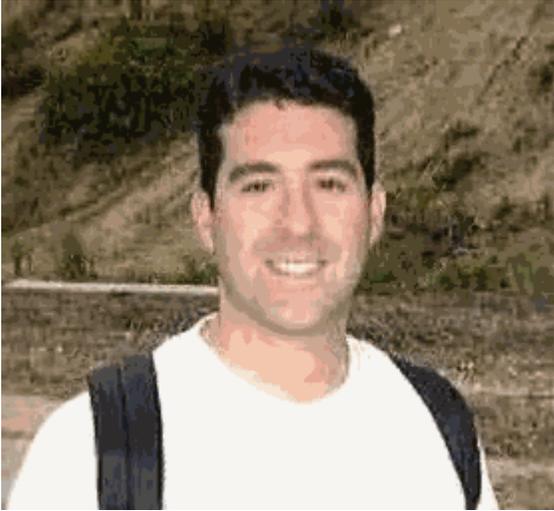


**The Hydrologic Cycle of Seaford (a representative town in Long Island)**  
**Research done by Adam Cohen**



## **Introduction**

I am carrying out my research on the water cycle of Long Island. I will concentrate on the town of my upbringing and of employment, which is Seaford, N.Y. All of the water for Nassau and Suffolk come from ground water. There is no other source for our water. It is important to realize that when we use the term "drinking water", we are also including all the water that is consumed in our households including our faucets to water our lawns and wash our automobiles. All of the industry is obviously included as well.

## **Why Seaford, New York?**

I chose to emphasize Seaford because I lived there from the age of three and I attended school through high school there. I also now teach there, and I feel the students should be aware of their own neighborhood. It would also be easy and cost effective to take the students of Seaford on a field trip through their own town.

Also, Seaford is a town that lies on the south shore of Long Island and there is a waste treatment plant in close proximity.

## **A short history of Seaford**

Seaford sits on the south shore of Long Island, west of Amityville and east of Merrick. The south shore of the island is primarily an Outwash Plain, which is a glacial remnant, which helped to carve out our present topography. An Outwash plain can generally be described as: streams of melted ice that rushed out from the edge of the glacier, that carried sand, gravel, silt, and clays tending to form a flat, sloping stretch of land. Most of the south shore seems to fit this general description. The south shore has been changing of course for the past 20,000 years due to coastal erosion from the Atlantic Ocean.

The land area that makes up Seaford changes in elevation from a maximum height of 30 feet above sea level near our northern boundary (Jerusalem Ave.) to a height of 0 feet above sea level at our southern boundaries.

Prior to the year 1643, primarily Native Indians inhabited the land now known as Seaford. The name of the tribe that the Indians were part of was called the Massapequa's. The leader of the Massapequa tribe was named Tackapausha. Seaford had been known as the "land on the cove" to the Indians. In 1643 a European settler named Captain John Seaman purchased a large piece of land from the Massapequa Indians. Some of the Indians were killed and some were eventually sent off to live out their lives in reservations (a fate that many of the Native Indians of this country faced).

## **Reason for My Project:**

Why study the groundwater of Seaford, Long Island?

Since this project will hopefully be used by high school, Earth Science students I would like them to be aware of some practical, relative knowledge that affects their lives and especially the water cycle. The water cycle is part of the N.Y. State Earth Science syllabus and my hopes are that this research will prove to be an interesting way to supplement the instruction of the water cycle.

### Scientific Basis for the project:

This research was primarily literature based. Much of the data was borrowed from the New York Water Supply Company and The Cedar Creek Waste Treatment Plant. There is a lot of talk today about the high concentration of cancer on Long Island. Many people are quick to hypothesize that the cause must be, at least in part to, the ground water that we drink. I wanted to show that the quality of water that is consumed in a "typical" Long Island town could be safe and clean.

