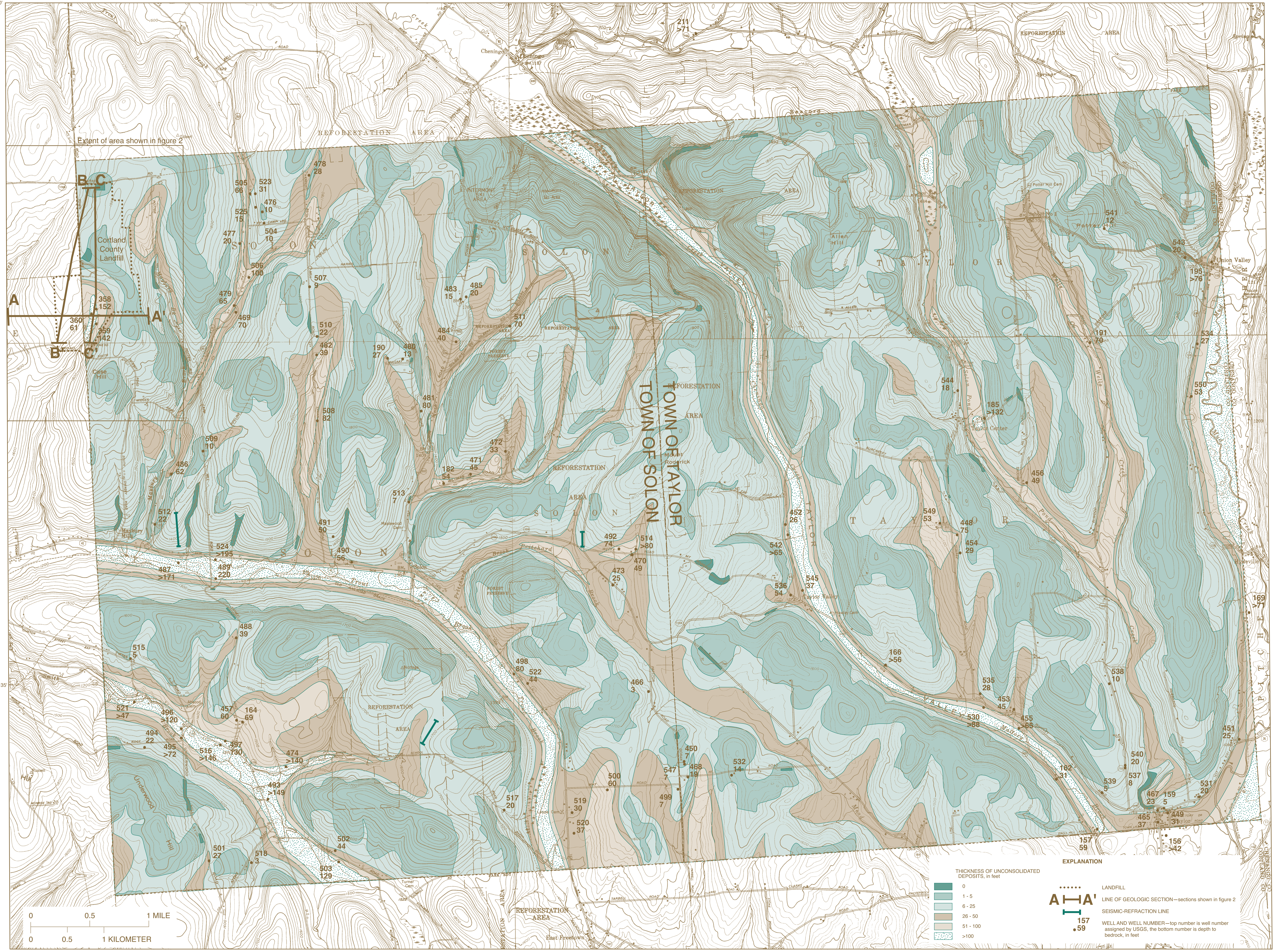
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
Cortland County Department of Planning

WATER-RESOURCES INVESTIGATIONS REPORT 98-4197
Thickness of unconsolidated deposits in the Towns of Solon and Taylor, Cortland County, New York



Base from New York State Department of Transportation, 1:24,000, 1974
McGraw, N.Y.; Truxton, N.Y.; Cincinnatus, N.Y.; and Cuyler, N.Y.

