the surface.

WRI

LOCATION OF STUDY AREA IN MISSISSIPPI 8 ARROLL **EXPLANATION** Thickness of allwiwm Less than 50 feet 50 to 100 feet Lime of geothydrollogic section with drillling log location Figure 1.--Location of the Mississippi River valley alluvial aquifer, with thickness and location of geohydrologic sections. S Table 1. -- The freshwater section in the area of occurrence of the Mississippi River valley alluvium. Water-Supply Source Formation System Series Group Mississippi River Holocene Quaternary X Loess Pleistocene Terrace deposits Citronelle Pliocene Formation Miocene Undifferentiated Undifferentiated Vicksburg Oligocene Forest Hill Sand Undifferentiated X Jackson Cockfield Formation Cook Mountain Base map from U.S. Geological Survey Map of Mississippi, 1972. Sparta Sand Claiborne Thickness map revised from Boswell, Eocene Zilpha Clay Cushing and Hosman, 1968. DAMS Winona Sand Formation Meridian Sand Member Middle Wilcox Paleocene

THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER IN MISSISSIPPI

INTRODUCTION

This atlas describing the Mississippi River valley alluvial aquifer in Mississippi, is the ninth in a series of aquifer atlases prepared in cooperation with the Mississippi Board of Water Commissioners. In this report the extent, character, and present utilization of the aquifer in Mississippi are summarized.

The Mississippi River valley alluvial aquifer contains freshwater having less than 1,000 mg/L (milligrams per liter) of dissolved solids in the 7,000 mi² Yazoo Basin (Fenneman, 1938) adjacent to the Mississippi River in northwestern Mississippi, and in a narrow band covering an area of 500 mi² adjacent to the Mississippi River in southwestern Mississippi (fig. 1). The Yazoo Basin, which is bordered on the west by the Mississippi River and on the east by an abrupt loess-covered escarpment, is commonly known as the "Delta"

The rich soils in the Yazoo Basin are intensively cultivated. The nearly level terrain and the availability of abundant supplies of ground water have contributed to a large increase in irrigation

GEOLOGY AND HYDROLOGY

The Mississippi River valley alluvium, Quaternary in age, was deposited by the meandering Mississippi River on an eroded Tertiary surface. North of Vicksburg the alluvium covers eroded Eocene deposits (table 1, figs. 2-7). Some of these Eocene deposits are major aquifers beneath the Mississippi Alluvial Plain. South of Vicksburg the alluvium overlies Oligocene and Miocene deposits, which also contain major aquifers. The thickness of the alluvium ranges from less than 50 feet to about 200 feet (fig. 1), and averages about 140 feet (Harvey, 1956). The thicker alluvial deposits cover the more deeply eroded surfaces of the Eocene, Oligocene, and Miocene deposits.

The alluvium consists of gravel, sand, and clay, in what can be visualized as a three-layer sandwich; a lower layer consisting of irregular lenses of gravel intermixed with sand; a middle layer of sand; and an upper layer of silty clay. The clay layer is discontinuous and contains windows through which the sand layer is exposed at the land surface. Locally a thin clay lies between the lower gravel and sand layer and the underlying Eocene Formations. The alluvial deposits are generally saturated with water to within 20 feet of

RECHARGE, MOVEMENT, AND WATER LEVELS

Precipitation on the land surface is the principal source of recharge to the alluvial aquifer. The Mississippi River and its tributaries, both those bounding and those crossing the area, and in places, the underlying Tertiary aquifers, may serve as additional sources of recharge. During most of the year ground-water levels are high and water from the aquifer seeps into streams. The movement of water is generally south (fig. 8) and toward or away from major streams, depending upon the water level in the aquifer and the incised depth of streams into the aquifer. The Sunflower River (fig. 1) is an example of a deeply incised stream which receives substantial quantities of water from the alluvial aquifer during low stream stages.

