flattening or otherwise changing the shape of the slope generally is required.

Another form of slope instability is commonly evidenced by sloughing, ravelling, or gullying. These surface phenomena ordinarily are caused by water seepage or surface runoff. Sloughing caused by seepage water that emerges on a slope can be controlled by blanketing the sloughing area with permeable granular material or by intercepting water before it emerges on the slope. Interception ditches or drains often prevent sloughing that results from seepage at the top of a pan formation or in sand or silt that is shallow over an impervious layer. Each case must be considered as an individual problem. Erosion by surface water is particularly serious on sand or silt cut or fill slopes and drainage channels. The surface water from above an erodible slope must be collected and disposed of by means of an adequate disposal system.

SOIL COMPACTION

The primary purpose of soil compaction in embankment construction is to provide uniform density, strength, and compressibility. The degree of compaction should be commensurate with the use of the earth embankment. Dense, impervious embankments are required for dams. Pavements, base courses, and the upper portions of highway embankments and parking fields should be well compacted.

Soils that are excessively wet must be dried to optimum moisture content for best compaction. Some soils may be so wet as to be unusable, particularly during poor drying weather. Granular soils generally need additional moisture to facilitate compaction. Organic soils, such as muck and peat, and even mineral soils that contain only a small percentage of organic matter are unsuitable for use in embankment construction.

Proper compaction can be achieved only by spreading the soil in thin layers and providing uniform coverage with adequate compaction equipment. Bouldery soils and soil-rock mixtures cannot be spread in thin layers unless the boulders and large rock are removed. For broken rock or boulder fills, the thickness of the layer should not exceed the size of the largest particles used, and preferably should not exceed 2 feet. Large boulders and coarse rock are not suitable for construction of low fills and pavement subgrades.

WINTER EMBANKMENT CONSTRUCTION

During freezing weather, much greater compactive effort is required to obtain the minimum acceptable degree of compaction of soils. As the temperature falls below 20° to 25° F., it becomes virtually impossible to attain a satisfactory degree of densification with standard compaction equipment, even when working with relatively clean sand and gravel. Highway embankments constructed during freezing temperatures generally settle unevenly for a period of years, and consequently the pavement becomes rough. Therefore, winter work on construction of embankments should be limited to the placement of rock fills. The surface of partially constructed embankments that are left exposed during the winter months should be crowned and rolled smooth to shed water and thus prevent infiltration.

In the construction of earth embankments, no fill should be placed on a frozen surface, nor should snow, ice, or frozen material be incorporated in the embankment.

FROST ACTION IN SOILS

The freezing of any soil under natural field-moisture conditions results in temporary increases in volume and strength. The frozen moisture films separate the soil grains, and if ice lenses form they separate soil layers. The accumulation of ice lenses cause frost heaving. As the soils thaw, the amount of accumulated water is generally more than the soil can hold at saturation. The expulsion of this excess water causes frost boils and is a major factor in pavement failures. Even where no noticeable heaving has occurred, thawing decreases bearing capacity to approximately 50 percent of the normal summertime strength. Greater reductions in bearing capacity occur in soils where frost heaving occurs.

All soils are frost susceptible to some degree. The fine-grained or silty soils have the lowest strength when thawing; however, these soils also have correspondingly lower strength than granular soils under normal moisture-density conditions. The granular soils frequently contain silt lenses, which increase the likelihood of differential frost heaving. The design of all roads should provide uniformity of subgrade to minimize differential heaving, and also sufficient thickness of pavement, base, and subbase to support traffic over the subgrade when its bearing capacity is lowest, during the spring thaw.

TOPSOIL

Topsoil, as referred to here and in table 14, is soil material that may be used to cover less fertile or otherwise unsatisfactory soils to facilitate the establishment of vegetative cover.

Improvement of public areas, industrial parks, athletic fields, and residential developments may require the importation of topsoil. When topsoil is moved, some of its field characteristics may change. For example, some soils that are wet when excavated may be excellent material when placed in dryer locations. Topsoil for athletic fields must be stone free.

Mulching, fertilizing, and seeding will establish turf, which provides erosion control on highway cuts and fills, without the use of topsoil. This does not imply, however, that good topsoil is less effective for the growth of turf or for other uses.

SOIL FEATURES AFFECTING HIGHWAY LOCATION

Highway location may be influenced by many soil features, both as to location on the landscape and selection of the gradeline with respect to the surface.

Sloping till uplands and hilly outwash deposits generally involve cuts and fills. As compared with well-drained and flood-free terraces, they involve more earthwork in construction.

Undulating and gully-dissected deposits of silty and clayey bottom sediments also involve cuts and fills. Cuts in these materials may involve the handling of wet materials, and embankment foundations may be unstable. Thus, by comparison, the volume of earthwork in till uplands and hilly outwash may be greater, but the overall expense of construction may be less. In wet seasons, construction is easier on a till landscape than on a clay terrain. Sandy bottom sediments generally present few difficulties, but deep cuts in these materials may be troublesome because of ground water.

Terraces and flats present variable conditions. On terraces of granular material highway construction generally is easy and generally involves relatively light cuts and fills. Good drainage permits uninterrupted grading operations; even after rainstorms, these areas may be occupied without delay.

Alluvial flats present variable soil conditions. First-bottom alluvium is subject to overflow and normally has a relatively high water table. The moderately high gradeline necessary on such an area, in order to avoid roadway flooding and wet subgrades, involves obtaining borrow material from a source other than adjacent alluvium, because alluvium may be wet and hence unsuitable for use as embankment material. Unless the alluvial deposits are sandy, compacting the subgrade soils is difficult. Unfortunately, the subgrades, unless adequately compacted, will eventually yield enough to cause uneveness in pavements. This problem is less severe on second bottoms.

Where drainage permits, the flat lands and gentle slopes are used more intensively for agriculture than are the steeply sloping lands. Consequently, building highways on uplands is less likely to involve property damage than building them on areas better suited to agriculture.

Cities and villages ordinarily are on the lowlands. Expanding urban developments are consuming more flat landscapes, even first bottoms. Thus, the acquisition of land for highways planned to serve existing and future traffic involves taking some buildings.

The gradeline selected for any highway location is influenced by drainage, soil texture, and sometimes by other properties of the soils. Areas that are poorly drained and subject to flooding require a moderately high gradeline. In granular materials, variably permeable strata may be encountered in cuts, and subgrades in such cuts consequently are not uniform. On some areas adjacent to the sides of glacial Lake Cayuga, the soils are extremely variable within relatively short distances. Cuts in these areas should receive special treatment, and very light fills should be avoided. In fact, in most places, extremely light cuts and very light fills should be avoided.

Some soils are underlain by dense fragipans. Where possible, the grade should be planned so that cutting in and out of the pan is not necessary.

In flat areas where the soils are shallow over bedrock, the grade should be high enough, wherever possible, so that blasting rock for ditches is not necessary.

Descriptions of the Soils [21]

This section describes each soil series recognized in Tompkins County and each kind of soil that is outlined on the detailed soil map. The information in it will be of particular interest to persons who are concerned with the use and management of specific fields or farms.

Characteristics and qualities that are common to all the soils of a given series are described under the series name, in this order: the outstanding physical features of the soils, the landform the soils occupy, and their association with soils of other series; the principal layers of a cultivated soil of each series, the significance of each layer, and the range of characteristics within the series; general properties that affect the use of the soils, including seasonal changes in the water table, depth of the root zone, capacity for holding available water, capacity for supplying plant nutrients, and properties that limit suitability for cultivation.

Under the name of the mapping unit are described the characteristics and qualities that differentiate the particular unit from others of the series, such as slope or stone content; the suitability of the unit for agricultural and nonagricultural uses; and special management problems, including control of runoff and erosion, drainage, and maintenance of fertility. Only general suggestions about management are given, because practices need to be planned to meet conditions on a particular farm and to be changed to take advantage of progress in technology.

The terms "series" and "mapping unit" are defined in the section "How Soils are Mapped and Classified." Other technical terms used in the soil descriptions are defined in the Glossary.

The approximate acreage and proportionate extent of the soils are given in table 15.

Alden Series

These are the wettest soils in the uplands in the central and southern parts of the county. They are deep and very poorly drained. The topmost 12 to 24 inches is water-deposited silty material, and the lower part is channery glacial till.

Alden soils occur in slightly concave depressions and along nearly level drainways. They are associated with Ellery, Erie, and Langford soils in the central part of the county and with Volusia, Chippewa, and Mardin soils in the southern part of the county. The slope generally is not more than 1 percent, but in small areas that occur as seepy spots among the better drained soils, it is as much as 8 percent. Alden soils typically support reeds, sedges, rushes, willows, and alders. Where they intergrade to Chippewa or Ellery soils, they support red maple, elm, alder, and hemlock.

Alden soils have five principal parts: (1) a thin surface layer of nearly black muck; (2) a fairly thick subsurface horizon that is very dark gray and black and has an abrupt lower boundary; (3) a gray silty layer that is almost free of mottles; (4) a gray silty layer that is mottled; and (5) olive-colored, weakly calcareous, channery silt loam glacial till.

The muck on the surface in undisturbed areas is 2 to 6 inches thick. The underlying very dark gray mucky silt loam is 8 to 12 inches thick. In areas that have been pastured, these two layers have been mixed to form a surface layer of mucky silt loam 10 to 18 inches thick. This layer commonly is 10 to 20 percent organic matter. It is medium acid or slightly acid.

The unmottled gray layer below the surface soil is 9 to 13 inches thick. In most places, it is silty or very fine sandy material that contains few stones and that appears to have been deposited by water. In some areas, the roots of water-tolerant plants penetrate this layer and are surrounded by a yellowish-red rim, rich in iron. The

[21] This section was prepared by MARLIN G. CLINE, professor of soil science, Cornell University.

TABLE 15.—*Approximate acreage and proportionate extent of the soils*

Soil	Acres	Percent
Alluvial land	4,941	1.6
Arkport fine sandy loam, 2 to 6 percent slopes	634	.2
Arkport fine sandy loam, 6 to 12 percent slopes	344	.1
Bath channery silt loam, 2 to 5 percent slopes	113	(1)
Bath channery silt loam, 5 to 15 percent slopes	4,663	1.5
Bath channery silt loam, 5 to 15 percent slopes, eroded	85	(1)
Bath channery silt loam, 15 to 25 percent slopes	4,550	1.4
Bath and Valois gravelly silt loams, 5 to 15 percent slopes	26,202	8.3
Bath and Valois gravelly silt loams, 5 to 15 percent slopes, eroded	451	.1
Bath and Valois gravelly silt loams, 15 to 25 percent slopes	6,247	2.0
Bath and Valois soils, 25 to 35 percent slopes	5,721	1.8
Bath, Valois, and Lansing soils, 35 to 60 percent slopes	2,342	.7
Braceville gravelly silt loam, 0 to 5 percent slopes	145	(1)
Canandaigua and Lamson soils	120	(1)
Chenango gravelly loam, 0 to 5 percent slopes	324	.1
Chenango gravelly loam, 5 to 15 percent slopes	1,123	.4
Chenango gravelly loam, 15 to 25 percent slopes	188	.1
Conesus gravelly silt loam, 0 to 3 percent slopes	1,360	.4
Conesus gravelly silt loam, 3 to 8 percent slopes	7,942	2.5
Conesus gravelly silt loam, 3 to 8 percent slopes, eroded	252	.1
Chenango gravelly loam, fan, 0 to 8 percent slopes	2,567	.8
Darien gravelly silt loam, 2 to 8 percent slopes	912	.3
Erie channery silt loam, 3 to 8 percent slopes	22,131	7.0
Erie channery silt loam, 3 to 8 percent slopes, eroded	250	.1
Erie channery silt loam, 8 to 15 percent slopes	3,018	1.0
Erie channery silt loam, 8 to 15 percent slopes, eroded	867	.3
Ellery, Chippewa, and Alden soils, 0 to 8 percent slopes	3,039	1.0
Eel silt loam	2,272	.7
Erie-Ellery channery silt loams, 0 to 3 percent slopes	6,340	2.0
Fredon silt loam, 0 to 5 percent slopes	573	.2
Fresh water marsh	432	.1
Genesee silt loam	2,265	.7
Halsey silt loam	1,323	.4
Halsey mucky silt loam	886	.3
Howard gravelly loam, 0 to 5 percent slopes	2,678	.9
Howard gravelly loam, 5 to 15 percent simple slopes	8,376	2.7
Howard gravelly loam, 5 to 15 percent complex slopes	1,051	.3
Howard gravelly loam, 15 to 25 percent slopes	3,592	1.1
Holly and Papakating soils	1,252	.4
Honeoye gravelly silt loam, 2 to 8 percent slopes	2,511	.8
Honeoye gravelly silt loam, 8 to 15 percent slopes	259	.1
Honeoye gravelly silt loam, 8 to 15 percent slopes, eroded	279	.1
Howard and Palmyra soils, 25 to 35 percent slopes	2,181	.7
Howard and Palmyra soils, 35 to 60 percent slopes	1,095	.3
Howard-Valois gravelly loams, 5 to 15 percent slopes	1,893	.6
Howard-Valois gravelly loams, 15 to 25 percent slopes	704	.2
Hudson silty clay loam, 2 to 6 percent slopes	2,559	.8
Hudson silty clay loam, 6 to 12 percent slopes, eroded	3,157	1.0
Hudson silty clay loam, 12 to 20 percent slopes, eroded	2,687	.9
Hudson-Cayuga silt loams, 2 to 6 percent slopes	2,364	.8
Hudson-Cayuga silt loams, 2 to 6 percent slopes, eroded	226	.1
Hudson-Cayuga silt loams, 6 to 12 percent slopes, eroded	1,684	.5
Hudson-Cayuga silt loams, 12 to 20 percent slopes	687	.2
Hudson and Collamer silt loams, 2 to 6 percent slopes	895	.3
Hudson and Dunkirk soils, 20 to 45 percent slopes	2,377	.8
Ilion silty clay loam, 0 to 2 percent slopes	1,319	.4
Ilion silty clay loam, 2 to 6 percent slopes	1,187	.4
Kendaia silt loam, 3 to 8 percent slopes	4,066	1.3
Kendaia and Lyons silt loams, 0 to 3 percent slopes	3,521	1.1
Langford channery silt loam, 2 to 8 percent slopes	23,063	7.3
Langford channery silt loam, 3 to 8 percent slopes, eroded	743	.2
Langford channery silt loam, 8 to 15 percent slopes	3,075	1.0
Langford channery silt loam, 8 to 15 percent slopes, eroded	1,332	.4
Lansing gravelly silt loam, 0 to 3 percent slopes	878	.3
Lansing gravelly silt loam, 3 to 8 percent slopes	6,522	2.1
Lansing gravelly silt loam, 3 to 8 percent slopes, eroded	275	.1
Lansing gravelly silt loam, 8 to 15 percent slopes	515	.2
Lansing gravelly silt loam, 8 to 15 percent slopes, eroded	167	.1
Lima silt loam, 0 to 3 percent slopes	166	.1
Lima silt loam, 3 to 8 percent slopes	1,996	.6
Lima silt loam, 3 to 8 percent slopes, eroded	83	(1)
Lordstown channery silt loam, 5 to 15 percent slopes	9,097	2.9
Lordstown channery silt loam, 5 to 15 percent slopes, eroded	56	(1)
Lordstown channery silt loam, 15 to 25 percent slopes	7,673	2.4
Lordstown channery silt loam, 25 to 35 percent slopes	7,049	2.2
Lordstown soils, 35 to 70 percent slopes	4,005	1.3
Lordstown, Tuller, and Ovid soils, shallow and very shallow, 0 to 15 percent slopes	1,286	.4
Lordstown, Tuller, and Ovid soils, shallow and very shallow, 15 to 35 percent slopes	713	.2
Lyons silt loam	968	.3
Mardin channery silt loam, 2 to 8 percent slopes	8,851	2.8
Mardin channery silt loam, 8 to 15 percent slopes	6,709	2.1
Mardin channery silt loam, 8 to 15 percent slopes, eroded	823	.3
Made land	1,031	.3
Mardin and Langford soils, 15 to 25 percent slopes	1,869	.6
Madalin mucky silty clay loam	916	.3
Madalin silty clay loam	59	(1)
Middlebury and Tioga silt loams	1,047	.3
Muck and Peat	537	.2
Niagara silt loam, 2 to 6 percent slopes	666	.2
Ovid silt loam, 0 to 6 percent slopes	5,326	1.7
Ovid silty clay loam, 6 to 12 percent slopes, eroded	330	.1
Ovid and Rhinebeck silt loams, moderately deep, 0 to 2 percent slopes	60	(1)
Ovid and Rhinebeck silt loams, moderately deep, 2 to 6 percent slopes	600	.2
Ovid and Rhinebeck silt loams, moderately deep, 6 to 12 percent slopes	310	.1
Palmyra gravelly loam, 0 to 5 percent slopes	140	(1)

See footnote at end of table.