THICKNESS OF UNCONSOLIDATED DEPOSITS IN THE TOWNS OF SOLON AND TAYLOR, CORTLAND COUNTY, NEW YORK

by
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Miller, T.S., 1999, Thickness of unconsolidated deposits in the Towns of Solon and Taylor, Cortland County, New York: U.S. Geological Survey Water-Resources Investigations Report 98-4197.

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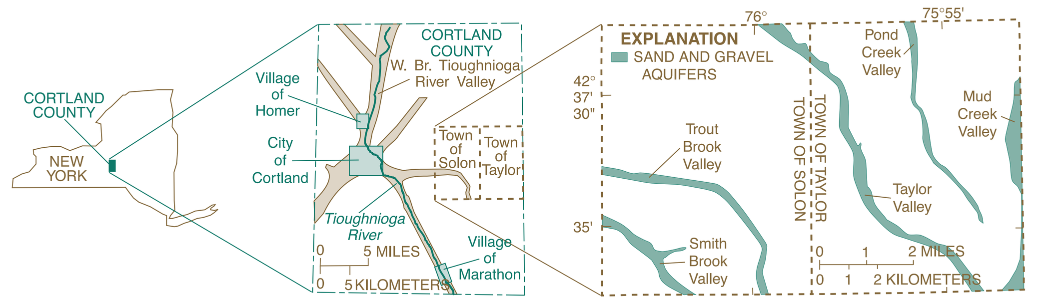
INTRODUCTION

Siting of waste-disposal facilities in Cortland County poses a potential threat to local ground-water resources. An especially sensitive waste-disposal siting issue arose in 1988, when the New York State Low-Level Radioactive Waste Siting Commission (NYSLLWSC) identified 15 sites in six towns (Towns of Solon, Taylor, Freetown, Cincinnatus, Marathon, and Willet) in the eastern part of the county for possible disposal of low-level radioactive waste (New York State Low-Level Radioactive Waste Siting Commission, 1988). Eventually, two sites in the Town of Taylor became "finalist sites"; one was selected from the list of 15 potential sites, and the other was offered by a private landowner. Little information was available on geohydrologic conditions in eastern Cortland County, such as the extent of aquifers and the thickness of unconsolidated deposits of low permeability (such as clay and till), even though these two criteria were among those used by NYSLLWSC for selection of potential disposal sites. The source of information on thickness of drift over bedrock was the surficial geologic map of New York (Muller and Cadwell, 1986). The siting effort was terminated before a final selection was made, but the issue had made county managers aware that detailed information on the extent and thickness of unconsolidated deposits (particularly till, which typically has low permeability and can limit the migration of contaminants) is needed before sound decisions on waste-disposal siting can be made.

Glaciers deposited till nearly everywhere over bedrock in the uplands of central New York, but the thickness of the till varies greatly from place to place. An analysis by Coates (1966) of 400 drillers' logs of wells in a 2,000-mi^2 area in the uplands of south-central New York (south of the Cortland County) indicated that (1) till is thin or absent on hilltops and is thickest on the lower parts of hills, (2) overall till thickness averages 60 ft, and (3) till thickness on the south, east, west, and north slopes averages 92, 52, 62, and 22 ft, respectively. Hills that have thick till on their south slopes have been referred to as "till-shadowed hills" by Coates (1974), who attributes this characteristic to glaciers that deposited thick amounts of till on the downflow side of a hill (analogous to flowing streams or wind that deposit sediment on the lee side of an object). Because the till on the south slopes is relatively thick and typically has low permeability, these slopes have been considered as potential areas for waste-disposal sites.

In 1997, the U.S. Geological Survey (USGS), in cooperation with the Cortland County Department of Planning, began a 1-year study to map the thickness of unconsolidated deposits and the extent of valley-fill aquifers in the Towns of Solon and Taylor (an area of 60 mi^2) in eastern Cortland County (fig. 1).

Figure 1. Location of sand and gravel aquifers (unconfined and (or) confined) in the Towns of Solon and Taylor, Cortland County, New York.



Purpose and Scope

This report (1) depicts the thickness of unconsolidated deposits and the extent of valley-fill aquifers in the Towns of Solon and Taylor in eastern Cortland County, (2) examines whether the "till-shadowed hill" concept developed by Coates (1966) is applicable in this area, and (3) provides three schematic geologic sections (fig. 2) showing the thickness of unconsolidated deposits in the uplands in the northwestern part of the study area.

