CHANGES IN QUANTITY OF GROUND WATER

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The importance of ground water in New Mexico is indicated by its uses. It supplies more than 90 percent of municipal and industrial requirements. It is the only source of water to irrigate about one-half the State's total irrigated area and it furnishes supplemental water to almost one-third of the area irrigated from surface-water supplies. The development of the resource has largely occurred during the past two decades. Ground-water use has increased the State's irrigated area by about 325,000 acres since 1940, and diversion for municipal and industrial use has increased at rates greater than population expansion.

Ground water is contained in subsurface reservoirs which provide a medium for storage and transmission of water from areas of intake to areas of discharge at the land surface. Under natural conditions, reservoirs are in a state of approximate equilibrium. When wells into the reservoir pump or flow, a new or artificial discharge is superimposed on the hydraulic system. The water so diverted must derive from increased recharge, decreased discharge, from storage, or from a combination of these sources. Initially a pumping or flowing well takes water from storage. The effect of pumping, whether pumping is continued or not, spreads radially outward from the well and in time reaches areas of recharge and areas of discharge. If, in the areas of recharge, the reservoir had perviously rejected water, the effect of pumping may cause the reservoir thereafter to take more water. Pumping effects reaching areas of discharge will cause diminution of discharge. The total effect on a reservoir by artificial diversion from wells is the sum of the effects of individual wells.

I will briefly describe some representative reservoirs from which irrigation developments have been made and the changes that have been observed.

HIGH PLAINS

In eastern New Mexico large irrigation developments have been made from ground-water reservoirs located on the southern High Plains. These reservoirs which immediately underlie the surface consist of loose or poorly consolidated fine sand and various mixtures of clay, sand, and gravel. The western limit of the plateau upon which these reservoirs are located is defined in most places by an escarpment exposing sections of the reservoir rock. Bedrock is a sequence of consolidated sedimentary rocks in which water deposits of economic importance have not been proven.

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The ground-water reservoirs are recharged by precipitation, mainly from runoff in the drainage ways and in the numerous depressions that dot the plain. Natural discharge from these reservoirs is by seeps and springs at the eastern boundary of the High Plains in Texas. Idealized, the aquifers are wedge-shaped, the thickness of saturated sediments increasing as recharge from precipitation accumulates eastward in the direction of ground-water flow.

Principal High Plains areas of irrigation in New Mexico are located near House in Quay County, in the Clovis area, in Portales Valley, and in the Causey-Lingo and Tatum-Lovington-Hobbs areas.

House area, Quay County

In the House area in southwestern Quay County, the Ogallala formation provides an aquifer in which saturated sediments range in thickness from 25 to 100 feet and average about 50 feet. Depths to water range from 25 to 100 feet. Water levels fluctuate in response to pumping and only in years of heavy precipitation is recharge significant.

Irrigation began in 1936 when four wells pumped about 380 acre-feet of water. The amount of irrigated land increased progressively until 1950 when about 4,400 acres was irrigated. Since 1950 irrigation has decreased and averaged about 3,500 acres from 1950 to 1960.

In the 19 years from 1941 to 1960 about 85,000 acre-feet of water was pumped for irrigation. In the 9 years from 1941 to 1950 water levels declined in excess of 5 feet under an area of 1/4 square mile. During the next 10 years the area of 5-foot decline had spread to 25 square miles and within that area the maximum decline was in excess of 20 feet.

Clovis area, Curry County

The Ogallala formation mantles the Clovis area in Curry County and is the principal aquifer in a saturated zone ranging from about 45 feet in the vicinity of Melrose to about 200 feet in the southeastern part of Curry County. Depths to water range from 130 to more than 330 feet. It is estimated that the water in storage in the Clovis area in New Mexico aggregates about 5 million acre-feet. Annual recharge is about 15,000 acre-feet.

The Ogallala formation of the Clovis area grades into the reworked material that comprises the Portales Valley aquifer. The two reservoirs are contiguous and hydraulically connected. Their common boundary is defined by a water-table ridge located north of Blackwater Draw. The location of that boundary may be changed by the effects of pumping in both reservoirs.

