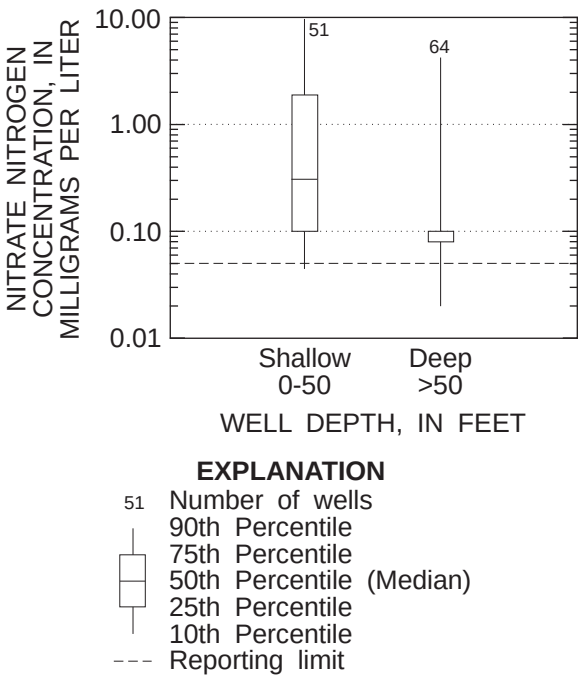

Figure 18.--Distribution of nitrate nitrogen concentrations for shallow and deep water wells (U.S. Geological Survey data).

Two common measurements of the suspended-material content in streams are suspended sediment (Guy, 1969) and suspended solids (Fishman and Friedman, 1989). Historically, the USGS has collected much more suspended-sediment data than suspended-solids data. Suspended sediment is collected as a depth-integrated sample from several verticals across the stream and the entire sample, often several liters, is analyzed without subsampling. Conversely, the suspended-solids method used by the U.S. Geological Survey subsamples from a composited depth- and width-integrated sample and the most dense particles (such as sand) may not be evenly dispersed in the composite sample, even with vigorous agitation. Laboratory analysts pipette a second subsample from the field sample, purposefully avoiding large particles that might clog the pipettes. Each subsampling may exclude the largest and most dense particles, biasing suspended-solids data relative to suspended-sediment data.

Figure 19 shows the relation between concentrations of suspended sediment and suspended solids in samples collected by the USGS in Minnesota and North Dakota. Suspended-solids data underestimates suspended-sediment content by more than a factor of two. There also is substantial scatter in the data. Because of the substantial difference between suspended-sediment and suspended-solids data and the difficulty trying to reliably relate the two values, this report focuses only on suspended-sediment data. The USGS and Environment Canada are the two agencies that have collected the suspended-sediment data included in this report.

Figure 20 shows the distribution of suspended-sediment concentrations for those sites in the basin where values meet the same criteria that were applied to nutrient data. Data were available for only a few sites, with limited spatial coverage of the basin. Median concentrations of suspended sediment in the Red River ranged from 46 mg/L below Fargo, N. Dak. to 108 mg/L at Emerson, Manitoba. Median sediment concentrations were lowest in Beaver Creek, N. Dak. and the Red Lake and Roseau Rivers, Minn. The highest suspended-sediment concentrations generally were found in the Pembina River, especially at Walhalla, N. Dak. Suspended-sediment concentrations in the Pembina River ranged from 3 mg/L to nearly 7,000 mg/L. The steep topography in the watershed of the Pembina River leaves the soils more susceptible to erosion. Also, the stream-bed gradient increases the sediment-carrying capacity of the stream. Other streams in the Red River Basin have the capacity to carry large quantities of suspended sediment, but data to quantify this were not available.

Data have been collected at only a few sampling sites to determine the amount of coarse material (sand and gravel) in proportion to the amount of finer material (clay and silt). The Red River at Emerson, Manitoba tended to carry the finest suspended sediment; in more than half the samples, 98 percent of the material was finer than sand. The site on the Red River at Halstad, Minn. also carried a high percentage of fine material. The Red River at sites below Fargo, N. Dak. and at Oslo, Minn. had median percentages finer than sand of 84 and 89, respectively, indicating that coarser material is transported at these sites. The Pembina River typically had about 85 percent of the suspended-sediment load as material finer than sand.

Additional data on suspended sediment, including daily sediment samples for several years, have been collected by the Water Survey of Canada for Environment Canada. Sites sampled on streams discussed in this report include the Pembina River at Windygates, the Red River at Emerson, and the Roseau River at Gardenton, all in Manitoba. Suspended-sediment data from these sites and from many other sites throughout Manitoba through 1985 are summarized in a report by Penner and others (1987). During the period of data analyzed by Penner and others (1987) the mean daily suspended-sediment concentration was 393 mg/L in the Pembina River, 223 mg/L in the Red River, and 35 mg/L in the Roseau River. The mean annual load in tons for each of these streams was 104,000 for the Pembina River, 952,000 for the Red River, and 10,700 for

