5-1948

Ground-Water Levels in the Lower Platte River Valley, Nebraska

H. A. Waite
University of Nebraska - Lincoln

Nebraska Water Survey Paper

Number 3 May 1948

GROUND-WATER LEVELS IN THE LOWER PLATTE RIVER VALLEY, NEBRASKA

H. A. WAITE

★ ★ ★

UNIVERSITY OF NEBRASKA

CONSERVATION AND SURVEY DIVISION

NEBRASKA WATER SURVEY PAPER

NUMBER 3 MAY 1948

GROUND-WATER LEVELS IN THE LOWER PLATTE RIVER VALLEY, NEBRASKA

BY

H. A. WAITE

PUBLISHED BY THE UNIVERSITY OF NEBRASKA
CONSERVATION AND SURVEY DIVISION, LINCOLN

CONSERVATION AND SURVEY DIVISION

G. E. Condra, Chief and State Geologist
E. C. Reed, Associate Chief and Associate State Geologist

AS defined by law, the mission of the Conservation and Survey Division of the University is to survey and describe the geology, topography, natural resources, industries, and conservation problems of Nebraska and serve as a factual Information Bureau relating to the conservation and development of the state's resources.

Reports of the Division are published by its departments: Geological Survey, Water Survey, Soil Survey, Resource and Industry Survey, Biological Survey, and Conservation Problem Survey. The Information Bureau service is carried on by correspondence, field examination, hearings, conferences, lectures, special reports, and by use of departmental publications.

WATER SURVEY PUBLICATIONS

This publication is the third of a series of Water Survey Papers designed to include special reports and articles of less comprehensive nature than Water Survey Bulletins. More formal reports of cooperative investigations in Nebraska are published as Water Supply Papers by the U. S. Geological Survey in cooperation with the Nebraska Water Survey of the Conservation and Survey Division.

This paper was prepared for presentation at the fifty-fifth annual convention of the Nebraska State Irrigation Association held at North Platte, Nebraska, December 4-6, 1947. Immediately after the paper had been presented, Mr. Lloyd C. Thomas, president of the Association, stated that he believed the paper contained information that would be of interest to practically all of the members of the Association and asked Dr. Condra if the paper could be published by his Division, so that copies could be distributed to the members of the Association and others as soon as possible. Dr. Condra replied in the affirmative provided that the members so desired, and provided that approval of the Director of the U. S. Geological Survey could be obtained for publication of the paper. A vote was taken and President Thomas announced that it was unanimous. The approval of the Director of the Geological Survey has been obtained and the paper is herewith published by the Conservation and Survey Division of the University of Nebraska.

Ground-water Levels in the Lower Platte River Valley, Nebraska[1]

By Herbert A. Waite [2]

Ground-water levels in the Lower Platte River Valley, Nebraska, are of interest because ground water sustains many activities that are of concern to the State, the community, the businessman, and the farmer. Many individuals have a vital stake in the ground-water resources of the Lower Platte River Valley in Nebraska; water from wells plays no small part in the economy of that region. The public water supplies and the rural domestic supplies are obtained from wells. Industry and irrigation, too, depend heavily upon ground water as a basic factor in their profitable operations.

The systematic collection of water-level records is a basic procedure in even the simplest investigation of ground-water resources. Practically all interpretations of changes in storage in ground-water reservoirs are based on these critical ground-water data. Periodic water-level observations are instrumental in supplying a wealth of water facts concerning ground-water withdrawals, the rises and declines of the water table, spacing of wells, possible recharge to underground reservoirs, and other related data. When extended over sufficiently long periods of time, water-level records furnish valuable information in regard to seasonal fluctuations and long-term trends of the water table, the value of which increases as time goes by and demands on ground-water sources become progressively greater.

The first comprehensive studies of the behavior of the water table in the Platte River Valley were begun in 1930 as one phase of the cooperative ground-water program started in that year by the United States Geological Survey and the Conservation and Survey Division of the University of Nebraska. Periodic measurements of the depth to the water table were made at about 100 wells in the segment of the Platte Valley between Gothenburg

[1] Published with the permission of the Director of the Geological Survey, U. S. Department of the Interior.

[2] District Geologist of U. S. Geological Survey in charge of cooperative State-Federal ground-water investigations in Nebraska.

and Grand Island.[3] The wells were selected so that fluctuations of the water table could be observed in all parts of the area. During the early part of the investigation measurements were made in only 60 wells, but other wells were added later as it became desirable to study the fluctuation of the water table in more detail.

As a result of increased interest in ground-water levels, a State-wide program of water-level measurements was begun in 1934, and about 60 of the wells in the Platte Valley on which measurements were begun in 1930 and 1931 were included in this program. In 1945 the scope of the water-level observation program in the Lower Platte River Valley was greatly expanded in connection with a comprehensive program of ground-water investigations in the Missouri River Basin in Nebraska begun by the Ground Water Division, United States Geological Survey, in cooperation with the United States Bureau of Reclamation and with the continued cooperation of the Conservation and Survey Division of the University of Nebraska.

The area considered in this paper is confined to the Platte River Valley bottom lands and terraces from the range line two miles west of North Platte to the range line one mile east of Fremont, and aggregates approximately 2,500 square miles. Periodic measurements of the depth to water in about 260 observation wells are now being made. The locations of all observation wells in the Lower Platte River Valley are shown in figure 1. The Central Nebraska Public Power and Irrigation District and the Loup River Public Power District have installed observation wells in the vicinities of their respective projects and many of these wells are situated in the valley. A total of 38 of these wells has been incorporated in the present water-level observation program. In order to achieve more nearly uniform coverage in the valley, 74 privately owned wells were added to the observation-well program and 66 small-diameter wells, equipped with screened drive points, were installed by the Geological Survey in selected localities. Water-level measurements since 1930 and prior to 1945 in all observation wells in the Platte Valley have been published in

[3] Lugn, A. L., and Wenzel, L. K., Geology and ground-water resources of south-central Nebraska, with special reference to the Platte River Valley between Chapman and Gothenburg; U. S. Geol. Survey Water-Supply Paper 779, pp. 105–108, 1938.

annual reports of the Geological Survey.[4] Subsequent measurements (since January 1, 1945) will be published in similar reports of this series.

The net changes in water level in the lower Platte River Valley for the periods December 1930 to December 1939, December 1939 to December 1946, and for the over-all period December 1930 to December 1946 are shown in three maps which have been prepared for this purpose. (Figs. 2, 3, and 4, respectively.)

The amount of rise or decline in water levels during the respective periods is shown by distinctive patterns. Figure 2 indicates that a net decline of the water table was predominant over much of the area during the period December 1930 to December 1939. By contrast, figure 3 shows that a general net rise in water levels occurred in much of the area during the period December 1939 to December 1946. However, the amount of general rise, as indicated on figure 3, was not sufficient to balance the general decline indicated in all areas of figure 2. This is borne out by figure 4, which covers the over-all period December 1930 to December 1946 and shows net changes in water level for the combined periods of the first two maps.

The amount of the net decline shown in the vicinity of Cozad and Lexington for the period December 1939 to December 1946 is sufficiently small that it is entirely possible that it could be eliminated in one or two seasons of more favorable precipitation. However, it is possible that this decline may be a forerunner of a long-term water-level trend. The decline of the water table in western Hall County, on the other hand, has been progressive, even through the period December 1939 to December 1946 when water levels in the remainder of the Lower Platte River Valley were rising. During the period from 1930 until the present, the net declines in water levels in observation wells in this area ranged up to a maximum of about 7 feet. On the basis of this known water-level history, it would seem that any additional expansion of pump irrigation in this rather critical area should proceed cautiously lest the area be faced eventually with problems of local overdevelopment and attendant increasing pumping lifts.

[4]U. S. Geol. Survey Water-Supply Papers 777 (1935); 817 (1936); 840 (1937); 845 (1938); 886 (1939); 908 (1940); 938 (1941); 946 (1942); 988 (1943); and 1018 (1944).

The net changes in water level are least in the vicinity of the river and are greatest in areas that are farther from the river, where conditions are less favorable for recharge. The Platte River apparently tends to stabilize the water table beneath the lands lying immediately adjacent to it. Fluctuations of stage in the river probably affect the ground-water levels at greater distances from the river in the Platte Valley than in most other valleys, because the water table for several miles adjacent to the river is in approximate equilibrium with the water surface of the river.

