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Prepared in cooperation with the Suffolk County Water Authority

Analysis of Aquifer Framework and Properties, Alvahs Lane Well Field, Cutchogue, New York

Scientific Investigations Report 2024–5128

U.S. Department of the Interior
U.S. Geological Survey

Cover. Aerial photograph of the Alvahs Lane well field. Image from the Suffolk County GIS Viewer, Nearmap imagery, copyright Nearmap and Esri, 2015.

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Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Volume	
gallon (gal)	3.785	liter (L)
gallon (gal)	0.003785	cubic meter (m^3)
gallon (gal)	3.785	cubic decimeter (dm^3)
	Flow rate	
gallon per minute (gal/min)	0.06309	liter per second (L/s)
	Hydraulic conductivity	
foot per day (ft/d)	0.3048	meter per day (m/d)
	Transmissivity	
foot squared per day (ft^2/d)	0.09290	meter squared per day (m^2/d)

Datum

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizonal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Abbreviations

bls	below land surface
SCWA	Suffolk County Water Authority
USGS	U.S. Geological Survey

Analysis of Aquifer Framework and Properties, Alvahs Lane Well Field, Cutchogue, New York

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Abstract

The U.S. Geological Survey, in cooperation with the Suffolk County Water Authority, evaluated the aquifer transmissivity and storage properties at the Alvahs Lane well field north of the village of Cutchogue, New York. This analysis of aquifer properties provides the Suffolk County Water Authority with hydrogeologic information needed to develop water supplies to meet the increasing water demands of the residents of Suffolk County, New York.

An aquifer test was conducted at the Alvahs Lane well field from October 18 through October 21, 2022, when a production well was pumped at 550 gallons per minute for about 24 hours, and groundwater-level drawdown and recovery were measured in two monitoring wells. The three wells are screened in a glaciofluvial aquifer under unconfined (water table) conditions. Drawdown and recovery data were analyzed with an analytical solution for partial penetration and delayed yield in an unconfined aquifer to provide estimates of the glaciofluvial aquifer properties. Inclusion of lateral aquifer boundaries was not necessary for the analysis to result in satisfactory matches with the observed water-level responses. Aquifer transmissivity was estimated at 32,000 feet squared per day. Assuming a saturated aquifer thickness of 120 feet, this result is equivalent to a horizontal hydraulic conductivity value of 270 feet per day. Specific yield was estimated at 0.15 (dimensionless). The estimated properties are consistent with those of a highly transmissive unconfined aquifer.

Introduction

The U.S. Geological Survey (USGS), in cooperation with the Suffolk County Water Authority (SCWA), collected and analyzed groundwater levels during an aquifer test at the Alvahs Lane well field north of the village of Cutchogue, New York (fig. 1), as part of the ongoing SCWA investigation of the aquifers of Suffolk County.

The well field is underlain by about 200 feet (ft) of Pleistocene glaciofluvial sand and gravel and glaciolacustrine silt and clay (Schubert and others, 2004). The glaciofluvial deposits below the water table that form the upper glacial aquifer in this location consist of aquifer sediments above and below a glaciolacustrine confining unit. The lower glaciofluvial aquifer sediments are underlain by the Cretaceous Magothy aquifer, which consists of about 350 ft of sand, silt, and clay. The maximum water-table altitude in the study area near the well field is about 6 ft above the North American Vertical Datum of 1988 (NAVD 88; Como and others, 2015), and the depth to the freshwater/saltwater interface is about 200 ft below NAVD 88 (fig. 2; Walter and others, 2020). A groundwater divide separates water flowing to Great Peconic Bay and Long Island Sound (Walter and others, 2020).

The purpose of this report is to describe the design and results of an aquifer test at the Alvahs Lane well field in Cutchogue, New York. The report describes the test design, the methods of collecting groundwater-level data, and the methods of estimating aquifer properties from the data. This analysis of aquifer properties provides the SCWA with hydrogeologic information needed to develop water supplies to meet the increasing water demands of the residents of Suffolk County, New York, as well as hydrogeologic information needed for the ongoing USGS and New York State Department of Environmental Conservation cooperative investigation of the regional groundwater resources of the Long Island aquifer system, New York (U.S. Geological Survey, 2024a).

