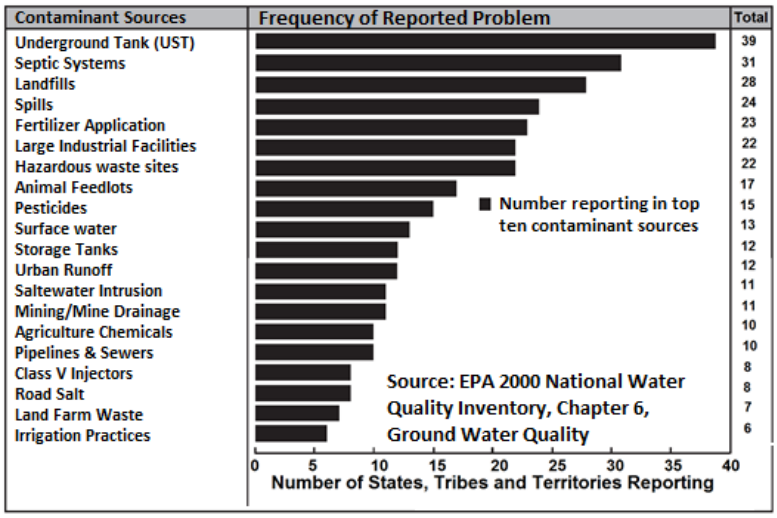
Basics of Wells: Protecting Groundwater

Groundwater pollution continues to be a major issue in the US; but what are the primary causes and pathways? The indisputable major sources of US groundwater contamination over the past few decades are: 1) leaks from underground storage tanks (refined gasoline and diesel from old steel tanks at filling stations) and a variety of process and waste chemicals at industrial sites with buried tanks, 2) improperly built residential septic systems, 3) poorly constructed landfills, 4) agriculture related sources and 5) surface and shallow well disposal (Class V injectors) of mine waste, solvents, metal ions, hazardous wastes etc. Class V wells, which may number over a million wells, are not used in oil and gas produced water disposal, yet are one the most troublesome threats to groundwater resources.

There are many sources of groundwater contamination, both human-oriented and natural. Groundwater is contaminated when detrimental substances are mixed in waters recharging the aquifer. These recharge routes include porous surface rocks over groundwater zones, old wells of any type that are in communication with the aquifer, and streams that feed water to underground water sources. Common contaminants include road salt, manufactured products leaking from surface, nitrates from fertilizer overuse, pesticides, landfill drainage and accidental spills.



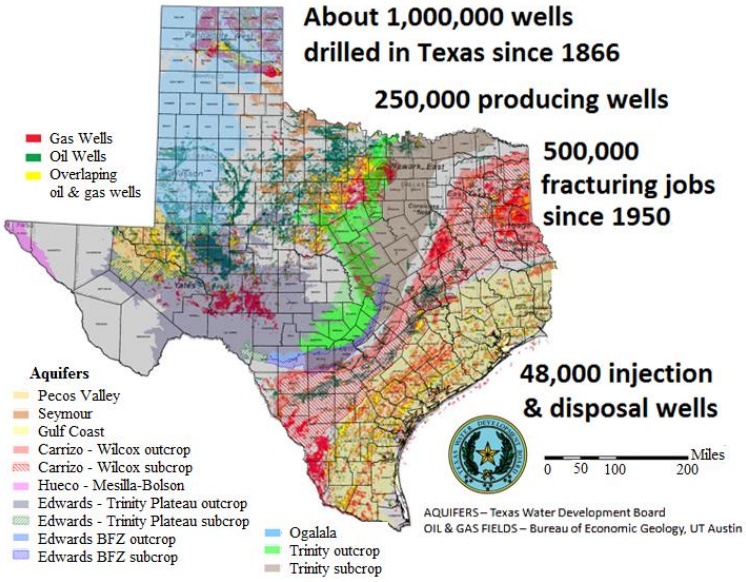
Groundwater may also be contaminated by natural sources within the rock that hold the water. Natural contaminates include salt, arsenic, metal ions and natural gas among other chemicals that waters leach from rocks.

