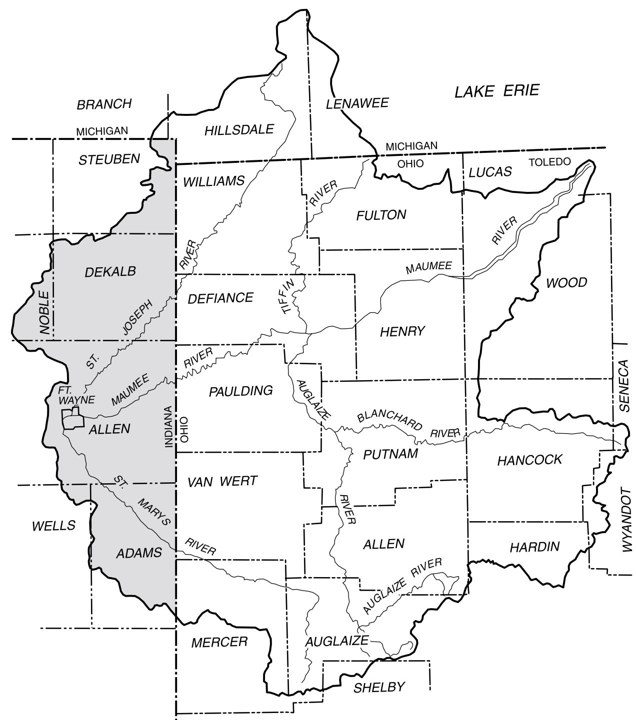
WATER RESOURCE AVAILABILITY IN THE MAUMEE RIVER BASIN, INDIANA - EXECUTIVE SUMMARY

INDIANA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER
published 1996

In response to legislative directives contained in the 1983 Water Resource Management Act, the Indiana Department of Natural Resources, Division of Water published a report describing the availability, distribution, quality and use of surface water and ground water in the Maumee River basin, Indiana.* The fifth in a series of 12 regional watershed assessments, the report provides hydrologic data and related information for persons interested in the basin's water resource. The following is a summary of that report. The full report can be obtained from the Indiana Department of Natural Resources, Division of Water. For ordering information, please see the instructions printed at the end of this summary. The report may also be viewed in its entirety on the web at www.IN.gov/dnr/water/

Figure 1. Location of the Maumee River Basin



The Maumee River basin encompasses a total of 1283 square miles in northeast Indiana (figure 1). Six Indiana counties lie partially within the Maumee River basin. The basin is dominated by its major population center, Fort Wayne. The location of Fort Wayne at the junction of three rivers has made it a focus of commerce and has also caused the city to experience major flooding.

Streams of the basin include the Maumee, St. Marys, and St. Joseph Rivers; Cedar Creek; and an extensive network of smaller tributary streams and ditches. Streamflow leaving the basin enters the state of Ohio and eventually reaches Lake Erie. Although a large portion of the Maumee River Basin lies within Ohio, the discussion below will focus on the Indiana portion of the basin.

SOCIOECONOMIC SETTING

About 61 percent of the Maumee River basin's total population lives in urban areas. Nearly 80 percent live in Allen County. The total population in the basin is growing and is expected to continue to grow in the future.

Per capita income in the basin averages about 97 percent of that for Indiana. Recent unemployment trends are slightly higher than the state average, but lower than the national average. Employment and earnings by industry are largely based on manufacturing, the service industry, wholesale and retail trade, and government. These four economic sectors make up approximately 76 percent of the total employment earnings for the basin.

PHYSICAL ENVIRONMENT

The climate of the Maumee River basin is classified as temperate continental, which describes areas having warm summers, cool winters, and the absence of a pronounced dry season. Precipitation and temperature throughout the basin vary considerably on a daily, seasonal and yearly basis.

*Indiana Department of Natural Resources (Beaty, J.E., ed.), 1996, Water resource Availability in the Maumee River Basin, Indiana: Division of Water, Water Resources Assessment 96-5

