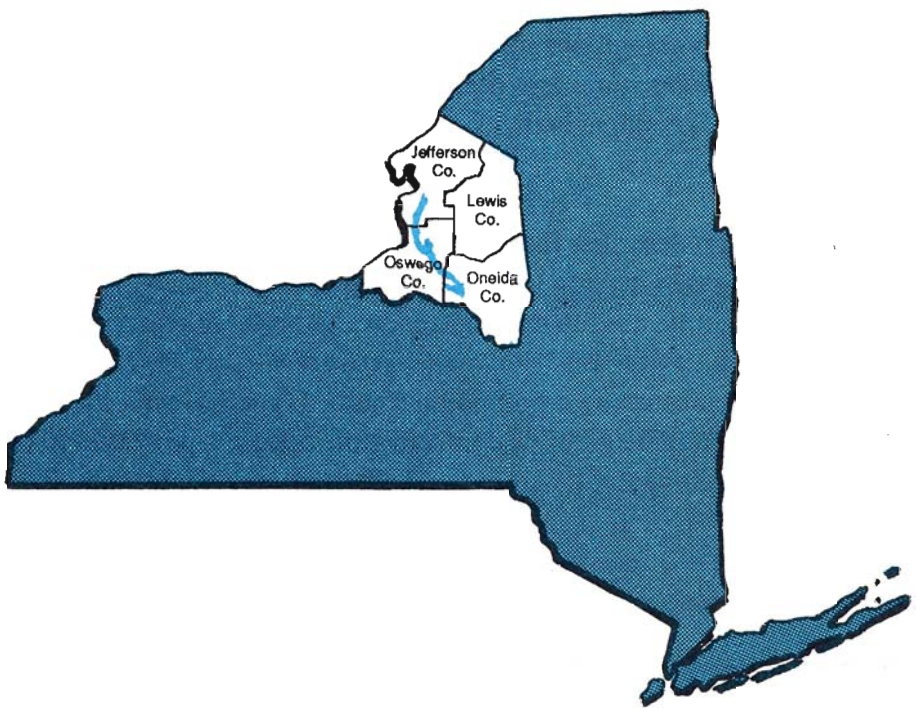
Bulletin No. 4 March 1990

# *Tug Hill Aquifer: A Guide for Decision-Makers*

***Mary Jane Porter***
***New York State Water Resources Institute***
***Tom Feeney***
***Temporary State Commission on Tug Hill***




**Learn about groundwater mapping.**

**Make informed development decisions.**

**Use aquifer maps to protect groundwater!**

## Introduction

This bulletin is designed to help local government officials, developers, and citizens understand and use technical information that has been collected on the Tug Hill Aquifer in making decisions on how to protect and manage community groundwater resources.

The Tug Hill Aquifer is a 47-mile-long, crescent-shape deposit of sand and gravel, flanking the western and southwestern side of the Tug Hill Plateau. It extends from southern Jefferson County, through Oswego County, and into northern Oneida County in northern New York. The Tug Hill Aquifer is the source of water for approximately 10,800 people through municipal water supplies and an additional 3,700 people who are dependent on private wells. Water quality is generally very good.

The U.S. Geological Survey (USGS) recently completed a study of the Aquifer and released a report entitled: ***Hydrogeology and Water Quality of the Tug Hill Glacial Aquifer in Northern New York.*** This report includes six types of maps (a total of 24 plates) depicting: (a) locations of wells, streamflow-measurement sites, and seismic survey sites used to support the study, (b) surficial geology, (c) depth to bedrock, (d) potentiometric surface, (e) well yields, and (f) land use.

Part I of this bulletin describes the maps included in the USGS report to help users understand the value of the maps in making land use management decisions. Part II provides examples of how the maps might be used to make groundwater protection and development decisions.

This guide is not a substitute for professional help. If you have questions concerning the use of the USGS report or require additional information, contact a professional or an agency listed on the last page of this bulletin.

This bulletin is one of a four-part series on groundwater. Other bulletins in the series focus on what groundwater is, potential sources of groundwater contamination, and aquifers.

## Acknowledgements

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Many individuals contributed to the bulletin by their reviews and critical comments including members of the NYS Water Resources Institute and Tug Hill Commission staffs, and representatives of potential users, including Anne C. Schuler, Annsville, Thomas H. Jones, Sandy Creek Regional Planning Board, and Judith Mead and Lois Casselman, Adams Town Planning Board, who generously gave of their time to provide reaction to preliminary drafts of the bulletin.

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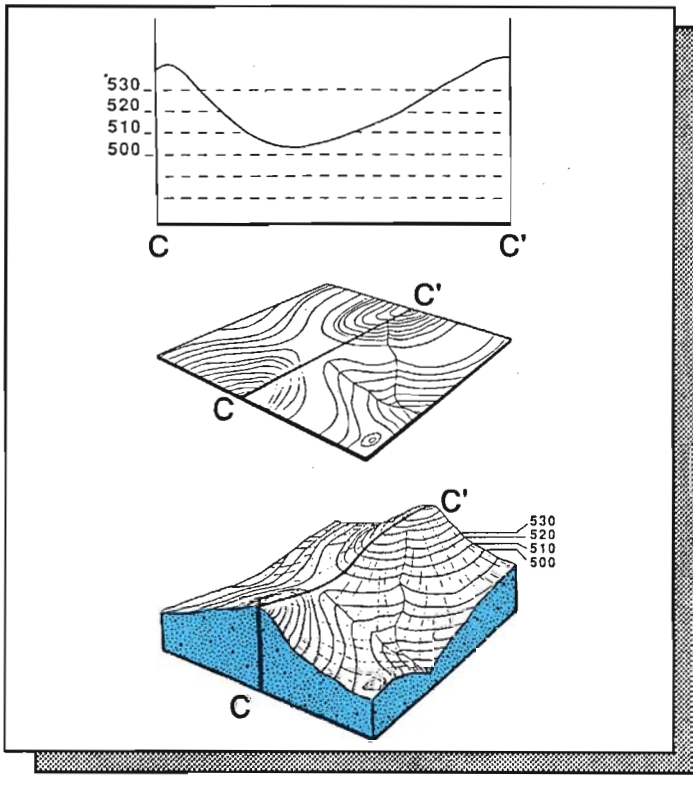
# Part I - Description of Maps in USGS Report on Tug Hill Aquifer

## Topographic Maps

Topographic maps are used as a base map in the USGS report on the Tug Hill Aquifer, as well as for most other USGS hydrologic and geologic maps. Topographic maps use contour lines to connect points of equal elevation to represent hills and valleys on the land surface. Most information concerning the land surface can be found on topographic maps, such as roads, dwellings, airports, rivers, lakes, etc.



