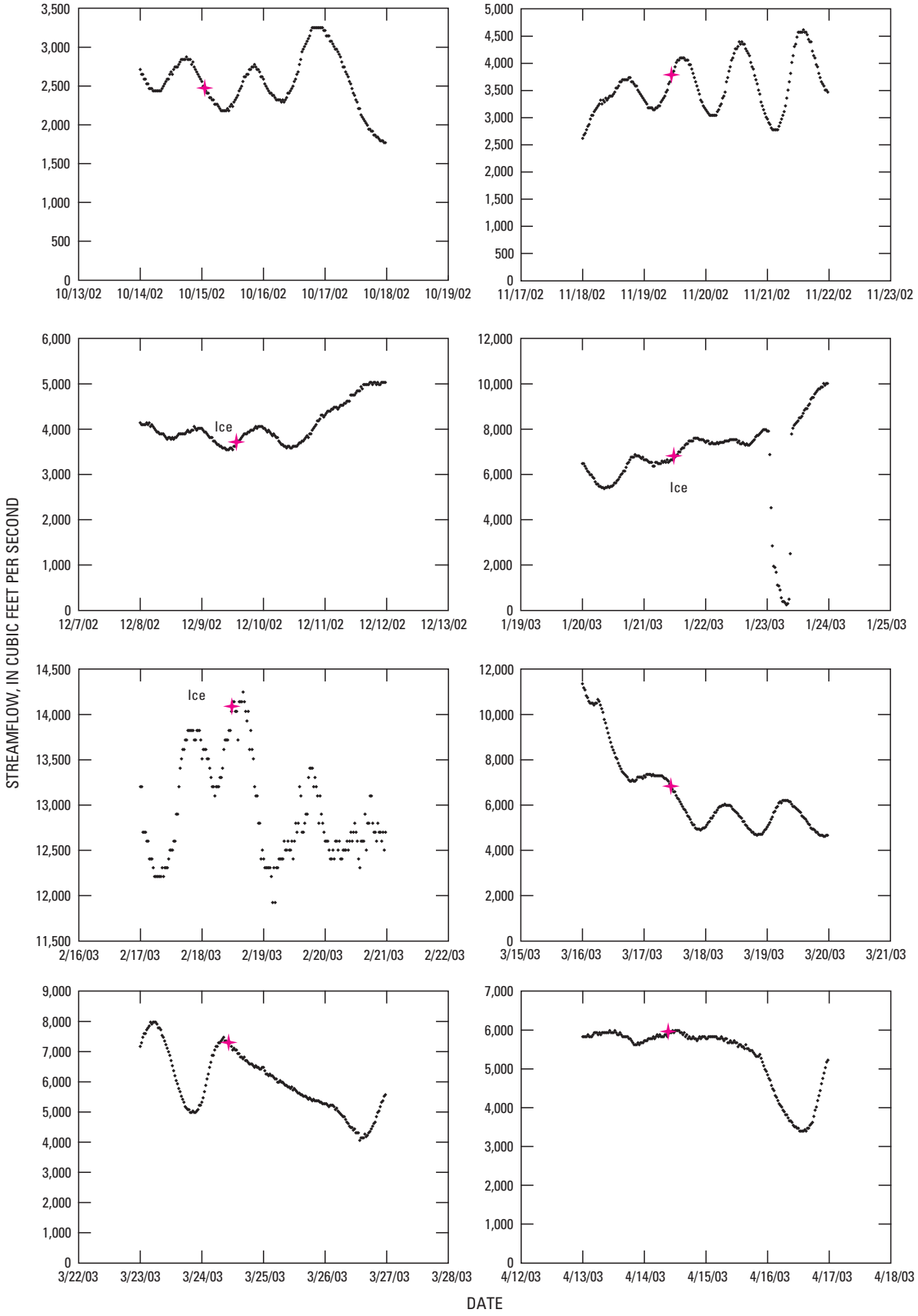


**Figure 3.** Flow conditions during sampling in the Platte River near Ashland between October 2002 and September 2004. Sample collection times are represented by stars.

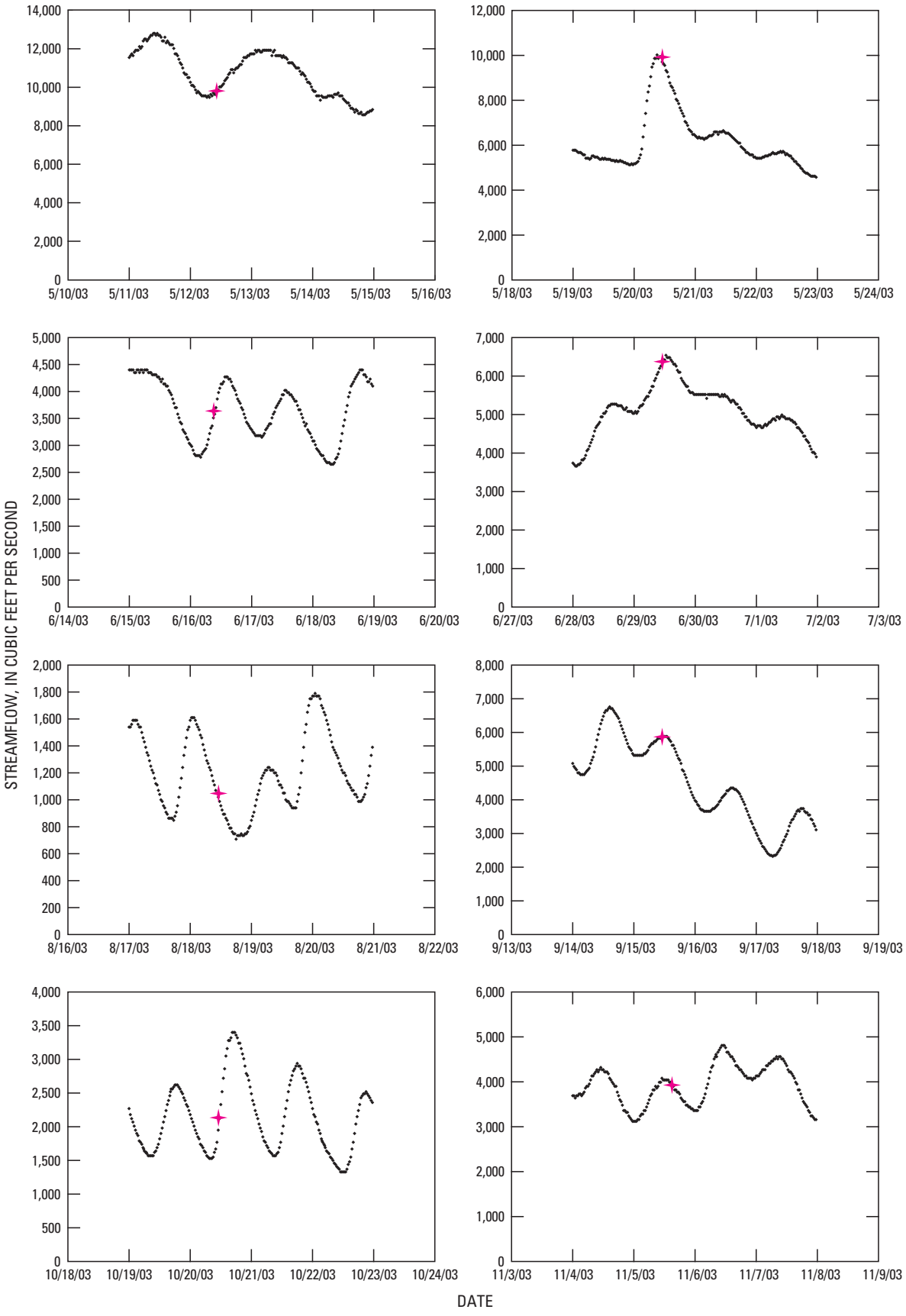


**Figure 3.** Flow conditions during sampling in the Platte River near Ashland between October 2002 and September 2004. Sample collection times are represented by stars.—Continued

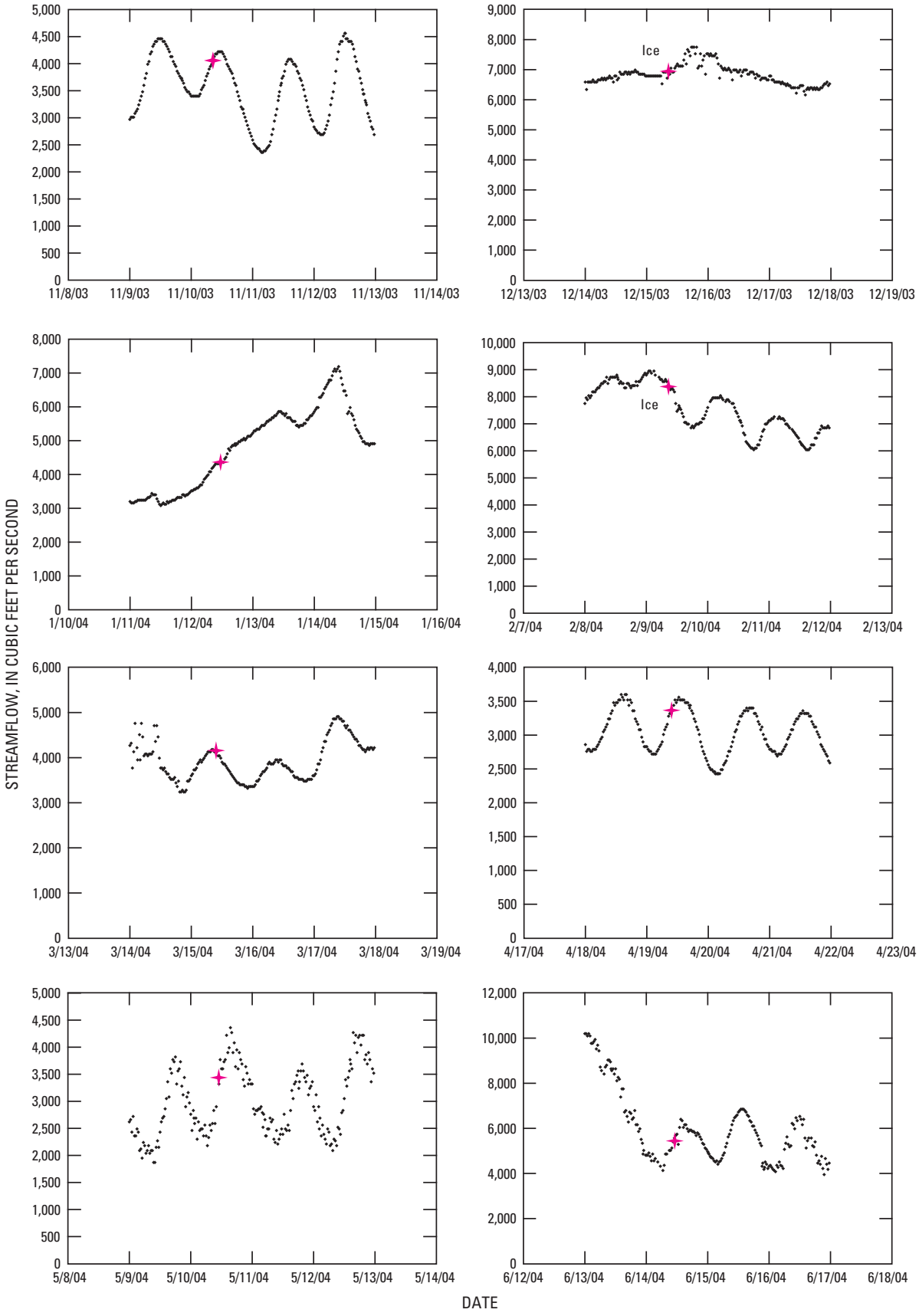


**Figure 3.** Flow conditions during sampling in the Platte River near Ashland between October 2002 and September 2004. Sample collection times are represented by stars.—Continued

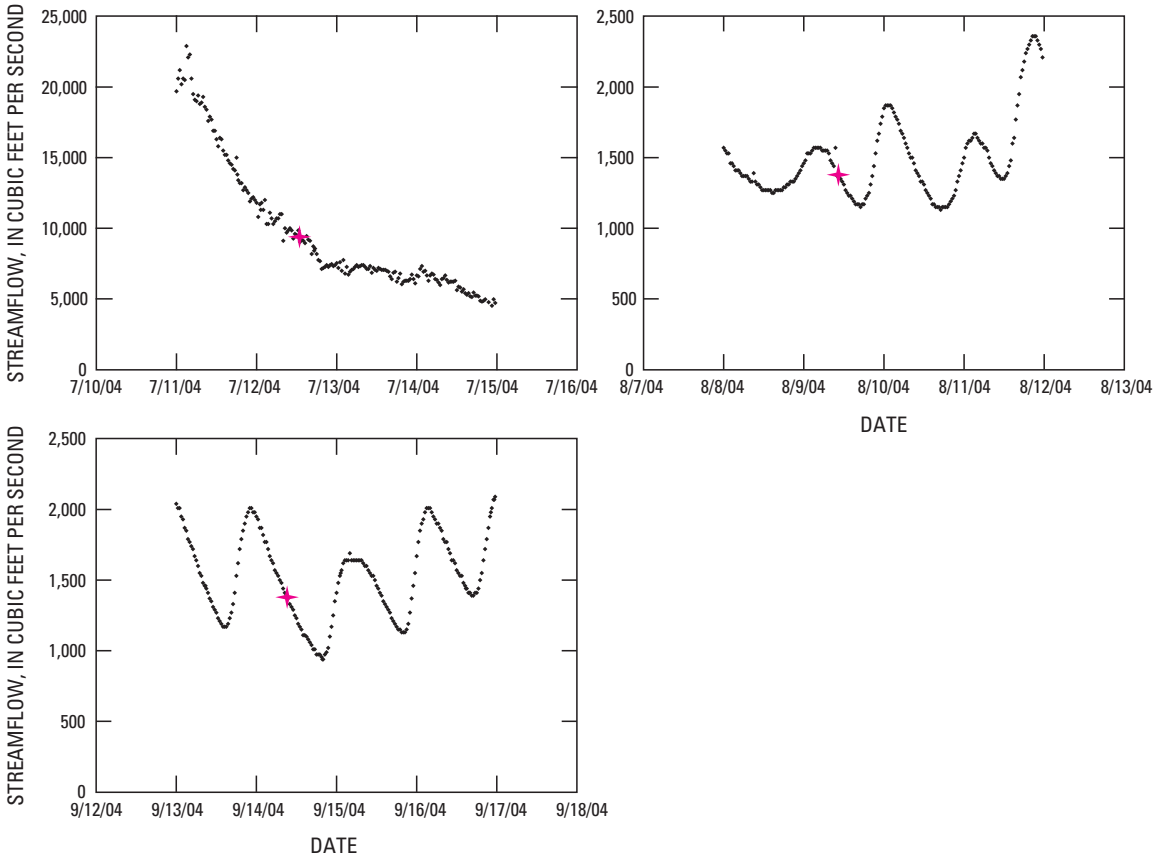


**Figure 3.** Flow conditions during sampling in the Platte River near Ashland between October 2002 and September 2004. Sample collection times are represented by stars.—Continued

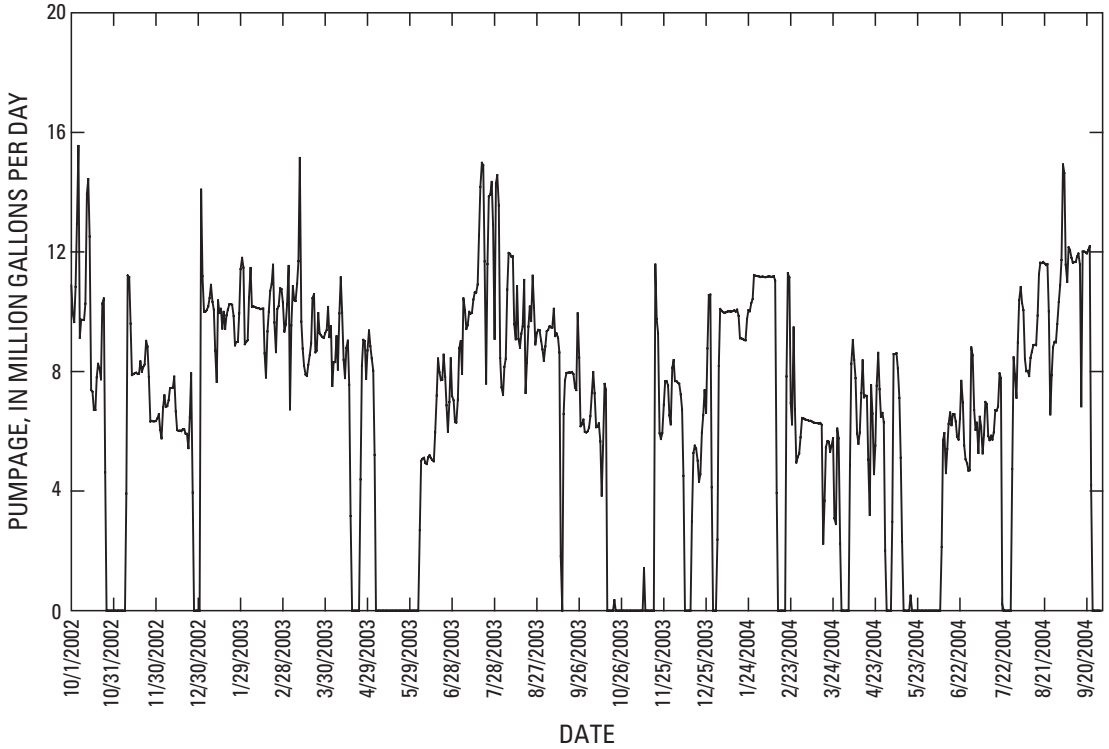


**Figure 4.** Pumpage in collector well W90-1H during the period of the study.

## Field Water-Quality Properties

Field water-quality properties were measured at each site (fig. 5; table 2). Water temperature in the Platte River varied seasonally and generally mirrored the air temperature, with a measured minimum temperature of 0ºC and maximum temperature of 29.8ºC. The temperature of the ground water from well W90-1H generally mirrored the Platte River temperature with a lag of 1 to 2 months. Measured water temperature in well W90-1H varied from 4.5 to 20.8ºC. Water temperature at the drinking-water sampling sites (raw water and finished water) showed less variability than in the ground-water well, with summer temperatures similar to air temperatures and somewhat stable temperatures (around 12 to 13ºC) in the winter. This is a result of the indoor location of these two sampling sites.

The pH of Platte River samples varied from 7.55 to 8.97 through the sample period, with no apparent seasonal trend. Samples collected from well W90-1H had less variability in measured pH values than the Platte River, ranging from 7.26 to 8.00 during the study period. In general, the pH of the raw-water and finished-water samples was similar to the pH of the ground water samples from well W90-1H.

Specific conductance of samples collected from the Platte River varied from 310 to 567 microsiemens per centimeter (µS/cm) during the study period. The specific conductance of samples from well W90-1H, raw water, and finished water were similar and showed less variability than the Platte River samples. One outlier measurement occurred on April 1, 2004, when specific conductance of the finished water sample measured 744 µS/cm.

Dissolved-oxygen (DO) concentrations in samples from the Platte River ranged from 4.35 to 15.37 mg/L. The lower concentrations generally occurred in the summer months and the higher concentrations during the winter months. Measured DO concentrations in the ground-water samples from well W90-1H showed a trend similar to the Platte River with a lag time of 1 to 2 months. The DO measurements in well W90-1H ranged from 0.12 to 8.74 mg/L. Compared to the W90-1H samples, raw-water samples had higher DO concentrations in the summer months and lower DO concentrations during the winter months. In general, DO concentrations in the finished water samples were higher than in the raw water samples due to aeration during the treatment process.

Turbidity in Platte River samples ranged from 6.46 to 1,536 NTU (nephelometric turbidity units) during the study period (fig. 6; table 2). Turbidity in samples from well W90-1H, raw water, and finished water were similar and ranged from 2 to 4 magnitudes less than the turbidity of Platte River samples collected at similar sample times.