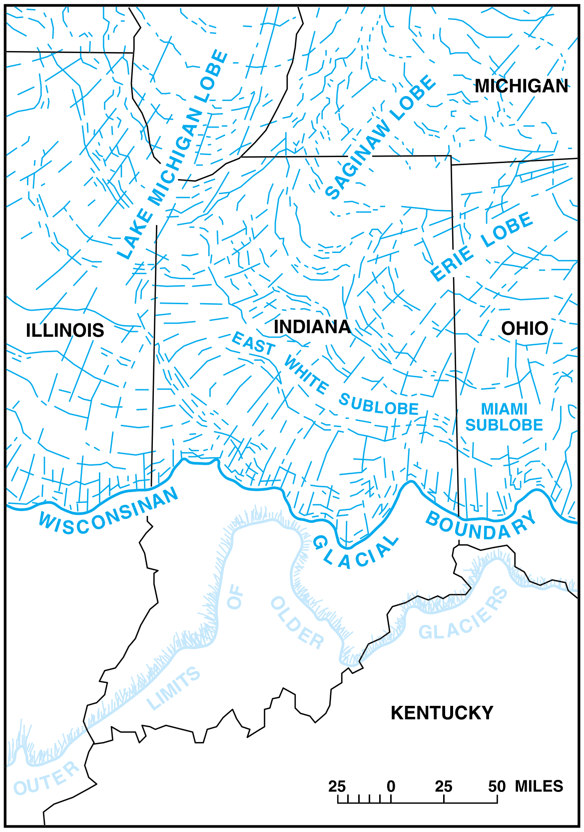


Figure 2. Extent of major ice lobes in Indiana

Annual potential evapotranspiration in the Maumee River basin accounts for approximately 26.43 inches of the 34.5 inches of normal annual precipitation. The theoretical average annual water surplus of more than 8 inches is considered adequate for the basin as a whole; however, the variability of rainfall and its uneven geographic distribution can occasionally limit crops and water surplus.

The landscape of the Maumee River basin is primarily a product of latest Wisconsin glacial events of the Erie and Saginaw ice lobes (figure 2). Major landscape elements include: 1) the Tipton Till Plain which is a vast region of very low relief and generally corresponds to the southern part of the basin; 2) the Maumee Lacustrine Plain, which is a flat, nearly featureless lake bottom that generally corresponds to the central core of the basin; and 3) the Steuben Morainal Lake Area which is characterized by low- to high-relief and generally corresponds to the northern part of the basin.

The land surface over the greater part of the Maumee River basin is underlain by glacial till or till-like sediments. Such sediments are fine- to medium-grained and poorly-sorted having minimal reworking by meltwater and mass movement. The surface till in most of the Maumee River basin is typically clay-rich, reflecting the abundance of both lake and shale bedrock in the source area of the Erie Lobe east of the basin. In contrast, tills of the Saginaw Lobe, which underlie Erie Lobe tills in many places in the northern part of the basin, are sandy due to the combination of coarse-grained bedrock and abundant outwash in the source area.

Deposits formed in glacial lakes are also widespread in the Maumee basin, especially in the east central part of the basin known as the Maumee Lacustrine Plain. Sediments range from silt and clay laid down in quiet water in the central portions of the lake, to coarse sand and gravel associated with high-energy shorelines.

Outwash sediments of sand and gravel also occur in the Maumee River basin in small valley trains along the St. Joseph River and Cedar Creek, and in broader aprons and fans. Large buried outwash bodies also occur at many places in the basin.

The great variability in thickness of the unconsolidated deposits in the southern and northern parts of the basin, 50 to 100 feet and 150 to 400 feet, respectively, is an indication of the differences in glacial activity in the northern and southern parts of the basin.

Regional bedrock structure in the Maumee River basin is controlled by two principal features; the Cincinnati Arch in the south and the Michigan Basin in the north. Bedrock is not naturally exposed at the land surface; but rocks occurring at the bedrock surface range from Ordovician to Mississippian age.

Soil parent materials differ from south to north in the Maumee River basin. In the south, moderately fine textured soils are associated with Lagro glacial till. Very fine to fine textured soils predominate in the lacustrine plain of the east central portion of the basin. Loam and sandy loam soils are a product of the loamy Trafalger till in the northwest.

SURFACE-WATER HYDROLOGY

The surface-water resources of the Maumee River basin include the Maumee, St. Marys, and St. Joseph Rivers; Cedar, Little Cedar, Blue, Fish, and Spy Run Creeks; an extensive network of smaller tributary streams and ditches; two man-made reservoirs; natural lakes; ponds; and scattered remnants of marshes, swamps, and other wetlands.

The present surface-water hydrology of the Maumee River basin is different from the natural drainage conditions