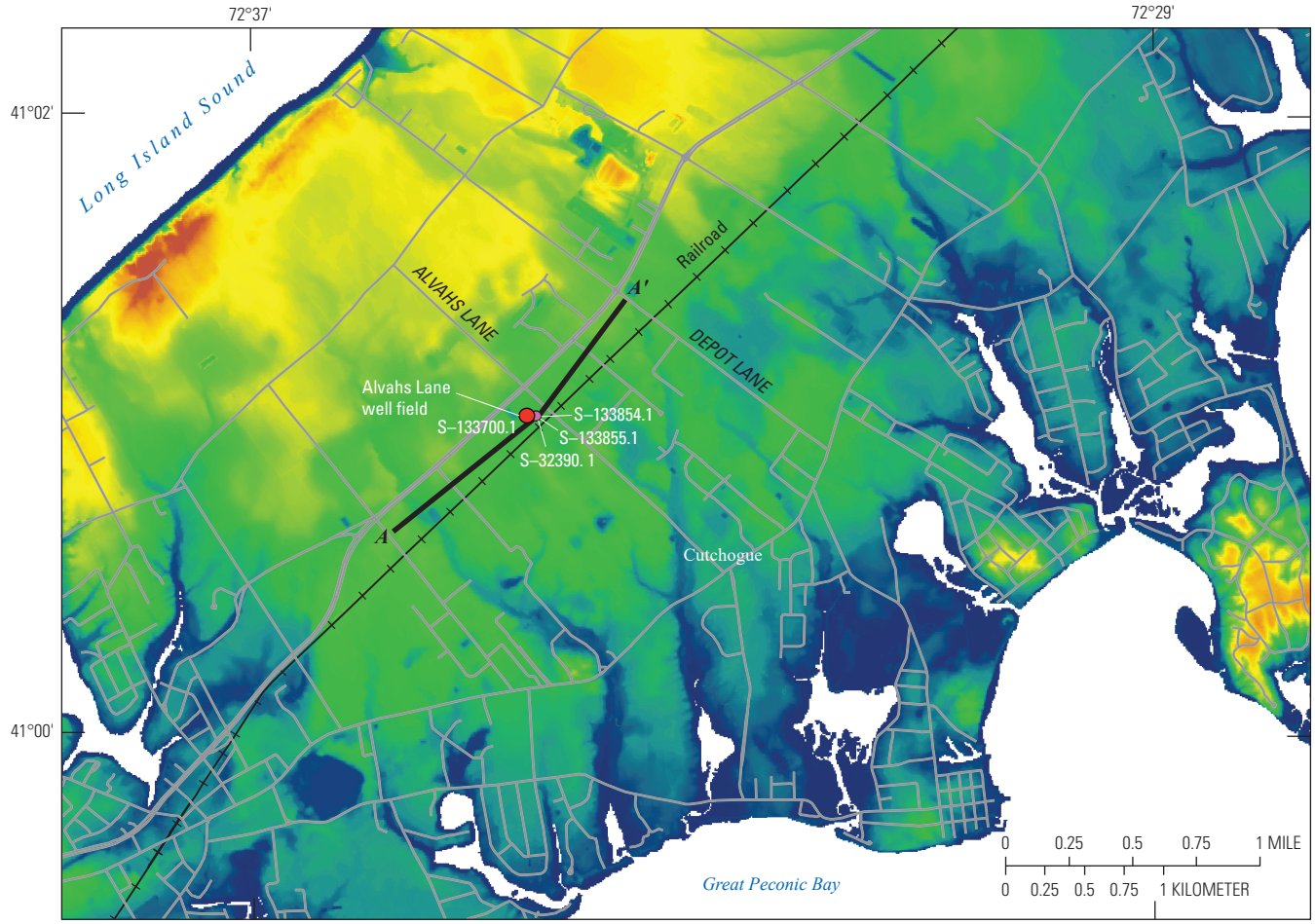

Figure 1. Map showing land surface altitude and location of selected wells in the study area, Alvahs Lane well field, Cutchogue, New York.

