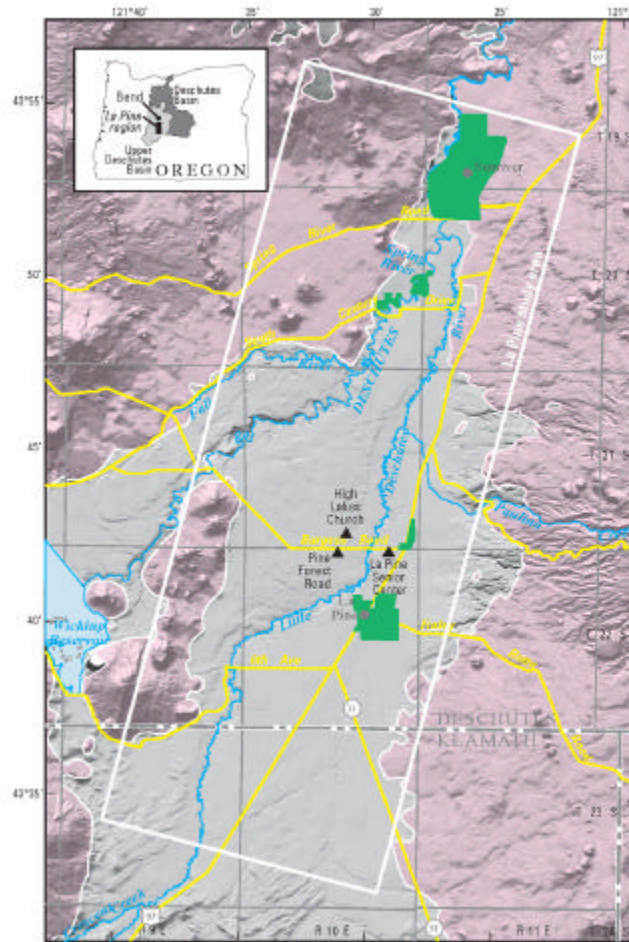

National Decentralized Water Resources Capacity Development Project

Executive Summary



Organic Wastewater Compounds, Pharmaceuticals, and Coliphage in Groundwater Receiving Discharge From Onsite Wastewater Treatment Systems Near La Pine, Oregon: Occurrence and Implications for Transport

Oregon Department of Environmental Quality
Portland, Oregon

April 2005

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**Submitted by Oregon Department of
Environmental Quality
Portland, OR**

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National Decentralized Water Resources Capacity Development Project
(NDWRCDP) Research Project

Final Report, April 2005

DISCLAIMER

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CONVERSION FACTORS

Multiply	By	To Obtain
<i>Length</i>		
inch (in.)	25.4	millimeter (mm)
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
<i>Area</i>		
square mile (mi ²)	2.590	square kilometer (km ²)

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

$$^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) + 32$$

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). UTM refers to the Universal Transverse Mercator coordinate system; zone 10 in this report.

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 ($\mu\text{S}/\text{cm}$ at 25 °C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter ($\mu\text{g}/\text{L}$). One liter (L) is equal to 1,000 milliliters (mL). Nitrate concentrations are reported in units of milligrams nitrogen per liter (mg N/L), in contrast to the occasionally seen units of milligrams nitrate per liter (mg NO_3^-/L).

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ABSTRACT

This project involved documenting the occurrence of organic wastewater compounds (components of “personal care products” and other common household chemicals), pharmaceuticals (human prescription and nonprescription medical drugs), and coliphage (viruses that infect coliform bacteria and that are found in high concentrations in municipal wastewater) in onsite wastewater (septic tank effluent). These contaminants were also documented in a shallow, unconfined, sandy aquifer that serves as the primary source of drinking water for most residents near La Pine, Oregon. Samples from two types of observation networks provided basic occurrence data for onsite wastewater and downgradient groundwater. One observation network was a group of 28 traditional and innovative (advanced treatment) onsite wastewater treatment systems and associated downgradient drainfield monitoring wells, referred to as the innovative systems network. The drainfield monitoring wells were located adjacent to or under onsite wastewater treatment system drainfield lines. Another observation network, termed the transect network, consisted of 31 wells distributed among three transects of temporary, stainless-steel-screened, direct-push monitoring wells installed along three plumes of onsite wastewater. The transect network, by virtue of its design, also provided a basis for increased understanding of the transport of analytes in natural systems.