The map covering the period December 1939 to December 1946 (fig. 3) shows that the water levels in observation wells in some parts of this area, notably south of the river between North Platte and Lexington, have risen as much as 17 feet. This amounts to a rise of about 12 to 15 feet above the normal rise for the region during this period and suggests that the water table has been artificially raised owing to seepage losses from canals and reservoirs in the vicinity.

The Lower Platte River Valley has been arbitrarily subdivided into six segments for purposes of comparison of changes in ground-water storage. (See fig. 1). The "East of Merrick County" segment includes the valley area between the range line 1 mile east of Fremont and the range line 12 miles west of Columbus. The "Merrick County" segment extends from the range line 12 miles west of Columbus to the east line of Hall County. The "Hall County" segment is restricted to the valley portion of that county and to a very small portion of extreme northwestern Adams County. The "Buffalo County" area includes all of the valley portion of that county and the valley portions of Kearney and Phelps Counties lying directly south of Buffalo County. Likewise, the "Dawson County" segment includes all of the valley portion of that county and the small valley portions of Phelps and Gosper Counties lying directly south of Dawson County. The "Lincoln County" area is restricted to the valley portion of Lincoln County up to the range line 2 miles west of North Platte.

Graphs showing changes in ground-water storage in each of the six segments of the Lower Platte River Valley are presented in figure 5, together with the monthly precipitation at the following stations of the U. S. Weather Bureau: Schuyler, Central City, Grand Island, Kearney, Lexington, and North Platte.

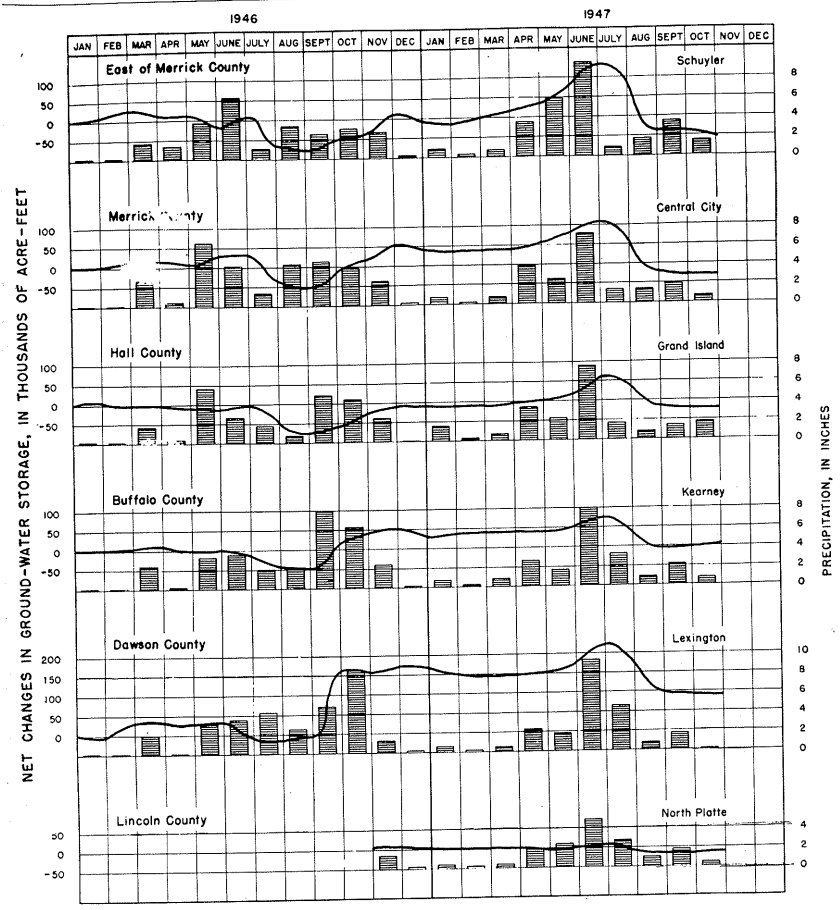


Figure 5. Graphs showing changes in ground-water storage in each of six segments of the Lower Platte River Valley, together with the monthly precipitation in inches at the nearest stations of the U. S. Weather Bureau.

In each graph the curve starts at the zero point—this point representing the total amount of water in ground-water storage on January 1, 1946. Points along the curve which are above the zero line represent times at which ground-water storage was in excess of the amount in storage on January 1, 1946. Likewise, points below the zero line represent times at which ground-water storage was less than the amount in storage at the beginning of 1946. The increases or losses in ground-water storage, in thousands of acre-feet, can be determined by reference to the scale on the left margin of the graphs. Actually, the curves are an index of changes in water level in the respective segments.

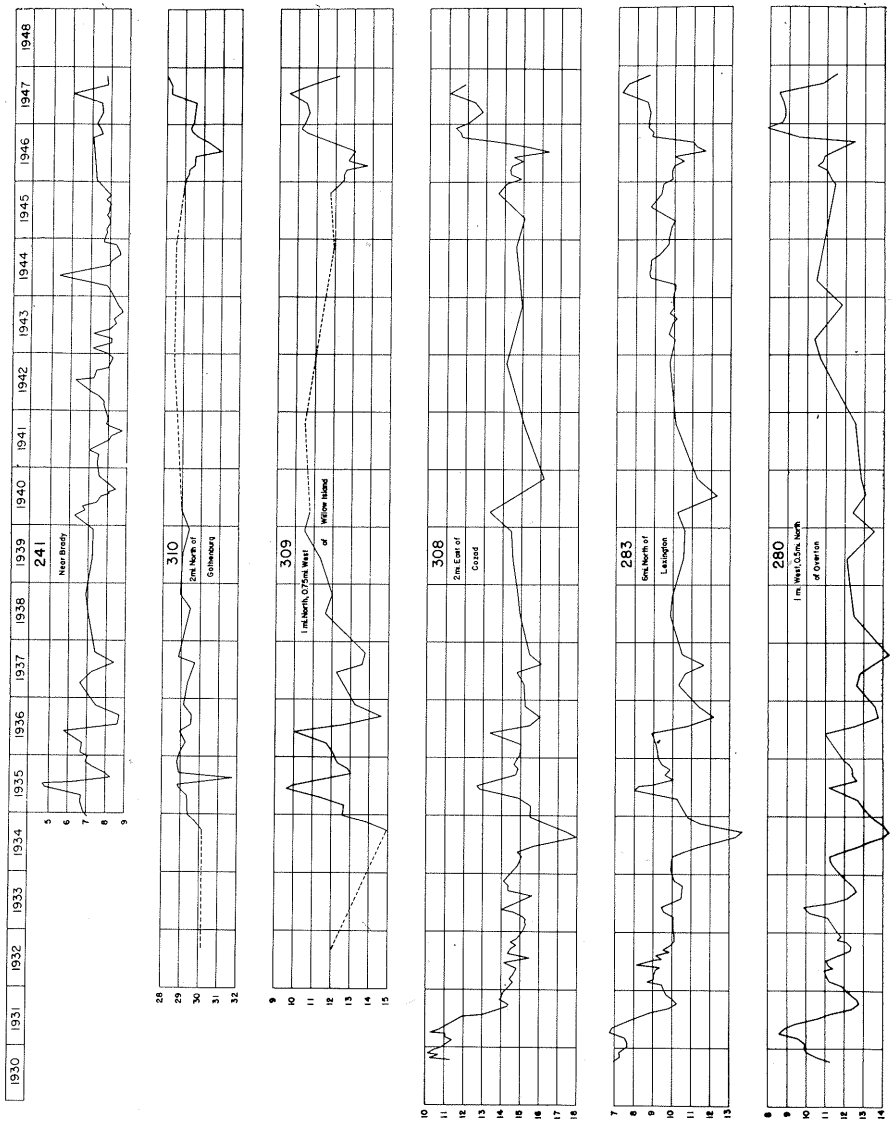


Figure 6. Hydrographs showing fluctuations of the water levels in six wells in the Lower Platte River Valley between North Platte and Kearney.