Concentrations of DOC in samples from the Platte River ranged from 1.9 to 6.0 mg/L during the study period, with higher concentrations generally measured in the summer months (fig. 7; table 2). Samples from well W90-1H contained more consistent concentrations of DOC throughout the year than samples from the Platte River, with concentrations in well W90-1H ranging from 1.8 mg/L to 3.5 mg/L. In general, DOC concentrations in W90-1H samples were similar to Platte River samples during the winter months and lower during the summer months. Blind samples also were analyzed by the NWQL as part of the Organic Blind Sample Project to assess operational performance of the dissolved organic methods (table 3) (U.S. Geological Survey, 2004).

## Microbial Concentrations

Results from microbial analysis are presented in this section of the report. Results of QA/QC samples that were analyzed for microbes also are presented.

### *Cryptosporidium* and *Giardia*

Samples from all four sites were analyzed for *Cryptosporidium* and *Giardia* concentrations (tables 4 and 5). Environmental and duplicate samples from the Platte River on March 17, 2003, and from well W90-1H on June 30, 2002, respectively, had no detectable *Cryptosporidium* or *Giardia*. In addition, an equipment blank collected on April 1, 2003, using surface-water collection equipment had no detectable *Cryptosporidium* or *Giardia* (table 5). Mean recovery of *Cryptosporidium* was 42 percent and mean recovery of *Giardia* was 39 percent, with a coefficient of variation (CV) of 36.5 percent for *Cryptosporidium* and a CV of 38.7 percent for *Giardia* for all samples collected during this study (table 6). All of these samples were analyzed using the *Whatman Cryptest*® filter. These findings are less than the mean and CV of recovery for *Cryptosporidium* (mean=54, CV=33.1) and greater than the mean and CV of recovery for *Giardia* (mean=25, CV=100.8) in natural waters reported by DiGiorgio and others (2002) using the *Gelman Envirocheck*® high-volume filter.

*Cryptosporidia* were detected in 48 percent (13 of 27) of Platte River samples collected during the study, and *Giardia* were detected in 44 percent (12 of 27) of Platte River samples collected during the study. Both microbes, however, were not always detected in the same sample. In general, *Cryptosporidium* concentrations were greater and more variable than *Giardia* concentrations. *Cryptosporidia* were detected in every Platte River sample between November 5, 2003 and July 12, 2004 (9 of 13 detections), whereas *Giardia* detections generally were more scattered throughout the sampling period. Neither *Cryptosporidium* nor *Giardia* was detected in any samples from well W90-1H, the raw water, or the finished water.

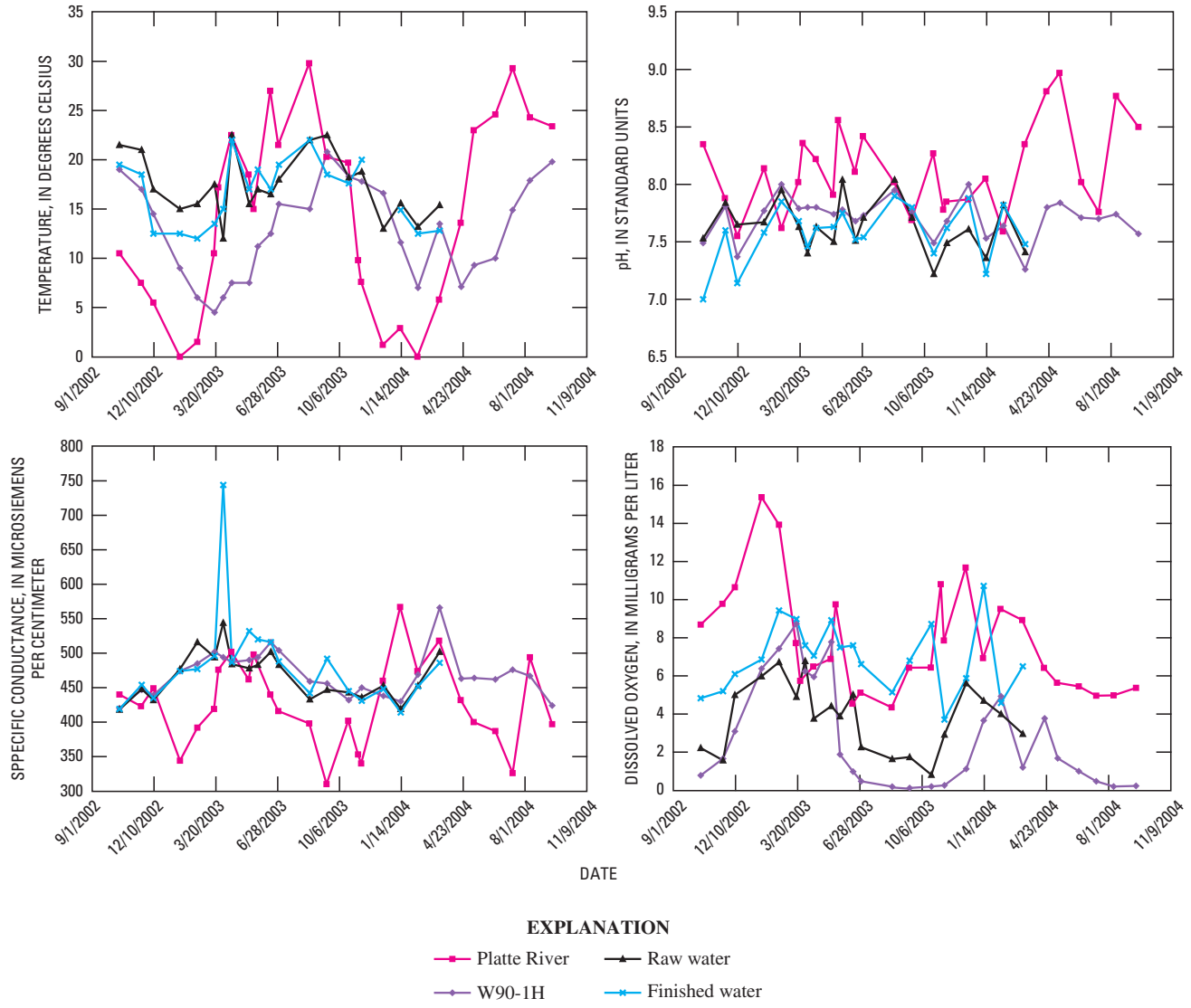


**Figure 5.** Field water-quality properties at selected sites during the riverbank filtration study, Platte River, Nebraska.

**Table 2.** Field water-quality properties and dissolved organic carbon in samples collected during the riverbank filtration study, Platte River, Nebraska.

[ft³/s, cubic feet per second; °C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; NTU, nephelometric turbidity units; S, stable; R, rising; P, Peak; F, falling, I, ice; --, not measured; NA, not applicable]

| Site identification | Station name | Date | Time | Flow rate | Flow condition | Air temperature | Water temperature | pH | Specific conductance | Dissolved oxygen | Turbidity | Dissolved organic carbon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Units --> | | | | ft³/s | | ˚C | ˚C | units | µS/cm | mg/L | NTU | mg/L |
| 06801000 | Platte River near Ashland | 10/15/02 | 1000 | 3,320 | S | 3.5 | 10.5 | 8.35 | 440 | 8.69 | 19.1 | 2.9 |
| | | 11/19/02 | 1100 | 3,820 | S | 5.5 | 7.5 | 7.88 | 423 | 9.78 | 40.2 | 1.9 |
| | | 12/9/02 | 1230 | 3,620 | I | 1.0 | 5.5 | 7.55 | 449 | 10.65 | 29.4 | 2.0 |
| | | 1/21/03 | 1200 | 6,760 | I | -8.0 | 0.0 | 8.14 | 344 | 15.37 | 7.22 | 2.9 |
| | | 2/18/03 | 1000 | 13,720 | I | 6.5 | 1.5 | 7.62 | 392 | 13.93 | 18.7 | 2.0 |
| | | 3/17/03 | 1130 | 6,590 | F | 17.0 | 10.5 | 8.02 | 419 | 7.72 | 211 | 2.5 |
| | | 3/24/03 | 1100 | 7,290 | P | 21.0 | 17.2 | 8.36 | 476 | 5.74 | 98.9 | 2.7 |
| | | 4/14/03 | 1100 | 5,990 | S | 26.5 | 22.5 | 8.22 | 502 | 6.49 | 59.6 | 2.7 |
| | | 5/12/03 | 1100 | 9,860 | S | 20.0 | 18.5 | 7.91 | 462 | 6.89 | 1,005 | 5.8 |
| | | 5/20/03 | 1030 | 9,940 | P | 26.0 | 15.0 | 8.56 | 498 | 9.75 | 502 | 6.0 |
| | | 6/16/03 | 1030 | 3,860 | S | 30.0 | 27.0 | 8.11 | 440 | 4.54 | 469 | 3.8 |
| | | 6/29/03 | 1130 | 6,420 | P | 27.5 | 21.5 | 8.42 | 416 | 5.12 | 577 | 3.7 |
| | | 8/18/03 | 1030 | 1,050 | S | 40.7 | 29.8 | 8.02 | 398 | 4.35 | 46.5 | 3.9 |
| | | 9/15/03 | 1100 | 5,880 | F | 20.0 | 20.3 | 7.69 | 310 | 6.43 | 463 | 4.1 |
| | | 10/20/03 | 1130 | 2,120 | S | 24.0 | 19.7 | 8.27 | 402 | 6.44 | 36.9 | 2.4 |
| | | 11/5/03 | 1600 | 3,820 | S | 2.0 | 9.8 | 7.78 | 353 | 10.81 | 90.6 | 2.2 |
| | | 11/10/03 | 1030 | 4,220 | S | 9.5 | 7.6 | 7.85 | 340 | 7.86 | 79.2 | 2.8 |
| | | 12/15/03 | 1000 | 6,920 | I | -- | 1.2 | 7.87 | 460 | 11.68 | 19.6 | 2.1 |
| | | 1/12/04 | 1130 | 4,360 | R | -1.3 | 2.9 | 8.05 | 567 | 6.93 | 6.46 | 2.3 |
| | | 2/9/04 | 1030 | 8,260 | I | -3.5 | 0.0 | 7.59 | 474 | 9.51 | 10.1 | 2.1 |
| | | 3/15/04 | 1100 | 4,040 | S | 1.0 | 5.8 | 8.35 | 518 | 8.93 | 103 | 3.6 |
| | | 4/19/04 | 930 | 3,320 | S | 11.5 | 13.6 | 8.81 | 432 | 6.42 | 46.3 | 3.6 |
| | | 5/10/04 | 1030 | 3,440 | S | 23.5 | 23.0 | 8.97 | 400 | 5.64 | 50.3 | 3.1 |
| | | 6/14/04 | 1030 | 5,400 | S | 24.7 | 24.6 | 8.02 | 387 | 5.45 | 1,536 | 3.1 |
| | | 7/12/04 | 1100 | 9,270 | F | 33.8 | 29.3 | 7.76 | 326 | 4.96 | 1,180 | 3.8 |
| | | 8/9/04 | 1030 | 1,370 | S | 26.5 | 24.3 | 8.77 | 494 | 4.98 | 89.0 | 3.5 |
| | | 9/14/04 | 930 | 1,370 | S | 22.2 | 23.4 | 8.50 | 397 | 5.37 | 72.5 | 3.6 |

**Table 2.** Field water-quality properties and dissolved organic carbon in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | Time | Flow rate | Flow condition | Air temperature | Water temperature | pH | Specific conductance | Dissolved oxygen | Turbidity | Dissolved organic carbon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Units --> | | | | $ft^3/s$ | | ˚C | ˚C | units | µS/cm | mg/L | NTU | mg/L |
| 410322096191701 | W90-1H | 10/15/02 | 1300 | NA | NA | 3.5 | 19.0 | 7.49 | 420 | 0.78 | 0.11 | 2.3 |
| | | 11/20/02 | 1130 | NA | NA | 5.5 | 17.0 | 7.81 | 447 | 1.66 | .13 | 1.8 |
| | | 12/9/02 | 1520 | NA | NA | 1.0 | 14.5 | 7.37 | 439 | 3.09 | .07 | 1.8 |
| | | 1/21/03 | 1330 | NA | NA | -8.0 | 9.0 | 7.77 | 474 | 6.38 | .14 | 2.4 |
| | | 2/18/03 | 1230 | NA | NA | 6.5 | 6.0 | 8.00 | 485 | 7.43 | .52 | 2.1 |
| | | 3/18/03 | 1030 | NA | NA | 13.0 | 4.5 | 7.79 | 502 | 8.74 | .18 | 2.7 |
| | | 4/1/03 | 0930 | NA | NA | 22.0 | 6.0 | 7.80 | 494 | 6.24 | .14 | 2.5 |
| | | 4/15/03 | 0900 | NA | NA | -- | 7.5 | 7.80 | 487 | 5.95 | .13 | 2.4 |
| | | 5/13/03 | 0900 | NA | NA | -- | 7.5 | 7.74 | 490 | 7.78 | .17 | 2.3 |
| | | 5/27/03 | 1030 | NA | NA | -- | 11.2 | 7.78 | 494 | 1.88 | .23 | 3.5 |
| | | 6/17/03 | 1030 | NA | NA | -- | 12.5 | 7.68 | 516 | .98 | .16 | 3.1 |
| | | 6/30/03 | 0930 | NA | NA | 23.0 | 15.5 | 7.73 | 504 | .47 | .08 | 2.3 |
| | | 8/19/03 | 1000 | NA | NA | 24.0 | 15.0 | 7.95 | 459 | .19 | .21 | 2.6 |
| | | 9/16/03 | 1030 | NA | NA | 24.0 | 20.8 | 7.76 | 456 | .12 | .24 | 2.6 |
| | | 10/21/03 | 0920 | NA | NA | 11.5 | 18.3 | 7.49 | 432 | .20 | .33 | 2.3 |
| | | 11/11/03 | 0930 | NA | NA | -- | 17.8 | 7.68 | 450 | .26 | .14 | 2.5 |
| | | 12/16/03 | 1000 | NA | NA | -- | 16.6 | 8.00 | 438 | 1.12 | .19 | 2.0 |
| | | 1/13/04 | 1105 | NA | NA | 0.5 | 11.6 | 7.53 | 430 | 3.66 | .27 | 1.8 |
| | | 2/10/04 | 1000 | NA | NA | -8.0 | 7.0 | 7.64 | 469 | 4.93 | .11 | 1.7 |
| | | 3/16/04 | 0930 | NA | NA | -2.0 | 13.5 | 7.26 | 566 | 1.20 | .32 | 3.1 |
| | | 4/20/04 | 1210 | NA | NA | 23.8 | 7.1 | 7.80 | 463 | 3.77 | .31 | 2.5 |
| | | 5/11/04 | 1225 | NA | NA | 20.6 | 9.3 | 7.84 | 464 | 1.68 | .12 | 2.3 |
| | | 6/14/04 | 1300 | NA | NA | 27.0 | 10.0 | 7.71 | 462 | 1.00 | .11 | 2.0 |
| | | 7/12/04 | 1400 | NA | NA | 32.5 | 14.9 | 7.70 | 476 | .47 | .36 | 2.5 |
| | | 8/9/04 | 1230 | NA | NA | 26.5 | 17.9 | 7.74 | 467 | .20 | .21 | 2.5 |
| | | 9/14/04 | 1220 | NA | NA | 30.6 | 19.8 | 7.57 | 424 | .23 | .24 | 2.1 |

**Table 2.** Field water-quality properties and dissolved organic carbon in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | Time | Flow rate | Flow condition | Air temperature | Water temperature | pH | Specific conductance | Dissolved oxygen | Turbidity | Dissolved organic carbon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Units --> | | | | $ft^3/s$ | | ˚C | ˚C | units | µS/cm | mg/L | NTU | mg/L |
| 410315096190101 | Raw water | 10/15/02 | 1340 | NA | NA | -- | 21.5 | 7.53 | 418 | 2.22 | 0.10 | -- |
| | | 11/20/02 | 1330 | NA | NA | -- | 21.0 | 7.84 | 448 | 1.57 | .12 | -- |
| | | 12/9/02 | 1615 | NA | NA | -- | 17.0 | 7.65 | 432 | 5.00 | .24 | -- |
| | | 1/21/03 | 1500 | NA | NA | -- | 15.0 | 7.67 | 477 | 5.98 | .17 | -- |
| | | 2/18/03 | 1330 | NA | NA | -- | 15.5 | 7.95 | 516 | 6.72 | .11 | -- |
| | | 3/18/03 | 1230 | NA | NA | -- | 17.5 | 7.63 | 494 | 4.90 | .13 | -- |
| | | 4/1/03 | 1300 | NA | NA | -- | 12.0 | 7.40 | 544 | 6.78 | .14 | -- |
| | | 4/15/03 | 1100 | NA | NA | -- | 22.5 | 7.63 | 484 | 3.76 | .14 | -- |
| | | 5/13/03 | 1100 | NA | NA | -- | 15.5 | 7.50 | 478 | 4.42 | .15 | -- |
| | | 5/27/03 | 1500 | NA | NA | -- | 17.0 | 8.04 | 483 | 3.88 | .18 | -- |
| | | 6/17/03 | 1200 | NA | NA | -- | 16.5 | 7.51 | 502 | 5.02 | -- | -- |
| | | 6/30/03 | 1300 | NA | NA | -- | 18.0 | 7.71 | 483 | 2.26 | .14 | -- |
| | | 8/19/03 | 1130 | NA | NA | -- | 22.0 | 8.04 | 433 | 1.64 | .17 | -- |
| | | 9/16/03 | 1130 | NA | NA | -- | 22.5 | 7.71 | 447 | 1.74 | .12 | -- |
| | | 10/21/03 | 1100 | NA | NA | -- | 18.2 | 7.22 | 443 | 0.81 | .15 | -- |
| | | 11/11/03 | 1330 | NA | NA | -- | 18.8 | 7.49 | 436 | 2.92 | .22 | -- |
| | | 12/16/03 | 0830 | NA | NA | -- | 13.0 | 7.61 | 453 | 5.62 | .32 | -- |
| | | 1/13/04 | 1350 | NA | NA | -- | 15.6 | 7.36 | 419 | 4.70 | .07 | -- |
| | | 2/10/04 | 1130 | NA | NA | -- | 13.2 | 7.82 | 453 | 4.00 | .25 | -- |
| | | 3/16/04 | 1130 | NA | NA | -- | 15.4 | 7.41 | 502 | 2.96 | .17 | -- |

**Table 2.** Field water-quality properties and dissolved organic carbon in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | Time | Flow rate | Flow condition | Air temperature | Water temperature | pH | Specific conductance | Dissolved oxygen | Turbidity | Dissolved organic carbon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Units --> | | | | $ft^3/s$ | | ˚C | ˚C | units | µS/cm | mg/L | NTU | mg/L |
| 410315096190102 | Finished water | 10/15/02 | 1420 | NA | NA | -- | 19.5 | 7.00 | 419 | 4.83 | 0.12 | -- |
| | | 11/20/02 | 1000 | NA | NA | -- | 18.5 | 7.60 | 454 | 5.20 | .12 | -- |
| | | 12/9/02 | 1630 | NA | NA | -- | 12.5 | 7.14 | 435 | 6.10 | .07 | -- |
| | | 1/21/03 | 1515 | NA | NA | -- | 12.5 | 7.58 | 474 | 6.86 | .09 | -- |
| | | 2/18/03 | 1400 | NA | NA | -- | 12.0 | 7.85 | 477 | 9.43 | .11 | -- |
| | | 3/18/03 | 1240 | NA | NA | -- | 13.5 | 7.68 | 496 | 8.98 | .12 | -- |
| | | 4/1/03 | 1400 | NA | NA | -- | 15.0 | 7.46 | 744 | 7.60 | .09 | -- |
| | | 4/15/03 | 1130 | NA | NA | -- | 22.0 | 7.62 | 487 | 7.06 | .29 | -- |
| | | 5/13/03 | 1400 | NA | NA | -- | 17.0 | 7.63 | 532 | 8.92 | .10 | -- |
| | | 5/27/03 | 1400 | NA | NA | -- | 19.0 | 7.75 | 520 | 7.49 | .22 | -- |
| | | 6/17/03 | 1130 | NA | NA | -- | 17.0 | 7.52 | 516 | 7.60 | -- | -- |
| | | 6/30/03 | 1200 | NA | NA | -- | 19.5 | 7.54 | 488 | 6.62 | .09 | -- |
| | | 8/19/03 | 1100 | NA | NA | -- | 22.0 | 7.90 | 442 | 5.14 | .13 | -- |
| | | 9/16/03 | 1200 | NA | NA | -- | 18.5 | 7.80 | 492 | 6.80 | .23 | -- |
| | | 10/21/03 | 1115 | NA | NA | -- | 17.6 | 7.40 | 445 | 8.72 | .17 | -- |
| | | 11/11/03 | 1400 | NA | NA | -- | 20.0 | 7.62 | 431 | 3.71 | .18 | -- |
| | | 12/16/03 | 0840 | NA | NA | -- | -- | 7.88 | 448 | 5.88 | .22 | -- |
| | | 1/13/04 | 1405 | NA | NA | -- | 14.9 | 7.22 | 414 | 10.72 | .05 | -- |
| | | 2/10/04 | 1200 | NA | NA | -- | 12.5 | 7.82 | 452 | 4.58 | .14 | -- |
| | | 3/16/04 | 1200 | NA | NA | -- | 12.8 | 7.48 | 486 | 6.50 | .23 | -- |

**Table 3.** Percentage recovery of dissolved organic carbon blind samples analyzed as part of the Organic Blind Sample Project by the National Water Quality Laboratory from February 23, 1999, to September 25, 2003. (Data from U.S. Geological Survey, 2004).

