

ISSUE PAPER SERIES

Tug Hill Aquifer 101 For Local Communities

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NEW YORK STATE TUG HILL COMMISSION

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This paper was prepared in cooperation with the U.S. Geological Survey.

The Tug Hill Commission Technical and Issue Paper Series are designed to help local officials and citizens in the Tug Hill region and other rural parts of New York State. The Technical Paper Series provides guidance on procedures based on questions frequently received by the Commission. The Issue Paper Series provides background on key issues facing the region without taking advocacy positions. Other papers in each series are available from the Tug Hill Commission. Please call us or visit our website for more information.



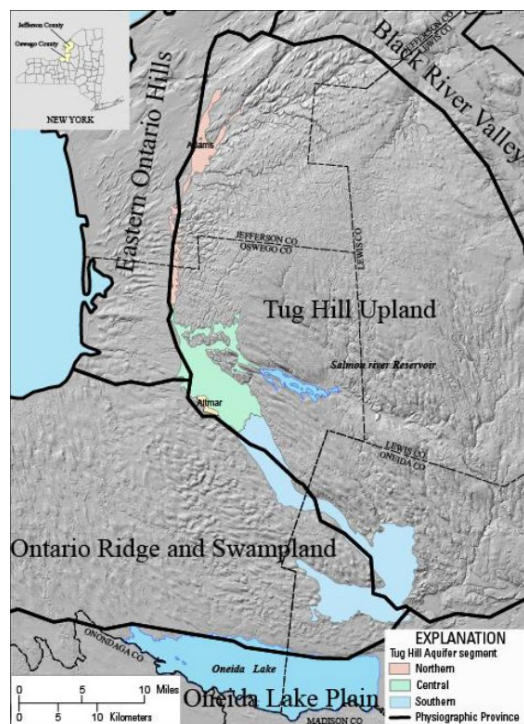
Tug Hill Aquifer 101 For Local Communities

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What is the Tug Hill Aquifer?

The Tug Hill glacial aquifer is a 47-mile long, crescent-shaped aquifer on the western side of the Tug Hill Plateau in Jefferson, Oswego, and Oneida Counties in north-central New York. It can be divided into three parts (northern, central, and southern) based on geohydrological setting, depositional history, and type of glacial deposits. The Tug Hill Aquifer has been identified as an important source of drinking water for communities along the western edge of Tug Hill Plateau since the 1980s, when it was first investigated by the U.S. Geological Survey. Recently, there has been renewed interest by local communities to understand this regional drinking-water supply and how to protect it. In November of 2006, the United States Environmental Protection Agency (EPA) designated the northern section of the existing Tug Hill Aquifer, and its tributary surface watershed, as a Federal Sole Source Aquifer (SSA). This paper details the SSA designation, provides an update on progress of current studies, and gives guidance on how these studies can be used by local planners to manage this important resource. Ongoing research to understand and manage the aquifer resources has been supported by the NYS Tug Hill Commission, NYS Department of Environmental Conservation (NYSDEC), U.S. Geological Survey (USGS), Tug Hill Tomorrow Land Trust, Jefferson and Oswego counties, and the Salmon Rivers Council of Governments.



Historical context

In 1980 and 1981, the USGS investigated the hydrogeological character of the part of the Tug Hill aquifer that lies in Oswego County. This led to further study, and in 1988, a report on the hydrogeology and water quality of the entire Tug Hill Aquifer was published (Miller et al. 1988) which included the first map that depicted the aquifer boundary.

In the early to mid-2000s, there was renewed focus on the aquifer. In 2006, the northern section was designated by the EPA as a sole source aquifer, which recognized the value of the aquifer's water resources as a drinking-water supply and required some additional level of federal review for certain projects.

Also, during this period, there was expansion of Fort Drum in the Watertown area and a growth in the agricultural industry, which created some additional development pressure in the northern portion of the aquifer. Additional stresses included a water bottling plant that was proposed in the central

portion of the aquifer and significant changes which were occurring in water withdrawal at the Felix Schoeller paper company well field near Richland. There was reduced withdrawal for a period and in turn, the company sold their wells to the town of Richland to be used as a municipal well field.

In 2007, the USGS, with multiple stakeholders, entered into a program to collect more detailed data in order to better understand the aquifer resource. The program was designed in two phases:

1. Data collection phase
2. Numerical groundwater flow modeling

Based on the limited sources of funding available for this study, only the data collection phase in the northern and central parts of the aquifer were investigated in detail. Periodic updates on the investigation were presented at stakeholder meetings throughout the course of the project to keep communities and interested parties informed. Much of that material is available on the Tug Hill Commission website: www.tughill.org/projects/tug_hill_aquifer/.