TABLE 15.—*Approximate acreage and proportionate extent of the soils*—Continued

Soil	Acres	Percent	Soil	Acres	Percent
Palmyra gravelly loam, 5 to 15 percent simple slopes	385	.1	Volusia channery silt loam, 3 to 8 percent slopes, eroded	41	(1)
Palmyra gravelly loam, 5 to 15 percent complex slopes	18	(1)	Volusia channery silt loam, 8 to 15 percent slopes	11, 286	3.6
Palmyra gravelly loam, 15 to 25 percent slopes	108	(1)	Volusia channery silt loam, 8 to 15 percent slopes, eroded	947	.3
Phelps gravelly silt loam, 0 to 3 percent slopes	1, 144	.4	Volusia-Chippewa channery silt loams, 0 to 3 percent slopes	327	.1
Phelps gravelly silt loam, 3 to 8 percent slopes	2, 004	.6	Volusia and Erie soils, 15 to 25 percent slopes	1, 429	.5
Red Hook gravelly silt loam, 0 to 5 percent slopes	135	(1)	Wayland and Sloan silt loams	8, 346	2.7
Rhinebeck silt loam, 0 to 2 percent slopes	1, 268	.4	Williamson very fine sandy loam, 2 to 6 percent slopes	224	.1
Rhinebeck silt loam, 2 to 6 percent slopes	3, 695	1.2	Mines and pits	203	.1
Rhinebeck silty clay loam, 6 to 12 percent slopes, eroded	567	.2	Cornell University	3, 789	1.2
Rock outcrop	2, 176	.7			
Tuller channery silt loam, 0 to 6 percent slopes	902	.3			
Volusia channery silt loam, 3 to 8 percent slopes	9, 088	2.9	Total	314, 240	99.7

[1] Less than 0.1 percent.

dominant gray colors indicate that this layer has been wet most of the time.

In some places the underlying mottled material is partly silt and very fine sand deposited by water, and in other places it is channery glacial till. Its dominant grayish color indicates waterlogging; the mottles are local concentrations of iron. In most places this layer extends to a depth of about 36 inches, below which is weakly calcareous, firm glacial till.

In some areas thin layers of silty clay or silty clay loam occur in the upper part of the soil. These layers appear to be water deposited. The thickness of the dark-colored surface soil ranges from 10 inches, where Alden soils intergrade to Ellery or Chippewa soils, to as much as 18 inches, where Alden soils intergrade to muck. In the northern part of the county, Alden soils intergrade to Lyons soils. In these places the entire profile is nearly neutral and the depth to free carbonates is only 30 inches. Though water-deposited material is typical of the upper part of the soil, the seepy sloping areas consist entirely of glacial till and have a channery surface soil. In these spots a fragipan may be present. The pH value in the upper part of the soil ranges from 5.5 on the highlands in the southern part of the county to almost 7.0 where Alden soils merge with Lyons soils.

The water table remains at or near the surface of Alden soils from the time the frost leaves the ground until early summer. During very dry periods of midsummer, the water table recedes to a depth of more than 30 inches, but it rises after each significant rain. Undrained, these soils are too wet for crops or pasture. Some areas can be drained enough to support pasture or hay crops. Tree roots are confined mainly to the topmost 10 inches, and only water-tolerant species grow.

These soils are rich in nitrogen, but they release it so slowly that plants show evidence of nitrogen deficiency. The supply of potassium and phosphorus is medium. Wetness is the outstanding limiting factor.

Alden soils in Tompkins County were mapped only in an undifferentiated unit of Ellery, Chippewa, and Alden soils.

Alluvial Land (Ab)

This mapping unit is called a miscellaneous land type because it consists mostly of unclassified soils. Areas, too small to be mapped separately, of classified soils on terraces and bottom land also occur within the mapped areas.

Alluvial land consists of very recent alluvium adjacent to streams. The streams cut and erode these areas during floods, shifting material from one place to another. Some areas include stony or gravelly material; other areas are free of coarse fragments. Within short distances the drainage ranges from nearly well drained to very poorly drained.

Areas of Alluvial land typically lie between the distinct bottom land or the terraces and the stream. Some are long narrow strips of intermingled wet and dry soil material that occupy the major part of very narrow valleys in the uplands. For the most part, the soil material within this mapping unit has little or no profile development.

Because these soils are adjacent to streams, are frequently flooded, and have such a wide range in drainage, they have very low potential for agricultural use. Most areas are left in brush and weeds. Some support water-tolerant trees, such as willow and sycamore. (Capability unit Vw-1; woodland suitability group 16)

Arkport Series

These are deep, well-drained, moderately coarse textured soils that have formed in sandy lake deposits. Although Arkport soils are moderately sandy, they contain enough fine material that they are not outstandingly droughty. Thin bands of slightly firm, slightly clayey material, 1/4 inch to 2 inches thick, are conspicuous and important features of the subsoil. Clay has concentrated in these bands, and the soil above them holds water. Arkport soils are strongly acid or medium acid.

Arkport soils occupy deltas formed by sand that was dropped as streams entered glacial lakes. The soils on the tops of these deltas are nearly level or undulating. Those on the sides that face the valleys are sloping. Some of the deltas have been dissected by streams. The dissection forms are steep, and they have been cut through Arkport soils into Dunkirk or Hudson soils in most places. These steep areas have been mapped with the steep Hudson and Dunkirk soils. The adjacent soils on high land are mainly Williamson, Collamer, and Howard soils. The associated wet spots are Lamson soils.

Arkport soils have four principal parts: (1) a plowed layer of dark grayish-brown fine sandy loam; (2) an upper subsoil of yellowish-brown, porous fine sandy loam; (3) a lower subsoil of brown to grayish-brown, loose fine sandy loam and loamy fine sand, within which are thin bands of firmer, darker brown very fine sandy loam; and (4) a substratum of alternate layers of fine sand and very fine sand.

The plowed layer in cultivated fields is 2 to 4 percent organic matter. It is porous and permits good root development. It has only moderate water-holding capacity. If unlimed, it is strongly acid or medium acid in most places. It has a very low potassium reserve and medium to low phosphorus-supplying power. The plowed layer of most fields is 8 to 10 inches thick.

The yellowish brown upper part of the subsoil extends to a depth of 16 to 18 inches. Its bright color shows that it is well aerated most of the time. This layer has only moderate capacity to supply moisture, but it is an excellent medium, physically, for plant roots. In most places it is strongly acid, and its supply of available nutrients is low or moderately low.

The lower banded part of the subsoil extends from a depth of about 16 inches to a depth of 36 inches. The bands of reddish-brown to dark-brown very fine sandy loam are very important, although each one is very thin and their total thickness ranges from only 4 to 12 inches. The material between them is grayish-brown fine sandy loam and loamy fine sand that is loose in place. The bands are slightly firm. The bands themselves hold a significant amount of water available to plants and they also keep the sandy material above them moist. They give an otherwise droughty soil a moderate capacity to supply water to plants. This banded zone ranges from medium acid to neutral, depending on the area, and within a given area acidity decreases with depth. The supply of nitrogen and potassium is very low; the supply of phosphorus is moderately low.

In most areas the substratum is coarser textured than the soil above it. Consequently, water moves through it rapidly. In some places thin layers of silt improve its water-holding capacity. Roots penetrate the substratum, and alfalfa roots have grown to a depth of more than 5 feet. The substratum is commonly slightly acid or neutral in the upper part but is calcareous at a depth of 3 to 5 feet.

In most places the plowed layer is fine sandy loam or very fine sandy loam. In a few places it is silt loam underlain by sand. Arkport soils intergrade to silty Dunkirk soils, and layers of silt totaling one-fifth of the thickness of the subsoil are permitted within the range of the series. Arkport soils also merge with the gravelly Howard soils, and in these places fine gravel may be present. The most acid profiles are strongly acid to a depth of 40 inches and medium acid or slightly acid at a depth of 5 feet. The least acid profiles are neutral to a depth of 36 inches and have calcareous material at a depth of 40 inches.

Though Arkport soils are saturated during rainy periods in spring, the water disappears quickly after the rains stop. Though free water is held above the bands of the lower part of the subsoil, the upper subsoil drains to a moist condition within a short period. During April, only 2 to 4 drying days are needed before these soils will bear machinery. During May and June, 1 or 2 consecutive drying days will permit cultivation. The Arkport soils are among the first in the county to be ready for tillage in spring.

Although deep-rooted crops like alfalfa may draw some water from a depth of as much as 5 feet, the root zone is mainly confined to the topmost 30 or 40 inches. It is difficult to appraise the capacity of this volume of soil to supply moisture for plants, because of the effects of the bands of fine-textured material. The amount probably varies between 3½ and 5 inches of water. Crops begin to show effects of drought long before these supplies are exhausted, however. Generally they show moisture stress after a week or 10 days without rain in the middle of the summer. If conditions are favorable for the establishment of deep root systems, however, crops in these areas show the effects of extreme drought less than crops on many of the finer textured soils of the county.

Arkport soils are moderately low to low in fertility. The total nitrogen supply is lower than that of most soils of the county, but the nitrogen is readily available. The reserve supply of potassium is very low, and the supply of phosphorus is medium to low. These soils, however, are extremely responsive to fertilization.

The capacity of the surface soil to absorb bases is low. It is equal to 4 to 8 tons of ground limestone per acre. In unlimed soils, this capacity is only 30 to 40 percent filled in most places and 2 to 4 tons of ground limestone is needed to raise the pH to a value near 7.0. If the surface soil has been limed previously to pH 6.0, the amount required is 1 or 2 tons.

Arkport soils are among the best of the county, although they are low in fertility and have only moderate capacity to supply moisture. They are erodible if they have significant slopes.

Arkport fine sandy loam, 2 to 6 percent slopes (ArB).—This gently sloping and undulating soil is the better of the two Arkport soils mapped in Tompkins County. It occurs on the top of deltas and has gentle, slightly convex slopes or slightly uneven topography. It is associated mainly with Arkport fine sandy loam, 6 to 12 percent slopes. It also adjoins areas of Collamer and Williamson soils, and in a few places it intergrades to Howard or Chenango soils. Most of the areas are small, and most show no evidence of erosion, but in places a few inches of surface soil has been washed from small knolls and has accumulated on lower spots.

This soil is well suited to crops, pasture, or forest. It is especially well suited to crops that are planted early in spring, including some vegetable crops. It also provides excellent sites for many nonagricultural uses.

Fertilization and liming are the outstanding management needs. Crops require fertilization. Nitrogen, phosphorus, and potassium supplies are lower than in most soils of the county. Erosion is a moderate problem. This soil is moderately susceptible to drought in midsummer but is among those on which vegetable crops can be expected to respond to irrigation. (Capability unit IIe–3; woodland suitability group 1a)

Arkport fine sandy loam, 6 to 12 percent slopes (ArC).—This soil occupies the faces and the moderately sloping dissection forms of deltas of glacial lakes. It is associated mainly with Arkport fine sandy loam, 2 to 6 percent slopes. It also adjoins areas of Collamer and Howard soils. Small knolls occur in a few places, and these have commonly been moderately eroded. These spots can be detected by the lighter color of the surface soil. They occupy less than 15 percent of the mapped areas.

This soil is suited to crops, pasture, or forest. It is also well suited to many nonagricultural uses. It is less well suited to intensive cultivation than is Arkport fine sandy loam, 2 to 6 percent slopes, mainly because of the erosion problem.

Maintenance of fertility and control of erosion are the two outstanding management needs. This soil needs large amounts of fertilizer, including nitrogen, phosphorus, and potassium. It also needs lime for crops that are not tolerant of acidity. It is very erodible, and on these slopes erosion is an important problem. Consequently, this soil is less well suited to intensive continuous production of vegetables than is the less strongly sloping Arkport soil. Sod-forming crops should be included in the rotation. Some areas can be tilled on the contour. Long slopes should be stripcropped if intertilled crops are grown. (Capability unit IIIe-5; woodland suitability group 1a)

Bath Series

The Bath series consists of deep, well-drained, strongly acid, medium-textured soils that have formed in acid or very low-lime glacial till. Bath soils have a fragipan that restricts internal drainage. Consequently, their well-drained characteristics must be attributed either to steep topography or to the fact that they receive little or no runoff from higher adjacent land.

The most common associates are the moderately well-drained Mardin soils and the somewhat poorly drained Volusia soils. The shallow Lordstown soils occupy steep slopes of adjacent valley sides. The poorly drained Chippewa soils and the very poorly drained Alden soils occupy depressions and level areas in the same general region. Locally, where lime-bearing water accumulates, Erie or Ellery soils have formed in the association, instead of Volusia and Chippewa soils.

Bath soils have four principal parts: (1) a plowed layer of dark grayish-brown channery silt loam; (2) a thick subsoil of yellowish-brown channery silt loam free of mottles; (3) a thick, dense fragipan of acid very channery silt loam; and (4) the underlying strongly acid, dense, very channery loam glacial till.

The 6- to 8-inch plowed layer is silt loam and contains many flat stone fragments. These stones are troublesome in tillage and in some harvesting operations, but they do not prevent cultivation. The plowed layer is porous and well aerated. It is good physically for root development. Where unlimed, it is strongly or very strongly acid. It is 3 to 6 percent organic matter and is, consequently, at least moderately well supplied with nitrogen.

The yellowish-brown subsoil extends to a depth of 18 to 30 inches. It contains many small flat stone fragments, but it has good water-holding capacity and is well aerated. It is strongly or very strongly acid and has only moderate capacity to supply phosphorus and potassium. This relatively thick layer provides a root zone much thicker than that of the associated soils.

The top of the fragipan is 18 to 30 inches below the surface. The pan extends to a depth of 4 to 5 feet. Narrow V-shaped cracks filled with light-colored silty material divide the fragipan into sections 6 to 12 inches wide. The cracks become narrower with depth and finally end. Plant roots penetrate several inches along the cracks, but almost none penetrate the sections between the cracks. The entire fragipan is strongly acid; its density and poor aeration prevent roots from developing in it and drastically restrict downward movement of water.

The underlying glacial till is very channery loam or silt loam. It is as dense as the fragipan. Its upper part is medium or strongly acid, but acidity decreases with depth. In some places free lime occurs below a depth of 5 feet. This glacial till rests on bedrock. In the shallowest areas bedrock is only 4 feet below the surface, but in most places it is at least 6 feet below the surface and on some valley sides is at a depth of more than 30 feet.