Water levels in wells screened in the alluvial aquifer are generally between 5 and 30 feet below land surface, except near points of heavy pumping. Hydrographs of observation wells reveal cyclic Mist Seasonal fluctuations (fig. 9) rather than continuing yearly declines as in the deeper Tertiary and Miocene aquifers. Water levels are generally highest just before the irrigation season and lowest in September following the irrigation season. At Greenwood, water levels in wells sometimes exceed 50 feet below land surface and average about 39 feet due to the continuous withdrawal of 10 Mgal/d of cooling water. Large differences between water level extremes also occur at Natchez where the withdrawal is 40 Mgal/d, and at Clarksdale and Vicksburg where withdrawals are 17 Mgal/d and 6.7 Mgal/d respectively. Water levels in wells near the Mississippi River and large streams directly reflect the stage of the river (fig. 9, Well Warren J4).

WELL AND AQUIFER CHARACTERISTICS

Major wells producing from the alluvial aquifer range in depth from 60 to 260 feet. Large capacity wells commonly are screened in the coarse gravel at the base of the aquifer. The deepest known wells are in Adams and Issaquena Counties. Yields range from 250 to 5,000 gal/min and specific capacities of large diameter wells range from 10 to 168 (gal/min)/ft of drawdown (effect of well efficiency unaccounted for).

Fourteen aquifer tests in Mississippi (Newcome, 1971) indicated transmissivity values ranging from 13,000 to 79,000 (ft³/d)/ft and hydraulic conductivity values ranging from 170 to 790 (ft³/d)/ft².

The alluvial aquifer is under confined conditions wherever a relatively impermeable surface material is present and the water level in wells stands above the level of the base of the confining bed. When a well is pumped under these conditions the aquifer usually undergoes a change from a confined type to an unconfined type in the vicinity of the well. Water table conditions generally exist in areas of point-bar deposits and artesian conditions in backswamp deposits. In a study of ground-water seepage in and out of Lake Washington, Harbeck and others (1961) found the alluvial aquifer to be under water table conditions and storage coefficients to range from 0.10 to 0.18.

The following table gives the range of hydraulic characteristics calculated from 14 pumping tests.

Transmissivity (ft ³ /d)/ft	Hydraulic conductivity (ft ³ /d)/ft ²	Storage coefficient dimensionless

Maximum	79,000	790	0,060
Median	39,000	360	.012
Minimum	13,000	170	.0005
Number of tests	14	14	12

QUALITY

Water from the alluvial aquifer is a hard, calcium bicarbonate type water that frequently contains excessive iron in solution. The water is generally alkaline although the pH is sometimes as low as 6.0.

The dissolved-solids concentration in 84 water samples ranged from 153 to 883 mg/L and the concentration generally increased from north to south and from east to west (fig. 10). The dissolved-solids concentration exceeds 500 mg/L in parts of Washington, Sharkey, Warren, and Humphreys Counties. Shallow alluvial wells from 35 to 105 feet deep in DeSoto, Quitman, and Tunica Counties, produce water having a dissolved-solids concentration less than 200 mg/L.

Iron concentration in water from the alluvial aquifer exhibit extreme variation, ranging from 0 to 26 mg/L. Throughout most of the area, however, the iron concentration in water is between 5 and 10 mg/L (fig. 11), but in parts of Bolivar, Claiborne, Coahoma, Quitman, Tallahatchie, Sunflower, and Washington Counties, iron concentration exceeds 10 mg/L. Locally in Adams and Warren Counties iron concentra-

Hardness of water in the alluvial aquifer ranged from 81 to 550 mg/L and, like the dissolved-solids concentration, generally increases from north to south and from east to west (fig. 12). Hardness exceeds 500 mg/L in Warren County and at places in Washington

tion is less than 1 mg/L.

The water temperature can be expected to range from 16°C in the north to 20°C in the south, the range of mean annual air tempera-

Chemical analyses of water samples from alluvial wells are given in table 2. The location of these wells are shown on figure 13. WATER USE

The alluvial aquifer is the primary source of water for irrigation in Mississippi and it is a major source of water for cooling and other industrial uses. In 1975, 745 Mgal/d were withdrawn on an annual basis from the alluvial aquifer (table 3). Of that amount, 551 Mgal/d or 74 percent was used for irrigation. This is the equivalent of 1,648 Mgal/d during the 122-day growing season (Callahan, 1977). Industrial self supplied water use was 159 Mgal/d or 21 percent. Municipal water use was 35 Mgal/d or 5 percent. Rice irrigation accounted for 97 percent of the total irrigation water use and row crop irrigation the remaining 3 percent. Bolivar, Leflore, Sunflower, and Washington Counties account for more than two-thirds of the total irrigation water use.