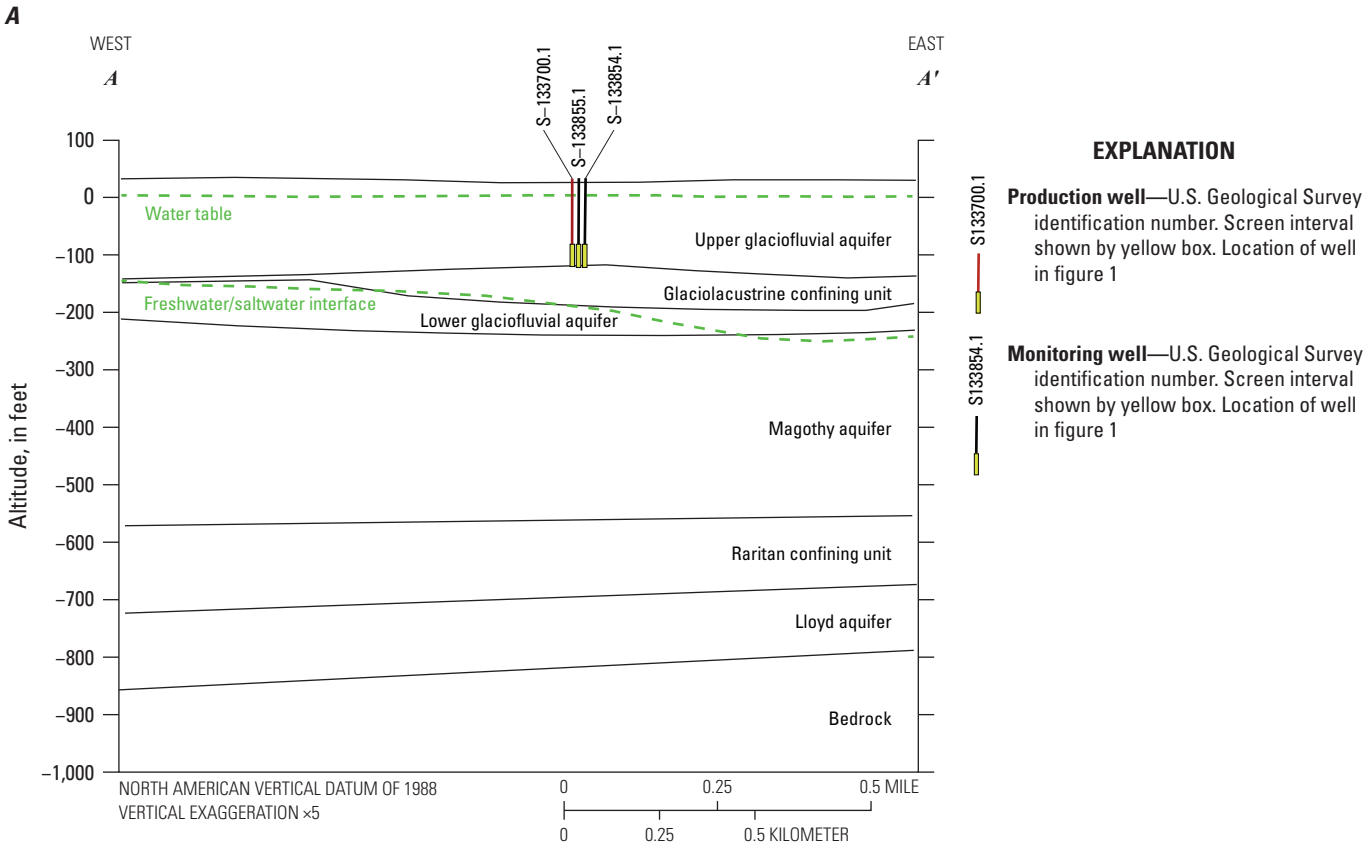

Figure 2. *A*, Hydrogeologic section of aquifer framework, freshwater/saltwater interface, and selected wells, and *B*, graph showing subsurface lithology description and gamma log for borehole S-32390.1 at the Alvahs Lane well field, Cutchogue, New York. Aquifer and confining-unit surfaces modified from Smolensky and others (1989), and freshwater/saltwater interface modified from Walter and others (2020). Lithologic data and gamma log from U.S. Geological Survey (2024b). Location of section shown in figure 1.