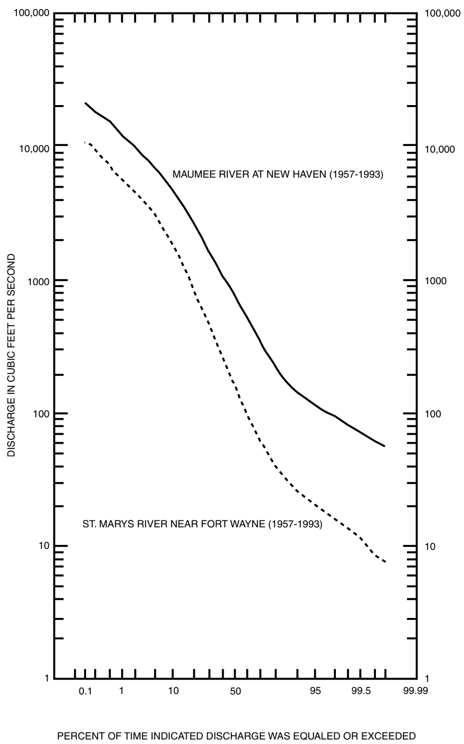
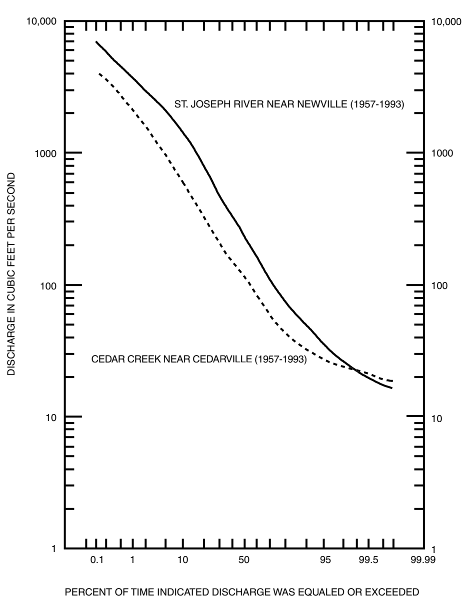


Figure 3. Duration curves of daily mean stream flow for the Maumee River at New Haven and the St. Marys River near Fort Wayne



Duration curves of daily mean stream flow for the St. Joseph River near Newville and Cedar Creek near Cedarville

that existed prior to permanent settlement of the area. The most extensive changes are related to clearing of hardwood forests and ditching and tiling of former swamps.

Of the major streams in the Maumee River basin in Indiana, the St. Marys River has the least potential as a water-supply source. It has the lowest percentage (29 percent) of base flow and the steepest flow-duration curve. The steep flow-duration curve indicates high overland flow and low base flow. Daily flows on the St. Marys are highly variable, but annual flows are fairly consistent (figure 3).

The Maumee River has the most uniform flow characteristics and the highest potential for future development of the streams in the basin. Base-flow on the Maumee during a normal year constitutes about 42 percent of the total runoff.

Of the basin's streams, the St. Joseph River supports the largest number and the highest volume of high-capacity withdrawals, primarily for public supply. The river's value as a water-supply source stems from its large drainage area, the presence of outwash deposits which sustain stream flow, and its water quality. High base flow, approximately 50 percent, on the St. Joseph River is related to the presence of permeable sandy soils and outwash sand and gravel deposits.

The St. Joseph River has two water-supply reservoirs, the Cedarville and Hurshtown, which store water to supplement Fort Wayne's public water supply.

Flooding in the Maumee River basin has caused damage and loss of property many times in the past. Rains and/or snowmelt occurring in winter or early spring are the major contributory causes for peak annual flooding along the major streams in the basin. Floods along the Maumee River are intensified when the St. Joseph and St. Marys Rivers reach peak flow at the same time. Of the counties in the basin, flooding has been most disastrous in Allen County because of urban development in Fort Wayne. Flooding problems in the basin have been addressed by a number of planning and construction initiatives undertaken by local and governmental entities.

SURFACE-WATER QUALITY

The Indiana Department of Environmental Management (IDEM) recently assessed water quality of 764 miles of stream in the Maumee River basin for designated uses of aquatic life support and recreational use (figure 4). For aquatic life support, 649 miles or 85 percent are supportive; 31 miles or 5 percent are supportive, but threatened; nine miles or 1 percent, are partially supportive; and 75 miles, or 9 percent are not considered supportive. For full-body contact recreational use, 110 miles or 14 percent are supportive; 86 percent are not supportive.

The majority of river reaches that do not support aquatic life are impaired by low levels of dissolved oxygen (DO) in the water column. Recreational use impairment is primarily related to high levels of coliform bacteria, specifically E. coli.

Data from the six active IDEM water-quality monitoring stations in the Maumee River basin are used in this study to analyze selected constituents of streams in the Maumee River basin. Results are compared to state and federal water-quality standards.

Apparent seasonal trends are noted in median levels of dissolved oxygen within streams in the Maumee River basin. The variations in seasonal median DO levels may be inversely related to seasonal changes in water temperature. Seasonal variations in specific conductance may not be significant for most stations. There appear to be large seasonal and spacial variations in nitrate-nitrite levels in the rivers of the basin. The seasonal trend in nitrates generally mirrors the runoff from the land surface.