Where the soil is thinnest over bedrock, flagstones 12 to 16 inches wide are present throughout the soil and on the surface. In these areas Bath soils intergrade to the shallow Lordstown soils. Bath soils intergrade to the moderately well drained Mardin soils where the landform permits some accumulation of water from adjacent areas. As these soils merge, depth to the fragipan decreases and mottling appears at the top of the fragipan. Typically, the amount of lime in the glacial till increases slightly from the hilltops toward the valleys. In this transition zone Bath soils intergrade to Valois soils. The transition is marked by a less acid fragipan.

More than 4,000 measurements of depth to the water table were made on Bath and similar soils over a 2-year period (*17*). From the first of April till the middle of May, the water table was above a depth of 25 inches only 2 percent of the time, and 75 percent of the time no free water was found within 40 inches of the surface. After soaking rains in April, 4 or 5 consecutive drying days commonly are needed before the soils can be cultivated. During May, only 3 or 4 days are required, and by mid-June, machinery can be used after 1 or 2 drying days.

Roots can use mainly the 18 to 30 inches of soil above the fragipan. This zone holds between 4 and 6 inches of water available to plants. Plants begin to show moisture stress when this amount is about half exhausted. Normally, the soils are filled nearly to capacity with available water at the beginning of June. As the season progresses, rain normally is not adequate to recharge the reserves as rapidly as they are exhausted by growing plants. Consequently, reduced growth rates can be expected after 7 to 10 rainless days in midsummer.

In Bath soils that have not been eroded, the total nitrogen supply is moderately high. Nitrogen is released slowly in the cool moist spring, however, and the response to nitrogen fertilization at that season is high. During midsummer, nitrogen is released more rapidly but plant growth is more demanding. Response to nitrogen in midsummer is common but less certain. The phosphorus-supplying power is medium. It is increased by liming but is not adequate for good production. The potassium-supplying power is medium. Enough potassium may be supplied by a Bath soil when plants are small, but the readily available reserve is limited and applications of potash are generally necessary for good yields. Lack of lime is the most important chemical limitation. The pH value of an unlimed Bath soil is commonly below 5.0. The plowed layer typically has capacity to absorb 8 to 12 tons of ground limestone per acre. If a Bath soil has never been limed, 4 to 8 tons of lime is needed to raise the pH to a value near 7.0. If the pH value is 6.0, from 1½ to 3 tons is commonly needed. Without adequate liming, fertilization of most crops commonly grown is ineffective.

Bath channery silt loam, 2 to 5 percent slopes (BaB).—This soil is the most gently sloping of the Bath soils, and it represents mainly the wetter half of the well-drained range. It is typically on hilltops and is closely associated with the moderately well drained Mardin soils and the somewhat poorly drained Volusia soils. This soil, as mapped, typically includes small acreages of Mardin soils, which aggregate as much as 15 percent of some areas. Locally, areas of Volusia soils, too small to be mapped separately, are included also.

Only in this particular topographic position do Bath soils have such gentle slopes. Consequently, the total acreage of this mapping unit is small.

This soil is suited to crops, pasture, or forest. It is well suited to crops like potatoes. If adequately limed, it is productive of alfalfa. It is among the more desirable sites in the uplands for housing.

This soil is one of the best in the uplands. It is suited to intensive cultivation, and crops on it respond well to simple practices such as liming and fertilization. Small stones interfere moderately with cultivation (fig. 19). (Capability unit I-1; woodland suitability group 5a)

Bath channery silt loam, 5 to 15 percent slopes (BaC).—This soil is the most extensive of the Bath soils in the county and is typical of the central part of the well-drained range. It is near the crests of hills or on distinctly convex slopes where water does not accumulate. Closely associated with this soil are the moderately well drained Mardin soils, spots of which are included in the least strongly sloping parts of some areas of the Bath soil. In some places, the slope is crossed by shallow drainways and the hillside has a distinctly rolling character. In some of the drainways, small areas of Volusia soils occur as seep spots. Locally, areas of Lordstown soils, too small to be mapped separately, are included in the mapped areas of this Bath soil.

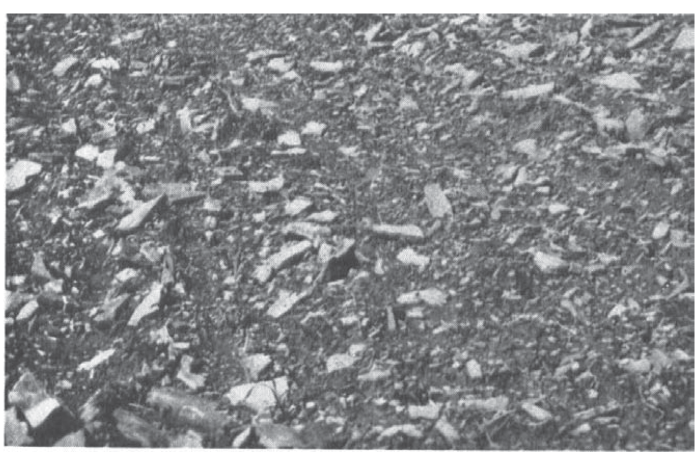

Figure 19.—Coarse, flat fragments of rock on surface of Bath channery silt loam

This soil is suited to crops, pasture, or forest, but the management it requires is moderately demanding. Under good management, it is productive of most crops normally grown in the county. Its use, however, is somewhat limited because the slopes are steep enough to cause difficulty in farming operations. It is difficult, for example, to turn the soil uphill when plowing, and farm machinery tends to slip downslope during tillage. This soil is among the better sites in the uplands for many nonagricultural uses, such as housing.

Runoff is moderately rapid, and erosion is a problem. In many areas contour cultivation and stripcropping will control runoff. Water from above the stripcropped areas can be directed to a safe channel. Sod waterways in natural drainways allow the water to flow downhill without cutting.

This soil can be highly productive of most crops commonly grown in the county, if the management needs are met. Like the other Bath soils, it must be limed adequately before the potential response to nitrogen, phosphorus, and potassium can be obtained. (Capability unit IIIe-3; woodland suitability group 5a)

Bath channery silt loam, 5 to 15 percent slopes, eroded (BaC3).—About 50 to 80 percent of this soil consists of areas from which a significant part of the original plowed layer has been removed by erosion. In these areas depth to the fragipan ranges from 14 to 24 inches. Except for a few small spots, little erosion is evident on the rest of this soil. These small spots, typically on short but relatively steep slopes, have lost from 12 to 18 inches of soil. The depth to the fragipan in such spots is between 6 and 12 inches.

The plowed layer contains much less organic matter than that in an uneroded soil. Consequently, it is less porous, absorbs water more slowly, allows more water to run off, and is more likely to be eroded. Runoff takes away water that plants need. The risk of runoff and erosion is so great that moderate restrictions in use are required, along with control of runoff to maintain and improve the productive capacity. With suitable practices, the soil can be used for crops, pasture, or forest. Also, suitable locations on it are among the more desirable sites for many nonagricultural uses, such as housing.

Erosion control generally requires that sod-forming crops be grown a large proportion of the time. Such crops also help to restore good physical condition and to maintain the organic-matter content of the plowed layer. All tillage should be across the slope or on the contour. Some areas can be protected by diversion of water on the upper part of the slope. If intertilled crops are grown, they should be planted in strips across the slope. These practices, along with adequate liming and fertilization, permit at least a moderately high level of production. Yields are generally lower, however, than on the uneroded Bath soils of similar slope. The root zone is thinner than on the uneroded soil, and the available moisture capacity is correspondingly less. Partly for this reason, and partly because much water is lost by runoff during the storms of midsummer, crops on this soil are more subject to damage by drought than those on the uneroded soils. (Capability unit IVe-3; woodland suitability group 5a)

Bath channery silt loam, 15 to 25 percent slopes (BaD).—This moderately steep soil is mainly within the drier half of the drainage range for the series. It is typically steep enough that use of machinery is very difficult. Though some areas have hilly, complex topography, most are on hillsides that slope dominantly in one direction. Intermittent streams cross many areas at right angles to the contour. Spots of wet soil occur along these small streams. Locally, small areas of the moderately well drained Mardin soils are included in some of the areas mapped.

The amount of erosion was not differentiated in mapping this moderately steep soil.

Some erosion is evident in most cleared areas. Predominantly, this soil is uneroded or only slightly eroded, but in some areas it has lost a significant part or all of the original surface soil. Even the uneroded areas have less than 24 inches of porous soil above the fragipan. The water-holding capacity is less than that of the less strongly sloping Bath soils.

This soil can be used for crops, pasture, or forest. It should be used as little as possible for intertilled crops. Long-term hay and pasture are among the better uses. Runoff is rapid, and erosion is a potential problem in all areas. Loss of water contributes to droughtiness in the middle of the summer. Contour cultivation, stripcropping, and the use of sod-forming crops contribute to soil and water conservation. Lime is necessary for even moderate yields of hay and pasture, and nitrogen, phosphorus, and potassium are deficient. (Capability unit IVe-2; woodland suitability group 5b)

Bath and Valois gravelly silt loams, 5 to 15 percent slopes (BgC).—An area of this mapping unit may consist of Bath gravelly silt loam, of Valois gravelly silt loam, or of some of both. Valois soils are described under the heading "Valois Series."

These soils occupy either moderate uniform slopes or the complex slopes of small knolls. At the base of knolls or on gentle slopes, a thin zone above the fragipan may be mottled. These spots are inclusions of Langford or Mardin soils. A few wet spots are in slight depressions in some areas; these are shown by wet-spot symbols. Many areas of Bath and Valois soils are closely associated with larger areas of Langford or Erie soils. The wet Erie soils control the use of some fields. Some entire fields, however, are predominantly Bath and Valois soils.

These soils are suited to most crops commonly grown in the county, to pasture, or to forest. They are also among the best sites in the uplands for housing.

These soils have moderate limitations as cropland. Their slope causes moderately rapid runoff and loss of water that crops need in midsummer. Slope also creates a moderate erosion problem. Adjustment of crop rotations or simple practices are needed to control runoff. In addition, good crop production and conservation require adequate fertilization and liming. (Capability unit IIIe-3; woodland suitability group 5a)

Bath and Valois gravelly silt loams, 5 to 15 percent slopes, eroded (BgC3).—These moderately sloping soils are moderately eroded. The amount of soil lost varies greatly from spot to spot within a single area. Some spots are uneroded, and some have lost as much as 12 inches of soil. In most places, however, the plowed layer consists mainly of former subsoil material and the depth to the fragipan is 4 to 6 inches less than in the uneroded Bath and Valois soils. Consequently, the depth of the root zone is 4 to 6 inches less and the available moisture capacity is 1 to 1½ inches less than in the uneroded soils. Also, organic matter has been lost. The plowed layer is less porous than that of the uneroded soils; hence, a good seedbed is more difficult to prepare and the surface absorbs water more slowly. All of these factors contribute to slightly lower yields on these soils than on Bath and Valois gravelly silt loams, 5 to 15 percent slopes.

In many places these soils consist of a series of moderately sloping knolls, the sides of which are the most severely eroded. Some areas, mainly on valley sides, have nearly uniform slopes. The least sloping parts commonly have some mottling above the fragipan; they are inclusions of Langford soils. A very few small spots of the somewhat poorly drained Erie soils may be included; these are mainly in small flat areas or in slight depressions.

The soils of this mapping unit are suited to crops, pasture, or forest. They are also among the better sites in the uplands for housing. They can be used for most crops grown in the area, but management needs are exacting if intertilled crops are grown frequently. After rains a crust may form at the surface. Consequently, less water is absorbed and the loss of water by runoff and the hazard of erosion are greater than on the uneroded mapping unit of similar slopes. The use of sod-forming crops to hold soil and to increase the organic-matter content is important. Special practices are commonly needed to control runoff. Liming and fertilization are essential for even moderate yields and for conservation. Nitrogen is especially needed, because much of the nitrogen has been lost. Although the management needs are much more exacting than those of the uneroded mapping unit of similar slope, yields under good management may be only slightly less. (Capability unit IVe-3; woodland suitability group 5a)

Bath and Valois gravelly silt loams, 15 to 25 percent slopes (BgD).—These are moderately steep soils on which modern machinery can be used only with difficulty. The dominant soils are characteristic of the drier two-thirds of the well-drained range described for the two series. About 50 percent of this unit has lost 4 to 6 inches of soil by erosion. On most of the remaining acreage, erosion losses have been too small to be measured. Some spots, however, have lost as much as 12 inches.

This mapping unit occupies either strongly sloping hillsides or upland areas that have pronounced, irregular, hilly topography. Small areas of moderately well drained Langford soils are included locally. In the hilly areas, strata of gravel occur erratically in the substratum. In such places small areas of gravelly Howard soils are included.

The slopes limit the use of this unit. The soils can be used for crops, pasture, or forest, but farming operations are difficult. Selected sites that have favorable topography are suitable for housing.

Runoff is moderately rapid or rapid. Consequently, these soils are more subject to drought than are Bath and Valois soils on less steep slopes. Runoff also contributes to a serious erosion hazard. These factors combine to limit the suitability of this mapping unit for intensive cropping. It can be cropped successfully, but it is best if the cropping system includes a high proportion of sod-forming crops or pasture. Structures to divert excessive runoff are needed to protect many of the areas. The soils in this unit are suited to deep-rooted, long-lived legumes for hay or pasture if adequate lime and fertilizer are applied. They are not productive of native pasture plants unless fertilized and limed. (Capability unit IVe–2; woodland suitability group 5b)

Bath and Valois soils, 25 to 35 percent slopes (BoE).—The significant features of this mapping unit are steep slope, good drainage, moderately good water-holding capacity, strong acidity, and moderate fertility. Slope is the factor that limits the use of these soils.

This mapping unit is mainly on steep valley sides and steep hills in valleys. In many places it is on the steep slopes where streams have made broad V-shaped landforms in deep glacial till. The adjacent areas consist mainly of the moderately well drained and the somewhat poorly drained members of the Bath and Valois catenas.

The soils in this unit are too steep to be cultivated safely with modern machinery. Most of the acreage is used for pasture or forest. Most of the pastures are unimproved and brushy. The steep slope makes improvement very difficult. If the soils were to be plowed, erosion would be a very serious hazard. (Capability unit VIe–1; woodland suitability group 5b)

Bath, Valois, and Lansing soils, 35 to 60 percent slopes (BtF).—This is an undifferentiated unit of very steep soils in deep glacial till. It occupies valley walls, escarpments along streams, and dissected landforms. Because slope dominates in determining the potential use of these soils, distinctions among the soils included were not made in the mapping. Lansing soils are described under the heading "Lansing Series," and Valois soils are described under "Valois Series." Small areas of equally steep Honeoye, Cayuga, and Darien soils are included in some of the areas mapped. Generally, soils of only one series dominate any one area.

Erosion has not been differentiated, and all degrees of erosion from none to severe are included. Some areas are unstable because streams have undercut the very steep slopes and have caused sections to slump and to leave the parent material exposed. Such areas are shown on the soil map by escarpment symbols where feasible.

The steepness of the slope precludes most uses other than forestry, recreation, or wildlife. Some areas are now in State parks. (Capability unit VIIe–1; woodland suitability group 10)

Braceville Series

The Braceville series consists of deep, moderately well drained, medium-textured soils that have a fragipan. These soils have formed in stratified water-laid deposits of gravel, sand, and silt. These deposits are associated with the glacial outwash terraces, but the material either is poorly sorted or contains layers of silt that must have been laid down in slow-moving water. The original material carried little lime; thus, the soils are very strongly acid or strongly acid. They are the moderately well drained associates of the Chenango soils.

