State Water Resources Control Board

Ground Water In California

Rivers and lakes are what first come to mind when California's water resources are mentioned. Yet vast stores of underground water have played a leading role in transforming California into the nation's top agricultural producer and most populous state.

Today, ground water supplies about 40 percent of the water we use, or about 16 to 17 million acre-feet per year. (An acre-foot is the amount of water required to cover an acre to the depth of one foot, or approximately 326,000 gallons.) The State's largest subterranean reserves lie beneath the fertile farmlands of the Central Valley. There, scientists estimate, is stored 100 million acre-feet of usable water. Worldwide, the figures are even more impressive. Geologists estimate that some 90 percent of the world's usable water supply occurs as ground water.

Mankind has long depended upon this valuable, invisible resource. The ancient Egyptians and Chinese dug wells to tap its riches 2,000 years before Christ. And for millennia before that, it seems likely that artesian springs bubbling to the earth's surface were enjoyed by our primitive forbearers, who shared their water holes with prehistoric beasts.

Much more recently, some otherwise arid and uninhabitable regions of California were settled because ground water was available. But it wasn't until the beginning of this century that the resource came into widespread use for irrigation, as advances in drilling and pumping technology made the water easier to reach.

Its use became so widespread, in fact, that dropping water tables and escalating pumping costs by the 1930s focused sights on development of surface waters and construction of extensive storage and conveyance systems such as the State Water Project and the federal Central Valley Project. But as the foregoing figures attest, ground water continues to meet many of our water needs.

WHAT IT IS

Ground water occurs not as underground lakes or streams but in horizontal layers of water-bearing sand, gravel or broken rock. The formations, called aquifers, are separated by layers of clay or rock and make up larger ground water

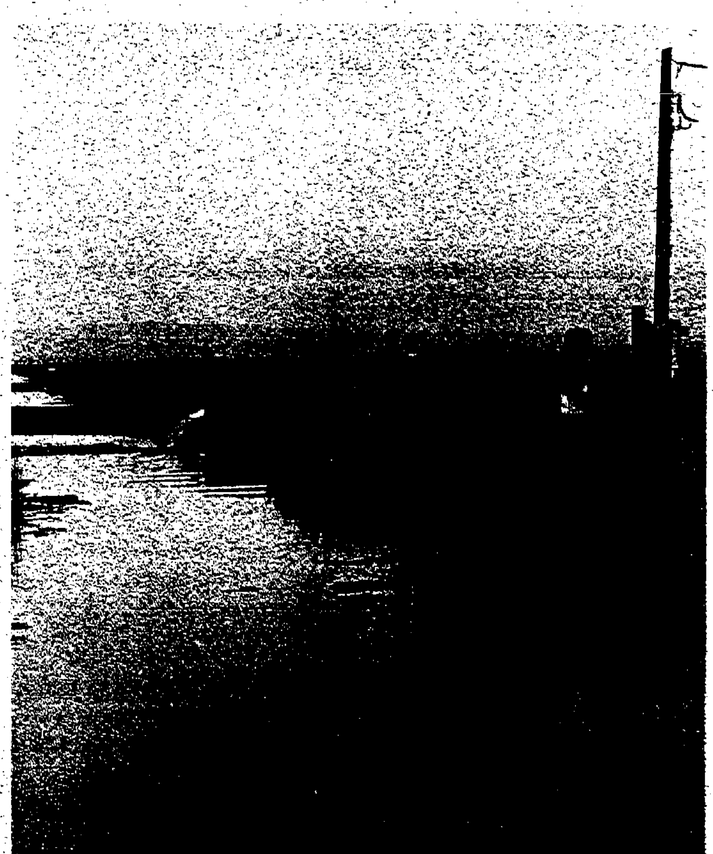


Photo courtesy of Department of Water Resources

Ground water supplies some 40 percent of the water used in California. Here ground water is pumped into an irrigation canal from an electrically-powered well.

basins. These basins can run underneath the earth's surface for hundreds of miles. Aquifers often discharge to surface waters and can make a significant contribution to streamflows.

Notable ground water basins underlie nearly half of the State's land area. As noted earlier the resource is immense; the total storage capacity of our ground water basins has been estimated at one billion acre-feet. The amount of water actually stored underground is pegged at approximately 850 million acre-feet, while the amount that is usable (pumpable) is about 250 million acre-feet. Still, this represents several times the amount of water stored in all the State's surface reservoirs, including Shasta, Oroville and Folsom lakes.