The final report entitled *“Geohydrology and Water Quality of the Northern and Central Parts of the Tug Hill Glacial Aquifer System, Jefferson and Oswego Counties, North-Central New York”* was completed in 2022 and can be found on the United States Geological Survey (USGS) website: pubs.er.usgs.gov/publication/sir20225039. The key findings from that report, as well as other prior reports and background information, are incorporated into this paper. Please note that all totals are estimates based on data from a 5-year period.

Who uses water from the Tug Hill Aquifer?

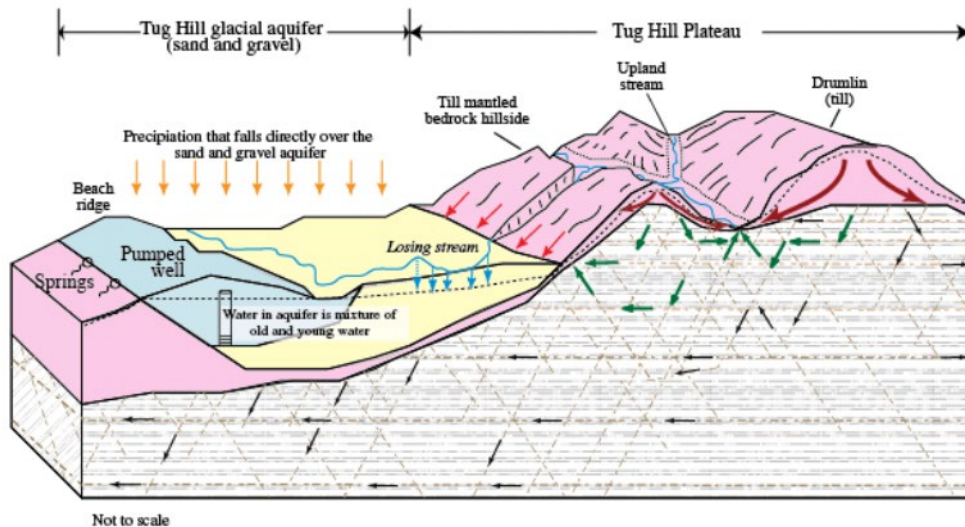
The aquifer supplies drinking water to numerous municipalities (Villages of Adams, Mannsville, Lacona/Sandy Creek, and Pulaski; and hamlets of Richland and Orwell) as well as rural homeowners on private wells. Slightly over 11,400 people are provided drinking water from the aquifer in the northern and central parts of the aquifer. About 3.34 million gallons per day, or about 1.2 billion gallons per year, were withdrawn annually during 2012-2017. Industries and businesses not supplied by municipal water were not accounted for in this estimate due to lack of reported data.

Water from the aquifer is an important source of water for agriculture (primarily dairy) and value-added production at Great Lakes Cheese. The NYSDEC Salmon River Fish Hatchery in the town of Albion also depends on cold water from the aquifer to support its fishery operations. Groundwater that seeps into streams provides the cool baseflow to streams which is critical in sustaining the ecological environment needed for trout to thrive in the area.

Where does the aquifer water come from?

Both the northern and central parts of the Tug Hill Aquifer gain water from:

- (1) Precipitation that falls directly over the aquifer;
- (2) Runoff from till and bedrock hills that border the eastern side of the aquifer;
- (3) Losses from streams that drain from Tug Hill and discharge water to the aquifer; and
- (4) Ground-water inflow from the till and bedrock on the adjoining Tug Hill Upland.



Where does the aquifer water go?

Groundwater in the northern and central parts of Tug Hill Aquifer discharges to:

- (1) Domestic, agricultural, and commercial pumping wells and large production wells for municipalities and a fish hatchery
- (2) Springs, seeps, headwaters of streams, and wetlands along the western boundary of the aquifer; and
- (3) Wetlands and main trunks of major streams within the middle areas of the aquifer

Continuous water-level data collected at 6 wells for several years, along with historical data collected in the 1980s and early 2000s, indicate that the water table generally fluctuates less than 15 feet seasonally. Water levels collected in many wells throughout the aquifer indicate that the water table generally slopes from east to west and the general direction of groundwater flow is also from east to west.