In the Clovis area the first successful irrigation wells were drilled about 1948 and rapid development of irrigation began in

1953. By late summer in 1955 more than 400 wells had been drilled and about 74,000 acres were irrigated. Since 1956 the area irrigated has averaged about 80,000 acres and the pumpage has amounted to about 80,000 acre-feet per year.

Interpretations of water-level changes from 1954 to 1960 indicate that declines may have exceeded 20 feet in an area of 33 square miles. A more significant decline of 5 feet is observed under 310 square miles.

Portales Valley, Roosevelt County

Portales Valley is a broad and shallow depression on the High Plains. Water flows in the few stream courses only after infrequent heavy rainfall and accumulates in playas and depressions.

The ground water reservoir is composed of reworked and redeposited materials from the Ogallala formation. Recharge is from infiltration of precipitation, a favorable area being a belt of sand dunes that extend along the north side of the valley. Ground water moves east-southeast along the axis of the valley, and is discharged naturally by evaporation from water-table lakes, evaporation from areas where the water table is near the surface, flow from a few small springs, and subsurface flow across the State line. Pumpage from wells has imposed an artifical discharge on the reservoir, causing substantial depletion to the reservoir.

Irrigation in the Portales Valley began in 1910 when the Portales Irrigation Company was established. About 4,000 acre-feet of water was pumped annually until 1914 when the company failed. By 1929, the irrigated area had increased to about 4,800 acres. Irrigation of 56,000 acres in 1960 is an 8-fold increase over the estimated 7,400 acres irrigated in 1932.

Water pumped for irrigation in the 18-year period from 1932 to 1950 totaled about 470,000 acre-feet, and water levels declined more than 5 feet under 60 square miles, and more than 10 feet under 34 square miles. Pumpage for irrigation during the 10-year period from 1950 to 1960 was about 870,000 acre-feet, and water levels declined from the 1949 datum more than 10 feet under 150 square miles, more than 20 feet under 65 square miles, and more than 30 feet under 12 square miles. Along the axis of the valley in the center of the irrigated area, net declines averaged about 1/2 foot per year from 1932 to 1950, and about 2-1/2 feet per year from 1950 to 1960.

Lea County

In New Mexico the largest ground-water reservoir on the High Plains is in the Ogallala formation covering about 2,000 square miles of Lea County. Large irrigation developments have been made in the Tatum-Lovington-Hobbs area where irrigation has

increased from less than 1,000 acres in 1930 to about 95,000 acres in 1960. The thickness of the saturated sediments ranges from zero to more than 200 feet and averages about 95 feet. Wells yield moderate to large quantities of water of good chemical quality. In the area of extensive irrigation development, pumping lifts range from 55 to 115 feet and average about 85 feet.

Average annual recharge to the reservoir in New Mexico is about 29,000 acre-feet and the amount of water in storage in New Mexico approximates 27 million acre-feet. The reservoir extends beyond the State line into Texas, where large irrigation developments are continuing to be made.

In the Tatum-Lovington-Hobbs area about 146,000 acre-feet of water was pumped for irrigation from 1940 to 1950. In the next decade, 1950-1960, pumpage for irrigation was 10 times greater or about 1,470,000 acre-feet. Water-level measurements from 1940 to 1950 did not reflect significant declines. However, because of the large annual amounts of water pumped beginning about 1948, data recorded from 1950 to 1960 indicated declines of more than 5 feet under 550 square miles, more than 10 feet under 310 square miles, and more than 20 feet under 35 square miles.

In Lea County essentially all pumping is from storage--that is, the water is being mined. Presently only an insignificant amount of annual recharge is pumped. As the reservoir is depleted, flows to Texas will decrease and increasing amounts of recharge will be intercepted by wells. Only when the water in storage has been depleted will pumping be limited to the recharge.

CLOSED DRAINAGE BASINS

In New Mexico important developments for irrigation have been made in basins which are closed topographically and in which surface drainage is to playa lakes. Usually the valley floors of these basins are relatively flat, and normal flows in streams on the slopes of bounding mountains do not reach the playas. The rocks underlying the valley floors are generally derived from adjacent mountain masses and vary markedly in composition and areal extent. Recharge is by infiltration of precipitation within the basin. Natural ground-water discharge may be entirely or partially to the basin playa or to adjacent basins. Pumping in these basins is mainly from storage.