### Why the Project was done the way it was:

I felt it would be beneficial to approach the hydrology of a particular town by incorporating it into a study of the water cycle. This approach should make it easier to incorporate groundwater into a more holistic and relative study. I chose to emphasize my research on two major areas; where does our water come from and what is the quality of our water? AND What happens to all of our waste- water? I think the two latter questions are extremely important in a time when we live in an environmentally sensitive age. I also think that these are areas that many high school students do not have a lot of knowledge of. If we educate our youth, we empower them to make wise and responsible choices about environmental issues.

### **How do humans affect the water cycle in an area like Seaford?**

The water cycle has been an ongoing **CYCLIC** process **that** has been occurring on earth for many years. The fact that the Earth has water that is found in all three states, is why the planet is so inhabitable by millions of different species of organisms from the smallest bacteria, to the humans to the killer whales and the giant sequoia trees. No organism has really had a significant impact on the water cycle over the past 3.5 billion years, until about 300 years ago. It was then that the *Homo sapiens* have had the technological advances, which has affected the water cycle. The major cause of pollution is runoff. When precipitation hits the impermeable surfaces like roads, sidewalks, parking lots, etc., it is forced to runoff and while doing so it picks up many contaminants like oil, detergents, gasoline, fertilizers, pesticides, etc. Some of these contaminants are extremely soluble like nitrates, and others will float on or be carried with the water.

Seaford, like most towns in Long Island is pretty well developed. A majority of the land surface is paved with cement and other impervious materials. When the precipitation hits these surfaces and picks up many contaminants as mentioned above, what is the fate of this runoff? Seaford has a sewer and drain system. Each public street is lined with drainage sewers that collect runoff. Once this runoff is in the sewers, it is directed to one of three places. In south Seaford, these drainage pipes carry the water directly into the bay. Because of the latter, during storms or times of heavy precipitation, it is not uncommon for these streets to flood since the bay is directly connected to the drains. When this happens some local people have been known to open up the manhole covers in the street for drainage. These manhole covers lead to the Cedar Creek "waste" water treatment plant. Further north in Seaford, the water is directed to streams, which will eventually lead into the ocean. In still more northern parts of Seaford and other towns north of Seaford, this runoff is directed to drainage basins also known as "sumps". The water that is directed to these "sumps" will infiltrate into the ground and eventually make its way into the drinking water source. These contaminants are still dissolved in the water. What happens to these contaminants? Many of these contaminants are cleaned out of the water over the slow process of the water infiltrating.

