Ground Water in the Lower Arkansas River Valley, Arkansas

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1669-V

Prepared in cooperation with the U.S. Army, Corps of Engineers

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By M. S. BEDINGER *and* H. G. JEFFERY

CONTRIBUTIONS TO THE HYDROLOGY OF THE UNITED STATES

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GROUND WATER IN THE LOWER ARKANSAS RIVER VALLEY, ARKANSAS

By M. S. Bedinger and H. G. Jeffery

ABSTRACT

The alluvium and terrace deposits of Quaternary age are the principal sources of ground water in the area. The predominant characteristic of the alluvium is the change from gravel or coarse sand at the base to fine-grained material at the top. The alluvium ranges in thickness from 76 feet at a well in Desha County to 195 feet at a test hole in Lincoln County and averages about 100 feet. The terrace deposits in the southwest consist of coarse sand and gravel at the base and silt and clay at the surface; they range in thickness from about 60 feet in Pulaski County to about 100 feet in Lincoln County. The terrace deposits of the Grand Prairie region in Arkansas County consist of material grading variably from coarse sand or gravel at the base to relatively "heavy" clay at the surface; these deposits range in thickness from 75 to 200 feet. Rainfall is the most important source of recharge in the valley. Recharge from rainfall in the Grand Prairie, however, is negligible because of a thick section of dense clay at the surface, and the main source of recharge is underflow from adjacent areas and influent seepage from the Arkansas and presumably the White River.

In six counties, parts of which are included in the report area, 360,000 acre-feet of ground water was used for irrigation in 1959. Of this, 310,000 acre-feet was used to irrigate rice and 50,000 acre-feet was used to irrigate row crops. Ground water from the alluvial aquifer is predominantly of the calcium magnesium bicarbonate type, and the dissolved-solids content varies considerably. The water is classified good to excellent for irrigation. The iron content and the hardness of most supplies make the water undesirable for domestic use, and in a few areas, chloride concentration is high enough to cause an undesirable salty taste.

INTRODUCTION

This preliminary report presents information on groundwater, only one phase of a continuing and comprehensive study of the geology and ground-water conditions in the lower Arkansas River valley. The study, begun in May, 1957, is being made by the U.S.

Geological Survey in cooperation with the U.S. Army, Corps of Engineers. The present report is based not only on information obtained specifically for this investigation but also on data collected previously as a part of the statewide program of ground-water studies made cooperatively by the U.S. Geological Survey, the Arkansas Geological and Conservation Commission, and the University of Arkansas. Previous ground-water studies in the project area include reports on Jefferson County (Klein and others, 1945); the Grand Prairie region (Engler and others, 1945), (Counts and Engler, 1954), and (Sniegocki, 1963); and Desha and Lincoln Counties (Bedinger and Reed, 1961).

The study for this report was begun under the supervision of P. E. Dennis, former district supervisor, and was completed under the supervision of R. T. Sniegocki, district supervisor, Branch of Ground Water. The quality-of-water phase of the investigation was under the supervision of M. E. Schroeder, district supervisor, Branch of Quality of Water.

The present study is limited to the area that lies within about 10 miles of the Arkansas River and that stretches from the Mississippi River to Little Rock (fig. 1). Geologically, the study area is limited to the alluvium and terrace deposits of Quaternary age that contain the principal or "shallow" acquifer of the area.

The area is bordered on the northwest by the Interior Highlands and on the southeast by the Mississippi River. Physiographically, the area lies in the Coastal Plain province.

The Mississippi Alluvial Plain of the area includes the flood plains of the larger streams and alluvial terraces that border the flood plain. The surface of the flood plain is characterized by features of stream aggradation. The larger bayous and rivers draining the area generally have well-developed natural levees and are bordered by oxbow lakes, brakes, and meander scrolls. The low-lying interstream areas generally are occupied by backswamps.

The Grand Prairie region borders the flood plain of the Arkansas River on the northeast. The Grand Prairie, a terrace which rises about 10 feet above the flood plain, extends northwestward from Arkansas County to the Interior Highlands.

Near the southwestern boundary of the area, alluvial terraces 1 to 5 miles wide lie between the flood plain and the West Gulf Coastal Plain. These terraces rise about 20 feet above the flood plain.

A maturely dissected ridge of the West Gulf Coastal Plain rises a hundred feet or more above the adjacent terraces and flood plain and frames the valley on the southwest.

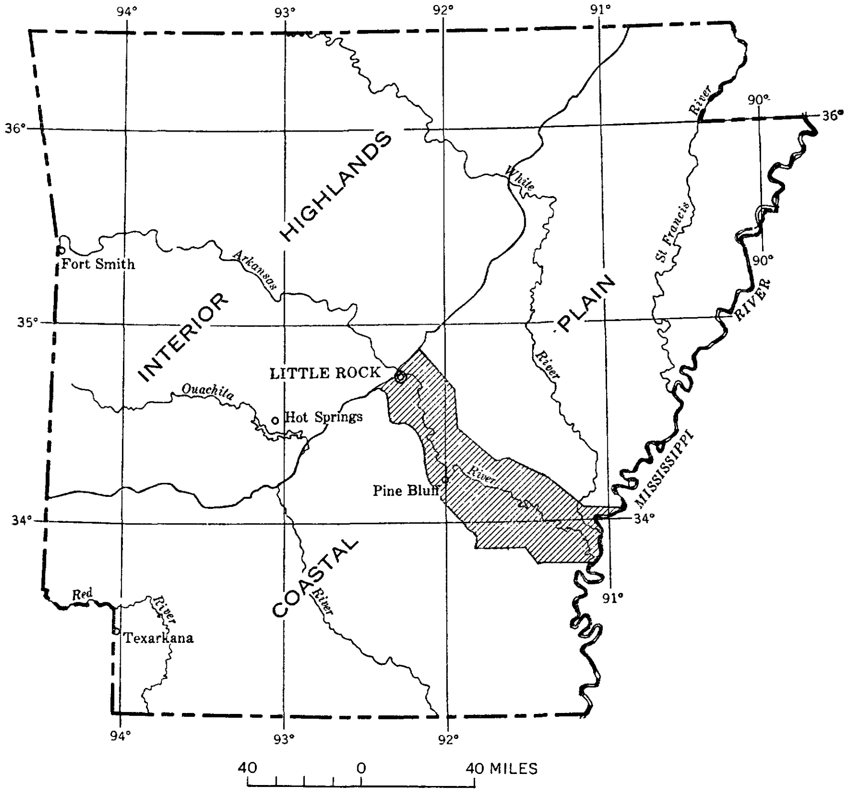


FIGURE 1.—Index map of Arkansas showing location of the study area.