[mg/L, milligrams per liter]

| Range, in mg/L | Number of samples | Median (percent) | Mean (percent) | Standard deviation (percent) |
|---|---|---|---|---|
| 0.600–1.000 | 10 | 113 | 119 | 16.8 |
| 1.000–15.00 | 11 | 99.8 | 100 | 5.5 |
| 15.00–20.00 | 4 | 110 | 114 | 20.1 |

## Total Coliform and *E. coli*

Samples from all four sites were analyzed for total coliform and *E. coli* concentrations (tables 4 and 7). Total coliforms were detected in all samples collected from the Platte River, in 30 percent (7 of 23) of the samples collected from well W90-1H, and in 16 percent (3 of 19) of the raw water samples. Total coliforms were not detected in any of the finished water samples. *E. coli* were detected in 88 percent (22 of 25) of the samples collected from the Platte River and in 9 percent (2 of 23) of the samples collected from well W90-1H. *E. coli* were not detected in any of the raw or finished water samples. Reported concentrations of total coliforms and *E. coli* in many samples from the Platte River and of total coliforms in samples from well W90-1H were greater than the maximum amount measured by the analytical method used, so summary statistics could not be calculated for these samples (table 4).

## Coliphages

Samples from all four sites were analyzed for male-specific and somatic coliphage concentrations (tables 4 and 7). Male-specific coliphages were not detected in any samples on the dates that duplicate samples were collected, whereas two of six duplicate samples contained detectable levels of somatic coliphages. The environmental and duplicate samples collected from the Platte River on October 20, 2003, contained identical concentrations of somatic coliphages. Concentrations measured in the environmental and duplicate samples collected from well W90-1H on March 16, 2004, measured concentrations differing by 7 pfu (44 percent).

In the Platte River, somatic coliphages were detected more often and generally in higher levels than male-specific coliphages. Somatic coliphages were detected in 23 percent (6 of 26) of samples from well W90-1H at concentrations less than in the Platte River sampled at approximately the same time. Somatic coliphages were detected in only a few samples at levels near the method detection limit (MDL) in the raw water and the finished water. Male-specific coliphages also were detected in only a few samples at levels near the MDL in well W90-1H, the raw water, and the finished water.

## Aerobic Spores

Samples from all four sites were analyzed for aerobic spore concentrations (tables 4 and 7). Aerobic spores were detected in all samples collected from the Platte River and well W90-1H during this study. The mean concentration of aerobic spores in samples from the Platte River was 2.7 magnitudes greater than the mean concentration in samples from well W90-1H. Aerobic spores were detected in 18 of 19 raw water samples (95 percent) and 4 of 19 finished water samples (21 percent). The mean aerobic spore concentration in samples from well W90-1H was 0.3 magnitudes greater than the mean aerobic spore concentration in samples of the raw water. The mean aerobic spore concentration in raw water samples was 1.5 magnitudes greater than the mean aerobic spore concentration in the finished water samples.

## Enterococci

Samples from all four sites were analyzed for enterococci concentrations (tables 4 and 7). Enterococci were detected in all samples from the Platte River. Only one sample from well W90-1H and one sample from the raw water contained detectable concentrations of enterococci, although these samples were not collected at the same time. Enterococci were not detected in any samples from the finished water.

## Microscopic Particulate Analysis

MPAs were completed on samples from all four sites (tables 8 and 9). Of the classified non-diatomaceous algae analyzed in samples from the Platte River, *Scendesmus* was detected most often (14 of 15 samples). Unclassified algae were detected in all samples collected from the Platte River. *Scendesmus* also was the most detected classified algae in samples from well W90-1H (4 of 14 samples). All non-diatomaceous algae were detected less frequently and at lower mean concentrations in samples from well W90-1H than in samples from the Platte River except for *Phacus*, which was detected in 2 of 14 samples from the well, but not in any of the 15 samples from the Platte River. However, the MDLs for the samples from the Platte River were, on average, 5.8 magnitudes higher than the MDL (table 9). *Scendesmus* (2 of 7 samples) and *Pediastrum* (1 of 7 samples) were the only classified non-diatomaceous algae detected in raw water samples. Unclassified algae were detected in 3 of 7 raw water samples. Non-diatomaceous algae were not detected in 4 samples from the finished water, except for 1 sample, which contained unclassified algae.

**Table 4.** Summary statistics of microbial concentrations in samples collected during riverbank filtration study, Platte River, Nebraska.

[Summary statistics are based on quantified concentrations; MDL, method detection limit; n, number of samples; det, number of detections; max, maximum; med, median; std. dev., standard deviation; L, liter; v, variable; na, not applicable; mpn, most probable number; mL, milliliter; >, greater than; cfu, colony forming units; pfu, plaque forming units; *, note that aerobic spore units are different for the Platte River and W90-1H sites than for the raw water and finished water sites]

| | | | 06801000 Platte River near Ashland | | | | | | 410322096191701 Well W90-1H | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | units | MDL | n | det | max | med | mean | std. dev. | n | det | max | med | mean | std. dev. |
| *Cryptosporidia* | oocysts/L | v | 27 | 13 | 28 | 4.0 | 5.0 | 7.2 | 14 | 0 | na | na | na | na |
| *Giardia* | cysts/L | v | 27 | 12 | 6.0 | 2.3 | 2.0 | 1.8 | 14 | 0 | na | na | na | na |
| Total coliform | mpn/100 mL | 1 | 25 | 25 | >2,420 | na | na | na | 23 | 7 | 20 | 1 | 6 | 8 |
| *E. coli* | cfu/100 mL | 1 | 25 | 22 | >2,420 | na | na | na | 23 | 2 | 1 | 1 | 1 | 0 |
| Male-specific coliphage | pfu/100 mL | 1 | 27 | 12 | 53 | 3 | 8 | 15 | 26 | 3 | 2 | 1 | 1 | 1 |
| Somatic coliphage | pfu/100 mL | 1 | 27 | 26 | >1,000 | na | na | na | 26 | 6 | 16 | 2 | 4 | 6 |
| Aerobic spores* | 100 cfu/100 mL | 0.01 | 26 | 26 | 4,900 | 490 | 1,100 | 1,400 | 25 | 25 | 8.4 | 1.5 | 2.0 | 1.6 |
| Enterococci | mpn/100 mL | 1 | 25 | 25 | 980 | 50 | 134 | 249 | 24 | 1 | 2 | 2 | 2 | na |

| | | | 410315096190101 Raw water | | | | | | 410315096190102 Finished water | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Units | MDL | n | det | max | med | mean | std. dev. | n | det | max | med | mean | std. dev. |
| *Cryptosporidia* | oocysts/L | v | 8 | 0 | na | na | na | na | 5 | 0 | na | na | na | na |
| *Giardia* | cysts/L | v | 8 | 0 | na | na | na | na | 5 | 0 | na | na | na | na |
| Total coliform | mpn/100 mL | 1 | 19 | 3 | 4 | 4 | 3 | 2 | 19 | 0 | na | na | na | na |
| *E. coli* | cfu/100 mL | 1 | 19 | 0 | na | na | na | na | 19 | 0 | na | na | na | na |
| Male-specific coliphage | pfu/100 mL | 1 | 11 | 1 | 1 | 1 | 1 | na | 11 | 2 | 1 | 1 | 1 | 0 |
| Somatic coliphage | pfu/100 mL | 1 | 11 | 3 | 1 | 1 | 1 | 0 | 11 | 1 | 1 | 1 | 1 | na |
| Aerobic spores* | cfu/100 mL | 1 | 19 | 18 | 930 | 46 | 105 | 209 | 19 | 4 | 4 | 3 | 3 | 1 |
| Enterococci | mpn/100 mL | 1 | 19 | 1 | 1 | 1 | 1 | na | 19 | 0 | na | na | na | na |

The most frequently detected classified diatom in samples from the Platte River was *Navicula* (9 of 15 samples). The highest mean concentration of classified diatoms in samples from the Platte River was *Asterionella*, although concentrations of this diatom also had the highest standard deviation. Unclassified diatoms were detected in 60 percent of the samples (9 of 15) from the Platte River. At least one type of diatom was detected in all samples from the Platte River. Detectable concentrations of classified diatoms were not present in any samples from well W90-1H, except for *Tabellaria*, which was detected in one sample. Unclassified diatoms were detected in 2 of 14 samples from well W90-1H. Classified diatoms were not detected in raw water samples, while unclassified diatoms were detected in 1 of 7 raw water samples. Diatoms were not detected in any of the four finished water samples.

Five other microscopic particles were quantified by the MPA (rotifers, amoebae, nematodes, flagellates, and pollen). The only type of these other microscopic particles detected in the Platte River samples was amoebae, which were detected in 20 percent of the samples (3 of 15). Rotifers, amoebae, nematodes, and pollen were detected in at least one sample from well W90-1H. These five types of microscopic particles were detected in at least one raw water sample. None of these five types of microscopic particles were detected in finished water samples using the MPA analysis.

## Laser Particle Counts

LPCs were completed on samples from all four sites (tables 10 and 11). The first sample analyzed from each site during the study (October 2002) was analyzed in eight size classifications ranging from 0.5 to 100 µm. All samples after that were analyzed in size classifications ranging from 1.0 µm to greater than 100 µm. For statistical analysis (table 10), values denoted with "M" are based upon a data set that included at least one value that was not quantified (such as, <1,000). These values are not included in the summary statistics values, but are included in the total number of samples. In general, the mean LPC in each size classification decreased as size increased. Mean LPC in each size classification generally was greater in samples from the Platte River than in samples from well W90-1H, and also generally greater in samples from the raw water than in samples from the finished water. However, mean LPCs generally were greater in the raw water samples than in samples from well W90-1H. Mean total LPCs in samples from well W90-1H may have been larger than mean total laser particle counts in the raw water because one sample where 0.5-1.0 µm was quantified was included in the W90-1H data set, whereas this size classification was not measured in any of the raw water samples.

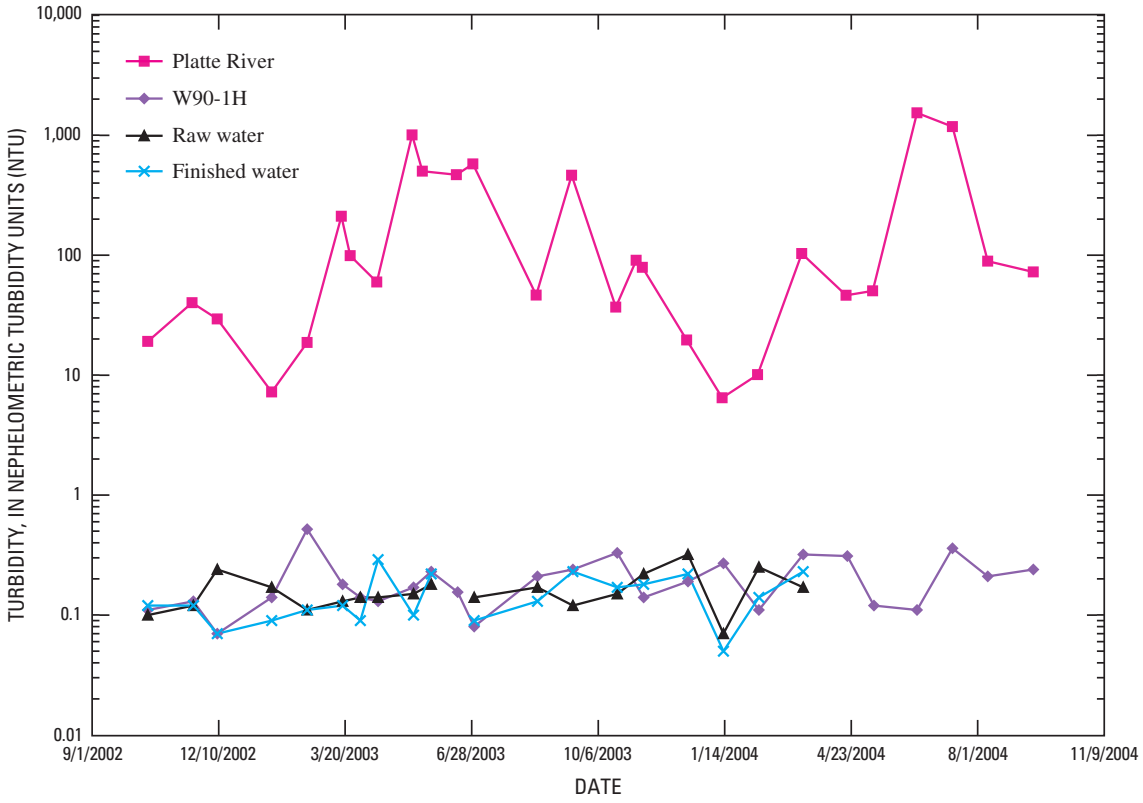


**Figure 6.** Turbidity at selected sites during the riverbank filtration study, Platte River, Nebraska.

## Stable Hydrogen and Oxygen Isotope Ratios

Stable hydrogen and oxygen isotope ratios were measured in surface-water (Platte River) and ground-water (wells W90-1H and W49-9) samples (fig. 8; table 12). Stable hydrogen isotope ratios of surface water showed seasonal variations ranging from -73.1 ‰ to -48.7 ‰ relative to VSMOW reference water. Stable oxygen isotope ratios of surface water ranged from -9.86 ‰ to -6.04 ‰. Stable hydrogen isotope ratios of ground water showed seasonal variations ranging from -71.6 ‰ to -45.0 ‰ relative to VSMOW reference water. Stable oxygen isotope ratios of ground water ranged from -9.82 ‰ to -5.25 ‰.

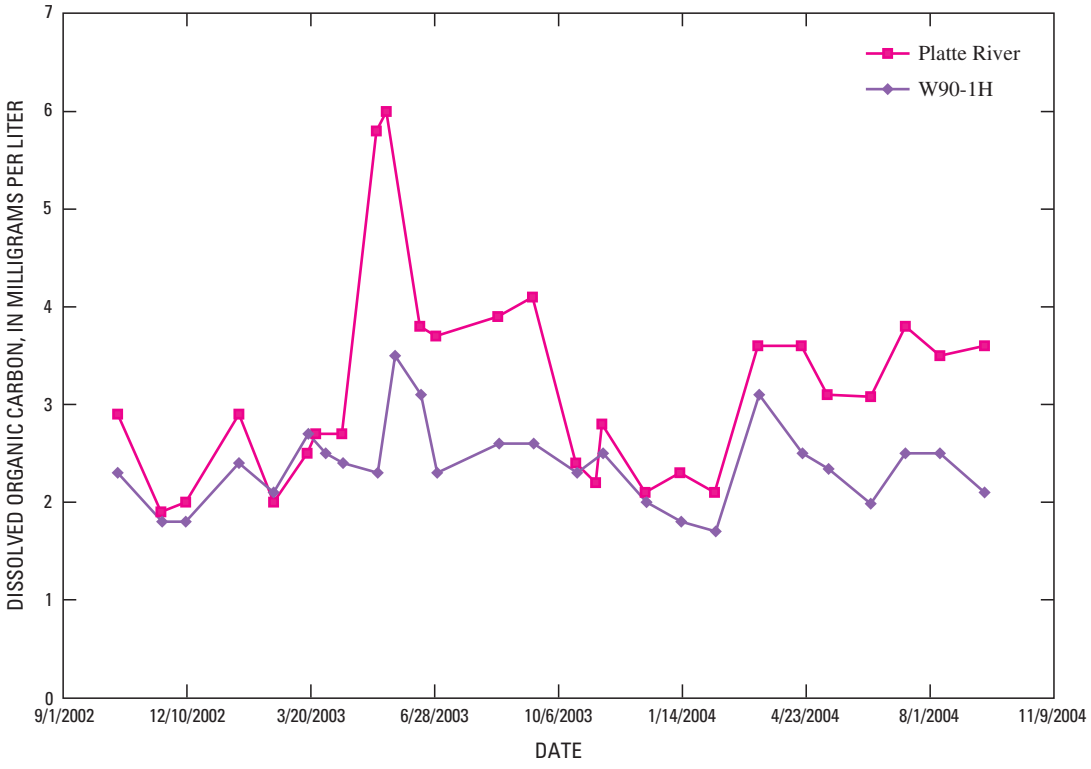


**Figure 7.** Dissolved organic carbon (DOC) in samples from the Platte River and collector well W90-1H during the riverbank filtration study, Platte River, Nebraska.