### What is the Water Cycle anyway? (A.K.A) The Hydrological Cycle

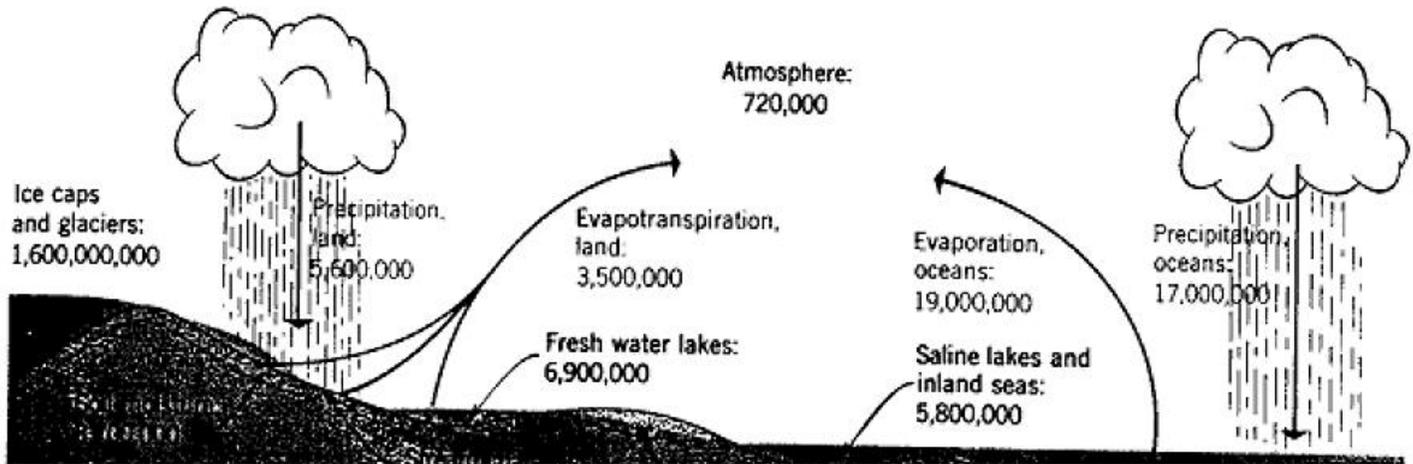
The planet earth has a natural way of recycling the resource water. Of the earth's surface, almost 3/4 is covered with water. When water is cycled through the oceans, atmosphere and land we refer to this process as the hydrological cycle. Since it is a true cycle there is really no correct place to start, however it seems to be customary to start explaining it at the process of evaporation. Evaporation, which of course is powered by the sun, turns the liquid water of the oceans (and to smaller degree fresh water) into a gaseous state, which we call water vapor. Living very close to the Atlantic ocean means that here in Seaford, it is common to have very humid air, since the H<sub>2</sub>O need only be transported a short distance to reach us and hence, our air is commonly filled with moisture. Of course, when the vapor rises in the atmosphere it is cooled. As this moisture filled air is cooled, it loses its capacity to hold water and the water vapor is condensed. The process of condensation changes water vapor gas) back into a liquid state. Now the atmosphere will be filled with tiny water droplets. This does not mean they will fall right away. Many students get confused here because they feel the water droplets are very dense and they could not possibly be suspended in the air. To clear this up, one must realize that these droplets are so tiny (microscopic), that they are not very dense, however, as these droplets start to stick together (water

is very cohesive) the droplets get larger, and more massive. They will eventually have to abide by the laws of gravity. To further understand this concept, one should note that these small water particles are kept in suspension by the equivalent of Stokes law, and the fact that the air, which holds the particles is in motion.

What is stokes law? Visit the following link.

[http://res.agr.ca/CANSIS/GLOSSARY/stokes\\_law.html](http://res.agr.ca/CANSIS/GLOSSARY/stokes_law.html)

### The Water Cycle



For a great link to find out more about the hydrologic cycle try:

<http://zebu.uoregon.edu/1997/ph161/l9.html>

OR:

<http://www.und.nodak.edu/instruct/eng/fkarner/pages/cycle.htm>

<http://danpatch.ecn.purdue.edu/~epados/ground/src/cycle.htm#cycl>

## What are the relative amounts of water held or exchanged during the global Hydrological Cycle?

Heller, Orians, Purves (1995) Life: The Science Of Biology, fourth edition

	10 <sup>18</sup> grams
Evaporation from oceans	319
In oceans	1,380,000
Precipitation over oceans	283
Transport over land	36
Runoff	36
Precipitation over land	95
Evapotranspiration over land	59
Locked-in water in sedimentary rocks near earth's surface	210,000 (plays very small role in hydrologic cycle)

	% TOTAL EARTH WATER	% FRESH WATER	% UNFROZEN WATER (FRESH)
OCEAN	97	-	-
ICE	2	87	-
GROUND	0.6	13	97
LAKES & STREAMS	-	0.3	3
FRESH	0.009	-	-
SALTY	0.008	-	-

\*[http://pbisotopes.ess.sunysb.edu/cei542/Notes/water2\\_17\\_98.htm](http://pbisotopes.ess.sunysb.edu/cei542/Notes/water2_17_98.htm)

### Methods

Most of my methods involved acquiring information from various departments including the New York State department of Health, The New York Water Service Corporation, United States Environmental Protection Agency, and the Wantagh Cedar Creek Waste Treatment Plant. Also the methods included various literature searches which will be referenced. Of course, much of the research information was acquired from speaking with experts. I was able to learn a lot about the history and the mechanics of ground water in the area, from Carol R. of the Tackapausha Preserve Museum in Seaford.