WELL-NUMBERING SYSTEM

The well-numbering system used in this report is based on the location of wells with respect to the Federal land-survey system used in Arkansas (fig. 2). The component parts of a well number are the township, range, and section numbers and three lowercase letters which indicate the quarter section, the quarter-quarter section, and the quarter-quarter-quarter section in which the well is located. Serial numbers are appended to wells in the order in which the wells were inventoried within the quarter-quarter-quarter section.

GEOLOGY

The alluvium and terrace deposits of Quaternary age are the principal units studied in the present investigation. Older rocks underlie the alluvium and border it on the south and southwest. The older rocks include sedimentary rocks of Paleozoic age, sedimentary and igneous rocks of Cretaceous age, and sedimentary rocks of Tertiary age.

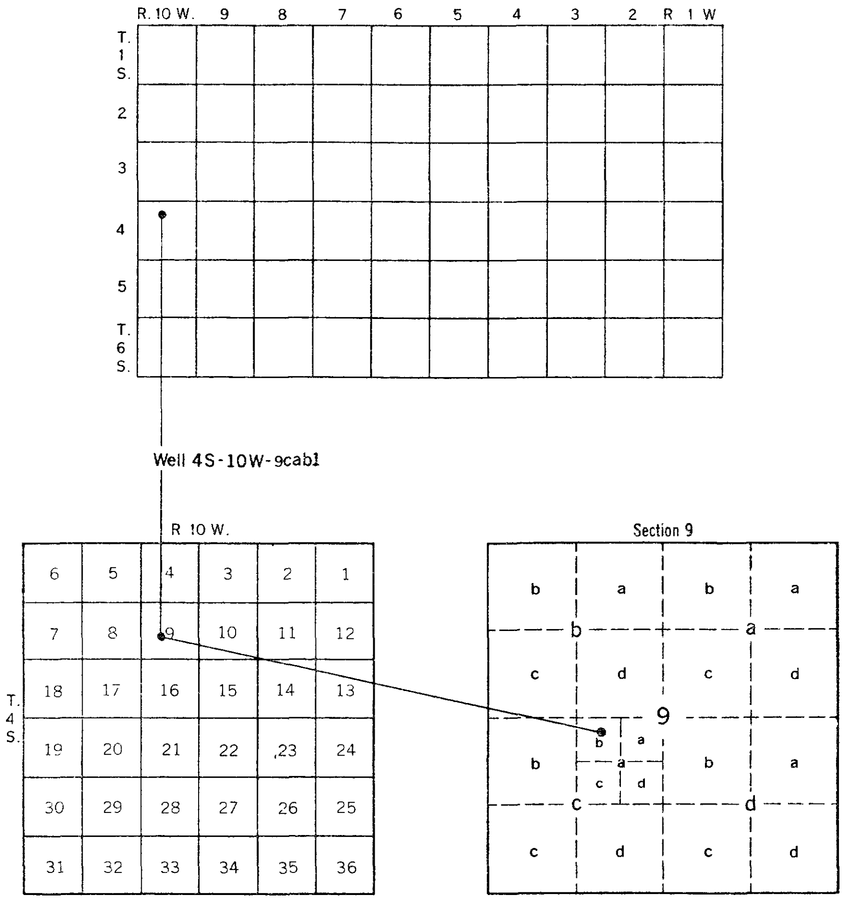


FIGURE 2.—Sketch illustrating well-numbering system.

QUATERNARY SYSTEM

Rocks of Quaternary age include the alluvial terrace deposits in the southwestern part of the area, the alluvial terrace deposits of the Grand Prairie region, and the alluvium of the Arkansas River flood plain. The sand and gravel in the lower part of these deposits constitute a single aquifer, the aquifer of principal importance to the present study.

TERRACE DEPOSITS

The alluvial terrace deposits in the southwestern part of the area crop out in a strip, 1 to 5 miles wide, which borders the Tertiary deposits of the West Gulf Coastal Plain. The terrace is about 20 feet higher than the alluvium.

The terrace deposits consist of coarse sand and gravel at the base and silt and clay at the surface and range in thickness from about 60 feet in Pulaski County to about 100 feet in Lincoln County.

The terrace of the Grand Prairie region in Arkansas County is about 10 feet higher than the adjacent alluvium. The material composing the terrace grades variably from coarse sand or gravel at the base to relatively "heavy" clay at the surface and ranges in thickness from 75 to 200 feet.

ALLUVIUM

Quaternary alluvium denotes the relatively thick sequence of fluvial deposits which cover most of the project area. The alluvium is a part of an extensive deposit of the Arkansas and Mississippi Rivers and their tributaries and blankets much of the eastern half of Arkansas and adjacent States.

The predominant characteristic of the alluvium is the change from gravel or coarse sand at the base to fine-grained material at the top. Generally, the alluvium may be divided into two parts, a lower part including the gravel and sand and minor amounts of silt and clay and an upper part consisting of silt and clay and minor amounts of sand. The alluvium ranges in thickness from 76 feet at well 9S–4W–9cad1 in Desha County to 195 feet at test-hole 10S–5W–8bbb1 in Lincoln County. The average thickness is about 100 feet.