Methane gas, iron and manganese are the most common natural contaminants. Water may also contain radon gas and other radioactive atoms. Overdrawing a water source may pull in salt water.

Possible pollution sources to US groundwater from the oil and gas industry include spills of oil and treating chemicals and a small possibility of deep wells communicating with shallow, poorly cemented older oil or gas wells that may be in communication with the aquifer. Studies on deep oil and gas wells, particularly the multi-fractured, deep shale wells shows the upper range of leak frequency at less than 0.004% of new wells with the lower range established by a study of Texas wells showing no leaks in sixteen thousand wells (Kell, GWPC, 2011).

There are many reports of potential leakage from wells that are likely methane movement from disturbed soil and pockets of gas migrating towards the surface that are part of natural movements above overfilled rock reservoirs. The presence of bubbles in well cellars or through soil around the wellhead may or may not be an indicator of leaks from the well. Any disturbance of soil by drilling, digging, pile driving or even walking through a swampy area is frequently accompanied by release of methane gas; particularly where natural methane in the soil is more highly concentrated (swamps, muskeg, tundra, etc.). This type of seepage is usually short lived, except in presence of natural seeps fed by deeper reservoirs along an established seep path. Depending on depth of disturbance, the bubbles may decrease or stop in seconds to days (Naftz, USGS, 1998). Composition of this deep gas from natural seeps may occasionally be biogenic but is more commonly thermogenic (~96%).

Texas is the top oil and gas producing state in the US and the home of numerous conventional gas and oil developments and many shale developments. These oil and gas developments were the location of the first commercial fracturing jobs in 1950 and have experienced about half of the total fracturing stimulations done in the United States in the past 65 years. Texas is also underlain by 29 major and minor aquifers and has large groundwater withdrawals with a total of about 80% of the withdrawals being used for agriculture and municipal water supply. If there is widespread deep well pollution of groundwater, particularly of the past 65 years, the problems would be recognized in widespread polluted water. With over a million wells drilled since 1866 and well over a half million fracturing jobs, Texas makes a good study area for the risk of pollution to groundwater from wells since virtually all the wells drilled pass through the various deep and shallow fresh water aquifers that range from a few feet below ground level to nearly 5000 feet in some areas.



To assess potential of groundwater contamination in a high density oil and gas well environment, data from Texas Commission on Environmental Quality (TCEQ) and Texas Groundwater Protection Council (TGPC) pollution reports (1998 to 2011) were reviewed for specific references to reported oil, gas and injection well relevance on a county-by-county basis. Studies of pollution reports show correlation of pollution in broad areas near large cities with other industries and a few concentrated small areas of oil or saltwater pollution in pipeline or oil storage or processing locations (plants, compressor stations, separators tanks, etc.) but very few direct connections to well leakage. The upshot of this is that surface facilities need more inspection and maintenance but wells, which are more difficult to repair, are much less of a pollution problem. However, when cases of deeper well pollution occur or are suspected, they should go to the head of the line to be fixed.

Although past pollution incidents are known, the frequency of these problems is low, although the impact can be high. Thousands of oil and gas operators have drilled oil and gas wells in Texas and other parts of the US and some of those operators took short-cuts in well construction, operation and maintenance. Often, only low remaining pressure in these poorly build or maintained wells keep pollution to a minimum, but with redevelopment activities, these hidden problems can come back with a vengeance as conduits to groundwater. Strong, local-area knowledgeable, state regulation and strong law enforcement are the best solutions to these issues. Older wells, particularly those plugged and abandoned decades ago are a higher-risk class, both from possible ongoing pollution and from impact of redevelopment. Vigorous state run, industry-fee funded programs like the Texas Orphan Well plugging program are essential to reducing the risk of groundwater pollution from older oil and gas operations.

Disclosure: George E. King is a Texas Registered Professional Engineer with over 44 years oilfield experience. His technical background includes fracturing, workovers, chemicals, acidizing, well integrity and horizontal wells.