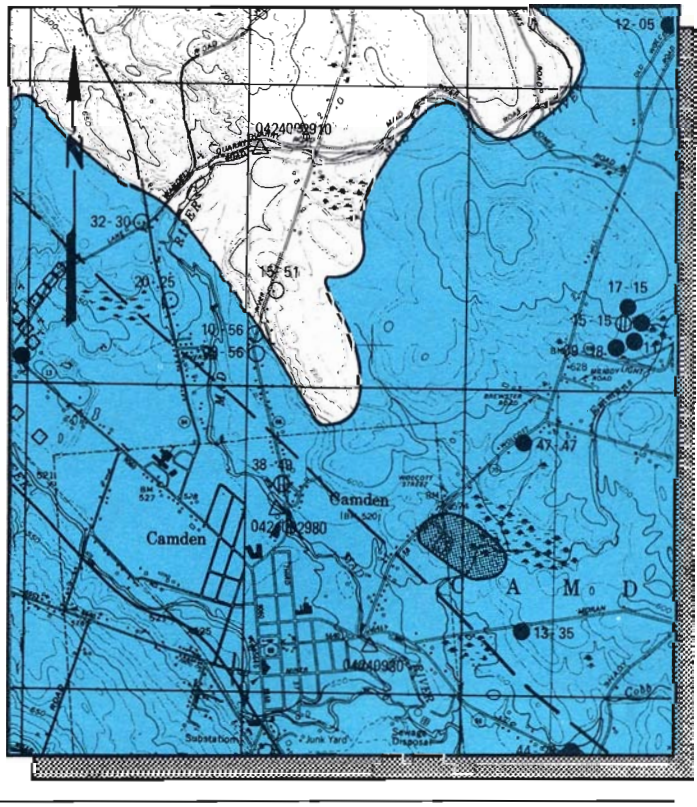

Map Description:

- Contour lines never cross or split;
- Closely spaced contours indicate steep slopes; contour lines widely spaced indicate flatter slopes; and
- Contour lines form a "V" when they cross a stream. The "V" points upstream.

In the report on the Tug Hill Aquifer, a thick black line is used on all maps to denote the boundary of the Aquifer. A dashed line is used in areas where permeable deposits are adjacent to the Aquifer boundary. Stippled areas represent non-aquifer material (till) within the Aquifer (see below right).

## Plate A: Location of wells, streamflow-measurement sites, and seismic survey sites.

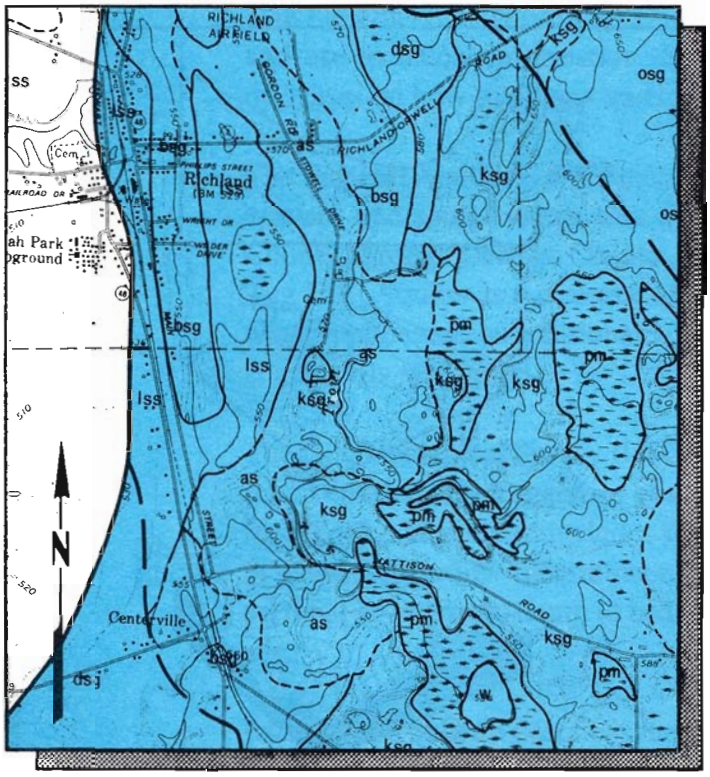
The USGS report used records from drilled wells, measurements of flow in small streams, and seismic surveys to develop an information base. This map shows the location of these data points and their identification numbers. Tables in the USGS report keyed to these numbers contain information about each data point.




Map Description:

- Wells drilled in unconsolidated material. This well does not penetrate bedrock.
- Well drilled into bedrock.
- Well (test boring) drilled only to determine information about the Aquifer.
- Spring: Location where groundwater discharges to the surface at a point.
- Seismic surveys supplement information obtained from well records. Information includes the depth to the water table and the depth to bedrock.
- Streamflow measurement point: Measurements at several points along the same stream can determine whether water is being lost or gained.

## Plate B: Surficial Geology




Glaciers retreating (melting away) from the Tug Hill region roughly 12,000 years ago deposited a variety of sediments. Twelve different geologic sediments comprise the surficial geology of the area, in addition to open water and bedrock exposures. Seven of these sediments form the Aquifer.