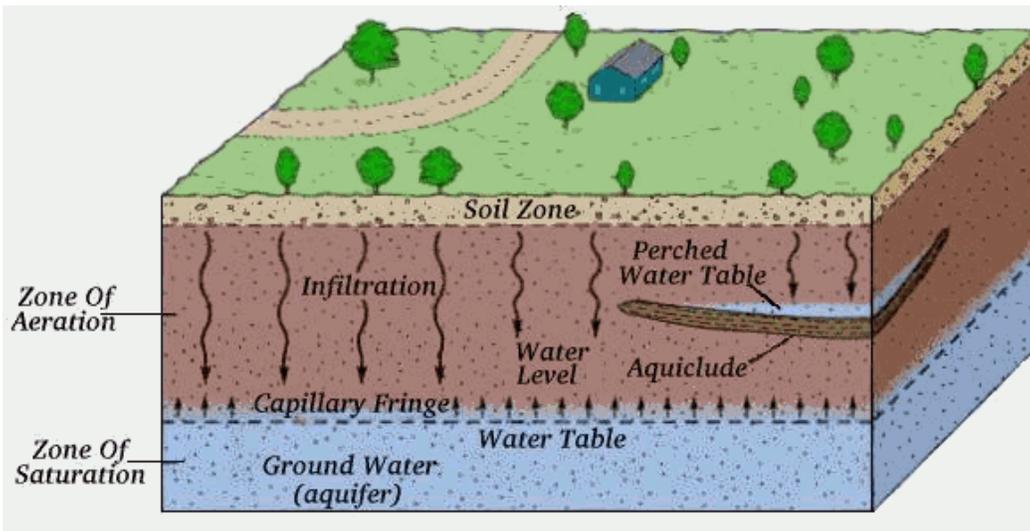
### So now that we know a little about Seaford, where do we get our drinking water?

All of our drinking water (which also includes any water, which comes from any faucet in/on our house) comes from groundwater on Long Island. That means that we do not get any of our water from any reservoirs, which is how New York City gets their water. When rain hits the earth's surface, it has some choices. It can hit an impermeable surface or land on a saturated surface and become runoff, or it can permeate (percolate) into the ground and become ground water. The water will keep infiltrating through the ground until it hits a substance, which does not allow water to pass through it, which is known as an impermeable substance. On Long Island the groundwater typically flows northward from the groundwater divide north and all water that lands south of the divide will tend to flow south toward the Atlantic Ocean. This ground-water divide is located centrally on Long Island, usually in close proximity to the Long Island Expressway. Due to the latter, there is not much mixing of water from a West to East fashion. The water that sinks into the ground through the interstices of soil and rock, and furnishes the supply for springs and wells is known as **Ground Water**.

To Find out more about groundwater, you can go to the site below from the United States Geological Society. <http://water.usgs.gov/pubs/FS/OFR93-643/index.html>

Groundwater flows downward due to gravity. When there is a permeable rock or sediment that is capable of transmitting groundwater, it is called an aquifer. This is the case in Seaford, and the water will permeate until it reaches the Magothy aquifer. The wells used for seaford and surrounding areas range between 350 feet and 850 feet. In contrast an impermeable rock is called an aquiclude. Groundwater moves from high to low areas because of gravity. When trying to compute the rate of groundwater movement (discharge), we need to consider the permeability of the aquifer, the cross-sectional area, and the difference in elevation between where water enters and leaves the aquifer. This relationship was founded by a French engineer named Henry Darcy and hence, named Darcy's Law. Most groundwater flow is very slow because much of the water is slowed down since it is attracted to the pore walls. This molecular attraction between the water and the walls is termed surface tension (much the same reason why it is possible to build a sandcastle). In general, the rate of ground water is only a couple of centimeters/day. \*This slow rate of groundwater flow has considerable significance toward water quality. The more time the groundwater is trapped in the porous material, the more time it can be "cleaned" of sewage, and any harmful substances. This "cleaning" is done by oxygen and microorganisms breaking down these materials naturally.