Continuous water-level and temperature data was recorded at specific wells. Well B-29 was in the Richland well-field.

What was studied in the most recent data collection phase?

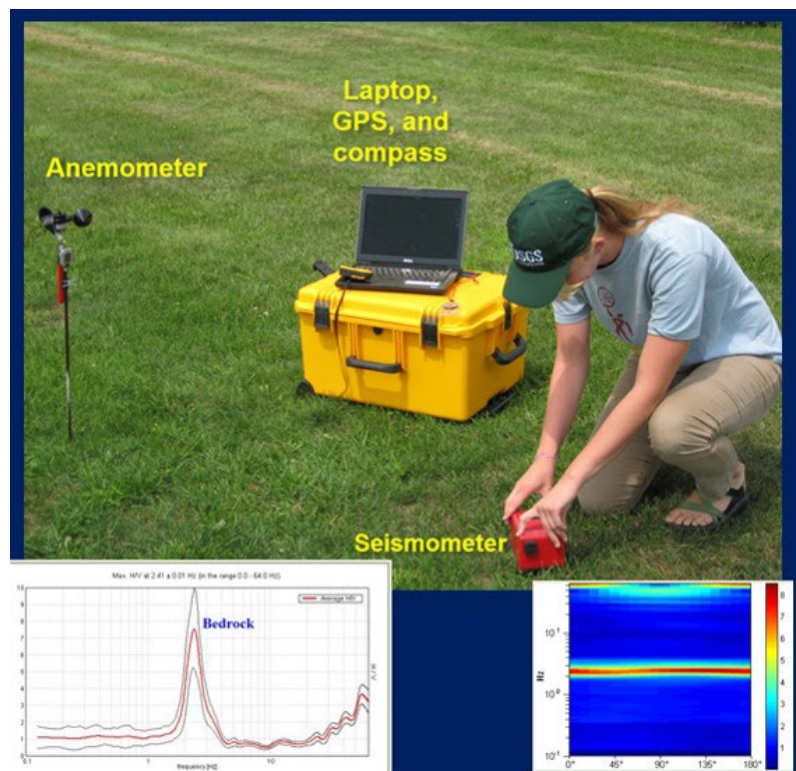
Field work for the recent detailed assessment included:

- Well site inventory of 171 wells (including two test wells drilled for this project);
- Streamflow measurements made during low-flow periods at 31 sites;
- Seismic surveys to determine depth to bedrock, which is typically the bottom of the aquifer;
- Collection and analysis of 21 surface-water samples and 20 groundwater samples; and
- Temperature data loggers installed at 6 surface-water sites

What were the findings of the most recent data collection?

In the northern portion of the aquifer:

- Unconsolidated deposits range in thickness from 4 to 136 feet, with a median thickness of 38 feet;
- The aquifer is comprised of a combination of glaciofluvial outwash and alluvial sand and gravel in the Sandy Creek Valley northeast of Adams, and mostly glaciolacustrine beach and deltaic sand or sand and gravel north and south of the village of Adams;
- The aquifer is under unconfined conditions, which makes it vulnerable to contamination from chemicals that are applied to land surface and can readily infiltrate to the water table;
- In the Sandy Creek Valley northeast of the village of Adams, direction of groundwater flow is predominately to the southwest (downgradient in the valley). Elsewhere in the aquifer, the direction of groundwater flow is predominantly from east to west, with all water ultimately discharging into Lake Ontario;
- Groundwater discharges into streams over the central parts of the aquifer and streams typically lose water to the groundwater system along the eastern margin of the aquifer; and
- Withdrawals from the northern portion of the aquifer are approximately **217 million gallons per year (594,000 gallons per day)**, not counting industries and businesses that do not use municipal water. Annual withdrawal by the



Seismic surveys were conducted at over 200 sites.

municipalities of Adams, Adams Center and Mannsville is 197 million gallons with the remainder used by individual homeowners and farms.