B

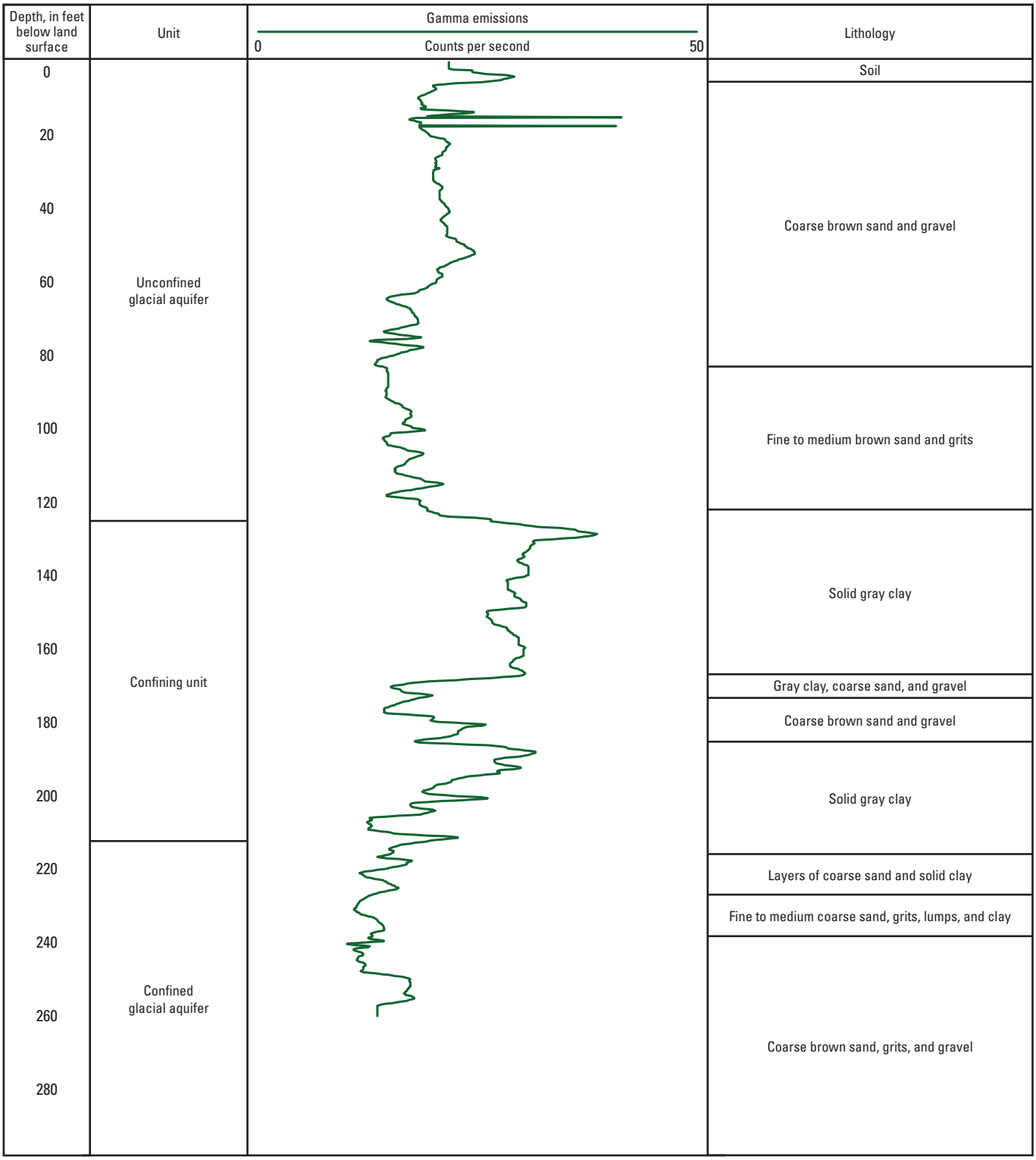

Figure 2.—Continued

Alvahs Lane Well Field Aquifer Test

The USGS inventoried wells and boreholes in the study area (fig. 1; table 1) to provide aquifer framework information. At the Alvahs Lane well field, lithologic and gamma logs were available for exploratory hole S–32390.1 (fig. 2; U.S. Geological Survey, 2024b). Production well S–133700.1 and monitoring wells S–133854.1 and S–133855.1 are screened in the upper glacial aquifer above the glaciolacustrine confining unit. Although no logs were available for other wells in the well field, their screen depths indicate that they are also screened in the upper part of the glaciofluvial aquifer.

Aquifer Test Design

Production well S–133700.1 is located near the regional groundwater divide, as shown in Walter and others (2020), that separates groundwater flow to Great Peconic Bay and Long Island Sound. This well is completed in the upper glacial aquifer with a natural gravel-packed screen from 80 to 115 ft below land surface (bls; fig. 2; table 1).

Monitoring well S–133855.1 is about 55 ft northeast of the production well and is screened from 85 to 115 ft bls. Monitoring well S–133854.1 is about 255 ft northeast of the production well and is also screened from 85 to 115 ft bls (fig. 2). Both wells were instrumented with continuous groundwater-level recorders. Production well S–133700.1 was pumped at 550 gallons per minute (gal/min) for about 24 hours starting at 11:59 p.m. eastern standard time on October 18, 2022, and ending at 11:44 p.m. the next day.

Groundwater-Level Data Collection During Test

The USGS collected groundwater-level data in monitoring wells S–133854.1 and S–133855.1 (fig. 1; table 1) from October 18 through October 21, 2022. Groundwater levels were recorded at 1-minute intervals by using submersible vented pressure transducers as described by Freeman and others (2004) and checked against manual measurements with a steel level tape during installation, removal of the instrumentation, and other various times. Altitude of groundwater-level measuring points was determined from well casing stick-up measurements above land surface and estimated land surface relative to NAVD 88 based on a digital elevation model generated by using the method described by Danielson and others (2016).