**Table 5.** *Cryptosporidium* and *Giardia* concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.

[*Crypto*, *Cryptosporidium*; MDL, method detection limit; L, liter; <, less than; --, not measured]

| Site identification | Station name | Date | *Crypto* | *Giardia* | Sample volume | MDL | *Crypto* | *Giardia* |
|---|---|---|---|---|---|---|---|---|
| Units --> | | | oocysts | cysts | (L) | units/L | oocysts/L | cysts/L |
| 06801000 | Platte River near Ashland | 10/15/02 | 0 | 1 | 1.50 | 0.7 | <MDL | 0.7 |
| | | 11/19/02 | 2 | 6 | 2.25 | .4 | 0.9 | 2.7 |
| | | 12/9/02 | 0 | 9 | 1.50 | .7 | <MDL | 6.0 |
| | | 1/21/03 | 1 | 2 | 5.00 | .2 | .2 | .4 |
| | | 2/18/03 | 0 | 2 | 3.25 | .3 | <MDL | .6 |
| | | 3/17/03 | 0 | 0 | 1.00 | 1.0 | <MDL | <MDL |
| | | 3/24/03 | 0 | 0 | 1.50 | .7 | <MDL | <MDL |
| | | 4/14/03 | 0 | 0 | 0.50 | 2.0 | <MDL | <MDL |
| | | 5/12/03 | 0 | 1 | .25 | 4.0 | <MDL | 4.0 |
| | | 5/20/03 | 0 | 1 | .25 | 4.0 | <MDL | 4.0 |
| | | 6/16/03 | 0 | 0 | .25 | 4.0 | <MDL | <MDL |
| | | 6/29/03 | 0 | 0 | .25 | 4.0 | <MDL | <MDL |
| | | 8/18/03 | 0 | 0 | .50 | 2.0 | <MDL | <MDL |
| | | 9/15/03 | 1 | 0 | .25 | 4.0 | 4.0 | <MDL |
| | | 10/20/03 | 0 | 1 | .50 | 2.0 | <MDL | 2.0 |
| | | 11/5/03 | 2 | 1 | .50 | 2.0 | 4.0 | 2.0 |
| | | 11/10/03 | 2 | 0 | .50 | 2.0 | 4.0 | <MDL |
| | | 12/15/03 | 2 | 2 | .75 | 1.3 | 2.7 | 2.7 |
| | | 1/12/04 | 2 | 0 | 1.00 | 1.0 | 2.0 | <MDL |
| | | 2/9/04 | 2 | 1 | 8.50 | .1 | .2 | .1 |
| | | 3/15/04 | 3 | 0 | .75 | 1.3 | 4.0 | <MDL |
| | | 4/19/04 | 7 | 1 | .25 | 4.0 | 28.0 | 4.0 |
| | | 5/10/04 | 3 | 0 | .50 | 2.0 | 6.0 | <MDL |
| | | 6/14/04 | 1 | 0 | .25 | 4.0 | 4.0 | <MDL |
| | | 7/12/04 | 2 | 0 | .25 | 4.0 | 8.0 | <MDL |
| | | 8/9/04 | 0 | 0 | .50 | 2.0 | <MDL | <MDL |
| | | 9/14/04 | 0 | 0 | .50 | 2.0 | <MDL | <MDL |
| 410322096191701 | W90-1H | 10/15/02 | -- | -- | -- | -- | -- | -- |
| | | 11/20/02 | 0 | 0 | 10.75 | .1 | <MDL | <MDL |
| | | 12/9/02 | -- | -- | -- | -- | -- | -- |
| | | 1/21/03 | -- | -- | -- | -- | -- | -- |
| | | 2/18/03 | -- | -- | -- | -- | -- | -- |
| | | 3/18/03 | -- | -- | -- | -- | -- | -- |
| | | 4/1/03 | 0 | 0 | 10.00 | .1 | <MDL | <MDL |
| | | 4/15/03 | 0 | 0 | 10.00 | .1 | <MDL | <MDL |
| | | 5/13/03 | 0 | 0 | 10.50 | .1 | <MDL | <MDL |
| | | 5/27/03 | 0 | 0 | 11.00 | .1 | <MDL | <MDL |
| | | 6/17/03 | 0 | 0 | 11.00 | .1 | <MDL | <MDL |

**Table 5.** *Cryptosporidium* and *Giardia* concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | *Crypto* | *Giardia* | Sample volume | MDL | *Crypto* | *Giardia* |
|---|---|---|---|---|---|---|---|---|
| Units --> | | | oocysts | cysts | (L) | units/L | oocysts/L | cysts/L |
| 410322096191701 | W90-1H | 6/30/03 | 0 | 0 | 11.00 | 0.1 | <MDL | <MDL |
| | | 8/19/03 | 0 | 0 | 11.00 | .1 | <MDL | <MDL |
| | | 9/16/03 | -- | -- | -- | -- | -- | -- |
| | | 10/21/03 | -- | -- | -- | -- | -- | -- |
| | | 11/11/03 | 0 | 0 | 11.00 | .1 | <MDL | <MDL |
| | | 12/16/03 | -- | -- | -- | -- | -- | -- |
| | | 1/13/04 | -- | -- | -- | -- | -- | -- |
| | | 2/10/04 | -- | -- | -- | -- | -- | -- |
| | | 3/16/04 | -- | -- | -- | -- | -- | -- |
| | | 4/20/04 | 0 | 0 | 10.00 | .1 | <MDL | <MDL |
| | | 5/11/04 | 0 | 0 | 8.50 | .1 | <MDL | <MDL |
| | | 6/14/04 | 0 | 0 | 10.00 | .1 | <MDL | <MDL |
| | | 7/12/04 | 0 | 0 | 10.50 | .1 | <MDL | <MDL |
| | | 8/9/04 | 0 | 0 | 10.50 | .1 | <MDL | <MDL |
| | | 9/14/04 | 0 | 0 | 11.00 | .1 | <MDL | <MDL |
| 410315096190101 | Raw water | 10/15/02 | -- | -- | -- | -- | -- | -- |
| | | 11/20/02 | 0 | 0 | 5.50 | .2 | <MDL | <MDL |
| | | 12/9/02 | -- | -- | -- | -- | -- | -- |
| | | 1/21/03 | -- | -- | -- | -- | -- | -- |
| | | 2/18/03 | -- | -- | -- | -- | -- | -- |
| | | 3/18/03 | -- | -- | -- | -- | -- | -- |
| | | 4/1/03 | -- | -- | -- | -- | -- | -- |
| | | 4/15/03 | 0 | 0 | 11.00 | .1 | <MDL | <MDL |
| | | 5/13/03 | 0 | 0 | 5.50 | .2 | <MDL | <MDL |
| | | 5/27/03 | 0 | 0 | 10.50 | .1 | <MDL | <MDL |
| | | 6/17/03 | 0 | 0 | 10.50 | .1 | <MDL | <MDL |
| | | 6/30/03 | 0 | 0 | 10.50 | .1 | <MDL | <MDL |
| | | 8/19/03 | 0 | 0 | 10.00 | .1 | <MDL | <MDL |
| | | 9/16/03 | -- | -- | -- | -- | -- | -- |
| | | 10/21/03 | -- | -- | -- | -- | -- | -- |
| | | 11/11/03 | 0 | 0 | 11.00 | .1 | <MDL | <MDL |
| | | 12/16/03 | -- | -- | -- | -- | -- | -- |
| | | 1/13/04 | -- | -- | -- | -- | -- | -- |
| | | 2/10/04 | -- | -- | -- | -- | -- | -- |
| | | 3/16/04 | -- | -- | -- | -- | -- | -- |

**Table 5.** *Cryptosporidium* and *Giardia* concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | *Crypto* | *Giardia* | Sample volume | MDL | *Crypto* | *Giardia* |
|---|---|---|---|---|---|---|---|---|
| **Units -->** | | | **oocysts** | **cysts** | **(L)** | **units/L** | **oocysts/L** | **cysts/L** |
| 410315096190102 | Finished water | 10/15/02 | -- | -- | -- | -- | -- | -- |
| | | 11/20/02 | 0 | 0 | 11.00 | 0.1 | <MDL | <MDL |
| | | 12/9/02 | -- | -- | -- | -- | -- | -- |
| | | 1/21/03 | -- | -- | -- | -- | -- | -- |
| | | 2/18/03 | -- | -- | -- | -- | -- | -- |
| | | 3/18/03 | -- | -- | -- | -- | -- | -- |
| | | 4/1/03 | 0 | 0 | 10.00 | .1 | <MDL | <MDL |
| | | 4/15/03 | -- | -- | -- | -- | -- | -- |
| | | 5/13/03 | 0 | 0 | 11.00 | .1 | <MDL | <MDL |
| | | 5/27/03 | 0 | 0 | 11.00 | .1 | <MDL | <MDL |
| | | 6/17/03 | -- | -- | -- | -- | -- | -- |
| | | 6/30/03 | -- | -- | -- | -- | -- | -- |
| | | 8/19/03 | -- | -- | -- | -- | -- | -- |
| | | 9/16/03 | -- | -- | -- | -- | -- | -- |
| | | 10/21/03 | -- | -- | -- | -- | -- | -- |
| | | 11/11/03 | 0 | 0 | 11.00 | .1 | <MDL | <MDL |
| | | 12/16/03 | -- | -- | -- | -- | -- | -- |
| | | 1/13/04 | -- | -- | -- | -- | -- | -- |
| | | 2/10/04 | -- | -- | -- | -- | -- | -- |
| | | 3/16/04 | -- | -- | -- | -- | -- | -- |
| **Duplicates** | | | | | | | | |
| 6801000 | Platte River duplicate | 3/17/03 | 0 | 0 | 1.00 | 1.0 | <MDL | <MDL |
| 410322096191701 | W90-1H duplicate | 6/30/03 | 0 | 0 | 11.00 | .1 | <MDL | <MDL |
| **Equipment blank** | | | | | | | | |
| | Equipment blank | 4/1/03 | 0 | 0 | 10.00 | .1 | <MDL | <MDL |

**Table 6.** *Cryptosporidium* and *Giardia* recovery efficiencies from analysis of samples during the riverbank filtration study, Platte River, Nebraska.

[*Crypto*, *Cryptosporidia*; CV, coefficient of variation; --, no comments]

| Date | Recovery efficiency | | Comments |
|---|---|---|---|
| | ***Crypto*** **(percent)** | ***Giardia*** **(percent)** | |
| 10/15/02 | 52 | 45 | -- |
| 11/19/02 | 46 | 38 | -- |
| 11/19/02 | 29 | 25 | W90-1H matrix spike |
| 12/9/02 | 43 | 50 | -- |
| 12/9/02 | 33 | 60 | Platte River matrix spike |
| 1/21/03 | 49 | 29 | -- |
| 2/18/03 | 35 | 25 | -- |
| 3/17/03 | 27 | 15 | -- |
| 4/1/04 | 39 | 14 | -- |
| 4/14/03 | 55 | 31 | -- |
| 5/12/03 | 27 | 34 | -- |
| 5/12/03 | 20 | 17 | Raw water matrix spike |
| 5/20/03 | 26 | 24 | -- |
| 6/16/03 | 24 | 65 | -- |
| 6/29/03 | 45 | 39 | -- |
| 8/18/03 | 58 | 64 | -- |
| 9/15/03 | 57 | 49 | -- |
| 10/20/03 | 10 | 19 | -- |
| 11/5/03 | 66 | 57 | -- |
| 12/15/03 | 66 | 57 | -- |
| 1/12/04 | 12 | 28 | -- |
| 2/9/04 | 53 | 55 | -- |
| 3/15/04 | 46 | 28 | -- |
| 4/19/04 | 53 | 41 | -- |
| 5/10/04 | 48 | 53 | -- |
| 6/14/04 | 60 | 46 | -- |
| 7/12/04 | 43 | 39 | -- |
| 8/9/04 | 38 | 40 | -- |
| 9/14/04 | 56 | 52 | -- |
| **Mean** | **42** | **39** | -- |
| **CV (percent)** | **36.5** | **38.7** | -- |

**Table 7**. Total coliform, *E. coli*, male-specific and somatic coliphage, aerobic spore, and enterococci concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.

[cfu, colony forming units; mL, milliliter; pfu, plaque forming units; mpn, most probable number; <, less than; >, greater than; --, not measured; E, estimated; NA, not applicable]

| Site identification | Station name | Date | Total coliform | *E. coli* | Coliphages | | Aerobic spores | Enterococci |
|---|---|---|---|---|---|---|---|---|
| | | | | | Male-specific | Somatic | | |
| Units --> | | | cfu/100 mL | cfu/100 mL | pfu/100 mL | pfu/100 mL | cfu/100 mL | mpn/100 mL |
| 06801000 | Platte River Ashland | 10/15/02 | 201 | 26 | <1 | 20 | 9,000 | 24 |
| | | 11/19/02 | >201 | 41 | 1 | 40 | 70,000 | 15 |
| | | 12/9/02 | >201 | 3 | <1 | 21 | 48,000 | 18.5 |
| | | 1/21/03 | -- | -- | 2 | 33 | 12,000 | 21.8 |
| | | 2/18/03 | >201 | <1 | 3 | 57 | 24,000 | 35.9 |
| | | 3/17/03 | 37 | <1 | <1 | 216 | 490,000 | 91.1 |
| | | 3/24/03 | >201 | 35 | <1 | 11 | 69,000 | 45 |
| | | 4/14/03 | 15 | <1 | 5 | 9 | 30,000 | 21.1 |
| | | 5/12/03 | >201 | >201 | 18 | 840 | 410,000 | 980 |
| | | 5/20/03 | >201 | >201 | 2 | 290 | -- | -- |
| | | 6/16/03 | >201 | 166 | <1 | 8 | 250,000 | 840 |
| | | 6/29/03 | >201 | >201 | <1 | 16 | 240,000 | 132 |
| | | 8/18/03 | >201 | 14 | <1 | 4 | 370,000 | 50.1 |
| | | 9/15/03 | >201 | >201 | 53 | >1,000 | 310,000 | 60.1 |
| | | 10/20/03 | >201 | 56 | <1 | 27 | 37,000 | 31 |
| | | 11/5/03 | >201 | >201 | <1 | 147 | 46,000 | 62 |
| | | 11/10/03 | >2,420 | 817 | 5 | 233 | 63,000 | 50.4 |
| | | 12/15/03 | 771 | 44 | 3 | 121 | 11,000 | 21.8 |
| | | 1/12/04 | 345 | 30 | 1 | 384 | 9,500 | 9.7 |
| | | 2/9/04 | 727 | 249 | 6 | 431 | 12,000 | 50.4 |
| | | 3/15/04 | 550 | 67 | <1 | E34 | 80,000 | 62.75 |
| | | 4/19/04 | 78 | 27 | <1 | 2 | 24,000 | -- |
| | | 5/10/04 | 2,420 | 94 | <1 | 3 | 17,000 | 27.2 |
| | | 6/14/04 | >2,420 | >2,420 | <1 | <1 | 49,000 | 9.7 |
| | | 7/12/04 | -- | -- | <1 | E162 | 47,000 | 178.9 |
| | | 8/9/04 | >2,420 | 329 | <1 | 15 | 52,000 | 98.5 |
| | | 9/14/04 | >2,420 | >2,420 | 1 | 7 | 51,000 | 416 |
| 410322096191701 | W90-1H | 10/15/02 | <1 | <1 | 2 | 4 | 190 | <1 |
| | | 11/20/02 | <1 | <1 | <1 | <1 | 130 | <1 |
| | | 12/9/02 | <1 | <1 | <1 | <1 | 220 | <1 |
| | | 1/21/03 | -- | -- | <1 | 1 | 150 | <1 |
| | | 2/18/03 | <1 | <1 | <1 | 1 | 130 | <1 |
| | | 3/18/03 | 20 | <1 | <1 | 2 | 230 | <1 |
| | | 4/1/03 | <1 | <1 | <1 | 2 | 190 | <1 |
| | | 4/15/03 | 1 | <1 | <1 | <1 | 90 | <1 |

**Table 7**. Total coliform, *E. coli*, male-specific and somatic coliphage, aerobic spore, and enterococci concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | Total coliform | *E. coli* | Coliphages | | Aerobic spores | Enterococci |
|---|---|---|---|---|---|---|---|---|
| | | | | | Male-specific | Somatic | | |
| Units --> | | | cfu/100 mL | cfu/100 mL | pfu/100 mL | pfu/100 mL | cfu/100 mL | mpn/100 mL |
| 410322096191701 | W90-1H | 5/13/03 | 5 | <1 | <1 | <1 | 340 | <1 |
| | | 5/27/03 | 1 | 1 | <1 | <1 | -- | -- |
| | | 6/17/03 | <1 | <1 | <1 | <1 | 150 | <1 |
| | | 6/30/03 | 1 | <1 | <1 | <1 | 100 | <1 |
| | | 8/19/03 | <1 | <1 | <1 | <1 | 260 | <1 |
| | | 9/16/03 | <1 | <1 | <1 | <1 | 180 | <1 |
| | | 10/21/03 | <1 | <1 | <1 | <1 | 835 | <1 |
| | | 11/11/03 | <1 | <1 | <1 | <1 | 450 | 2 |
| | | 12/16/03 | <1 | <1 | 1 | <1 | 100 | <1 |
| | | 1/13/04 | <1 | <1 | <1 | <1 | 60 | <1 |
| | | 2/10/04 | <1 | <1 | <1 | <1 | 55 | <1 |
| | | 3/16/04 | 14 | 1 | 1 | 16 | 190 | <1 |
| | | 4/20/04 | 1 | <1 | <1 | <1 | 330 | -- |
| | | 5/11/04 | -- | -- | <1 | <1 | 80 | <1 |
| | | 6/14/04 | <1 | <1 | <1 | <1 | 77 | <1 |
| | | 7/12/04 | -- | -- | <1 | <1 | 52 | <1 |
| | | 8/9/04 | <1 | <1 | <1 | <1 | 175 | <1 |
| | | 9/14/04 | <1 | <1 | <1 | <1 | 140 | <1 |
| 410315096190101 | Raw water | 10/15/02 | <1 | <1 | -- | -- | 34 | <1 |
| | | 11/20/02 | <1 | <1 | <1 | 1 | 160 | <1 |
| | | 12/9/02 | <1 | <1 | -- | -- | 120 | <1 |
| | | 1/21/03 | -- | -- | <1 | <1 | 40 | <1 |
| | | 2/18/03 | <1 | <1 | -- | -- | 70 | <1 |
| | | 3/18/03 | 4 | <1 | 1 | 1 | 90 | <1 |
| | | 4/1/03 | 1 | <1 | <1 | <1 | 70 | <1 |
| | | 4/15/03 | <1 | <1 | -- | -- | 30 | <1 |
| | | 5/13/03 | <1 | <1 | <1 | <1 | 20 | <1 |
| | | 5/27/03 | <1 | <1 | <1 | <1 | -- | -- |
| | | 6/17/03 | <1 | <1 | -- | -- | 40 | <1 |
| | | 6/30/03 | <1 | <1 | <1 | <1 | 51 | <1 |
| | | 8/19/03 | <1 | <1 | -- | -- | 65 | <1 |
| | | 9/16/03 | <1 | <1 | <1 | <1 | 930 | <1 |
| | | 10/21/03 | <1 | <1 | -- | -- | 6 | <1 |
| | | 11/11/03 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | 12/16/03 | <1 | <1 | -- | -- | 40 | <1 |

**Table 7**. Total coliform, *E. coli*, male-specific and somatic coliphage, aerobic spore, and enterococci concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | Total coliform | *E. coli* | Coliphages | | Aerobic spores | Enterococci |
|---|---|---|---|---|---|---|---|---|
| | | | | | Male-specific | Somatic | | |
| Units --> | | | cfu/100 mL | cfu/100 mL | pfu/100 mL | pfu/100 mL | cfu/100 mL | mpn/100 mL |
| 410315096190101 | Raw water | 1/13/04 | <1 | <1 | <1 | <1 | 15 | <1 |
| | | 2/10/04 | <1 | <1 | -- | -- | 30 | <1 |
| | | 3/16/04 | 4 | <1 | <1 | 1 | 83 | 1 |
| 410315096190102 | Finished water | 10/15/02 | <1 | <1 | -- | -- | 3 | <1 |
| | | 11/20/02 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | 12/9/02 | <1 | <1 | -- | -- | <1 | <1 |
| | | 1/21/03 | -- | -- | 1 | <1 | <1 | <1 |
| | | 2/18/03 | <1 | <1 | -- | -- | <1 | <1 |
| | | 3/18/03 | <1 | <1 | <1 | <1 | 3 | <1 |
| | | 4/1/03 | <1 | <1 | 1 | 1 | <1 | <1 |
| | | 4/15/03 | <1 | <1 | -- | -- | 4 | <1 |
| | | 5/13/03 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | 5/27/03 | <1 | <1 | <1 | <1 | -- | -- |
| | | 6/17/03 | <1 | <1 | -- | -- | 3 | <1 |
| | | 6/30/03 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | 8/19/03 | <1 | <1 | -- | -- | <1 | <1 |
| | | 9/16/03 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | 10/21/03 | <1 | <1 | -- | -- | <1 | <1 |
| | | 11/11/03 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | 12/16/03 | <1 | <1 | -- | -- | <1 | <1 |
| | | 1/13/04 | <1 | <1 | <1 | <1 | <1 | <1 |
| | | 2/10/04 | <1 | <1 | -- | -- | <1 | <1 |
| | | 3/16/04 | <1 | <1 | <1 | <1 | <1 | <1 |
| **Duplicates** | | | | | | | | |
| 06801000 | Platte River duplicate | 10/20/03 | -- | -- | <1 | 27 | -- | -- |
| 410322096191701 | W90-1H duplicate | 4/15/03 | -- | -- | <1 | <1 | -- | -- |
| | | 3/16/04 | -- | -- | <1 | 9 | -- | -- |
| 410315096190101 | Raw water duplicate | 5/13/03 | -- | -- | <1 | <1 | -- | -- |
| | | 1/13/04 | -- | -- | <1 | <1 | -- | -- |
| 410315096190102 | Finished water duplicate | 9/16/03 | -- | -- | <1 | <1 | -- | -- |
| **Equipment blank** | | | | | | | | |
| NA | Equipment blank | 6/18/03 | -- | -- | <1 | <1 | -- | -- |

**Table 8.** Summary statistics of microscopic particulate analysis concentrations in samples collected during riverbank filtration study, Platte River, Nebraska.