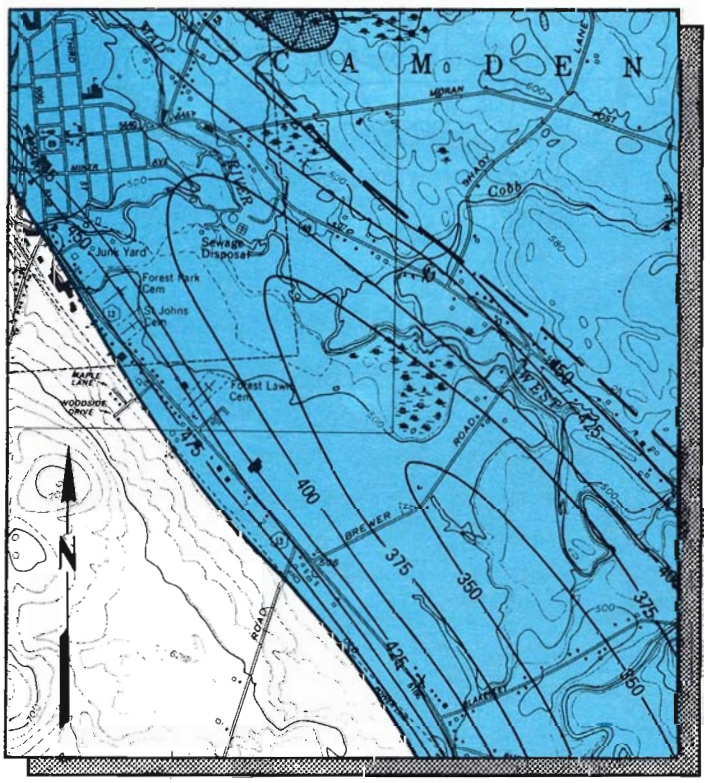
Symbols on the map use the first letter to denote how the sediment was deposited, and the second (and third) denote its composition.

Map Description:

| | | | |
|---|---|---|---|
| w | open water | *osg | outwash sand and gravel |
| *pm | peat marl | | |
| lsc | lake silt and clay | *a | alluvium |
| *dsg | delta sand and gravel | *as | eolian sand |
| ksg | kame sand and gravel | *lss | lake silt and sand |
| at | ablation till | *bsg | beach sand and gravel |
| a/at | alluvium overlying ablation till | lt | lodgement till |
| | | r | bedrock |

* Indicates sediments composing the Aquifer, if saturated.

## Plate C: Bedrock-Surface Altitude.




Since most of the bedrock in New York State lies beneath a cover of glacially deposited sediments, geologists must rely upon data from wells and seismic surveys, as well as from bedrock outcrops visible in the field to construct a map of the bedrock surface.

In the same way topographic maps use contours to indicate the land surface, bedrock altitude maps use contours to show the surface of the bedrock. These maps can be used to determine the depth to bedrock and the thickness of the unconsolidated Aquifer.

Map Description:

— 400 — Contour line of the bedrock surface showing altitude above sea level, in feet.

## Plate D: Potentiometric Surface

The potentiometric surface map uses contour lines to connect points of equal altitude of groundwater within the Aquifer as measured from wells (small x's on map). In unconfined areas of the Aquifer the potentiometric surface is the same as the "water table".

Contour lines can be used to determine the direction of groundwater flow and the depth to groundwater.

Map Description:

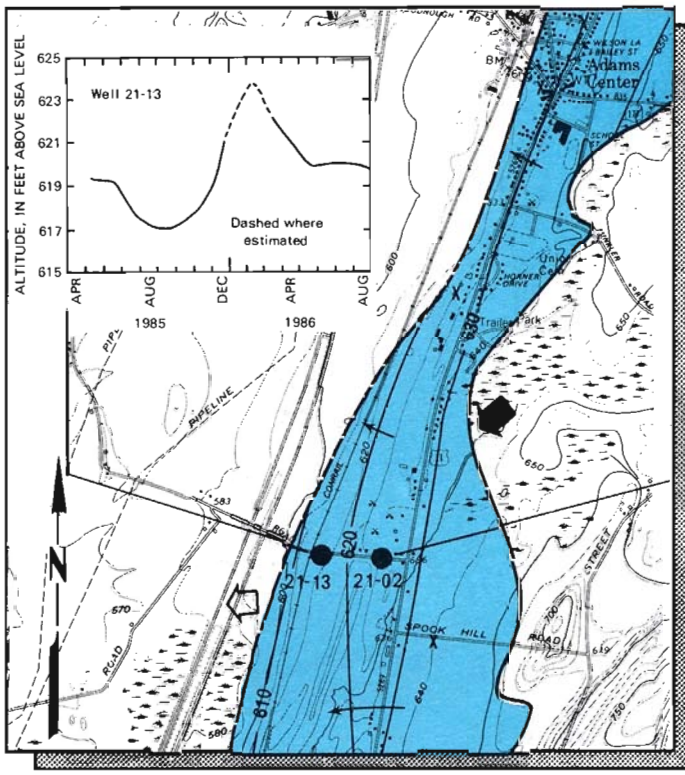
**640** Water table contour lines (potentiometric surface) show altitude above sea level.

**630** Small arrow shown at right angle to contour indicates the general direction of groundwater flow. Arrow points from high to low altitude.

Recharge point: surface water flows into Aquifer.

Discharge point: groundwater flows out of the Aquifer.

Hydrograph: shows seasonality of the water table.



