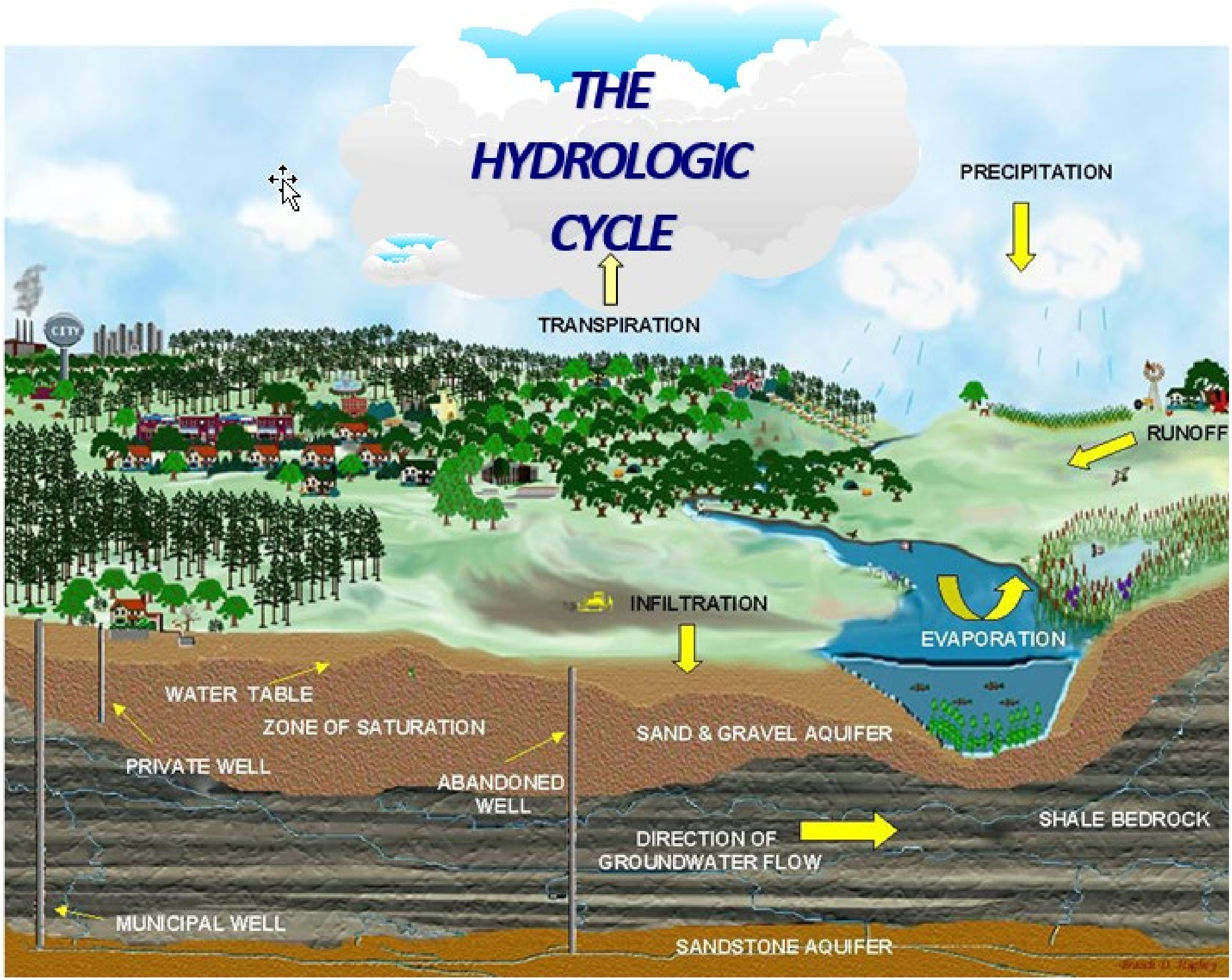
THE HYDROLOGIC CYCLE
PRECIPITATION
TRANSPIRATION
RUNOFF
INFILTRATION
EVAPORATION
WATER TABLE
ZONE OF SATURATION
PRIVATE WELL
ABANDONED WELL
SAND & GRAVEL AQUIFER
SHALE BEDROCK
DIRECTION OF GROUNDWATER FLOW
MUNICIPAL WELL
SANDSTONE AQUIFER

EGLE

THE HYDROLOGIC CYCLE

The constant movement of water above, on, and below the Earth's surface is called the *hydrologic cycle*. The concept of the hydrologic cycle is central to an understanding of the occurrence of water and the development and management of water supplies.

Although the hydrologic cycle has neither a beginning nor an end, it is convenient to discuss its principal features by starting with *evaporation* from vegetation, from exposed moist surfaces including the land surface, and from water bodies. This moisture forms clouds, which return the water to the land surface or lakes and streams in the form of *precipitation*. Precipitation occurs in several forms, including rain, snow, and hail. The remaining rain wets vegetation and other surfaces and then begins to infiltrate into the ground. Melt waters comprise the largest quantity of precipitation. *Infiltration* rates vary widely, depending on land use, the character and moisture content of the soil, and the intensity and duration of the precipitation.

The first infiltration replaces soil moisture, and, thereafter, the excess percolates slowly across the intermediate zone (also known as the "vadose zone") to the *zone of saturation*. The top of the zone of saturation is the *water table*. When and if the rate of precipitation exceeds the rate of infiltration, *runoff* occurs.

Ground water flows through the rock and soil layers of the earth until it discharges as a spring or as seepage into a stream. Water reaching streams, both by runoff and from ground water discharge, moves to the lake or ocean where it is again evaporated to perpetuate the cycle.

Movement is, of course, the key element in the concept of the hydrologic cycle. Typical rates of water movement vary from hundreds of miles per day in the atmosphere, to only yards per day below the land surface. In rocks with extensive fractures, or in some limestone formations that have caves, ground water can move at rates of several hundreds of feet per day. This has been documented in parts of Michigan. Some "basics" to ground water movement are:

- In almost all cases, ground water flows down gradient under the influence of gravity.
- The velocity of ground water flow is influenced by the permeability of the rock or sediments through which it is passing.
- The greater the amount of recharge, the greater the chance of higher rates of ground water movement.
- Ground water may be moving at different rates at different depths in different directions at a single site.

Contrary to popular historical belief, ground water does not flow in "underground rivers" or "veins." An *aquifer* is a water-bearing reservoir capable of yielding enough water to satisfy a particular demand. In a sand aquifer, ground water is found within the open spaces between sand grains. Bedrock formations such as limestone, sandstone, granite, and shale also serve as aquifers in many regions. Ground water is found in bedrock within fissures and crevices, along bedding planes, and in tiny spaces within the rock structure.

Confining layers (such as clay) restrict the movement of ground water either into or out of adjacent aquifers, acting as ground water roadblocks. *Unconfined aquifers* do not have protective confining layers and are less desirable as a safe drinking water supply. Therefore, drilling a deeper well into a *confined aquifer* is much more likely to be protected from contamination than a shallow well in an unconfined aquifer. Wells drilled into confined aquifers are referred to as *artesian wells.* The water level in an artesian well stands at some height above the top of the aquifer, but not necessarily above the land surface. When the artesian well stands above the land surface, the well is a *flowing artesian well*.