Study Methods

Drillers' logs from 105 well records were compiled from the files of the Cortland County Environmental Health Department and the USGS. Before this investigation began, records from only 11 wells in the study area were available. The 105 wells were inspected, plotted on 7.5-minute USGS topographic maps, and well locations were digitized through ARC/INFO[1] software. Soil units in areas where bedrock is less than 5 ft below land surface, as mapped by the U.S. Department of Agriculture (Seay, 1961), also were digitized. Additional efforts included (1) field mapping to identify areas where bedrock crops out at land surface, and (2) three seismic-refraction surveys to measure the thickness of unconsolidated deposits in areas where little information was available.

GEOLOGY

Bedrock beneath the study area consists of Devonian shale and siltstone of marine origin that dips to the south-southwest at 10 to 40 ft/mi (Coates, 1981). Eastern Cortland County is part of the dissected and glaciated Appalachian Plateau, where relief is about 800 ft; valley elevations typically range from 1,100 to 1,300 ft, and hilltop elevations from 1,700 to 1,900 ft, above sea level. The geomorphology of the study area is a result of millions of years of fluvial erosion of the bedrock during the Tertiary Period (1.6 to 66 million years ago), followed by several episodes of glacial erosion and deposition during the Pleistocene Epoch (0.01 to 1.6 million years ago).

The study area contains a complex network of valleys. The geomorphic development of these valleys included (1) ground-water sapping (seepage erosion that results in asymmetrical drainages with headwaters that have an amphitheater, often with a spring in it), (2) dendritic incision by streams with (a) long south-trending reaches that roughly follow the south-southwestward dip of bedrock, and (b) relatively short north-trending reaches in the updip direction, (3) preferential erosion and alignment along joints, (4) stream piracy (capture of one stream by another), and (5) glacial diversions of streams.

Ice sheets had intermittently covered the northeastern United States, including the study area, between 1.6 million and 10,000 years before present. The last of these ice sheets covered the study area between 23,000 and 10,000 years before present (Fullerton, 1980). Erosion by the ice during glaciation modified the bedrock topography and removed most of the previously deposited unconsolidated materials (Muller and others, 1988); thus, sediments that were deposited during the last glaciation (Late Wisconsinan) are the most prevalent. Some of the sediments that were eroded by the last glacier became entrained in the ice, or were dragged along its bottom and ground up, and were later deposited as till on top of bedrock. The till in the study area is a poorly sorted mixture of clay, silt, sand, and stones that were compacted by the ice. Till is commonly referred to by drillers and farmers as "hardpan" or "boulder clay."

THICKNESS AND DISTRIBUTION OF UNCONSOLIDATED DEPOSITS

The unconsolidated deposits in the study area can be classified into two depositional regimes—those in the uplands, and those in the valleys. Till predominates in the uplands, whereas a complex mixture of alluvium, glaciofluvial, glaciolacustrine, and till deposits are found in the valleys. Till yields water to wells extremely slowly and, therefore, does not form a significant aquifer; as a result, the wells of most homeowners in the uplands tap bedrock. Saturated deposits of sand and gravel, of which are found mostly in the valleys, typically yield large amounts of water to wells and are important aquifers. Most of the large valleys in the study area (fig. 1) contain either an unconfined or confined sand and gravel aquifer, and some valleys contain both.

The thickness of unconsolidated deposits in the uplands (mostly till) ranges from 0 to more than 150 ft. Uplands areas in which till is absent (where bedrock crops out at land surface) include: (1) the tops of hills, especially the highest ones, (2) oversteepened valley walls (valley walls severely eroded by the glacier), (3) some stream channels, and (4) some north-facing slopes, especially on the highest parts of hills. The thickest deposits of till (typically from 50 ft to as much as 150 ft thick) are in the middle parts of south-facing, amphitheater-shaped, upland basins (fig. 2). Some areas in which till is thicker than 100 ft may not be shown on the map, particularly in settings similar to that at the landfill (at the northwest corner of the map), where one well log shows 152 of till in a south-facing, amphitheater-headed valley (fig. 2). Most of the upland valleys, however, are narrow and thus occupy relatively small areas, and the data set available to this study was inadequate to verify that these areas contain thick deposits of till.