The principal use of water from municipally-owned wells screened in the alluvial aquifer is for cooling. The largest withdrawal of ground water for cooling purposes (Callahan, 1976) is at Clarksdale, where 17 Mgal/d was pumped in 1975. The largest withdrawal for public water supply, 6.7 Mgal/d, is by the city of Vicksburg.

Public supplies generally do not utilize the alluvial aquifer owing to excessive hardness and iron concentrations in the water. Deeper Tertiary aquifers such as the lower Wilcox and Meridian-upper Wilcox aquifers, Sparta Sand, Cockfield Formation, and Miocene aquifers supply water suitable for public supply.

Self-supplied industrial water use is largely for fish farming. The largest withdrawal for self-supplied industry other than fish farming, 40 Mgal/d, is at Natchez.

WATER SUPPLY POTENTIAL

Irrigation, cooling, and industrial water use will place increasing demands on the alluvial aquifer. In the 7,000 mi² Yazoo basin the alluvial aguifer has been estimated to be capable of yielding over 1,700 Mgal/d (Lower Mississippi Region Comprehensive Study, 1974, Appendix C, p. 150). The water-supply potential for the 500 mi² area in southwestern Mississippi is in addition to the 1,700 Mgal/d available in the "Delta" above Vicksburg.

Well fields located a short distance from the Mississippi River at some places in the area could produce more than 50 Mgal/d. Heavy pumpage in favorably located places induces water from the Mississippi River into the pumped wells, resulting in a mixture of alluvial water and Mississippi River water. Collector wells that utilize horizontal screens, will supply several million gallons of water per day for a nuclear powerplant that is now under construction near Port Gibson. Much of the water produced by well fields near the Mississippi River would be in addition to the 1,700 Mgal/d estimated to be available

Well fields in the 7,000 mi² area north of Vicksburg can yield at least 15 Mgal/d at most places. The water-supply potential is enhanced by the lower energy requirements for pumping from the shallow, high-yielding aquifer.

because of induced infiltration.

A detailed study is suggested before designing a large well field at a specific site. Conservative well yields and spacing help avoid excessive water-level declines caused by pumping interference among wells.

To convert inch-pound units to International System units

Multiply 0.3048 foot(ft) meter(m) 1.609 mile(mi) kilometer(km) square kilometer(km²) square mile(mi²) 2.590 liters per second(L/s) gallons per minute(gal/min) 0.06309 cubic meters per second(m³/s) million gallons per day (Mga1/d) meters per kilometer (m/km) feet per mile(ft/mi) gallons per minute per foot 0.21 liters per second per meter (gal/min)/ft (1/s)/mcubic feet per day per square 0.305 foot(ft³/d)/ft² or ft/d cubic meters per day per square $meter(m^3/d)/m^2$ cubic feet per day per foot 0.093 cubic meters per day per meter

 $(m^3/d)/m$

Table 2.-- Quality of water from wells in the Mississippi River valley alluvial aquifer.