[Summary statistics are based on quantified concentrations; MDL, method detection limit; units are in organisms per 100 liters; n, number of samples; det, number of detections; max, maximum; med, median; std. dev., standard deviation; na, not applicable; x.xeyy, x.x times 10 raised to the yy power, for example, 2.5e10 is 2.5 times $10^{10}$]

| | 06801000 Platte River near Ashland | | | | | | 410322096191701 Well W90-1H | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | det | max | med | mean | std. dev. | n | det | max | med | mean | std. dev. |
| **MDL** | **15** | **15** | **1.5e08** | **1.7e05** | **1.1e07** | **3.8e07** | **14** | **14** | **5.2e06** | **7.6e00** | **3.7e05** | **1.4e06** |
| Non-diatomaceous algae | | | | | | | | | | | | |
| *Scendesmus* | 15 | 14 | 2.5e10 | 1.8e07 | 2.1e09 | 6.6e09 | 14 | 4 | 7.4e06 | 3.0e01 | 1.9e06 | 3.7e06 |
| *Selenastrum* | 15 | 2 | 6.5e08 | 5.5e08 | 5.5e08 | 1.4e08 | 14 | 0 | na | na | na | na |
| *Pediastrum* | 15 | 8 | 5.5e08 | 6.9e05 | 1.4e08 | 2.5e08 | 14 | 1 | 3.2e05 | 3.2e05 | 3.2e05 | na |
| *Phacus* | 15 | 0 | na | na | na | na | 14 | 2 | 1.6e02 | 9.6e01 | 9.6e01 | 8.6e01 |
| *Agmellum* | 15 | 6 | 3.1e10 | 1.3e08 | 5.4e09 | 1.3e10 | 14 | 0 | na | na | na | na |
| *Stichococcus* | 15 | 7 | 3.0e08 | 1.7e06 | 4.5e07 | 1.1e08 | 14 | 0 | na | na | na | na |
| Unclassified algae | 15 | 15 | 3.1e09 | 1.6e07 | 3.4e08 | 7.9e08 | 14 | 11 | 5.2e07 | 2.4e02 | 6.1e06 | 1.6e07 |
| Total non-diatoms | 15 | 15 | 5.9e10 | 2.7e07 | 4.6e09 | 1.5e10 | 14 | 12 | 5.2e07 | 2.1e02 | 6.3e06 | 1.6e07 |
| Diatoms | | | | | | | | | | | | |
| *Fragilaria* | 15 | 4 | 2.2e08 | 7.6e07 | 9.3e07 | 1.1e08 | 14 | 0 | na | na | na | na |
| *Tabellaria* | 15 | 7 | 1.7e08 | 2.2e06 | 3.6e07 | 6.3e07 | 14 | 1 | 2.2e06 | 2.2e06 | 2.2e06 | na |
| *Asterionella* | 15 | 6 | 3.1e09 | 3.4e06 | 5.3e08 | 1.3e09 | 14 | 0 | na | na | na | na |
| *Navicula* | 15 | 9 | 2.3e08 | 1.7e06 | 3.0e07 | 7.5e07 | 14 | 0 | na | na | na | na |
| Unclassified diatoms | 15 | 9 | 8.5e08 | 3.5e06 | 1.2e08 | 2.8e08 | 14 | 2 | 3.5e06 | 1.8e06 | 1.8e06 | 2.5e06 |
| Total diatoms | 15 | 15 | 3.1e09 | 1.4e07 | 3.4e08 | 8.1e08 | 14 | 2 | 5.7e06 | 2.9e06 | 2.9e06 | 4.0e06 |
| Other | | | | | | | | | | | | |
| Rotifers | 15 | 0 | na | na | na | na | 14 | 3 | 1.6e02 | 6.9e00 | 5.8e01 | 8.9e01 |
| Amoeba | 15 | 3 | 3.5e07 | 1.7e05 | 1.2e07 | 2.0e07 | 14 | 3 | 4.0e01 | 1.8e01 | 2.2e01 | 1.7e01 |
| Nematodes | 15 | 0 | na | na | na | na | 14 | 4 | 3.1e01 | 1.5e01 | 1.7e01 | 1.1e01 |
| Flagellates | 15 | 0 | na | na | na | na | 14 | 0 | na | na | na | na |
| Pollen | 15 | 0 | na | na | na | na | 14 | 1 | 6.0e00 | 6.0e00 | 6.0e00 | na |

**Table 8.** Summary statistics of microscopic particulate analysis concentrations in samples collected during riverbank filtration study, Platte River, Nebraska.—Continued

| | 410315096190101 Raw water | | | | | | 410315096190102 Finished water | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | det | max | med | mean | std. dev. | n | det | max | med | mean | std. dev. |
| **MDL** | **7** | **7** | **6.0e01** | **2.2e00** | **1.0e01** | **2.2e01** | **4** | **4** | **1.5e03** | **1.0e01** | **3.8e02** | **7.5e02** |
| Non-diatomaceous algae | | | | | | | | | | | | |
| *Scendesmus* | 7 | 2 | 2.2e01 | 1.3e01 | 1.3e01 | 1.3e01 | 4 | 0 | na | na | na | na |
| *Selenastrum* | 7 | 0 | na | na | na | na | 4 | 0 | na | na | na | na |
| *Pediastrum* | 7 | 1 | 4.0e00 | 4.0e00 | 4.0e00 | na | 4 | 0 | na | na | na | na |
| *Phacus* | 7 | 0 | na | na | na | na | 4 | 0 | na | na | na | na |
| *Agmellum* | 7 | 0 | na | na | na | na | 4 | 0 | na | na | na | na |
| *Stichococcus* | 7 | 0 | na | na | na | na | 4 | 0 | na | na | na | na |
| Unclassified algae | 7 | 3 | 7.5e01 | 2.2e01 | 3.3e01 | 3.8e01 | 4 | 1 | 4.0e01 | 4.0e01 | 4.0e01 | na |
| Total non-diatoms | 7 | 5 | 7.5e01 | 2.2e01 | 2.6e01 | 3.0e01 | 4 | 1 | 4.0e01 | 4.0e01 | 4.0e01 | na |
| Diatoms | | | | | | | | | | | | |
| *Fragilaria* | 7 | 0 | na | na | na | na | 4 | 0 | na | na | na | na |
| *Tabellaria* | 7 | 0 | na | na | na | na | 4 | 0 | na | na | na | na |
| *Asterionella* | 7 | 0 | na | na | na | na | 4 | 0 | na | na | na | na |
| *Navicula* | 7 | 0 | na | na | na | na | 4 | 0 | na | na | na | na |
| Unclassified diatoms | 7 | 1 | 2.0e00 | 2.0e00 | 2.0e00 | na | 4 | 0 | na | na | na | na |
| Total diatoms | 7 | 1 | 2.0e00 | 2.0e00 | 2.0e00 | na | 4 | 0 | na | na | na | na |
| Other | | | | | | | | | | | | |
| Rotifers | 7 | 3 | 1.8e02 | 1.8e02 | 1.2e02 | 1.0e02 | 4 | 0 | na | na | na | na |
| Amoeba | 7 | 2 | 6.0e01 | 3.5e01 | 3.5e01 | 3.5e01 | 4 | 0 | na | na | na | na |
| Nematodes | 7 | 5 | 5.5e01 | 1.7e01 | 2.5e01 | 1.9e01 | 4 | 0 | na | na | na | na |
| Flagellates | 7 | 1 | 3.0e01 | 3.0e01 | 3.0e01 | na | 4 | 0 | na | na | na | na |
| Pollen | 7 | 2 | 3.5e01 | 1.9e01 | 1.9e01 | 2.3e01 | 4 | 0 | na | na | na | na |

**Table 9.** Microscopic particulate analysis concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.

[MDL, method detection limit; L, liter; unclass., unclassified; --, not measured or not applicable; <, less than; m, organism detected but not quantified; large amorphous debris is greater than 5 micrometers in diameter; fine amorphous debris is 1 to 5 micrometers in diameter; NA, not applicable; —, no comments; x.xE+y, x.x times 10 raised to the y power, for example, 2.0E+1 is 2.0 times $10^1$]

| Site identification | Station name | Date | MDL | *Scendesmus* | *Selenastrum* | *Pediastrum* | *Phacus* |
|---|---|---|---|---|---|---|---|
| **Units -->** | | | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** |
| | | | Non-diatomaceous algae | | | | |
| 06801000 | Platte River near Ashland | 10/15/02 | -- | -- | -- | -- | -- |
| | | 11/19/02 | 2.0E+1 | 8.7E+8 | 6.5E+8 | 5.4E+8 | <MDL |
| | | 12/9/02 | -- | -- | -- | -- | -- |
| | | 1/21/03 | 1.0E+7 | 2.0E+8 | 4.5E+8 | 5.5E+8 | <MDL |
| | | 2/18/03 | -- | -- | -- | -- | -- |
| | | 3/17/03 | 1.5E+5 | 1.5E+6 | <MDL | <MDL | <MDL |
| | | 3/24/03 | 3.5E+5 | 3.5E+6 | <MDL | 7.0E+5 | <MDL |
| | | 4/14/03 | 1.5E+8 | 9.1E+8 | <MDL | <MDL | <MDL |
| | | 5/12/03 | 1.7E+6 | <MDL | <MDL | <MDL | <MDL |
| | | 5/20/03 | 2.3E+6 | 2.5E+7 | <MDL | <MDL | <MDL |
| | | 6/16/03 | 2.6E+6 | 1.0E+8 | <MDL | 2.5E+6 | <MDL |
| | | 6/29/03 | 1.3E+5 | 1.0E+7 | <MDL | 2.6E+5 | <MDL |
| | | 8/18/03 | 1.3E+6 | 2.5E+10 | <MDL | <MDL | <MDL |
| | | 9/15/03 | 1.3E+5 | 1.9E+9 | <MDL | <MDL | <MDL |
| | | 10/20/03 | -- | -- | -- | -- | -- |
| | | 11/5/03 | 1.7E+5 | 4.4E+6 | <MDL | 6.8E+5 | <MDL |
| | | 11/10/03 | 1.6E+5 | 7.4E+6 | <MDL | 3.2E+5 | <MDL |
| | | 12/15/03 | -- | -- | -- | -- | -- |
| | | 1/12/04 | 1.4E+4 | 5.1E+5 | <MDL | 3.0E+4 | <MDL |
| | | 2/9/04 | -- | -- | -- | -- | -- |
| | | 3/15/04 | 3.5E+4 | 4.2E+4 | <MDL | <MDL | <MDL |
| | | 4/19/04 | -- | -- | -- | -- | -- |
| | | 5/10/04 | -- | -- | -- | -- | -- |
| | | 6/14/04 | -- | -- | -- | -- | -- |
| | | 7/12/04 | -- | -- | -- | -- | -- |
| | | 8/9/04 | -- | -- | -- | -- | -- |
| | | 9/14/04 | -- | -- | -- | -- | -- |
| 410322096191701 | W90-1H | 10/15/02 | -- | -- | -- | -- | -- |
| | | 11/20/02 | 6.0E+1 | <MDL | <MDL | <MDL | <MDL |
| | | 12/9/02 | -- | -- | -- | -- | -- |
| | | 1/21/03 | 1.4E+1 | <MDL | <MDL | <MDL | <MDL |
| | | 2/18/03 | -- | -- | -- | -- | -- |
| | | 3/18/03 | 5.2E+6 | <MDL | <MDL | <MDL | <MDL |
| | | 4/1/03 | 6.5E+3 | <MDL | <MDL | <MDL | <MDL |
| | | 4/15/03 | 3.5E+0 | <MDL | <MDL | <MDL | <MDL |
| | | 5/13/03 | 3.9E+0 | <MDL | <MDL | <MDL | 3.5E+1 |

**Table 9.** Microscopic particulate analysis concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | MDL | *Scendesmus* | *Selenastrum* | *Pediastrum* | *Phacus* |
|---|---|---|---|---|---|---|---|
| Units --> | | | per 100 L | per 100 L | per 100 L | per 100 L | per 100 L |
| | | | Non-diatomaceous algae | | | | |
| 410322096191701 | W90-1H | 5/27/03 | 3.0E+0 | 6.0E+0 | <MDL | <MDL | 1.6E+2 |
| | | 6/17/03 | 4.5E+0 | <MDL | <MDL | <MDL | <MDL |
| | | 6/30/03 | 3.0E+0 | 1.2E+1 | <MDL | <MDL | <MDL |
| | | 8/19/03 | 9.2E+0 | <MDL | <MDL | <MDL | <MDL |
| | | 9/16/03 | 6.0E+0 | 4.8E+1 | <MDL | <MDL | <MDL |
| | | 10/21/03 | -- | -- | -- | -- | -- |
| | | 11/11/03 | 2.0E+1 | 7.4E+6 | <MDL | 3.2E+5 | <MDL |
| | | 12/16/03 | -- | -- | -- | -- | -- |
| | | 1/13/04 | 3.0E+0 | <MDL | <MDL | <MDL | <MDL |
| | | 2/10/04 | -- | -- | -- | -- | -- |
| | | 3/16/04 | 3.0E+2 | <MDL | <MDL | <MDL | <MDL |
| | | 4/20/04 | -- | -- | -- | -- | -- |
| | | 5/11/04 | -- | -- | -- | -- | -- |
| | | 6/14/04 | -- | -- | -- | -- | -- |
| | | 7/12/04 | -- | -- | -- | -- | -- |
| | | 8/9/04 | -- | -- | -- | -- | -- |
| | | 9/14/04 | -- | -- | -- | -- | -- |
| 410315096190101 | Raw water | 10/15/02 | -- | -- | -- | -- | -- |
| | | 11/20/02 | 6.0E+1 | <MDL | <MDL | <MDL | <MDL |
| | | 12/9/02 | -- | -- | -- | -- | -- |
| | | 1/21/03 | -- | -- | -- | -- | -- |
| | | 2/18/03 | -- | -- | -- | -- | -- |
| | | 3/18/03 | -- | -- | -- | -- | -- |
| | | 4/1/03 | -- | -- | -- | -- | -- |
| | | 4/15/03 | 2.5E+0 | <MDL | <MDL | <MDL | <MDL |
| | | 5/13/03 | 2.2E+0 | <MDL | <MDL | <MDL | <MDL |
| | | 5/27/03 | -- | -- | -- | -- | -- |
| | | 6/17/03 | 4.5E+0 | <MDL | <MDL | <MDL | <MDL |
| | | 6/30/03 | 2.0E+0 | 2.2E+1 | <MDL | 4.0E+0 | <MDL |
| | | 8/19/03 | 1.0E+0 | 3.0E+0 | <MDL | <MDL | <MDL |
| | | 9/16/03 | -- | -- | -- | -- | -- |
| | | 10/21/03 | -- | -- | -- | -- | -- |
| | | 11/11/03 | 1.0E+0 | <MDL | <MDL | <MDL | <MDL |
| | | 12/16/03 | -- | -- | -- | -- | -- |
| | | 1/13/04 | -- | -- | -- | -- | -- |

**Table 9.** Microscopic particulate analysis concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | MDL | *Scendesmus* | *Selenastrum* | *Pediastrum* | *Phacus* |
|---|---|---|---|---|---|---|---|
| **Units -->** | | | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** |
| | | | Non-diatomaceous algae | | | | |
| 410315096190101 | Raw water | 2/10/04 | -- | -- | -- | -- | -- |
| | | 3/16/04 | -- | -- | -- | -- | -- |
| 410315096190102 | Finished water | 10/15/02 | -- | -- | -- | -- | -- |
| | | 11/20/02 | 1.0E+1 | <MDL | <MDL | <MDL | <MDL |
| | | 12/9/02 | -- | -- | -- | -- | -- |
| | | 1/21/03 | -- | -- | -- | -- | -- |
| | | 2/18/03 | -- | -- | -- | -- | -- |
| | | 3/18/03 | -- | -- | -- | -- | -- |
| | | 4/1/03 | 1.5E+3 | <MDL | <MDL | <MDL | <MDL |
| | | 4/15/03 | -- | -- | -- | -- | -- |
| | | 5/13/03 | 1.3E+0 | <MDL | <MDL | <MDL | <MDL |
| | | 5/27/03 | -- | -- | -- | -- | -- |
| | | 6/17/03 | -- | -- | -- | -- | -- |
| | | 6/30/03 | -- | -- | -- | -- | -- |
| | | 8/19/03 | -- | -- | -- | -- | -- |
| | | 9/16/03 | -- | -- | -- | -- | -- |
| | | 10/21/03 | -- | -- | -- | -- | -- |
| | | 11/11/03 | 1.0E+1 | <MDL | <MDL | <MDL | <MDL |
| | | 12/16/03 | -- | -- | -- | -- | -- |
| | | 1/13/04 | -- | -- | -- | -- | -- |
| | | 2/10/04 | -- | -- | -- | -- | -- |
| | | 3/16/04 | -- | -- | -- | -- | -- |
| **Duplicates** | | | | | | | |
| 410322096191701 | W90-1H duplicate | 3/18/03 | 5.2E+6 | <MDL | <MDL | <MDL | <MDL |
| 410315096190101 | Raw water duplicate | 5/13/03 | 2.0E+0 | <MDL | <MDL | <MDL | <MDL |
| **Equipment blank** | | | | | | | |
| NA | Equipment blank | 1/21/03 | 1.3E+3 | <MDL | <MDL | <MDL | <MDL |

**Table 9.** Microscopic particulate analysis concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | *Agmellum* | *Stichococcus* | Unclassified algae | Total non-diatoms |
|---|---|---|---|---|---|---|
| **Units -->** | | | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** |
| | | | Non-diatomaceous algae | | | |
| 06801000 | Platte River near Ashland | 10/15/02 | -- | -- | -- | -- |
| | | 11/19/02 | <MDL | <MDL | 5.4E+8 | 2.6E+9 |
| | | 12/9/02 | -- | -- | -- | -- |
| | | 1/21/03 | 2.5E+8 | <MDL | 5.5E+8 | 2.0E+9 |
| | | 2/18/03 | -- | -- | -- | -- |
| | | 3/17/03 | 4.5E+5 | 4.5E+5 | 6.0E+6 | 8.4E+6 |
| | | 3/24/03 | <MDL | 7.0E+5 | 6.6E+6 | 1.2E+7 |
| | | 4/14/03 | <MDL | 3.0E+8 | 3.0E+8 | 1.5E+9 |
| | | 5/12/03 | <MDL | <MDL | 3.4E+6 | 3.4E+6 |
| | | 5/20/03 | <MDL | 6.9E+6 | 4.4E+7 | 7.6E+7 |
| | | 6/16/03 | <MDL | 5.0E+6 | 3.3E+8 | 4.4E+8 |
| | | 6/29/03 | <MDL | 1.0E+6 | 1.6E+7 | 2.7E+7 |
| | | 8/18/03 | 3.1E+10 | <MDL | 3.1E+9 | 5.9E+10 |
| | | 9/15/03 | 8.9E+8 | <MDL | 1.9E+8 | 3.0E+9 |
| | | 10/20/03 | -- | -- | -- | -- |
| | | 11/5/03 | <MDL | 1.7E+6 | 5.1E+6 | 1.2E+7 |
| | | 11/10/03 | <MDL | <MDL | 1.5E+7 | 2.3E+7 |
| | | 12/15/03 | -- | -- | -- | -- |
| | | 1/12/04 | 3.0E+4 | <MDL | 6.9E+5 | 1.3E+6 |
| | | 2/9/04 | -- | -- | -- | -- |
| | | 3/15/04 | 7.0E+4 | <MDL | 3.5E+5 | 4.6E+5 |
| | | 4/19/04 | -- | -- | -- | -- |
| | | 5/10/04 | -- | -- | -- | -- |
| | | 6/14/04 | -- | -- | -- | -- |
| | | 7/12/04 | -- | -- | -- | -- |
| | | 8/9/04 | -- | -- | -- | -- |
| | | 9/14/04 | -- | -- | -- | -- |
| 410322096191701 | W90-1H | 10/15/02 | -- | -- | -- | -- |
| | | 11/20/02 | <MDL | <MDL | <MDL | <MDL |
| | | 12/9/02 | -- | -- | -- | -- |
| | | 1/21/03 | <MDL | <MDL | <MDL | <MDL |
| | | 2/18/03 | -- | -- | -- | -- |
| | | 3/18/03 | <MDL | <MDL | 5.2E+7 | 5.2E+7 |
| | | 4/1/03 | <MDL | <MDL | 5.6E+5 | 5.6E+5 |
| | | 4/15/03 | <MDL | <MDL | 1.9E+2 | 1.9E+2 |
| | | 5/13/03 | <MDL | <MDL | 5.9E+1 | 9.4E+1 |