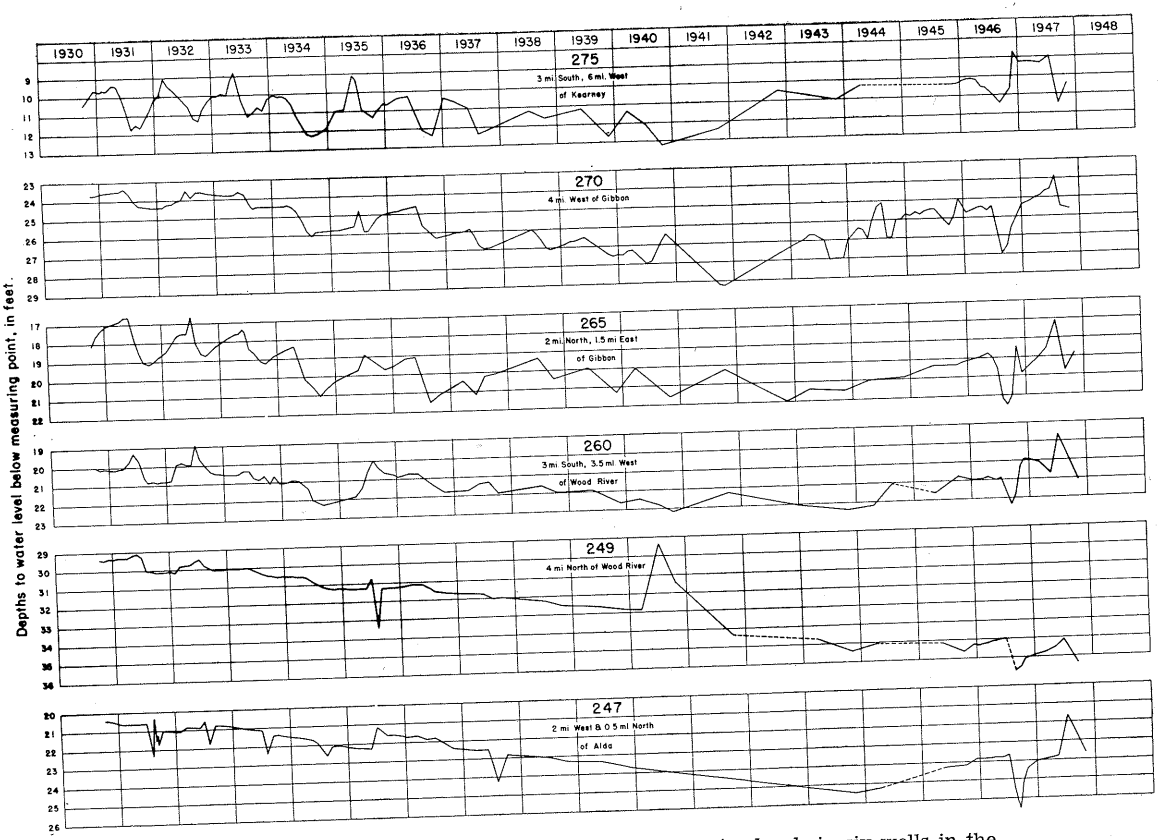


Figure 7. Hydrographs showing fluctuations of the water levels in six wells in the Lower Platte River Valley between Kearney and Grand Island.

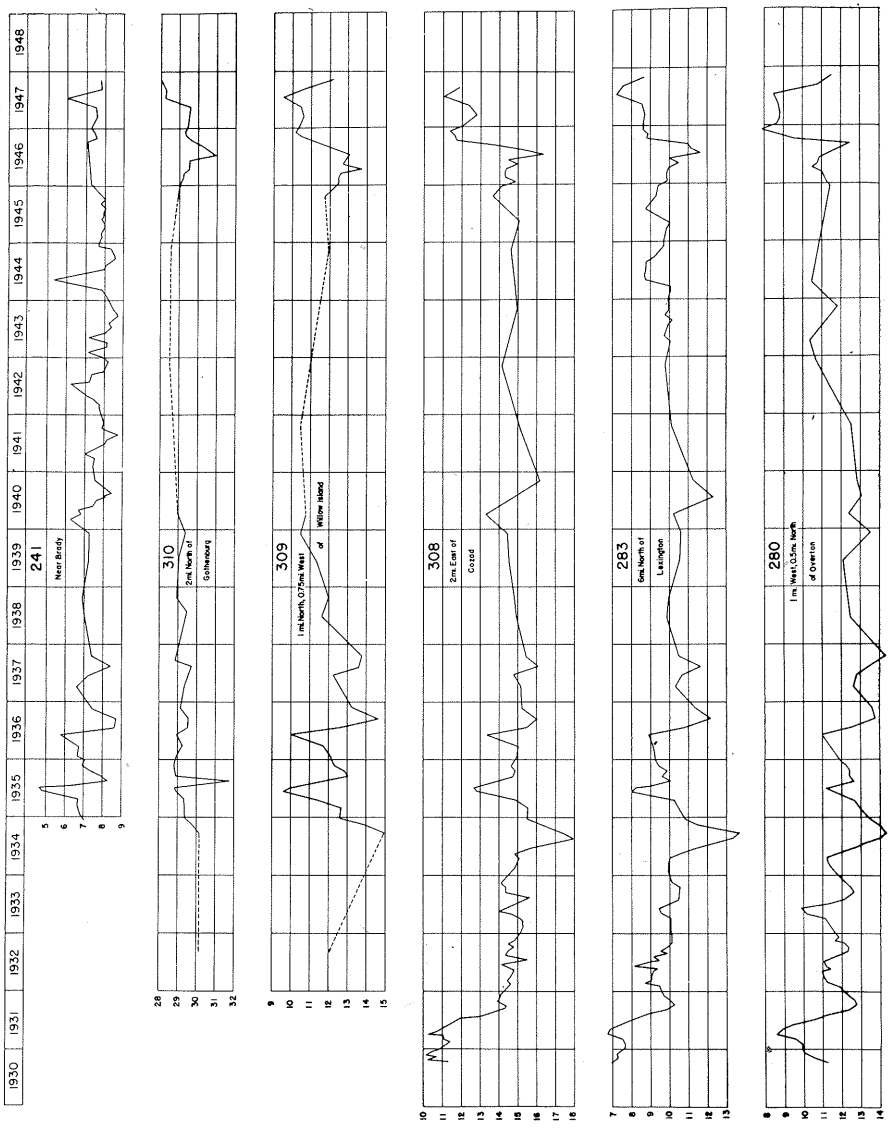


Figure 6. Hydrographs showing fluctuations of the water levels in six wells in the Lower Platte River Valley between North Platte and Kearney.