In the central portion of the aquifer:

- Unconsolidated deposits range in thickness from 5 to 130 feet, with a median thickness of 43.5 feet;
- The southern and eastern areas are composed mostly of glaciofluvial sediments, whereas most of the western areas of the central part are composed mostly of glaciolacustrine sediments such as deltaic sand and beach sand and gravel;
- Groundwater flows predominantly from east to west;
- Streams in the central part of the aquifer are recharged by the aquifer, as well as heads of streams and springs along the western boundary of the aquifer. Especially large amounts of groundwater discharges to springs at the head of Spring Brook near Richland, keeping water temperatures nearly constant, between 46.0 and 48.0 °F. Spring Brook is the municipal source of water for the village of Pulaski;
- Withdrawals from the central portion of the aquifer are approximately **1 billion gallons per year (1,000 million gallons per year)**, not counting industries and businesses that do not use municipal water. The municipalities of Sandy Creek, Lacona, Orwell, Pulaski and Richland account for withdrawal of about 261 million gallons per year. Homeowners withdraw approximately 43 million gallons per year. The NYSDEC Salmon River Fish Hatchery withdraws about 701 million gallons per year; and
- The surface-water drainage divide between West Branch Fish Creek basin and Salmon River basin is the boundary between the central and southern parts of the aquifer.

What is the water quality of the Tug Hill Aquifer?

Water quality samples were collected from 23 surface water and 20 groundwater sites in 2009 and 2013 and were analyzed by USGS for physiochemical properties, major ions, trace elements, nutrients, dissolved gasses, and groundwater age. Specific analyses include:

- Water temperature, pH, specific conductance
- Dissolved gasses (oxygen, chlorofluorocarbons, carbon dioxide, nitrogen, methane)
- Nutrients (nitrogen, phosphorus)
- Major ions (magnesium, potassium, sodium, calcium, chloride, sulfate, silica, etc.)
- Trace metals (barium, boron, lithium, etc.)
- Radionuclides (tritium)

In the northern portion of the aquifer, both surface water and groundwater quality were good, with no nutrient levels exceeding drinking-water standards. Manganese concentrations at one sample site, and

manganese and iron concentrations at another site separately exceeded the NYSDOH drinking-water standards. Groundwater age was estimated by determining the concentrations of chlorofluorocarbon in three wells. The age of the groundwater varied from as old as from the early 1950s, to the early to mid-1970s. Tritium sampling confirmed the dating of the well with the oldest water.

In the central portion of the aquifer, both surface water and groundwater quality were found to be good. No nutrient concentrations exceeded drinking-water standards. Iron and manganese concentrations exceeded NYSDOH drinking-water standards in one groundwater sample. Aging of the groundwater in this area indicated that the groundwater is from the mid to late 1970's.

In comparing the water quality between the northern and central portions of the aquifer, the median concentrations of chemical constituents in surface water and groundwater were generally greater in the northern part of the aquifer system. This is due to large portions of the northern aquifer being underlain with limestone formations while noncarbonate rocks underlie and compose the clasts in the central part of the aquifer.



Stream temperature data was collected at 8 sites.

Northern Tug Hill Aquifer Sole Source Aquifer Designation

The EPA is authorized through the federal Safe Drinking Water Act to designate an aquifer as a SSA if it is shown that the aquifer supplies at least 50% of the drinking water consumed in the area overlying the aquifer. In most cases these areas have no alternative drinking water sources that could physically, legally, and economically supply all those who depend on the aquifer for drinking water.