Variations in water quality are observed among samples from different streams and from different locations within the same stream. The highest median dissolved oxygen (DO) is observed in water samples from the St. Joseph River just north of Fort Wayne. In the St. Marys River, there is a trend of increasing median DO levels as the river flows from near the Ohio/Indiana border to the city of Fort Wayne.

Median hardness levels range from about 280 mg/L to 330 mg/L, therefore, the waters in the basin are classified as “very hard”.

Water quality is generally good in the streams of the Maumee River basin, although iron and manganese concentrations commonly are high, and the rivers are frequently turbid. Of the three major rivers in the basin, the St. Joseph has the highest water quality; and the St. Marys suffers the most from water-quality degradation. The Maumee River reflects an ‘average’ water quality due to mixing of water from the St. Joseph and the St. Marys.

In addition to collecting water samples from the basin streams, the IDEM has also collected biological samples of macroinvertebrates and fish to assess the overall health of the aquatic ecosystem. An index of biotic integrity is developed based on the number and types of species collected.

The IDEM has completed the preliminary phase in a macroinvertebrate sampling program by sampling 26 sites in the basin’s three major drainage systems and developing a provisional macroinvertebrate Index of Biotic Integrity (mIBI). Of the 26 sites evaluated in the Maumee River basin, only one is classified as non-impaired; 17 are slightly impaired; and eight are moderately impaired; none of the sites sampled are classified as severely impaired.

In 1991, the USEPA and IDEM sampled fish populations in the Maumee River basin in Indiana. A total of 77 sites were sampled to develop an Index of Biotic Integrity (IBI) for the basin. The three major rivers in the basin were evaluated using the IBI. Overall trends are toward increasing biological integrity with increasing drainage area. In general, the St. Joseph River and its tributaries contain the most diverse fish community in the basin, and the St. Marys, the least.

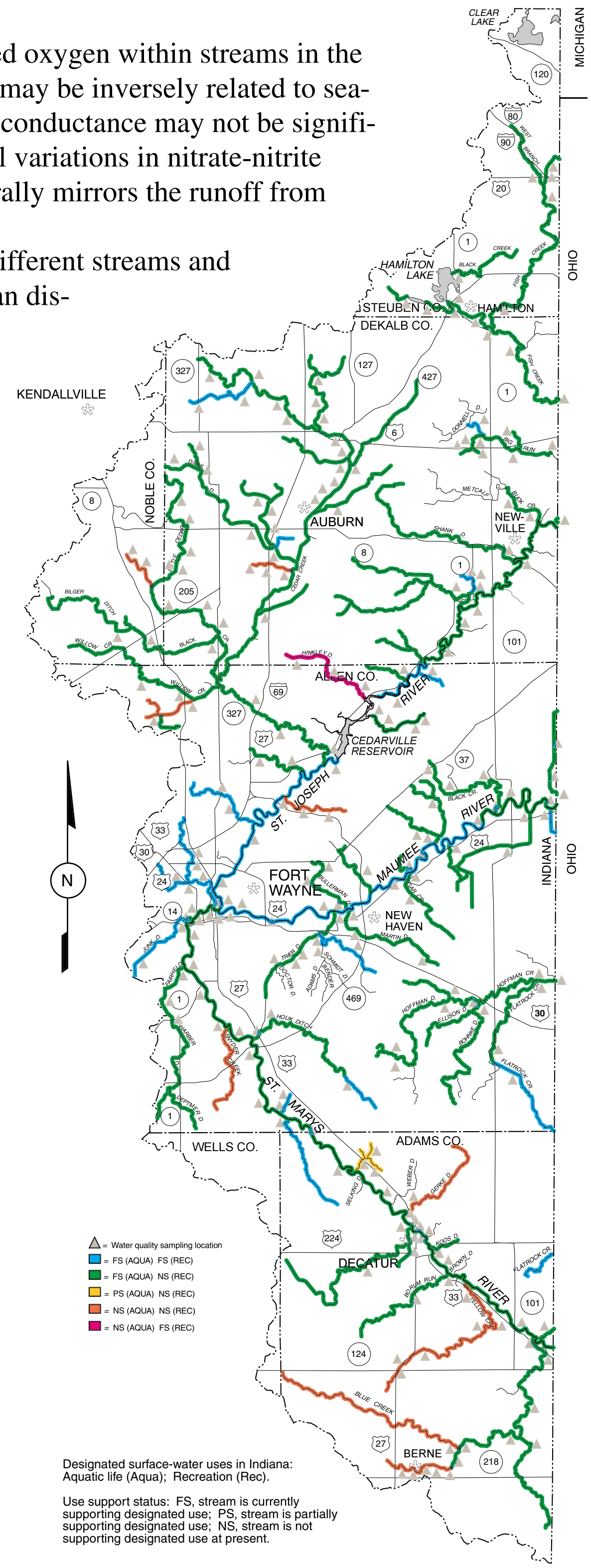


Figure 4. Designated uses and use - support status of selected streams
(adapted from Indiana Department of Environmental Management (IDEM) 1992 - 1993 305(b) (1995) and selected IDEM files