The groundwater-level monitoring period included (1) stabilization of groundwater levels prior to the beginning of the aquifer test, (2) drawdown from the 24-hour period of controlled pumping from the production well, and (3) a 36-hour period of groundwater-level recovery following the cessation of pumping (fig. 3). Several upward spikes of about 0.1 ft (for example, at about 6 a.m. on October 20, 2022) were likely caused by heavy trains passing along the nearby railroad tracks (fig. 1).

Groundwater-Level Analysis

Groundwater levels in monitoring wells S–133855.1 and S–133854.1 indicated the position of the water table in the upper glacial aquifer. Groundwater-level drawdown in the two monitoring wells was as much as 1.6 ft when well S–133700.1 was pumped for about 24 hours at a rate of 550 gal/min (fig. 4). Three downward spikes of about 1 ft resulted from bursts of S–133700.1 pumping during the resting and recovery periods. These groundwater-level records are consistent with the aquifer being under unconfined (water-table) conditions and highly transmissive.

Table 1. Construction and aquifer information for selected wells in the study area, Alvahs Lane well field, Cutchogue, New York.

[Data are from U.S. Geological Survey (2022). All depths are below land surface. USGS, U.S. Geological Survey; NWIS, National Water Information System; ID, identification number; SCWA, Suffolk County Water Authority; ft, feet; NAVD 88, North American Vertical Datum of 1988; —, not measured or not reported; E, exploratory well; P, production well; M, monitoring well]

USGS station name	NWIS ID	SCWA ID	Site use	Land Surface, in ft above NAVD 88	Year drilled	Depth to bottom of screen, in ft[2]	Depth to top of screen, in ft[2]	Distance from production well, in ft
S–32390.1	410056072302601	—	E	36	—	—	—	388
S–133700.1	410053072302702	1	P[1]	36	2015	115	85	0
S–133855.1	410053072302701	West	M	35.1	2015	115	85	55.11
S–133854.1	410055072302501	East	M	34.9	2015	115	85	255.29

[1]Production well was pumped at 550 gallons per minute during aquifer test.

[2]Depth listed is relative to land surface.

