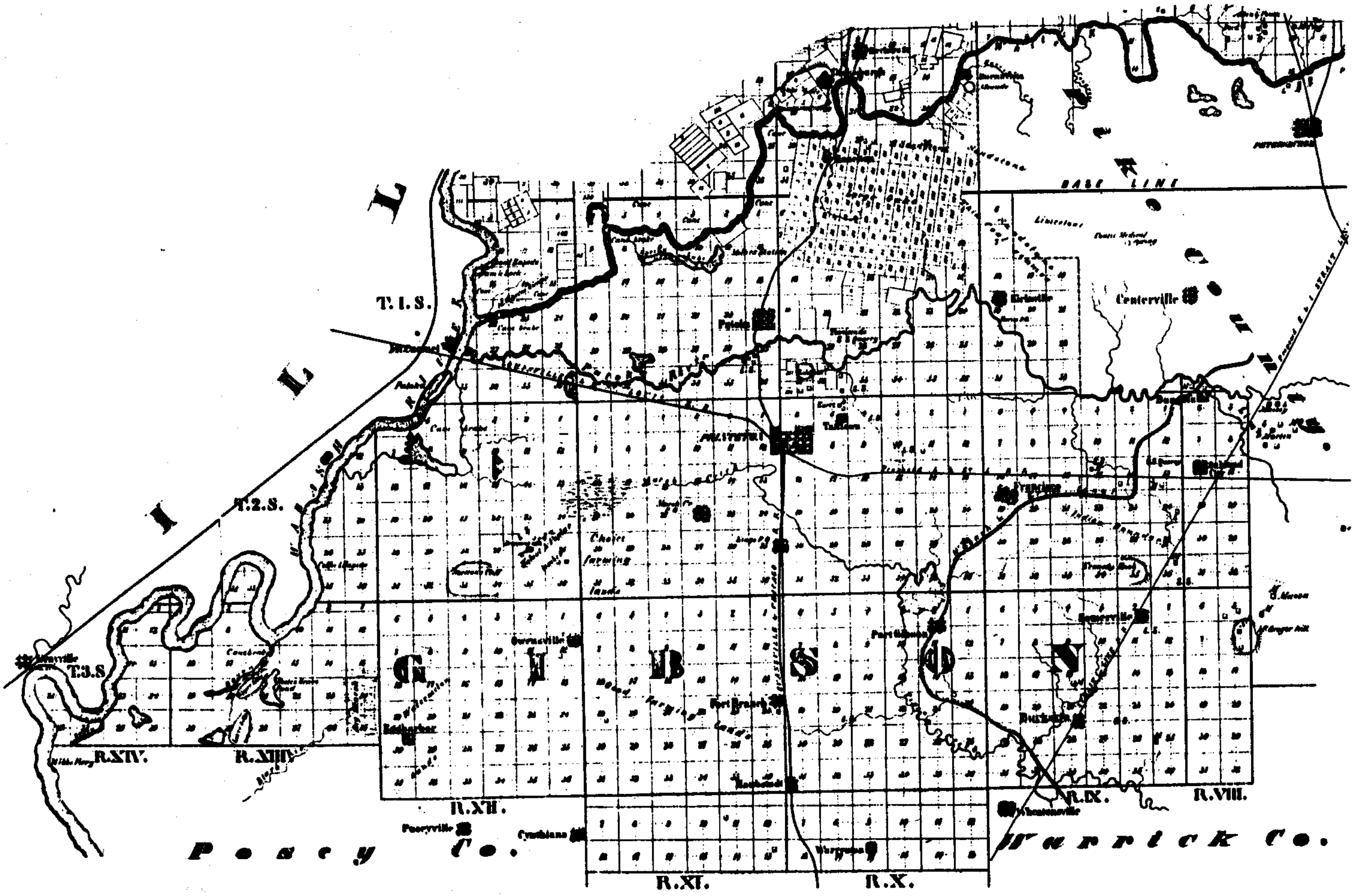
HYDROGEOLOGY OF GIBSON COUNTY, INDIANA



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DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER

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HYDROGEOLOGY OF GIBSON COUNTY, INDIANA

By John R. Barnhart, Bruce H. Middleman

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CONTENTS

ILLUSTRATIONS

TABLES

PLATES
(in pocket)

INTRODUCTION

Purpose and Scope

The purpose of this report is to determine the depth and extent of the principle aquifers of Gibson County, describe their characteristics, and define the general groundwater quality.

Data on which this report is based were compiled from water well records, oil and gas well records, coal mine permits, and water analyses on file with the Indiana State Board of Health and the Indiana Department of Natural Resources.