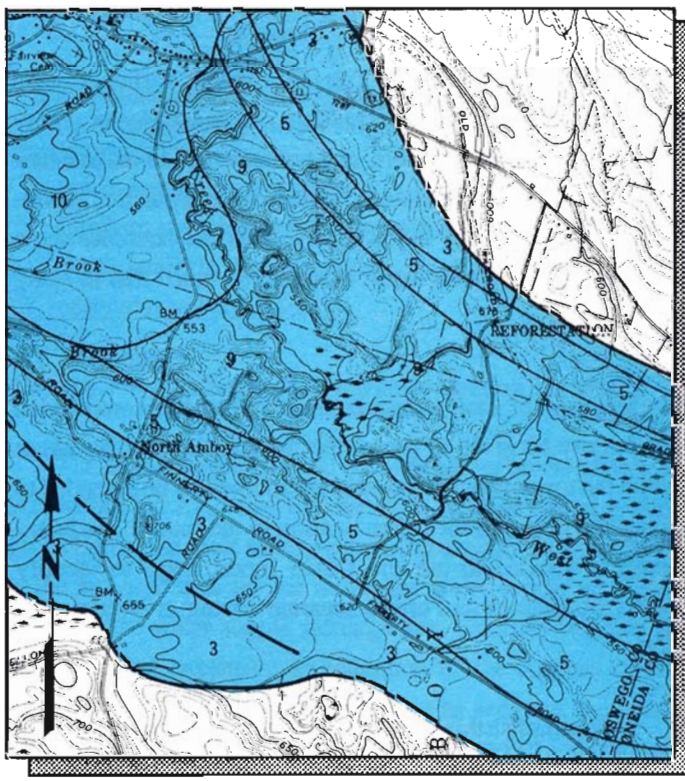

## Plate E: Potential Well Yields

The amount of water that can be pumped by a well varies with respect to the thickness of the aquifer, the type of material that comprises it, and the type of well. This map can be used to determine the amount of groundwater that might be obtained from a well in a given area.

Map Description:

| Symbol | Approximate Yield | Type of Well |
|---|---|---|
| 1 | 1 to 100 gpm | Scr, Opn, Drn, Dug |
| 2 | 1 to 50 gpm | Scr, Drn, Dug |
| 3 | 10 to 100 gpm | Dug |
| 4 | 1 to 100 gpm | Scr |
| 5 | 10 to 250 gpm | Scr, Opn, Drn, Dug |
| 6 | 10 to 250 gpm | Scr, Opn |
| 7 | greater than 250 gpm | Scr, Opn, Dug |
| 8 | greater than 250 gpm | Scr, Opn |
| 9 | 10 to 250 gpm | varies |
| 10 | 1 to 50 gpm | varies |

*(gpm = gallons per minute)*




Types of wells:

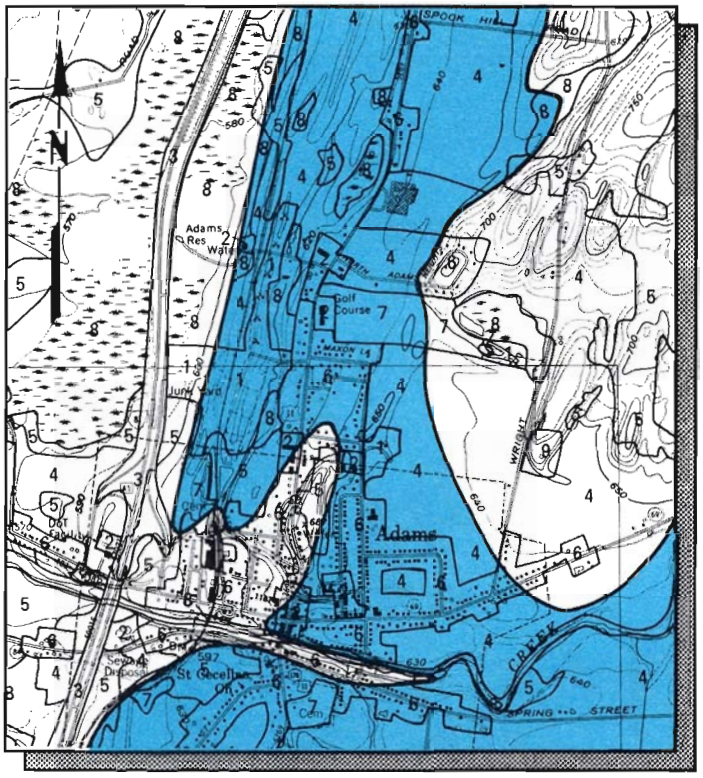
Scr: drilled well with a screened casing

Opn: drilled well with a casing open only at the bottom

Drn: driven well point

Dug: shallow, dug well

## Plate F: Land Use




Unconfined (water table) aquifers are susceptible to contamination from activities on the land surface because precipitation readily infiltrates the sand and gravel. Control of activities on the land surface can greatly reduce the potential for contamination of the Aquifer. This map can help to identify potential sources of contamination.

Map Description:

| Symbol | Land Use |
|---|---|
| 1 | Industrial and sand and gravel mining |
| 2 | Commercial |
| 3 | Transportation |
| 4 | Agriculture and pastures |
| 5 | Woodland |
| 6 | Residential |
| 7 | Open public land |
| 8 | Water and wetland |
| 9 | Inactive land |

# Part II - Examples Using Aquifer Information in Making Management Decisions

The USGS report on the Tug Hill Aquifer, particularly the maps described in Part I of this bulletin, can be used by local government officials, developers, and homeowners to make better management decisions related to groundwater protection, development, and use. The following hypothetical examples show how the maps might be used. It should be noted that in many cases the USGS maps should be used only as a preliminary source of information prior to a more detailed study of specific sites. Local government officials, developers, homeowners, and other users of the maps may find it useful to ask for technical assistance. A list of contacts is included on the last page of this bulletin.

## Example 1: Protection Zones

Members of a town planning board recently recommended that priority be given to protecting the groundwater resources within the town, and that the existing zoning law be amended to reduce the potential for contamination in the future. The board members decided to use the USGS report maps to identify aquifer boundaries and create separate zoning or overlay districts.

To accomplish this task, the board suggested that two protection zones be studied:

- An aquifer recharge overlay district including all of the Aquifer located within the town;
- A separate overlay district to specifically protect the recharge area for the municipal water supply.

**Case 1a. "Aquifer Recharge Area Overlay District"**

Review of the current zoning map shows that the town has been divided into six different zoning districts: Agricultural (AR), Commercial (C-1), Light Industrial (LI), Low-Density Residential (R-1), Medium-Density Residential (R-2), High-Density Residential (R-3), and Hamlet (H). Superimposing the boundary of the Aquifer (from the USGS report) onto the zoning map shows that land over the Aquifer is currently zoned commer-

cial, residential, agricultural, light industrial and hamlet. Review of the zoning law indicates a number of allowed commercial uses that could contaminate the groundwater. Similarly, allowed densities in the residential zone may be too high for unsewered areas. (See Bulletin No. 2 for examples of land use activities posing groundwater contamination risks.)