The silt and clay of the upper part acts as a confining bed to water in the sand and gravel of the lower part of the alluvium. Locally, where the upper part is composed of very fine or fine sand, the aquifer is relatively unconfined. In places, saturated sand in the upper part may be separated from the main aquifer by lenses of clay or silt. Generally, however, these clay or silt lenses are of small areal extent, and there is little difference in hydrostatic head between the sand in the upper part and the main body of the aquifer.

At the surface, the alluvium may be divided into several types of flood-plain deposits on the basis of mode of deposition, topographic expression, and lithologic character. These deposits include natural-levee, backswamp, point-bar, swale, and channel-fill deposits and tributary alluvium. The surface deposits of the Arkansas valley are described in reports by the Waterways Experiment Station (1951) and by Bedinger and Reed (1961). Hydrologically, the surface materials are important in that they control infiltration of rainfall to the aquifer. Point-bar deposits, the most permeable of the surface materials, facilitate recharge. Natural-levee deposits are less permeable but are of large areal extent and probably permit considerable recharge. Backswamp, swale, and channel-fill deposits and tributary alluvium generally are the least permeable of surface materials and retard infiltration of rainfall.

GROUND-WATER HYDROLOGY

WATER TABLE

FLUCTUATIONS

Fluctuations of ground-water levels are of two types, basic and superposed.

Superposed fluctuations represent the response of the aquifer to external forces that cause little or no change in storage within the aquifer. These fluctuations are due to loading of the aquifer and are characteristic of confined and semiconfined aquifers. Such fluctuations are superposed on the basic water-level fluctuations.

Basic fluctuations of the piezometric surface are caused by changes in storage within the aquifer. These fluctuations generally follow yearly cycles.

SUPERPOSED

Superposed fluctuations observed in the area from the Mississippi River to Little Rock include fluctuations resulting from earthquakes, passing railroad trains, and barometric changes.

Water-level changes caused by earthquakes are ordinarily negligible and of short duration. Permanent changes, however, can be produced if the epicenter is nearby and the aquifer is permanently disturbed.

The effects of the earthquakes in Alaska on July 10, 1958, and the earthquake in Montana on August 17–18, 1959, were recorded in several wells in the area. The magnitude of water-level changes was small—only a few hundredths of a foot—as illustrated by the hydrograph in figure 3.

Passing railroad trains can affect the water level in nearby wells. The water level in well 9S–2W–26ddcl is regularly affected by railroad trains that pass within about 200 feet of the well. As shown in figure 4, the order of magnitude of the fluctuations is a few hundredths of a foot.

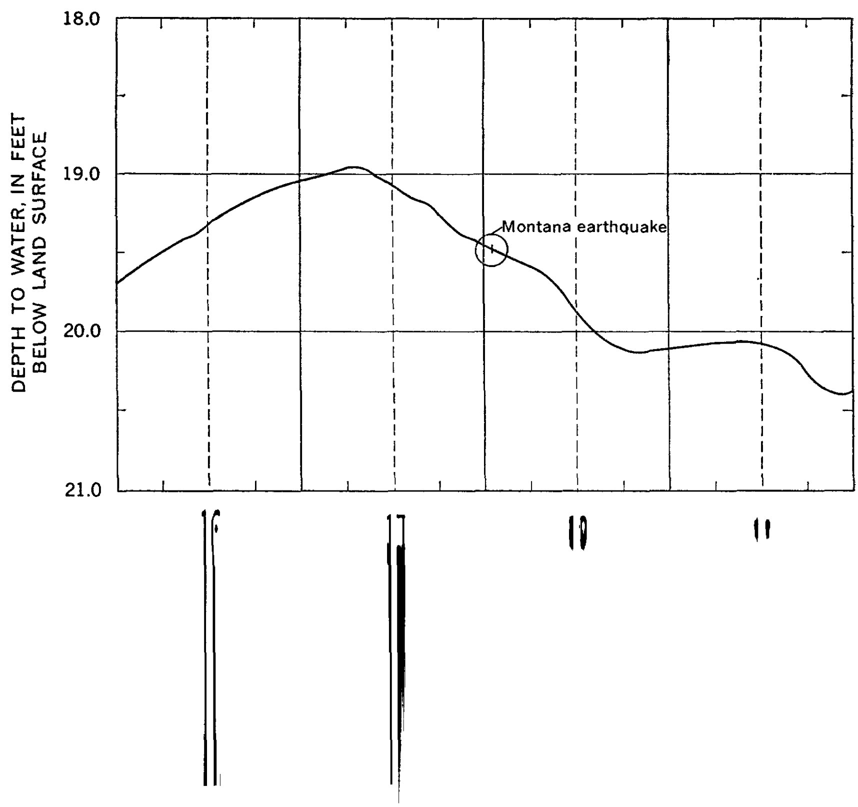
Fluctuations of water levels due to barometric pressure are the commonest superposed fluctuations. The effect of barometric changes on the piezometric surface is complexly related to the physical properties of the aquifer and the confining bed. It is expressed as the barometric efficiency of the aquifer, which is the ratio of the change in water level to the change in barometric pressure, both expressed in feet of water. Water-level fluctuations produced by barometric changes range from zero in unconfined aquifers to more than a foot in confined aquifers.

