Physical Geology

Groundwater: Long Island's Aquifers

Aquifers and aquicludes

Layers of sediment or rock below the surface that have high porosity and permeability are called **aquifers**. The definition of aquifer is economic rather than scientific. If a useful amount of water can be extracted from a layer of rock that layer is considered an aquifer.

Layers of clay or bedrock that are highly impermeable to groundwater are commonly referred to as **aquicludes**.

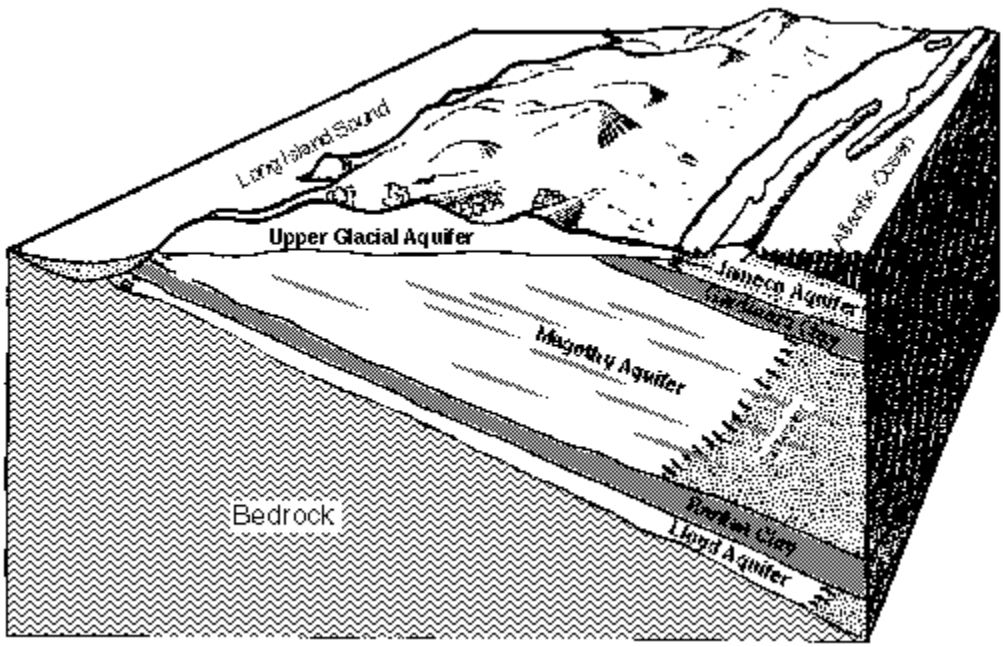
Types of aquifers

Unconfined aquifers are those that extend all the way to the surface. They have a **water table** and are commonly called **water table aquifers**.

Confined aquifers are those that are overlain and underlain by impermeable aquiclude layers. The water in the lower part of a confined aquifer is often under pressure from the weight of the water in the upper part of the aquifer. This pressure will cause water to rise up in a well beyond the upper limit of the confined aquifer. Thus, the **hydraulic head** (height of water in a well) in a confined aquifer can extend above the upper surface of the aquifer.

Confined aquifers can create free flowing **artesian wells** and **artesian springs** if the pressure in the aquifer is sufficient to raise water above the land surface.

Long Island's Aquifers



Long Island's Aquifer Systems

Long Islandâs aquifers are both confined and unconfined. The glacial sands and gravels that the island is built from form a large unconfined **glacial aquifer**. This aquifer is recharged by rainfall on Long Island.

Because it is in direct contact with the surface, the glacial aquifer is an unconfined aquifer. The glacial aquifer recharges very quickly from water percolating down from the surface.

The water table is highest along the center of the island. This is also where the greatest rainfall occurs. Groundwater tends to flow from **recharge areas in the center of the island** to **discharge areas along the north and south shores**.

Below the glacial sediments are layers of sand and clay mostly deposited during the Cretaceous Period. These lower aquifers are all confined by overlying or internal impermeable layers of clay. Water movement from the glacial aquifer across these clay layers is very slow in most places, so that they take longer to recharge than the overlying glacial aquifer.

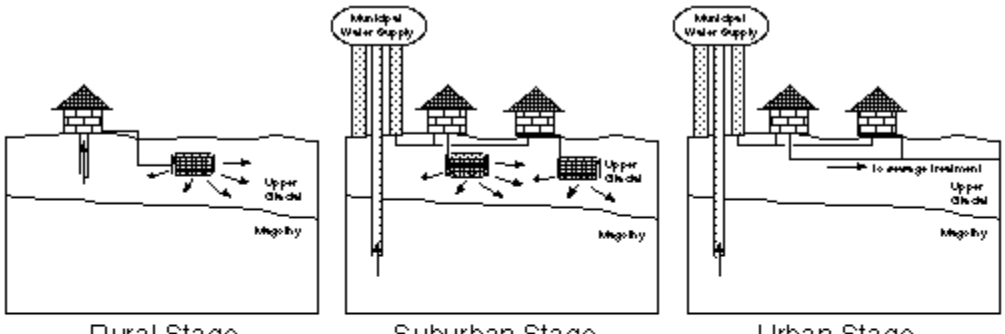
These layers include the following aquifers:

Magothy aquifer: a sequence of sands sandwiched within layers of clay that act as localized aquicludes.

Lloyd aquifer: a deep sand and gravel aquifer separated from the overlying Magothy aquifer by an interval of clay called the **Raritan clay**.

Groundwater Use on Long Island

Groundwater use on Long Island has progressed through several stages through time. These stages can also be observed geographically as one moves from the populated western part of the island to the rural eastern part.