The planning board agrees to draft additional restrictions for land uses within the Aquifer recharge area to avoid groundwater contamination, and an Aquifer Recharge Area (ARA) Overlay District is established.

The intent of the ARA overlay district is to protect the health and general welfare of the groundwater users and to protect and preserve the Aquifer recharge areas in the town.

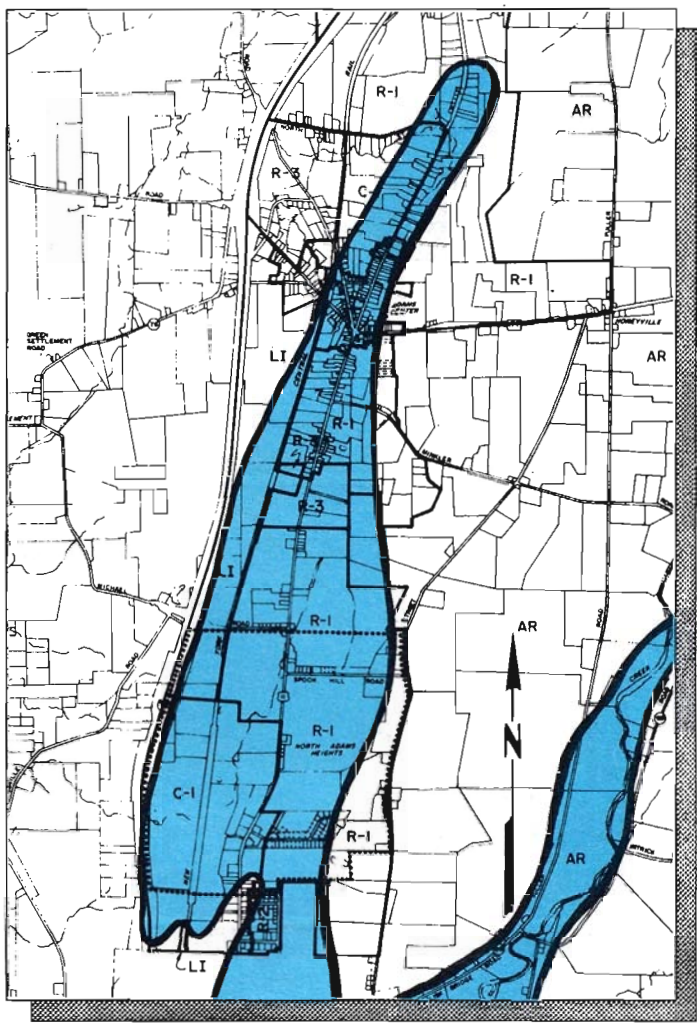
The ARA overlay district will be superimposed on original zoning districts. All uses, dimensional regulations, and other provisions of the town zoning law will remain in force and effect, except where the ARA overlay district imposes additional restrictions and requirements, those restrictions and requirements will prevail.

- Restrictions in the ARA overlay district include: A lot may be used or occupied for agriculture, an agricultural structure, a one-family dwelling, a two-family dwelling, or an individual mobile home; no other purposes will be allowed.

- A site plan must be reviewed and have approval from the planning board for any new land use. A minimum lot size of 2 acres is allowed with on-site wastewater disposal, and the maximum impervious surface area can only comprise 20% of the lot.

- In areas without public sewers, funeral homes, dry cleaning shops, laundromats, and industrial or commercial uses involving on-site disposal or waste from operations other than personal hygiene and food preparations for residents, patrons and employees are prohibited. Septic system cleaners containing toxic chemicals are also prohibited.

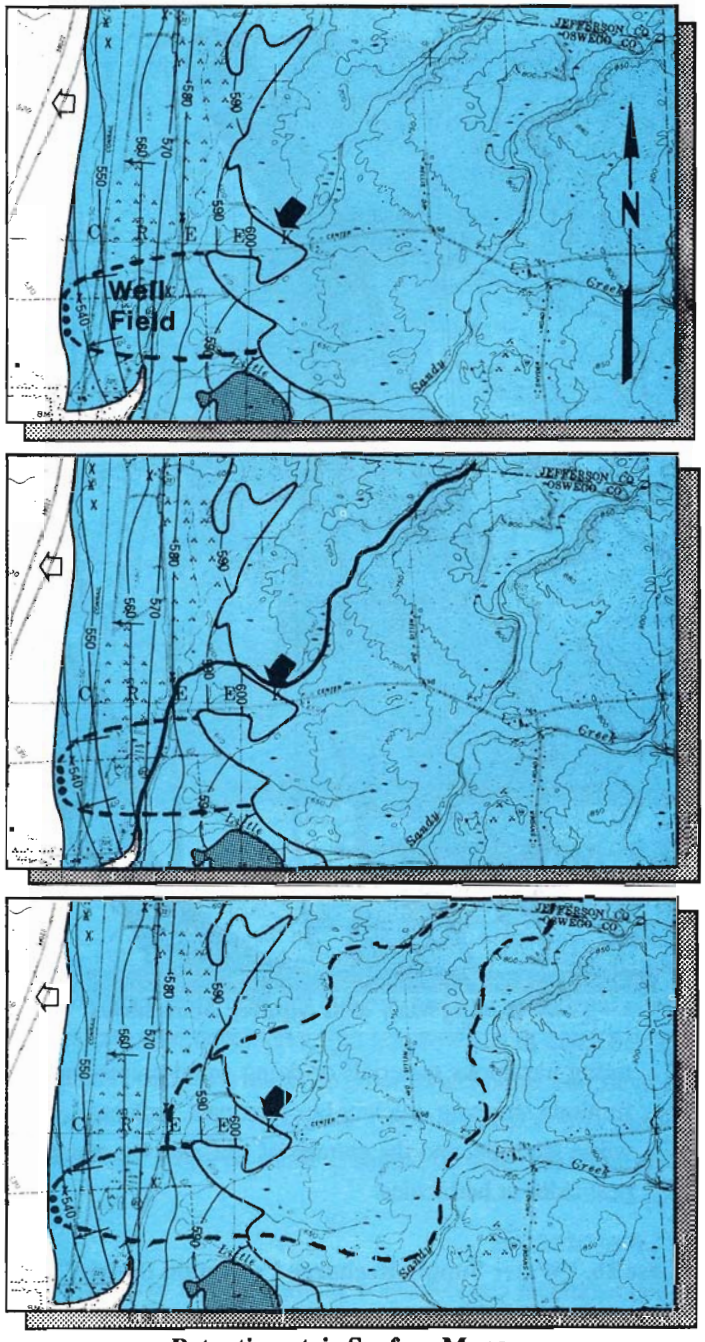
- Uses that are prohibited at all times include automobile service stations or any other underground storage and/or transmission of petroleum products, any business manufacturing hazardous materials or doing wood preserving and furniture stripping, truck or bus terminals, junkyards; solid waste landfills, and the storage of salt, deicing materials, pesticides or herbicides.




