Flowing Wells

Maybe you've heard about, or even seen, a flowing water well. Watching water flow over the top of a well casing without the need for a pump can be mesmerizing. Authors Alan Freeze and John Cherry, in their renowned 1979 textbook titled Groundwater wrote, "Flowing wells (along with springs and geysers) symbolize the presence and mystery of subsurface water, and as such they have always evoked considerable public interest".

Before we discuss why water flows to the surface without the use of a pump, we'll look at the waste and damage these wells can cause.

Complications Arising From Uncontrolled Flowing Wells

NYS Department of Health Standards for Water Wells require that flowing wells be constructed, equipped, and operated to control the rate of discharge (see subsection 18; link leaves NYS DEC's website). When flowing wells are not controlled they waste our precious groundwater resource and can damage the surrounding environment. The discharge rate for uncontrolled flowing wells can range from a few drips an hour to over 1,000 gallons per minute (gpm), or 1.4 million gallons per day. A flow of just 5 gpm will waste over 2.6 million gallons of water in a year. This misuse has many serious consequences. The water supply of the aquifer is reduced and may impact wells miles away.

There is also the possibility that area water quality and aquatic habitat may be harmed. From Spring through Autumn the temperature of groundwater is colder than that of surface water. If this cold groundwater is added to a stream, lake, or river the habitat of warm water aquatic species may be impacted and the turbidity or water chemistry may be altered by the infusion of groundwater carrying high volumes of sediment.

Water spilling over the outside of the casing of a flowing well will enlarge the hole and could lead to subsurface voids, damaging the land, the well, property and structures, and lead to

flooding in the area. It is also possible for rocks and sediment to erupt during a breakout or blowout and create unstable and hazardous conditions near the well.

However, all this can be avoided by controlling the flowing well. This might be accomplished simply by adding a few feet of well casing to the top of the well or by following other standard well drilling industry practices to stop the flow while maintaining its use. Owners of flowing wells should enlist the aid of a NYSDEC registered well driller to ensure the proper operation of groundwater wells. NYSDEC regulations address the damage caused by uncontrolled flowing wells, including:

- 6 NYCRR Part 608 Use and Protection of Waters
- Part 661 Tidal Wetlands--Land Use Regulations
- Part 663 Freshwater Wetlands Permit Requirements
- Part 750 State Pollutant Discharge Elimination System (SPDES) Permits
- Subpart 646-4 Stormwater Management

Why Do Some Wells Flow At Land Surface?

Most of us associate artesian wells with flowing wells. But while all flowing wells are due to artesian conditions, not all artesian wells flow. Indeed, only a small fraction of artesian wells actually discharge to land surface without use of a pump.

All artesian aquifers are "confined aquifers", which means a low permeability sediment layer such as clay overlies, or confines, the aquifer. On the other hand, aquifers without such a confining layer are defined as unconfined or water table aquifers. Unconfined aquifers are exposed to normal atmospheric pressure whereas artesian (confined) aquifers are pressurized. That pressure drives the water in wells upward, sometimes above ground level.

Geologically Controlled Flowing Wells

Figure 1 shows two types of aquifers, water table or unconfined (upper blue aquifer) and artesian or confined (lower blue aquifer). The yellow layers are not aquifers but contain unsaturated sediments.

The difference between the flowing artesian and non-flowing artesian wells is their relation to the "potentiometric surface", which is the level to which water rises in a well penetrating a confined aquifer. This imaginary surface is driven by the area of recharge, seen at the left of the figure, which is at a higher elevation than the wells. When the well casing penetrates the confining unit, water is forced up the casing by the hydraulic pressure in the formation as it seeks equilibrium with the elevation of the water at the recharge area.

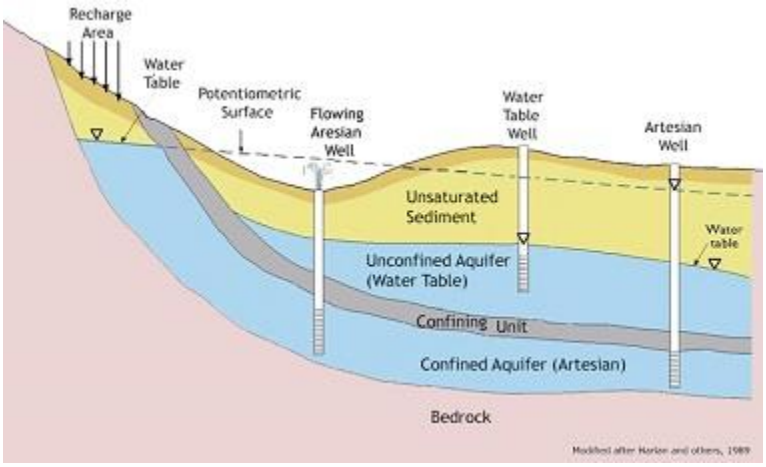

Figure 1. Water table aquifer and an artesian aquifer with flowing and non-flowing wells.

The top of the artesian well on the right side of Figure 1 is above the potentiometric surface and thus does not flow out of the well, although the water level does rise above the top of the confined (artesian) aquifer. However, the top of the artesian well located in the left-center part of the figure is below the potentiometric level and so does flow at the surface.

Interestingly, the lower aquifer in this figure starts out on the left as an unconfined aquifer (there is not a confining unit above it). This leaves it open to recharge from above in the form of rain and snow melt. But the aquifer soon dives under a confining unit and becomes an artesian (confined) aquifer.

Topographically Controlled Flowing Wells

In addition to flow due to confined wells as described above, topography may influence hydrogeological conditions in an area and can be the controlling factor for the existence of flowing wells in a region. This is also described as a gravity-driven flow system.

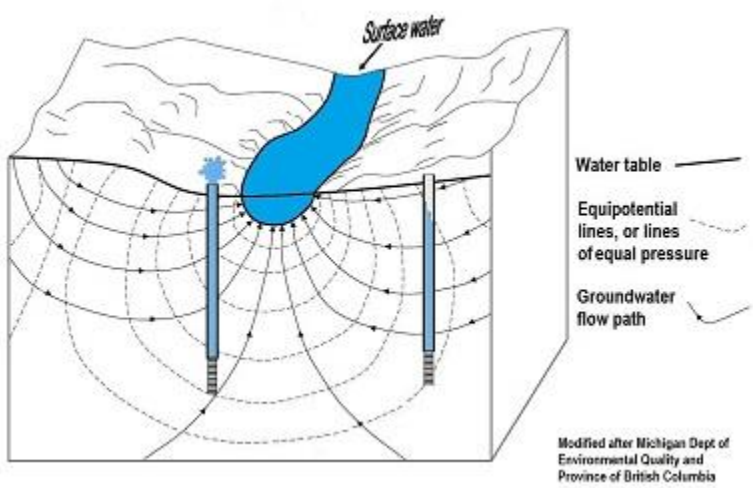

Figure 2. Topographically controlled flowing well in an unconfined aquifer

In unconfined aquifers, flowing wells can occur when the well intake is deep enough to intercept a zone where the pressure (or hydraulic head) is higher than the land surface. Looking at Figure 2, locate the equipotential line at the base of the well located to the left of the surface water. Follow that line upward and you'll see that when it reaches to the surface it is higher than the top of the well. The water flows out of the well because it is trying to reach equilibrium with that flow line. Similarly, the well on the right side of the figure does not flow because the equipotential line intersects the well below the surface.

Please note that despite topographically controlled conditions existing in an unconfined aquifer setting, groundwater literature usually refers to this as artesian flow even though it is driven by different circumstances than the flow in a confined aquifer.