The total acreage of Braceville soils in Tompkins County is very small. Most of it occurs as small areas that are associated with Chenango soils on terraces. Small areas are associated with Chenango soils on beach ridges in the uplands and on alluvial fans. The wetness in these two places is caused by underlying deposits of slowly permeable glacial till or lacustrine clays.

Braceville soils have four principal parts: (1) a plowed layer of grayish-brown to dark grayish-brown gravelly silt loam or silt loam; (2) an upper subsoil of yellowish-brown gravelly silt loam that grades to a grayish-brown material of similar character but with distinct mottles; (3) a firm, fragipanlike lower subsoil of gravelly silt loam or silt loam that is slowly permeable to water; and (4) intermingled layers of gravel, sand, and silt characteristic of the original deposit.

In most fields the plowed layer is 7 to 9 inches thick. Its grayish-brown to dark grayish-brown colors are associated with a 3- to 6-percent organic-matter content. This layer is permeable. It contains enough gravel to interfere slightly with tillage in most places. Unlimed, it is strongly acid or very strongly acid. It has a moderate potassium reserve and moderate phosphorus-supplying capacity. It is well suited to root development.

The upper part of the subsoil extends to a depth between 7 and 24 inches. It has few mottles immediately below the plowed layer, but mottles increase in number with depth. This pattern of mottling indicates that the upper part is infrequently wet, but that the lower part is saturated for significant periods. In most areas distinct mottling appears at a depth of about 12 to 14 inches. This layer is permeable. It is wet because of the slowly permeable layers beneath it. It is strongly acid or very strongly acid. It has a moderate potassium reserve and a moderate capacity to supply phosphorus.

The lower part of the subsoil is a dense, slowly permeable layer that is responsible for the wetness of the soil above in many areas. This layer is high in silt, and in some places it does not contain gravel. Few roots penetrate it. It is medium acid or strongly acid. It has moderate supplies of phosphorus and potassium. The depth to this layer varies, depending upon the characteristics of the original deposit, and the layer extends to a depth of 30 to 45 inches. Though this fragipan layer is characteristic of the Braceville soils, it is not present in some of the mapped areas. In these areas wetness results from the slowly permeable layers of the substratum or from the underlying, slowly permeable glacial till or lake sediments.

The underlying water-laid deposit varies in texture and thickness from place to place. It is typically dominated by gravel and sand, but it contains layers of silt loam or gravelly silt loam that range from a fraction of an inch to more than 12 inches in thickness. The deposit is thick in some places; in others it is underlain by glacial till or lake sediments at a depth of more than 40 inches.

Though these soils are typically strongly acid to a depth of more than 3 feet, areas that merge with Phelps soils are medium acid to slightly acid in the lower part of the profile. The plowed layer normally contains gravel, but in some areas it has almost no gravel.

During April, water stands less than 6 inches below the surface for a short time after each rainy period, and recedes to a depth of 20 inches or more during rainless periods. At this time of year, 4 to 6 drying days are needed before the soil can be plowed. During May, free water stands within 15 inches of the surface for only short periods and recedes to 30 inches or more during extended dry periods. At this time of year, 2 to 4 drying days are needed before cultivation. During June, 1 or 2 consecutive drying days normally permit tillage.

Few roots penetrate the fragipanlike layer of the lower part of the subsoil. Most do not penetrate below a depth of 15 to 20 inches. This volume of soil will hold 3 to 4 inches of water that plants can use. In the early part of the season these values are not significant, because the soil frequently contains free water. During midsummer, however, dry periods may be long enough to exhaust most of this supply. Commonly, free water stands above the firm fragipan layer for short periods after rains. After it disappears, crops show signs of moisture deficiency within 7 to 10 days without rain in midsummer.

The dark color of the surface soil is associated with a 3- to 6-percent organic-matter content, which is reflected in a moderately high capacity to absorb bases. This capacity is equivalent to 7 to 13 tons of ground limestone per acre. In unlimed soils, this capacity is only about 20 or 30 percent filled. Unlimed plowed layers need from 3½ to 6 tons of ground limestone for a pH value near 7. If the soils have been limed previously to pH 6.0, the requirement is 1½ to 3 tons of ground limestone per acre. The soil within the root zone has only a medium amount of phosphorus and potassium.

Braceville soils are potentially moderately productive soils, but they have outstanding deficiencies in nutrients and lime and a moderate problem of wetness.

Braceville gravelly silt loam, 0 to 5 percent slopes (BvA).—This is the only Braceville soil mapped in Tompkins County. As mapped it includes areas, too small to be mapped separately, of the somewhat poorly drained Red Hook soils and of soils, mainly seepy spots on the sides of hills, that have slopes of more than 5 percent.

This soil is suited to crops, pasture, and forest. If adequately drained, it is suited to intertilled crops, including vegetable crops. Its wetness imposes moderate limitations for some nonagricultural uses, but it is used in some places as housing sites. It is a source of gravel, but the quality of the deposits is so variable that each potential excavation site needs close examination.

Liberal use of lime and complete fertilizer is necessary for good yields. Although erosion is generally not a problem, contour farming is advisable for some of the more strongly sloping areas. Some areas may be improved by drainage. (Capability unit IIw-1; woodland suitability group 8a)

Canandaigua Series

The Canandaigua series consists of deep, poorly drained and very poorly drained, silty soils that have formed in calcareous lake deposits consisting mainly of layers of silt and very fine sand but including thin layers of clay. These soils have a very dark colored surface soil and a gray subsoil. The poorly drained soils of this series have a mineral surface horizon rich in organic matter. The very poorly drained soils have a mucky surface soil. Canandaigua soils contain less clay than Madalin soils. They contain more silt and clay and less sand than Lamson soils.

Canandaigua soils occupy level or depressed areas within the basins formerly occupied by glacial lakes. In most places higher lying soils are members of the Collamer and Niagara series, but Canandaigua soils also occupy silt-filled depressions within areas of glacial till dominated by Erie and Lansing soils. The proportions of the very fine sand and silt layers vary widely within short distances in some areas.

The Canandaigua soils consist of three principal parts: (1) a surface soil that is either very dark gray silt loam high in organic matter or mucky silt loam; (2) a subsoil of light brownish-gray to grayish-brown silt loam that has many prominent mottles; (3) a substratum that consists of calcareous layers of silt and very fine sand and thin layers of clay.

The surface soil ranges from 8 to 18 inches in thickness. In the poorly drained soils, it is very dark gray and is 8 to 10 percent organic matter. In the wettest soils, a thin layer of muck covers the surface of undisturbed areas. If these areas are pastured, the muck is mixed with underlying mineral material and the resulting mixture is a mucky silt loam that is as much as 20 percent organic matter. In areas that have not been drained, this layer is saturated with water for very long periods, but it is porous and permits root development when the water is removed. In most places this layer is slightly acid or neutral, but in some upland depressions it is medium acid. It contains a very large amount of total nitrogen, but the nitrogen is very slowly available to plants if the soil is undrained. The capacity to supply potassium and phosphorus is medium.

The gray colors of the subsoil are the results of intense wetness for long periods. Gray and dark gray are dominant. In the wettest places, a thin layer beneath the surface soil is almost free of mottles, probably because iron has been made soluble and has been removed. In undrained areas some roots penetrate 3 to 4 inches into this layer, but few extend farther. If these soils are drained, roots commonly penetrate to a depth of between 15 and 20 inches. The subsoil contains little nitrogen and has only medium potassium- and phosphorus-supplying power. It is nearly neutral, however. It extends to a depth of 18 to 40 inches.

Silt is dominant in the substratum, but it is interspersed with layers of very fine sand in many places. Thin layers of clay are present in most places. Most of these layers are only a fraction of an inch thick, but some are several inches thick. Especially where these layers of clay are present, the substratum is very slowly permeable to water. It is calcareous and has medium potassium and phosphorous supplying power, but few roots reach it.

Two major variations are allowed within the range of the series. Drainage is poor in some of the soils, and very poor in others. Organic-matter content of the surface soil is greater and the grayness of the subsoil is more pronounced where drainage is very poor. The surface soil is between 8 and 14 inches thick in most places, but in some areas that have received deposits of eroded material, it is as much as 18 inches thick. The texture of layers in the soil profile ranges from clayey to sandy. The clay content of the subsoil ranges from as little as 15 percent to as much as 30 percent. The depth to free lime ranges from 18 to 40 inches. It is commonly least in the wettest areas.

Canandaigua soils have water standing at the surface for long periods throughout the months of April and May. In the poorly drained soils, the water table recedes to a depth of 6 inches or slightly more for short periods during April and to a depth of as much as 20 inches for short periods during May. In the very poorly drained soils, free water stands within 6 inches of the surface most of the time during both months. In most years, the water table begins to recede near the first of June but rises to within a few inches of the surface after each major rain. Neither the poorly drained nor the very poorly drained soils are suitable for cultivation unless drained. The poorly drained ones may be used for grass hay.

If these soils are drained artificially, the water table can be controlled until June. Though the water table recedes during dry midsummer periods, the soils receive water both as runoff and as seepage after each soaking rain. Moisture deficiency is not commonly a problem, even in drained areas.

Canandaigua soils contain a large amount of total nitrogen. The nitrogen is very slowly available throughout the year in the undrained areas. In drained areas, it is slowly available in spring but may be readily available during midsummer. The capacity of these soils to supply phosphorus and potash is medium. The subsoil and substratum contain an abundant supply of lime. The surface soil in many areas is nearly neutral, but in some it is medium acid. It has a very high capacity to absorb bases. This capacity is equivalent to 14 to 20 tons of ground limestone per acre. An unlimed surface soil may need from none to as much as 5 tons of ground limestone per acre to raise the pH to a value near 7.0. If these soils have been limed previously to pH 6.0, the requirement is 3 to 5 tons. Many areas need no lime.

Wetness is the outstanding limitation of these soils. If adequately drained they are responsive to management and can be among the most productive of the county.

Canandaigua and Lamson soils (Ca).—The name of this mapping unit indicates that any given area may consist of the silty Canandaigua soils, of the sandy Lamson soils, or of a mixture of the two. Lamson soils are described under the heading "Lamson Series." Slope is not indicated in the name of the mapping unit, because both of these soils are nearly level or depressional. The depressions without outlets are very poorly drained and have a mucky surface soil. The nearly level areas are poorly drained and have a very dark gray mineral surface soil rich in organic matter. The centers of some large areas have a mucky surface layer like that in the very poorly drained areas, but the margins are less wet and have a surface layer like that in the poorly drained areas. Most areas are dominated by poorly drained soils. This mapping unit is associated mainly with the Collamer and Niagara soils in drier sites, but the upland depressions are surrounded by Erie or Ellery soils.

If undrained, these soils cannot be used for crops other than grass hay, and the wettest parts are poorly suited even to this. Drained areas may be used for a large variety of crops. They can be used for pasture and are productive during the dry midsummer months. Only water-tolerant species of trees are adapted. The soils are too wet for most nonagricultural purposes. Some are suitable for wildlife marshes or for dugout ponds.

Control of water is the outstanding problem. The soils can be tile drained if outlets are available. Ditching for tile or for open drains, however, is difficult, because the sandy layers tend to flow into the ditch. Areas that have been drained need nitrogen, phosphorus, and potash. Some, but not all, need lime. If drainage is feasible, these soils can be among the most productive in the county. (Capability unit IIIw-5; woodland suitability group 14b)

Cayuga Series

The Cayuga series consists of deep, well drained and moderately well drained, moderately fine textured soils. These soils developed in areas where there apparently was a thin layer of lake-laid silt and clay over glacial till, as is typical in areas of Lansing and Honeoye soils. The underlying calcareous till has been mixed to some degree with the fine lake deposit by the burrowing of animals, by the uprooting of trees, and by frost action, and Cayuga soils have formed in the mixture. The series includes both the well-drained soils and the drier half of the moderately well drained soils that have formed in these materials. Reaction in the upper part of the soil is slightly acid or neutral.

Cayuga soils occupy convex, gently sloping to moderately steep areas on the sides of valleys. They are mainly below the 1,000-foot contour, that is, below the water level of the glacial lakes. Many areas of Cayuga soils in Tompkins County appear to be in places that once had thick deposits of lake-laid material, for they are closely associated with Hudson soils, which formed where the lake-laid deposits were thick. Most areas of Cayuga soils are too small to be mapped separately, so they are mapped as complexes with Hudson soils.

Many areas are crossed by intermittent waterways, some of which have sharply incised dissection forms. The landforms are such that water is removed by runoff and relatively little water from adjacent areas accumulates. The somewhat poorly drained Ovid soils and the poorly drained Ilion soils occupy parts of many fields in which Cayuga soils are found.

Cayuga soils have four principal parts: (1) a plowed layer of very dark grayish-brown, gravel-free or slightly gravelly heavy silt loam; (2) a thin leached layer of brown gravel-free or slightly gravelly heavy silt loam that is commonly faintly mottled; (3) a subsoil of dark-brown to reddish-brown, gravel-free or slightly gravelly silty clay loam that is free of mottles in the upper part but has faint or distinct mottles in the lower part; and (4) a dense substratum of calcareous, grayish-brown, very gravelly loam glacial till.

The plowed layer in most places is thinner than that of the soils that have formed in glacial till. It is mainly 4 to 7 inches thick. In uneroded areas, it is 3 to 5 percent organic matter, and its nitrogen content is correspondingly moderately high. This layer has moderately good physical condition in most places. It is permeable to roots and water and is well aerated. In areas that have been intensively used or that have eroded, the plowed layer is much less porous, absorbs water slowly, and tends to become slightly cloddy if it is cultivated when too wet. In most areas, it contains some stone fragments that have worked up from the underlying till. It is slightly acid or neutral where it has not been limed. It has medium capacity to supply phosphorus and potassium.

The thin leached layer beneath the plowed layer extends only to a depth of between 8 and 12 inches. It is present only where the soils are not eroded and where they have not been plowed deeply. In other places, it has been incorporated in the plowed layer. Physically the material in this layer is porous and permeable to roots and water. It is much lower in nitrogen than is the plowed layer above it, but it is similar in its capacity to supply phosphorus and potassium. It is nearly neutral in most places.

The dark-brown subsoil extends to a depth of between 20 and 36 inches. It is much higher in clay than are other parts of the profile. It has a blocky structure, however, and plant roots penetrate between the blocks. The blocks become larger with depth, and roots are correspondingly restricted. The upper part is nearly free of mottles, which indicates that it is well aerated much of the time; the lower part has faint to distinct mottles, which show that it is saturated more frequently. This layer is nearly neutral in most places. Because it is moderately high in clay, its potassium reserve is very high. Its capacity to supply phosphorus is medium. Where the layer is thickest, coats of lime may be found in pores and cracks.

The underlying glacial till is dense and firm. Water penetrates it slowly, and few roots penetrate it. This layer is moderately to strongly calcareous. Its slow permeability contributes to slight wetness in the lower part of the subsoil. Only loss of water as runoff prevents these soils from being wet.

The thickness of the water-laid deposit varies from spot to spot. Where it is thinnest, the surface soil is a moderately gravelly silt loam. Where it is thickest, the surface soil is free of gravel and is a heavy silt loam or a silty clay loam. Differences of this kind may be found within distances of a few feet. Where the lake deposit is thickest, the Cayuga soils intergrade to Hudson soils. The least strongly sloping areas and those that receive some runoff from adjacent land merge with the somewhat poorly drained Ovid soils. In these places the lower part of the subsoil is distinctly mottled.