 $(ft^3/d)/ft$ or ft^2/d

		DATE	((1SSOLV	ED CONS	TITUENTS	AND HAR	RDNESS	GIVEN IN	MILLIG	RAMS PER	LITER			SPECIFIC CONDUCT-		
NO.	DEPTH (FT)	TION	SILICA (STO2)	(FF)	(CA)	MAG- NESI- UM (MG)	(NA)	SIUM (K)	BONATE (HCO3)	FATE (SO4)		RIDE (F)		NESS AS CACO3	ANCE (MICRO- MHOS AT 25°C)		COL- OR
F004 F012 F016 F018	245 215 180 235	9/61 9/61 9/61 9/61	18 18 16 14	0.00 0.00 0.69 0.02	62 82 73 71	30 46 35 32	17 11 11 9.3	2.5 2.3 1.9 1.8	368	10 8.8 8.2 10	29 6.5 12 8.0	0.3 0.3 0.2 0.2	322 380 389 329	27 _R 394 326 308	565 682 618 537	7.6 8.0 7.7 7.3	3 3 5 3
A020 B005 F020 G003 0009	112 106 120 126	7/65 7/65 5/54 5/54 5/54	29 32 	8.40 3.00 5.20 6.60 4.80	84 95 57 84 73	28 23 39 37 41	10.0 17 16 21	0.0 0.6 2.2 3.5 2.8	404 370 384 418 378	8.0 52 12 36 54	7.6 6.9 7.5 8.0 6.5	0.4	382 420 369 461 453	325 332 302 362 350	744 663 600 707 701	7.8 7.8 7.5 7.6 7.4	5 1 5 5
R020 T022 T080	110 100 160	7/65 7/65 9/19	31 31 39	11.00	106 86 106	30 26 29	9.8 21 28	0.8	352 415	2.2 47 80	4.8 18 15	0.2	431 503	388 322	720 664	8.2	5 5
E002 E003 E004	110	11/77 11/77 11/77	55	12.00 15.00 10.00	71 76 74	23 21 19	39 18 15	3.4 2.9 2.6		21 33 30	29 19 16	0.4 0.2 0.2	401 351 337	270 280 260	500 550 501	7.2 7.3 7.3	20 50 19
B001 D001	120	7/65		13.00	89 60	20	7.2	0.0	392	20	1.5	0.3	344 347	304 285	575 572	7.2	5
J003	149	1/56	24	10.00	77	19	26 25	3.3	332	24	16	0.3	360 353	270 280	582 350	7.5	7
J031	148	9/74	24	2.70	76	22	25	3.0		1.4	11	0.2	353	280	350	7.2	7
0005 A010	94 36	7/65	41	10.00	72	20	8.5	0.8 DESOTO 2.9	336 COUNTY 121	0.4	3.7	0.4	323	262	506 288	7.5	5
E005	119 98	6/54		8.70 5.80	59	18	9.5		298 240 COUNTY	2.2	7.0		270 249	196	464	7.8	5 6
A013	100	7/76	33	10.00	62	17	12	0.4	496	0.4	8.8	0.5	294	225	460	7.7	5
C002 E012 E013 J001 L018	124 131 112 118 113	6/54 7/72 7/65 7/65 1/76	29 38	9.00 3.70 2.30 6.90 3.80	56 76 118 71 97	28 15 28 19 28	16 14 42 15 21	3.1 0.4 2.2 0.0 3.0	477 348	0.8 0.2 68 0.2 2.4	13 3.2 28 3.9	0.2 0.1 0.5 0.2	316 317 575 300 400	254 251 410 255 360	547 512 893 516 605	8.1 8.0 7.9 7.0 7.0	9 0 5 30
C002 F004 L009 L011	95 108 180 180	6/54 7/65 3/72 1/56	28 38	5.00 4.20 6.40 5.60	64 72 60 71	16 17 19 15	9.3 11 20 15	1.8 0.0 2.4 2.3	290 325 319 297	64 6.2 2.8 6.6	4.0 3.7 10 9.5	0.2 0.4 0.3	274 312 291 307	226 250 230 238	457 498 491 486	7.7 8.1 7.2 7.2	6 2 5
N020	112	6/73	37 27	3.80	54	6.6	7.2 6.2	PANOLA	256 A COUNTY 161	2.0	1.8	0.2	258	192	390 290	7.2	3
									COUNTY								
A002 D001 E001 E002 E004	101 125 36 122 90	7/57 5/57 5/57 5/57 5/57	=======================================	2.60 7.50 0.29 3.10 3.80	49 69 22 88 62	16 20 7.7 19 14	9.2 7.9 17 17 13	1.0 2.4 1.0 2.0 1.6	238 290 98 312 280	16 4.0 25 45 2.0	3.2 18 14 18 5.5	0.0 0.0 0.0 0.0	236 330 190 392 268	188 138 81 256 212	367 515 245 595 438	7.4 7.4 6.6 7.6 7.5	10 10 8 10 8