Previous Investigations

A description of ground water occurrence and availability was included in the Geologic Atlases of the 30 minute Ditney and Patoka Quadrangles by Fuller and Ashley (1902) and Fuller and Clapp (1904). A brief report on water availability was made by Harrell (1935). Significant geologic and physiographic studies have been made by Collett (1874), Malott (1922, 1948), Fidlar (1948), Thornbury (1937, 1950), Friedman (1954), Wier (1955), Eggert (1982, and in preparation), and Ault, Sullivan, and others (1982).

Location

Gibson County is located in southwestern Indiana along the Illinois-Indiana state line (Figure 1). It is bounded on the east by Pike County, on the north by Knox County, and on the south by Posey, Vanderburgh, and Warrick Counties. The city of Princeton is the county seat.

Geologic Setting

Gibson County is located on the eastern shelf of the Illinois Basin, a prominent regional downwarp centered in southeastern Illinois and encompassing parts of Indiana, Illinois, and Kentucky. The basin is roughly oval in shape with the long axis oriented northwest - southeast. The Cincinnati and Kankakee arches form the eastern and northern boundaries of the basin in Indiana.

During the Paleozoic Era the Illinois Basin underwent repeated cycles of subsidence and uplift with consequent sedimentation and erosion. The cycles stopped in late Pennsylvanian or early Permian time when the basin was uplifted and subjected to a final episode of degradation. The remaining thickness of Pennsylvanian rocks in Gibson County is about 1200 to 1900 feet.

Post-depositional tectonism produced major and minor faulting in the basin. Two of these faults are found in Gibson County. The northeast trending New Harmony Fault (Figure 2) cuts across extreme western Gibson County and has more than 400 feet of vertical displacement. The west central Owensville fault also trends northeast but has much less displacement and appears to end north of Owensville (Ault and Sullivan, 1982).

Fig. 1. Location of Gibson County

During the Pleistocene period, Gibson County was mantled with till, outwash, and loess deposits from successive cycles of continental glaciation which ended approximately 8,000 years ago (Wayne, 1966) with the withdrawal of the Wisconsinian glaciers from Indiana.

Physiography

Gibson County lies entirely within the Wabash Lowland physiographic region defined by Malott (1922). The topography includes rugged uplands, gentle rolling hills, broad flat lacustrine plains, and the Wabash River Valley punctuated with isolated valley braid core hills. The three most influential controls on topographic expression in the Wabash Lowland have been denudation, glaciation, and the filling of valleys (Malott, 1922).

The highest point in the county is located in the rugged hills northeast of Princeton at an elevation of 640 feet above sea level. The lowest point is about 355 feet above sea level at the Gibson-Posey County line on the Wabash River. The maximum total relief is 285 feet whereas the maximum local relief is about 250 feet (Malott, 1922).

Surface Drainage

The northern part of Gibson County is drained by Patoka and White Rivers which join the Wabash River at the western edge of the county. The central and southeastern portions of the county are drained by tributaries of Pigeon Creek which flow southward to the Ohio River. The southwestern portion is drained by ditches, small streams, and the Black River which flow into the Wabash River.

The U.S. Geological Survey maintains stream gaging stations on Patoka River, Wabash River, and Pigeon Creek (Glatfelter, Stewart, and Nell, 1985) Water quality of the Patoka River is monitored biweekly by the Indiana Department of Environmental Management, Office of Water Management (formerly the Board of Health Stream Pollution Board). Records are available from 1957 to present (Indiana Water Data Directory, Draft, 1987).

Climate

Records of temperature and precipitation at Princeton, Indiana have been maintained since 1882 and are published by the National Oceanic and Atmospheric Administration (NOAA).

The average annual temperature at Princeton is 55.6° F. and the average annual precipitation is 43.85 inches (NOAA, 1984).

HYDROGEOLOGY OF THE BEDROCK AQUIFERS

The principal bedrock aquifers in Gibson County are middle and upper Pennsylvanian fluvial and deltaic sandstones. These sandstones generally are found in narrow channels or broad sheets, are variable in thickness, and are frequently interbedded with shales or grade laterally into shales or siltstones. Although these sandstones have relatively low permeabilities and commonly produce 4 gallons per minute (gpm) of water or less, in many areas they constitute the only available source of potable water. Fractured coals and jointed limestone beds are also used as aquifers in the consolidated rocks. However, the occurrence of joints and fractures at depth is not readily predictable and they are too limited in extent to be of great importance as aquifers. Elevation contours on the surfaces of the two major bedrock aquifers are shown on plates 1 and 2. Depths may be determined by subtracting the elevation of the top of the aquifer at a particular location from the corresponding ground surface elevation.

Petersburg and Dugger Formations

The Petersburg and Dugger Formations are the middle and upper units of the middle Pennsylvanian Carbondale Group (Figure 3). Potential aquifers in these formations are limited to channel and sheet sandstones.

