Real-Time Hydrologic Monitoring by the U.S. Geological Survey on Long Island and in the Five Boroughs of New York City

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A continuous, reliable record of hydrologic data supplies users with the information needed to make important and appropriate water and emergency management decisions. The U.S. Geological Survey (USGS) New York Water Science Center has been continually enhancing its network of real-time hydrologic stations to meet the water-data needs of other Federal, State, and local agencies, water managers, stakeholders, and the public. Real-time and historical data collected in New York by the USGS are made available online to the public on its National Water Information System Web Interface (NWISWeb) at http://waterdata.usgs.gov/ny/nwis.

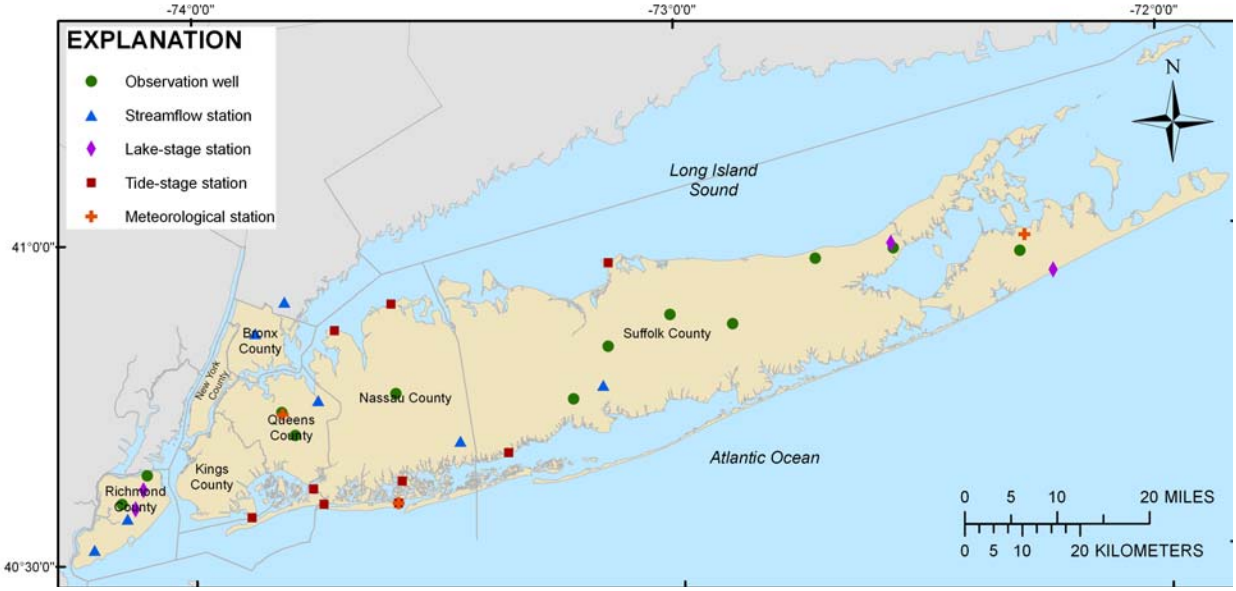

Figure 1. – Location of real-time-monitoring stations on Long Island and in the five boroughs of New York City.

The following are examples of some of the current USGS real-time hydrologic networks on Long Island and in the five boroughs of New York City:

Ground-Water-Level Monitoring

The USGS real-time ground-water-level monitoring network consists of 12 stations on Long Island and in the five boroughs of New York City (fig. 1). This network provides information that is critical to managing Long Island's water supply. This information is especially important because all drinking water on Long Island (in Nassau and Suffolk Counties) comes from the underlying sole-source aquifer system; therefore, it is vital that this resource be managed efficiently and protected for future use. These real-time ground-water-level stations form a local component of the USGS Climate Response and Real-Time Ground-Water Networks (http://groundwaterwatch.usgs.gov).

The Climate Response Network is a national network of more than 550 wells that have been selected by the USGS to represent essentially natural conditions in their respective aquifer systems. Water levels at these wells respond primarily to variations in precipitation and are useful for monitoring the hydrologic response of the ground-water system to extremes in weather and climatic condition, such as floods and droughts.