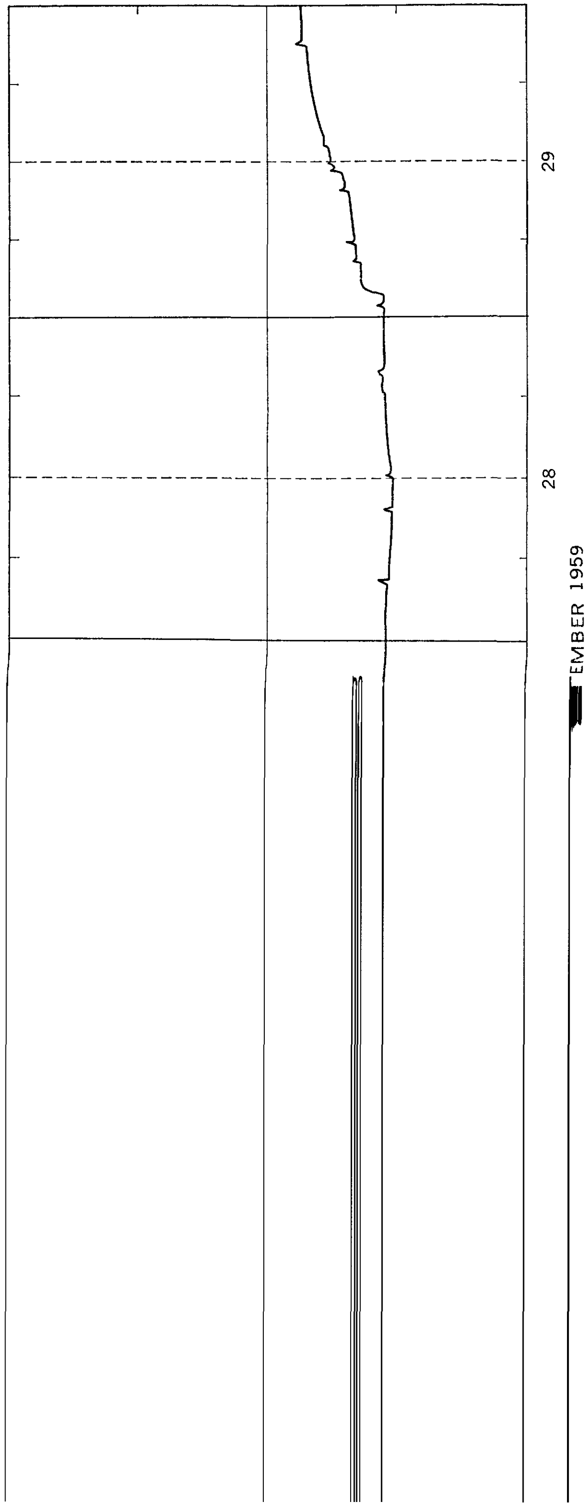
Hydrographs of most wells in the area show minor fluctuations in response to barometric-pressure changes. The barometric efficiency of the aquifer determined at a well in sec. 3, T. 12 S., R. 2 W., is about 90 percent. At several wells in the Grand Prairie, the barometric efficiency averages about 90 percent. The aquifers at these locations are overlain by a relatively thick section of clay that prohibits equalization of air pressure between the aquifer below the confining bed and the land surface.

BASIC

Stage fluctuations of the Arkansas River control temporary variations in the rate of discharge from the aquifer to the river and the rate of recharge to the aquifer from the river. Consequently, changes in river stage exert a major influence on water-level fluctuations near the river.

The effect of changes in stage of the Arkansas River is dependent largely upon the ratio of the coefficient of transmissibility to the coefficient of storage of the aquifer. This ratio has been termed the "coefficient of hydraulic diffusivity." A given change in stage of the river produces a ground-water "wave." The rate of movement and the magnitude of this wave are proportional to the coefficient of diffusivity. Generally, the effect diminishes at an inverse exponential rate from the river. In this area, the influence of river-stage changes is small beyond distances of 3 to 4 miles from the river.





effect of passing trains on the piezometric surface.

of the aquifer determined at a well in sec. 3, T. 12 S., R. 2 W., is about 90 percent. At several wells in the Grand Prairie, the barometric efficiency averages about 90 percent. The aquifers at these locations are overlain by a relatively thick section of clay that prohibits equalization of air pressure between the aquifer below the confining bed and the land surface.

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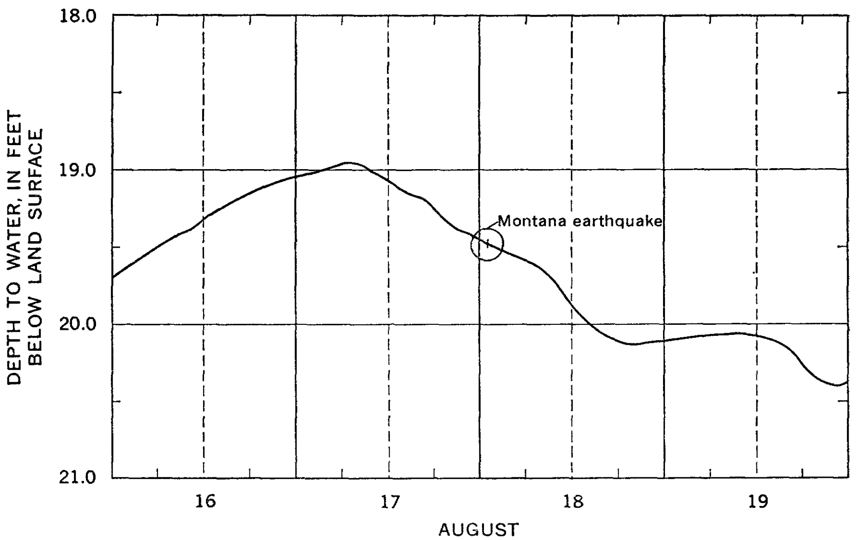

FIGURE 3.—Hydrograph of well 4S–7W–19bcal showing effect of Montana earthquake of August 17–18, 1959, on the piezometric surface.