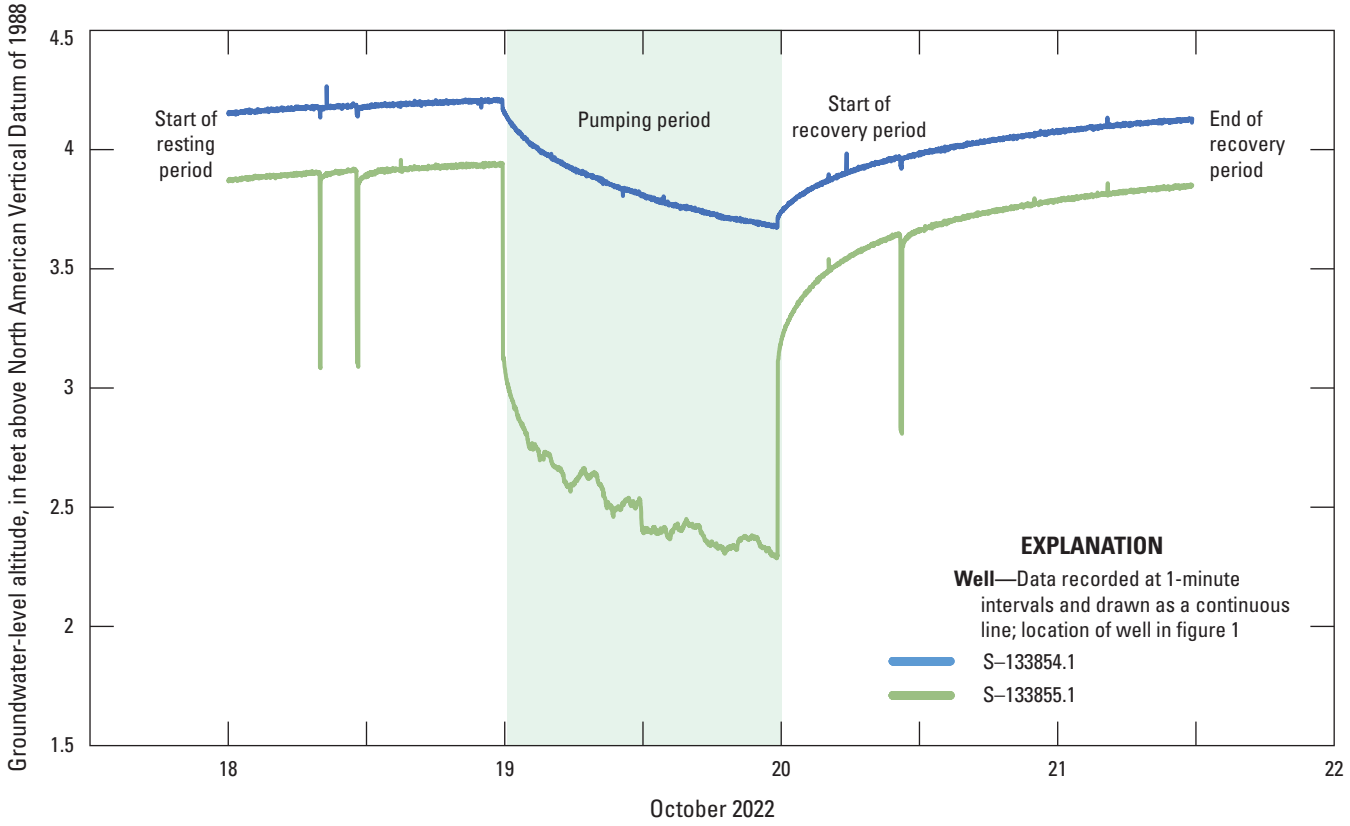

Figure 3. Graph showing groundwater-level altitudes for wells S–133855.1 and S–133854.1 at the Alvahs Lane well field, Cutchogue, New York, from October 18 through October 21, 2022. Data from U.S. Geological Survey (2022).

