Major Finding	Implication
(A) Background Water Quality.	
Stream quality and basic water quality (as defined by concentrations of major ions) in surficial aquifers are not uniform in the Red River of the North Basin Study Unit (fig. 1). The differences in water quality generally can be related to differences in geology, soils, and hydrology in four subregions in the basin. Saline seeps from deep ground-water sources affect streams in the northwestern portion of the Study Unit during times of extremely low streamflow.	***Water in the Red River of the North Basin, when unaffected by human activities, generally is safe to drink according to U.S. Environmental Protection Agency (USEPA) standards for dissolved solids, major ions, and radionuclides. Natural differences in water quality are important factors for water and land management. [See pages 6–7.]***
(B) Agriculture and Water Quality.	
Pesticide concentrations were mostly related to factors such as chemical persistence and rate of water movement over and through agricultural soils. In this largely agricultural area, the most heavily applied pesticides, which included the herbicides 2,4-D, MCPA, bromoxynil, and trifluralin, were not always the most frequently detected in streams and shallow aquifers. Atrazine, applied at about 7 percent of the rate of 2,4-D, was detected in streams throughout the basin and shallow ground water beneath cropland. The presence of the banned insecticide DDT and some of its breakdown products in stream-bottom sediments, fish tissues, and in some ground water illustrates the persistence of some pesticides.	***Pesticides detected in streams and shallow ground water did not exceed any drinking-water standards and, except for a single concentration of the herbicide triallate, were not acutely toxic to aquatic life based on current standards. USEPA has established drinking-water standards for 6 individual pesticides out of the 43 detected in the basin. The health effects of other pesticides or combinations of pesticides was not assessed. Some insecticides and most fungicides applied to specialty crops in this basin were not analyzed in this study. Pesticide persistence and its dependence on soil characteristics and hydrologic conditions suggest the importance of considering soil, geology, and hydrology in developing and implementing land-management plans. [See pages 8–9.]***
Streams draining areas containing the largest percentage of cropland (central and southern parts of the Red River of the North Basin Study Unit) had the highest concentrations of nutrients (dissolved phosphorus, nitrate, and organic nitrogen).	***Although the nutrient concentrations were relatively low, agricultural activity has increased the concentration and load of nutrients [see pages 10–11] potentially degrading stream quality and increasing eutrophication of lakes and reservoirs. [See page 12.]***
Nitrate concentrations generally were low in shallow ground water except in some surficial aquifers beneath cropland, where concentrations exceeded the USEPA 10 mg/L drinking-water standard in 27, 0, and 8 percent of the samples from the western, central, and southeastern parts of the Study Unit, respectively. Nitrate and pesticide concentrations were well below drinking-water standards in ground water deeper than these aquifers, particularly buried aquifers naturally protected by overlying sediments.	***Ground water most commonly used for domestic and public water supplies in the basin was safe to drink according to USEPA standards for nitrate and pesticides. Detectable concentrations of nutrients and pesticides that have reached ground water indicate the potential for further contamination over time. Shallow ground water beneath sandy soils is particularly vulnerable to contamination, and this study provided a perspective on how decades of agricultural activity affects the current variability of ground-water quality. [See pages 8–11.]***
Fish communities were affected more by differences in natural environmental factors (some of which are affected by land use) than by differences in the concentrations of nutrients and pesticides in streams in agricultural areas.	***More work would be useful to better assess the effects of land use, nutrients, and pesticides on the aquatic ecosystem. [See page 11.]***

Agriculture is the dominant land use in the Red River of the North Basin Study Unit.

Major Finding	Implication
(C) Red River Water Quality and Nonagricultural Sources of Contamination.	
Wastewater from urban areas along the Red River of the North has a minimal effect on the river's quality. The median concentration of ammonia, commonly associated with wastewater, was not higher in the river than in the tributaries, but ammonia concentration was slightly higher in the river downstream from the Fargo-Moorhead area. Compared to historical data for the river, concentrations of ammonia have decreased and nitrate have increased slightly downstream from the Fargo-Moorhead area. These trends likely reflect improved aeration of wastewater effluent over time.	***Fargo, North Dakota and Moorhead, Minnesota, the largest urban area in the basin, moderately affected Red River of the North water quality during flow conditions observed from 1993 to 1995. Ammonia concentrations were elevated at the point of discharge but were diluted by the river and tributary flows, based on measurements 78 miles downstream at Halstad, Minnesota. This dilution effect also is apparent where industries discharge ammonia to the main stem. [See page 12.]***
(D) Effects of other Nonpoint-Source Toxic Compounds on Water Quality.	
Mercury, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs) (potentially toxic chemicals that are associated with modern industrial sources) were widely detected in Red River of the North Basin Study Unit fish and (or) stream sediments.	***Mercury and PCB concentrations in fish tissue were below Federal standards for fish consumption, but some of the highest concentrations were at moderate levels based on Minnesota fish-consumption advisories. PAHs were detected in stream sediments at some locations at levels thought to adversely affect aquatic life. [See page 13.]***
Volatile organic compounds (VOCs), sampled in selected shallow aquifers and in the Red River of the North under ice conditions, were detected infrequently and at concentrations well below drinking-water standards.	***VOC's, which can enter water from the use of petroleum products and industrial solvents, were rarely detected in ground water beneath agricultural areas or in the Red River of the North. [See pages 10 and 13.]***
(E) Sediment in Streams.	
High suspended-sediment concentrations characterize streams that flow through the heavily cropped central part of the basin. The highest sediment concentrations coincided with high stream gradient, high streamflows, and erodible stream channels, such as were characteristic of the Pembina River, a tributary to the Red River of the North (fig. 2).	***Land-use practices that do not abate rapid runoff of water can increase suspended sediment in streams, thereby reducing water clarity and ecological integrity. Suspended sediment in streams can settle in reservoirs, which could require costly maintenance to restore storage capacity. Sediment delivery to streams may be an important factor for managing nutrient inputs to, and transport in, some streams. [See pages 14–15.]***
(F) Importance of Variations in Water Quality.	
The highest measured concentrations of herbicides commonly were detected during the first runoff events after application. The herbicide triallate (applied mostly during autumn) and nutrients were transported to streams during spring-snowmelt runoff. Relatively minor differences in the timing of recharge, agricultural practices, and geology can cause significant differences in magnitudes and fluctuations of nitrate concentrations in shallow ground water. Seasonal variation in flow affects available habitat and fish community composition (an indicator of stream quality).	***Water-quality criteria and indicators used for monitoring and overall management of contamination sources for water resources in this basin could be enhanced by considering the water-quality effects of seasonal and hydrologic variability. [See pages 16–17.]***

Widespread flooding, such as occurred during the spring of 1997, can affect stream quality.