These channel sands were deposited with associated silt and mud in the meandering river channels of Pennsylvanian deltas. The channel-fill deposits are lenticular in cross-section and sinuous in plan view (Eggert, 1982). Wells completed in channel sandstones may produce from 1 to 5 gpm. These sandstones are limited in extent and are only present locally. Sheet sandstones generally were deposited in laterally shifting channels or as crevasse-splay deposits. These deposits are also limited in extent and are used as aquifers locally. These channel and sheet sandstones have been mapped by Eggert but have not yet been published.

Shelburn Formation

The Shelburn Formation is the basal unit of the upper Pennsylvanian McLeansboro Group in Indiana (Figure 3). The Shelburn consists of coal, shale, siltstone, sandstone, and limestone. The formation crops out throughout eastern Gibson County (Figure 2). The chief aquifer of the Shelburn Formation is the Busseron Sandstone. The Busseron is a gray to tan, fine to medium grained sandstone. This sandstone is predominantly massive but also occurs interbedded with gray shale in parts of Gibson County. The Busseron overlies the Danville Coal or occupies channel cutouts in the coal (Wier and Ault, 1986). In Gibson County the Busseron Sandstone generally ranges from 20 to 50 feet in thickness but may be as much as 90 feet thick in places. Water yields range from less than 1 gpm to 5 gpm. Elevation contours on the top of the Busseron Sandstone are shown on Plate 1. Cable, Watkins, and Robison (1971) designated this sandstone as the unit 6 aquifer in Vigo and Clay Counties.

Patoka Formation

The Patoka Formation directly overlies the Shelburn Formation in the McLeansboro Group in Indiana (Figure 3). The Patoka consists of interbedded shale, siltstone, sandstone, and minor beds of coal and limestone. This formation crops out in the western half of Gibson County (Figure 2). The basal Inglefield Sandstone Member is the chief aquifer of the Patoka Formation. Robison (1971) referred to this aquifer as the Inglefield Sandstone Aquifer in Posey County. Lateral