Coliphage were frequently detected in onsite wastewater. Coliphage concentrations in 101 samples of raw and treated onsite wastewater were highly variable, and ranged from less than 1 to 3,000,000 plaque forming units per 100 milliliters (PFU/100 mL). Coliphage were occasionally detected at low concentrations in samples from wells located downgradient from onsite wastewater treatment system drainfield lines (eight occurrences among 110 samples). However, coliphage concentrations were below method detection limits in replicate or repeat samples collected from the eight sites. The consistent absence of coliphage detections in the replicate or repeat samples is interpreted to indicate that the detections reported for groundwater samples represented low-level field or laboratory contamination, and it would appear that coliphage were effectively attenuated to less than 1 PFU/100 mL over distances of several feet of transport in the La Pine aquifer and (or) overlying unsaturated zone.


Organic wastewater compounds were frequently detected in onsite wastewater. Of the 63 organic wastewater compounds in the analytical schedule, 45 were detected in the 21 samples of onsite wastewater. Concentrations of organic wastewater compounds reached a maximum of 1,300 µg/L (p-cresol). Caffeine was detected at concentrations as high as 320 µg/L. Fourteen of the 45 compounds were detected in more than 90 percent of onsite wastewater samples. Fewer (nine) organic wastewater compounds were detected in 51 groundwater samples, despite the presence of nitrate and chloride likely from onsite wastewater sources. The nine organic wastewater compounds that were detected in groundwater samples were:

-
- Acetyl-hexamethyl-tetrahydro-naphthalene (AHTN)
 - Caffeine
 - Cholesterol
 - Hexahydrohexamethyl-cyclopentabenzopyran
 - N,N-diethyl-meta-toluamide (DEET)
 - Tetrachloroethene
 - Tris (2-chloroethyl) phosphate
 - Tris (dichloroisopropyl) phosphate
 - Tributyl phosphate

Frequent detection of household-chemical type organic wastewater compounds in onsite wastewater provides evidence that some of these organic wastewater compounds may be useful indicators of human waste effluent dispersal in some hydrologic environments. The occurrence of organic wastewater compounds in groundwater downgradient from onsite wastewater treatment systems demonstrates that a subgroup of organic wastewater compounds is transported in the La Pine aquifer. The consistently low concentrations (generally less than 1 µg/L) of organic wastewater compounds in water samples collected from wells located no more than 19 feet from drainfield lines indicates that the reactivity (sorption, degradation) of this suite of organic wastewater compounds may limit their usefulness as tracers of onsite wastewater discharged into aquifers.

Groundwater samples from one of the three groundwater transects, along with one sample from the onsite wastewater treatment system associated with that transect, were analyzed for a suite of 18 pharmaceuticals. Eight pharmaceuticals were detected in the onsite wastewater at concentrations up to about 120 µg/L (acetaminophen). In downgradient groundwater samples, sulfamethoxazole (an antibacterial), acetaminophen (an analgesic), and caffeine (a stimulant, and not a medical drug) each were detected once, at concentrations between 0.10 µg/L and 0.18 µg/L—typical of the range of concentrations observed in other studies of wastewater-impacted groundwater. In addition to the readily identified pharmaceuticals, two pharmaceuticals—the anticonvulsant drugs primidone and phenobarbital—were tentatively identified in three groundwater samples from one nest of wells at another transect. Tentative identification of primidone and phenobarbital occurred during analysis of groundwater samples for organic wastewater compounds; chromatogram peaks not associated with the target organic wastewater compounds were observed and the mass spectra of the unidentified compounds were matched to known mass spectra in a mass spectral reference library. Estimated concentrations reached as high as 12 µg/L (primidone). As was the case with organic wastewater compounds, the pharmaceutical occurrence data indicate that some pharmaceuticals may be useful indicators of the presence of human waste in the environment, and a subset of pharmaceuticals is transported to groundwater from onsite wastewater treatment systems.

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