- \* Nicholas K. Coch and Allan Ludman, Physical Geology, Macmillan Publishing Co. 1991



[\\*\\*http://www.geo.sunysb.edu/geo101\\_f98/Notes aakin.Sept.28.1998.htm](http://www.geo.sunysb.edu/geo101_f98/Notes%20aakin.Sept.28.1998.htm)

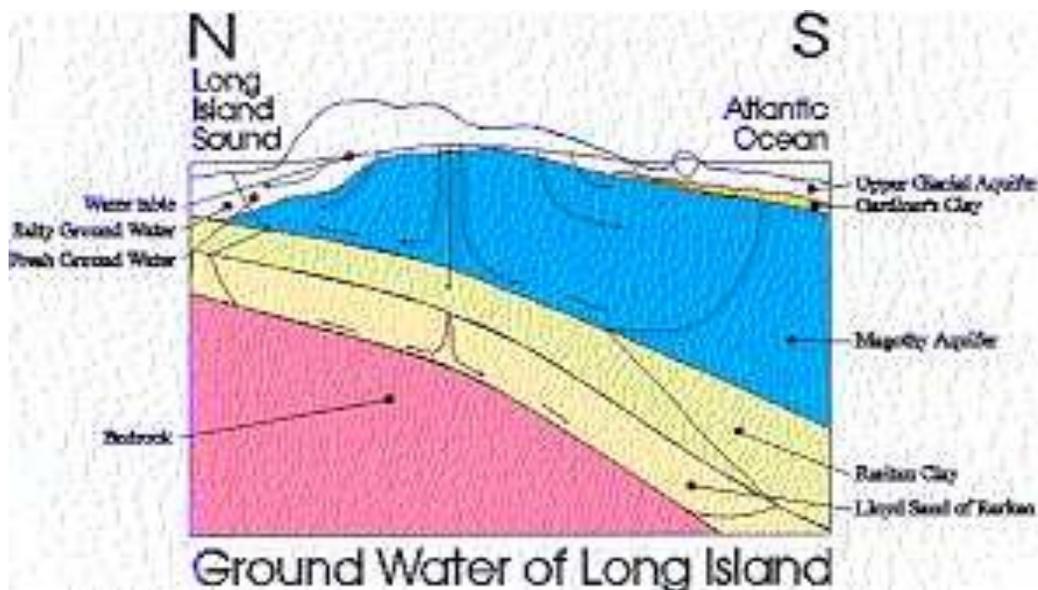
The above diagram was borrowed from the address above. Please visit it if you would like to find out more about aquifers and ground water.

Some of the water that infiltrates the ground is retained in a thin layer within the root systems of plants and it is known as soil-water zone. Directly below this zone we find the zone of aeration, which is characterized by pores that are partially filled with water that is infiltrating. The next zone down is the zone of saturation, where we find the pores totally filled until we look deep enough to find an impermeable material. Where the aeration zone ends and the zone of saturation meets it is known as the water table. This water table fluctuates seasonally, especially due to replenishment of water (recharge) and the pumping of water from wells. Many areas have experienced a drought during the summer of 1999 because the water table is dropping and there is not enough precipitation for substantial recharge. If the water table falls below the depth of the well, we say the well has "dried up". During the years of 1963-1966, there was an extended drought, on Long Island and average water table elevations dropped by 2 meters. Many new homes were being built with basements. In a couple of years (1970's), the water table rose due to a more humid climate with greater recharge...this caused many of these basements to flood.

[What are wells?](#) (click below to find out)

<http://www.bergen.org/AAST/Projects/ES/WS/groundwater.html>

The depth of the **water table** varies with many factors, some of which are character of the beds, amount of rainfall, temperature, relief of the land.



## Ground water Flow Rates

Groundwater flows relatively slow because it must usually pass through tiny pores. In order for water to be transmitted through these pore spaces, the spaces must be interconnected.