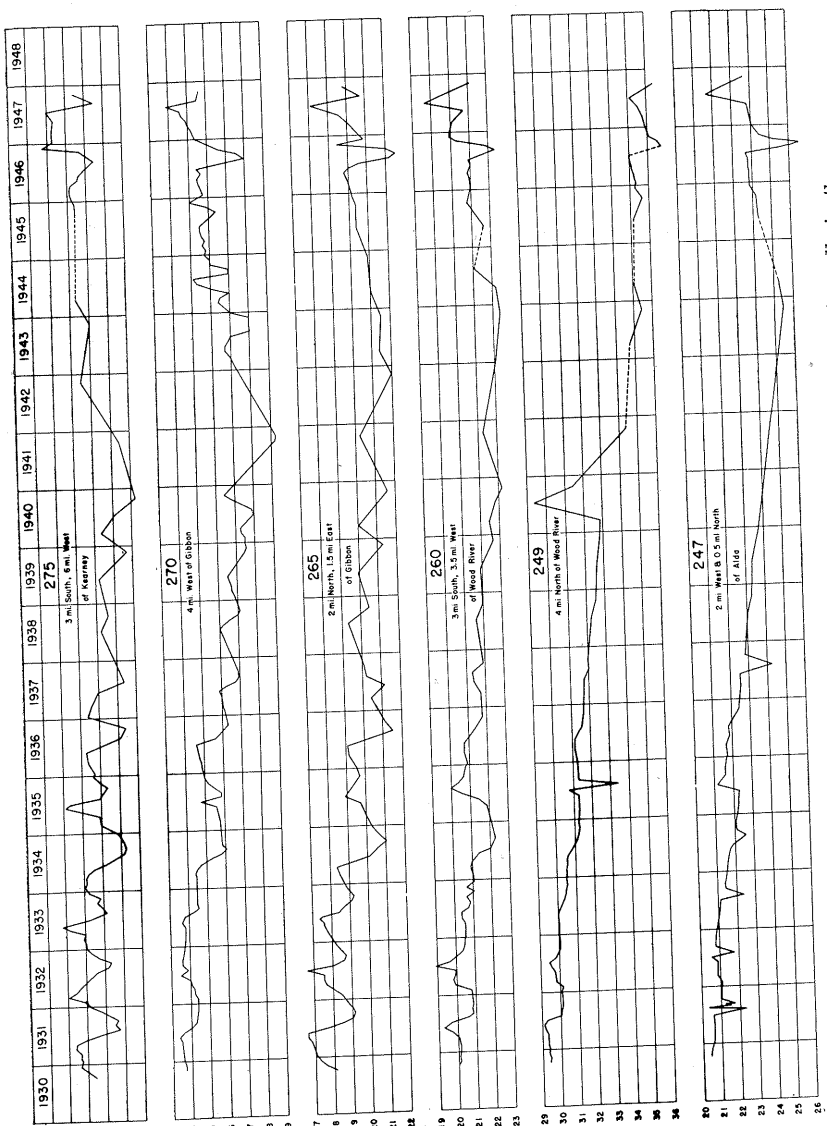


Figure 7. Hydrographs showing fluctuations of the water levels in six wells in the Lower Platte River Valley between Kearney and Grand Island.

These long-term water-level records are of interest, because most of them started in the fall of 1930 and have continued without interruption until the present time. In 1930 the water table was relatively high throughout the Lower Platte River Valley, largely as a result of unusually favorable precipitation during that year, with resultant lesser withdrawals from the ground-water reservoir. During the period from about 1931 through 1939, when drought conditions were prevalent, the water levels in observation wells showed net declines. After 1939, with a return to a period of more nearly normal precipitation, the water levels in many of the observation wells showed net rises. During the period from 1940 through 1946, the average annual precipitation for the State was below normal only twice, in 1940 and 1943. In each of the remaining years during this same period the average annual precipitation was above normal. The plus departures from normal precipitation slightly more than balanced the minus departures during this period.

It will be noted that although the water level records of several of the observation wells show annual losses and partial recovery, or even gains, the hydrographs of several wells in the critical area on the north side of the river between Kearney and Grand Island show that the long-term trend is downward despite partial recovery in 1947. The hydrographs of wells 265, 249, and 247 substantiate this fact rather conclusively. This situation exists in an area where there is no recharge from irrigation with river water.

In much of the valley area between Gothenburg and Kearney the ground-water levels have recovered from low stages reached in 1939. An exception, however, is the area in the vicinity of Cozad and Lexington, mentioned earlier, where the water levels in wells show net declines of 1 to 3 feet since 1930. The principal reason that ground-water levels west of Kearney have declined less than they have in the area between Kearney and Grand Island is the fact that the ground-water reservoir in the area between Gothenburg and Kearney receives valuable recharge from surface-water irrigation in that area.

Ground water is used for irrigation throughout the Lower Platte River Valley. The locations of irrigation wells are shown in figure 8. It is noteworthy that aproximately 3,930 irrigation wells are shown on this map. As this map was prepared in the

spring of 1947, the number of well locations shown on the map is considerably less than the number of irrigation wells existing at present. The map shows that the greatest concentration of irrigation wells is in Hall County, which has a total of 1,045. Dawson County with 983 wells and Buffalo County with 905 wells are close behind. This heavy development of pump irrigation took place during and immediately following the drought of the 1930's and was particularly heavy in the three counties mentioned.

For the sake of comparison, it should be pointed out that a field census made in 1931 and 1932 in connection with the cooperative ground-water survey showed that about 920 irrigation wells were being operated at that time between Gothenburg and Chapman. The total number of irrigation wells in this section had increased to about 3,275 by 1946, as shown by field surveys made by the Bureau of Reclamation in that year. Thus an increase of nearly 260 per cent is indicated for the period 1932-1946, or an average increase of about 19 per cent per year. The rate of increase in the future is, of course, a matter of conjecture.

It is hoped that the maps and charts presented in this paper will result in a better understanding of the methods used for interpreting the vast amount of basic water-level data that has been collected in the Lower Platte River Valley in Nebraska since the beginning of the cooperative ground-water survey in 1930.

igure 2

R PLATTE RIVER VALLEY

s in Ground-water Levels
O to December, 1939

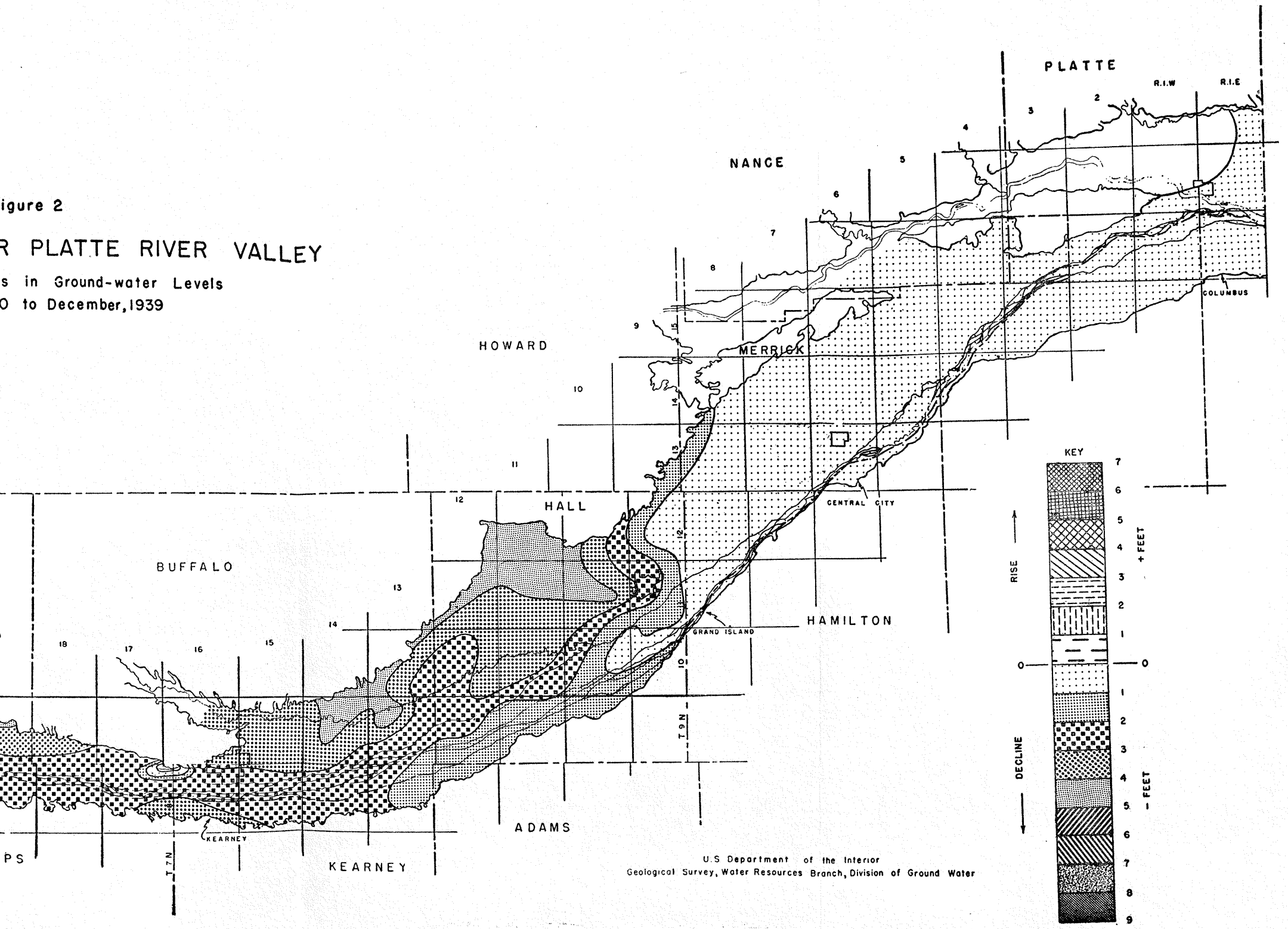
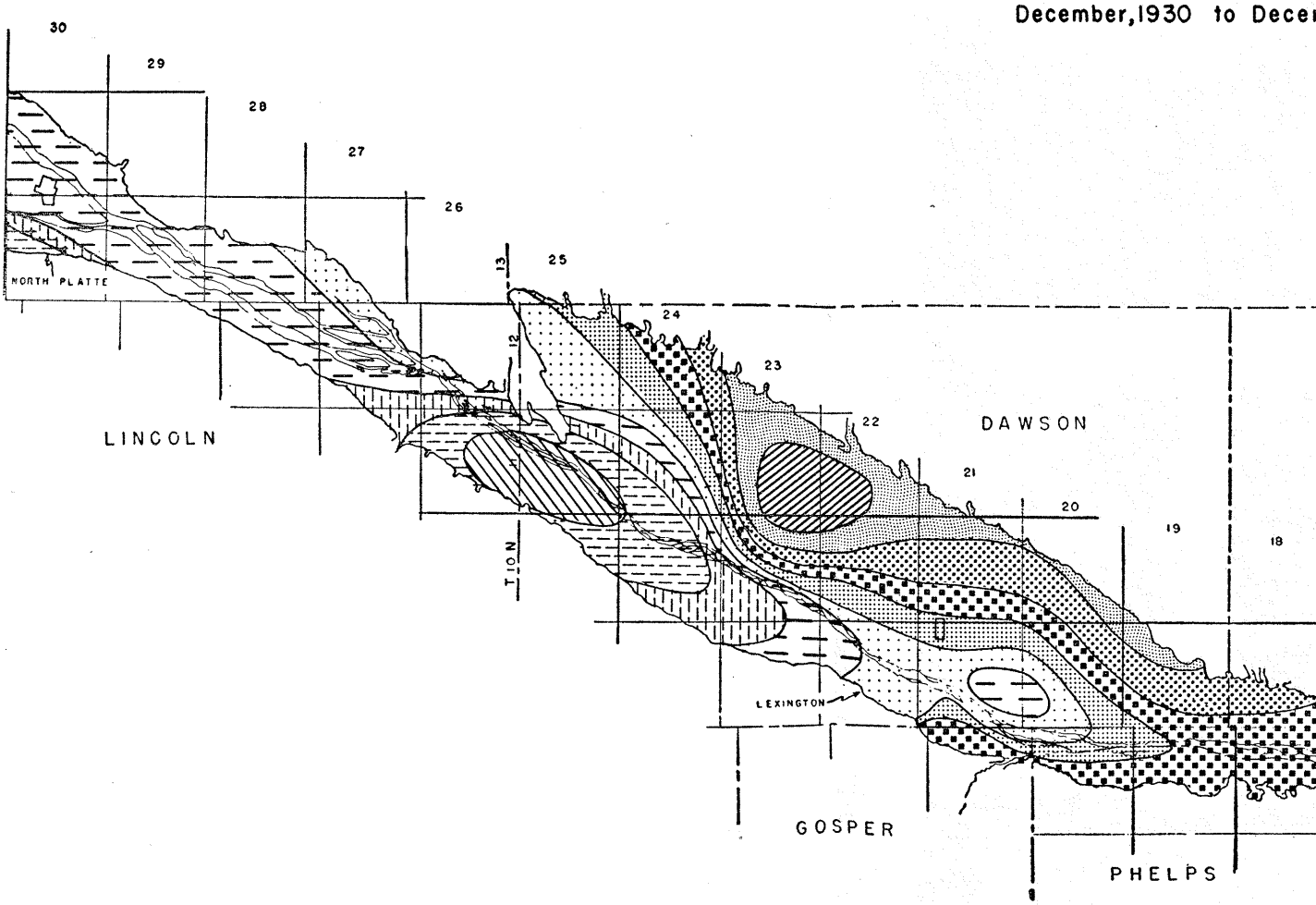