Water reaches the aquifers and basins through a number of routes. It infiltrates the soil on the earth's surface as rainfall, or percolates through the gravel of streambeds or unlined ditches. Or it may be placed in the ground artificially, through manmade percolation ponds or injection wells.

Once there, the water moves laterally through the aquifer, the rate at which it travels depending upon the material (water moves more quickly through something coarse, like gravel, than fine-grained sand). Unlike the water rushing in a stream or river, the water in the aquifer moves very slowly.

ADVANTAGES

Ground water has numerous advantages over surface water:

- Aquifers act as natural conveyance systems.
- The land above a ground water basin can be put to other uses.
- Because ground water is not exposed to the elements, it is protected from evaporation losses and some forms of pollution.
- Aquifers function as natural water-purification systems. Sediment, disease-causing organisms, and some other pollutants are filtered out of water as it percolates through the soil.
- Aquifers also are a conveniently available source of water for use during droughts, when surface supplies are depleted quickly. During the drought of 1976-77, for example, ground water supplied 80 percent of agricultural water needs in some parts of the State, keeping orchards and other crops alive until the rain and snow returned. This wasn't accomplished without a price, however: higher electric bills and a lower water table were the result.

GROUND WATER LAW

Unlike surface water allocations, many of which are governed by a permit process administered by the State Water Resources Control Board, no permit process exists for ground water except where court action has occurred.

California's earliest ground water law was the English common law adopted at statehood. Under this law, the landowner had a right to the resources on or beneath the land's surface. The California Supreme Court modified this concept in 1903 when it established the doctrine of correlative rights. Unlike surface water appropriations in which "first come, first served" determines the priorities, overlying rights are equal to other overlying rights to the beneficial, nonwasteful use of ground water.

Like surface water, ground water also can be appropriated (diverted and carried off of the overlying land) by cities, water districts and other users whose lands do not overlie a ground water basin. In the case of these ground water appropriators, the "first in time, first in right" concept does apply. However, overlying users take priority over appropriators, who may take only surplus water not needed by overlying users.

GROUND WATER ISSUES OVERDRAFT

Ground water overdraft--the long-term overpumping of ground water that exceeds natural or artificial replenishment--has long been a concern. Many of the areas where overdrafting has occurred have been corrected, but others still exist. Today, overdrafting occurs primarily in the San Joaquin Valley and in areas along the coast.

Ground water is considered a renewable resource, yet a balance must be maintained between its recharge (replenishment) and withdrawal. Lacking proper management and planning, both quality and quantity may suffer.

The prices paid for overdrafting a ground water supply include:

- increased pumping costs;
- the cost of deepening wells or lowering pumps;
- the cost of sinking new wells;
- lowered water quality; and
- land subsidence.

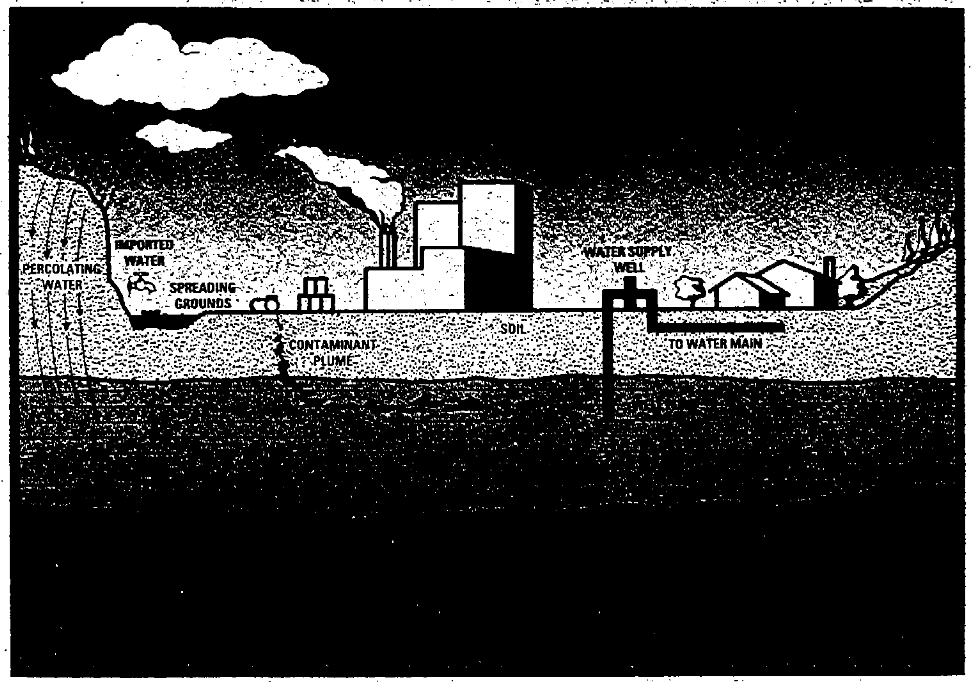
This last problem occurs as underground layers of clay become compacted by the withdrawal of water, causing the land surface to sink. The land surface can drop just a few feet or 20 to 30 feet, as it has in some parts of the San Joaquin Valley.