Groundwater moves very slowly from recharge areas to discharge points. **Flow rates** in aquifers are typically measured in feet per day. Flow rates are much faster where large rock openings or crevices exist (often in limestone) and in loose soil, such as coarse gravel. It may take years, decades, or even centuries for groundwater to move long distances through some aquifers. However, ground-water may take only a few days or weeks to move for a short distance through loose soil. Groundwater typically moves in **parallel paths** (i.e., layers) with little mixing, due to the slow movement of groundwater, which does not create sufficient turbulence to cause mixing to occur. This becomes an important factor in the location and movement of contaminants that enter the groundwater. (\*\*)

## What are some major concerns about the drinking water on Long Island? Nitrates in Seaford?

According to The Nassau County 1998 Groundwater Study and Summary Report, "sewering in most of the county has reduced nitrate and detergent concentrations that were of concern in the 1950's and 1960's".

Some people are concerned with the fact that Long Island is so densely populated. This naturally means that there will be more pollution going into the ground. One specific concern is (and was) the amount of Nitrates in the ground. When animal wastes and fertilizers are added to the ground, the bacteria will breakdown the nitrogen containing compounds into nitrates. If infants ingest nitrates in too high of a dose, they can suffer adverse health effects. Nitrates are a natural part of the human diet. Nitrates are absorbed when we eat vegetables and fruits and when we drink water. Many Long Island homeowners are using fertilizer on their lawns. The constant development of Nassau and Suffolk County has raised the levels of fertilizers and human waste.

## What is the danger of Nitrates?

Nitrate, a relatively non-toxic substance, occurs naturally as part of the nitrogen cycle. However, bacteria can convert **nitrate** to **nitrite** in the environment, in foods and in the human body.

Until infants reach about six months of age, their digestive system secretes lower amounts of gastric acid and the pH level in their digestive system is higher than most adults. Adults with a diminished capability to secrete gastric acid also can experience a rise in pH in their digestive system. In both situations, certain low acidic loving bacteria can proliferate, increasing the transformation of nitrate to nitrite.

## What is wrong with Nitrite?

In the red blood cells of humans, there are molecules called hemoglobin. Hemoglobin is a pigment which turns red in the presence of oxygen. The structure of the molecule makes it perfect for binding to gaseous oxygen molecules.

\*Sherwood

Once in the blood, nitrite oxidizes iron in the hemoglobin of red blood cells to form methemoglobin, which lacks hemoglobin's oxygen-carrying ability. Now the blood is in danger of carrying an insufficient amount of oxygen to the cells of the body. The nitrite can come from nitrate in drinking water or from food, some drugs or other sources.

Although methemoglobin is continually produced in humans, an enzyme in the human body reduces methemoglobin to hemoglobin. In most individuals, methemoglobin is rapidly converted back to hemoglobin. Typically, less than 1 percent of the total circulating hemoglobin in a healthy adult is present in the form of methemoglobin. Infants, however, have a low concentration (about 60 percent of the adult concentration) of the reducing enzyme, as do some older individuals with an enzyme deficiency. In these people, methemoglobin is not converted to hemoglobin as readily.

When methemoglobin levels are elevated, the condition known as methemoglobinemia, often referred to as "blue baby syndrome", can result as the blood lacks the ability to carry sufficient oxygen to individual body cell.

Since Methemoglobin lacks oxygen-carrying capacity the condition known as methemoglobinemia occurs. Because infants under

six months of age have a higher concentration of the digestive system bacteria known to transform nitrate to nitrite, and a lower than normal concentration of the enzyme known to reduce methemoglobin back to hemoglobin, they are at higher risk for methemoglobinemia. Consuming water from a source containing 10 or less mg/l nitrate-nitrogen provides assurance that methemoglobinemia should not result from drinking water.

Much of the latter information was found by researching the following site.

