Recharge Studies

refilling underground water reservoirs problem to many governmental agencies

Warren A. Hall

Approximately 60% of California's irrigated agriculture depends on reservoirs of ground water.

In some areas of the state, natural recharge is sufficient to replace water removed for irrigation. However, in many other areas, water is removed at a much faster rate than it can be replaced by natural means.

Research is under way to determine how ground-water recharge can best be accomplished.

The first successful artificial recharge operations made use of nature's own system. As flooding streams emerge from the mountains onto the valley floor, they drop the largest and coarsest sediment first near the base of the mountain with progressively finer materials found as the center of the valley is approached. By a system of inexpensive check and diversion dams, the excess winter flow is made to spread out over large areas of the coarse sediments which readily absorb water. From here it gradually trickles down to the pumps in the valley below.

There are disadvantages to this system, simple as it may be. When flood waters are spread out over these areas and allowed to percolate into the ground, all of the sediment carried by the water is filtered out near the ground surface and forms a seal to effectively limit further infiltration of water. Also, the coarse sediment areas are often far from the regions where excessive pumping is occurring. This results in low rate of replenishment in the critical areas where it is needed most.

These disadvantages provided the impetus to large scale water spreading on agricultural lands more or less directly over the overdraft areas. The path of the water was reduced from 10 or more miles to a few hundred feet. In addition, much of the sediment carried by the winter runoff would have settled out, leaving a relatively clear water to turn into the spreading checks. At the same time, these agricultural soils were much less permeable, requiring much greater areas devoted to recharge. Further, it was found that the infiltration rate into these soils decreased fairly rapidly over the spreading season.

To correct these problems, studies of methods of improving the permeability of the surface soils were conducted. Experiments indicated that cotton gin trash and other slowly decomposing organic waste products could materially increase the infiltration rates in some localities. Similar results were obtained with commercial soil conditioners. Bermuda grass, if allowed to grow with the tops above the water, proved to be almost as effective.

Inability of these surface treatments to provide satisfactory increases in infiltration rate on some large spreading areas led to studies on the effects of the deep subsurface soil conditions on the value of surface treatments.

Measurements were made of the pressure of the water at depths up to 80′ as it percolated down. A series of perched water tables were observed, each created by a thin horizontal layer of clay. When the uppermost perched water table rose to the soil surface, the permeability of the surface soil ceased to be an important factor in the infiltration rate. The less permeable clays backed up the water, greatly reducing the rate of inflow.

Plans Studied

One proposal to eliminate the effects of the deep, less permeable strata was to spread water in relatively long narrow basins with considerable productive farm land between. The perched water tables could flow laterally as they grew, decreasing the possibility of their rising to the surface.

Further studies on the limits of lateral flow are being conducted using the analogy between the flow of water through soil and the flow of oil between two closely spaced plates of glass. This research is not yet complete, but preliminary measurements indicate that fairly accurate solutions may be obtained with this equipment.

A second proposal to eliminate the effects of deep, less permeable strata is to construct long deep trenches cutting through all the surface soils down to a good water conducting stratum. These trenches would be spaced at intervals to make use of lateral flow but could occupy less surface area than a spreading pond at the soil surface.

Experimental trenches were constructed and operated. The first results were quite disappointing because of the translocation of silt during construction of the trench and on filling the trench with water. After the first year's operation, a thin crust of very low permeability was found over the sides and bottom of the trench. Experiments are being conducted to eliminate the silting problem.

A third proposal would bypass all the intervening obstacles to ground-water recharge by feeding the water directly to the ground water through wells. However, wells are subject to the same problems of decreasing permeability that plague surface recharge systems. In fact, they are magnified, for all of the water must pass through the small area of contact between the well casing and the soil. As a result, it becomes more easily clogged with sediment and microorganisms. It has proven to be almost impossible to effectively clean the clogging material from the walls of the well.

Probability of plugging and the resultant decreased capacity as well as the possibility of bacterial contamination of domestic water supplies virtually preclude use of existing pumping wells.

Some successful recharge with wells has been done using clear or filtered water, chlorinated to remove all organic matter. Notable is the fresh water barrier near Manhattan Beach, created to prevent intrusion of salt water into the nearby fresh water basins.

A recent proposal has been termed replenishment-irrigation. This method involves excess irrigation of regular crop land during the winter using the normal irrigation distribution system. Recently completed studies on 60 acres of three year old alfalfa are quite encouraging. Observations were made of the differences in plant mortality rates and yield between nonirrigated and checks excessively irrigated between December 15 and February 1. One check was continuously irrigated for the entire period. Others were irrigated continuously for periods of one week, two weeks, three weeks, and four weeks, both early and late in the test period. The percentage of the plants still living after the experiment was essentially the same for the irrigated checks and the controls. The check which was continuously irrigated had a first cutting yield slightly lower than the adjacent control. The sixth cutting, however, showed no significant differences.

An incidental benefit was the excellent control of weeds obtained in those checks irrigated.

Warren A. Hall is Assistant Professor of Irrigation, University of California, Davis.

The Kern County Land Company and the Agricultural Research Service cooperated in the studies on improving permeability of surface soils.