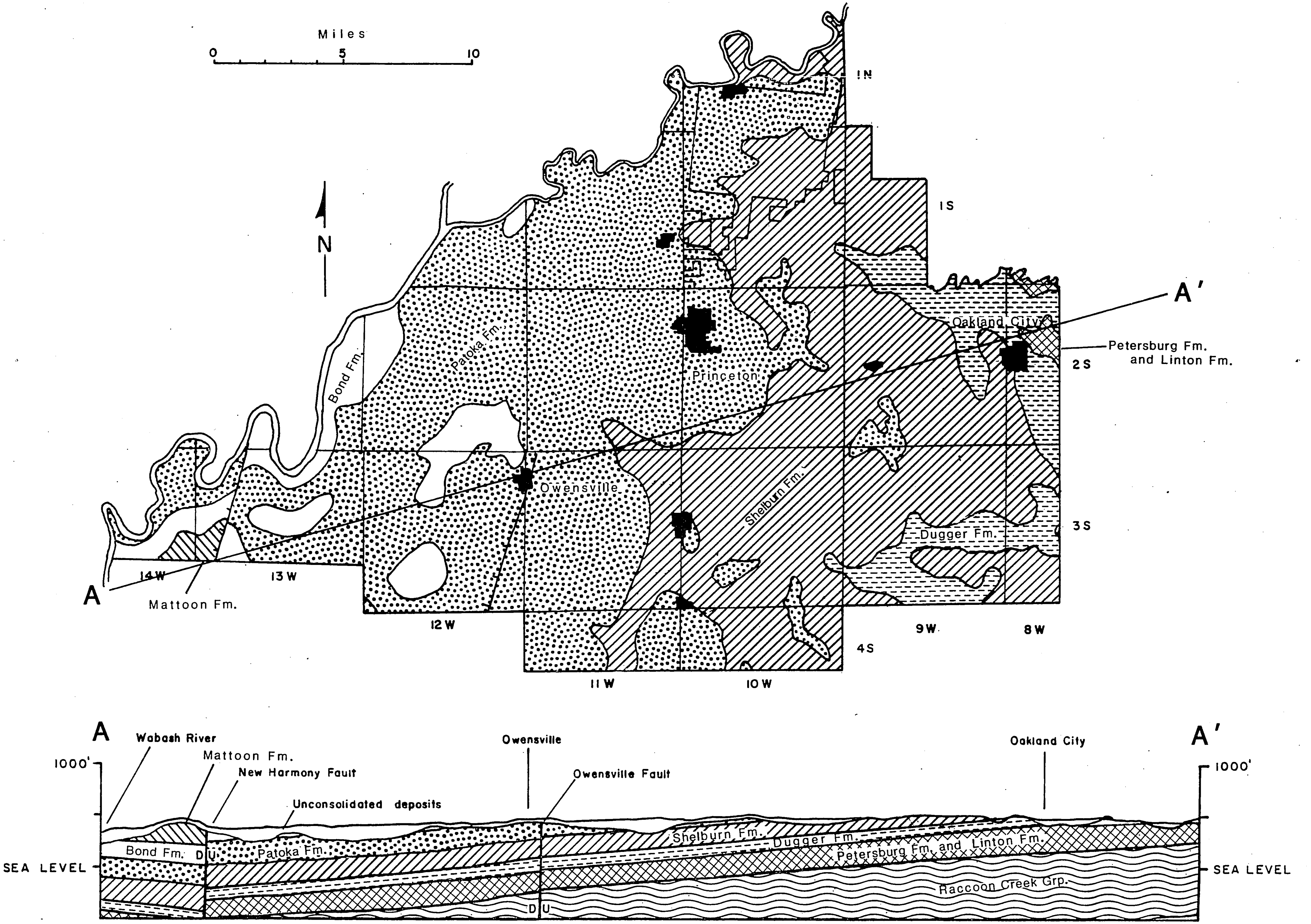

Fig. 2. Bedrock Geology of Gibson County, Indiana (modified from Gray, H.H., Ault, C.H., and Keller, S.J., 1987, Bedrock Geology Map of Indiana: Indiana Dept. Natural Resources, Geol. Survey Misc. Map 48).

SYSTEM	SERIES	GROUP	FORMATION	MEMBER UNLESS BED IS STATED
PENNSYLVANIAN	MISSOURIAN	McLeansboro	Mattoon	Merom Ss.
				Cohn Coal
			Bond	Livingston Ls.
				Riverview Ls.
				Fairbanks Coal
				St. Wendel Ss.
				Carthage Ls.
			Patoka	Parker Coal
				Raben Branch Coal
				Dicksburg Hills Ss.
				Vigo Ls.
				Hazelton Bridge Coal
				Inglefield Ss.
				Ditney Coal
	DESMOINESIAN		Shelburn	West Franklin Ls.
				Pirtle Coal
				Busseron Ss.
		Carbondale	Dugger	Danville Coal
				Universal Ls.
				Anvil Rock Ss.
				Hymera Coal
				Providence Ls.
				Herrin Coal
				Bucktown Coal
				Antioch Ls.
				Alum Cave Ls.
			Petersburg	Springfield Coal Mbr. Folsomville Mbr.
				Stendal Ls.
				Houchin Creek Coal
			Linton	Survant Coal
				Velpen Ls.
				Mecca Sh.
				Colchester Coal
				Coxville Ss.
		Raccoon Creek	Staunton	Seelyville Coal
				Silverwood Ls.
				Holland Ls.
				Perth Ls.

Fig. 3. Paleozoic statigraphy of Gibson County

(modified from Shaver, R.H., and others, 1986, Compendium of Rock-Unit Stratigraphy in Indiana Dept. Natural Resources Geol. Survey Bull. 59

changes in this sandstone limits its use as an aquifer. Therefore, the name Inglefield Aquifer is recommended. Cable and Wolf (1977) named the Inglefield Sandstone and the underlying West Franklin Limestone the Patoka Aquifer in Vanderburgh County. However, water well records in Gibson County do not indicate a good hydrologic connection between these two members. Therefore, the name Patoka Aquifer should not be used in Gibson County.

The Inglefield Sandstone is fine-grained, thin to thick bedded and weathers to a light gray or buff color (Wier and Ault, 1986). The thickness of the sandstone ranges from about 20 to 40 feet in Gibson County. In drill samples, the Inglefield member is gray to white and is usually very friable.

Typically wells yield 3-5 gpm although yields of 5-10 gpm are possible. Yields of 5-10 gpm are considered sufficient for most domestic use. Elevation contours on the top of the Inglefield Sandstone are shown on Plate 2.

The Dicksburg Hills Sandstone overlies the Hazelton Bridge Coal Member of the Patoka Formation (Figure 3). In its type locality, Sec. 18, T.1N., R.10W, Knox County, Indiana, it is composed of coarse angular quartz grains with abundant interstitial kaolin (Malott, 1948). Few wells are completed in the Dicksburg Hills sandstone. Most well records report this interval as sandy shale or shaly sandstone. This unit is probably too impermeable to serve as an aquifer in Gibson County.

Bond and Mattoon Formations

No evaluation of the sandstones in these formations was possible because of a lack of data. These formations subcrop beneath the thick alluvium of the Wabash River Valley. The water availability of the alluvial aquifer is so great that water wells are rarely, if ever, completed in the bedrock.

UNCONSOLIDATED DEPOSITS

The surficial deposits of Gibson County consist predominantly of Illinoian age till, outwash and valley train sands and gravels, and lacustrine silts and clays (Figure 4). The till which is present both in the uplands adjacent to the Wabash Valley and upon isolated erosional remnants or braid cores on the valley floor, suggest that at the time of deposition the pre-Illinoian Wabash Valley was completely filled with drift forming a relatively flat till plain (Fidlar, 1948). Numerous ice-marginal lakes formed during this time as meltwaters ponded along the fringe of the ice-front. In areas where drainage was directed away from the ice-front, such as the rolling plain south of Princeton, Indiana, outwash plains were created. (Fidlar, 1948).