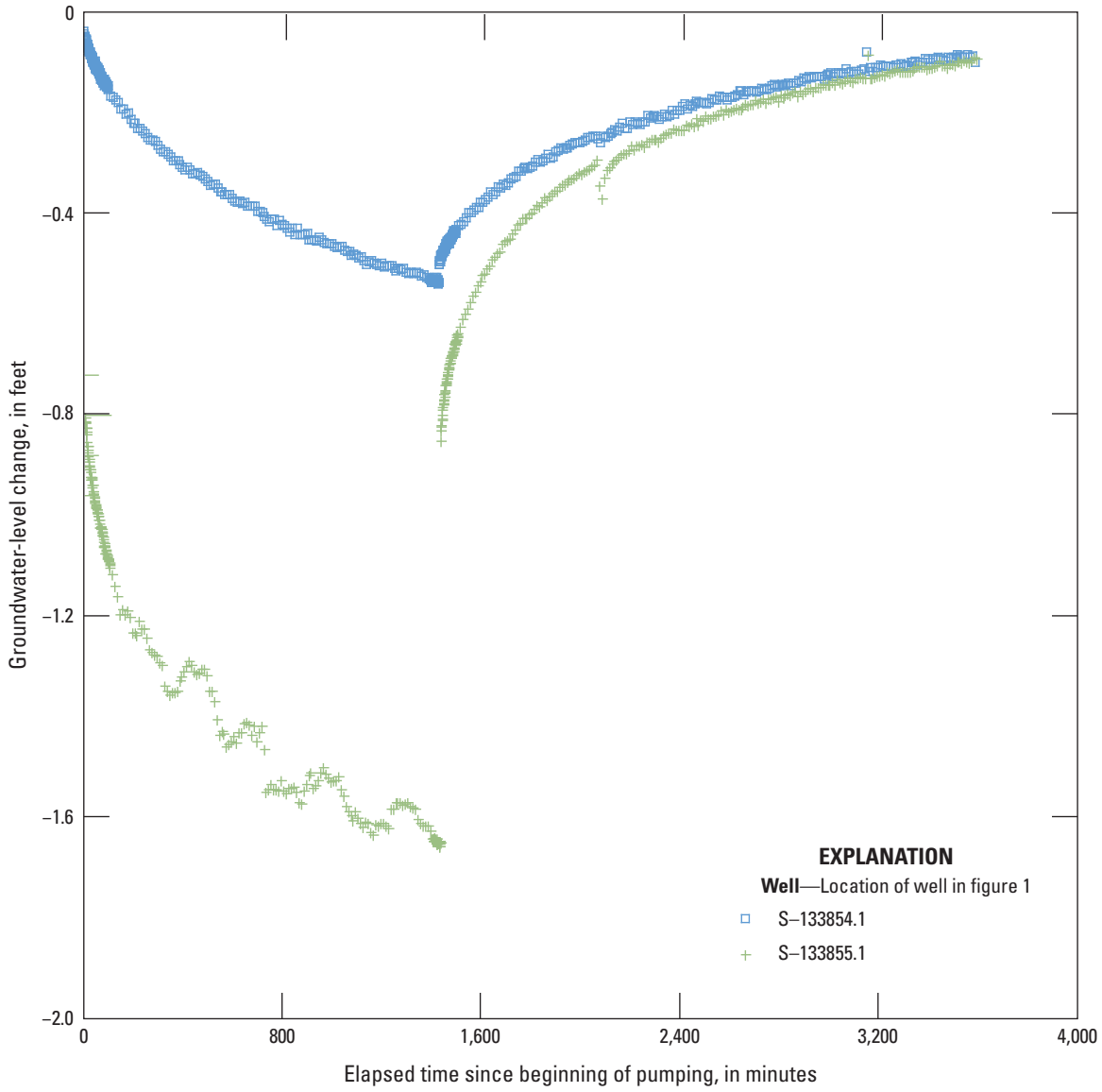

Figure 4. Graph showing groundwater-level change (drawdown and recovery) at wells S–133855.1 and S–133854.1 during an aquifer test at the Alvahs Lane well field, Cutchogue, New York, from October 18 through October 21, 2022. Data from U.S. Geological Survey (2022).

Aquifer Properties

The analytical solution of Neuman (1974) for an aquifer test in an unconfined (water-table) aquifer was used for the quantitative analysis of the groundwater-level data. The following idealized aquifer and well conditions are assumed in the application of this analytical solution: the aquifer is unconfined with delayed gravity response, has infinite areal extent and a uniform thickness of 120 ft, and is homogeneous; production (pumping) and monitoring wells are partially penetrating, flow is radial to the production well, flow is unsteady, and storage within wells is negligible. Inclusion of boundary conditions in the analysis was not necessary to obtain satisfactory matches with the observed groundwater-level changes in response to pumpage.

The aquifer properties of transmissivity, hydraulic conductivity, specific yield, and horizontal-to-vertical anisotropy ratio were estimated from the type-curve analysis by using AQTESOLV for Windows (Duffield, 2007). This computer program performs nonlinear least-squares parameter estimation for automatic type-curve matching. A slightly varying pumping rate of 550 gal/min from production well S–133700.1 during a 24-hour period was represented in the analysis. In addition, a 36-hour recovery period with no pumping was included in the groundwater-level matching.

The transient groundwater-level data from wells S–133855.1 and S–133854.1 (U.S. Geological Survey, 2022) were matched with the Neuman analytical solution (Neuman, 1974; fig. 5). The subsequent recovery data diverged slightly from the ideal model-curve geometry. There may have been minor interference from unknown offsite pumping, possibly from an irrigation well.

An aquifer transmissivity of about 32,000 feet squared per day (ft^2/d) with a vertical to horizontal anisotropy of 0.6 (dimensionless), and a specific yield of 0.15 (dimensionless) provided a satisfactory analytical match with the drawdown and recovery measured in monitoring wells S–133855.1 and S–133854.1. Assuming a saturated aquifer thickness of 120 ft, this result is equivalent to a horizontal hydraulic conductivity value of about 270 feet per day (ft/d). For comparison, Schubert and others (2004) suggested the horizontal hydraulic conductivity value of the Roanoke Point outwash unit at the well field to be 200 ft/d with a vertical to horizontal anisotropy of 0.1. Without monitoring wells screened at different depths, vertical anisotropy cannot be fully characterized; however, the value indicates a lack of fine-grained beds in the upper glacial aquifer that is consistent with the available lithologic and gamma log.