During April, free water stands above the dense glacial till after each rainy period. It rises to within 10 inches of the surface during wet periods, but recedes to a depth of more than 30 inches after several drying days. At this time of year, 4 to 6 consecutive drying days are generally needed before the soil will bear machinery. During May, water stands above the till periodically but rarely rises to within 18 inches of the surface for significant periods. At this time of year, 3 or 4 drying days will normally permit cultivation. Although free water is present above the till for short periods after rains in June, the soil can normally be cultivated after 1 or 2 drying days. Cayuga soils cannot be cultivated as quickly after rains as can Honeoye and Lansing soils.

Some plant roots, especially alfalfa roots, penetrate to a depth of 30 inches, but most roots remain in the topmost 15 inches. The zone that roots can use effectively is mainly 20 to 24 inches thick. This zone can hold 3½ to 4 inches of moisture that is available to plants. Moisture stress becomes apparent when one-half to two-thirds of the available moisture is used. Crops on this soil commonly show the effects of water deficiency after 7 to 10 days without rain in midsummer.

Cayuga soils are well supplied with lime. The capacity of the plowed layer to absorb bases is equivalent to 10 to 14 tons of ground limestone per acre. This capacity is 60 to 80 percent filled with bases in most areas. Where the surface soil is about pH 6.0, 2 to 3 tons of ground limestone are needed to raise the pH to a value near 7.0. Unlimed soils may need no lime in some areas; in others they need as much as 3 tons.

Though the nitrogen supply is moderately high in uneroded areas, nitrogen is released slowly during the cold springs, and applications of nitrogen fertilizer are necessary for good growth. The potassium-supplying power is very high as a consequence of the reserve in the clayey subsoil. Tests of the plowed layer may not show this reserve. Potassium fertilizer is commonly needed for crops like alfalfa, though the rate of depletion is less than on coarser textured soils of the county. Cayuga soils have medium capacity to supply phosphorus, and phosphorus fertilizer is necessary for good yields.

Cayuga soils are potentially highly productive, but they are also among those that require skilled management for high production and control of runoff and erosion. They are erodible soils, and they absorb water less rapidly than, for example, Honeoye and Lansing soils.

Chenango Series

The Chenango series consists of deep, well-drained, medium-textured, gravelly soils that have formed in glacial outwash sand and gravel that contain very little lime. These soils are very strongly acid to strongly acid. They are similar in some properties to Howard soils but are much lower in lime and have less clay in the lower subsoil.

Chenango soils occur on nearly level outwash terraces in the valleys, on alluvial fans where postglacial side streams left gravelly or channery deposits on the valley floors, and on hilly gravel deposits where streams that issued from the glacier dropped their loads. They are closely associated with the moderately well drained Braceville soils and the somewhat poorly drained Red Hook soils, both of which are in deposits of similar material. The adjacent soils on the uplands are mainly Lordstown, Volusia, and Erie soils. The adjacent soils on the flood plains of present streams are mainly Tioga and Middlebury soils.

Chenango soils have four principal parts: (1) a plowed layer of dark grayish-brown gravelly loam or gravelly silt loam; (2) an upper subsoil of yellowish-brown gravelly loam or gravelly silt loam; (3) a lower subsoil of dark-brown or dark yellowish-brown gravelly loam or gravelly sandy loam; and (4) layers of sand, gravel, and cobblestones of the original outwash deposit.

The plowed layer in most fields ranges from 7 to 9 inches in thickness. Its dark color is associated with its organic-matter content, which ranges mainly from 3 to 5 percent. The material is porous and permeable. In unlimed areas it is very strongly acid. It has a medium potassium reserve and medium phosphorus-supplying power. It is an excellent medium for roots if fertilized.

The yellowish-brown upper part of the subsoil extends to a depth of 12 to 18 inches. It also is porous and permeable. It is low in organic-matter content and is very strongly acid. It has a medium potassium reserve and medium phosphorous-supplying power. Physically, it is an excellent medium for plant roots, but its fertility is moderately low.

The dark-brown to dark yellowish-brown lower part of the subsoil extends to a depth of 36 to 50 inches. It appears to contain slightly more clay than the material above it, but it also contains more sand and gravel and less silt. It is permeable to roots and water. It has a lower available moisture capacity than the horizons above it, but the spaces between the pebbles are partly filled with fine material, which does prevent water from escaping rapidly into the substratum. This part of the subsoil is very strongly acid or strongly acid. It has a medium potassium reserve and medium phosphorous-supplying power. Plant roots penetrate it easily, and it is a source of water for crops.

The underlying glacial outwash consists of loose, porous gravel and sand. It holds a small amount of water. In some places beds of very fine sand or fine sand restrict the downward movement of water enough to hold water in the gravel above them for short periods. The gravel in the upper part of this layer is thinly coated with clay, but the fine material does not fill the pores. The upper part of this zone has been leached of the small amount of carbonates it originally held and is strongly acid or medium acid. Acidity decreases with depth, and carbonates are found as coats on the gravel at a depth of 5 to 8 feet. In some places the gravel in the very deep substratum is cemented by lime.

The texture of the upper part of these soils ranges mainly from gravelly loam to gravelly sandy loam. In some places, especially on alluvial fans, the surface soil is channery silt loam. Where Chenango soils merge with Howard soils in more calcareous material, lime is found at a depth of 50 or 60 inches and clay is most abundant in the lower part of the subsoil. On the sides of some valleys, the material is poorly sorted; till-like layers are present in the substratum; and many of the stone fragments are not rounded. On the alluvial fans, most of the stone fragments are flat pieces that lie like shingles in the substratum. The deposits of glacial outwash are very thick in most places. On alluvial fans the deposits are thick where the fan meets the upland and thinner down the slope toward the center of the valley. At the margins of alluvial fans the outwash is only a few feet thick over till or lake clays. Except on the alluvial fans, the depth to bedrock is very great.

Although Chenango soils are saturated when frost first leaves the ground in spring, they lose free water very quickly. Free water is present in the topmost 2 feet for only short periods during or immediately after soaking rains during April and May. During April, 2 or 3 consecutive drying days are normally enough to permit plowing. During May and June, only 1 or 2 days of drying are required. On the lower parts of the alluvial fans, free water may stand in the lower part of the subsoil for significant periods during April and May. These are places where Chenango soils intergrade to the moderately well drained Braceville soils.

Although the roots of deep-rooted crops and the roots of trees penetrate deeply into the substratum, most crops obtain most of their moisture from the topmost 30 or 40 inches. This volume of soil holds 3 to 5 inches of water that plants can use. Not all of this is easily available, however, and crops on these soils show the effects of moisture stress after a week or 10 days without rain in the middle of the summer. Some of the steepest areas are very droughty.

The surface soil has a moderate capacity to absorb bases. In most areas this is equal to 7 to 12 tons of ground limestone per acre. On unlimed areas 4 to 7 tons of ground limestone is needed per acre to raise the pH of the surface soil to a value near 7.0 If the soil has been limed previously to pH 6.0, the requirement is 1½ to 3 tons. The potassium reserve is medium. The potential phosphorus-supplying power is moderate, but it is less in unlimed soils.

Gently sloping Chenango soils are among the best potential soils in Tompkins County for crops. Moderate moisture-holding capacity limits crop yields in some years. For good yields, large amounts of lime and fertilizer are required.

Chenango gravelly loam, 0 to 5 percent slopes (CdA).—Generally, this soil is typical of the Chenango series. Some areas, however, are underlain by 5 to 10 feet of loose, poorly sorted gravelly material that was deposited over the firm glacial till. Some such areas are where beaches of the glacial lakes have formed gravelly ridges on the sides of the valleys, and some are where small deposits of gravel were left on the uplands. The characteristics of the soil itself are well within the range of the Chenango series, but the underlying poorly sorted gravelly material has greater water-holding capacity than the glacial till, and water is perched above the glacial till for significant periods in spring.

Most of this soil is on glacial outwash valley trains or on undulating parts of the uplands. Some of the areas mapped include spots of the moderately well drained Braceville soils. A very few areas of Red Hook soils, too small to be mapped separately, are shown on the soil map by wet-spot symbols.

This soil is excellent for crops, pasture, or forests. It is adapted to a wide variety of crops, including vegetables, fruits, and deep-rooted legumes. It is also among the best soils of the county for a wide variety of nonagricultural uses, and in some places has been taken over for nonagricultural uses.

Liming and fertilization are the first management needs. This soil has essentially no erosion problem. It has no need for artificial drainage, except in the few small wet spots. Supplemental irrigation in dry years would be effective. (Capability unit I-1; woodland suitability group 1a)

Chenango gravelly loam, 5 to 15 percent slopes (CdC).—This soil is on glacial outwash terraces and valley trains. Some areas are on moderately sloping terrace faces, some are on slopes to depressions on the terraces, and many are moderately sloping landforms against the valley sides. Some of the slopes are uniform and some are complex. Included in mapping are areas, too small to be mapped separately, of the moderately well drained Braceville soils, which are along the margins of terraces and in depressions on the terraces. Small spots of wet soils are shown by wet-spot symbols.

This soil is suitable for crops, pasture, or forest. It can be used for intertilled crops if precautions are taken to control runoff and erosion. It is among the best sites in the county for many nonagricultural uses, including sources of gravel and sites for housing.

Adequate liming and fertilization are the first requirements for good yields. Under intensive use for intertilled crops, erosion becomes a moderate problem. For some areas that have simple slopes, contour cultivation and stripcropping provide adequate water control. Areas that have complex slopes cannot be farmed on the contour, and they need to be protected by means of close-growing and sod-forming crops and by cultivation as nearly across the slope as possible. Some fields that contain spots of Braceville or Red Hook soils can be improved by draining the wettest spots. Yields are limited in some years by the limited ability of these soils to supply moisture. Conservation of moisture is very important. (Capability unit IIIe-4; woodland suitability group 1a)

Chenango gravelly loam, 15 to 25 percent slopes (CdD).—This soil is moderately steep or hilly. Parts of most areas that have been cleared of forest are somewhat eroded. In the greater part of most areas, erosion cannot be detected by examination of the soil but is evidenced by accumulations of eroded material in gently sloping places. Most areas, however, have spots where erosion is evident from the lighter color of the plowed layer and from concentrations of gravel on the surface. Such spots are most common on the complex slopes of hilly areas. The steepest slopes show distinct erosion, and the gently sloping areas among the hills have from a few inches to as much as 10 inches of eroded material over their original surface.

This soil commonly forms the steepest parts of fields that are dominated by the more gently sloping Chenango soils. It occupies the moderately steep faces of some terraces, the moderately steep faces of gravel deposits on the sides of valleys, and hilly gravelly areas in valleys or in the uplands where the ice front stood for long periods. It is closely associated with the moderately well drained Braceville soils and the somewhat poorly drained Red Hook soils, both of which formed in the same kinds of deposits. It intergrades to the sandy Arkport soils or the medium-lime Howard soils. The adjacent soils in the uplands are mainly of the Lordstown, Erie, or Volusia series. The associated soils of the first bottoms are mainly Tioga and Middlebury soils.

Although this soil can be used for crops, it is so steep that use of machinery is very difficult and the erosion hazard is serious when the soil is bare. Generally, long-term hay is the most feasible use, but pasture and forest are also suitable uses. This soil is among the best soils of the county for many nonagricultural uses, including sites for housing and sources of gravel.

Intensive liming and fertilization are essential for even moderate yields of crops and pasture. Plowing should be across the slope, to the extent feasible, and strips of sod should be left to retard runoff. Practices that control runoff and that increase infiltration of water are very important, for this soil is droughty in midsummer. Pastures are productive in spring and fall if limed and fertilized, but they are commonly not highly productive in midsummer. Most of the pastures have not been limed or fertilized, and consequently they produce little forage at any time. (Capability unit IVe-8; woodland suitability group 1b)

Chenango gravelly loam, fan, 0 to 8 percent slopes (CnB).—This soil occupies fans formed where streams of steep gradient emerge from the uplands. Rapidly running water has carried rock fragments downhill and deposited them where the stream emerges onto the valley floor. The fragments are largest and the deposits deepest at the apex of the fan, at the foot of the hill. The fan slopes gently toward the middle of the valley and spreads laterally along the foot of the hill. The deposit is thickest and the height of the fan is greatest in a line from the mouth of the stream toward the middle of the valley. The deposit is thinner on both sides of this line and toward the middle of the valley. The material is also coarsest at the apex of the fan and becomes increasingly fine with distance from it. Where the fan merges with the valley floor, the deposits are only 4 or 5 feet thick. Thus, this soil varies from one part of the fan to another, in accordance with the character of this deposit. Except for the predominance of flat stone fragments, the soil itself is well within the range of the Chenango series. The substratum generally contains more fine material than is typical of the substratum of Chenango soils on glacial outwash terraces. Braceville and Red Hook soils occur in these areas near the margins of the fan, where the deposit is thinnest and the soil is wettest.

This Chenango soil is among the best soils in the county for crops, pasture, or forest. Where the surface is not too channery, it is well suited to intertilled crops, including vegetables. It is also among the best sites in the county for some nonagricultural uses. It is well suited to use as building sites. Most areas are not good sources of gravel.

Intensive liming and fertilization are the first requirements for good crop production. Some areas are subject to streambank erosion, and special control practices are needed. The slope is strong enough, especially near the apex of the fan, that sheet erosion is a slight problem. For most areas adjustment of the cropping system is the most feasible method of controlling erosion. Some of the larger areas are adapted to contour tillage and stripcropping. Although this soil has slightly better moisture-holding capacity than some of the Chenango soils on terraces, practices that retard runoff and encourage infiltration are needed for maintenance of the moisture supply in midsummer. (Capability unit IIe-2; woodland suitability group 1a)

Chippewa Series

The Chippewa series consists of deep, poorly drained, medium-textured soils that have formed in acid or very low-lime glacial till. They have a fragipan 10 to 12 inches below the surface. They lie in places where water from adjacent land accumulates.

Chippewa soils are the poorly drained associates of the somewhat poorly drained Volusia soils and the moderately well drained Mardin soils. They occur mainly as flat areas on the hills in the southern part of the county. Many areas are not large enough to be mapped separately; hence, they are mapped either as inclusions within areas of, or as part of a complex with, the closely associated Volusia soils. The more extensive areas of Chippewa soils, which commonly contain depressional areas of the very poorly drained Alden soils, are mapped as part of an undifferentiated unit with Ellery and Alden soils.

Chippewa soils have four parts: (1) a surface layer of very dark gray or nearly black silt loam high in organic matter; (2) a layer of gray or dark grayish-brown, strongly mottled channery silt loam; (3) a firm, very slowly permeable fragipan of channery loam or heavy silt loam; and (4) firm, medium acid, channery loam or silt loam glacial till.

In forested areas the surface soil is only 4 to 6 inches thick. In cultivated areas from 4 to 6 inches of eroded material has been deposited on the surface. Here, the surface soil is very dark grayish brown or very dark gray and is 12 to 18 inches thick. In such areas the plowed layer commonly does not include all of the dark-colored soil. The organic-matter content is high (commonly 6 to 8 percent), and the nitrogen content is correspondingly high. The plowed layer may contain some flat stones, but it is commonly less channery than the associated soils. Though nitrogen is plentiful, it is released very slowly for use by crops. The plowed layer is normally strongly acid unless it has been limed.