Figure 2

MAP OF THE LOWER PLAT

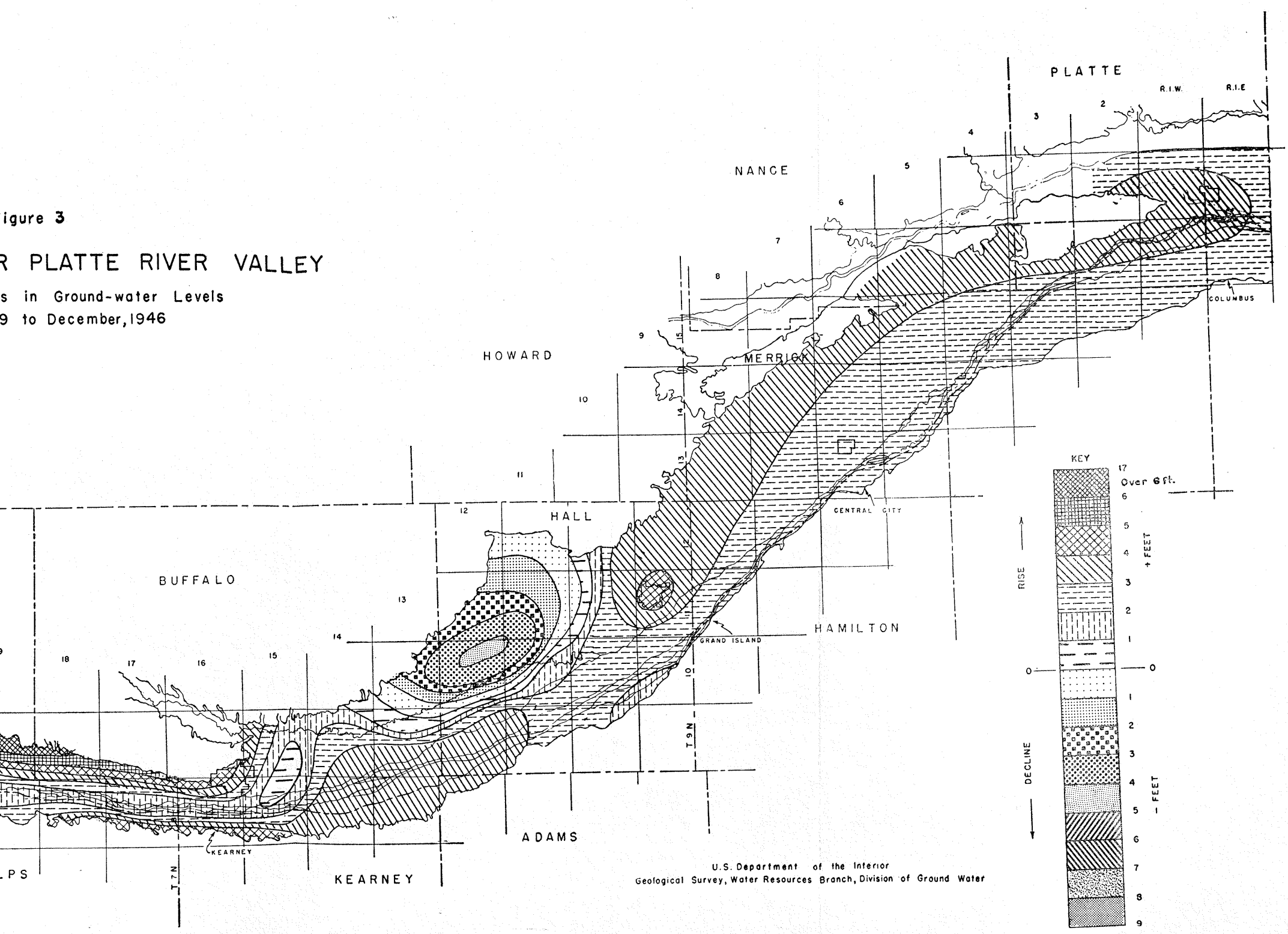
Showing Net Changes in Grou
December, 1930 to Dece



igure 3

R PLATTE RIVER VALLEY

s in Ground-water Levels
9 to December, 1946



U.S. Department of the Interior
Geological Survey, Water Resources Branch, Division of Ground Water