During the Sangamon inter-glacial period the till plain was severely dissected by meltwaters from the retreating ice-front. This inter-glacial stage was also a time of minor eolian deposition and extensive weathering and leaching of Illinoian till in the Wabash Valley (Fidlar, 1948). As the Illinoian ice-front retreated, major

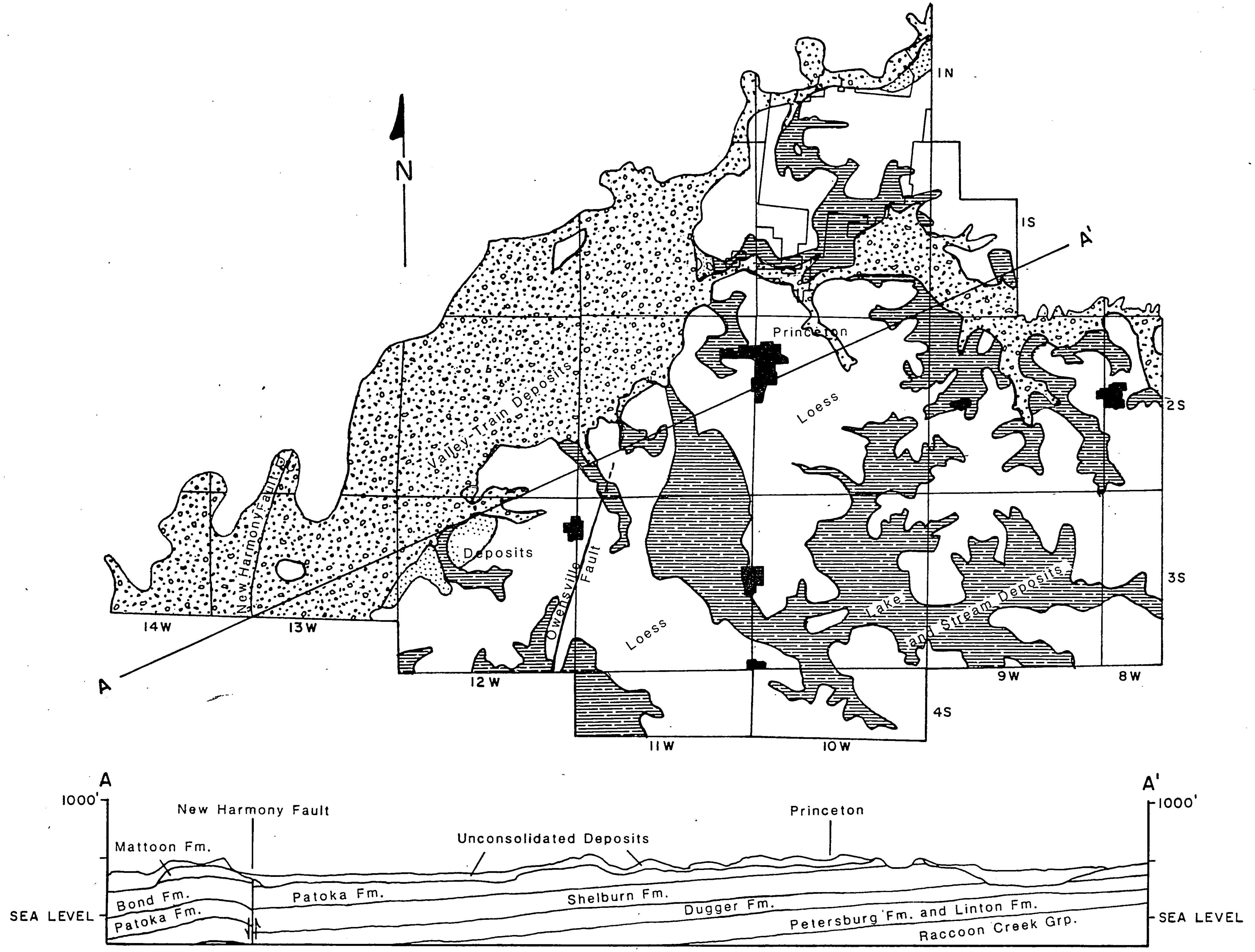

Fig. 4. Unconsolidated deposits of Gibson County, Indiana. (modified from Gray, H.H., Wayne, W.J., and Wier, C.E., 1970, Geologic Map of the 1 x 2 Vincennes Quadrangle and parts of adjoining quadrangles, Indiana and Illinois, showing bedrock and unconsolidated deposits: Indiana Dept. Natural Resources, Geol. Survey Regional Geol. Map 3, Part B)

drainage routes were formed above the larger buried valleys of the preglacial Wabash drainage system. Fidlar (1948) suggests that differential compaction of the glacial drift and minor regional upwarping (isostatic rebound) probably contributed to the formation of these drainage routes. In these areas, Illinoian till was eroded and thick sequences of valley-train sands and gravels were deposited.

