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Threats to Groundwater Quality

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To the unknowing observer, water supplies beneath the surface - groundwater - may not seem all that important to Texas.

But the truth convinces us otherwise. Groundwater supplies are plentiful in the state and provide essential water for agriculture, municipal and domestic use, industry, and recreation. More than half of Texas is underlain by one of 23 aquifers, including the massive Ogallala Aquifer in the High Plains. Stored in these groundwater systems are 430 million acre-feet of water that can be recovered using today's technology. Texans use 10.85 million acre-feet of groundwater annually, more than from any other source.

As impressive as the quantity of Texas' groundwater is, water isn't worth much if it's not of usable quality. Manmade chemicals, organic materials, and even naturally occurring phenomena are capable of polluting groundwater supplies.

Just how serious a problem is groundwater contamination? A 1985 study suggests that groundwater supplies serving 4.7 million people nationally are either contaminated or suspected of being contaminated. California estimates that 20 percent of its water wells have been polluted with pesticides and industrial chemicals. More than 50 to 60 percent of Texas' hazardous waste land disposal sites have decided to close because they cannot meet Environmental Protection Agency (EPA) guidelines, according to preliminary EPA estimates.

UNDERGROUND STORAGE TANKS

Underground tanks are used to store petroleum products, chemicals, hazardous wastes, and other substances. When these tanks begin to corrode, contaminants leak out, moving quickly through the soil profile and polluting water wells and aquifers.

It's difficult to pinpoint the severity of this problem in Texas because there is no accounting of the number of underground storage tanks. An EPA inventory is underway, however, as a result of 1984 amendments to the Resource Conservation Recovery Act. Those amendments require operators of underground storage tanks to notify EPA of tanks currently in operation and their conditions. The deadline for notifying EPA is May 1986.

Dr. Kirk Brown of the Texas A&M University Soil and Crop Sciences Department has been researching petrochemical leaks from underground storage tanks. Corrosion of steel storage tanks is the major cause of leaking, Brown says, and most tanks begin leaking after 15 years of use. There are more than 2 million underground storage tanks nationally, and Brown estimates that as many as 70,000 are leaking. He predicts that 350,000 tanks could be leaking nationally by 1990 if current trends continue. EPA officials, however, are estimating that through regulation, preventive measures, and corrective action, the actual number of leaking tanks will be much lower.

Oil and gas products that seep out of storage tanks constitute a threat to groundwater supplies. Certain petrochemicals move quickly (as fast as 4 feet per hour through the top 10 meters) through unsaturated sandy soils, increasing the danger of contamination. They also cause clay soils to swell, shrink, and crack, allowing organic chemicals to move through these soils from four to 1,000 times faster than water, depending on the type of chemicals involved.

HAZARDOUS WASTE SITES

The EPA has inventoried 19,000 sites across the country where toxic chemicals and hazardous waste may have contributed to groundwater pollution. Texas ranks ninth nationally in the number (26) of sites on the EPA's National Priority List (NPL).

Contaminants at EPA hazardous waste sites in Texas have included hazardous and toxic substances, heavy metals such as arsenic and cadmium, organic chemicals, chromium, lead, and PCBs.

Once a contaminated site has been identified, EPA and the Texas Water Commission (TWC) go through a three-phase process to correct the problem: 1) remedial investigations to determine the extent of pollution, 2) development and evaluation of cost-effectiveness of various clean-up alternatives, 3) design of a clean-up program, and 4) implementation of the clean-up program. Most of the Texas NPL sites are in the initial (investigation) phase, although a few are about to begin implementing clean-up programs, according to EPA.

The French, Ltd. site in Crosby has one of the highest EPA Hazardous Rating System (HRS) scores in the country, indicating severe contamination problems have occurred there. Other Texas sites with extremely high HRS rankings include Motco Inc. at La Marque, Sikes Disposal Pits at Crosby, and Geneva Industries/Fuhrmann Energy in Houston.

There are some NPL sites-the Odessa Chromium plant, for example-where groundwater contamination has definitely taken place, but the extent of contamination is still under investigation.