Figure 3

MAP OF THE LOWER PLAT

Showing Net Changes in Grou
December, 1939 to Dece

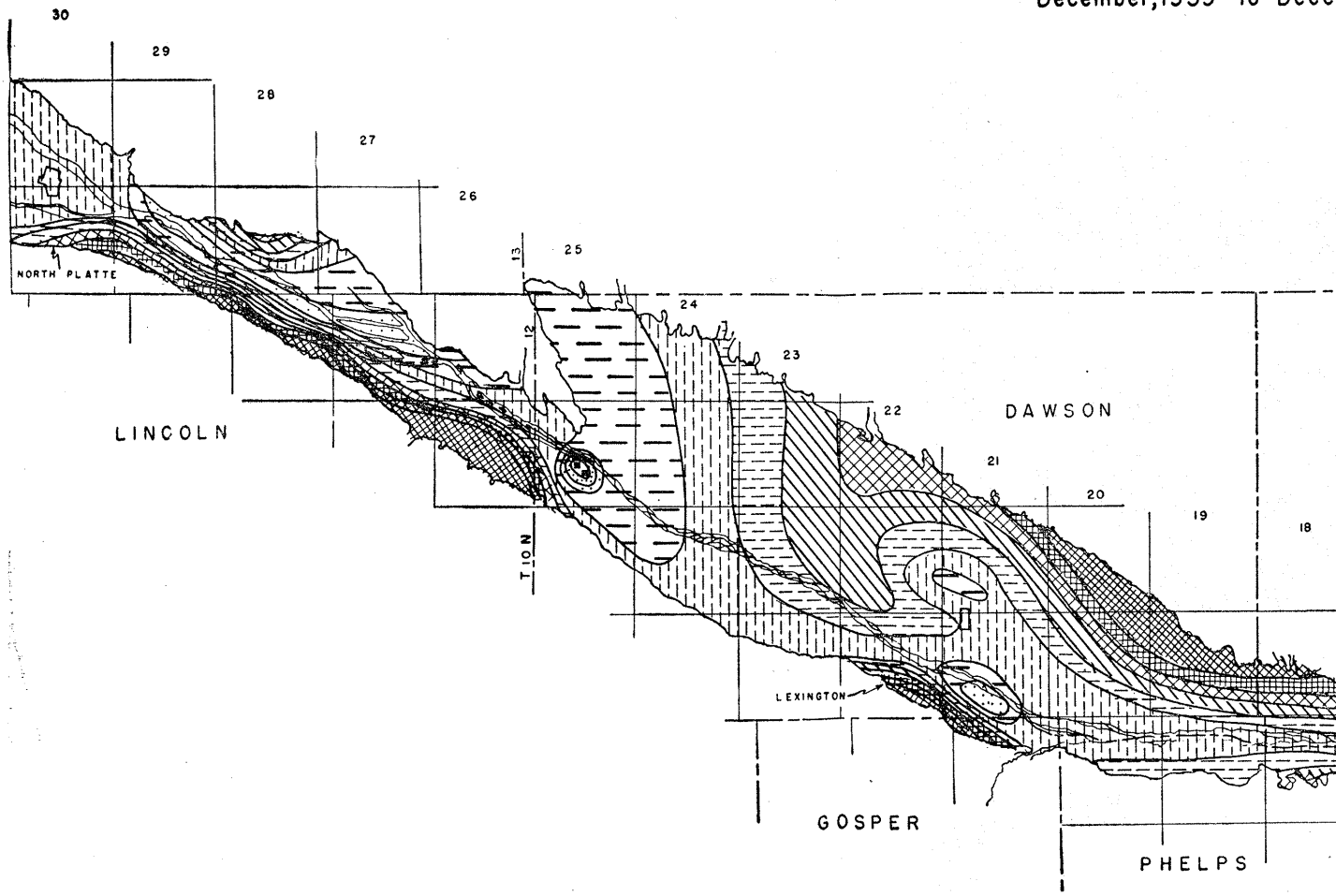
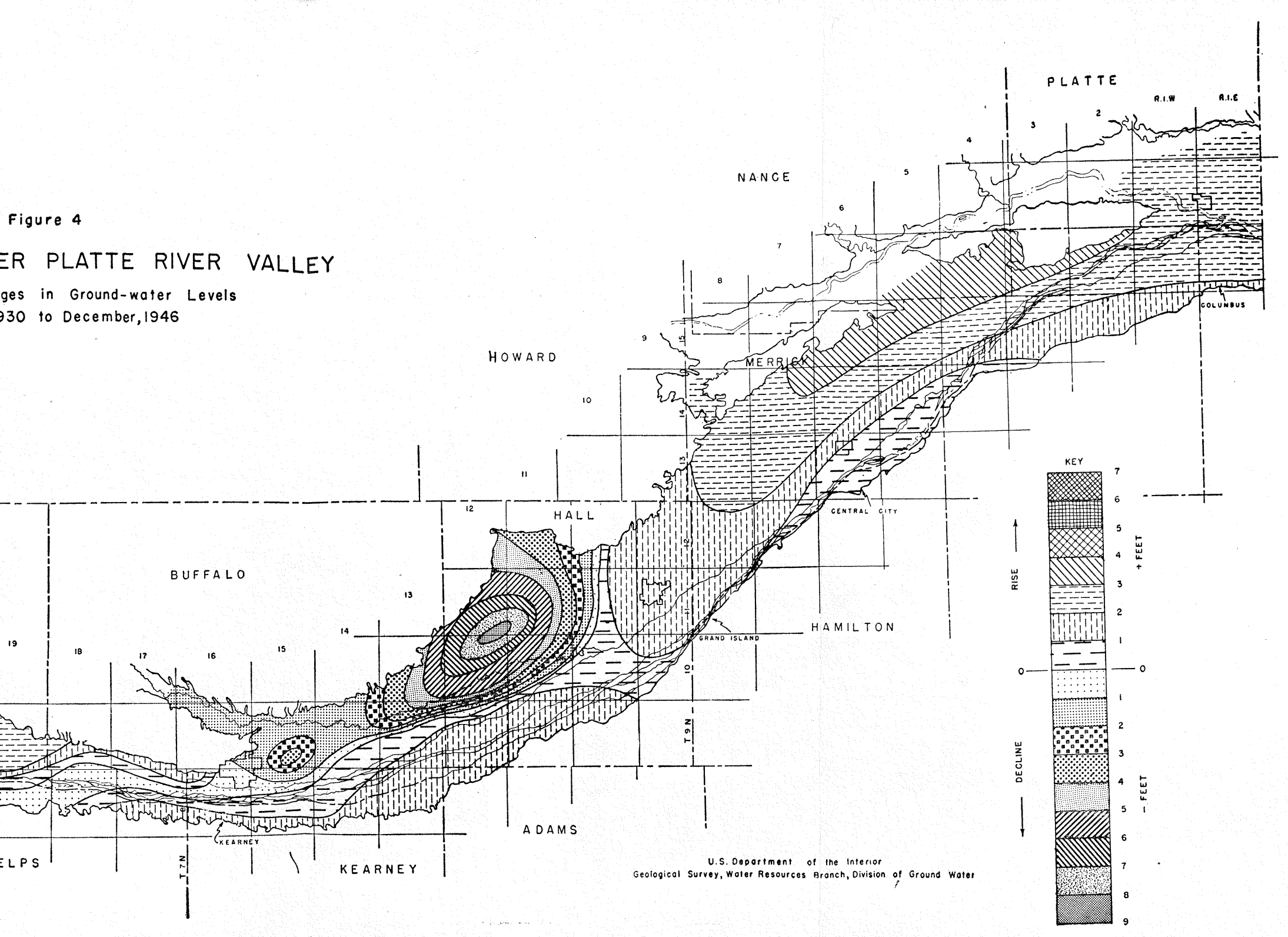