Further modification of Illinoian drift in Gibson County occurred during the Wisconsinan as meltwaters from this later ice sheet flowed down the Wabash Valley forming prominent terraces in the outwash. Lacustrine silts and clays were deposited as water ponded in tributary valleys dammed by sands and gravels deposited in the main valleys. In Gibson County, where tributary valleys were relatively broad, glacial lakes formed over large areas. (Thornbury 1937, 1950). The distribution and nature of lacustrine plain deposits in Gibson County are discussed in detail by Thornbury (1950) and Fidlar (1948).

The thickness of the Illinoian and Wisconsinan drift in Gibson County varies from a maximum of 140 feet along the flood plain of the Wabash to less than 10 feet in the higher elevations to the southeast. The most prolific aquifers are thick valley train sands and gravels in the Wabash River Valley. These deposits range in thickness from 30 to greater than 100 feet and are laterally continuous parallel to the valley. Some water wells in these areas are capable of producing 1000 gpm or more. In contrast, inter-till and outwash sands and gravels located outside of the river valleys tend to be less than 30 feet thick and are laterally discontinuous. Although wells capable of producing several hundred gpm are possible from these aquifers, production is generally much less. In southeastern Gibson County, where the unconsolidated cover is commonly less than 20 feet thick, water production is from the underlying bedrock.

WATER QUALITY

The chemical quality of Gibson County ground water was determined using analyses from coal mine permits on file at the Division of Reclamation, Indiana Geological Survey records, Indiana State Board of Health records, water chemistry data compiled by Geoscience Research Associates, and an unpublished thesis. These analyses are tabulated in Table 1. Because these analyses were performed by several different laboratories using, in some cases, different analytical methods a great deal of caution must be used in interpretation. However, some general trends in ground water quality can be identified.

Hardness

The water from the consolidated and unconsolidated aquifers is generally hard. This hardness is caused by the presence of dissolved calcium and magnesium in the water. Calcium and magnesium may be dissolved from limestone or dolomite fragments in the unconsolidated sediments or from limestone beds or carbonate cement in consolidated rocks. Calcium and magnesium react with soap to form soap curd. Hard water will not become sudsy until enough soap is added to remove the calcium and magnesium from the water. Therefore, hard water requires more soap than an equal volume of soft water.

Calcium and magnesium may be deposited in plumbing as scale which can completely plug pipes and reduce the efficiency of heaters and boilers.

For domestic purposes, hard water becomes objectionable at concentrations of about 100 mg/l or greater (Hem, 1985). Hardness concentrations in Gibson County are as much as four times this amount.

Iron

Most of the chemical analyses for wells in Gibson County (Table 1) have iron concentrations greater than the secondary maximum limit (0.3 mg/l, Table 2).

Iron is the second most abundant element in the outer crust of the earth. This mineral is found in most Pennsylvanian sandstones as magnetite and iron oxides (Greensburg, 1960) and is also abundant as pyrite in Pennsylvanian coals (Erd and Greensburg, 1960).

Ground water iron concentrations are normally low because iron solubility is strongly dependent on oxidation conditions and pH. But even low concentrations of iron can be objectionable as concentrations of 0.3 mg/l or greater may cause staining of clothes and plumbing fixtures.

Iron bacteria, which utilize the oxidation reaction of dissolved iron, can increase or decrease the iron content of well water. These bacteria precipitate iron bound in organic material forming a slime which can plug well screens and plumbing. Destroying iron bacteria in a well is difficult and may only be temporary (Hem, 1985).

Chloride

Chloride levels in Gibson County ground water are usually less than 100 mg/l. The chloride taste threshold for most people is about 500 mg/l. The secondary maximum limit for public water supplies is 250 mg/l.

Most elevated concentrations of chloride in Gibson County ground water reported to the Division of Water have been associated with oil field brines (Division of Water open file reports). These brines are produced along with oil or gas from wells and usually have high levels of dissolved salts (Table 1).

In the past, the brines were disposed of in evaporation ponds but it was difficult to prevent their infiltration into the ground water. Presently, the primary method of disposal is by injection into disposal or oil flood wells. Brines from injection wells can contaminate ground water if the injection well is improperly constructed or if there is a rupture in the well casing.