**Table 9.** Microscopic particulate analysis concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | *Agmellum* | *Stichococcus* | Unclassified algae | Total non-diatoms |
|---|---|---|---|---|---|---|
| **Units -->** | | | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** |
| | | | Non-diatomaceous algae | | | |
| 410322096191701 | W90-1H | 5/27/03 | <MDL | <MDL | 4.5E+2 | 6.2E+2 |
| | | 6/17/03 | <MDL | <MDL | 9.0E+0 | 9.0E+0 |
| | | 6/30/03 | <MDL | <MDL | 3.6E+1 | 4.8E+1 |
| | | 8/19/03 | <MDL | <MDL | 2.4E+2 | 2.4E+2 |
| | | 9/16/03 | <MDL | <MDL | <MDL | 4.8E+1 |
| | | 10/21/03 | -- | -- | -- | -- |
| | | 11/11/03 | <MDL | <MDL | 1.5E+7 | 2.3E+7 |
| | | 12/16/03 | -- | -- | -- | -- |
| | | 1/13/04 | <MDL | <MDL | 3.0E+0 | 3.0E+0 |
| | | 2/10/04 | -- | -- | -- | -- |
| | | 3/16/04 | <MDL | <MDL | 3.0E+4 | 3.0E+4 |
| | | 4/20/04 | -- | -- | -- | -- |
| | | 5/11/04 | -- | -- | -- | -- |
| | | 6/14/04 | -- | -- | -- | -- |
| | | 7/12/04 | -- | -- | -- | -- |
| | | 8/9/04 | -- | -- | -- | -- |
| | | 9/14/04 | -- | -- | -- | -- |
| 410315096190101 | Raw water | 10/15/02 | <MDL | -- | -- | -- |
| | | 11/20/02 | -- | <MDL | <MDL | <MDL |
| | | 12/9/02 | -- | -- | -- | -- |
| | | 1/21/03 | -- | -- | -- | -- |
| | | 2/18/03 | -- | -- | -- | -- |
| | | 3/18/03 | -- | -- | -- | -- |
| | | 4/1/03 | <MDL | -- | -- | -- |
| | | 4/15/03 | <MDL | <MDL | 7.5E+1 | 7.5E+1 |
| | | 5/13/03 | -- | <MDL | 2.2E+1 | 2.2E+1 |
| | | 5/27/03 | <MDL | -- | -- | -- |
| | | 6/17/03 | <MDL | <MDL | <MDL | <MDL |
| | | 6/30/03 | <MDL | <MDL | <MDL | 2.6E+1 |
| | | 8/19/03 | -- | <MDL | <MDL | 3.0E+0 |
| | | 9/16/03 | -- | -- | -- | -- |
| | | 10/21/03 | <MDL | -- | -- | -- |
| | | 11/11/03 | -- | <MDL | 2.0E+0 | 2.0E+0 |
| | | 12/16/03 | -- | -- | -- | -- |

**Table 9.** Microscopic particulate analysis concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | *Agmellum* | *Stichococcus* | Unclassified algae | Total non-diatoms |
|---|---|---|---|---|---|---|
| **Units -->** | | | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** |
| | | | Non-diatomaceous algae | | | |
| 410315096190101 | Raw water | 1/13/04 | | -- | -- | -- |
| | | 2/10/04 | -- | -- | -- | -- |
| | | 3/16/04 | -- | -- | -- | -- |
| 410315096190102 | Finished water | 10/15/02 | -- | -- | -- | -- |
| | | 11/20/02 | <MDL | <MDL | 4.0E+1 | 4.0E+1 |
| | | 12/9/02 | -- | -- | -- | -- |
| | | 1/21/03 | -- | -- | -- | -- |
| | | 2/18/03 | -- | -- | -- | -- |
| | | 3/18/03 | -- | -- | -- | -- |
| | | 4/1/03 | <MDL | <MDL | <MDL | <MDL |
| | | 4/15/03 | -- | -- | -- | -- |
| | | 5/13/03 | <MDL | <MDL | <MDL | <MDL |
| | | 5/27/03 | -- | -- | -- | -- |
| | | 6/17/03 | -- | -- | -- | -- |
| | | 6/30/03 | -- | -- | -- | -- |
| | | 8/19/03 | -- | -- | -- | -- |
| | | 9/16/03 | -- | -- | -- | -- |
| | | 10/21/03 | -- | -- | -- | -- |
| | | 11/11/03 | <MDL | <MDL | <MDL | <MDL |
| | | 12/16/03 | -- | -- | -- | -- |
| | | 1/13/04 | -- | -- | -- | -- |
| | | 2/10/04 | -- | -- | -- | -- |
| | | 3/16/04 | -- | -- | -- | -- |
| **Duplicates** | | | | | | |
| 410322096191701 | W90-1H duplicate | 3/18/03 | <MDL | <MDL | 3.8E+05 | 3.8E+05 |
| 410315096190101 | Raw water duplicate | 5/13/03 | <MDL | <MDL | 1.1E+02 | 1.1E+02 |
| **Equipment blank** | | | | | | |
| NA | Equipment blank | 1/21/03 | <MDL | <MDL | <MDL | 0.0E+00 |

**Table 9.** Microscopic particulate analysis concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | *Fragilaria* | *Tabellaria* | *Asterionella* | *Navicula* | Un-classified diatoms | Total diatoms |
|---|---|---|---|---|---|---|---|---|
| **Units -->** | | | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** |
| | | | | | Diatoms | | | |
| 06801000 | Platte River near Ashland | 10/15/02 | -- | -- | -- | -- | -- | -- |
| | | 11/19/02 | 2.2E+08 | 1.7E+08 | 8.2E+07 | <MDL | 1.9E+08 | 6.6E+08 |
| | | 12/9/02 | -- | -- | -- | -- | -- | -- |
| | | 1/21/03 | 1.5E+08 | 6.0E+07 | <MDL | <MDL | 2.0E+07 | 2.3E+08 |
| | | 2/18/03 | -- | -- | -- | -- | -- | -- |
| | | 3/17/03 | 7.5E+05 | 1.5E+06 | <MDL | 2.3E+06 | <MDL | 4.5E+06 |
| | | 3/24/03 | 1.7E+06 | 7.0E+05 | <MDL | 1.4E+06 | 1.4E+06 | 5.2E+06 |
| | | 4/14/03 | <MDL | <MDL | <MDL | 2.3E+08 | <MDL | 2.3E+08 |
| | | 5/12/03 | <MDL | <MDL | <MDL | 1.7E+06 | <MDL | 1.7E+06 |
| | | 5/20/03 | <MDL | <MDL | <MDL | 1.6E+07 | <MDL | 1.6E+07 |
| | | 6/16/03 | <MDL | 1.5E+07 | 6.6E+06 | 1.6E+07 | <MDL | 3.8E+07 |
| | | 6/29/03 | <MDL | 5.2E+05 | <MDL | 7.8E+05 | 1.3E+07 | 1.4E+07 |
| | | 8/18/03 | <MDL | <MDL | 3.1E+09 | <MDL | <MDL | 3.1E+09 |
| | | 9/15/03 | <MDL | <MDL | <MDL | <MDL | 8.5E+08 | 8.5E+08 |
| | | 10/20/03 | -- | -- | -- | -- | -- | -- |
| | | 11/5/03 | <MDL | <MDL | 1.7E+05 | <MDL | 2.7E+06 | 2.9E+06 |
| | | 11/10/03 | <MDL | 2.2E+06 | <MDL | <MDL | 3.5E+06 | 5.7E+06 |
| | | 12/15/03 | -- | -- | -- | -- | -- | -- |
| | | 1/12/04 | <MDL | <MDL | 1.5E+04 | 6.0E+04 | 7.5E+04 | 1.5E+05 |
| | | 2/9/04 | -- | -- | -- | -- | -- | -- |
| | | 3/15/04 | <MDL | <MDL | 1.4E+05 | 1.4E+05 | 3.5E+05 | 6.3E+05 |
| | | 4/19/04 | -- | -- | -- | -- | -- | -- |
| | | 5/10/04 | -- | -- | -- | -- | -- | -- |
| | | 6/14/04 | -- | -- | -- | -- | -- | -- |
| | | 7/12/04 | -- | -- | -- | -- | -- | -- |
| | | 8/9/04 | -- | -- | -- | -- | -- | -- |
| | | 9/14/04 | -- | -- | -- | -- | -- | -- |
| 410322096191701 | W90-1H | 10/15/02 | -- | -- | -- | -- | -- | -- |
| | | 11/20/02 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 12/9/02 | -- | -- | -- | -- | -- | -- |
| | | 1/21/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 2/18/03 | -- | -- | -- | -- | -- | -- |
| | | 3/18/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 4/1/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 4/15/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 5/13/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 5/27/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 6/17/03 | <MDL | <MDL | <MDL | <MDL | 4.5E+00 | 4.5E+00 |

**Table 9.** Microscopic particulate analysis concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | *Fragilaria* | *Tabellaria* | *Asterionella* | *Navicula* | Un-classified diatoms | Total diatoms |
|---|---|---|---|---|---|---|---|---|
| **Units -->** | | | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** |
| | | | | | Diatoms | | | |
| 410322096191701 | W90-1H | 6/30/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 8/19/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 9/16/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 10/21/03 | -- | -- | -- | -- | -- | -- |
| | | 11/11/03 | <MDL | 2.2E+06 | <MDL | <MDL | 3.5E+06 | 5.7E+06 |
| | | 12/16/03 | -- | -- | -- | -- | -- | -- |
| | | 1/13/04 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 2/10/04 | -- | -- | -- | -- | -- | -- |
| | | 3/16/04 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 4/20/04 | -- | -- | -- | -- | -- | -- |
| | | 5/11/04 | -- | -- | -- | -- | -- | -- |
| | | 6/14/04 | -- | -- | -- | -- | -- | -- |
| | | 7/12/04 | -- | -- | -- | -- | -- | -- |
| | | 8/9/04 | -- | -- | -- | -- | -- | -- |
| | | 9/14/04 | -- | -- | -- | -- | -- | -- |
| 410315096190101 | Raw water | 10/15/02 | -- | -- | -- | -- | -- | -- |
| | | 11/20/02 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 12/9/02 | -- | -- | -- | -- | -- | -- |
| | | 1/21/03 | -- | -- | -- | -- | -- | -- |
| | | 2/18/03 | -- | -- | -- | -- | -- | -- |
| | | 3/18/03 | -- | -- | -- | -- | -- | -- |
| | | 4/1/03 | -- | -- | -- | -- | -- | -- |
| | | 4/15/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 5/13/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 5/27/03 | -- | -- | -- | -- | -- | -- |
| | | 6/17/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 6/30/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 8/19/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 9/16/03 | -- | -- | -- | -- | -- | -- |
| | | 10/21/03 | -- | -- | -- | -- | -- | -- |
| | | 11/11/03 | <MDL | <MDL | <MDL | <MDL | 2.0E+00 | 2.0E+00 |
| | | 12/16/03 | -- | -- | -- | -- | -- | -- |
| | | 1/13/04 | -- | -- | -- | -- | -- | -- |
| | | 2/10/04 | -- | -- | -- | -- | -- | -- |
| | | 3/16/04 | -- | -- | -- | -- | -- | -- |

**Table 9.** Microscopic particulate analysis concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | *Fragilaria* | *Tabellaria* | *Asterionella* | *Navicula* | Un-classified diatoms | Total diatoms |
|---|---|---|---|---|---|---|---|---|
| **Units -->** | | | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** |
| | | | Diatoms | | | | | |
| 410315096190102 | Finished water | 10/15/02 | -- | -- | -- | -- | -- | -- |
| | | 11/20/02 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 12/9/02 | -- | -- | -- | -- | -- | -- |
| | | 1/21/03 | -- | -- | -- | -- | -- | -- |
| | | 2/18/03 | -- | -- | -- | -- | -- | -- |
| | | 3/18/03 | -- | -- | -- | -- | -- | -- |
| | | 4/1/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 4/15/03 | -- | -- | -- | -- | -- | -- |
| | | 5/13/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 5/27/03 | -- | -- | -- | -- | -- | -- |
| | | 6/17/03 | -- | -- | -- | -- | -- | -- |
| | | 6/30/03 | -- | -- | -- | -- | -- | -- |
| | | 8/19/03 | -- | -- | -- | -- | -- | -- |
| | | 9/16/03 | -- | -- | -- | -- | -- | -- |
| | | 10/21/03 | -- | -- | -- | -- | -- | -- |
| | | 11/11/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 12/16/03 | -- | -- | -- | -- | -- | -- |
| | | 1/13/04 | -- | -- | -- | -- | -- | -- |
| | | 2/10/04 | -- | -- | -- | -- | -- | -- |
| | | 3/16/04 | -- | -- | -- | -- | -- | -- |
| **Duplicates** | | | | | | | | |
| 410322096191701 | W90-1H duplicate | 3/18/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| 410315096190101 | Raw water duplicate | 5/13/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| **Equipment blank** | | | | | | | | |
| NA | Equipment blank | 1/21/03 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |

**Table 9.** Microscopic particulate analysis concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | Rotifers | Amoeba | Nematodes | Flagellates | Pollen |
|---|---|---|---|---|---|---|---|
| **Units -->** | | | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** |
| | | | Other | | | | |
| 06801000 | Platte River near Ashland | 10/15/02 | -- | -- | -- | -- | -- |
| | | 11/19/02 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 12/9/02 | -- | -- | -- | -- | -- |
| | | 1/21/03 | <MDL | 1.0E+04 | <MDL | <MDL | <MDL |
| | | 2/18/03 | -- | -- | -- | -- | -- |
| | | 3/17/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 3/24/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 4/14/03 | <MDL | 3.5E+07 | <MDL | <MDL | <MDL |
| | | 5/12/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 5/20/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 6/16/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 6/29/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 8/18/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 9/15/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 10/20/03 | -- | -- | -- | -- | -- |
| | | 11/5/03 | <MDL | 1.7E+05 | <MDL | <MDL | <MDL |
| | | 11/10/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 12/15/03 | -- | -- | -- | -- | -- |
| | | 1/12/04 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 2/9/04 | -- | -- | -- | -- | -- |
| | | 3/15/04 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 4/19/04 | -- | -- | -- | -- | -- |
| | | 5/10/04 | -- | -- | -- | -- | -- |
| | | 6/14/04 | -- | -- | -- | -- | -- |
| | | 7/12/04 | -- | -- | -- | -- | -- |
| | | 8/9/04 | -- | -- | -- | -- | -- |
| | | 9/14/04 | -- | -- | -- | -- | -- |
| 410322096191701 | W90-1H | 10/15/02 | -- | -- | -- | -- | -- |
| | | 11/20/02 | 1.6E+02 | 4.0E+01 | <MDL | <MDL | <MDL |
| | | 12/9/02 | -- | -- | -- | -- | -- |
| | | 1/21/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 2/18/03 | -- | -- | -- | -- | -- |
| | | 3/18/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 4/1/03 | <MDL | m | <MDL | m | <MDL |
| | | 4/15/03 | 6.9E+00 | 6.9E+00 | <MDL | <MDL | <MDL |
| | | 5/13/03 | <MDL | <MDL | 3.1E+01 | <MDL | <MDL |
| | | 5/27/03 | <MDL | <MDL | 6.0E+00 | <MDL | <MDL |
| | | 6/17/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 6/30/03 | <MDL | <MDL | 1.2E+01 | <MDL | 6.0E+00 |

**Table 9.** Microscopic particulate analysis concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | Rotifers | Amoeba | Nematodes | Flagellates | Pollen |
|---|---|---|---|---|---|---|---|
| Units --> | | | per 100 L | per 100 L | per 100 L | per 100 L | per 100 L |
| 410322096191701 | W90-1H | 8/19/03 | <MDL | 1.8E+01 | 1.8E+01 | <MDL | <MDL |
| | | 9/16/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 10/21/03 | -- | -- | -- | -- | -- |
| | | 11/11/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 12/16/03 | -- | -- | -- | -- | -- |
| | | 1/13/04 | 6.0E+00 | <MDL | <MDL | <MDL | <MDL |
| | | 2/10/04 | -- | -- | -- | -- | -- |
| | | 3/16/04 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 4/20/04 | -- | -- | -- | -- | -- |
| | | 5/11/04 | -- | -- | -- | -- | -- |
| | | 6/14/04 | -- | -- | -- | -- | -- |
| | | 7/12/04 | -- | -- | -- | -- | -- |
| | | 8/9/04 | -- | -- | -- | -- | -- |
| | | 9/14/04 | -- | -- | -- | -- | -- |
| 410315096190101 | Raw water | 10/15/02 | -- | -- | -- | -- | -- |
| | | 11/20/02 | 1.8E+02 | 6.0E+01 | 3.0E+01 | 3.0E+01 | <MDL |
| | | 12/9/02 | -- | -- | -- | -- | -- |
| | | 1/21/03 | -- | -- | -- | -- | -- |
| | | 2/18/03 | -- | -- | -- | -- | -- |
| | | 3/18/03 | -- | -- | -- | -- | -- |
| | | 4/1/03 | -- | -- | -- | -- | -- |
| | | 4/15/03 | 1.8E+02 | 1.0E+01 | 5.5E+01 | <MDL | <MDL |
| | | 5/13/03 | <MDL | <MDL | 1.7E+01 | <MDL | 3.5E+01 |
| | | 5/27/03 | -- | -- | -- | -- | -- |
| | | 6/17/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 6/30/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 8/19/03 | <MDL | <MDL | 1.6E+01 | <MDL | 3.0E+00 |
| | | 9/16/03 | -- | -- | -- | -- | -- |
| | | 10/21/03 | -- | -- | -- | -- | -- |
| | | 11/11/03 | 2.0E+00 | <MDL | 6.0E+00 | <MDL | <MDL |
| | | 12/16/03 | -- | -- | -- | -- | -- |
| | | 1/13/04 | -- | -- | -- | -- | -- |
| | | 2/10/04 | -- | -- | -- | -- | -- |
| | | 3/16/04 | -- | -- | -- | -- | -- |

**Table 9.** Microscopic particulate analysis concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | Rotifers | Amoeba | Nematodes | Flagellates | Pollen |
|---|---|---|---|---|---|---|---|
| **Units -->** | | | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** | **per 100 L** |
| 410315096190102 | Finished water | 10/15/02 | -- | -- | -- | -- | -- |
| | | 11/20/02 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 12/9/02 | -- | -- | -- | -- | -- |
| | | 1/21/03 | -- | -- | -- | -- | -- |
| | | 2/18/03 | -- | -- | -- | -- | -- |
| | | 3/18/03 | -- | -- | -- | -- | -- |
| | | 4/1/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 4/15/03 | -- | -- | -- | -- | -- |
| | | 5/13/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 5/27/03 | -- | -- | -- | -- | -- |
| | | 6/17/03 | -- | -- | -- | -- | -- |
| | | 6/30/03 | -- | -- | -- | -- | -- |
| | | 8/19/03 | -- | -- | -- | -- | -- |
| | | 9/16/03 | -- | -- | -- | -- | -- |
| | | 10/21/03 | -- | -- | -- | -- | -- |
| | | 11/11/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| | | 12/16/03 | -- | -- | -- | -- | -- |
| | | 1/13/04 | -- | -- | -- | -- | -- |
| | | 2/10/04 | -- | -- | -- | -- | -- |
| | | 3/16/04 | -- | -- | -- | -- | -- |
| **Duplicates** | | | | | | | |
| 410322096191701 | W90-1H duplicate | 3/18/03 | <MDL | <MDL | <MDL | <MDL | <MDL |
| 410315096190101 | Raw water duplicate | 5/13/03 | 1.6E+02 | <MDL | 3.0E+01 | <MDL | <MDL |
| **Equipment blank** | | | | | | | |
| NA | Equipment blank | 1/21/03 | <MDL | <MDL | <MDL | <MDL | <MDL |