GROUND-WATER HYDROLOGY

Ground-water availability in much of the Maumee River basin is considered fair to good. The most important aquifers in

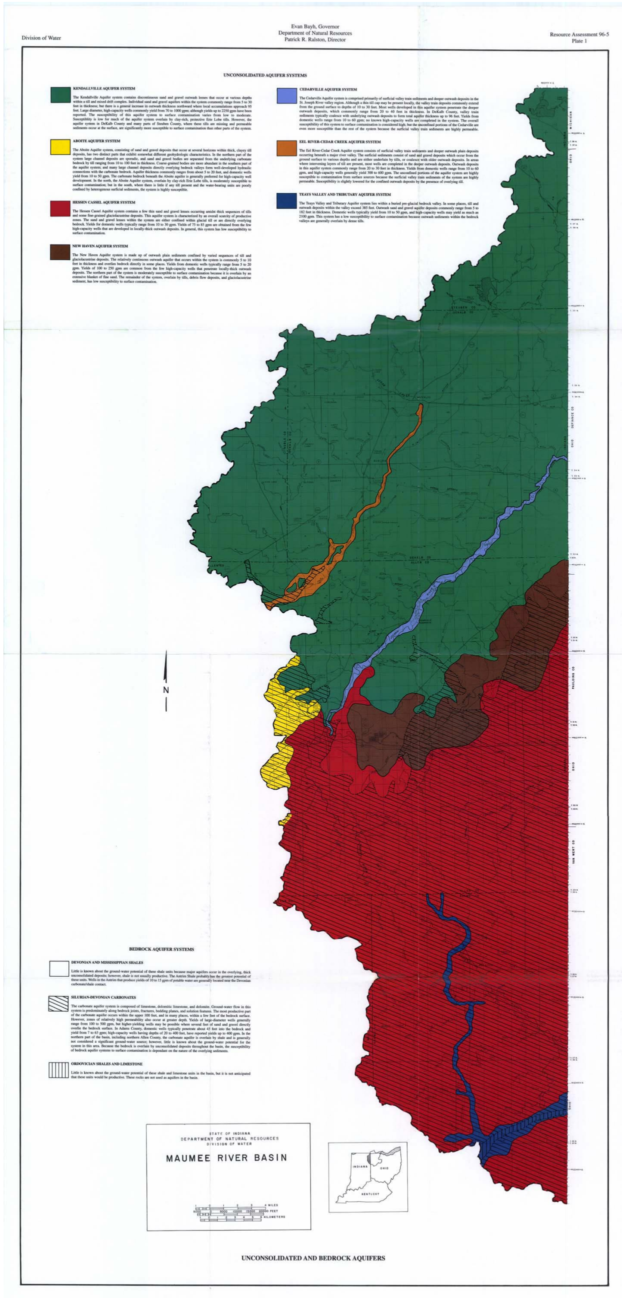


Figure 5. Aquifer systems.
(**click here to enlarge**)

the northern part of the basin, which comprises about 60 percent of the total area, consist of unconsolidated deposits of sand and gravel. In most of the southern part of the basin, Silurian and Devonian carbonates form the principal aquifer, although sand and gravel deposits in and above buried bedrock valleys are important in southern Adams County.

Seven unconsolidated aquifer systems are defined according to hydrologic characteristics of the deposits and environments of deposition. Two bedrock aquifer systems are defined on the basis of hydrologic and lithologic characteristics (figure 5).

Only two of the seven unconsolidated aquifer systems are laterally extensive in the Maumee River basin; the Kendallville Aquifer system and the Hessen Cassel Aquifer system.

The Kendallville Aquifer system, extending across much of the northern half of the basin, consists of sand and gravel lenses occurring at various depths within a till and mixed drift complex that contains appreciable fine-grained sediments. Thickness of individual sand and gravel units within the system commonly ranges from 5 to 30 feet. Expected high-capacity yields range from 70 to 1000 gpm; but yields up to 2250 are reported in some areas. Of the aquifer systems in the basin, the Kendallville has the highest potential for future ground-water development.

The Hessen Cassel Aquifer System consists of scattered lenses of glacial outwash occurring amidst thick sequences of tills and, along its northeastern extent, some fine-grained glaciolacustrine deposits. Although the aquifer system extends across most of the southern part of the basin, there is an overall scarcity of productive zones of sand and gravel within this system. The sand and gravel lenses are commonly 5 to 10 feet thick and are either confined within glacial till or are overlying bedrock. Locally-thick outwash deposits may produce yields from 75 to 85 gpm for high-capacity wells.