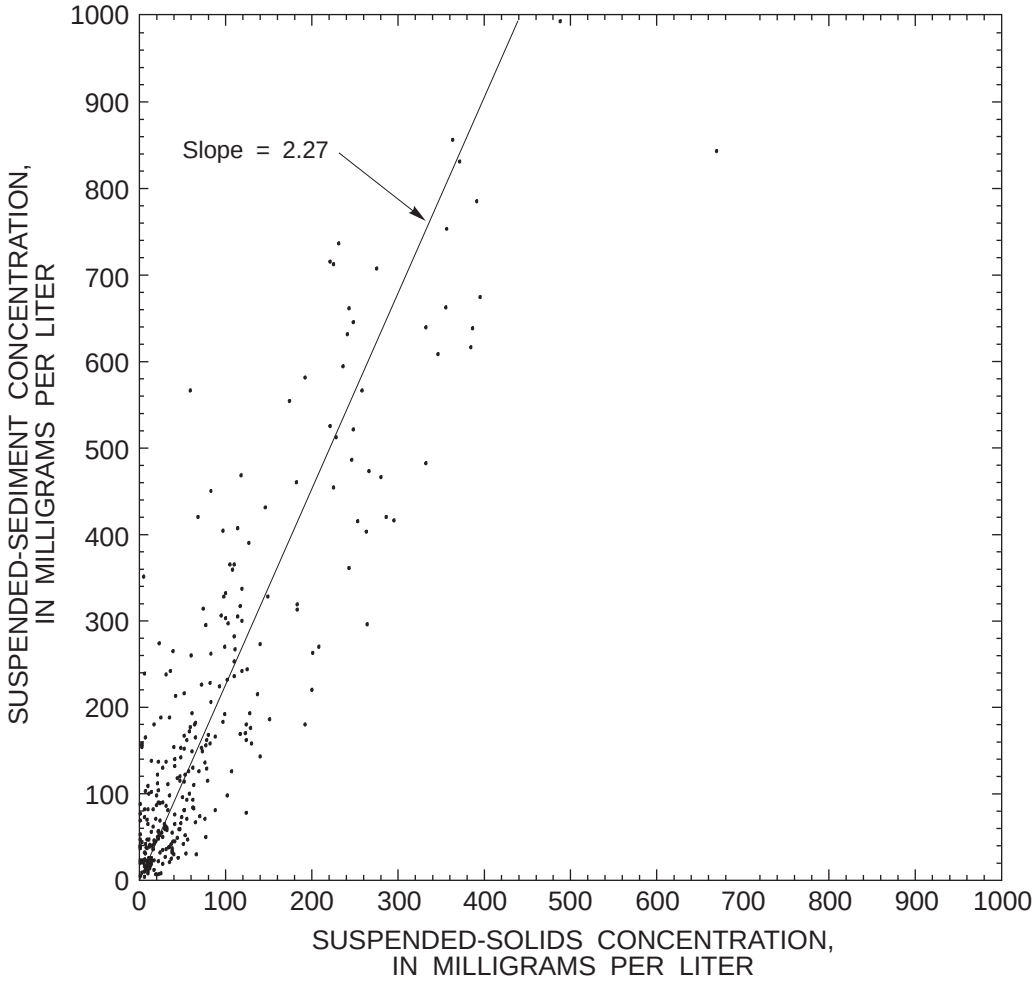

Figure 19.--Relation between suspended-sediment and suspended-solids concentrations (U.S. Geological Survey data).

the Roseau River. The mean annual yield in tons per square mile for each of these streams was 35.5 for the Pembina River, 23.5 for the Red River, and 6.12 for the Roseau River. A report by Hydrocon Engineering (Continental), Ltd. (1987) provides a detailed discussion of the sediment transport characteristics of the Pembina River at Windygates, Manitoba based on data collected by the Water Survey of Canada during 1962-84. A report by Glavic and others (1988) discusses sediment transport characteristics for the Red River at Emerson, Manitoba during 1978-86 and compares data collected by the USGS with data collected by the Water Survey of Canada.

Pesticides

This report is limited to a description of the presence of synthetic organic pesticides. Although inorganic compounds, such as copper sulfate (an algicide) and various arsenic compounds, have been used as pesticides, these chemicals will not be considered in this report. The term pesticides encompasses hundreds of commonly-used chemicals (herbicides, insecticides, fungicides, and other types) that have a large range in physical and chemical properties. Key factors that affect the movement and fate of pesticides in the environment are aqueous solubility, vapor pressure, lipophilicity (the tendency of a chemical to dissolve in lipids), and biological and chemical degradation processes. Extensive reviews of the properties and environmental behavior of pesticides have been published elsewhere (see, for example, Howard, 1991; Worthing and Hance, 1991).