The layer between the plowed soil and the fragipan is 4 to 6 inches thick. Its gray color shows that the soil is saturated for long periods. The prominent yellowish-brown iron staining shows that it dries periodically. This layer may be channery, but in some areas it is almost free of channery fragments and consists of very silty or very fine sandy material. In these places the layers above the fragipan appear to have formed in water-deposited material. This layer is low in organic-matter content. It is strongly acid or very strongly acid. It has medium capacity to supply phosphorus and potassium and has moderate water-holding capacity. It is permeable to roots and to water, and roots can develop in it if the water table is not high enough to interfere.

Where no eroded material has accumulated, the top of the fragipan is 10 to 12 inches below the surface. In the many small areas where material eroded from adjacent soils has been deposited, the top of the fragipan is 15 to 18 inches below the surface. The fragipan is very dense. Water moves downward in it very slowly, if at all, and roots do not penetrate it. Where large trees have been blown down, the bottom of the ball of earth that is held in the upturned roots is the top of the fragipan. The fragipan is strongly acid in the upper part. The pH is less than 6.0 at a depth of 3½ feet.

The underlying glacial till is almost as dense as the fragipan. It merges with the fragipan at a depth of 42 to 48 inches. It is normally acid in the upper part, but acidity decreases rapidly with depth. It is calcareous at a depth of 5 feet in some places.

In depressions where Chippewa soils intergrade to Alden soils, the surface soil is thickest and darkest and the layer below the surface soil is free of mottles, except around roots, and is only medium acid. Where Chippewa soils intergrade to Volusia soils, the surface soil is thinnest and lightest colored, though distinctly darker colored than that of Volusia soils. In these places the layer above the fragipan is dark grayish brown and is very highly mottled. The Chippewa soils associated with Alden soils are the wettest, and those associated with Volusia soils the driest of the series, and the differences described result from the differences in wetness. Chippewa soils are generally most strongly acid on the hilltops. On the sides of some valleys, they intergrade to Erie soils. In some of these places, the fragipan is only medium acid and the underlying till may be calcareous. Though the till is at least 6 feet thick over bedrock in most places, bedrock is within 3 or 4 feet of the surface in some areas where Chippewa soils are associated with Tuller soils.

When frost leaves the ground in spring, the water table is at the surface of Chippewa soils. In the areas that have no provision for removal of water, the water table fluctuates within 6 or 8 inches of the surface throughout the month of April. During this period, the soils cannot be cultivated. By the middle of May, when plants begin to grow and evaporation becomes significant, the water table recedes between rains but is generally above the fragipan. At this time of year the soils can rarely support machinery. By the first of June, the water table falls to the fragipan between rains. The soils will support machinery during May after 5 to 10 drying days. By the latter part of June, 3 to 7 drying days are generally necessary. Consequently, these soils can rarely be used for spring-planted crops unless they are drained artificially. The small areas of Chippewa soils included in the Volusia mapping units are too wet to be tilled at times when the Volusia soils are dry enough late in April and during most of May.

The available moisture capacity is not important, because free water commonly seeps in from adjacent areas long after rains have stopped. During very dry periods, it is common to see crops wilting on the associated Volusia soils when crops on the small areas of Chippewa soils show no sign of water deficiency.

A very high content of organic matter and of nitrogen shows that organic matter decomposes very slowly in these soils and that nitrogen is released in only small quantities. Because the nitrogen in the soil is released so slowly, nitrogen fertilizer is needed. But if these soils are drained they release nitrogen rapidly during warm dry periods in midsummer, and under such conditions the application of nitrogen fertilizer may not be advisable. Small grains are likely to lodge on drained Chippewa soils that have been heavily fertilized with nitrogen.

The phosphorus-supplying power is only medium, and lack of phosphorus generally limits yields of crops and pasture. If conditions are favorable for rapid decomposition of organic matter, crops in some areas may respond slightly to phosphorus for some time.

The supply of quickly available potassium may be adequate when crops are growing slowly, but the reserve that can be converted to available form is only medium, because the content of clay is generally less than 25 percent. Consequently, yields are commonly limited by lack of potassium when other deficiencies have been corrected.

Liming is an outstanding need of these strongly acid soils. The plowed layer has a capacity to hold bases equal to 12 to 16 tons of ground limestone. If the soil has not been limed, 5 to 10 tons is commonly needed to raise the pH to a value near 7.0. Even when the pH is near 6.0, as much as 3 or 4 tons is needed.

Collamer Series

The Collamer series consists of deep, moderately well drained, medium-textured soils that have formed in lake deposits. These deposits are predominantly silt but include layers of very fine sand and of clay. Collamer soils are very silty, stone-free soils that are very susceptible to erosion. They differ from Williamson soils in that they are less acid, contain more clay, and have a zone of clay concentration instead of a fragipan.

The Collamer soils in Tompkins County are mainly gently sloping or undulating. They occur in valleys once occupied by glacial lakes. The deposits in these valleys contain relatively thick layers of clayey material in many places. Where this clayey material appears at the surface, Hudson soils have formed. Consequently, Collamer soils are closely associated with Hudson soils in many places, and Hudson and Collamer silt loams therefore are mapped as an undifferentiated unit. Areas in which Collamer soils are dominant lie adjacent to areas of Niagara soils, which also formed in silty material. Collamer soils typically occupy the highest part of relatively smooth landscapes that receive little water from adjacent areas. They shed water, however, to the associated areas of Niagara soils. The poorly drained Canandaigua soils occur locally in depressions. In some places, as in one east of the Cornell campus, Collamer soils intergrade to the less clayey Williamson soils, which are on similar landforms. Locally, Collamer soils adjoin sandy Arkport soils where sandy deltas were deposited near the margins of ancient lakes.

Collamer soils, if uneroded, have four distinct parts: (1) a plowed layer of dark grayish-brown silt loam; (2) a leached layer of brown silt loam with few to common mottles; (3) a layer of dark-brown or dark grayish-brown heavy silt loam or silty clay loam, in which clay has accumulated and which has few mottles in the upper part but many mottles in the lower part; and (4) grayish-brown and dark grayish-brown layers of silt intermingled with layers of very fine sand and clay. These lowest layers are calcareous and represent the unmodified lake deposit.

In uneroded areas the plowed layer is about 8 inches thick. It is moderately high in organic-matter content (3 to 5 percent). This layer is porous, plant roots penetrate it easily, and it has good water-holding capacity. It has a moderately high total nitrogen content, a medium content of available phosphorus, and a medium potassium reserve. It is medium to strongly acid where it is unlimed.

The leached layer below the plowed layer is present only where the soils have not been plowed deeply and are not eroded. In the uneroded soil, this layer extends to a depth of 11 to 14 inches. The mottling is evidence of periodic wetness, but the dominant brown color indicates that aeration is good much of the time. If it has not been compacted by tillage, this layer is permeable to water and roots and has moderately good water-holding capacity. It is medium acid to strongly acid. It has a medium content of available phosphorus and a medium potassium reserve.

The more clayey lower part of the subsoil extends to a depth of 24 to 40 inches. It is arranged in moderately expressed blocks. The increase in mottling with depth shows that the upper part is aerated for longer periods than the lower part. Plant roots can penetrate this layer when it is not saturated. It is commonly medium acid to strongly acid in the topmost part, but acidity decreases with depth, and the lower part is slightly acid or neutral. This layer supplies little nitrogen, medium amounts of phosphorus, and medium amounts of potassium. It has good water-holding capacity.

The underlying silty lake deposit consists of alternating layers of silt, very fine sand, and clay. Few roots penetrate these layers, and water penetrates very slowly. This substratum is noncalcareous at the top in some places but may be calcareous at a depth of 24 to 42 inches. In the most acid spots, however, free carbonates are present only below a depth of 4 feet.

Because of the layering of the original deposit, the texture of the various horizons differs widely from spot to spot within the same field. In some places the profile includes a layer of very fine sandy loam as much as a foot thick. In some places, for example, along Fall Creek near Freeville and in spots on the Cornell property near Ithaca, the surface soil is very fine sandy loam. In the driest areas of these soils, the layer immediately below the plowed layer is not mottled. Where these soils join Niagara soils, the layer below the plowed layer is strongly mottled. Where Collamer soils join Hudson soils and locally in spots within the areas of Collamer soils, the subsoil is as high in clay as that of some Hudson soils, but the substratum is mainly silt and very fine sand. In places that join areas of Williamson soils, the subsoil is less than 20 percent clay and is slightly firm, like a weak fragipan. In most places the lake deposit is very thick. Bedrock is at least 10 feet below the surface.

After each rain during the month of April, free water stands for a short time within 6 inches of the surface. It recedes quickly, however, during dry periods, and at times the water table is more than 30 inches below the surface. During April, 4 to 6 drying days are generally needed before these soils can be plowed. During the month of May, the soil is saturated at a depth of 18 inches for short periods, but the water recedes quickly during dry periods. At this time of year, 3 or 4 drying days are generally needed before the soil can be cultivated. During June, when plants are growing rapidly, 1 or 2 drying days will usually permit tillage.

Though the roots of deep-rooted plants extend to a depth of 3½ feet in some places, the main root zone is confined to the topmost 18 to 24 inches. This volume of soil will hold from 3½ to 5 inches of water that plants can use. Not all of this water is easily available, however, Crops show a reduction in rate of growth and other signs of moisture deficiency after a week or 10 days without rain in the middle of the summer.

Where these soils are not eroded, the plowed layer has a moderate capacity to hold bases. In most places this capacity is equivalent to 8 to 12 tons of ground limestone per acre. In unlimed soils it is 30 to 50 percent filled. An unlimed soil needs from 2 to 6 tons of ground limestone per acre to raise the pH to a value near 7.0. If the surface soil has been limed previously to pH 6.0, the requirement is 2 to 3 tons of ground limestone. Though the nitrogen content is moderately high, nitrogen is released slowly in spring. Most crops respond to nitrogen fertilizers. The supplies of available phosphorus and potassium are only medium. The potassium supply is significantly less than that in the associated Hudson soils.

These are very erodible soils, even where the slope is gentle. They are moderately wet, especially in spring. Nevertheless, they respond to good management and are suitable for a wide variety of crops.

In this county, Collamer soils are mapped as part of an undifferentiated group, Hudson and Collamer silt loams, 2 to 6 percent slopes. Small areas of Collamer soils are included in the more strongly sloping units of Hudson soils.

Conesus Series

The Conesus series consists of deep, moderately well drained, medium-textured soils that have formed in moderately calcareous glacial till. Unless limed, these soils are strongly acid in the upper 18 inches, but the lower part of the subsoil is medium acid to neutral.

Conesus soils occupy nearly level to gently sloping or undulating areas, mainly in the northwestern fourth of the county. They are associated with the well-drained Lansing soils and the somewhat poorly drained Kendaia soils. Their position prevents the accumulation of large amounts of water from adjacent areas, but enough water does accumulate to keep the soils saturated for significant periods.

Conesus soils have four principal parts: (1) a plowed layer of dark or very dark grayish-brown gravelly silt loam; (2) an upper subsoil of yellowish-brown or brown, faintly mottled gravelly silt loam; (3) a lower subsoil that is dark brown, mottled, and moderately clayey; and (4) a firm substratum of dark grayish-brown, calcareous gravelly loam or silty clay loam till.

The plowed layer is 6 to 8 inches thick. Its dark color results from a moderately high organic-matter content (3½ to 6 percent). This layer is porous and well aerated, and plant roots can exploit it thoroughly. Unless it has been limed it is strongly acid. It has high capacity to supply potassium and medium capacity to supply phosphorus. It contains enough gravel to interfere slightly with tillage.

In uneroded areas the upper part of the subsoil extends to a depth of 12 to 16 inches. This is a porous, moderately gravelly, loamy layer that is physically a good medium for plant roots. The predominance of yellowish-brown to brown colors indicates that aeration is good most of the time. Mottles in the lower part of this layer, however, show that the soil at this depth is saturated for significant periods. This horizon is strongly acid. It has high capacity to supply potassium and medium capacity to supply phosphorus.

The lower part of the subsoil contains more clay than the layers above or below it. It is gravelly silty clay loam in most places. In uneroded soils this layer begins at a depth of 12 to 16 inches and extends to a depth of 30 to 42 inches. The dark-brown colors indicate generally good aeration, but the mottles are evidence of periodic wetness. Though this layer is higher in clay and is wet more frequently than the layers above, roots penetrate it and obtain moisture and nutrients from it. The material is arranged in small blocks. Large roots extend downward between the blocks, and many small roots penetrate the blocks themselves. The material is moderately gravelly. The upper part of this horizon is medium acid or strongly acid in some places, but the pH increases with depth, and the lower part is neutral. Because of its greater clay content, this horizon has a larger potassium reserve than the other horizons. It has only moderate phosphorus-supplying power.

The calcareous glacial till is 30 to 42 inches below the surface. The average depth to this material is about 3 feet. The till is gravelly silty clay loam or silt loam, very firm and dense. It is slowly permeable to water and is a major factor in keeping these soils moderately wet. Few plant roots penetrate this material, because it is poorly aerated. The lime content is only moderate, compared to that of the high-lime soils of the northernmost parts of the county. The phosphorus reserve is medium, and the potassium-supplying power is high. The till rests on bedrock at a depth that ranges from 4 feet to more than 20 feet.

The northernmost areas of Conesus soils intergrade to areas of the high-lime Lima soils, which are moderately well drained also. In these areas, the depth to the calcareous till may be as little as 30 inches and the pH of the upper part of the soil is near 6.0. The southernmost areas of Conesus soils intergrade to areas of the low-lime Langford soils. In these places the depth to calcareous till is commonly 3½ or 4 feet; the upper part of the subsoil is strongly acid, and the lower part of the subsoil is less clayey and more dense, resembling the fragipan of Langford soils. Flat fragments of stone are more prominent in the plowed layer of these areas.

Within single fields, Conesus soils at the dry limit of the drainage class merge with the well-drained Lansing soils, and Conesus soils at the wet limit of the drainage class merge with the somewhat poorly drained Kendaia soils. At the dry limit, the topmost 12 to 16 inches may be almost free of mottles. At the wet limit, faint mottles are present immediately under the plowed layer.

When frost leaves the ground in spring, Conesus soils are saturated. During the month of April, free water stands within 6 inches of the surface after soaking rains but recedes to a depth of nearly 30 inches during long periods without rain. At this time of year, 4 to 6 consecutive drying days are usually needed before the soil will bear machinery. During May, free water stands above a depth of 18 inches for only very short periods in years of normal rainfall, and only 3 or 4 consecutive drying days are required for tillage. During June, free water is commonly present periodically above the firm till but rarely stands for significant periods within the topmost 2 feet. At this time of year, only 1 or 2 consecutive drying days are needed before the soil can be tilled.

Most crops fill the topmost 12 to 16 inches with fine roots and, as the season advances, extend their root systems into the clayey lower part of the subsoil. Deep-rooted perennial crops send their roots to the top of the underlying till. It is difficult to establish the maximum depth at which plant roots can extract significant amounts of water from the soil. During midsummer, most crops probably exploit, at least moderately, the topmost 30 to 40 inches, which can hold between 5 and 7 inches of water that plants can use. Usually, part of the moisture supply has been exhausted by the time an extended drought begins in midsummer. Growth of crops slows significantly when half to two-thirds of the total available moisture is exhausted. Crops generally begin to show moisture stress after 10 days to 2 weeks without rain at the height of the growing season.

Conesus soils are moderately supplied with plant nutrients. They are moderately high in total nitrogen but release it so slowly in spring that crops respond readily to nitrogen fertilizers. Even in midsummer, when release of nitrogen is moderately rapid, crops commonly respond to nitrogen fertilizer, because at this season their requirements are high. They may fail to respond, however, if moisture is lacking or if other factors are limiting. The phosphorus-supplying power is moderate. Phosphorus availability is increased slightly by liming, but phosphorus fertilization is essential for good crop yields. The clayey lower subsoil provides a high reserve supply of potassium that is not present in many soils of the southern part of the county. The amount of potassium may be adequate to support moderate yields, but the potential productivity of the soils cannot be realized without supplemental potassium fertilization.