Other less extensive but locally-important unconsolidated aquifer systems include: New Haven, Cedarville, Eel River-Cedar Creek, Aboite, and the Teays Valley and Tributary.

The New Haven Aquifer system is relatively contiguous across its extent in north-central Allen County. It consists of outwash plain sediments confined by varied sequences of till and glaciolacustrine deposits. The aquifer, which commonly ranges from 5 to 10 feet in thickness, directly overlies bedrock in some places. High-capacity wells that penetrate locally-thick outwash deposits commonly yield from 100 to 250 gpm.

The Cedarville and the Eel River-Cedar-Creek aquifer systems, both occurring beneath major river valleys, have small areal extent in the Maumee River basin. Each consists of surficial valley train sediments and deeper outwash sand and gravel deposits having potential for ground-water development. Little is known about high-capacity yield potential of the Cedarville Aquifer system; but anticipated yields for the Eel River-Cedar Creek Aquifer system range from 300 to 600 gpm.

The Aboite Aquifer system located in west-central Allen County, consists of sand and gravel deposits that occur at several horizons within thick, clayey till deposits. The system is comprised of two distinct parts which exhibit somewhat different geohydrologic characteristics.

Sand and gravel deposits are more sporadic and less numerous in the northern part of the Aboite aquifer system than in the south. In addition, the productive deposits in the north do not have good hydraulic connection with the carbonate bedrock aquifer beneath them; whereas in the south, many such deposits directly overlie the carbonate. Common thickness of the individual aquifers that comprise the Aboite Aquifer system ranges from about 5 feet to 20 feet. Expected high-capacity yields range from 200 to 600 gpm, but yields up to 1000 gpm are reported in some areas.

The Teays Valley and Tributary Aquifer system consists of unconsolidated deposits in a buried pre-glacial bedrock in southern Adams County. In places, tills and outwash sediments above the bedrock valley exceed 385 feet in thickness. Outwash deposits of sand and gravel range from 5 to 185 feet in thickness in the main valley; and high-capacity wells may yield as much as 2100 gpm.

The Silurian-Devonian Carbonate bedrock aquifer system is the most utilized aquifer system in the southern part of the Maumee River basin. However, water-yielding capabilities of the aquifer system are not uniform throughout its extent. It is comprised of limestone, dolomite, and dolomitic limestone and is the only bedrock aquifer in the basin capable of supporting high-capacity pumpage. Yields from high-capacity wells range from 100 to 500 gpm, but higher yields may occur in areas where several feet of sand and gravel are present just above the bedrock surface.

GROUND-WATER QUALITY

Ground water in the Maumee River basin is generally hard to very hard and neutral to slightly alkaline. Ground-water chemistry in the northern part of the basin is dominated by calcium, magnesium, and bicarbonate; whereas, it is dominated by calcium, magnesium, and sulfate in the south. In general, ground water in the north is less mineralized than in the south.

Ground water in most of the basin meets drinking-water standards, although iron commonly exceeds the Secondary Maximum Contaminant Level (SMCL). Other constituents that commonly exceed SMCLs include manganese and total dissolved solids (TDS). Fluoride also equals or exceeds the SMCL in four samples from the bedrock and one sample from the Hessen Cassel Aquifer system; however, no sample exceeds the Maximum Contaminant Level (MCL) for fluoride.

Nitrate concentrations in the basin are generally below 1 mg/L except for three wells in Allen County and one in Adams. One of the ground-water samples from Allen County exceeds the MCL for nitrate.

Median sulfate concentrations in ground water of the Maumee River basin exceed the SMCL for all aquifer systems analyzed except the Kendallville. The relative