Other cases of groundwater contamination from hazardous waste sites are being pinpointed by the TWC in a quarterly campaign to bring public pressure on some of the state's worst polluters. In November 1985 the TWC began issuing a quarterly list of the "Worst Hazardous and Solid Waste" operations in Texas. The February 1986 listing shows five locations where groundwater contamination has resulted from hazardous waste operations (two at Jasper and one each at Marshall, Odessa, and Texas City) and two other instances (at El Paso and Cleburne) where groundwater contamination is suspected. Two of those sites, Hart Creosoting in Jasper and Witco Chemical in Marshall, have appeared on both the November 1985 and February 1986 "Worst" lists.

INJECTION WELLS

Injection wells are used across Texas for a variety of purposes including industrial and municipal waste disposal, solution mining of uranium and sulfur, brine production, and agricultural drainage.

Texas has approximately 48,000 injection wells associated with the production of oil and gas, 500 underground hydrocarbon storage wells, 40,000 solution mining wells, and 100 industrial waste disposal wells. Each of these activities carries with it the potential to contaminate groundwater supplies.

Industrial wells are used to dispose of liquid wastes through injection practices. Today 125 of these wells operate along the Gulf Coast, 92 of which dispose of hazardous waste from the petrochemical industry. Another 33 industrial wells dispose of nonhazardous waste from uranium mining activities. One hazard associated with industrial wells is that, if formation pressures are too high, nearby abandoned oil and gas wells that have not been adequately plugged can provide avenues for wastes to contaminate aquifers. Strict TWC regulations covering limits on injection pressure, well monitoring, and periodic inspection have prevented cases of groundwater contamination from occurring.

Uranium solution mining wells using in-place leaching techniques are concentrated in Karnes, Live Oak, and Duval counties in South Texas, where 40 sites with as many as 20,000 injection wells now operate. (Each site uses a ratio of roughly five injection wells per every producing uranium well, and similar practices are used in producing brine and sulfur.) In this operation a leaching solution is injected into rock formations to dissolve uranium, which is then pumped to the surface through production wells. Potential groundwater contamination problems include leaking of leaching solution into aquifers and surface spills. After mining activities are completed, the TWC requires restoration of the mine aquifer and disposal of contaminated groundwater. Disposal alternatives consist of deep well injection, solar evaporation ponds, and solid waste disposal of sludge. Uranium solution mining has a significant potential for contaminating groundwater supplies by increasing levels of total dissolved solids and uranium.

Solution wells are also used to produce brine for the petrochemical industry. Located mostly in the Trans-Pecos region and along the High Plains, 66 brine stations operate in Texas producing 9 million tons of salt_more than 10 billion gallons of brine_annually. Water, injected under pressure to the bottom of brine-filled cavities in salt beds, dissolves salts as it rises through the solution cavity and flows as brine to the surface. West Texas brine wells are drilled through aquifers that are recharged from infiltration of surface water and that are susceptible to contamination from surface sources.

Frasch process sulfur mining is practiced both along the Gulf Coast and in the Trans-Pecos region. Six Frasch mining sites currently operate in Texas along salt domes in coastal Fort Bend, Chambers, and Wharton counties, and within bedded limestone formations in Pecos and Culberson counties in West Texas. The mining process involves recovering liquid sulfur with injection wells. Water heated to 330 degrees is injected through wells into formations, causing the sulfur to melt. Then liquid sulfur flows to the bottom of the well and is brought to the surface as 99.5 percent pure. The process can also produce discharges of saline industrial wastewaters from mine sites, increases in pH levels, and higher concentrations of sodium, chloride, carbonate, and bicarbonate.

Approximately 90 agricultural drainage wells are operating in the Lower Rio Grande Valley, particularly in Hidalgo County. These wells alleviate the problem of perched (temporarily oversaturated) water tables in agricultural areas. Montmorillonite clay soils impede percolation of surface waters and raise water tables. As this water evaporates, salts are left behind in the soils. Drainage well systems collect near-surface waters and drain them into subsurface formations below impermeable clay beds. These wells dispose of fluids containing high concentrations of dissolved solids, nitrates, and pesticides.