**Table 9.** Microscopic particulate analysis concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | Comments |
|---|---|---|---|
| 06801000 | Platte River near Ashland | 10/15/02 | — |
| | | 11/19/02 | No other bioindicators indicated |
| | | 12/9/02 | — |
| | | 1/21/03 | Unclassified algae were coccoid |
| | | 2/18/03 | — |
| | | 3/17/03 | Unclassified algea were coccoid green algae; large number of non-intact diatoms were present, but not counted as they didn't meet the criteria. |
| | | 3/24/03 | Unclassified algea were coccoid green algae; large number of non-intact diatoms were present, but not counted as they didn't meet the criteria. |
| | | 4/14/03 | Unclassified algae were coccoid; no other bioindicators indicated |
| | | 5/12/03 | Unclassified algae were coccoid; large amounts of fine and coarse amorphous debris present |
| | | 5/20/03 | Large amounts of fine and coarse amorphous debris present |
| | | 6/16/03 | Unclassifed algae were coccoid; large amounts of fine and coarse amorphous debris present |
| | | 6/29/03 | Unclassifed algae were coccoid; large amounts of fine and coarse amorphous debris present |
| | | 8/18/03 | Unclassifed algae were coccoid; large amounts of fine and coarse amorphous debris present |
| | | 9/15/03 | Unclassifed algae were coccoid; large amounts of fine and coarse amorphous debris present |
| | | 10/20/03 | — |
| | | 11/5/03 | Unclassified algae were coccoid; large amounts of fine and coarse amorphous debris present |
| | | 11/10/03 | Large amounts of fine and coarse amorphous debris present |
| | | 12/15/03 | — |
| | | 1/12/04 | Unclassified algae were coccoid; large amounts of fine and coarse amorphous debris present |
| | | 2/9/04 | — |
| | | 3/15/04 | Unclassifed algae were coccoid; large amounts of fine and coarse amorphous debris present |
| | | 4/19/04 | — |
| | | 5/10/04 | — |
| | | 6/14/04 | — |
| | | 7/12/04 | — |
| | | 8/9/04 | — |
| | | 9/14/04 | — |
| 410322096191701 | W90-1H | 10/15/02 | — |
| | | 11/20/02 | No other bioindicators were identified |
| | | 12/9/02 | — |
| | | 1/21/03 | Iron-related bacteria were present in high numbers |
| | | 2/18/03 | — |

**Table 9.** Microscopic particulate analysis concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | Comments |
|---|---|---|---|
| 410322096191701 | W90-1H | 3/18/03 | Unclassified algae were green coccoid; large amounts of iron present |
| | | 4/1/03 | Iron debris was present |
| | | 4/15/03 | Unclassified algae is coccoid; iron debris was present at high levels |
| | | 5/13/03 | Unclassified algae were coccoid |
| | | 5/27/03 | Unclassified algae were coccoid |
| | | 6/17/03 | Unclassified algae were coccoid; large amounts of fine and coarse amorphous debris present |
| | | 6/30/03 | Unclassified algae were coccoid; plant pollen is pine; large amounts of fine and coarse amorphous debris present |
| | | 8/19/03 | Large number of non-intact diatoms were present, but not counted as they didn't meet the criteria. |
| | | 9/16/03 | Large amounts of amorphous debris present |
| | | 10/21/03 | — |
| | | 11/11/03 | Large amounts of fine and coarse amorphous debris were present; filamentous (sulfur/iron) bacteria present in large numbers; no bioindicators detected |
| | | 12/16/03 | — |
| | | 1/13/04 | Unclassified algae were coccoid; large amounts of amorphous debris present and ferric minerals; many undeveloped/hibernating rotifers |
| | | 2/10/04 | — |
| | | 3/16/04 | Unclassified algae are coccoid; large amounts of amorphous debris present and ferric minerals |
| | | 4/20/04 | — |
| | | 5/11/04 | — |
| | | 6/14/04 | — |
| | | 7/12/04 | — |
| | | 8/9/04 | — |
| | | 9/14/04 | — |
| 410315096190101 | Raw water | 10/15/02 | — |
| | | 11/20/02 | Unclassified algae were coccoid green algae (6-8 mm); high number of iron-related bacteria and iron debris were present |
| | | 12/9/02 | — |
| | | 1/21/03 | — |
| | | 2/18/03 | — |
| | | 3/18/03 | — |
| | | 4/1/03 | — |
| | | 4/15/03 | Unclassified algae were coccoid; iron debris present in low levels |
| | | 5/13/03 | Unclassified algae were green coccoid; iron debris was present at low levels |
| | | 5/27/03 | — |
| | | 6/17/03 | Large amounts of iron debris, dead filamentous algae and sulfate-reducing bacteria; no bioindicators detected |

**Table 9.** Microscopic particulate analysis concentrations in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | Comments |
|---|---|---|---|
| 410315096190101 | Raw water | 6/30/03 | — |
| | | 8/19/03 | Pollen is pine; large amount of amorphous debris present |
| | | 9/16/03 | — |
| | | 10/21/03 | — |
| | | 11/11/03 | Large amounts of amorphous debris and feric minerals were present |
| | | 12/16/03 | — |
| | | 1/13/04 | — |
| | | 2/10/04 | — |
| | | 3/16/04 | — |
| 410315096190102 | Finished water | 10/15/02 | — |
| | | 11/20/02 | Non-diatomaceous algea were coccoid green algae (6-8 mm) |
| | | 12/9/02 | — |
| | | 1/21/03 | — |
| | | 2/18/03 | — |
| | | 3/18/03 | — |
| | | 4/1/03 | No intact algae present; large number of coccoid algae no containing chlorophyll (25-100 mm diameter) |
| | | 4/15/03 | — |
| | | 5/13/03 | No bioindicators detected; mainly iron and amorphous debris |
| | | 5/27/03 | — |
| | | 6/17/03 | — |
| | | 6/30/03 | — |
| | | 8/19/03 | — |
| | | 9/16/03 | — |
| | | 10/21/03 | — |
| | | 11/11/03 | No bioindicators detected; large amounts of amorphous debris and iron debris present |
| | | 12/16/03 | — |
| | | 1/13/04 | — |
| | | 2/10/04 | — |
| | | 3/16/04 | — |
| **Duplicates** | | | |
| 410322096191701 | W90-1H duplicate | 3/18/03 | No other bioindicators detected; no iron particulates present |
| 410315096190101 | Raw water duplicate | 5/13/03 | Unclassified algae were coccoid; Iron debris present in low levels |
| **Equipment blank** | | | |
| NA | Equipment blank | 1/21/03 | No bioindicators present |

**Table 10.** Summary statistics of laser particle counts in samples collected during riverbank filtration study, Platte River, Nebraska.

[Units are counts per 100 milliliters; n, number of samples; med, median; max, maximum; std. dev. , standard deviation; µm, micrometers; na, not applicable; >, greater than; M, one or more samples measured but not quantified, these samples not included in summary statistics; x.xeyy, x.x times 10 raised to the yy power, for example, 1.8e08 is 1.8 times $10^8$]

| Particle size (µm) | 06801000 Platte River near Ashland | | | | | 410322096191701 Well W90-1H | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | n | max | med | mean | std. dev. | n | max | med | mean | std. dev. |
| 0.5-1.0 | 1 | 1.8e08 | 1.8e08 | 1.8e08 | na | 1 | 1.4e07 | 1.4e07 | 1.4e07 | na |
| 1.0-3.0 | 26 | 2.4e10 | 8.2e08 | 3.9e09 | 6.9e09 | 25 | 2.2e06 | 2.6e05 | 4.9e05 | 5.7e05 |
| 3.0-5.0 | 26 | 2.4e09 | 1.2e08 | 3.9e08 | 6.7e08 | 25 | 1.1e06 | 1.1e04 | 7.2e04 | 2.2e05 |
| 5.0-8.0 | 26 | 8.3e08 | 5.9e07 | 1.5e08 | 2.3e08 | 25 | 3.1e05 | 4.0e03 | 2.4e04 | 6.2e04 |
| 8.0-12.0 | 26 | 2.9e08 | 3.2e07 | 6.4e07 | 8.2e07 | 25 | 4.4e04 | 2.7e03 | 8.1e03 | 1.2e04 |
| 12.0-15.0 | 26 | 5.0e07 | 7.6e06 | 1.4e07 | 1.5e07 | 25 | 5.0e04 | 1.7e03 | 4.4e03 | 9.9e03 |
| 15.0-25.0 | 26 | 3.6e07 | 6.5e06 | 1.1e07 | 1.1e07 | 25 | 1.6e04 | 1.7e03 | 2.6e03 | 3.4e03 |
| 25.0-100 | 26 | 6.7e06 | 1.3e06 | 1.7e06 | 1.7e06 | 25 | 5.7e03 | 2.9e02 | 5.7e02 | 1.1e03 |
| >100 | 25 | M1.1e05 | M1.0e05 | M1.1e06 | M2.3e06 | 24 | M3.0e03 | M2.2e01 | M2.9e02 | M6.7e02 |
| **Total** | **26** | **2.7e10** | **1.1e09** | **4.5e09** | **7.9e09** | **25** | **1.8e07** | **2.8e05** | **1.2e06** | **3.5e06** |

| Particle size (µm) | 410315096190101 Raw water | | | | | 410315096190102 Finished water | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | n | max | med | mean | std. dev. | n | max | med | mean | std. dev. |
| 0.5-1.0 | 0 | na | na | na | na | 0 | na | na | na | na |
| 1.0-3.0 | 11 | 5.7e06 | 3.9e05 | 8.4e05 | 1.6e06 | 11 | 1.0e06 | 8.4e04 | 2.7e05 | 3.6e05 |
| 3.0-5.0 | 11 | 6.8e05 | 8.4e03 | 8.1e04 | 2.0e05 | 11 | 1.7e05 | 8.5e03 | 2.8e04 | 5.0e04 |
| 5.0-8.0 | 11 | 2.8e05 | 3.5e03 | 3.7e04 | 8.5e04 | 11 | 9.8e04 | 5.0e03 | 1.5e04 | 2.8e04 |
| 8.0-12.0 | 11 | 1.2e05 | 2.1e03 | 1.9e04 | 3.8e04 | 11 | 8.1e04 | 2.9e03 | 1.1e04 | 2.4e04 |
| 12.0-15.0 | 11 | 5.3e04 | 1.1e03 | 7.1e03 | 1.6e04 | 11 | 4.7e04 | 8.9e02 | 5.5e03 | 1.4e04 |
| 15.0-25.0 | 11 | 7.2e04 | 1.5e03 | 8.8e03 | 2.1e04 | 11 | 5.2e04 | 4.7e02 | 6.1e03 | 1.5e04 |
| 25.0-100 | 11 | 2.7e04 | 6.7e02 | 3.4e03 | 7.9e03 | 11 | 6.7e03 | 2.2e02 | 1.1e03 | 2.1e03 |
| >100 | 11 | 8.3e02 | 2.2e01 | 1.3e02 | 2.5e02 | 11 | M2.1e03 | M1.2e02 | M4.2e02 | M6.6e02 |
| **Total** | **11** | **6.9e06** | **4.0e05** | **1.0e06** | **2.0e06** | **11** | **1.5e06** | **1.1e05** | **3.4e05** | **4.7e05** |

**Table 11.** Laser particle counts in samples collected during the riverbank filtration study, Platte River, Nebraska.

[Units are counts per 100 milliliters; µm, micrometer; <, less than; --, not measured; x.xE+y, x.x times 10 raised to the y power, for example, 1.80E+8 is 1.8 times $10^8$]

| Site identification | Station name | Date | 0.5-1.0 µm | 1.0-3.0 µm | 3.0-5.0 µm | 5.0-8.0 µm | 8.0-12.0 µm | 12.0-15.0 µm | 15.0-25.0 | 25.0-100 µm | >100 µm | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06801000 | Platte River near Ashland | 10/15/02 | 1.80E+8 | 4.00E+7 | 3.40E+7 | 2.70E+7 | 3.90E+6 | 3.50E+6 | 6.40E+5 | <10 | -- | 2.89E+8 |
| | | 11/19/02 | -- | 2.70E+8 | 3.20E+7 | 2.10E+7 | 1.50E+7 | 4.20E+6 | 5.00E+6 | 1.20E+6 | 5.60E+3 | 3.48E+8 |
| | | 12/9/02 | -- | 3.70E+8 | 3.50E+7 | 1.70E+7 | 7.20E+6 | 1.10E+6 | 6.20E+5 | 4.10E+4 | 5.60E+2 | 4.31E+8 |
| | | 1/21/03 | -- | 6.50E+7 | 5.40E+6 | 2.40E+6 | 8.00E+5 | 1.10E+5 | 6.80E+4 | 5.00E+3 | 1.00E+2 | 7.38E+7 |
| | | 2/18/03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 3/17/03 | -- | 2.20E+9 | 2.70E+8 | 1.30E+8 | 8.90E+7 | 2.30E+7 | 1.70E+7 | 1.80E+6 | 1.00E+4 | 2.73E+9 |
| | | 3/24/03 | -- | 9.00E+8 | 1.10E+8 | 6.20E+7 | 4.00E+7 | 1.10E+7 | 9.70E+6 | 1.60E+6 | 1.70E+4 | 1.13E+9 |
| | | 4/14/03 | -- | 3.80E+8 | 6.00E+7 | 3.50E+7 | 2.50E+7 | 7.70E+6 | 7.70E+6 | 1.70E+6 | 1.00E+4 | 5.17E+8 |
| | | 5/12/03 | -- | 1.80E+10 | 1.70E+9 | 5.50E+8 | 1.80E+8 | 2.90E+7 | 2.10E+7 | 2.60E+6 | 1.00E+4 | 2.05E+10 |
| | | 5/20/03 | -- | 5.10E+9 | 6.20E+8 | 2.60E+8 | 1.20E+8 | 2.80E+7 | 2.60E+7 | 3.90E+6 | 1.00E+4 | 6.16E+9 |
| | | 6/16/03 | -- | 6.60E+9 | 6.10E+8 | 2.40E+8 | 9.50E+7 | 2.10E+7 | 1.50E+7 | 1.90E+6 | 1.00E+4 | 7.58E+9 |
| | | 6/29/03 | -- | 6.50E+9 | 7.30E+8 | 3.50E+8 | 1.70E+8 | 3.80E+7 | 3.60E+7 | 5.10E+6 | 1.00E+4 | 7.83E+9 |
| | | 8/18/03 | -- | 4.10E+8 | 4.00E+7 | 2.20E+7 | 1.60E+7 | 5.30E+6 | 5.40E+6 | 1.30E+6 | 1.00E+4 | 5.00E+8 |
| | | 9/15/03 | -- | 4.80E+8 | 4.90E+7 | 2.10E+7 | 1.20E+7 | 3.20E+6 | 2.40E+6 | 3.80E+5 | 1.00E+3 | 5.68E+8 |
| | | 10/20/03 | -- | 5.30E+8 | 7.00E+7 | 3.40E+7 | 1.70E+7 | 5.20E+6 | 3.40E+6 | 5.00E+5 | 1.00E+4 | 6.60E+8 |
| | | 11/5/03 | -- | 1.70E+9 | 1.60E+8 | 7.20E+7 | 4.10E+7 | 1.00E+7 | 7.40E+6 | 1.20E+6 | 5.60E+3 | 1.99E+9 |
| | | 11/10/03 | -- | 1.20E+9 | 1.30E+8 | 5.50E+7 | 2.80E+7 | 6.50E+6 | 5.20E+6 | 7.30E+5 | <1.0E+03 | 1.43E+9 |
| | | 12/15/03 | -- | 2.90E+8 | 2.20E+7 | 7.90E+6 | 3.50E+6 | 7.00E+5 | 5.70E+5 | 6.90E+4 | 1.00E+2 | 3.25E+8 |
| | | 1/12/04 | -- | 7.40E+7 | 5.00E+6 | 2.40E+6 | 1.50E+6 | 4.10E+5 | 3.90E+5 | 7.70E+4 | 3.90E+2 | 8.38E+7 |
| | | 2/9/04 | -- | 1.50E+8 | 9.50E+6 | 3.70E+6 | 1.90E+6 | 4.80E+5 | 3.70E+5 | 7.60E+4 | 5.60E+2 | 1.66E+8 |
| | | 3/15/04 | -- | 7.40E+8 | 1.40E+8 | 7.20E+7 | 3.60E+7 | 7.40E+6 | 5.50E+6 | 7.70E+5 | 2.20E+3 | 1.00E+9 |
| | | 4/19/04 | -- | 3.40E+8 | 7.40E+7 | 4.10E+7 | 2.20E+7 | 4.90E+6 | 4.50E+6 | 8.00E+5 | 5.60E+2 | 4.87E+8 |
| | | 5/10/04 | -- | 4.00E+9 | 2.90E+8 | 1.30E+8 | 7.50E+7 | 2.40E+7 | 2.70E+7 | 6.70E+6 | 1.10E+5 | 4.55E+9 |
| | | 6/14/04 | -- | 2.30E+10 | 2.40E+9 | 8.30E+8 | 2.90E+8 | 4.90E+7 | 3.40E+7 | 4.60E+6 | 1.00E+4 | 2.66E+10 |
| | | 7/12/04 | -- | 2.40E+10 | 2.20E+9 | 7.60E+8 | 2.80E+8 | 5.00E+7 | 2.80E+7 | 2.80E+6 | 1.00E+4 | 2.73E+10 |
| | | 8/9/04 | -- | 1.20E+9 | 1.90E+8 | 7.60E+7 | 4.50E+7 | 1.30E+7 | 1.00E+7 | 1.40E+6 | <1.0E+03 | 1.54E+9 |
| | | 9/14/04 | -- | 1.50E+9 | 2.00E+8 | 9.20E+7 | 5.00E+7 | 1.10E+7 | 1.20E+7 | 2.60E+6 | <1.0E+04 | 1.87E+9 |