\*\*<http://ianrwww.unl.edu/PUBS/water/g1369.htm#cases>

## **Methemoglobinemia Prevention**

The Environmental Protection Agency (EPA) has set a public water supply maximum contaminant level (MCL) of 10 milligrams per liter (mg/l) which is equal to 10 parts per million (ppm) for nitrate-nitrogen. This level provides a margin of safety against a significant risk for human health. The EPA believes water containing nitrate-nitrogen at or below this level is acceptable for daily drinking over a lifetime and does not pose a methemoglobinemia health risk for infants or adult

To find out more about nitrates, visit the link below.

<http://www.gem.msu.edu/pubs/msue/wq19p1.html>

Are pesticides a danger to our drinking water on Long Island? It seems that the chemical nature of many pesticides binds to the soil, which can make it difficult to leach their way into the ground water. You can find out what a study shows from the Cornell Co-operative Extension if you click on the link below.

<http://pmep.cce.cornell.edu/facts-slides-self/facts/pest-gr-gud-grw89.html>

Are gasoline and oil spills on Long Island a common occurrence, which may be a major cause of groundwater contamination? See the article in Newsday for more information. Click below.

<http://www.newsday.com/news/tanks/ncovsun.htm>

All of the water fit for consumption that is used by Seaford residents and commercial users is supplied by The New York Water Service Company. This company also supplies water to some of our bordering towns as well as Seaford.

The N.Y. Water supply Co. has 18 wells that they use to extract the water from the ground. These 18 wells combined have the capacity to pump 46.54 millions of gallons every day.

Of the 18 wells used, the deepest well is found in Massapequa and is 893 feet deep. That means that this well is supplied with the oldest drinking water, unfortunately this well does not supply any water to Seaford. The wells that supply Seaford with Water are found on Seamans Neck Road and Jerusalem Ave and they are 656 feet and 585 feet deep respectively.

As of 1997 data, the estimated population that is supplied by The N.Y. Water Supply Co. was 173,000 persons. The annual pumpage in gallons to this population was 5,632,810,000. This results in Gallons per capita/per day of 89 gallons: however, this is not extremely accurate because business and commercial use is also factored into this data.

### **What is done to the water once it has been pumped up from the wells?**

All of the water is treated with the following:

Chlorination: (Sodium or Calcium Hypochlorite)

This form of chlorine is used to eliminate natural odors and to provide a disinfecting residue to protect the water from microbes, reducing health hazards.

Caustic Soda (Sodium hydroxide):

This is used for the purpose of reducing the pipes (water supply lines) from corrosion damage. This chemical raises the pH of the water to reduce the natural acidity of source water due to acidic rainwater. The pH is raised to about 7.1 in order to make it as neutral as possible. The natural pH of the source water is naturally lower or more acidic. This chemical is stated to maintain "optimum treatment" in the prevention of lead and copper leaching from residential and commercial plumbing.

Sequestration- Sodium Hexametaphosphate

A blend of phosphate compounds, which is primarily used to stabilize naturally occurring, dissolved iron. Temperature and the passage of time naturally causes iron to deposit in plumbing, which can lead to discolored water and a metallic taste. This iron is naturally found in the aquifer system .

What is the quality of the water brought to our homes from the New York Water Supply Company?

The drinking water quality in Seaford and the surrounding towns, which are supplied by the New York Water Supply Co (Merrick, Bellmore, Wantagh, portions of; N. Merrick, N. Bellmore, Levittown and Massapequa), is of relatively excellent quality. The natural well water is drinkable at its' source. Treatment is added to ensure this quality as the water travels to the tap. NYWS Company must comply with regulations and standards that are enforced by the New York and Nassau County Departments of Health. NYWS maintains its own state-approved laboratory for monitoring treatment and bacteriological analysis. Samples are collected and analyzed weekly. Some tests are required less frequently are administered by independent state approved laboratories. These tests include **volatile organics, herbicides, pesticides** and **inorganics**.

\*Some dangers of excessive ingestion of volatile organic chemicals are as follows. Some people who drink water-containing barium in excess of the Maximum Contaminant Level (MCL) over many years could experience an increase in their blood pressure.

Some people who drink water-containing chlorobenzene in excess of the MCL over many years could experience problems with their liver or kidneys.