Closed basins in which more than 10,000 acres of irrigated land have been developed are the Estancia, Mimbres, and Animas Valleys. Lesser acreages of irrigation have developed in the Alamogordo-Tularosa area (Tularosa Basin), the Crow Flats area (Salt Basin), and in the Playas and Lordsburg Valleys.

Estancia Valley, Torrance County

The Estancia Valley is located east of the Sandia and Manzano Mountains. Precipitation within its boundaries recharges the ground water reservoirs which in turn discharge to the playa lakes southeast of the town of Estancia. The principal aquifer is a valley fill deposit consisting largely of unconsolidated sediments. However, locally underlying bedrock aquifers yield large quantities of water to wells.

The playa lake area is estimated to evaporate an average of about 35,000 acre-feet of water per year. This is indicative of the recharge to the basin because it is unlikely that effects of pumping have reached the discharge area.

Irrigation in the Estancia Valley was not successful until after World War II. In 1947, about 5,000 acres was irrigated and since 1951 the irrigated area has varied between 20,000 and 25,000 acres. From 1950 to 1960 water levels declined more than 5 feet under 150 square miles, more than 10 feet under 113 square miles, more than 20 feet under 28 square miles, and more than 25 feet under 14 square miles.

Animas Valley, Hidalgo County

The Animas Valley in Hidalgo County is a north-trending intermontane basin extending from near the Mexican boundary to about 20 miles north of Lordsburg. Only in its southern end is Animas Creek ephemeral. South of Animas Station the channel of Animas Creek merges with the plain of the valley and drainage continues northward as sheet flow to the playa lakes.

The ground-water reservoir in the valley fill is recharged by precipitation over the drainage basin and by a small underground flow from Playas Valley. Annual precipitation is about 10 inches and recharge probably does not exceed a few thousand acre-feet per year.

The irrigated area increased fairly rapidly from a few hundred acres in 1947 to about 11,000 acres in 1952. Since 1957 irrigation has remained steady at about 12,800 acres. Pumpage from 1950 to 1960 has averaged about 19,700 acre-feet annually. Essentially all the water used for irrigation is taken from storage because recharge to the reservoir is small compared with the amount of water pumped, and natural discharge has not been diminished. From 1950 to 1960 water levels declined more than 20 feet under 43 square miles and more than 30 feet under 9 square miles. If irrigation does not increase, water-level declines may be expected to decrease each year as more and more water flows toward the wells from distant areas.

Mimbres Valley, Luna County

The Mimbres Valley is a closed drainage basin located principally in Luna County. The unconsolidated sediments of undetermined thickness that underlie the valley floor constitute the reservoir which is recharged by runoff from surrounding mountains and by precipitation on the plains of the basin. Ground water moves generally southward and probably contributes to the flow of springs near Palomas Lake about 5 miles south of the Mexican border.

Irrigation with ground water began in the Deming area in 1908. Expansion was rapid from 1912 and by 1914 nearly 200 pumping plants were in operation. After 1918 the number of plants decreased to about 25 and not until the middle 1920's did irrigation begin to expand again. The irrigated area averaged 7,600 acres from 1930 to 1940; 16,800 acres from 1940 to 1950; 31,900 acrès from 1950 to 1960; and 35,000 acres in 1960. Until 1950 the irrigated lands were located principally south and west of Deming and north and east of the Little Florida Mountains in the Lewis Flats area. From 1951 to 1953 development increased in the Columbus, Red Mountain, and Franklin areas.

From 1913 to 1940 water levels declined more than 15 feet in two areas totaling about 33 square miles, and more than 10 feet in an area of about 113 square miles in the main irrigated area around and south of Deming. In the same period water levels in the Lewis Flats area declined more than 35 feet under 3 square miles and more than 20 feet under 16 square miles.

From 1940 to 1950 water levels in the Deming and Lewis Flats areas declined more than 18 feet in two areas totaling about 4 square miles and more than 8 feet under 138 square miles.

