POSSIBLE IMPROVEMENT OF QUALITY OF WATER OF THE PECOS RIVER BY DIVERSION OF BRINE AT MALAGA BEND, EDDY COUNTY, NEW MEXICO

By

W. E. Hale, L. S. Hughes, and E. R. Cox

ABSTRACT

About 420 tons of dissolved minerals of which about 370 tons is common salt is added daily to the mineral load of the Pecos River through seeps and springs along a stretch of about 3 miles in the Malaga Bend of the river in T.24 S., R.29 E., which is 17 miles southeast of Carlsbad in southern Eddy County, N.Mex. In this reach, the river gains on the average approximately 2 1/2 cfs, a mixture of water of which about 2 cfs is return from irrigation water applied to nearby lands and about 0.4 cfs (200 gpm) is a concentrated brine. Elimination of the small inflow of concentrated brine would result in substantial improvement in the quality of the water reaching the Red Bluff reservoir, the water from which is used for irrigation in the valley farther downstream in Texas.

Brine, almost saturated with sodium chloride, occurs at shallow depth in the alluvium in the Grandson Spring area on the inside of the Malaga Bend and between Livingston's Ford and the Lower Wading station on the outside and lower end of the Malaga Bend. Elsewhere at shallow depth in the Malaga Bend area, the ground water present is a mixture of brine and water derived from application of water to nearby farm lands. The chloride content of the water in the alluvium increases with depth and, in the lower part of the alluvium, the water is saturated with common salt.

The source of the concentrated brine in the alluvium at Malaga Bend is a brine aquifer that underlies the area at a depth of about 200 feet. The aquifer is developed mostly in gypsum near the base of the Rustler formation and in places directly overlies the thick sequence of impermeable salt and anhydrite beds of the Salado formation. The brine is under sufficient head in the brine aquifer to percolate upward through thin and incompetent beds of gypsum and clay into the overlying beds of sand, clay, and silt and thence into the river. The Malaga Bend area is the only known discharge area for this concentrated brine.

The basal brine aquifer extends northward from the Malaga Bend area in a strip 3 to 5 miles wide into Nash Draw. The known length of the aquifer containing brine is about 25 miles. The principal area of recharge is inferred to be in the vicinity of Bear Grass Draw in T. 18 N., R. 30 E.,

several miles north of Nash Draw. In the recharge area truncated beds of the Rustler formation are exposed or immediately underlie the alluvium in the area. Some recharge to the brine aquifer occurs at times through sinkholes in the area about 2 miles west of the Malaga Bend. The source of the dissolved salt in the basal brine aquifer is undoubtedly the salt in the underlying Salado formation.

The transmissibility of the brine aquifer obtained from aquifer tests appears to be about 60,000 gallons a day per foot, and on the basis of the width of the aquifer of 5 miles and a gradient of 1.4 feet per mile the aquifer is estimated to be transmitting about 0.6 cfs toward the discharge area in the Malaga Bend. This value is of the same order of magnitude as the rate of discharge (0.4 cfs) calculated on the basis of the observed gain in salt load of the river in the Malaga Bend area. The latter method of determining the discharge from the aquifer is considered to be more precise.

Some consideration was given to elimination of the brine from the Pecos River by means of a bypass channel across the Malaga Bend. This channel, about 1 mile long, and retaining dams in the cutoff section would be very costly; the surface area in the cutoff sections required to evaporate the return irrigation water and brine would need to be large; and the brine might break into the constructed channel. For these reasons, this method of elimination of the brine inflow was not given further consideration. The most feasible method of preventing the brine from entering the river appears to be by pumping the brine at such a rate as to maintain the head of the brine below river level. The pumped brine would have to be disposed of by injecting it into deeper-lying aquifers or by pumping it to surface basins where it could be evaporated. Meager data from nearby oil test wells indicate that deeper aquifers are not sufficiently permeable to receive the quantity of brine that would need to be pumped. The most favorable nearby surface-disposal area appears to be the Queen Lake depression about 2 miles southwest of the Malaga Bend. The investigation of the feasibility of improving the water of the Pecos River passing the Malaga Bend thus has centered around methods of pumping the brine and the determination insofar as possible of the suitability of Queen Lake as a disposal area.