\*Nassau County 1998 Groundwater Study and Summary Report

According to the **Nassau County 1998 Groundwater Study and Summary Report**, " Volatile organic chemicals have become a high priority water quality issue in the county due to the concern that they are known or suspected human carcinogens. Major sources of these (VOC's) in the groundwater are solvents, degreasers, gasoline and other petroleum based products that have been improperly disposed of or accidentally spilled. Regulations, which deal with hazardous chemicals and their disposal, are helping to improve water quality. At present, concentrations of these substances in public water supplies are at low level and easily treatable". Also, test results from the wells that service Seaford have not detected the presence of of any man-made or naturally occurring contamination, which poses a health risk

Below are the results of some of these 1997 tests for the New York Water Supply Company as reported by the Nassau County Department Of Health, Bureau of Water Supply Protection.

**Inorganic Chemical Constituents**

{All results are reported as mg/l= ppm (parts per million), and as an average of one or more tests ND = non-detectable}

Arsenic, Barium, Cadmium, Chromium, Fluoride, Mercury, Selenium, Silver, Zinc (all were ND)
Ammonia = ND
Chloride = 7.4
Detergents = ND
Nitrate = ND
Total Fe = .39

## Physical Constituents (Inorganic) Organic Contaminants

Bromo-Chloromethane, Bromoform, Chloroform, ChloroEthane, ChloroMethane.etc. [all=ND]*
Total Alkalinity = 31
Total Hardness = 5.8
(pH) = 7.01
Color =ND
Odor =ND
* All principle Organic Contaminants that were tested for were found to be Non-Detectable.

### **What happens to our "waste water" that goes down our toilets and down our sink drains?**

"Wastewater" is any water that runs down the drainpipes of any residential or commercial building. Before all this water can be returned to the water cycle it needs to be "cleaned" of as many contaminants and pollutants as possible. If we look back in history we can see that there were many outbreaks of life-threatening diseases which were traced back to microbes in the water. Since that time we have developed modern sewer systems which are networks of below ground pipes which transport wastewater to treatment plants. The wastewater treatment plant which treats the polluted water from Seaford and about half of Nassau County is located south of Cedar Creek Park in Wantagh, New York. This treatment facility treats about 600,000 people, and it is estimated that the per capita use in this sewer district is about 100gallons/per-day/per person (including industry). This means that about 60,000,000 gallons of water are treated each and every day.

There are 15 pumping stations, which bring the wastewater to the plant.

Once the water reaches the plant it undergoes the process of Primary Treatment;

The water is passed through a fine screen to filter the largest of the materials including anything from sand to grit to animals are filtered out and passed into a giant grinder. The water then passes through a grit chamber and a settling tank to further separate the solids from the water. This process removes 40-50% of the pollutants. Secondary Treatment; The solid materials that are still either dissolved in the water or floating on the surface, need to be separated from the water. The water passes through an aeration tank, which is used to stimulate the growth of bacteria and other microbes, which will consume most of the waste material. This bacterium is supplied naturally from the waste and is referred to as "activated sludge". The water then passes through another sedimentation tank to filter out as much solid material and bacteria. The last thing that needs to happen to the water before it is discharged 7 miles into the ocean is (Disinfection) in order to kill any remaining pathogens. The water is disinfected using a 15% solution of Sodium hypochlorite.

What happens to all of the solid material that has been filtered and separated from the water? This material is called sludge. Allowing it to undergo anaerobic digestion from bacteria treats this sludge. "dewatering" the sludge follows this process and the solid material is now the consistency of clay. This solid waste is carted off in the amount of 36 trucks a week, with each truck carrying about 25 tons. This adds up to an expense of \$90,000 a week, just for the solid waste to be carried off. The private carting company carries this sludge to Pennsylvania where local farmers use it as a fertilizer, returning and recycling it back into the earth.

For a look at a typical flow diagram of a waste water system, Click below!

<http://www.obsewer.com/obshome/operations/operationsViewFlowIndex.html>

## Helpful Links