**Town Zoning Map with Aquifer Boundaries**

**Case 1b. "Water Supply Recharge Protection District"**

The board also considered creating higher levels of protection within the ARA overlay district in order to ensure greater protection of the most sensitive areas. The most "sensitive area" is the recharge area for the municipal water supply wellfield. Defining the water supply recharge area precisely requires an extensive and expensive investigation of the Aquifer in the vicinity of the wellfield. Although not as accurate, the board decides that an area suitable for planning purposes and land use regulation can be defined, using a potentiometric surface map, as in the following.




**Potentiometric Surface Maps**

Groundwater flow lines (small arrows) drawn perpendicular to the potentiometric contours show that groundwater near the well field flows from east to west. Dashed lines drawn a set distance north and south of the field bound the area in which groundwater will flow to the wells. However, this does not take into account recharge from surface streams or from the adjacent uplands.

A large, dark arrow indicates that a small stream loses water to the Aquifer in the vicinity of the well field. Therefore, the topographic drainage basin for this stream must be included in delineating the recharge area.

The area enclosed in dashed lines identifies the land surface that contributes recharge directly to the municipal water supply. This area can be considered a sensitive area of the ARA overlay district and include special, more restrictive, land use conditions. The dashed blue line delineates an area of the uplands contributing surface runoff to the recharge area. Restrictions may also be necessary in this area to protect the water supply.

## *Example 2: Can the Site of Your New Home Supply You With Enough Water?*

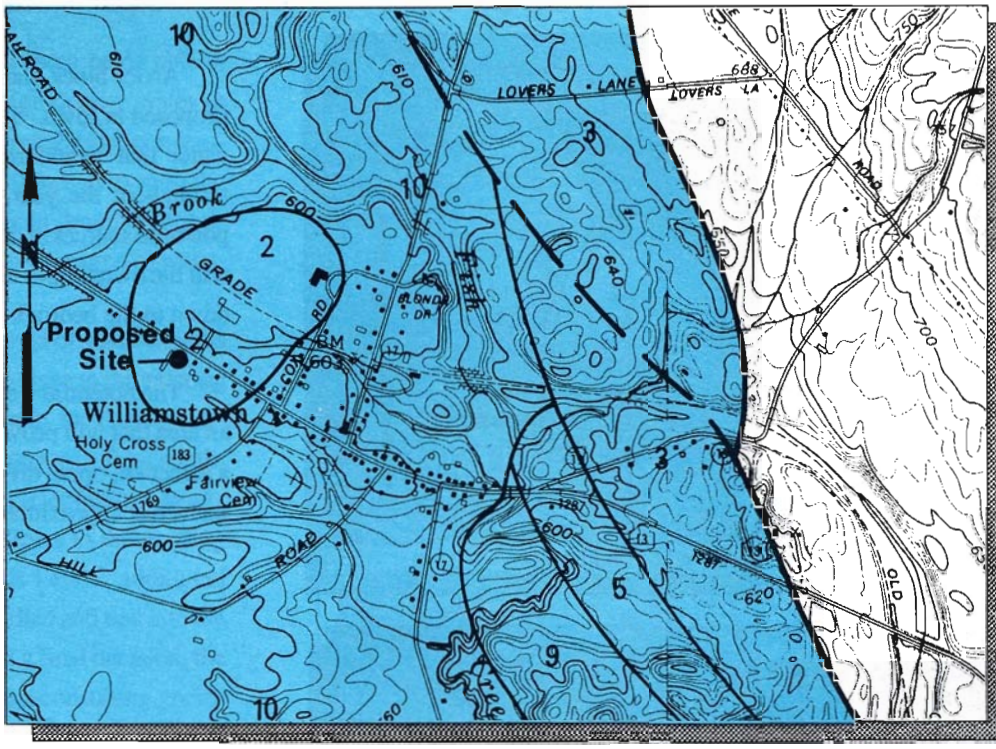
The Smith's acquired the option to buy land for the site of their new home. Before purchasing the land, they inquired whether they could drill a well to provide them with an adequate amount of potable water. By locating the site on a map of potential well yields (Plate E), the Smith family can determine approximately how much water they can expect to obtain from a well.