Unless limed, these soils are strongly acid. The plowed layer in uneroded areas has a capacity to absorb bases equal to 9 to 13 tons of ground limestone. In unlimed soil this capacity is about one-half filled. From 3 to 4 tons of ground limestone is needed to raise the pH to a value near 7.0. A Conesus soil that has been limed previously and has a pH of 6.0 requires 2 to 2½ tons. Nevertheless, Conesus soils are among the more fertile soils of the county, and they are among those on which the response of crops to liming and fertilization is high.

Conesus gravelly silt loam, 0 to 3 percent slopes (CfA).—This nearly level soil is mainly in the wetter half of the drainage range for the Conesus series. It has the darkest colored surface soil of all the Conesus soils mapped in Tompkins County, and the most strongly mottled subsoil. Its acreage is only about one-fifth that of Conesus soils on 3 to 8 percent slopes. Conesus soils occur on nearly level topography only in places that receive essentially no water from adjacent areas. Most of the nearly level areas in the region of Conesus soils are wet enough to be classified as Kendaia soils, which are somewhat poorly drained.

This soil is closely associated with nearly level Kendaia soils that receive runoff from higher areas. It also adjoins Conesus soils that have slopes of 3 to 8 percent and well-drained Lansing soils that have slopes of more than 3 percent. The areas mapped include a small but significant acreage of Kendaia soils and minor knolls of Lansing soils. The spots of Kendaia soils are especially significant because their wetness may interfere with fieldwork early in spring.

This soil is well suited to crops, pasture, or forest. Many areas are used intensively for intertilled crops. All of the crops commonly grown in the county can be grown, including vegetable crops and crops needed to support dairying. This soil also provides some of the better sites in the uplands for many nonagricultural uses, though temporary wetness and frost heaving present more serious problems than on the associated Lansing soils.

This soil is potentially one of the most productive in the county. Maintenance of fertility and correction of acidity are the most important management problems. Erosion is not a serious problem. Some areas, especially those that contain inclusions of Kendaia soils, can be improved by drainage. (Capability unit IIw–1; woodland suitability group 4)

Conesus gravelly silt loam, 3 to 8 percent slopes (CfB).—This soil is representative of the central concept of the Conesus series. The upper part of the subsoil, to a depth of 12 to 16 inches, is unmottled or only faintly mottled. Slopes range from short and slightly convex to long and uniform, and the gradient is most commonly between 3 and 5 percent. Some water runs off these gentle slopes, and some is received from adjacent areas.

This soil is commonly on the intermediate or on the highest parts of a broadly undulating landscape. In the intermediate positions, the associated soils are Lansing soils at slightly higher levels and mainly Kendaia soils in the extensive nearly level areas and in long narrow areas along shallow waterways. Included in many of the mapped areas are small knolls of as much as 8 percent gradient, which are mainly Lansing soils. These knolls have little effect on use or management of whole fields.

Many areas of this soil are crossed by long, narrow, shallow depressions in which water runs during heavy rains. Long, narrow strips of Kendaia soils, too small to be mapped separately, occur along such depressions. These strips occupy as much as 5 percent of some mapped areas. Near the 1,000-foot contour in the valley of Cayuga Lake are slightly elevated areas of this soil surrounded by areas on which there is a thin deposit of moderately fine textured lake-laid sediments. These surrounding soils are members of the Cayuga or Ovid series. Small areas of Ovid soils are also included in the mapped areas of this Conesus soil.

This soil is well suited to crops, pasture, or forest. It is used most commonly for crops and pasture, though some small woodlots remain. It is well suited to vegetables, including green beans, peas, and cabbage. This soil is also suited to many nonagricultural uses, but periodic wetness and frost heaving are more serious problems than on the associated Lansing soils.

Maintenance of fertility and control of acidity are the most important management problems. The erosion hazard is moderate. Contour tillage, stripcropping, and diversion of water are effective means of controlling erosion where intertilled crops are grown frequently. Tile drainage of wet spots and of narrow strips along water courses is very important for improvement of some areas. Response to management is high, and under good management this is one of the more productive soils of the county. (Capability unit IIe–7; woodland suitability group 4)

Conesus gravelly silt loam, 3 to 8 percent slopes, eroded (CfB3).—This soil is not extensive. It represents only about 6 percent of the acreage of Conesus soils that have slopes of 3 to 8 percent. The slopes are distinctly convex in most places, and the gradient is mainly near the upper limit of the range.

The erosion hazard is not serious, and the degree of erosion differs within individual areas. Most of the acreage has lost about 4 to 6 inches of soil and now has a plow layer that consists largely of material that was originally part of the upper subsoil. The plowed layer is lower in organic-matter content than that of the uneroded soil, but it is similar in texture. In small spots, mainly the most strongly sloping parts, the clayey subsoil is at the surface. In these places, the plowed layer is lowest in organic-matter content, and it is finer textured and less acid than that of the uneroded soil. Material removed by erosion has accumulated in small depressions and along small drainageways, where it raises the surface of the soil and reduces wetness.

This soil is adjacent to Lansing soils that have similar or steeper slopes and to Kendaia soils that are nearly level. On the slopes to Cayuga Lake, it is associated with the finer textured Cayuga and Ovid soils. The mapped areas have small inclusions of Kendaia and Lansing soils as well as significant acreages of uneroded soil and spots where eroded material has accumulated on the surface.

This soil is suited to crops, pasture, or forest. Practically all of the crops commonly grown in the county can be grown. Some areas are used for vegetable crops with reasonable success. This soil also provides some of the better sites for many nonagricultural uses, though periodic wetness and frost heaving are more important problems than on the associated Lansing soils.

As a result of its eroded condition, this soil has management needs somewhat different from those of Conesus gravelly silt loam, 3 to 8 percent slopes. Its surface soil is commonly less acid than that of the uneroded soil; consequently, the lime requirement is slightly lower. Its nitrogen supply is significantly lower, so it needs nitrogen fertilizer. In phosphorus-supplying capacity and potassium-supplying capacity, the two soils are about equal. Loss of organic matter and the resulting deterioration in tilth have made this eroded soil more susceptible to runoff and erosion than the uneroded soil; consequently, it has more need for erosion-control measures, such as contour tillage, stripcropping, diversion terraces, and grassed waterways. Drainage of wet spots would make timely cultivation easier. (Capability unit IIIe-8; woodland suitability group 4)

Darien Series

The Darien series consists of deep, somewhat poorly drained, moderately fine textured soils that have formed in glacial till. In most places the till appears to have been influenced by lake-laid clay and silt that apparently were overridden by the glacier and mixed with material similar to that in which Valois soils formed. In some places the clay may have been derived from shale in the till.

The Darien soils occupy gently sloping to undulating areas near valleys formerly occupied by lakes. They are commonly associated with the rolling to hilly topography that marks the places where the ice front stood for considerable periods. In these places they are typically associated with Langford and Erie soils, which formed in glacial till, and with Hudson and Rhinebeck soils, which formed in lake-laid clay. Because of their position on the landscape, they either dispose slowly of external water or receive water from adjacent higher land.

Darien soils have four distinct parts: (1) a plowed layer of very dark grayish-brown gravelly silt loam; (2) a thin leached layer of grayish-brown, mottled, heavy gravelly silt loam; (3) a subsoil of grayish-brown, strongly mottled gravelly silty clay loam; and (4) a substratum of olive-brown, mottled gravelly silty clay loam glacial till.

The plowed layer in most fields is 8 to 10 inches thick. Its very dark color is associated with a moderately high organic-matter content (4 to 6 percent). Also associated with the organic-matter content is a moderately high total nitrogen content. This layer is medium acid or slightly acid. It has a high potassium reserve and medium phosphorus-supplying power. It is a moderately good root zone, but it can become cloddy if it is plowed when either too wet or too dry.

The thin leached layer under the plowed layer extends to a depth of 12 to 15 inches. In some places most of it has been incorporated in the plowed layer. Its grayish color and mottling show that it is alternately wet and dry. The wetness is a result of slow permeability of the subsoil. This layer is porous and allows roots to penetrate when it is not wet. It is medium acid or slightly acid. It has high capacity to supply potassium and medium capacity to supply phosphorus.

The somewhat clayey subsoil extends to a depth of 36 to 48 inches. Its strong mottling is the result of periodic wetness. It is slowly permeable to water. It is arranged in coarse prisms and blocks, among which roots of deep-rooted plants can penetrate when the soil is not wet. This layer has a high reserve supply of potassium. It has medium phosphorus-supplying power. In most places it is slightly acid.

The dense glacial till is very slowly permeable to water, and few roots reach it. Though the upper part may be only neutral, the till is calcareous 36 to 48 inches below the surface. The reserve supply of potassium is high, and the supply of phosphorus is moderate. The slow permeability of this material is a major factor controlling the wetness of Darien soils. This layer of till is normally thick. Bedrock is commonly at a depth of more than 15 feet and in many places is at a depth of more than 50 feet.

Pockets of sandy, silty, or clayey lake material may be found locally within areas of these soils. These appear to be lake-laid materials that were not thoroughly mixed by glacial action. In some places silty deposits on the surface make the depth to the clayey subsoil 20 inches or slightly more.

Darien soils are very wet in spring. During April, free water stands between 6 and 15 inches below the surface much of the time. At this time of year, 5 to 7 consecutive drying days are commonly needed before the soil can be cultivated. During May, free water is generally below a depth of 10 inches, and for significant periods it is below 20 inches. During May, 3 to 5 consecutive drying days are needed before tillage. During June, the water table stands above the clayey subsoil for short periods after rains, but it is not commonly near the surface for extended periods. At this time of year, 2 or 3 consecutive drying days are needed before cultivation is possible.

Though some roots penetrate to the underlying glacial till, most are confined to the topmost 15 or 20 inches. This volume of soil holds between 3 and 4 inches of water available to plants. These values are not meaningful in spring and early summer when the soil contains free water after each soaking rain. In midsummer, however, they are significant, for Darien soils can be deficient in moisture. At this time of year, after 7 to 10 successive days without rain, plants commonly show the effects of moisture deficiency.

Darien soils have moderately high capacity to hold bases in the plowed layer. This capacity is equivalent to between 9 and 14 tons of ground limestone per acre in most areas. The unlimed surface soil is mainly medium acid. From 2 to 5 tons of ground limestone per acre is needed to raise its pH to a value near 7.0. If these soils have been limed previously to pH 6.0, the requirement is 2 to 3 tons. Within the root zone, Darien soils have a high potassium reserve and medium phosphorus-supplying power. They have a moderately high supply of total nitrogen. Nitrogen is released very slowly in spring, but during some periods in midsummer, the amount released may be adequate.

Wetness approaching the limit for cultivation and the tendency of the surface soil to clod are among the more serious limitations of Darien soils. The erosion hazard is moderate, and on sloping land erosion can be a serious problem.

Darien gravelly silt loam, 2 to 8 percent slopes (DgB).—This is the only Darien soil in Tompkins County. Some areas near the village of Varna are moderately well drained or well drained.

This soil is suited to crops, pasture, or forest. Its tendency toward moderately poor tilth makes it less well suited to some vegetable crops than are some other soils of the county. Its wetness favors use for the kinds of crops grown in support of dairying. Wetness limits its suitability for many nonagricultural uses. The substratum in some areas contains layers of silt, sand, or clay that may be unstable and consequently pose special problems in some kinds of construction.

Generally, this soil is not well suited to systematic drainage. Some fields can be improved greatly by draining the wettest spots. Lime is generally needed for legumes; complete fertilizer is needed for even moderate yields of all the common crops. In some areas the erosion hazard is moderate. Tillage across the slope or in strips is a practical means of water control in some such areas. Other areas can be improved by diverting water that runs onto them from adjacent higher land. (Capability unit IIIw-4; woodland suitability group 11a)

Dunkirk Series

The Dunkirk series consists of deep, well-drained, stone-free, silty soils that have formed in lake deposits. All of the Dunkirk soils in Tompkins County are steep. They are mapped as part of an undifferentiated mapping unit (Hudson and Dunkirk soils, 20 to 45 percent slopes) that is described under the heading "Hudson Series."

Dunkirk soils occur where streams have dissected the material deposited by the glacial lakes. In many places the streams have cut through layers of both silty and clayey material, and as a result Dunkirk and Hudson soils are closely associated. The associated soils on the undissected parts of the lake deposits are mainly of the Collamer, Niagara, Hudson, and Rhinebeck series. Locally, Dunkirk soils are associated with the sandy Arkport soils, which are on deltas.

The steep Dunkirk soils have three principal parts: (1) a surface soil of grayish-brown or dark grayish-brown silt loam; (2) a subsoil of dark-brown, blocky heavy silt loam or silty clay loam; and (3) horizontal beds of silty material interrupted by thin layers of clay.

Most cleared areas of Dunkirk soils are eroded to such an extent that the surface soil is 4 to 6 inches thick and is only 2 or 3 percent organic matter. In forested areas the surface soil is only 3 to 5 inches thick, but it is 5 or 6 percent organic matter. In the eroded areas the surface crusts if it is exposed to the sun, but under a good stand of grass it is porous and absorbs water rapidly. The surface soil is mainly medium acid or strongly acid if it has not been limed.

The subsoil, which extends from a depth of 8 inches to 30 or 40 inches, contains more clay than the layer above it or the layer below it. It is arranged in well-defined blocks, and plant roots penetrate it easily. It has good waterholding capacity. This layer has a medium reserve of potassium and medium phosphorus-supplying power but is low in nitrogen.

The underlying glacial lake deposit is predominantly silt but commonly has thin layers of clay spaced from a fraction of an inch to several inches apart. This material is slowly permeable to water, and few plant roots penetrate it deeply. It is normally only slightly acid or neutral in the upper part, but it is calcareous 30 to 50 inches below the surface.

Locally, Dunkirk soils contain layers of very fine sand. The amount of clay in the subsoil ranges from 15 to 30 percent in most places and commonly varies from spot to spot within the same area. In unlimed areas the pH in the upper part of the soil is near 5.0. The depth to carbonates is between 30 and 50 inches in most places. Where Dunkirk soils intergrade to Hudson soils, they are finer textured and have only a medium acid or a slightly acid surface soil. Faint mottling may occur in the lower part of the subsoil in some places, even on the steep slopes.

Though Dunkirk soils are saturated when frost leaves the ground in spring, free water rarely stands above a depth of 20 inches for significant periods during April. During May, free water may be found in the upper part of the soil immediately after rains, but it recedes quickly. Because the only Dunkirk soils in this county are on slopes too steep for cultivation, this periodic wetness has less significance than on Dunkirk soils of other areas. Roots of legumes extend to a depth of 30 or 40 inches or more. This volume of soil could hold from 5 to 7 inches of water available to plants. The slopes are so steep, however, that much of the water runs off the surface. The moisture content rarely is at field capacity when dry periods start. Consequently, these soils show the effects of drought quickly during midsummer.

Dunkirk soils have only moderate capacity to hold bases. In uneroded soils, the uppermost 6 inches of an acre can hold the equivalent of 8 to 12 tons of ground limestone. In eroded areas where organic matter has been lost, the capacity is more commonly equal to about 5 tons of ground limestone. In uneroded and unlimed areas, the capacity is about 30 percent filled. In these areas the soils need 4 to 6 tons of ground limestone per acre to raise the pH to a value near 7.0. If they are at pH 6.0, the requirement is 2 to 3 tons of ground limestone. These soils have medium capacity to supply potassium and phosphorus. The nitrogen supply depends largely upon the degree of erosion.