The Real-Time Ground-Water Network consists of more than 1,000 observation wells nationwide equipped with telemetry to supply data in real time. In addition to monitoring conditions in real time during droughts and floods, these sites record the effects of human-induced changes in the aquifer systems. Examples include changes such as lowering of ground-water levels by ground-water withdrawals, installation of sanitary- and storm-sewer systems, and changes in land use that can have adverse effects on the aquifer system and cause problems such as saltwater intrusion and wetland loss.

Ground-water conditions across the nation on March 4, 2008 from the USGS Climate Response Network are shown in figure 2. Sites displayed in red and orange indicate below-normal ground-water levels, sites in green indicate near-normal conditions, and sites in blue and black indicate above-normal conditions.

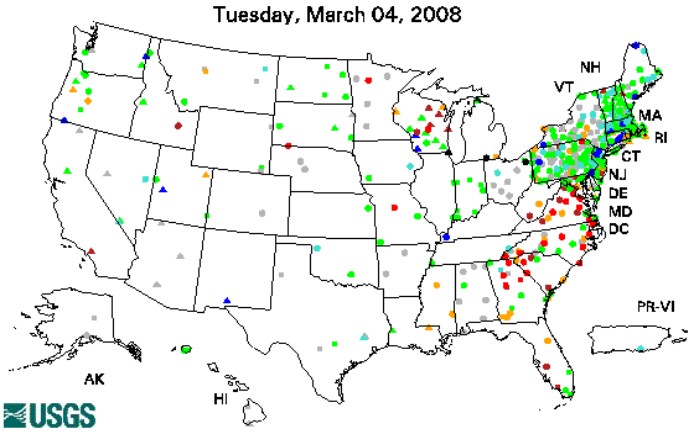

Figure 2. -Ground-Water Climate Response Network

Surface-Water Monitoring

Currently, there are 11 real-time streamflow and lake-level monitoring stations on Long Island and in the five boroughs of New York City (fig. 1). Real-time streamflow stations are part of the USGS Water Watch Network (http://water.usgs.gov/waterwatch/), a nationwide network of about 3,000 real-time streamflow stations used to monitor conditions across the country, including floods and droughts. Streamflow and lake-level data can be used to develop watershed models that assess the impact of land-use changes, to evaluate the effects of varying flow into wetlands and estuaries, and to monitor conditions critical to the health of aquatic species.

Surface-water conditions across the nation on March 4, 2008 from the USGS Water Watch Network are shown in figure 3. Sites displayed in red and orange indicate below-normal streamflow conditions, sites in green indicate near-normal streamflow conditions, and sites in blue and black indicate above-normal streamflow conditions.