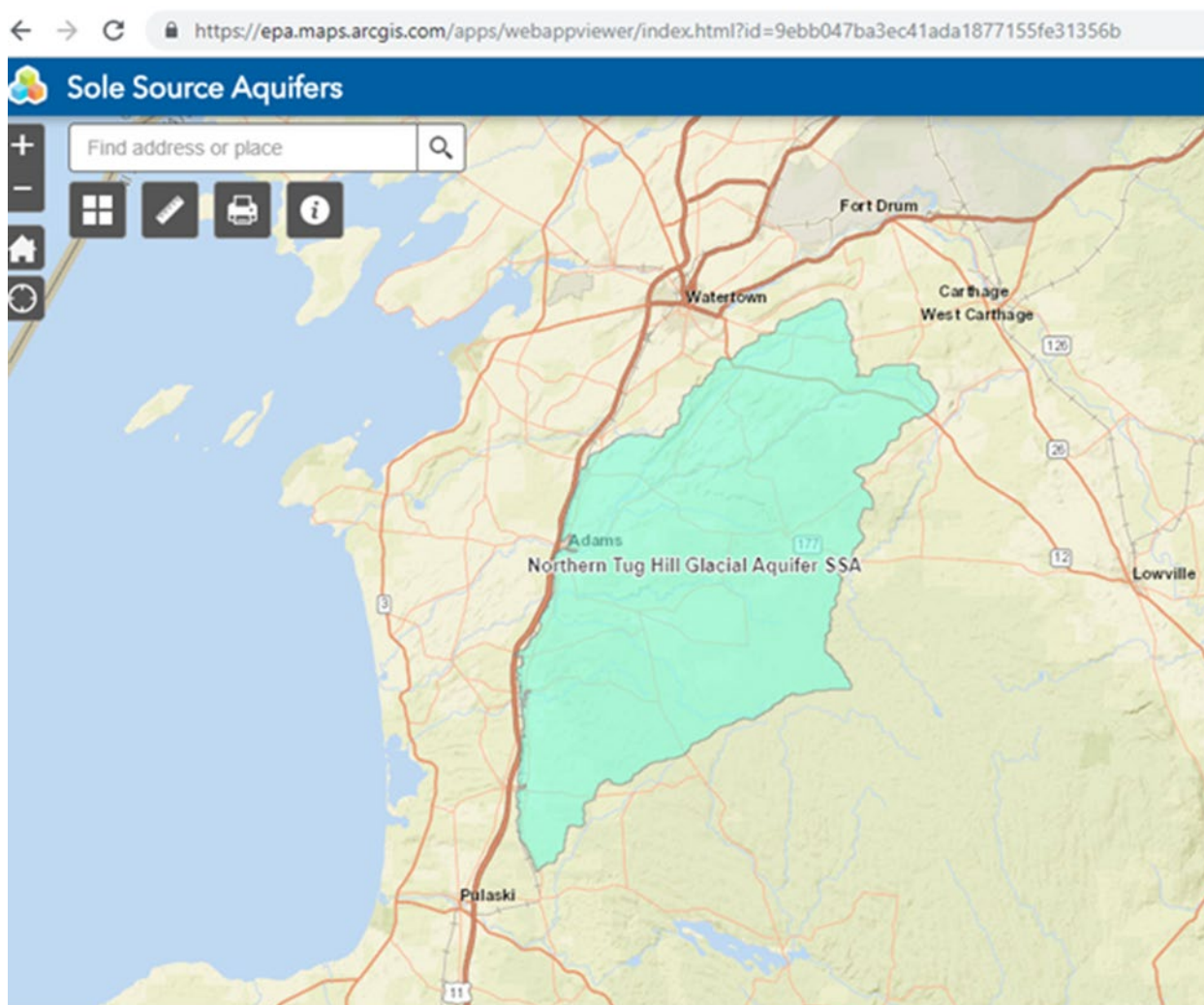
In the case of the Tug Hill Aquifer, the Oswego County village of Lacona petitioned EPA to designate the Northern Tug Hill Glacial Aquifer as a sole source aquifer on September 16, 2003. The village pursued the designation based on concerns it had over land uses taking place near its groundwater wells. The EPA designated the Northern Tug Hill Glacial Aquifer a SSA in November of 2006, in Federal Register 71 64524, available at www.federalregister.gov/documents/2006/11/02/E6-18487/northern-tug-hill-glacial-aquifer-in-jefferson-lewis-and-oswego-counties-ny-sole-source-aquifer.

Sand and gravel aquifers, like in the Tug Hill region, receive large amounts of recharge in the form of rain and snowmelt. The aquifer also receives major recharge from streams which originate outside of

the aquifer area, and that enter and cross over the aquifer area, and from hillside runoff along the aquifer boundaries. Because the Tug Hill Aquifer and overlying soils are largely composed of porous sand and gravel, contaminants can more easily move through the soil and into the aquifer before they can be captured (cleaned up), bind to the soil, be biologically degraded or otherwise made less potent. Once contaminants enter the aquifer, they travel quickly through the sand and gravel, and may threaten wells and nearby streams, lakes and wetlands that receive water from the aquifer.

SSA designations help to increase public awareness of the nature and value of local ground water resources by demonstrating the link between an aquifer and a community's drinking water supply. The realization that an area's drinking water originates from a vulnerable underground supply can lead to increased interest in protection measures. Additionally, all federally financially assisted projects constructed in the Northern Tug Hill Glacial Aquifer Area and its stream flow source area (see graphic below) will be subject to EPA review to ensure that these projects are designed and constructed so they do not create a significant hazard to public health. Water supply improvement projects in a SSA receive additional priority for funding (25 scoring points) through the Drinking Water State Revolving Fund.