Loading of pesticides to aquatic systems is related to usage or accidental release in contributing watersheds, and

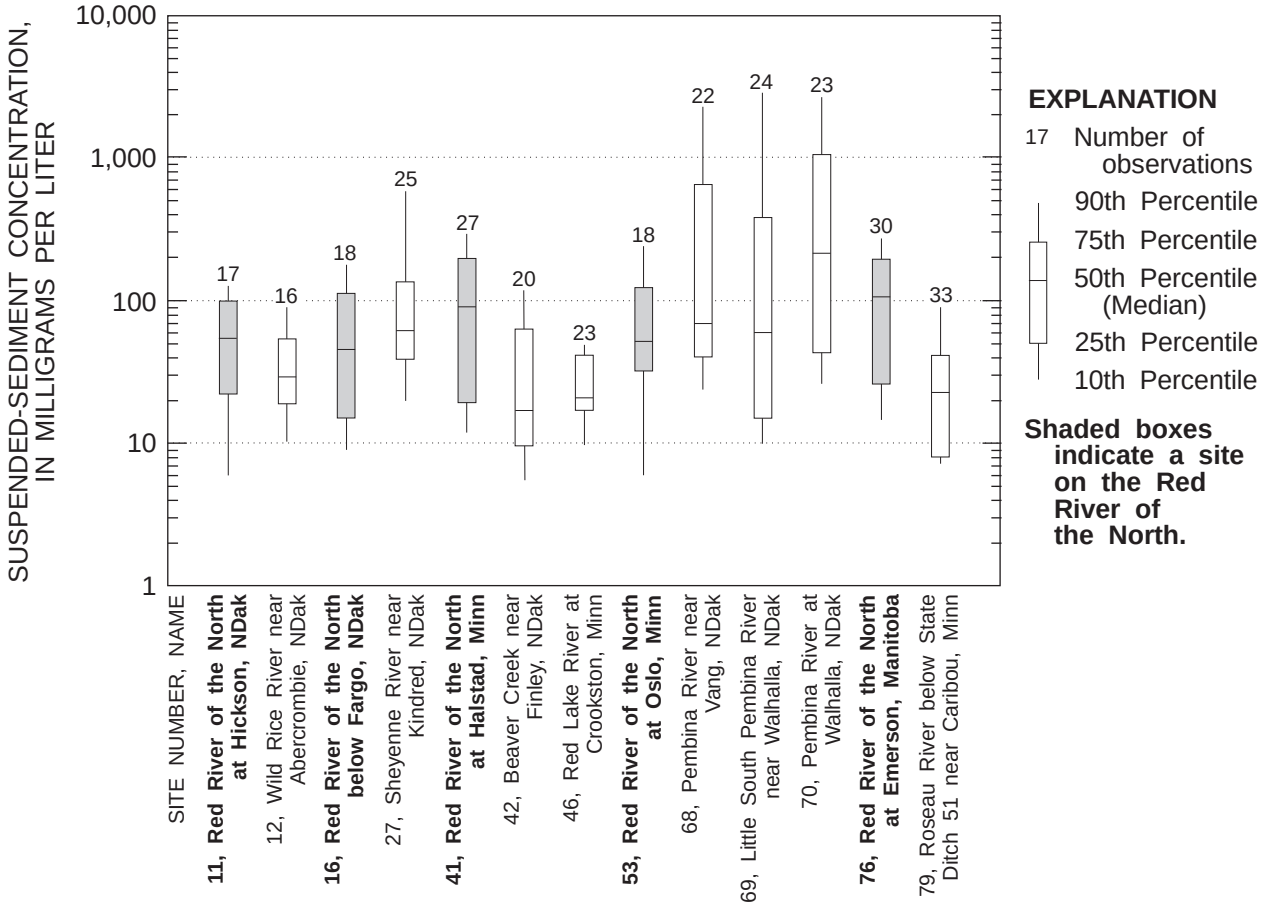

Figure 20.--Distribution of suspended-sediment concentrations for selected stream sites in the Red River of the North Basin (U.S. Geological Survey data).

other inputs such as atmospheric deposition. Loading also can be affected by aqueous solubility and adsorption to soils; loss mechanisms such as biological or chemical degradation and volatilization; and environmental factors such as runoff events and topography that affect transport of chemicals to aquatic systems. Occurrence of detectable levels of pesticides in water, aquatic sediments, or aquatic biological tissues thus depends on many factors, including loading rates, time since application, chemical half-life with respect to biological and chemical degradation, and physical and chemical properties of a chemical that influence its distribution among various media.

Because sampling programs vary greatly in analytes determined, time periods in which samples were collected, and sites or areas sampled, pesticide data are discussed separately for each sampling program (where sufficient data exist). Analytical capabilities can commonly allow chemicals to be measured at extremely low concentrations—levels that are well below established water-quality standards, guidelines, and criteria. The purpose of this report is to summarize available data whether or not criteria are exceeded. Measured concentrations are compared to established water-quality criteria, where appropriate. Analyses in which pesticides were not detected (below reporting limits) also are important in assessing contamination of water resources.

Relatively few sites in the Red River Basin have enough pesticide data to warrant statistical analyses and tests for trends in concentrations. Most of the data described in this section are from programs or surveys in which several sites over a large area are sampled infrequently, sometimes only once or several times over several decades. These data are insufficient to assess seasonal variations or long-term trends in pesticide concentrations, but are useful in providing an indication of which pesticides have been detected in surface and ground waters. However, seasonal and long-term patterns in concentrations are far more important in assessing potential contamination of water