According to the well yield map, the Smith's site is located in an area that will potentially yield from 1 to 50 gallons per minute for a shallow, large diameter dug well, a drilled well with a screened casing, or a driven well. A 1-to-50 gallons per minute yield is probably sufficient for the Smith family. However, it would not be an adequate source for a municipal supply, industry, or even a multi-family dwelling. Realizing that this is general in-

formation about the potential amount of water, it is a good idea to check with neighbors to see what type of well they have, how deep their wells are, whether they go dry in the summer, and if the groundwater is of good quality. It might be helpful to also use a topographic map in this case to find out what is updradient of the home site. To be well-informed, professional help should be sought.

| |
|---|
| 2 |

1 to 50 gallons per minute; sand under water table conditions.
Scr, Drn, Dug



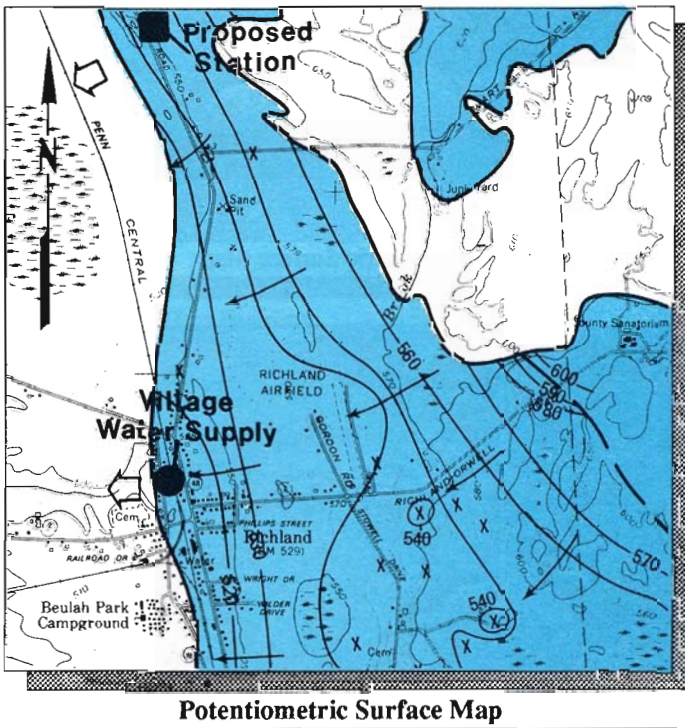

**Potential Well Yield Map**

## *Example 3: Will A New Fuel Oil Distribution Station Threaten the Village Water Supply?*

A fuel oil company recently proposed to build a distribution station on the Aquifer. The town does not have land use controls to prohibit construction. However, the firm will have to obtain the proper construction permits from the appropriate agencies ensuring safe operation and preventing groundwater contamination. A public water supply is located about one-half mile from the proposed site, and there is concern that a spill or leakage will contaminate groundwater in the area and threaten the municipal water supply.

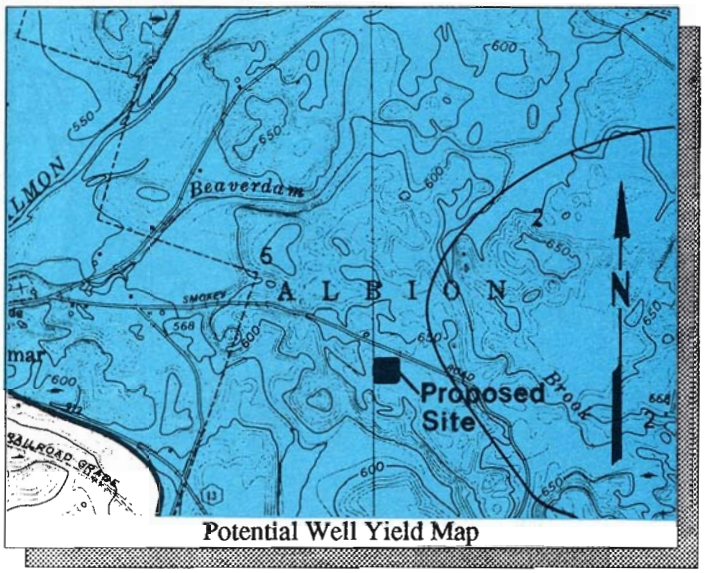
From the potentiometric map, it can be determined that any contamination entering the groundwater at the proposed site would not enter the village's water supply. Groundwater flows perpendicular (at right angles) to the potentiometric contours, from high values toward low. In this region of the Aquifer, groundwater flows from the northeast toward the southwest.

Groundwater feeding the water supply flows from eastern parts of the Aquifer, and to some degree, by surface streams that flow from the east and northeast that may act to recharge the Aquifer. Groundwater flow, and any contaminants within it will not flow south from the proposed site to the water supply. Other portions of the Aquifer might be contaminated, however. *NOTE:* depth to groundwater may vary seasonally.




**Potentiometric Surface Map**

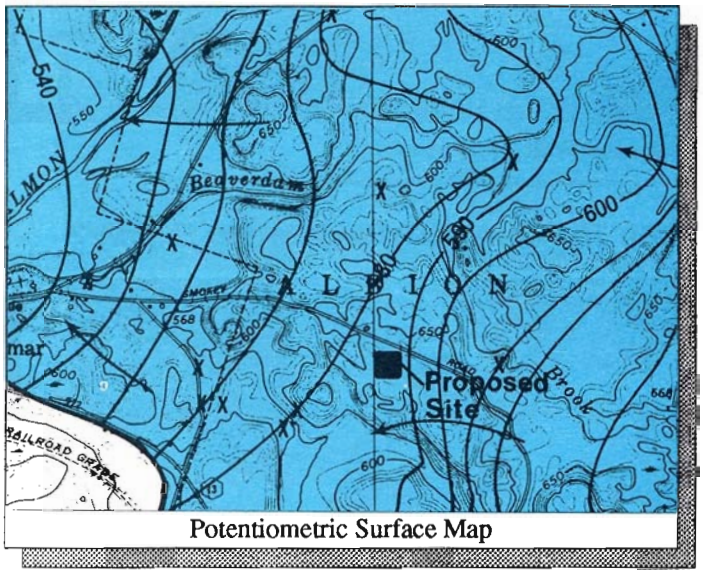
## Example 4: How Deep Can I Drill A Well Before I Hit Bedrock?