G005 K006 L003	122 125 124	7/57 7/57 7/57	=	13.00 6.20 6.90	47 49 66	20 25 28	6.7 8.6 20	3.0 2.4 2.4	250 278 334	5.6 6.4 31	3.5 6.0 14	0 • 0 0 • 0 0 • 0	250 274 351	200 225 274	391 439 565	7.2 7.5 7.5	10 10 13
A006	122	7/65	31	6.80	112	39	32	SHARKEY	COUNTY 522	74	7.6	0.0	559	440	886	7.0	1
B010 C007 H004	108 100 103	7/65 7/65 11/67	30 36 27	1.60 4.50 6.10	100	25 30 33	21 15 47	1.4 0.0 2.3	432 458 513	28 24 37	11 1.6 9.1	0.4 0.3 0.0	443 438 501	353 381 362	713 710 825	7.7 8.3 7.1	5
C030	137	7/65	30	10.00	79	27	16	UNFLOWE 0.6	334	49	8.4	0.0	388	308	610	8.3	2 3
H004 L020 0005 R019	96 118 122 98	7/65 7/65 7/65 7/65	29 31 26 31	3.70 3.20 7.10 3.60	78 84 93 65	19 19 25 15	19 15 58 11	0.8 1.0 1.2 0.0	364 360 427 300	6.6 17 58 2.2	9.7 8.5 36 3.1	0.0	339 365 510 279	273 0 335 224	567 584 826 456	7.9 7.8 8.2 7.9	2 3
T001	115	7/65	32	3.90	52	11	7.9	0.0	224	5.4	4.6	0.2	229	175	361	7.9	S
F002 H001 H012 0001	124 102 99 112	7/65 7/65 7/65 7/65	29 26 37 34	3.40 5.90 26.00 4.30	62 75 64 47	17 23 19 15	TA 8.8 9.0 9.4 6.7	0.0 0.4 0.6 0.2	280 366 298 222	0.4 0.2 0.0 4.8	9.5 3.2 6.0 3.2	0 • 4 0 • 5 0 • 4 4 • 0	272 318 287 230	225 282 238 179	444 538 462 353	8.0 8.0 7.4 7.6	5 4 5 5
B001 D003 F003	106 115 109	7/65 7/65 7/65	21 31 34	3.40 7.20 11.00	30 68 73	11 22 22	9.5 8.5	TUNICA 0.0 0.7 0.4	COUNTY 163 328 356	1.6	3.1 3.1 2.8	0 · 1 0 · 1 0 · 1	153 297 325	120 260 273	264 498 527	8.2 8.3 7.7	2 5 5
J007 J021	169 181	7/65 3/63 2/74	30 34 39	13.00	75 144 120	24 46 48	9.0 28 29	1.0 WARREN 5.0 5.5	352 N COUNTY 697 598	0.0	2.2 18 46	0.2	326 635 641	286 550 500	1060 1000	6.7 7.1	5 30
D101 E007	70 120	10/68 7/65	38 30	12.00	96 72	32 18	12 50	2.3 2.9	TON COUN 474 429	3.2 0.6	8.0	0.3	425 392	372 254	734 648	7.1	15
G024 G039 G042 J016	58 87 50	8/11 7/65 5/62 7/68	50 30 		174 123 189	6.1 27 9.8	20	1.6	879 516 456 216	46 15 22 24	11 20 132	0.6	883 523 667 248	460 418 513 200	8 ₁ 7 	7.8	5
J018 K005 L036 M008	96 132 85 122	7/68 5/54 7/68 7/65	31 5.2 28	1.80 9.20 4.30 4.40	85 65 118 104	25 37 38 20	22 21 54 11	0.9 2.9 1.3 0.2	369 416 472 434	58 9.2 132 7.2	4.9 8.5 34 4.0	0.0	410 399 654 406	316 314 450 342	673 642 1020 664	7.8 7.6 7.7 7.9	10 5 15
0024 P004 Q018 R003 S001	100 100 131 61 126	7/68 7/68 5/54 7/65 5/54	29 8.4 27		137 135 71 123 58	36 42 34 28 41	7a 19 24 5.8	1.1 0.3 2.8 0.8 1.3	564 608 388 514 378	140 40 38 14 18	42 4.8 6.0 1.0 4.5	0.2	751 572 423 458 372	490 508 317 422 313	1190 962 662 754 588	7.8 7.8 7.2 8.2 7.2	15 15 5 2 5
E007 K010	150	11/77	43 27	2.20	37 91	10		3.4 1.2	ON COUNT 280 470		21	0.3	316 482	130 390	502 835	7.0	45
G002 G050 G070	154	12/77 12/77 12/77	48 39 42	9.80 7.20 9.30	66 74 93	21 24 32	15 13 19	3.4 3.3 3.9	340 330	13 41 9.8	5.8 4.9 9.8	0.2 0.2 0.2	333 370 438	250 280 360	510 587 732	6.9 7.0 7.4	55 45 38