Nitrates

Although no available water analyses for Gibson County show unsafe levels of nitrate concentration (45 mg/l), there are numerous wells in

Table 1. Chemical Analyses of Gibson County Water Wells
(in mg/l except as indicated)

Abbreviations: n.a., not available; C, coal mine monitor well; O, oil well; M, municipal well; P, private; I, industrial; IGS, Indiana Geological Survey in Keller, 1983; BOH, Board of Health; REC, Division of Reclamation; MR, Reifenstein, 1980; USGS, U.S. Geological Survey; * Complete analysis not available; +, well actually in Illinois; #, results in pH units; $, results in millimhos;

Owner	Township	Range	Section	Well Depth	Date Sampled	pH #	Hardness as $CaCO_3$	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Iron (Fe)	Manganese (Mn)	Alkalinity as $CaCO_3$	Chloride (Cl)	Sulfate (SO_4)	Fluoride (F)	Nitrate (NO_3)	Total Dissolved Solids (TDS)	Specific Conductance $	Source	Use
						Mississipian			Tar Springs Formation													
n.a.*	3S	10W	17	1529	n.a.	2.52	7434	1700	776	20100	70.5	132	-	-	34800	2840	-	-	60500	-	IGS	0
						Pennsylvanian			Mansfield Formation													
n.a.*	2S	10W	20	1296	n.a.	7.58	2246	587	190	10100	27.7	73	-	716	15200	1860	-	-	28900	-	IGS	0
						Pennsylvanian			Dugger Formation Sandstone Aquifers													
Vigo Coal #1*	3S	9W	27	85	10/84	7.2	338	-	-	-	-	0.4	0.75	100	14	72	-	-	622	970	REC	C
Vigo Coal #2*	3S	9W	28	71	10/84	7.4	302	-	-	-	-	0.1	.01	72	11	204	-	-	683	1000	REC	C
Vigo Coal #3*	3S	9W	28	107	10/84	7.2	585	-	-	-	-	0.1	0.35	104	41	520	-	-	1450	1900	REC	C
n.a.	1S	9W	12	90	79	6.70	260	58	28	50	2.1	0.54	0.06	357	2.3	0.4	0.36	1.6	613.4	783	MR	P
						Pennsylvanian			Busseron Sandstone													
Francisco #1	2S	9W	27	164	3/75	7.7	124	23	16	210	2	.5	.04	532	17	10	2.3	.1	600	-	BOH	M
Francisco #3	2S	9W	28	-	3/75	7.3	378	84	41	31	1	4.2	.3	360	16	56	.3	1.2	451	-	BOH	M
Francisco #8	2S	9W	27	168	9/78	7.6	196	39	24	130	2	4.1	.03	460	12	<.1	1.0	.8	490	-	BOH	M

Table 1. Continued

Owner	Township	Range	Section	Well Depth	Date Sampled	pH #	Hardness as $CaCO_3$	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Iron (Fe)	Manganese (Mn)	Alkalinity as $CaCO_3$	Chloride (Cl)	Sulfate (SO_4)	Fluoride (F)	Nitrate (NO_3)	Total Dissolved Solids (TDS)	Specific Conductance $	Source	Use
						Pennsylvanian			Inglefield Aquifer													
Smith	2S	11W	25	155	5/87	8.4	24	3	4	250	1.2	0.14	<.01	570	31	30	1.9	<0.1	676	1100	BOH	P
Anslinger	3S	11W	35	130	5/87	7.4	380	94	35	29	0.8	0.30	.01	460	<5	8	0.2	<0.1	438	740	BOH	P
Amax #1+	2S	13W	10	299	8/80	8.08	290	35.2	11.3	157.6	-	0.20	0.36	358.6	71.0	20.0	1.13	-	632	741	REC	C
						Quaternary			Outwash Aquifers													
Patoka #1	1S	11W	24	98	10/77	7.1	266	66	25	32	1	6.8	.05	318	3	2	.4	1.9	331	-	BOH	M
Hazelton #1	1N	11W	30	70	2/64	7.6	409	119	27	6	<1	4.8	1.1	370	7	30	0	.2	417	-	BOH	M
Princeton #1	1S	11W	28	79	5/72	7.6	244	70	17	10	1	.6	.13	206	8	49	.1	< .1	280	-	BOH	M
Princeton #5	1S	11W	28	81	2/64	7.8	296	83	22	8	1	1.6	.1	231	5	72	.1	0	332	-	BOH	M
Fort Branch #1	3S	10W	6	57	6/62	8.0	336	75	36	12	1	2.1	0.10	341	3	9	.1	-	343	-	BOH	M
Fort Branch #2	3S	10W	6	65	6/62	7.7	334	81	32	11	1	2.3	0	331	4	9	.1	-	339	-	BOH	M
Henneberger	2S	10W	7	38	4/55	7.5	517	128	48	14	.8	2.7	.13	340	32	154	.1	.3	610	958	USGS	I

the county that are susceptible to nitrate contamination. Wells that are at risk include dug or bucket rig wells and wells completed in shallow unconfined aquifers.

Nitrates in ground water may come from several possible sources including plant debris, animal excretement, sewage, fertilizers, and some industrial wastes.