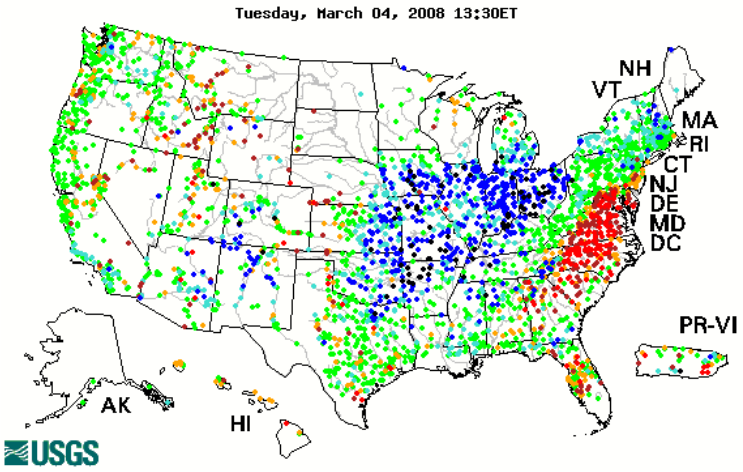

Figure 3. -Surface-Water Watch Network

The coastal areas of southeastern New York are highly vulnerable to tidal flooding, which requires timely evacuations of people from flood-threatened areas in advance of approaching hurricanes and "nor'easters" (northeast coastal storms). Currently, the USGS operates six real-time tidal water-elevation stations along the southern shore of Long Island (fig. 1) that provide life-property-saving information by automatically sending out telephone and e-mail alerts to emergency-management officials and National Weather Service (NWS) forecasters when tide levels exceed the NWS minor coastal-flood thresholds. In addition, the USGS has recently installed and begun operating three real-time estuary monitoring stations along the northern shore of Long Island (fig. 1) that monitor tidal water elevation in embayments that are the subject of tidal-wetland-loss studies. Real-time water-quality data, such as measurements of temperature, specific conductance (used to calculate salinity), dissolved–oxygen concentration, pH, turbidity, and chlorophyll concentration also are collected at some of these coastal-flood and estuary-monitoring stations.

Meteorological Monitoring

The USGS currently operates three meteorological stations on Long Island and in the five boroughs of New York City (fig. 1). Two of the stations (at Queens College, in central Queens County, and on Reynolds Channel, in southern Nassau County) are fully equipped weather stations that record precipitation, air temperature, relative humidity, wind speed and direction, barometric pressure, and solar radiation; the third station (at Sag Harbor, in eastern Suffolk County) records only precipitation. Real-time meteorological data are used by the USGS to help understand the effects of marine weather on coastal flooding, and to correlate climatic events, such as heavy rainfall, with changes in streamflow, ground-water levels, and estuarine water quality.

Monitoring-Station Design and Construction

With the many types of parameters being measured and disseminated in real time, station design and construction are important matters to consider. Each site serves at least one specific purpose and function, and these factors, along with site-specific issues, need to be considered when designing a station. Each station needs to be a reliable and stable platform for the collection and transmission of data; therefore, many operational details must be adequately addressed prior to installation. External factors such as location, need for storm resilience, aesthetics, threat of vandalism, and future expandability also need to be weighed in the design. Some examples of special design and construction considerations at real-time data-collection sites are:

- Existing gage houses that have been retrofitted with new and expanded data-collection capabilities and real-time telemetry. Many of these sites have been operated for nearly 100 years; as a result, careful attention is needed to preserve their historical character and data consistency, while incorporating new technology.

- New sites that are built to withstand various types of weather must also be self-contained and able to be operated in remote locations. Key sites are often located in areas with no access to landline telephone service or electricity. These sites need to be able to collect and wirelessly transmit data under their own power.

- In some locations, real-time sites incorporate special designs like unbreakable solar panels to withstand vandalism. Recently, the USGS has been testing and utilizing a real-time data-collection and telemetry platform that fits inside a standard below-ground enclosure. This system uses cellular Short Message Service (SMS) text messaging to transmit data. If successful, this technology will represent an important advance because it will allow real-time data collection and delivery in space-limited urban environments that are prone to vandalism.

Types of Real-Time Telemetry

Typically, data are collected at a monitoring site by a data-collection platform (DCP) that is connected to various instruments that measure specific parameters. Once data have been collected, they are relayed to USGS offices by one or more means. These include communication through the Geostationary Operational Environmental Satellite (GOES) system, landline or cellular telephone modem, radio, and, more recently, cellular SMS messaging. Data transmitted through GOES telemetry are relayed through one or more satellites and ground receiver stations to processing servers that disseminate the information over the Internet. Landline and cellular telephone telemetry retrieves data at specific times and distributes the values online through many of the same ground-based processes as those employed with the GOES system. The newest technology being utilized—cellular SMS messaging—transmits data via a cellular signal to a receiver station which then resends it as an e-mail message that is subsequently processed and distributed over the Internet. These various telemetry options allow the USGS to reliably transmit and receive data in many different configurations and environments. They also facilitate use of multiple combinations of telemetry that provide for redundant transmission of data in the event that one means should fail.

Real-time data collection and delivery have proven to be highly valuable in providing timely data needed to understand hydrologic processes. Real-time data play an important role in the mission of the USGS to provide cooperators and the public with the data necessary to protect life and property.