The Making Groundwater Maps in Planning, Design, and Construction for Architectural and Engineering Projects on Long Island, NY

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ABSTRACT

Long Island is located on the Eastern Coast of North America (United States,) extending approximately 118 miles from Western Brooklyn (Kings County), New York City (The Narrows - (longitude 74° 2' W.)) to the Eastern end of Suffolk County (Montauk Point - (about longitude 71° 50' W.)). The width is approximately 20 miles from Long Island Sound on the North to the Atlantic Ocean on the South. Although, Long Island is part of New York State, and lies parallel to the Southern Coast of the State of Connecticut, and it is separated from New York State by Long Island Sound. As an Island, Long Island is detached from the New York City mainland by Upper New York Bay and the East River which is a Channel (Strait) between Bronx County and New York County (Bough of Manhattan).

Long Island is part of the Atlantic Coastal Plain. The buried bedrock under Long Island consists of both Precambrian and Paleozoic metamorphic rocks. The oldest geologic cover of unconsolidated soil deposits consists of Cretaceous Period sediments. The Lower Cretaceous Marine Environment (100-142 million years ago) deposited Carbonate sands and muds. The Upper Cretaceous Continental Deposition consisted of Deltaic Sediments like bog, marsh, and stream deposits (Organic Mud and Silt, Sand and Gravel). There is no Tertiary Period Deposits found on Long Island since it was removed from earlier glaciations (Illinoisan) 115,000 years ago. Covering the Cretaceous deposits are Pleistocene Epoch deposits consisting of Glacial Terminal Moraine Deposits (Till) (Harbor Hill and Ronkonkoma) that consists of Sand to Boulder poorly sorted sediment mixtures, Stratified Drifts (Drumlins), River Deposits (Eskers), and Outwash Deposits (Sand to Gravel). The last glacial period was the Wisconsin Glaciations 60,000 - 25,000 years ago and continued to 20,000 years ago (Ronkonkoma Glacier). Harbor Hill Moraine was deposited around 19,000 years ago.

The Holocene Epoch began when the Continental Ice Sheet started to retreat to Connecticut around 16,000 years ago, leaving the lake bottom drained and exposed, which now is Long Island Sound. Long Island Sound bedrock and glacial sediment were exposed to strong winds that carried silt-size particles

(Loess) to be deposited in the low-lying topography of Long Island around 15,500 years ago. The drainage of surface water across Long Island reworked the unconsolidated sediments by cutting channels in the landscape forming the hills and ridges. Sea Level started to rise over the last 8,000 years, which has contributed to thick deposits of peat along the southern shores of Long Island. A thick cover of Urban Fill (5- 15 feet thick) today covers most of the landscape on the Western part of Long Island, Brooklyn, and Queens Counties (New York City) and Nassau County. Suffolk County Urban Fill is thinner (2-10 feet thick) since it is more rural and larger in area then the other counties. The Urban Fill consists of man-made transported soils and mixtures of man-made material (debris) like brick, concrete, ash, cinders, metal, wood, plastic, and powders and liquids. Some of the Urban Fills contain hazardous materials like pesticides, petroleum, oils, etc., that have polluted and contaminated the groundwater on Long Island. The age of Urban Fill spans more than 400 years of Long Island's development.

Surface Drainage (Rivers, Streams, Lakes, and Ponds) and Precipitation (Rain, Sleet, and Snow) and, the Atlantic Ocean, Long Island Sound, Bays, Lagoons, and Inlets (Estuaries) along the coastline are sources for Groundwater recharge and discharge on Long Island, New York. Water at the surface and within the bodies of water surrounding Long Island move downward and upward through the unconsolidated soil deposits producing aquifers (unconfined and confined), aquitards (semi-permeable, leaky zones). The bedrock under Long Island is an aquifuge, with very little or no permeability. Through percolation and infiltration, water saturates these stratigraphic deposits and, moves and flows to wells on Long Island, as a source of public and domestic water. The upper glacial unconfined aquifer, at atmospheric pressure, are composed of till, outwash, and coastal soil deposits. The age of this groundwater (unconfined) is days and weeks compared to the confined aquifers on Long Island that are years and decades old. Saltwater intrusion over time has affected freshwater quality of these unconfined and confined aquifers. The potentiometric surface of the confined aquifers may intersect (crossover) low areas allowing the groundwater to flow as springs and rise in wells as artesian groundwater.