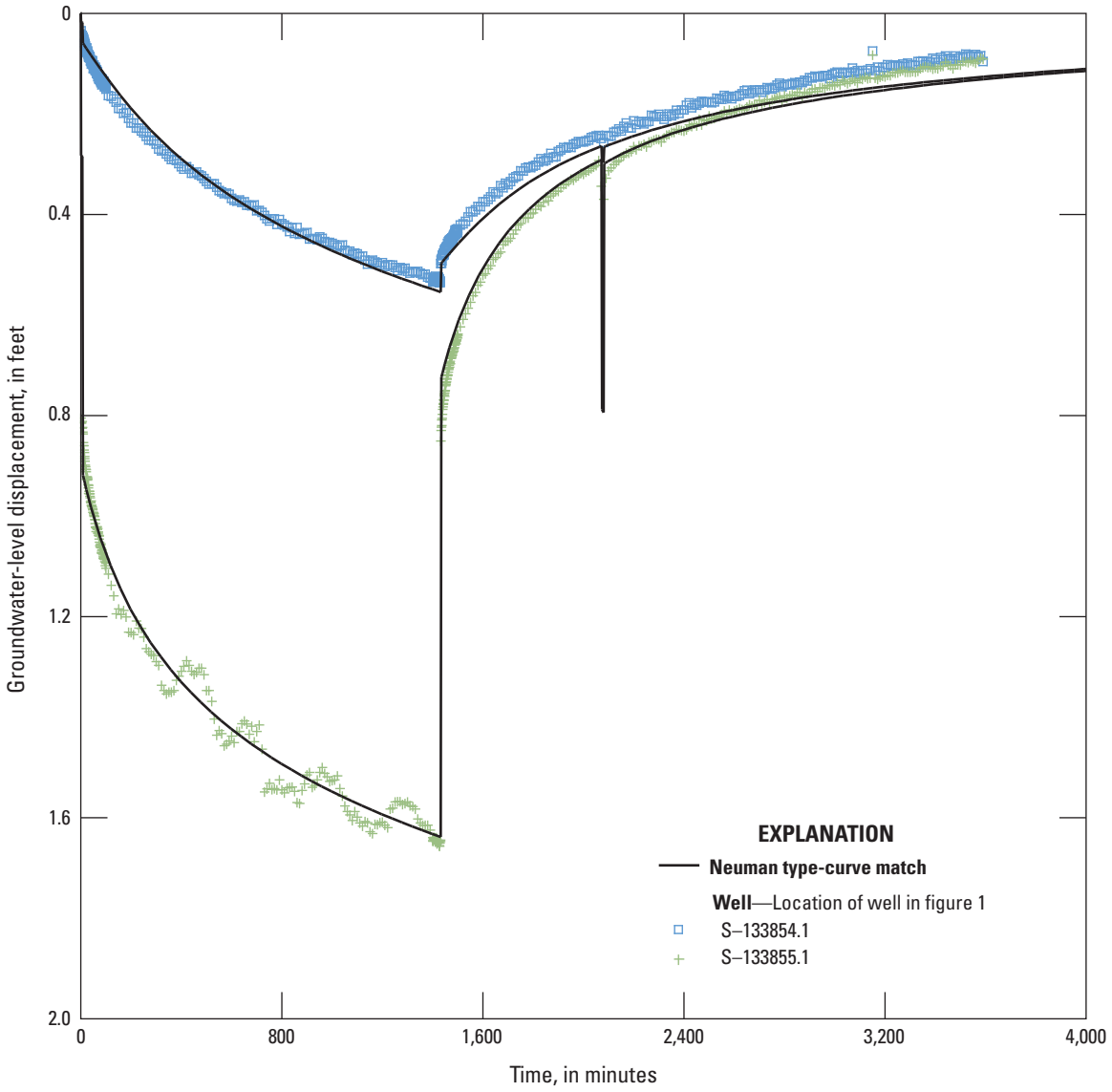

Figure 5. Graph showing groundwater-level change (drawdown and recovery) and Neuman type-curve match (Neuman, 1974) for monitoring wells S–133855.1 and S–133854.1 at the Alvahs Lane well field, Cutchogue, New York. Data from U.S. Geological Survey (2022).

Summary

The U.S. Geological Survey, in cooperation with the Suffolk County Water Authority, evaluated the aquifer transmissivity and storage properties at the Alvahs Lane well field north of the village of Cutchogue, New York. Analysis of a drilling-record log and groundwater levels generated during the aquifer test provided the Suffolk County Water Authority with hydrogeologic information needed to develop water supplies to meet the increasing water demands of the residents of Suffolk County, New York, as well as hydrogeologic information needed for the ongoing USGS and New York State Department of Environmental Conservation cooperative investigation of the regional groundwater resources of the Long Island, New York, aquifer system.

Two monitoring wells, S–133855.1 and S–133854.1, screened in the unconfined (water-table) part of the glaciofluvial aquifer were instrumented with continuous groundwater-level recorders for the aquifer test. Analysis of drawdown and recovery groundwater-level data through the application of a Neuman analytical model provided estimates of aquifer characteristics and properties. Boundary conditions were not necessary for the analysis to result in satisfactory matches with the observed groundwater-level changes in response to pumpage. Aquifer transmissivity was estimated to be 32,000 feet squared per day, and hydraulic conductivity was estimated to be 270 feet per day. Specific yield was estimated to be 0.15 (dimensionless). The estimated properties are consistent with that of a highly transmissive unconfined aquifer.

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