NITRATE POLLUTION

Nitrate contamination of groundwater is a major concern, especially in regions where large doses of agricultural fertilizers are applied. Nitrate in itself is not a health problem, but when ingested it can be converted into nitrite. In turn, nitrite can lead to "blue baby syndrome" (methemoglobinemia), which can be fatal to infants during the first three months of life. Nitrate presents some unique problems as a groundwater threat: it is soluble, moves quickly through soils, and often indicates potential biological contamination.

A recent United States Geological Survey (USGS) study showed that more than 8,200 wells nationwide were contaminated with nitrate levels above the EPA drinking water standard of 10 parts per million (ppm). The cases of most severe contamination were found in shallow wells (less than 100 feet in depth) in heavy agricultural areas. Numerous studies have linked increased use of nitrogen fertilizers with the upswing in nitrate pollution. Since the early 1950s, for example, the use of fertilizer nationwide has increased from 20 to 40 millions tons annually, while the average percent of nitrogen in fertilizer has gone up from 6.1 percent to 20.4 percent.

It should be noted, however, that agricultural fertilizers are not the only source of the nitrate problem. Natural phenomena_ranging from rainfall to oxidization of organic materials_and symbiotic nitrogen fixation, as well as manure from animal feedlots, can all contribute to the problem. A recent study has shown that only half the nitrogen supplied to cultivated fields was from fertilizer, followed in descending rank by root residue, biological nitrogen fixation, rainfall, and barnyard manure.

Eroded soil, the burning of fossil fuel, and decaying organic matter can contribute to airborne nitrogen, which is returned to the earth as nitrate precipitation. During the early portions of a thunderstorm, for example, initial concentrations of nitrate in rainfall can be as high as 8 ppm. Nitrogen deposits from precipitation range from 1 to 13 pounds per acre annually.

Nitrogen is also found in geologic deposits. Organic materials in lignite and bituminous coal, clay and caliche soils, marine shales, and playa lakes are converted to nitrogen and ammonia. These deposits are concentrated in the Rio Grande Valley and in Central Texas.

Both symbiotic and nonsymbiotic nitrogen fixation take place in the soil, with the rate of fixation depending on plant species and other factors. Estimates of nitrogen fixation range from 20 to 100 pounds of nitrogen per acre per year for nonsymbiotic organisms. Symbiotic microbes in legumes may add as much as 40 to 200 pounds of nitrogen per acre per year.

The concentration of livestock and poultry in feedlots, corrals, and confinement buildings (and the associated storage of manure) also provides a source of nitrate. According to 1984 figures from the Texas Department of Agriculture, Texas had 2.13 million head of cattle on feed that produced 2.97 million tons of dry manure (tdm). Other major contributors included broilers (45 million, 456,000 tam), dairy cattle (314,000 head, 258,000 tam), laying hens and pullets (17.4 million, 180,000 tam), and hogs (415,000 head, 48,000 tam). The threat of groundwater contamination would appear to be especially significant where large commercial feedlot operations are concentrated. The Texas Panhandle, for example, contains nine counties that each fed more than 200,000 head of cattle in 1984. If the underlying soil beneath a feedlot is porous and water tables are shallow, groundwater contamination can result. With proper site selection and management, however, contamination risks can be significantly lessened.

LIGNITE COAL MINING

Lying beneath Texas are 1 million acres of land containing 10.7 billion tons of lignite (the energy equivalent of 37.7 billion barrels of oil) within 200 feet of the surface. Total lignite reserves are estimated at 23.5 billion tons. The largest concentrations of Texas lignite are in bands that parallel the Gulf of Mexico shoreline about 100 to 175 miles inland.

The lignite mining process disturbs surface and subsurface conditions, including below-ground aquifers. Surface mining of lignite removes and mixes the overburden (materials such as dirt and rocks that lie over an aquifer) and can destroy shallow aquifer systems. There is a potential for groundwater pollution from acid drainage when materials in the overburden are oxidized. A balancing factor is that soils with low permeability (which would normally allow pollutants to penetrate rapidly) are not acidic but alkaline, while acidic clay and shale soils have a low permeability. This suggests a generally low groundwater pollution risk.