Long Island is an important source of groundwater, and is utilized for domestic, public, commercial, industrial, and agriculture from groundwater wells. Long Island's groundwater is a sole-source groundwater resource for both Nassau & Suffolk Counties, New York. Brooklyn and Queens Counties have not use groundwater for domestic use for over a decade. The Jamaica Water Supply was the last company in New York City using ground water domestically until 2007. The Water Distribution Network in New York City today depends on the Upstate New York Watersheds, flowing through Aqueducts and Tunnels that bring fresh water to New York City. The withdrawal of groundwater on Long Island accounts for 25% of all ground water usage in Northeastern US. The coastal plain sediments (Pleistocene and Holocene) are comprised of a cover of glacial and coastal deposits, with variable thicknesses and is Long Island's Unconfined Aquifer, covering over the Cretaceous Age south dipping stratigraphic beds that make up the Lloyd, Magothy and, Jameco Aquifers (confined) and the (Raritan, Gardiners Aquitards (confining beds). The metamorphic Bedrock outcrops on the Western North side of Long Island in various places and dips south to greater than 2000 feet in depth (thickness of the overburden).

Architectural and Engineering Projects need information on both the Geology and Groundwater (Hydrogeology) in Planning, Design, and Construction of both Buildings and Structures (Foundations), and Infrastructure projects, including Rails, Roadways, and Utilities (Water Mains and Sewers, etc.). Today it is easy to map the subsurface geology including depth to groundwater or the elevation of groundwater. There are many sites on the internet to retrieve this data to produce a site-specific groundwater map. In more than 30 years working as a geologist, I have produced numerous Groundwater GIS Maps that were needed to predict groundwater conditions on the site. There are times when Perch Water (unconfined) is encountered and is mistaken as groundwater on either a boring log or a groundwater monitoring well log. Having both geological and groundwater data can help clarify this interpretation.

The making of a GIS Groundwater Map of the site will help with the interpretation of the hydrogeology, including the depth and/or elevation of groundwater at the site, and the flow direction of groundwater through the site.

Case studies from recent projects illustrate how Groundwater Maps are used.

The steps needed to make a GIS Groundwater Map are as follows:

- Copy a GIS Street Base Map as the base map covering the site and paste it into a Blank Word Document.
- Use the USGS Depth to Groundwater Viewer to obtain the depth of groundwater within the site. (Make a sketch of the site to show all groundwater depths)
- Highlight the site limits if it is a building, structure, or roadway (route), and use a color that is bright.
- Use the Insert tab on the word document to draw a text box to input the data and paste. (You can copy the text box for each depth by modifying the copy)
- If you can obtain surface elevation of the site, like a topographic map, you can then convert the depth of groundwater to the elevation on the map.
- Use the Insert tab on the word document to go to the shape icon and select an arrow. Paste the arrow from the text box to the location of the groundwater depth found on the USGS Groundwater to Depth Map Viewer.
- If you can't read the street names clearly on the GIS Street Base Map, you should label and paste the street name and an arrow for each by inserting a text box and arrow pointing to the street.
- Format the Word Document showing Project Number: , Project Location: , above the GIS Street Base Map going from left to right. Add a Legend below the base map showing the building, or roadway limits of the project, etc., label and paste.

- Below the GIS Street Base map and Legend, label the following on the next 3 lines, Prepared by: , the next line Date: , the next line Source:(Map and Date and copy and paste then below, paste the URL (link) of the Map you are using.

- Example:

  Source: USGS Depth to Groundwater Map Viewer Map, 2016
  https://ny.water.usgs.gov/maps/li-dtw/?year=2016

KEY WORDS

Atlantic Coastal Plain, Groundwater, Hydrogeology, Cretaceous Period, Tertiary Period, Pleistocene Epoch, Holocene Epoch, Aquifers, Aquitards, Aquifuge, Artesian, Perch Water, Springs, Moraine, Till, Outwash, Loess, Urban Fill, Coastal Deposits, Glacial Deposits, Potentiometric Surface, Water-Table, GIS Street Base Map, GIS Groundwater Map, Groundwater Well, USGS Depth to Groundwater Viewer Map, Groundwater Elevation Measurement.