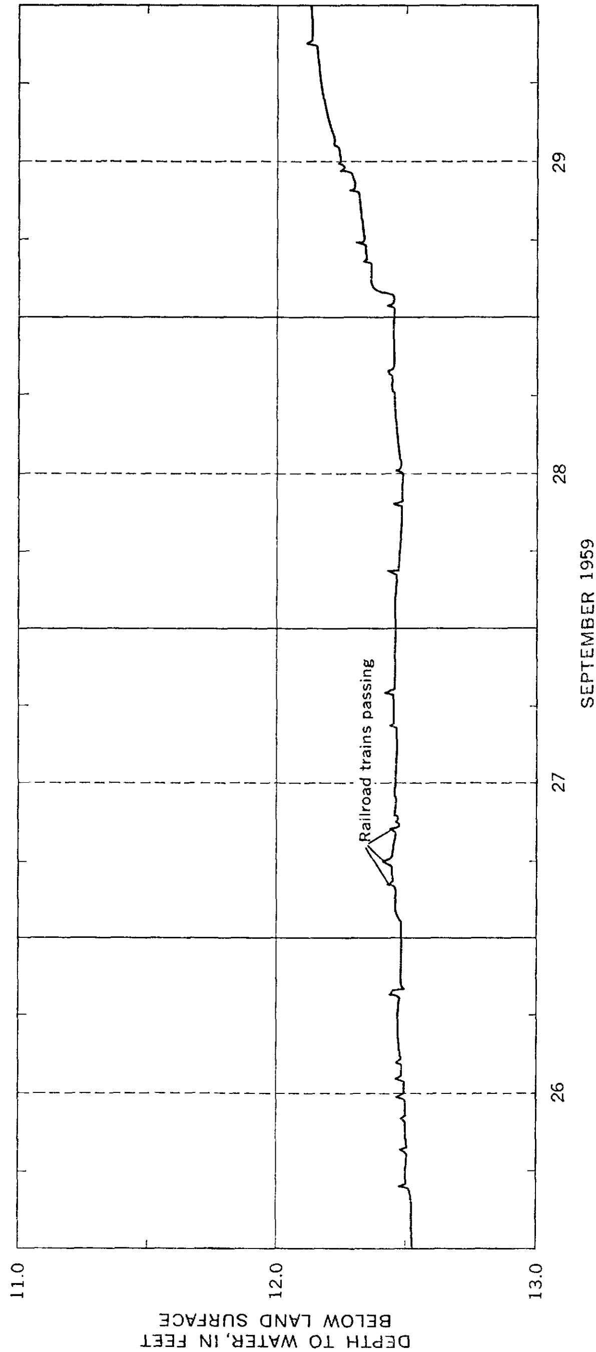

FIGURE 4.—Hydrograph of well 9S–2W–26ddc1 showing effect of passing trains on the piezometric surface.

The stage of the Arkansas River and the water levels near it are generally highest in the spring. From the spring high, the stage declines and is low in the summer and early winter. The stage rises during the late winter and early spring. Exceptions to this cycle occur, however, as illustrated by the hydrograph of the river for 1959, when the river reached its highest stage in the fall.

The influence of river-stage fluctuations is shown by comparison of the hydrograph of the river at Pine Bluff with the hydrographs of wells in plate 1. Wells 5S–8W–35dddl and 6S–5W–29dcal are 0.3 and 0.4 mile from the river, respectively, and well 9S–2W10bbdl is 2 miles from the river. Note that the effect of river-stage changes diminishes with distance from the river.

Seasonal fluctuations in water levels at distances of 3 or 4 miles or more from the river are beyond the predominating influence of the river and follow a definite yearly cycle. The chief hydrologic agents that cause this cycle are precipitation, evapotranspiration, and pumping.

Water levels in the area beyond the zone of pronounced influence of river fluctuations are highest in the spring. Water levels decline sharply in late spring or early summer primarily because of pumping of wells for irrigation. Also, less precipitation is available for recharge, and water loss by evapotranspiration is increased. Water levels continue to decline during the summer. In the fall, water levels rise when pumping ceases, continue to rise during the winter, and reach their highest level in the spring.

The fluctuations in wells beyond the zone of pronounced river influence are shown by the hydrographs of wells in plate 2. Although these wells are beyond the zone of pronounced influence of the river, some fluctuations in these wells seem to correlate with fluctuations in river stage. The correlation, probably more apparent than real, is caused by local recharge from precipitation coincident with river-stage changes.

The yearly fluctuations recorded in some wells show definite characteristics of both cycles described. Water-level fluctuations in wells shown in plate 3 are considerably accentuated by pumping for irrigation from the late spring to late summer. The rise in water levels after the pumping season is typical of wells beyond the influence of the river; however, the the abrupt rise of water levels late in the winter of 1958 and in the fall of 1959 definitely correlates with similar changes in river stage.

CONFIGURATION

The configuration of the piezometric surface in the area from the Mississippi River to Little Rock is shown by contours in plates 4 and 5.

These contour maps were constructed for the spring and fall of 1959 and show the periods of the high and low piezometric surface, respectively. The direction of water movement is downgradient and perpendicular to the trend of the contour lines.

The piezometric maps show that there is a general areal movement of ground water to the southeast. Flexures in the contours on the piezometric surface are indications of local variations in recharge to and discharge from the aquifer or of differences in transmissibility. If transmissibility is constant, flexures that bend downgradient reveal areas of recharge or areas of less discharge than surrounding areas. One example of this is the ground-water ridge in Pulaski and Lonoke Counties. This ridge is overlain by more permeable surface materials and acts as a recharge area. Ground-water movement is directed westward to the Arkansas River and eastward to an area of heavy pumping. Another example is the broad ground-water ridge that parallels the river in Desha County.

Upgradient bending of contour lines is coincident with areas of ground-water discharge or with areas that receive less ground-water recharge than surrounding areas. This upgradient flexuring is exemplified by the shape of the piezometric surface in the area north of the river and east of Pine Bluff, where the slope of the piezometric surface is directed toward the area of large ground-water withdrawal in the Grand Prairie. Another example of upgradient flexuring is in the area south of the river and east of Pine Bluff, which is underlain by less permeable surface materials and is generally coincident with a large area of rice irrigation.