Nitrate poisoning or methemoglobinemia is caused by the reduction of nitrate to nitrite by bacteria in the intestines of babies. Nitrite enters the bloodstream and reacts with hemoglobin to form methemoglobin. This compound interferes with the blood's ability to transport oxygen causing suffocation (Hergert, 1986). Methemoglobinemia is commonly known as blue baby syndrome.

Adults have a much higher tolerance for nitrate because they lack the nitrate forming bacteria.

Sulfate

Most available analyses show that Gibson County ground water contains less than 250 mg/l sulfate, the secondary maximum limit.

Sulfate concentrations of 250 mg/l or greater can impart a bitter taste to water and may have a laxative effect (Lehr and others, 1980).

Most sulfate in ground water forms when sulfide minerals are oxidized. One of the most abundant sulfide minerals, pyrite (FeS_2) is commonly found in glacial outwash, shales, carbonates, and especially in coals.

Under reducing conditions, sulfate can react with hydrogen to form hydrogen sulfide (H_2S) gas. Hydrogen sulfide gas has the odor of rotten eggs and at 1 mg/l or greater is objectionable (Lehr and others, 1980).

Fluoride

Fluoride is an important constituent of ground water because it is utilized by humans and animals in the structure of bones and teeth (Lehr and others, 1980).

Fluorite, which is found disseminated in many of the rocks and unconsolidated materials of Indiana (Greenburg, 1960, Erd and Greenberg, 1960), is a common source of fluoride in ground water.

Available analyses (Table 1), show a relatively wide range of fluoride levels. Some of these levels, >1 milligram per liter, exceed the E.P.A. secondary maximum limit (Table 2).

Table 2 Maximum contaminant levels for selected inorganic chemicals

(All values except pH are in milligrams per liter, if multiple uses have been designated, the most protective standard applies; dash indicates no available criterion).

Aquatic life: Values for all constituents except iron, pH, selenium, and silver are for one-hour averages; selenium and silver are not to be exceeded at any time; trace metals where applicable at a hardness of 250 milligrams per liter.

Public supply: Maximum permissable level of a contaminant in water at the tap; national secondary regulations (reference e) are not enforceable; both national primary regulations and state regulations are enforceable (references b,c and f).

Irrigation and livestock: All values from National Academy of Sciences, 1974.

Constituent	Aquatic life		Public supply		Irrigation	Livestock
	Value	Reference	Value	Reference		
Arsenic (trivalent)	0.360	a	0.05	b,c	0.1	0.2
Barium	-	-	1.0	b,c	-	
Cadmium	0.011	a	0.01	b,c	0.1	0.5
Chloride	0.019	a	250	d,e	-	
Chromium (hexavalent)	0.016	a	0.05	b,c	0.10	1.0
Copper	0.042	a	1.0	e	0.2	0.5
Fluoride	-	-	4.0 prim	f	1.0	2.0
			2.0 sec	f		
			2.4 state	b		
Iron	1.00	d	0.3	e	5.0	-
Lead	0.264	a	0.05	b,c	5.0	0.1
Manganese	-	-	0.05	e	0.2	-
Mercury	0.002	a	0.002	b,c	-	0.01
Nitrate (as nitrogen)	-	-	10.0	b,c	-	10.0
pH (standard unit)	6.0-9.0	d	6.5-8.5	e	4.5-9.0	-
Selenium	0.260	g	0.1	b,c	0.02	0.05
Silver	0.020	g	0.05	b,c	-	-
Sulfate	-	-	250	d,e	-	-
Total dissolved solids	-	-	500	e	500-1000	3000
Zinc	0.254	h	5.0	e	2.0	25.0

[a] U.S. Environmental Protection Agency, 1985a
[b] Indiana Environmental Management Board, 1979
[c] U.S. Environmental Protection Agency, 1975
[d] Indiana Stream Pollution Control Board, 1985
[e] U.S. Environmental Protection Agency, 1979
[f] ______________1986a
[g] ______________1980
[h] ______________1987

SUMMARY

Quarternary age valley-train deposits, outwash plain deposits, and Pennsylvanian age sandstone units form the principal aquifers in Gibson County. The valley-train deposits consist of sand and gravel and form prolific aquifers. Wells installed in these aquifers may produce up to 1000 gpm. However, the valley-train deposits are confined to the White and Wabash River valleys. The outwash plain deposits, located in central Gibson County, may produce up to 300 gpm. The two major sandstone aquifers are the Inglefield Sandstone and the Busseron Sandstone. The Inglefield is found in the eastern half of the county and produces 1/2 to 5 gpm.

Water quality of the unconsolidated aquifers tends to be within recommended standards. The water is hard and total dissolved solids (T.D.S.) and iron concentrations tend to be higher than E.P.A. secondary maximum limits. The water quality of the bedrock aquifer is also fair with T.D.S. and iron concentrations tending to be higher than E.P.A. secondary maximum limits.

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