**Table 11.** Laser particle counts in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | 0.5-1.0 µm | 1.0-3.0 µm | 3.0-5.0 µm | 5.0-8.0 µm | 8.0-12.0 µm | 12.0-15.0 µm | 15.0-25.0 | 25.0-100 µm | >100 µm | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 410322096191701 | W90-1H | 10/15/02 | 1.40E+7 | 2.20E+6 | 1.10E+6 | 3.10E+5 | 4.40E+4 | 5.00E+4 | <10 | <10 | -- | 1.77E+7 |
| | | 11/20/02 | -- | 3.10E+5 | 1.60E+4 | 3.40E+3 | 1.10E+3 | 3.30E+2 | 4.30E+2 | 2.30E+2 | 5.60E+0 | 3.32E+5 |
| | | 12/9/02 | -- | 1.70E+5 | 1.00E+4 | 2.40E+3 | 7.00E+2 | 1.30E+2 | 1.70E+2 | 7.20E+1 | 2.20E+1 | 1.84E+5 |
| | | 1/21/03 | -- | 1.30E+6 | 1.60E+5 | 6.20E+4 | 2.20E+4 | 8.30E+3 | 8.90E+3 | 5.60E+2 | 1.00E+2 | 1.56E+6 |
| | | 2/18/03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 3/18/03 | -- | 3.50E+5 | 3.80E+4 | 2.20E+4 | 1.70E+4 | 5.30E+3 | 4.40E+3 | 2.90E+2 | 1.70E+1 | 4.37E+5 |
| | | 4/1/03 | -- | 1.80E+5 | 5.40E+3 | 2.20E+3 | 1.50E+3 | 3.70E+3 | 3.30E+3 | 5.30E+2 | 3.00E+3 | 2.00E+5 |
| | | 4/15/03 | -- | 1.10E+5 | 2.40E+3 | 9.30E+2 | 6.70E+2 | 1.40E+3 | 9.90E+2 | 2.20E+2 | 1.20E+3 | 1.18E+5 |
| | | 5/13/03 | -- | 3.20E+5 | 8.80E+3 | 2.90E+3 | 1.60E+3 | 6.40E+2 | 6.50E+2 | 2.10E+2 | 6.70E+1 | 3.35E+5 |
| | | 5/27/03 | -- | 2.50E+5 | 1.10E+4 | 6.40E+3 | 4.40E+3 | 1.30E+3 | 1.30E+3 | 3.20E+2 | 6.80E+2 | 2.75E+5 |
| | | 6/17/03 | -- | 1.10E+5 | 5.80E+3 | 2.20E+3 | 2.00E+3 | 1.20E+3 | 1.70E+3 | 7.30E+2 | 5.60E+0 | 1.24E+5 |
| | | 6/30/03 | -- | 2.10E+5 | 6.50E+3 | 2.50E+3 | 1.50E+3 | 6.80E+2 | 9.40E+2 | 2.50E+2 | 1.00E+0 | 2.22E+5 |
| | | 8/19/03 | -- | 2.80E+5 | 7.00E+3 | 2.70E+3 | 1.20E+3 | 4.60E+2 | 6.20E+2 | 1.20E+2 | 1.00E+0 | 2.92E+5 |
| | | 9/16/03 | -- | 2.80E+5 | 6.60E+3 | 2.30E+3 | 1.60E+3 | 4.80E+2 | 4.60E+2 | 7.20E+1 | 1.00E+0 | 2.92E+5 |
| | | 10/21/03 | -- | 1.90E+6 | 7.50E+4 | 2.80E+4 | 1.50E+4 | 4.50E+3 | 5.20E+3 | 1.40E+3 | 1.10E+1 | 2.03E+6 |
| | | 11/11/03 | -- | 6.40E+5 | 2.20E+4 | 9.80E+3 | 6.30E+3 | 2.50E+3 | 3.00E+3 | 7.20E+2 | 2.80E+1 | 6.84E+5 |
| | | 12/16/03 | -- | 3.70E+5 | 1.60E+4 | 4.90E+3 | 2.70E+3 | 1.70E+3 | 2.30E+3 | 5.30E+2 | 1.00E+0 | 3.98E+5 |
| | | 1/13/04 | -- | 1.30E+6 | 9.90E+4 | 3.70E+4 | 1.80E+4 | 3.90E+3 | 2.90E+3 | 2.60E+2 | 1.40E+2 | 1.46E+6 |
| | | 2/10/04 | -- | 1.70E+5 | 1.60E+4 | 7.90E+3 | 5.80E+3 | 2.40E+3 | 2.80E+3 | 4.40E+2 | 7.80E+2 | 2.06E+5 |
| | | 3/16/04 | -- | 2.40E+5 | 1.40E+4 | 5.80E+3 | 3.50E+3 | 2.00E+3 | 2.30E+3 | 3.50E+2 | 3.60E+2 | 2.68E+5 |
| | | 4/20/04 | -- | 7.70E+5 | 1.20E+5 | 6.00E+4 | 4.00E+4 | 1.30E+4 | 1.60E+4 | 5.70E+3 | 1.90E+2 | 1.02E+6 |
| | | 5/11/04 | -- | 1.80E+5 | 2.40E+4 | 9.60E+3 | 6.00E+3 | 2.00E+3 | 2.90E+3 | 5.90E+2 | 7.80E+1 | 2.25E+5 |
| | | 6/14/04 | -- | 1.20E+5 | 9.50E+3 | 4.00E+3 | 2.70E+3 | 1.70E+3 | 1.90E+3 | 2.90E+2 | 1.10E+1 | 1.40E+5 |
| | | 7/12/04 | -- | 1.10E+5 | 8.90E+3 | 1.40E+3 | 5.60E+2 | 3.10E+2 | 4.00E+2 | 1.40E+2 | 2.20E+1 | 1.22E+5 |
| | | 8/9/04 | -- | 1.00E+5 | 8.20E+3 | 2.50E+3 | 1.40E+3 | 5.80E+2 | 7.90E+2 | 1.40E+2 | <1.0E+08 | 1.14E+5 |
| | | 9/14/04 | -- | 2.60E+5 | 7.90E+3 | 2.60E+3 | 1.10E+3 | 2.80E+2 | 3.10E+2 | 1.10E+2 | 5.60E+0 | 2.72E+5 |

**Table 11.** Laser particle counts in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | 0.5-1.0 µm | 1.0-3.0 µm | 3.0-5.0 µm | 5.0-8.0 µm | 8.0-12.0 µm | 12.0-15.0 µm | 15.0-25.0 | 25.0-100 µm | >100 µm | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 410315096190101 | Raw water | 10/15/02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 11/20/02 | -- | 2.20E+5 | 8.60E+3 | 2.20E+3 | 1.50E+3 | 1.10E+3 | 3.80E+3 | 4.00E+3 | 2.20E+1 | 2.41E+5 |
| | | 12/9/02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 1/21/03 | -- | 5.70E+6 | 6.80E+5 | 2.80E+5 | 1.20E+5 | 5.30E+4 | 7.20E+4 | 2.70E+4 | 1.00E+2 | 6.93E+6 |
| | | 2/18/03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 3/18/03 | -- | 4.20E+5 | 1.20E+5 | 9.00E+4 | 6.50E+4 | 1.30E+4 | 6.90E+3 | 1.20E+3 | 5.60E+0 | 7.16E+5 |
| | | 4/1/03 | -- | 3.20E+5 | 3.10E+4 | 1.50E+4 | 1.20E+4 | 4.90E+3 | 6.50E+3 | 2.60E+3 | 8.30E+2 | 3.93E+5 |
| | | 4/15/03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 5/13/03 | -- | 4.30E+5 | 5.00E+3 | 1.70E+3 | 9.20E+2 | 3.70E+2 | 4.00E+2 | 1.50E+2 | 1.00E+0 | 4.39E+5 |
| | | 5/27/03 | -- | 3.90E+5 | 4.70E+3 | 2.60E+3 | 2.10E+3 | 8.20E+2 | 1.50E+3 | 5.10E+2 | 2.80E+2 | 4.03E+5 |
| | | 6/17/03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 6/30/03 | -- | 3.80E+5 | 4.40E+3 | 1.60E+3 | 1.00E+3 | 4.20E+2 | 6.10E+2 | 1.90E+2 | 5.60E+0 | 3.88E+5 |
| | | 8/19/03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 9/16/03 | -- | 4.30E+5 | 8.40E+3 | 3.50E+3 | 2.00E+3 | 5.70E+2 | 8.10E+2 | 1.20E+2 | 1.00E+0 | 4.45E+5 |
| | | 10/21/03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 11/11/03 | -- | 1.30E+5 | 8.10E+3 | 3.80E+3 | 2.70E+3 | 1.20E+3 | 1.50E+3 | 6.70E+2 | 3.90E+1 | 1.48E+5 |
| | | 12/16/03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 1/13/04 | -- | 2.70E+5 | 5.00E+3 | 1.60E+3 | 1.10E+3 | 3.80E+2 | 5.70E+2 | 2.50E+2 | 1.60E+2 | 2.79E+5 |
| | | 2/10/04 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 3/16/04 | -- | 5.80E+5 | 1.50E+4 | 6.70E+3 | 4.60E+3 | 1.80E+3 | 1.90E+3 | 1.10E+3 | 1.70E+1 | 6.11E+5 |
| 410315096190102 | Finished water | 10/15/02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 11/20/02 | -- | 9.60E+5 | 5.50E+4 | 1.80E+4 | 2.90E+3 | 3.10E+2 | 2.40E+2 | 1.20E+2 | 1.20E+2 | 1.04E+6 |
| | | 12/9/02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 1/21/03 | -- | 1.00E+6 | 1.70E+5 | 9.80E+4 | 8.10E+4 | 4.70E+4 | 5.20E+4 | 6.70E+3 | 1.00E+2 | 1.45E+6 |
| | | 2/18/03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 3/18/03 | -- | 7.60E+4 | 1.20E+4 | 7.50E+3 | 4.80E+3 | 8.90E+2 | 4.50E+2 | 6.70E+1 | 2.80E+1 | 1.02E+5 |
| | | 4/1/03 | -- | 2.90E+5 | 3.40E+4 | 2.30E+4 | 1.90E+4 | 6.10E+3 | 5.20E+3 | 3.10E+3 | 2.10E+3 | 3.83E+5 |
| | | 4/15/03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 5/13/03 | -- | 1.30E+5 | 5.70E+3 | 1.50E+3 | 5.70E+2 | 3.00E+2 | 3.70E+2 | 2.70E+2 | 6.70E+1 | 1.39E+5 |
| | | 5/27/03 | -- | 1.50E+5 | 8.50E+3 | 5.00E+3 | 3.20E+3 | 9.40E+2 | 9.70E+2 | 2.40E+2 | 1.10E+2 | 1.69E+5 |
| | | 6/17/03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

**Table 11.** Laser particle counts in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | 0.5-1.0 µm | 1.0-3.0 µm | 3.0-5.0 µm | 5.0-8.0 µm | 8.0-12.0 µm | 12.0-15.0 µm | 15.0-25.0 | 25.0-100 µm | >100 µm | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 410315096190102 | Finished water | 6/30/03 | -- | 5.70E+4 | 1.80E+3 | 1.10E+3 | 7.20E+2 | 2.70E+2 | 1.70E+2 | 4.40E+1 | 4.50E+2 | 6.16E+4 |
| | | 8/19/03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 9/16/03 | -- | 7.70E+4 | 9.80E+3 | 5.00E+3 | 4.50E+3 | 3.70E+3 | 5.40E+3 | 8.20E+2 | 1.00E+0 | 1.06E+5 |
| | | 10/21/03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 11/11/03 | -- | 7.00E+4 | 6.20E+3 | 3.00E+3 | 2.20E+3 | 9.80E+2 | 1.50E+3 | 2.20E+2 | <1.0e00 | 8.41E+4 |
| | | 12/16/03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 1/13/04 | -- | 8.40E+4 | 2.20E+3 | 7.10E+2 | 4.20E+2 | 1.90E+2 | 1.90E+2 | 3.30E+1 | 9.70E+2 | 8.87E+4 |
| | | 2/10/04 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | | 3/16/04 | -- | 7.50E+4 | 3.50E+3 | 1.60E+3 | 8.10E+2 | 3.60E+2 | 4.70E+2 | 2.00E+2 | 2.40E+2 | 8.22E+4 |
| **Duplicates** | | | | | | | | | | | | |
| 06801000 | Platte River duplicate | 12/9/02 | -- | 3.00E+8 | 1.80E+7 | 7.60E+6 | 2.50E+6 | 3.30E+5 | 1.70E+5 | 5.00E+1 | 5.60E+2 | 3.29E+8 |
| | | 11/15/03 | -- | 1.10E+9 | 1.20E+8 | 6.00E+7 | 3.50E+7 | 9.40E+6 | 7.40E+6 | 1.20E+6 | 1.70E+4 | 1.33E+9 |
| 410322096191701 | W90-1H duplicate | 12/16/03 | -- | 2.90E+5 | 1.00E+4 | 3.00E+3 | 1.80E+3 | 8.70E+2 | 1.00E+3 | 1.30E+2 | 1.00E+0 | 3.07E+5 |
| 410315096190101 | Raw water duplicate | 1/21/03 | -- | 5.20E+6 | 5.70E+5 | 3.00E+5 | 1.90E+5 | 1.30E+5 | 1.00E+5 | 1.30E+4 | 5.60E+2 | 6.50E+6 |
| | | 6/30/03 | -- | 3.80E+5 | 4.10E+3 | 1.30E+3 | 1.10E+3 | 4.70E+2 | 9.50E+2 | 4.70E+2 | 1.40E+2 | 3.89E+5 |
| 410315096190102 | Finished water duplicate | 5/27/03 | -- | 7.20E+4 | 2.50E+3 | 1.40E+3 | 8.30E+2 | 3.90E+2 | 8.80E+2 | 1.90E+3 | 4.50E+2 | 8.04E+4 |
| | | 1/13/04 | -- | 1.30E+5 | 6.10E+3 | 2.40E+3 | 1.40E+3 | 6.40E+2 | 6.10E+2 | 1.20E+2 | 2.30E+3 | 1.44E+5 |

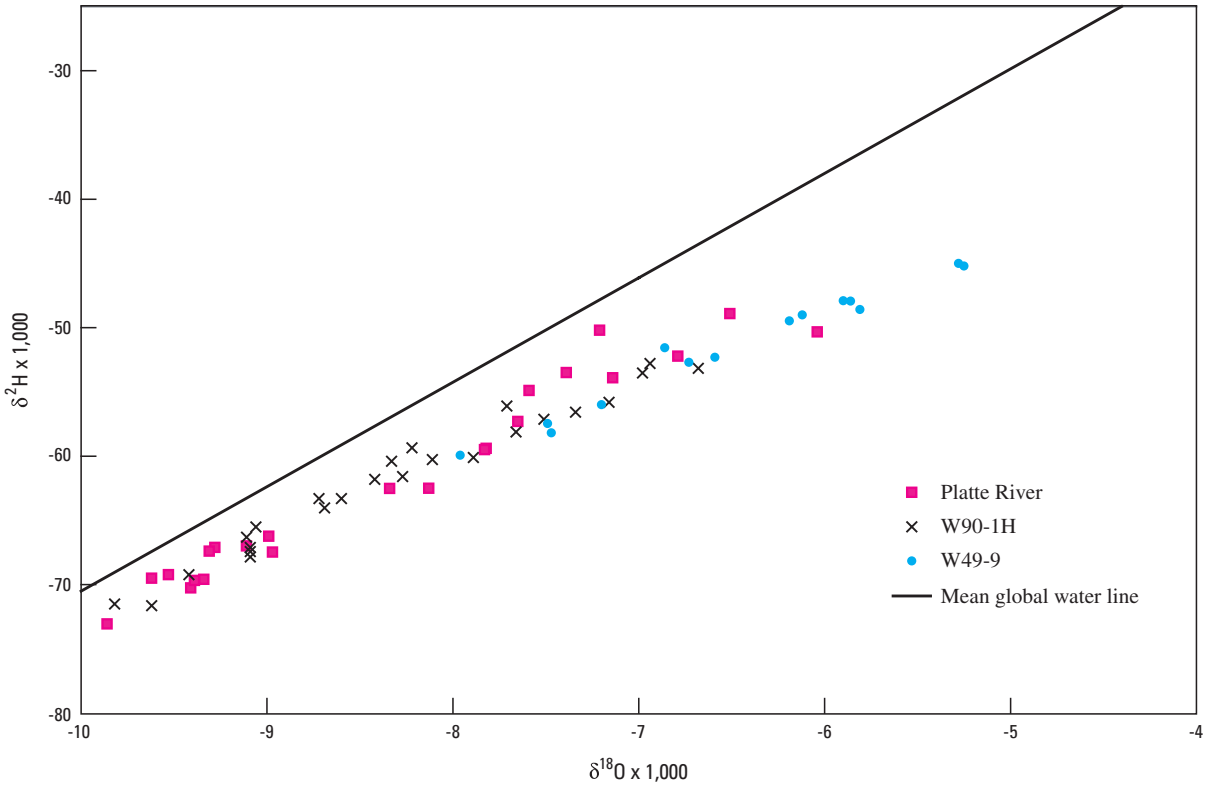


**Figure 8.** Stable hydrogen and oxygen isotope ratios in samples from the Platte River and the well field during the river-bank filtration study, Platte River, Nebraska.

**Table 12.** Stable hydrogen and oxygen isotope ratios in samples collected during the riverbank filtration study, Platte River, Nebraska.

[per mill; per thousand; --, not measured]

| Site identification | Station name | Date | Hydrogen ratio (per mill) | Oxygen ratio (per mill) |
|---|---|---|---|---|
| 06801000 | Platte River near Ashland | 10/15/02 | -59.4 | -7.82 |
| | | 11/19/02 | -67.0 | -9.11 |
| | | 12/9/02 | -70.3 | -9.41 |
| | | 1/21/03 | -69.6 | -9.34 |
| | | 2/18/03 | -73.1 | -9.86 |
| | | 3/17/03 | -69.7 | -9.39 |
| | | 3/24/03 | -67.5 | -8.97 |
| | | 4/14/03 | -62.5 | -8.34 |
| | | 5/12/03 | -54.9 | -7.59 |
| | | 5/20/03 | -57.3 | -7.65 |
| | | 6/16/03 | -62.5 | -8.13 |
| | | 6/29/03 | -52.2 | -6.79 |
| | | 8/18/03 | -50.3 | -6.04 |
| | | 9/15/03 | broken sample | broken sample |
| | | 10/20/03 | broken sample | broken sample |
| | | 11/5/03 | broken sample | broken sample |
| | | 11/10/03 | -66.2 | -8.99 |
| | | 12/15/03 | -69.2 | -9.53 |
| | | 1/12/04 | -67.1 | -9.28 |
| | | 2/9/04 | -69.5 | -9.62 |
| | | 3/15/04 | -67.4 | -9.31 |
| | | 4/19/04 | -59.5 | -7.83 |
| | | 5/10/04 | -53.9 | -7.14 |
| | | 6/14/04 | -53.5 | -7.39 |
| | | 7/12/04 | -50.2 | -7.21 |
| | | 8/9/04 | -48.9 | -6.51 |
| | | 9/14/04 | -48.7 | -6.09 |
| 410322096191701 | W90-1H | 10/15/02 | -52.8 | -6.94 |
| | | 11/20/02 | -57.1 | -7.51 |
| | | 12/9/02 | -60.1 | -7.89 |
| | | 1/21/03 | -64.0 | -8.69 |
| | | 2/18/03 | -67.1 | -9.09 |
| | | 3/18/03 | -71.6 | -9.62 |
| | | 4/1/03 | -69.2 | -9.42 |
| | | 4/15/03 | -67.4 | -9.09 |
| | | 5/13/03 | -67.8 | -9.09 |
| | | 5/27/03 | -59.4 | -8.22 |

**Table 12.** Stable hydrogen and oxygen isotope ratios in samples collected during the riverbank filtration study, Platte River, Nebraska.—Continued

| Site identification | Station name | Date | Hydrogen ratio (per mill) | Oxygen ratio (per mill) |
|---|---|---|---|---|
| 410322096191701 | W90-1H | 6/17/03 | -61.6 | -8.27 |
| | | 6/30/03 | -60.3 | -8.11 |
| | | 8/19/03 | -53.5 | -6.98 |
| | | 9/16/03 | -53.2 | -6.68 |
| | | 10/21/03 | -56.6 | -7.34 |
| | | 11/11/03 | -55.8 | -7.16 |
| | | 12/16/03 | -58.1 | -7.66 |
| | | 1/13/04 | -61.8 | -8.42 |
| | | 2/10/04 | -65.5 | -9.06 |
| | | 3/16/04 | -71.5 | -9.82 |
| | | 4/20/04 | -66.3 | -9.11 |
| | | 5/11/04 | -63.3 | -8.72 |
| | | 6/14/04 | -63.3 | -8.60 |
| | | 7/12/04 | -60.4 | -8.33 |
| | | 8/9/04 | -56.1 | -7.71 |
| | | 9/14/04 | -54.0 | -7.06 |
| 410349096202101 | W49-9 | 6/17/03 | -48.6 | -5.81 |
| | | 6/30/03 | -47.9 | -5.86 |
| | | 8/19/03 | -49.5 | -6.19 |
| | | 9/16/03 | -51.6 | -6.86 |
| | | 10/21/03 | -57.5 | -7.49 |
| | | 11/12/03 | -59.9 | -7.96 |
| | | 12/16/03 | -58.2 | -7.47 |
| | | 1/13/04 | -56.0 | -7.20 |
| | | 2/10/04 | -52.3 | -6.59 |
| | | 3/16/04 | -52.7 | -6.73 |
| | | 4/20/04 | -47.9 | -5.90 |
| | | 5/11/04 | -49.0 | -6.12 |
| | | 6/14/04 | -- | -- |
| | | 7/12/04 | -45.0 | -5.28 |
| | | 8/9/04 | -45.2 | -5.25 |
| | | 9/14/04 | -51.4 | -6.35 |

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