The relation between the Arkansas River and the aquifer is of particular importance. Under natural conditions, the river presumably was a gaining stream throughout the area, except during periods of flood. Pumping for irrigation has locally reversed the natural gradient. The piezometric map for the spring of 1959 (pl. 4) shows that the river is gaining from Little Rock to Pine Bluff. Downstream from Pine Bluff on each side of the river, there are three successive zones of differing relations between the river and the aquifer. On the right side of the river (looking downstream), the river is gaining from Pine Bluff to near the Jefferson-Lincoln County Line; the river is losing from this line to near Jones Lake in Lincoln County and is gaining downstream from Jones Lake. On its left side, the river is losing in a short stretch northwest of the mouth of Plum Bayou. Downstream from this area the river is gaining to near the mouth of Bayou Meto. Further downstream the river is losing.

The relation between the river and the aquifer in the fall shows only minor changes from the previous spring. In general, the areal configuration of the piezometric surface for the fall (pl. 5) is the same as that for the spring. Water levels, however, are lower at this time of the year.

RECHARGE

The alluvial aquifer is recharged mostly by infiltration of rainfall but also by underflow from adjacent rocks and terrace deposits, infiltration of irrigation water, and influent seepage from the river. The amount of underflow from adjacent terrace deposits and rocks is relatively small, but in places sufficient quantities are added to alter the chemical character of water from the alluvium. Infiltration of irrigation water is of local significance where large amounts of water are applied to crops in relatively permeable soils. Throughout most of the area, recharge by influent seepage from the river occurs only for short periods of time during high river stages. In places where ground-water withdrawal for irrigation or municipal supplies is large, the natural hydraulic gradient may be temporarily or permanently reversed, and thus significant amounts of recharge may be induced from the river.

Recharge by penetration of rainfall is greatest in areas that are underlain by point-bar and natural-levee deposits. These deposits are the most permeable of the surface materials, and the water levels under these deposits generally are higher than those under adjacent areas underlain by backswamp deposits.

Recharge to the aquifer generally decreases with distance downstream from Little Rock to the Mississippi River. This reduction corresponds to the decrease downstream in grain size of surface materials and in areal extent of point-bar and natural-levee deposits.

Recharge to the aquifer by direct penetration of rainfall has been computed in two areas by regional-flow analysis of the piezometric map for the spring of 1959. The area (about 90 square miles) west of the river from Little Rock to Pennington Bayou has an average accretion rate of about 3 inches per year. This area is underlain largely by point-bar, natural-levee, backswamp, and terrace deposits.

Recharge to a small area south of Old River Lake in Pulaski County was computed to be about 8 inches per year. This area is underlain by natural-levee and point-bar deposits.

Recharge by penetration of rainfall is negligible in the Grand Prairie region, where recharge is greatly retarded by a thick section of dense clay at the surface. Recharge to the Prairie occurs by underflow from adjacent areas and influent seepage from the Arkansas River and presumably from the White River.

As shown by the piezometric maps (pls. 4–5) and as discussed in the section "Water table," the Arkansas River is gaining throughout most of the area. Influent seepage from the river, however, contributes water to the aquifer in Lincoln and Arkansas Counties.

Analysis of the piezometric map for the fall of 1959 indicates that during this period water was moving from the river into the aquifer in Lincoln County at the rate of about 2 mgd (million gallons per day). Analysis of this map also indicates that about 10 mgd was contributed from the river to the aquifer in Arkansas County.

Analysis of the piezometric map for the spring of 1959 indicates that during this period water was moving from the river to the aquifer at the rate of about 1 mgd in Lincoln County and about 8 mgd in Arkansas County.

DISCHARGE

The alluvial aquifer is discharged by effluent seepage to the river, evapotranspiration from the water table and capillary fringe, underflow into underlying aquifers, and pumping from wells. Discharge by effluent seepage into the river and pumping from wells accounts for most of the discharge in the area, but discharge by evapotranspiration probably is large. In the area between Little Rock and Pine Bluff there is presumably some underflow into sands of Tertiary age where the alluvium directly overlies these sands.

Throughout most of its length the river is gaining by discharge of water from the aquifer, as previously discussed in detail in the section "Water table."

Some ground water is discharged by evaporation from the capillary fringe where the water levels are near the surface. Discharge by evaporation is limited to areas where the water levels are near the surface, such as the alluvial area near Little Rock.

The quantity of ground water discharged by transpiration is not known, but it is probably large. Dense growths of plants, many related species of which are known to draw water from the zone of saturation or capillary fringe in arid regions, are present in the area, especially along the meander belts of the Arkansas River and major streams and in many backswamp areas.

Most of the water pumped from the alluvial aquifer is used for irrigation. Relatively small amounts are withdrawn for domestic and industrial use. It is estimated that about 580 million gallons, or about 1,800 acre-feet, of water per year is pumped for domestic used in the counties in the project area. The cities within the project area having public water supplies obtain water from wells in deposits of Tertiary age.

The amount of ground water used for irrigation in 1959 is estimated to have been 360,000 acre-feet in Pulaski, Lonoke, Jefferson, Arkansas, Desha, and Lincoln Counties. Of the water pumped for irrigation, 310,000 acre-feet was used in the growing of rice, and 55,000 acre-feet was used for irrigation of row crops. Pumpage estimates are based partly on reported acreages of rice and row crops irrigated by wells. The acreages are reported by counties, and no attempt has been made to estimate the amount of water used in the part of each county within the boundary of the project area. Total pumpage from each county of the project area is as follows:

Use of ground water for irrigation, Mississippi River to Little Rock, 1959

County	*Water used (acre-feet)*	*County*	*Water used (acre-feet)*
Arkansas	130,000	Lonoke	96,000
Desha	38,000	Pulaski	8,000
Jefferson	60,000		
Lincoln	33,000	Total (rounded)	360,000

GEOCHEMISTRY

The ground water from the alluvial aquifer is predominantly of the calcium magnesium bicarbonate type, but the dissolved-solids content varies considerably. Composition of the alluvial material and the rate at which water moves through the aquifer affect the dissolved-solids content because coarse gravel and sand have less mineral matter available for solution than the finer materials. Water that moves a greater distance through the acquifer, or that is in contact with the finer materials, has the larger dissolved-solids content.