The alluvium in the Malaga Bend area extends to a depth of 150 feet below the Pecos River in places. It is composed of silt, sand, clay, and some gravel. The transmissibility of the alluvium appears to be small, of the order of 10,000 gallons a day per foot. Pumping of shallow wells constructed in the alluvium and finished only a few feet into the saturated brine would have the most immediate effect in eliminating the brine inflow to the Pecos River. The number of wells required would be large and, unless careful regulation of the discharge were maintained, considerable overlying fresh water would be drawn into the wells, which would diminish the efficiency of the pumping system. Wells finished and open only in the basal part of the alluvium probably could be pumped at rates greater than the shallower wells, and the number of wells required to effectively lower the head of the brine below river level throughout the bend area would

be less than that required for a shallow-well system. Again, however, careful observations would need to be maintained and the pumping rate from each well regulated to prevent drawing in of fresher water in the upper part of the alluvium.

Aquifer tests indicate that the basal brine aquifer has a high coefficient of transmissibility and low coefficient of storage. One or two properly located wells in the basal brine aquifer could be pumped at such a rate as to lower the head of the brine below river level over the entire discharge area. There is little likelihood that the fresh water in the overlying alluvium would be drawn into the wells. An initial pumping rate of 600 to 700 gallons a minute from the deeper wells would lower the head of the brine to about river level in a few days. The pumping rate could be lowered in time and eventually could be reduced to approximately 200 gallons a minute, the natural discharge rate from the aquifer. Some additional water may be induced into the basal brine aquifer in the recharge area as a result of lowering of the head on the brine aquifer, but the amount probably would be small. A high initial rate of withdrawal of brine from the basal brine aquifer would induce the brine to move from the alluvium into the basal brine aquifer, hastening the diminution of flow of brine to the river.

The brine stored in the alluvium will continue to drain to the river for several years, but if brine is prevented from entering the alluvium by diverting it through wells penetrating the basal brine aquifer, improvement in the quality of the river water moving past the Malaga Bend should occur within a few years. The efficiency of any pumping system in eliminating the flow of brine into the river may never reach 100 percent.

The Queen Lake depression is a sink developed by solution and collapse of rocks in the Rustler and underlying Salado formations. The depression has since been filled partially with alluvium. The playa covers an area of about 60 acres and is underlain by silt and clay. Exposures of gypsum and dolomite of the Rustler formation occur in the adjacent slopes of the depression, but most of the Rustler formation in the depression is mantled by silt, clay, and sand. Ground water moves in a general eastward direction toward the Pecos River through the fill and upper beds of the Rustler formation in the vicinity of Queen Lake. The playa sediments are not absolutely watertight but water moves only slowly through them. Storm runoff into the playa is lost almost entirely by evaporation. Tests of samples of the playa deposits indicate an initial permeability of about 1 gallon a day per foot. Continued tests with brine on some samples resulted in the material becoming essentially tight to passage of brine. The cause of the decrease in permeability is not known. If the depression were used for storage of brine, deposition of salt together with inwash of silt along the margins probably will make the depression tighter than it now is. Some leakage from the lake will occur but it may diminish under natural conditions in time. Some remedial measures might be necessary, however, to

retard leakage from the lake, the brine from which would move east and south and eventually enter the river. The storage capacity of the Queen Lake depression is about 5,500 acre-feet and would provide storage for pumped brine and the salt precipitated from it for approximately 100 years. A dam placed on a draw on the west side of the Queen Lake depression would prevent much of the surface runoff from entering the lake, so as to permit maintaining more concentrated brine in the lake and hence faster precipitation of salts.

Although an action program which involves pumping of brine from the basal brine aquifer in the Malaga Bend area and storage of the brine in Queen Lake appears to have a fair chance of success hydraulically, such a program should be considered as experimental. An observation program should be maintained to provide data on the effects of pumping on the quality of the water in the Pecos River and the movement and quality of water in the Queen Lake area. The data obtained would aid in making changes in the pumping regimen and would provide a basis for any remedial measures needed to retard the leakage from the Queen Lake depression. It may be advisable to attempt the development of wells in the basal part of the alluvium in the Malaga Bend area to hasten the required debrining of the alluvium. Some consideration should be given to plugging active sinkholes in the recharge area about 2 miles west of Malaga Bend.