One way of maintaining ground water levels--besides reducing or halting pumping--is artificial recharge. The process, which has been practiced in California since the 1890s, employs shallow percolation ponds or spreading basins where water is impounded and allowed to seep into the ground. In this age of growing populations and dwindling water supplies, reclaimed (purified) wastewater offers a ready source of recharge water.

QUALITY

Until recently, the quality of ground water was generally taken for granted. Because it is shielded from the elements, its quality generally is good, although it sometimes contains high levels of dissolved minerals. Ground water may be very "hard" (high in the minerals calcium and magnesium). Hardness does not pose a health risk but does make household cleaning tasks more difficult. Also, soap lathers less vigorously in hard water than in soft.

The link between pollution and ground water is less obvious than it is with surface water, where it is easier to see and monitor the effects. Surface waters may become polluted more quickly



and readily, but they are better equipped to handle pollution. The exposure to air and sunlight as a swift-moving stream courses along causes some pollutants to evaporate, while others are consumed by aerobic (oxygen-using) bacteria.

Ground water lacks the natural self-cleansing abilities of streams and rivers. Under the aquifer's anaerobic conditions, there is virtually no exposure to the atmosphere. The environment is relatively bacteria-free, the temperature relatively constant. As the water inches along, the lack of turbulence allows pollutants to move through the system as a "plume," rather than disperse and become diluted.

It was once believed that soil would filter out all contaminants, and it does filter out many. But with the introduction of thousands of new chemical compounds into the atmosphere and major advances in detection technology, traces of chemicals have been discovered in wells state- and nationwide.

Once a ground water supply is contaminated, it is difficult and expensive to clean up.

SEAWATER INTRUSION

Even before the advent of the modern, high-tech age that brought with it a myriad of industrial chemicals, areas along the coast faced pollution problems. Seawater intruded into coastal aquifers as heavy pumping overdrafted the aquifers and created conditions for ocean water to move into the aquifer. Some of the worst problems occurred along the coastal plain of Los Angeles and Orange Counties, where some wells became so saline they had to be abandoned. Another significant problem area is the lower Salinas Valley.

Seawater intrusion has been halted in some areas by reinjection wells which force fresh water back into the aquifer on the coastline and create a freshwater barrier to keep seawater out. Reducing pumping is another solution.

AGRICULTURAL DRAINAGE

Agricultural drainage can also add salinity--as well as pesticides and fertilizers--to ground water. All water contains some salts. In high concentrations, they can be harmful to plants. In irrigated areas that lack adequate drainage (part of the San Joaquin Valley, as one example), saline water pools below the land surface and rises into the root zone.

NITRATE

Other areas have had problems with contamination by nitrate. Nitrate is widely used as a fertilizer and occurs in animal manure and septic-system effluent. Nitrate is not filtered out by the soil and percolating water can transport nitrate from these sources to ground water. It also may migrate with the water through poorly constructed wells. High nitrate levels can cause a potentially fatal condition in infants called methemoglobinemia, or "blue-baby" syndrome.

Industrial and Agricultural Chemicals: Since the Second World War, the number of household, industrial and agricultural chemicals has risen dramatically. More and more new substances are introduced into the environment each year as we seek to increase the productivity of agriculture and make our lives more comfortable.