The maximum, minimum, and the modal concentrations of the principal constituents determined are shown in table 1. The mode, representative of the concentration that occurred most often, is shown as a single value; however, different levels of dissolved-solids content occurred so frequently that the central tendency of concentrations was a range rather than a single value. The distribution of specific-conductance values, an approximation of dissolved-solids content, is shown in figure 5. The modal conductance is 600 micromhos, although the central tendency approaches a range of 250 to 750 micromhos. The frequency of occurrence of the concentrations of the major constituents follows the same pattern.

The dissolved-solids content was determined for a sufficient number of samples from the project area to develop a relationship with specific conductance. (See fig. 6.) Based on values extrapolated from figure 6, the dissolved-solids content of water in the alluvium between Little Rock and the Mississippi River ranged from 76 ppm (parts per million) in Pulaski County to 1,090 ppm in Desha County.

The maximum concentrations shown in table 1 for sodium sulfate and chloride are not typical of water in the alluvium. In general, they represent localized conditions of water quality.

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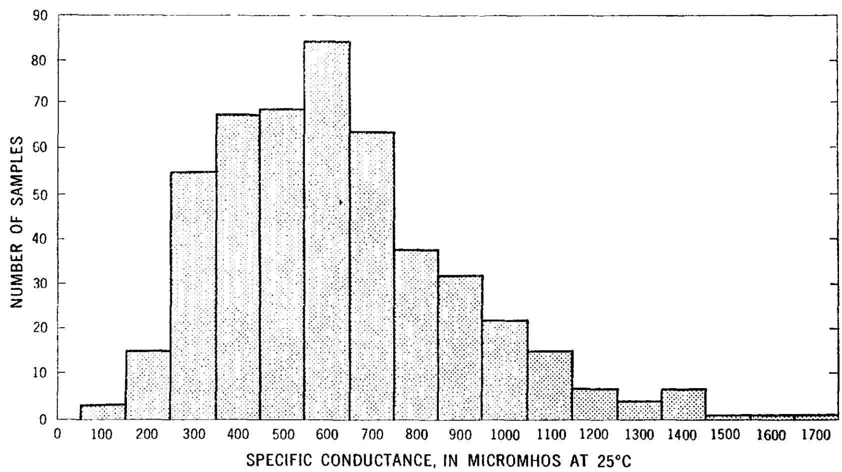

FIGURE 5.—Distribution of specific conductances of water from the alluvium between the Mississippi River and Little Rock, Ark.

TABLE 1.—*Maximum, minimum, and modal concentrations of chemical constituents, hardness, and specific conductance of water from the alluvium—Mississippi River to Little Rock*

[Chemical constituents and hardness in parts per million. Based on 473 analyses collected from 1949 to 1960]

County	Iron (Fe)		Sodium (Na)		Bicarbonate (HCO_3)		Sulfate (SO_4)		Chloride (Cl)		Calcium, magnesium hardness as $CaCO_3$		Specific conductance (micromhos at 25° C)	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Arkansas	26	0.71	123	30	568	136	66	0.0	257	16	621	154	1,520	434
Desha	62	.0	173	9.9	620	53	172	1.0	175	3.2	650	51	1,690	171
Lincoln	32	.11	84	17	457	16	82	.0	178	8.0	458	39	1,080	275
Jefferson	38	.0	97	4.1	672	62	241	.0	186	3.8	574	29	1,250	123
Lonoke	40	2.2	44	5.3	452	80	-----	.0	74	4.0	400	43	767	124
Pulaski	52	.10	79	5.9	616	18	137	.0	141	3.2	505	6	1,120	114
Mode for area	8.0		25		300		5.0		18		260		600	

The principal uses of water from the alluvium in the area are for domestic and irrigation supplies. Most of the water used for irrigation can be classified as "excellent to good." Some of the supplies have a percent sodium approaching 50, but the dissolved-solids content is low enough that even these waters fall in the "good to permissible" category for irrigation. The high iron content and the hardness of most of the water make the supplies undesirable for domestic use. In a few areas, high sodium and chloride concentrations in the water cause an undesirable, salty taste.

Plate 6 shows the quality characteristics and ionic concentrations of water from representative wells in the alluvium between Little

Rock and the Mississippi River. The well-location number is designated for each "kite" diagram. The size and shape of the "kite" diagrams illustrate the types of water in the area, relations between the principal mineral constituents, and variations in total ionic concentrations. The vertical axis of the pattern represents the total cation concentrations, and the horizontal axis represents the total anion concentration. Thus, the total ionic concentration in equivalents per million is equal to the combined lengths of the vertical and horizontal axis.

The typical water from the alluvium, the calcium magnesium bicarbonate type, is indicated when the major part of the quadrilateral is in the upper right quarter. Variations from the typical pattern are caused by local differences in the composition of surficial and aquifer materials, influent seepage from adjacent or underlying formations, and influent seepage from the river.

Analyses of ground water show three principal atypical waters in the lower Arkansas River valley. For ease of identification, a small circle inside the "kite" diagram in plate 6 is used to denote the typical water and the principal atypical waters.