The EPA has in place a Memorandum of Understanding (MOU) with its sister agencies in the federal government, that requires those agencies to submit projects that they are funding within the SSA area to EPA. EPA then has 15 days to issue a finding as to whether or not the project is in compliance with the Safe Drinking Water Act and requires no changes. If the EPA finds an issue with a proposed project, it can halt the release of federal funds for the project until EPA's conditions are met. Importantly, the designation of an SSA provides limited federal protection of ground water resources and by no means constitutes a complete protection strategy.



Screen shot of the interactive mapping tool of Sole Source Aquifers on EPA's website, epa.maps.arcgis.com/apps/webappviewer/index.html?id=9ebb047ba3ec41ada1877155fe31356b.

Where do we go from here?

As summarized here, the data collection phase of the study included a reassessment of the aquifer boundary, water quality, geologic framework, water use, groundwater flow directions, and recharge and discharge conditions based on new geohydrological data that was collected as part of the data collection phase, which was in the northern and central portions of the aquifer. This information will help communities and the public to understand current conditions of the aquifer. If stakeholders in the southern portion of the aquifer are interested in pursuing a similar in-depth investigation, they should reach out to USGS and the Tug Hill Commission to talk about ways to approach funding.

The next phase of the project is to develop several numerical groundwater-flow models of the aquifer system, in order to provide communities and stakeholders with a tool for decision making. Lack of funding is currently precluding work on the next phase.

The SSA designation of the Northern Tug Hill Aquifer recognizes the importance of the aquifer to the region as a drinking water source and increases awareness of the aquifer. SSA designation also highlights potential threats to water quality within the watershed and can benefit from data collected in the 2022 USGS report on the Northern and Central portions of the aquifer system.

Some existing statewide or national tools include the [NYSERDA Climate Change Science Clearinghouse](#), which can help communities identify how changes in precipitation will affect the water supply, and the [Natural Resource Navigator](#), which identifies restoration and protection needs to protect water quality. Communities can contact NYSERDA for more information on how these tools can assist them.

In addition, the [USEPA Drinking Water Mapping Application to Protect Source Waters](#) has current information on reports for State Pollutant Discharge Elimination Systems.

For More Information

Miller, T.S. et al. 1988, Hydrogeology and water quality of the Tug Hill glacial aquifer in northern New York. U.S. Geological Survey Scientific Investigations Report 88-4014.
pubs.er.usgs.gov/publication/wri884014

Miller, T.S. et al. 2007, Hydrogeology of Two Areas of the Tug Hill Glacial Drift Aquifer in Oswego County, NY. U.S. Geological Survey Scientific Investigations Report 2007-5169.
pubs.er.usgs.gov/publication/sir20075169

Miller, T.S. et al. 2022. Geohydrology and Water Quality of the Northern and Central Parts of the Tug Hill Glacial Aquifer, Jefferson and Oswego Counties, North-Central New York. U.S. Geological Survey Scientific Investigations Report 2022-5039.
pubs.er.usgs.gov/publication/sir20225039

Porter et al. 1990. Tug Hill Aquifer: A Guide for Decision-makers". Cornell Cooperative Extension.
ecommons.cornell.edu/handle/1813/3405

A detailed technical information about the Tug Hill Aquifer, the full report by the United States Geological Survey (USGS) entitled "Hydrogeology and Water Quality of the Tug Hill Glacial Aquifer in Northern New York," (1989), Water-Resources Investigations Report 88-4014, is available for review at the Tug Hill Commission's office in Watertown.

Four educational bulletins published by the Tug Hill Commission in conjunction with the USGS report: 1) Raymond, L.S.; "What is Groundwater," July 1988; 2) Raymond, L.S.; "Groundwater Contamination," November 1988; 3) Raymond, L.S.; "Aquifers," June 1990; and 4) Porter, M.J. and Feeney, T; "Tug Hill

Aquifer: A Guide for Decision-Makers,” March 1990 are also available for review at the Tug Hill Commission’s office in Watertown.

Heath, R.C.; Basic Ground-Water Hydrology (WSP #2220), USGS

NY USGS Groundwater web page
waterdata.usgs.gov/ny/nwis/gw.

EPA’s Sole Source Aquifer web page
www.epa.gov/dwssa

EPA’s Source Water Protection web site
www.epa.gov/sourcewaterprotection

New York Rural Water Association Source Water Protection
www.nyruralwater.org/technical-assistance/source-water-protection

New York State Department of Health Drinking Water Protection Program
www.health.ny.gov/environmental/water/drinking/

New York State Department of Environmental Conservation Water Resources
www.dec.ny.gov/chemical/290.html