In recent years, areas of the State, particularly the Santa Clara and San Fernando valleys, turned their farm fields into industrial centers. The Santa Clara Valley, for example, became known as "Silicon Valley" as the high-tech computer and electronics industries replaced the fruit orchards that once dominated the landscape and economy. Because the new enterprises produced no visible signs of pollution—no smokestacks belching fumes into the air or streams of liquid waste discharging into rivers--they were dubbed "clean" industries.

Yet even these enterprises employ powerful industrial solvents and other chemicals as part of their industrial processes. And with the development of sophisticated testing equipment, varying levels of some of the chemicals were discovered in local ground water basins.

One of the largest groups of these substances is volatile organic chemicals (VOCs), carbon-based compounds that volatilize (evaporate) readily. Common VOCs include trichloroethylene (TCE), tetrachloroethylene or perchloroethylene (PCE) and 1,1,1-trichloroethane (TCA). Some are suspected carcinogens (cancer-causing agents) and are used by industry or the military as degreasing agents. Some are even found in household products. VOCs' chemical properties permit them rapid travel through soil, so they reach the aquifer more quickly than other pollutants.

Agricultural chemicals—pesticides and fertilizers—also can enter ground water sources through their application, storage and disposal of the containers they come in. For example, traces of the banned pesticide dibromochloropropane, or DBCP, a soil fumigant once used to combat nematodes (tiny worms in the soil) have turned up in certain wells in the Central Valley.

Agricultural and industrial chemicals and wastes reach ground water in a number of different ways. Their improper storage, use or disposal are several routes. Industrial processes generate liquid and solid waste, some of it hazardous, which must be disposed of in some manner. If a waste-disposal pond or surface impoundment is not lined properly, the waste can leach through the lining and enter the aquifer below. Underground tanks, another way of storing wastes and chemicals, are subject to rust, corrosion or cracking. Hazardous materials are sometimes disposed of illegally, by so-called "midnight dumpers."

Hazardous wastes and chemicals are not limited to major industry or even to metropolitan areas. Many small businesses use and dispose of powerful solvents. The neighborhood gas station poses a potential threat of leaking underground gasoline storage tanks.

Until the early 1980s, little attention had been given to regulating or investigating potential pollution sources such as underground tanks. Since then, the State Water Resources Control Board and Regional Water Quality Control Boards have taken a lead role in programs aimed at halting or containing ground water contamination, some of which are described below.

Fortunately, the extent of industrial contamination has stayed relatively limited because of early detection and cleanup. But careful monitoring and management will always be necessary.

PROGRAMS

Numerous State Board activities protect both surface and ground water. Permits are required of all communities and businesses wishing to discharge wastes into State waters. These permits are issued and enforced by the Regional Boards.

Other important programs include the Board's **Waste Disposal to Land Regulations,** waste discharge requirements which are issued by the Regional Boards to control the discharge to land of hazardous and nonhazardous wastes. **The Toxic Pits Cleanup Act** regulates surface impoundments containing liquid hazardous wastes and requires double-lining and monitoring. The **Solid Waste Assessment Testing (SWAT)** program detects hazardous waste leakage from solid waste disposal sites. The **Underground Storage Tank Program** is aimed at finding, preventing and cleaning up leakage from tanks that contain gasoline and other hazardous substances. **Ground Water Monitoring Networks** operating in several high-priority basins measure traditional water quality parameters and selected toxic substances.

Under the federal **Resource Conservation and Recovery Act (RCRA),** hazardous wastes are tracked from "cradle to grave"—from generation, storage, transport, disposal. The State Board plays an important role through its own authority in the areas of land disposal and ground water monitoring. It also performs water quality-related review work to provide the California Department of Health Services, the program's lead agency, with information to guide it in issuing permits to land disposal facilities.

CONJUNCTIVE USE

Prudent management of both ground and surface waters has become the order of the day, as a result of California's growth and its demands for water, as well as changing public priorities. One method of effectively managing this supply is by conjunctive use, storing excess surface water in ground water basins for withdrawal in times of drought.

This concept is nothing new. Conjunctive use has been practiced in Southern California, the San Joaquin Valley and Santa Clara County for many years, substituting imported surface water for ground water but artificially recharging some of this surface water into the ground. Used in tandem in this manner, the two sources can meet water needs in a way that neither could separately.

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