The percentages of sodium and sulfate are higher in the water from wells 9S–2W–35ddbl, 9S–3W–29baal, and 10S–2W–12daal (pl. 6) than in the typical water from the alluvium. The sodium-calcium ratio and the sulfate plus nitrate content of water from these wells are

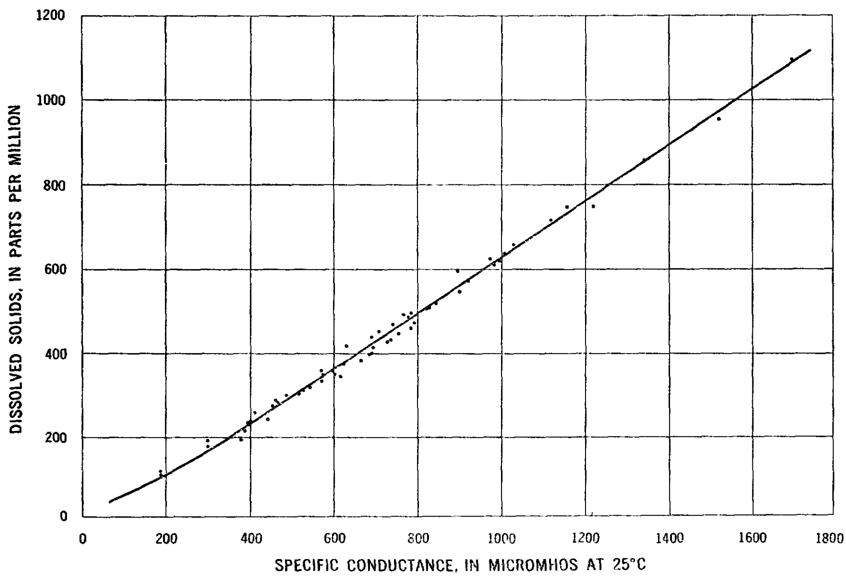

FIGURE 6.—Relation of dissolved-solids content to specific conductance in water from the alluvium between the Mississippi River and Little Rock, Ark.

similar to those of water from terrace deposits southwest of the Arkansas River. These wells, however, are about 15 miles from the terrace deposits and separated by water of typical quality.

The pattern for water from well 3S–10W–23cadl in plate 6 shows a high sulfate concentration. The percentage composition of water from this well is similar to that of water in the underlying formations of late Eocene age; this fact indicates that the well draws some water from the underlying formation.

The patterns for water from wells 2N–12W–34cca3, 5S–4W–30dddl, 6S–4W–36aabl, 6S–5W–5ccbl, 7S–5W–30aacl, 7S–6W–24caal, and 8S–4W–32ddbl (pl. 6) differ from that for typical water, as they indicate higher percentages of chloride plus sulfate and sodium plus potassium. The percentage composition of water from these wells is intermediate between typical water from the alluvium and river water.

In areas where the piezometric surface has been lowered enough to reverse the natural hydraulic gradient, water from the river will move into the aquifer. As the river water moves through the aquifer, its chemical quality is modified through contact with soluble minerals in the aquifer material and by mixing with other water in the aquifer.

Figure 7 illustrates the types of water to be expected by the recharge of the alluvium by river water. The percentage compositions of the calcium magnesium bicarbonate water of the alluvium will plot within the box in the upper left-hand corner of the diagram. The percentage compositions of the sodium chloride river water will plot within the box in the right-hand section of the diagram. Any river water moving into the alluvium will acquire calcium, magnesium, and bicarbonate, and the percentage composition of the resulting mixture should be between the typical ground-water and river-water boxes. The points plotted between the two boxes represent analyses of ground-water samples from wells 2N–12W–34cca3 and 7S–5W–30aacl. The water from these wells has the predominant calcium magnesium characteristics of the water in the alluvium and has a higher percentage of chloride plus sulfate than typical water.

The atypical water from wells 2N–12W–34caa3 and 7S–5W–30aacl is probably caused by influent seepage of river water. The atypical waters in southeastern Jefferson County and in Arkansas County are separated from the river by water of typical chemical character. As noted in the section "Water table," the river is influent in this area; apparently, however, the effect of the present stage of influent seepage has not been great enough to alter the chemical character of ground water sampled near the river. No completely satisfactory explanation has been found for the distribution of these atypical waters.

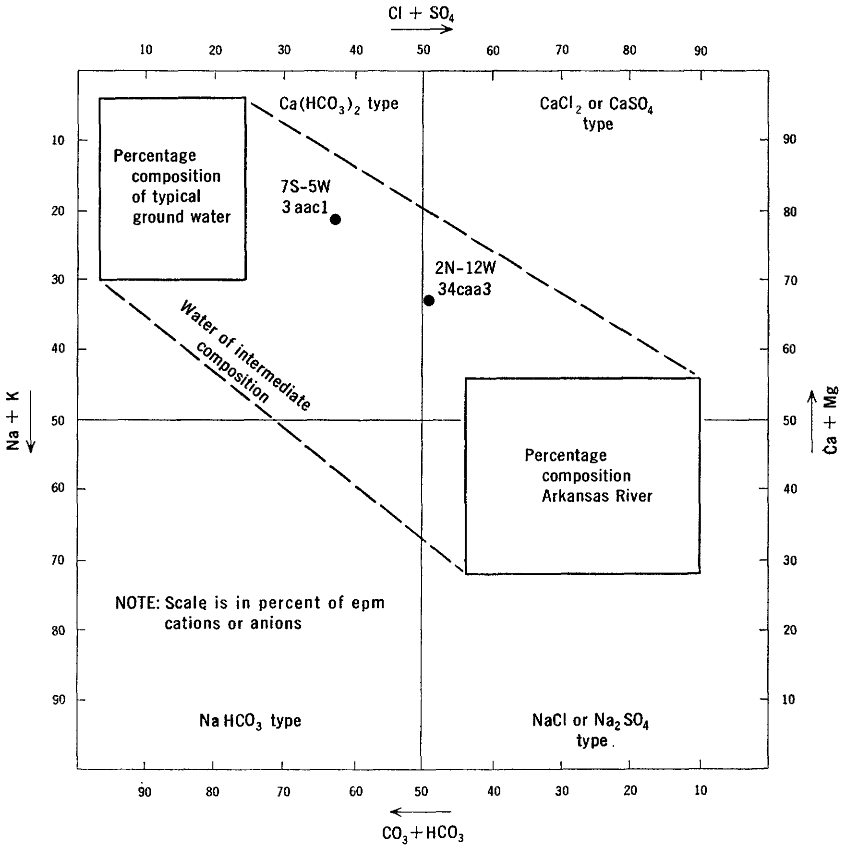

FIGURE 7.—Percentage composition of river water, typical ground water, and mixtures.

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