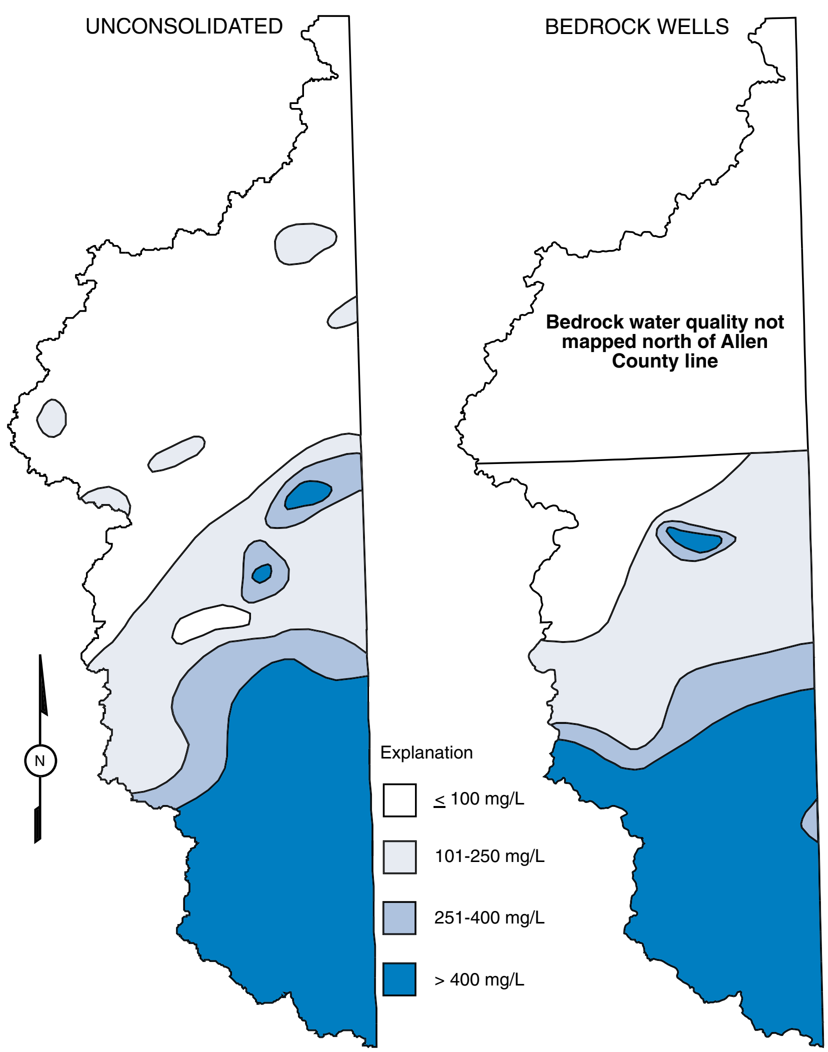


Figure 6. Generalized areal distribution for **Sulfate**

proportion of samples having concentrations of sulfate exceeding the SMCL varies considerably among aquifer systems. In general, ground-water in the southern part of the basin exceeds the SMCL for sulfate (figure 6).

Relative to other regions of the country, ground water in the Maumee River basin has high concentrations of strontium. Concentrations of strontium in most ground water generally range between 0.01 and 1.0 mg/L. In the Maumee River basin, samples from the unconsolidated and bedrock aquifer systems have median strontium concentrations of 4.4 mg/L and 9.7 mg/L, respectively. Strontium levels in the southern portion of the basin are approximately twice as high as those in the north. There is no SMCL or MCL established for strontium.

The Kendallville Aquifer system, occupying most of the northern half of the basin, is the least mineralized system analyzed; however, the median total dissolved solids (TDS) level for the system slightly exceeds the SMCL. This system has the lowest median hardness and the lowest median concentrations for sodium, chloride, sulfate, strontium, calcium, magnesium, potassium, and TDS of those analyzed in the basin. Alkalinity levels for this system are among the highest found in the basin.

The Teays Valley and Tributaries Aquifer system is the most highly-mineralized system analyzed; however, it should be noted that this system has a small sample set. The median TDS level for the samples in this system exceeds the SMCL by a factor of three; and sulfate concentrations exceed the SMCL for all samples. This aquifer system has the highest median hardness, the highest median concentrations for sodium, chloride, sulfate, fluoride, calcium, magnesium, potassium, and TDS of those analyzed.

The Silurian-Devonian Aquifer system, the primary ground-water source for most of the southern half of the basin, is the second most highly-mineralized system analyzed. Median total dissolved solids (TDS) levels exceed the SMCL for over 75 percent of the wells sampled. Sulfate concentrations are in excess of the SMCL for over 70 percent of the wells sampled, and hydrogen sulfide gas is often detected. Fluoride concentrations also equal or exceed the SMCL for some samples. Two of the unconsolidated aquifer systems, the Hessen Cassel and the New Haven Aquifer systems, have very similar ground-water chemistry to the underlying Silurian-Devonian Carbonate bedrock aquifer system. In general, the concentrations of individual constituents in the two unconsolidated aquifers are slightly lower than those in the bedrock aquifer system. However, the median concentrations of sulfate in the two systems are much lower, approximately 40 percent, than those in the underlying bedrock. In contrast to most other constituents, alkalinity values for both unconsolidated systems are higher than those in the Carbonate. The New Haven Aquifer system has the highest median alkalinity of the aquifer systems tested in the basin.