From 1950 to 1960 water levels in the Deming, Red Mountain, Lewis Flats, and Franklin areas declined more than 30 feet in areas totaling 13 square miles, more than 20 feet in areas totaling 81 square miles, and more than 15 feet in areas totaling 162 square miles.

RIVER VALLEYS

In drainage areas containing through-flowing streams the ground-water reservoirs discharge principally to water courses and lakes of the surface drainage system. Ground water near the surface may be consumptively wasted by evaporation from the soil and be transpiration from vegetation. Locally the stream may lose water to the ground-water reservoir but reappearance is likely at some lower elevation in the system.

Roswell artesian basin, Eddy and Chaves Counties

The Roswell artesian basin lies within the Pecos River Valley. It extends from near Vaughn on the north to the Seven Rivers Hills to the south, and from the summit of the Sacramento Mountains on the west to the escarpment of the High Plains on the east. The principal area where ground water is used for irrigation extends along the west side of the Pecos River from north of Roswell southward to Seven Rivers. In this area about 117,000 acres of land is irrigated by artesian and nonartesian or shallow water, and about 10,000 acres of surface-water-right land is supplemented with ground water.

Artesian water is obtained from the San Andres formation, a limestone unit containing water under artesian conditions. Shallow or nonartesian water is obtained from unconsolidated sand and gravel fill overlying the limestone aquifer. The reservoirs are related to each other and to the water in the Pecos River and its tributaries. Source of water in the artesian reservoir is precipitation on outcrop of limestone formations west of the Pecos River. The shallow-water reservoir in the valley fill obtains its recharge principally by upward leakage from the underlying artesian reservoir, return flow from irrigation, and direct precipitation on its surface area. Before development of wells for irrigation, the basin discharged to the Pecos River through springs and accretions from the valley fill.

Since irrigation with artesian water began about 1900, artesian levels have declined about 50 feet in the Roswell area, and about 300 feet in the Artesia area. The area of original artesian flow has been reduced to a small fraction of its original size.

Leaky artesian wells and return flow from irrigation caused water levels in the valley fill to rise. Drainage works were constructed in the 1920's to prevent some lands from becoming water-logged. Development of ground water from the valley fill since 1937 has caused those water levels to decline as much as 65 feet in some local areas. Lowering of water levels has diminished the flow of many of the drains.

Natural discharge of the basin to the Pecos River before wells were constructed was about 235,000 acre-feet annually. In the last decade, ground-water discharge from the reservoir by wells has averaged more than 430,000 acre-feet per year. Rainfall, indicative of recharge, for the same period has been about 75 percent of normal. During this period discharge by wells was approximately 4 times as great as natural discharge and 2-1/2 times as

great as probable recharge. Water to meet the overdraft is pumped largely from reservoir storage.

Carlsbad area, Eddy County

The Carlsbad area in the Pecos River Valley is bounded on the north by the Roswell artesian basin. As in the Roswell basin, ground water occurs in a limestone reservoir and in a valley fill reservoir. In most places the two lie adjacent rather than superimposed. The two are related to each other and to the river. Locally each yields large quantities of water to wells, the limestone generally producing water of better quality.

Irrigation wells in the limestone and valley-fill reservoirs were developed rapidly after 1945 to subjugate new lands and to provide water to supplement surface-water sources. About 4,200 acres of land is irrigated solely with ground water and about 20,000 acres of land irrigated by surface water receives supplemental ground water. Estimated pumpage from both reservoirs was about 54,000 acre-feet in 1960.

Recharge to the limestone reservoir is from precipitation on the outcrop areas and leakage from Lake Avalon. The aquifer discharges mainly to the Carlsbad Springs area and to wells which, since 1954, have pumped from 13,000 to 17,000 acre-feet per year.

Water levels in the limestone reservoir fluctuate in response to precipitation, pumping from wells, and leakage from Lake Avalon. The magnitude of these fluctuations has not been large, but even small declines are reflected by decreased flow in the Pecos River.

Declines of water level in the valley-fill reservoir east of the Southern Canal ranged from 5 to 10 feet from 1947 to 1960. Water levels in an area south of Carlsbad and west of the Canal where ground water is the only source of water for irrigation declined as much as 30 feet during the same period.