Stages of Water Resource Use on Long Island

Rural stage: At first, Long Islanders were few and far between. Each household pumped water from shallow wells in the upper glacial aquifer. Sewage was returned to the aquifer via individual cesspools and septic tanks. Much of rural eastern long Island is still at this stage.

At the rural stage, impact on the water table is minimal because most water removed is recharged via the

septic systems, and the amount of sewage being introduced into the water table is not significant.

Suburban stage: However, with increasing population growth, the number of septic systems grows to overwhelm the capacity of the aquifer sediments to filter and purify the seeping sewage. In western Suffolk, Nassau, Queens, and Kings counties, urbanization has polluted the shallow glacial aquifer with sewage, household detergents, and industrial toxins. In these places the glacial aquifer is no longer usable.

In Nassau and western Suffolk counties, water is pumped from deep public-supply wells that tap the lower confined aquifers. These deeper, confined aquifers have not yet been invaded by the polluted groundwater in the glacial aquifer.

Pros: used water is returned to the Upper Glacial aquifer.

Cons: the Upper Glacial become increasingly polluted.

Urban stage: In western Nassau county, large municipal sewage systems have been built to accomadate the septic discharge of high density populations. These sewage systems are good in that the sewage is not put into the aquifer, but is instead treated and pumped into the sea. However, this creates another problem.

Sewer systems rapidly deplete aquifers because so much of the water that is discharged is not recharged, but is instead lost to the sea. This is especially the case with Long Island's deeper confined aquifers, which recharge very slowly from above.

Groundwater Problems on Long Island

Saltwater intrusion

On Long Island excessive discharge causes **intrusion of the water table by sea water**. Because freshwater is lighter than saltwater, fresh groundwater forms a barrier to saltwater flow, lying between the land surface and deeper infiltrating saltwater. However, excessive removal of freshwater from the aquifer pulls the saltwater farther inland and closer to the surface, where it can find its way into wells.

Saltwater intrusion is becoming a big problem in western Nassau county where many deep wells near the shore are becoming too salty for use. New wells must be sunk farther inland.

Brooklyn and Queens no longer pump groundwater, having long ago contaminated their aquifers with sewage and saltwater. They get their water from upstate New York. Because of the current absence of exploitation, the aquifers in this area are beginning to recharge and recover.

Contamination

Toxic substances can enter the groundwater system through a variety of sources. Most of the contamination is concentrated in the Upper Glacial Aquifer, however, over time these contaminants can work their way downward into the Magothy Aquifer.

Contaminants can be **point source** contaminants, meaning that they eminate from a particular place like a leaking fuel tank or a factory dump. Some contaminants are light and tend to float on the water table. Others are heavy and sink downward, flowing along the bedrock. [slide]

Non-point source contaminants are those that come from a variety of unidentified sources. Fertilizer runoff, pesticides, and septic waste are all no-npoint source pollutants.

The main challenges facing Long Island water managment:

We pump (discharge) more water from the aquifers than they can naturally recharge. If we do this for a long period of time, then the aquifer shrinks and is replaced by salt water, which is unusable.

To solve the above problem we need to return (recharge) the water we use into the aquifer. However, we tend to pollute the water we use, either with sewage or with industrial wastes. When we recharge this water we pollute the aquifers.

We already have in place and extensive system of storm drains and **sumps** or recharge basins throughout Long Island. These allow water that might otherwise run into the sea to find its way back to the water table. However, with this pro comes the con of pollution. Infiltration through the loose sands and gravels of the surface of Long Island is rapid and any pollutants picked-up by the runoff is carried down toward the drinking water supply. This includes fertilizers, pesticides, road oil, and anything anyone happens to dump down these drains.

Fortunately, studies have shown that if contaminants in the runoff are not excessive, runoff is greatly filtered and purified by the sediments as the runoff infiltrates back into the water table.

Proposed managment policies (solutions?)

A number of possible approaches to management of Long Island water resources have been proposed:

Continue with present practices (called **planned overdevelopment**). Withdrawel of water from deep confined aquifers will eventually result in contamination by saltwater encroachment and by surface contamination encroachment as polluted water from the glacial aquifer is drawn slowly downward to replace the water being pumped from the deeper aquifers.

Although deep contamination is already a problem in some areas, large scale contamination of deep wells would probably not occur for several more decades.

Conserve water resources and carefully manage natural recharge

To maintain our natural supply of clean drinking water what we really need to do is carefully manage the aquifer system. Natural recharge is the only way to get clean water back into the aquifer. To allow natural recharge to work, we need to do the following:

Avoid placing industrial development and land uses with high pollution potential (i.e. landfills, gas stations) in areas of high groundwater recharge (in the middle of Long Island). Put these in areas of discharge.

Limit residential use of groundwater contaminants (i.e. pesticides, lawn fertilizers)

We also need to conserve water by cutting down on excessive use. In the future this may entail raising the cost of water to encourage people to be more frugal. It is a question of do we pay a little now, or do we do nothing and pay through the nose later.

We need to consider limiting additional development, unless we can find the water to supply the increased use and population.

We may also need to consider switching to sewer systems instead of septic tanks as communities grow. Itâs a bit of a Catch22, but if the choice is between cleaning up the glacial aquifer, but making it lower, and polluting both it and the lower aquifers, what choice have we?

Presently, Long Island does not have a comprehensive water managment policy. Local governments follow their own managment policy, if they have one at all. In Suffolk county there is an overall managment authority that coordinates local efforts, but in Nassau itâs every town for itself.

As residents of Long Island, you need to understand the science behind these choices so that you can help make sure that intelligent groundwater policies are formulated and implimented in the future.