The highly complex relationships of the various glacial deposits in the Maumee River basin preclude site-specific comments about susceptibility of the regional aquifer systems to contamination. However, a few gross generalizations can be made. In general, the basin aquifer systems are not highly susceptible to surface contamination. The surficial deposits covering the greater part of the Maumee River basin are comprised of glacial till or till-like sediments which are not highly permeable. Lacustrine sediments, which are also important surficial sediments in the basin, also have low permeability. Only the Cedarville and Eel River-Cedar Creek Aquifer systems, having unconfined sand and gravel surficial sediments, are considered to be highly susceptible to surface contamination.

Numerous ground-water protection initiatives have been undertaken in the state in recent years, including development of a Ground-Water Protection Strategy and Implementation Plan and a Wellhead Protection Plan.

WATER USE AND PROJECTIONS

The total demand for water in the Maumee River basin is expected to increase in future decades, particularly in the Fort Wayne area, as the population and economy continue to grow.

Water withdrawn by registered water withdrawal facilities in the Maumee River basin totals 18.7 billion gallons. Surface-water accounts for approximately 79 percent of the total water withdrawn. Most of the water is used for public supply and industrial purposes, approximately 76 and 20 percent, respectively. Water withdrawal for agriculture and energy comprise the remaining four percent. Most of the registered facilities, approximately 80 percent, are located in Allen County.

A general increasing trend in demand is projected for most water withdrawal and instream uses in the basin.

WATER RESOURCE DEVELOPMENT

Future water demands in the Maumee River basin are expected to remain high, especially public water supply for the large population.

Lakes and wetlands will continue to provide a wide range of recreational opportunities, fish and wildlife habitat, various hydrologic benefits, and in a few cases, minor water supply sources. However, these systems are not considered as significant sources of supply because of their limited storage capacity, water-quality considerations, and regulatory, economic and environmental constraints.

The largest withdrawals from streams come from the St. Joseph and the Maumee Rivers. The largest volumes of water withdrawn are used for public supply and industrial purposes. Stream withdrawals are expected to remain high. Surface-water supply in the basin generally exceeds demand because streamflow in the St. Joseph River is augmented by storage from the two reservoirs. However, during periods of low stream flow, withdrawals from the St. Joseph River for public supply may produce instream use impacts on streamflow downstream of the public supply intake point.

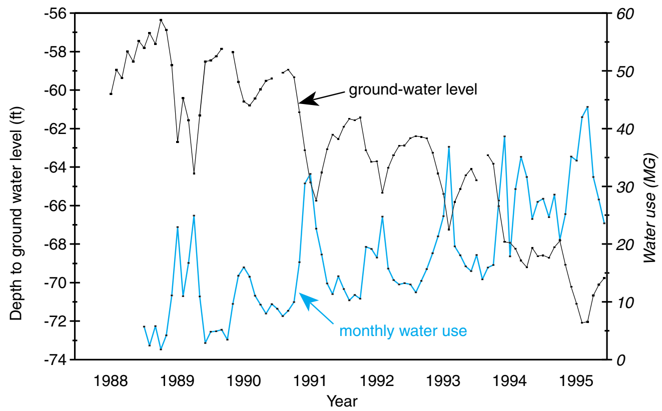


Figure 7. Mean monthly ground-water levels in Allen 8 and monthly pumpage from nearby public-supply wells

Ground-water withdrawals in the Maumee River basin are used primarily for public and domestic water supply and dewatering for industrial purposes. Although ground-water supplies are generally adequate for current demand in much of the Maumee River basin, increasing demands may continue to create localized or short-term conflicts among ground-water users.

Ground-water use conflicts in the Maumee River basin and vicinity have occurred primarily as a result of dewatering operations at limestone quarries and ground-water withdrawals by public supply facilities. Impacts have occurred mostly in localized areas of the carbonate bedrock aquifer system in Allen County and the Teays Valley and Tributary Aquifer system in southern Adams County.

Although the carbonate bedrock aquifer appears capable of supporting current water withdrawals in the area, continued increases in high-capacity pumpage for public supply should be carefully planned to minimize possible ground-water conflicts in the future (figure 7). If the population continues to grow in the greater Fort Wayne area, and if the population density continues to shift from many sectors of the city of Fort Wayne to the west and north-west, there will be a shift from dependance on surface water as a primary supply source for public supply to greater dependence on ground water.

Further ground-water development in and around the basin should be carefully planned to minimize conflicts among the many ground-water users of the region.

Provisions in Indiana laws, particularly IC 14-25-4, will remain a key factor in developing and protecting ground-water resources in and around the Maumee River basin. Additional regulations, water conservation practices, and improved management may be needed to protect ground water in localized areas.

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