Potential Well Yield Map

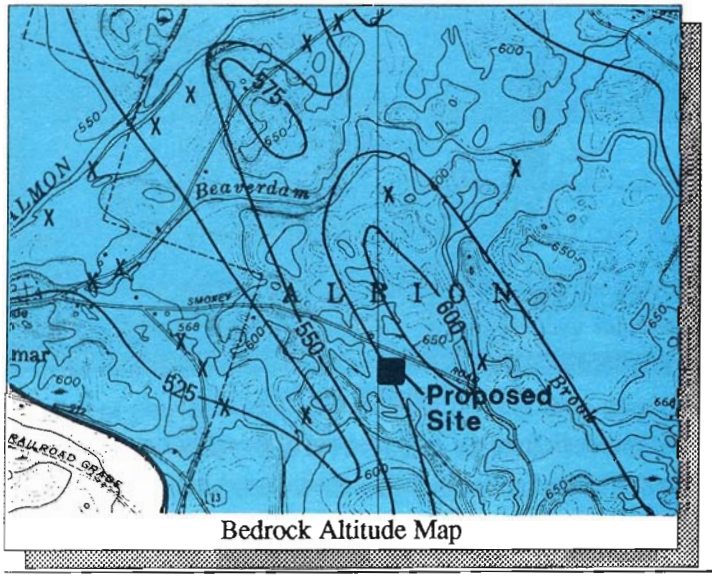
An ice block manufacturing and delivery company has been proposed in town. The owner is interested in obtaining coldest water that would remain at roughly a constant temperature throughout the year, and be as deep as possible, away from potential sources of contamination at the land surface. How deep will the owner have to drill to install a screened well that extends down to the bedrock surface?

The potential well yield map shows that the site is located in an area that will provide roughly 10 to 250 gallons per minute to a screened, open, driven or dug well. The elevation of the land surface is approximately 660 feet at the site.



Potentiometric Surface Map

The potentiometric surface map shows the water table at an altitude of roughly 585 feet. Therefore, the depth from the land surface to the water table is approximately 75 feet (660 - 585 = 75).



Bedrock Altitude Map

The bedrock altitude map shows the bedrock surface at an altitude of 575 feet. The depth from the land surface to bedrock is 85 feet (660 - 575 = 85). Therefore, the thickness of the Aquifer is 10 feet (85 - 75 = 10). This is likely to be an intermittent well due to seasonal fluctuations.

A water well installed at the site of the proposed ice block company would have to be drilled to a depth of roughly 85 feet before bedrock (the bottom of the Aquifer) is encountered. Because the Aquifer is only 10 feet thick, an open-ended well, or short well screen (perhaps 5 feet) installed at the bedrock surface, should be used. Use of a dug or driven well would not be feasible at this depth.

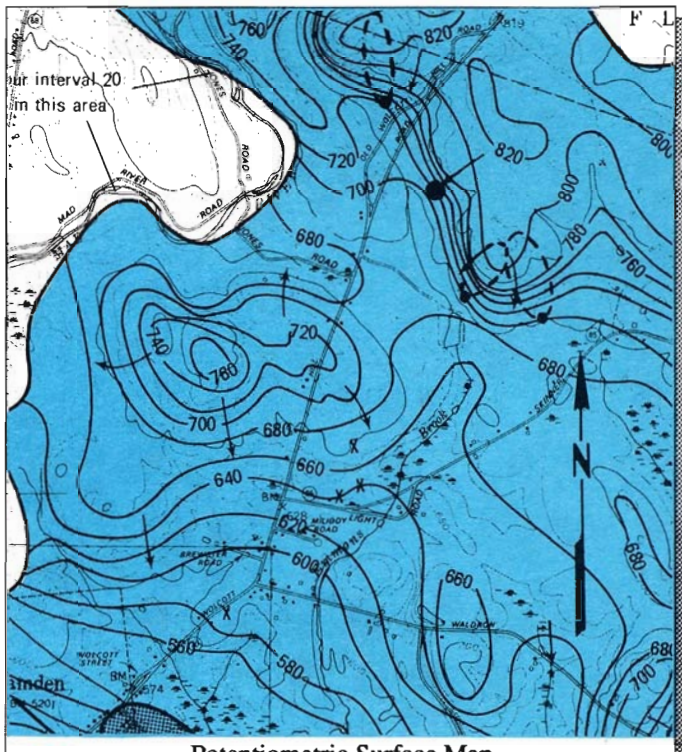
Because there is not much room for drawdown due to pumping and the well depth will vary seasonally, it is not recommended the ice block manufacturing company locate here.

## Example 5: How Can the Village Expand Its Water Supply Without Impacting the Existing Supply?

The Village Water Board is concerned about being able to continue to provide an ample supply of high-quality water to village residents and businesses. New state regulations concerning surface water supply, the potential for future growth in the area, and the need to ensure adequate water in drought periods spurred the board to consider developing a new source of water.

The village can continue to use the method of shallow wells as long as the new wells are not installed too close to the existing wells 1, 2, and 3. Using the potentiometric map, the board determined that between wells 1 and 2 groundwater will flow southwestward, from the high area of the 820 potentiometric contours without influencing the groundwater that flows to the existing wells. If the village owns land between wells 1 and 2, additional wells of the same construction could be installed and tied into the existing transmission mains. Before making a final decision, the board decides to confirm their findings with a consulting geologist.

— Shallow well and contributing area.




Potentiometric Surface Map

## List of Contacts

Tug Hill Commission
Dulles State Office Building
Watertown, NY 13601
(315) 785-2380

Jefferson County Planning Department
175 Arsenal Street
Watertown, NY 13601
(315) 785-3144

Herkimer-Oneida Counties Cooperative Planning Board
800 Park Avenue
Utica, NY 13501
(315) 798-5710

Oswego County Planning Department
46 East Bridge Street
Oswego, NY 13126
(315) 349-8292

NYS Department of Environmental Conservation
Region 6
Dulles State Office Building
Watertown, NY 13601
(315) 785-2513 (for Jefferson & Oneida Counties)

NYS Department of Environmental Conservation
Region 7
615 Erie Boulevard, West
Syracuse, NY 13204
(315) 426-7400 (for Oswego County)

NYS Department of Health
Dulles State Office Building
Watertown, NY 13601
(315) 785-2277 (for Jefferson County)

Oswego County Health Department
70 Bunner Street
Oswego, NY 13126
(315) 349-3557

Oneida County Health Department
Environmental Health
800 Park Avenue
Utica, NY 13501
(315) 798-5064

St. Lawrence-Eastern Ontario Commission
Dulles State Office Building
Watertown, NY 13601
(315) 785-2461