Table 3. -- Water supplies from the Mississippi River valley alluvial aquifer

County	Principal water use	Depth of wells (ft)	Pumping rates of wells (gal/min)	Daily withdrawal (thousand gal)	Technica Chemical analysis	al data ava Electric log	ilable Pumping test
Adams	Self-supplied industry	155-265	1,500-2,000	40,125	X	X	X
Bolivar	Row crop irrigation Rice irrigation Self-supplied industry	55-210	300-3,600	2,600 189,000 8,805	X	X X	X X
Carroll	Row crop irrigation Rice irrigation			240 200		X X	
Coahoma	Clarksdale Self-supplied industry Row crop irrigation Rice irrigation	100-150 90-180 90-200	1,600-3,600 45-300 400-3,600	17,320 1,541 1,000 26,900	X X X	X X X	
De Soto	Row crop irrigation Rice irrigation Self-supplied industry	75-100 	1,200-2,800	500 5,200 107	X X X	X X X	
Holmes	Row crop irrigation Rice irrigation Self-supplied industry	 	1,200-3,000	870 6,200 6,696		X X	
Humphreys	Self-supplied industry Row crop irrigation Rice irrigation	105-135 85-135	125-3,000 600-3,150	44,880 1,300 20,800	X X X	X X X	
Issaquena	Row crop irrigation Rice irrigation	95-235	500-3,300	570 900		X X	
Leflore	Greenwood utilities Row crop irrigation Rice irrigation Self-supplied industry	90 -1 90 70 -205 	1,300-2,700 450-3,200	10,369 1,500 62,000 3,508	X X X	X X X	Х
Panola	Self-supplied industry Rice irrigation	105 105-120	2,000 1,400	3,573 2,300	Х	X	
Quitman	Row crop irrigation Rice irrigation Self-supplied industry	95-125	350-3,100	1,300 16,800 415	X X	X	
Sharkey	Self-supplied industry Row crop irrigation Rice irrigation	 85-135	300-3,300	3,221 1,300 11,900	X X X	X X X	
Sunflower	Row crop irrigation Rice irrigation Self-supplied industry	60-160	250-4,000	1,800 60,400 8,892	X X	X X	X X
Tallahatchie	Self-supplied industry Row crop irrigation Rice irrigation	90 - 105 70 - 135	2,000 500-3,100	7,211 1,200 21,700	X X	X X X	
Tate	Rice irrigation Self-supplied industry		==	2,600 80			
Tunica	Row crop irrigation Rice irrigation Self-supplied industry	75-140 	400-3,500	1,600 31,800 6,950	X X	X X	
Warren	Vicksburg Eagle Lake Water District Self-supplied industry	120 - 180 154 	1,400 200	6,700 41 225	X	X X X	X
Washington	Self-supplied industry Row crop irrigation Rice irrigation	110 70-160	770 250-5,100	11,406 1,600 69,300	X X	X X X	X X
Yazoo	Yazoo City Self supplied industry Row crop irrigation Rice irrigation	130 - 210 105 - 160 85 - 110	1,000-1,900 1,500-3,000 3,000	478 11,800 240 4,900	X X	X X X X	
Subtotal	Municipalities Self-supplied indus Row crop irrigation Rice irrigation			34,908 159,435 17,620 532,900			

THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER

G. J. Dalsin

Jackson, Mississippi Cartography by L. A. Gandl