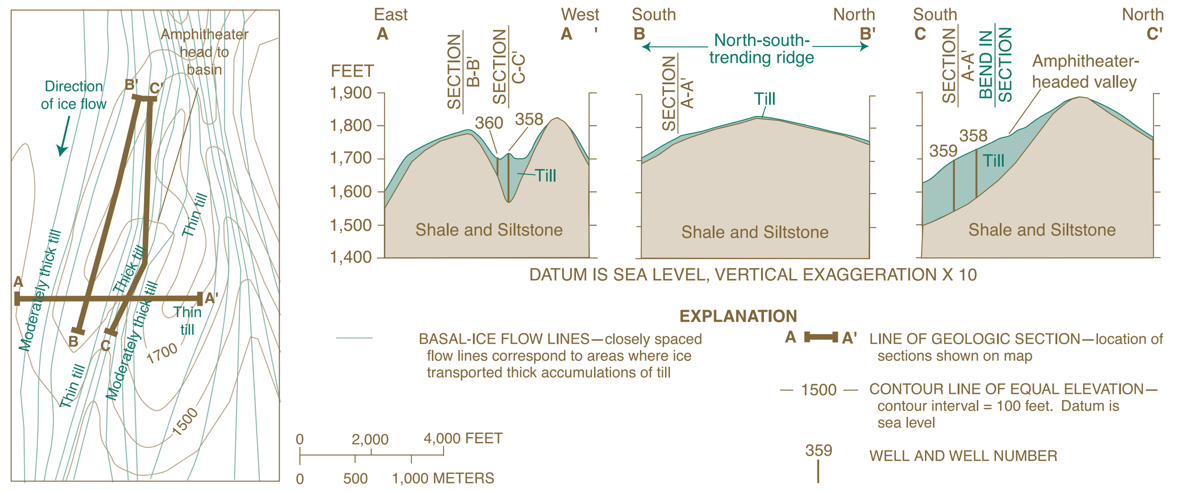


Figure 2. Distribution and thickness of till near the Cortland County landfill, in the northwestern part of the study area. (Location of plan view and geologic sections are shown on plate.)

The large valleys in the study area contain relatively thick deposits of unconsolidated sediments. The largest valleys typically contain thicker unconsolidated deposits (typically 100 to more than 200 ft) than small valleys, which typically contain less than 100 ft of unconsolidated sediment.

The distribution and thickness of unconsolidated deposits in the Towns of Solon and Taylor is generally consistent with that found by Coates (1966) in south-central New York, except for two significant differences: (1) the thickness of till in the uplands in the Towns of Solon and Taylor (as inferred from depth-to-bedrock data from 63 wells in the uplands) averages 31 ft, which is only half the thickness (60 ft) found by Coates in south-central New York (1966); and (2) till in this study area along the southern ridges of elongated hills whose long axis trends roughly north-south (fig. 2) is relatively thin (5 to 25 ft thick), whereas the till found by Coates (1966) on south-facing slopes was typically much thicker. Sources of information indicating the presence of thin till along south-facing ridges for this study included: (1) soil maps, (2) several driller's logs of domestic wells along the ridges of the south-facing slopes, and (3) a geohydrologic investigation conducted for the Cortland County Landfill in the northwestern part of the Town of Solon and northeastern part of Town of Cortlandville (Barton and Loguidice, P.C., 1991).

Soil maps by the U.S. Department of Agriculture (Seay, 1961) indicate that soils 5 ft thick or less occupy 32 percent of the study area. Well logs and field mapping compiled in this investigation generally were consistent with the U.S. Department of Agriculture's information, except locally, where the soils were slightly thicker (5 to 10 ft thick). Results of this study indicate that unconsolidated deposits less than 25 ft thick occupy 76 percent of the study area, and unconsolidated deposits greater than 25 ft thick occupy 24 percent of the area, much of which includes valleys.

Although data collected for this study showed some agreement with Coates's "till-shadowed hill" concept, significant differences were noted, as cited earlier. Therefore, the "till-shadowed hill" concept may not be an appropriate criterion for waste-disposal siting in areas other than south-central New York. Further testing of the "till-shadowed hill" hypothesis in other parts of New York would be advisable before its application to the location of waste-disposal sites would be appropriate.

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