Figure 4

ER PLATTE RIVER VALLEY

ges in Ground-water Levels
930 to December, 1946

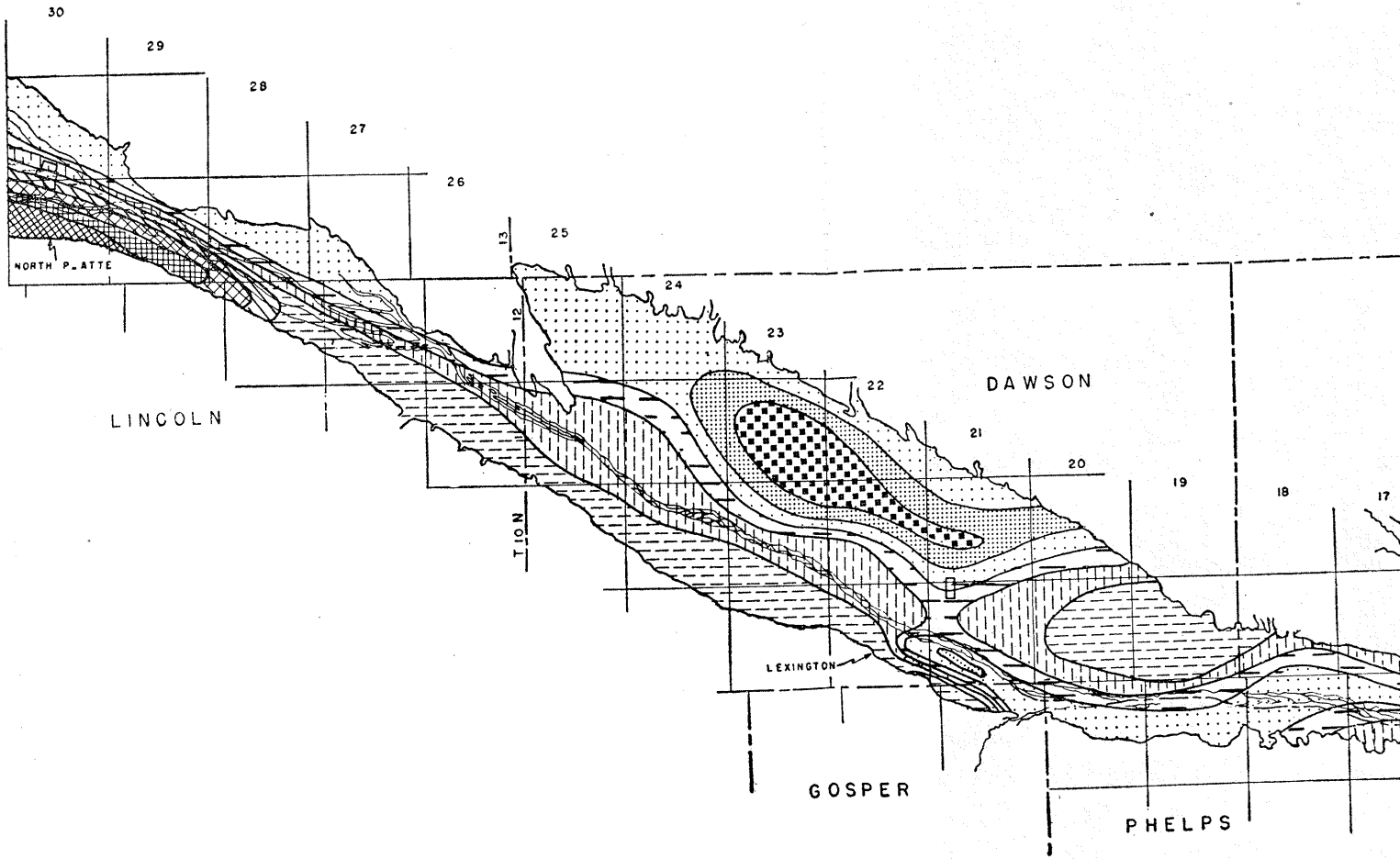


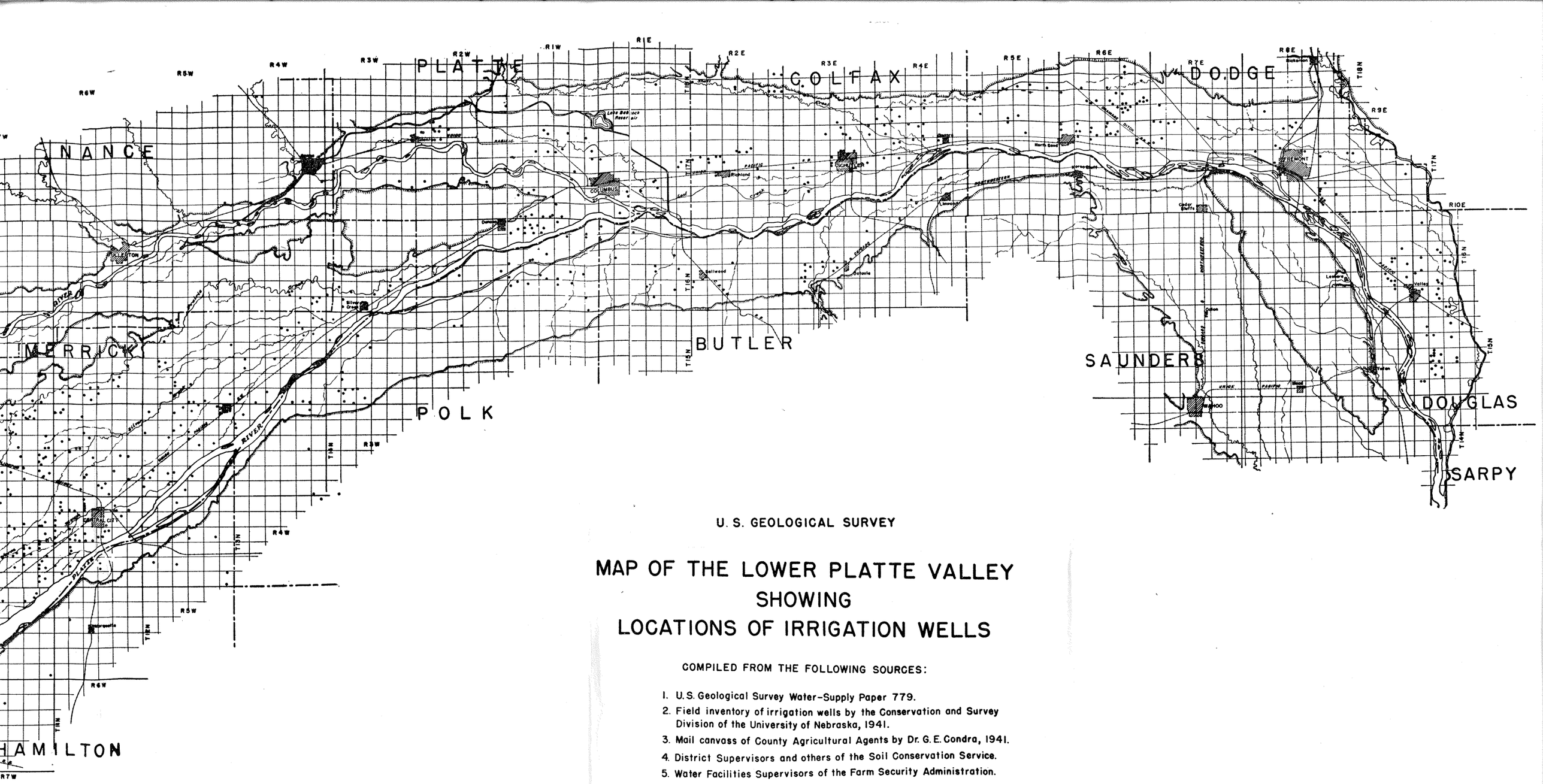
U.S. Department of the Interior
Geological Survey, Water Resources Branch, Division of Ground Water

Figure 4

MAP OF THE LOWER PLATTE R

Showing Net Changes in Ground-wate
December, 1930 to December, 19





U. S. GEOLOGICAL SURVEY

MAP OF THE LOWER PLATTE VALLEY SHOWING LOCATIONS OF IRRIGATION WELLS

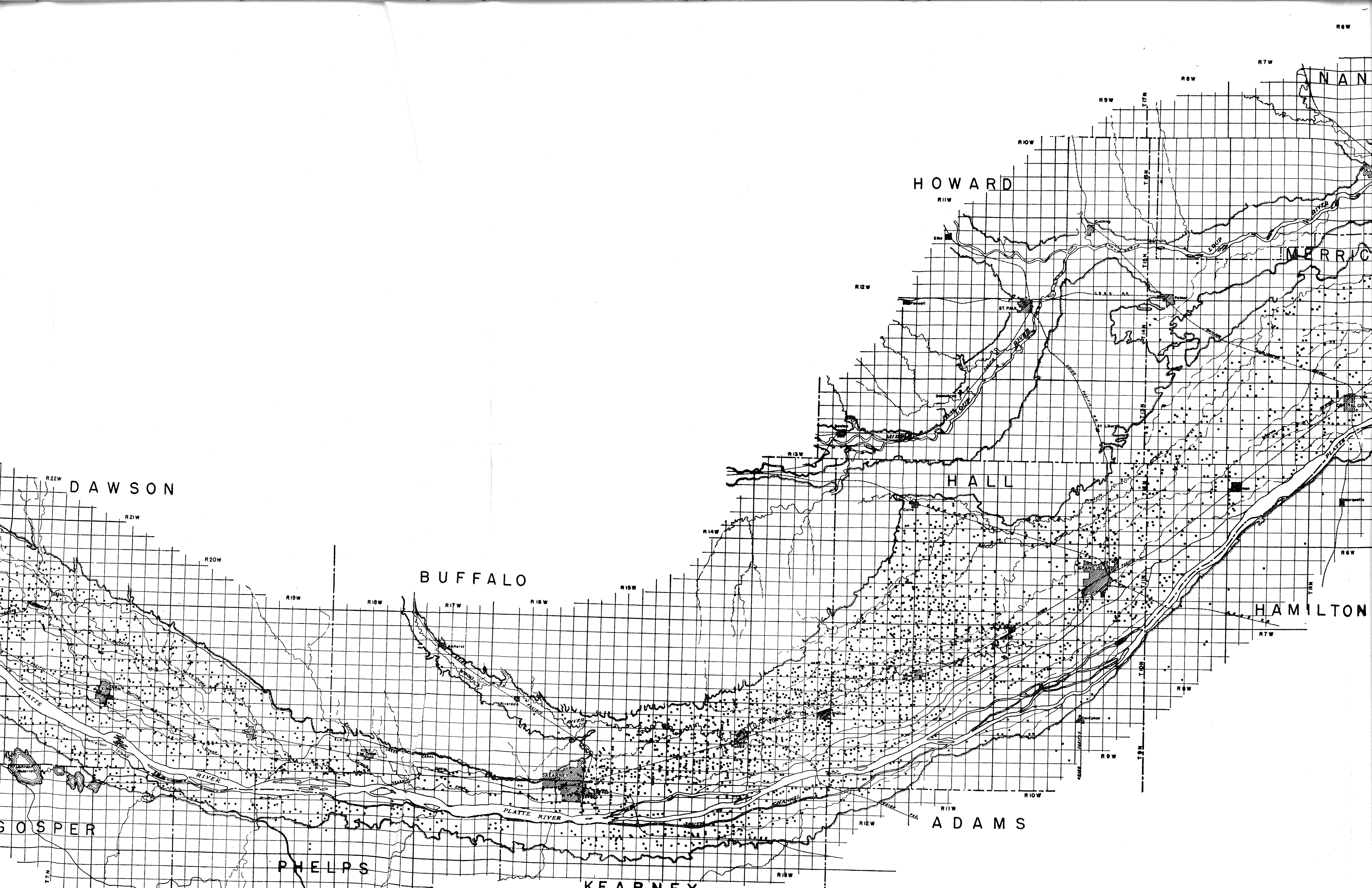
COMPILED FROM THE FOLLOWING SOURCES:

1. U.S. Geological Survey Water-Supply Paper 779.
2. Field inventory of irrigation wells by the Conservation and Survey Division of the University of Nebraska, 1941.
3. Mail canvass of County Agricultural Agents by Dr. G. E. Condra, 1941.
4. District Supervisors and others of the Soil Conservation Service.
5. Water Facilities Supervisors of the Farm Security Administration.
6. Nebraska Well Drillers and Pump Manufacturers.
7. Field inventory by the U. S. Geological Survey.
8. Field inventory by the Bureau of Reclamation.

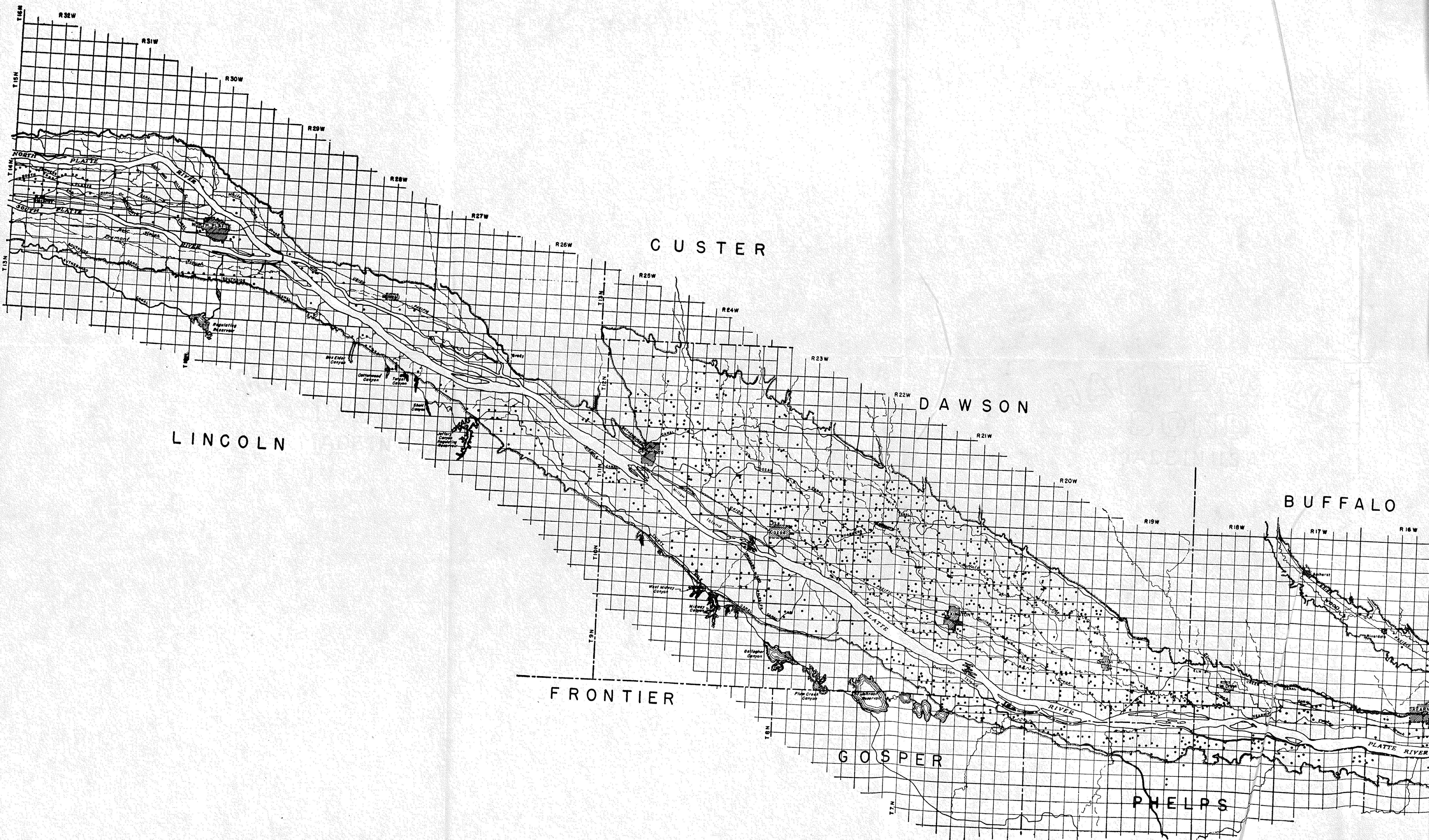
0 1 2 3 4 5 6
Scale of Miles

1947

Figure 8. Map of the Lower Platte River Valley showing the locations of irrigation wells.



DAWSON
BUFFALO
HOWARD
HALL
HAMILTON
ADAMS
GOSPER
PHELPS
PLATTE RIVER
R22W
R21W
R20W
R19W
R18W
R17W
R16W
R15W
R14W
R13W
R12W
R11W
R10W
R9W
R8W
R7W
R6W



CUSTER
DAWSON
BUFFALO
LINCOLN
FRONTIER
GOSPER
PHELPS
R32W
R31W
R30W
R29W
R28W
R27W
R26W
R25W
R24W
R23W
R22W
R21W
R20W
R19W
R18W
R17W
R16W
T15N
T13N
T12N
T10N
T9N
T8N
T7N
PLATTE RIVER