Even gently sloping Dunkirk soils are extremely erodible. On the steeply sloping Dunkirk soils in Tompkins County, the erosion hazard is extremely serious. Most areas are in grass or trees.

Eel Series

The Eel series consists of moderately well drained, medium-textured, deep soils. These soils are young. They are forming in neutral or calcareous recent alluvium on the first bottoms along streams and are just beginning to acquire characteristics different from those of the original deposit. In most areas the upper part of the soil is nearly neutral. Organic matter has accumulated in the surface layer, but except for evidence of wetness below a depth of 15 to 18 inches, the subsoil has been changed little.

Eel soils are nearly level and occupy the flood plains of some of the larger streams. They are associated with the well-drained Genesee soils and the poorly drained Wayland soils. Some are in lower positions than Genesee soils; others are at the same elevation but farther from the stream. They are mainly in the region of Honeoye and Lansing soils in the uplands, but they extend southward in the valleys into the regions of Erie and Langford soils.

Eel soils have four distinct parts: (1) a surface soil of dark-gray to dark grayish-brown silt loam; (2) an upper subsoil of grayish-brown silt loam or fine sandy loam with few or no mottles, (3) a lower subsoil of dark grayish-brown sandy loam or fine sandy loam with many mottles;

and (4) a mottled substratum that consists of layers of gravel, sand, and silt.

In plowed fields the surface soil is 8 to 12 inches thick. Its very dark color is associated with a 4 to 6 percent organic-matter content and indicates that the total nitrogen content is moderately high. The material is very porous, is an excellent medium for growth of plant roots, and is permeable to air and water. It is nearly neutral in most areas. It has high capacity to supply potassium and medium capacity to supply phosphorus.

The upper part of the subsoil is not saturated for long periods, as is evident from the lack of mottles. This layer extends to a depth of 15 to 18 inches. Like the surface soil, it permits roots to develop and is permeable to air and water. It is much lower in organic-matter content and in nitrogen than the surface soil, but it has equally high capacity to supply potassium and medium capacity to supply phosphorus. It is nearly neutral in most areas.

The lower part of the subsoil extends to a depth of 30 to 40 inches. This layer, in which water stands for significant periods, differs from the upper part mainly in the presence of mottles. It is permeable to roots when it is not saturated.

The substratum is porous and is permeable to water. In some places the moderate wetness of these soils is caused by slowly permeable layers, but more commonly it results from a water table controlled by the level of the stream. Depth to free water decreases with distance from the stream, and many areas of Eel soils are in places on the flood plain where this stream-controlled water table is at only a moderate depth. The substratum is calcareous below a depth of 30 inches in most places.

The surface soil in most areas is silt loam free of gravel, but in some areas it is fine sandy loam, and in some it is moderately gravelly. The characteristics of the substratum vary greatly. In some areas the silty material extends to a depth of several feet; in other areas layers of gravel and sand dominate the substratum and occur at a depth of as little as 3 feet.

Most areas of Eel soils are subject to flooding early in spring. Free water ordinarily recedes to a depth of almost 18 inches during drying periods in April and rises to within 6 inches of the surface during wet periods. At this time of year, 4 to 6 drying days are needed before the soil can be plowed. During May, the depth to free water fluctuates between 15 and 30 inches much of the time and 3 or 4 consecutive drying days are needed before tillage is possible. During June, these soils can normally be cultivated after 1 or 2 drying days.

Plant roots thoroughly penetrate the topmost 18 inches of these soils in spring. As the season progresses and the water table subsides, the roots of most crops penetrate to a depth of between 24 and 36 inches. This volume of soil holds from 4 to 7 inches of water that plants can use. This amount is significantly less than that in the root zone of Genesee soils, but Eel soils have equal capacity to supply water because they have free water in the substratum. Crops show signs of moisture stress during very dry periods of midsummer, but Eel soils are among the best in the county in moisture-supplying capacity.

The total nitrogen content is moderately high in the plowed layer, but nitrogen is released slowly in spring and only moderately rapidly in midsummer. Crops generally respond well to nitrogen fertilizers. The surface soil has a moderate capacity to absorb bases. This capacity, which is equal to 8 to 12 tons of ground limestone per acre, is 70 to 80 percent filled with bases in most areas. From none to as much as 3 tons of ground limestone per acre is needed to neutralize the surface soil. If the soil is at pH 6.0, the requirement is 2 to 3 tons of ground limestone per acre. The Eel soils are moderately high in quickly available potassium. The potassium reserve is high, and the phosphorous-supplying capacity is medium.

Eel soils are among the better soils of the county, but they are moderately wet and are flooded occasionally.

Eel silt loam (Em).—This is the only Eel soil mapped in Tompkins County. It ranges in wetness from moderately well drained through the drier half of the somewhat poorly drained range. In the wettest places it is mottled immediately below the plowed layer. Included in the areas mapped is a small acreage of medium-acid soils. Also included are local areas, too small to be mapped separately, of the poorly drained Wayland soils.

This soil is suited to crops, pasture, or forest. Though moderately wet, it is suited to vegetables as well as to the crops commonly grown in support of dairying. Its susceptibility to flooding limits its use for many nonagricultural purposes. Some areas in the vicinity of Ithaca are used for field-crop experiments.

The management needs are mainly simple. Some areas can be improved by draining the wet spots. Most areas are not wet enough to justify systematic tile drainage unless very intensive use is planned. Outlets may be difficult to establish. Streambank erosion is a problem in some areas, and special practices are needed for its correction. The fertility level is moderate to high, compared with that for most soils in the county, but the response to fertilization is good. (Capability unit IIw–3; woodland suitability group 3)

Ellery Series

The Ellery series consists of deep, poorly drained, medium-textured soils formed in slightly calcareous glacial till. Like the associated Erie soils, these soils have a very slowly permeable fragipan. Unless drained, they are too wet for crops other than hay.

Ellery soils are nearly level. Some areas are large enough to be mapped separately, but a large proportion of the total acreage consists of small depressions or long narrow strips along drainageways that are within areas of Erie or Langford soils. All of these areas receive runoff from the adjacent Erie and Langford soils.

Ellery soils have four principal parts: (1) a surface soil of nearly black or very dark gray heavy silt loam; (2) a subsoil of dark-gray or dark grayish-brown channery silt loam with many yellowish-brown mottles; (3) a very dense fragipan of dark grayish-brown to olive-brown, mottled channery heavy silt loam; and (4) an underlying layer of olive-gray and olive, weakly calcareous, channery loam glacial till.

The dark-colored surface soil is 6 to 12 inches thick in forested areas where eroded material has not accumulated. An 8- to 15-inch surface soil is common in the centers of the largest areas that have been cleared. Around the margins of these large areas and in the numerous small areas that are intermingled with Erie soils, eroded material has been deposited on the surface. In such places the dark-colored surface soil is commonly 15 or 18 inches thick. The texture ranges from silt loam to silty clay loam. Small flat stones are present in some areas, but where eroded material has accumulated, the surface is stone free. The organic-matter content, ranging mainly from 6 to 10 percent, is much higher than in associated soils. The surface soil is commonly less acid than that of the associated soils. The pH ranges mainly from 5.5 to 6.2.

Below the dark-colored surface soil is a permeable, dark grayish-brown, loamy layer that has many yellowish-brown mottles. The gray colors indicate lack of aeration for very long periods, but the mottles show that air penetrates this layer at some times of the year. This layer commonly contains flat stones, but in some places it is free of stones and appears to have formed in water-deposited material unlike the glacial till from which the fragipan formed. This layer is 4 to 8 inches thick.

The top of the fragipan is 12 to 15 inches below the surface in areas on which there has been no deposition of eroded material. In many areas, however, especially in the small depressions, material eroded from adjacent areas has been deposited on the surface and the top of the fragipan is now 18 to 25 inches below the surface. The fragipan is very dense and is almost impermeable to water. It is only slightly acid. It is commonly less thick than the pan in Erie soils. From 30 to 40 percent of its volume consists of flat stones. Where no material has been deposited on the surface, the bottom of the pan lies between 36 and 42 inches below the surface. Where material has been deposited on the surface, the bottom of the pan is mainly 42 to 50 inches below the surface.

The underlying glacial till is like that under Erie and Langford soils. It is very dense and very slowly permeable. Flat stones constitute 30 to 40 percent of the material, by weight.

The northernmost areas of Ellery soils intergrade to the high-lime Lyons soils. In these areas, the pH is mainly above 6.0, the fragipan is thin, and free lime is found 30 inches below the surface. The southernmost areas of Ellery soils intergrade to the more acid Chippewa soils. Here the till is deepest and most acid, the upper part of the soil is medium acid to strongly acid, and the fragipan is thick. On the margins of closed depressions that have no outlets, the organic-matter content of the surface soil increases and the colors are almost black. In these places Ellery soils intergrade to Alden soils. Where Ellery soils merge with Erie soils, the surface soil is lightest colored and is commonly 4 to 6 inches thick. The thickness of deposits on the surface is one of the most variable and most significant properties. Where there are no such deposits, the soil is too wet for any crop except hay. In many of the small depressions, however, deposits 12 inches thick have raised the surface far enough above the fragipan that the soil is not too wet to be cropped with the adjacent Erie soils.

Ellery soils commonly remain frozen longer than the adjacent Erie soils. When they thaw in spring, they are saturated to the surface. In April, periods when the soil will support machinery are rare. Throughout this month, the water table typically fluctuates within 10 inches of the surface and is at the surface much of the time. By the end of May, the water table may fall periodically to a few inches above the fragipan, but after a soaking rain it is near the surface. During the month of May, 5 to 10 consecutive drying days are commonly needed before the soil will support machinery. Cultivation may be possible in less time where a thick deposit of eroded material has accumulated on the surface. In June the water table recedes to the fragipan during periods of a week or more without rain, but it rises to within a few inches of the surface if the rain causes appreciable runoff from the adjacent soils. During June, 3 to 7 consecutive drying days are commonly needed before equipment can be used.

Ellery soils receive so much runoff from adjacent areas that droughtiness is not a common problem in midsummer. During dry periods of 3 weeks or more, some plants may show signs of moisture deficiency, largely because their root systems were restricted to the topmost few inches by a high water table earlier in the season. Root systems are confined mainly to the topmost 12 inches.

It is a common practice to lay tile lines in the long narrow areas of Ellery soils that are associated with Langford or Erie soils. Where drainage has been established by this means, Ellery soils may be cultivated almost as soon as the associated soils and they commonly produce the most luxuriant vegetation in the field. Especially where these soils have 6 to 12 inches of eroded material over the original surface, crops like alfalfa may persist longer than on the associated Erie soils. Large areas of Ellery soils cannot be artificially drained at reasonable cost.

Ellery soils are abundantly supplied with nitrogen, but they release it very slowly in spring. The supplies of phosphorus and potassium are medium. Acidity is less than on the associated soils, but lime is needed on most areas. Because the organic-matter content of the plowed layer is so great, the capacity to absorb lime is very high; it is commonly equal to 15 tons of ground limestone per acre. Even where the pH value is near 6.0, Ellery soils commonly need 3 to 4 tons of ground limestone per acre to raise the pH to a value near 7.0.

Because of the pattern in which Ellery soils occur, they have been mapped with soils with which they are associated. A complex of Erie and Ellery soils, mapped as "Erie-Ellery channery silt loams, 0 to 3 percent slopes," is described under the heading "Erie Series." Ellery soils also are mapped as part of an undifferentiated unit with Ellery, Chippewa, and Alden soils.

Ellery, Chippewa, and Alden soils, 0 to 8 percent slopes (EcA).—This is an undifferentiated unit, a given area of which may consist of any one, any two, or all three kinds of the named soils. Chippewa soils are described under the heading "Chippewa Series," and Alden soils are described under "Alden Series."

All of these soils are wet. Ellery and Chippewa soils are poorly drained. Chippewa soils are more strongly acid than Ellery soils. Alden soils are very poorly drained. They have a mucky surface soil that is very high in organic-matter content. Ellery and Chippewa soils have a mineral surface soil that is high in organic-matter content but is not mucky.

This mapping unit occurs in the uplands, mainly in level and slightly depressed areas that receive large amounts of runoff from adjacent higher areas. Some small areas occur as seep spots among better drained, moderately sloping soils. The nearly level areas include spots of muck and peat, mainly in forested areas, and also spots of slightly higher Erie and Volusia soils, too small to be mapped separately. These inclusions make up as much as 15 percent of some of the areas mapped.

Most areas of this mapping unit are too wet for cultivation unless they have been drained artificially. Although systematic tile drainage is rarely applied, removal of excess surface water by means of structures may improve the drainage enough so that water-tolerant feed and pasture crops can be grown. Some areas are in permanent pasture; these pastures are not highly productive unless limed and fertilized, but they do provide feed during dry periods when other pastures are poor. Some of the larger areas are forested with water-tolerant species. (Capability unit IVw–3; woodland suitability group 15)

Erie Series

The Erie series consists of deep, somewhat poorly drained, medium-textured soils that have formed in low-lime glacial till. A very dense, very slowly permeable fragipan, which lies only 12 to 18 inches below the surface in uneroded areas, is the outstanding physical property of these soils.

Erie soils occupy positions that have slow surface runoff or that receive water from adjacent higher land. Water moves downward in these soils extremely slowly. Although the substratum generally contains some lime, the soil above the fragipan is strongly acid.

Erie soils occupy extensive, gently to moderately sloping areas in the uplands. The slopes are nearly straight or slightly concave. Associated small knolls or larger convex landforms are occupied mainly by the moderately well drained Langford soils. Very slight depressions or level areas within the gently sloping areas are occupied by the poorly drained Ellery soils. Distinct depressions without outlets are occupied by the very poorly drained Alden soils. Erie soils dominate land use throughout large areas in the central and north-central parts of the county.

Erie soils have four distinct parts: (1) a plowed layer of dark grayish-brown channery silt loam; (2) an upper subsoil of grayish-brown highly mottled channery silt loam; (3) a dense, very slowly permeable fragipan of olive or olive-brown channery clay loam to loam; and (4) a substratum of weakly calcareous, olive, channery silt loam glacial till.

The surface soil in unplowed areas is thin, and a thin, yellowish-brown, strongly mottled loamy layer may lie between it and the grayish-brown, highly mottled material above the fragipan. This yellowish-brown layer has been incorporated into the plowed layer in most fields.

The plowed layer in most places is 6 to 9 inches thick. It contains many flat and some rounded stones, which are troublesome but do not interfere seriously with tillage. Its moderately dark color results from an organic-matter content that ranges mainly from 4 to 7 percent in uneroded fields. The plowed layer has a slightly higher organic-matter content than that of Langford soils and is correspondingly higher in total nitrogen content. Unless limed, the plowed layer is strongly acid or very strongly acid. It has good water-holding capacity.

The mottled zone of channery silt loam or loam between the plowed layer and the fragipan is 4 to 10 inches thick. The pronounced mottling on the grayish-brown material indicates that this layer is alternately wet and dry. The layer is strongly acid in most places. It is permeable and has good water-holding capacity. Roots can develop in it when it is not wet.

Depth to the fragipan in uneroded areas ranges from 12 to 18 inches and is commonly between 12 and 15 inches. The pan extends to a depth of 3 to 5 feet. This thick, dense layer is an effective barrier to water and to plant roots. It has silt-filled cracks that are 8 to 18 inches apart and commonly extend to a depth of 2½ to 4 feet. Water moves vertically through these cracks, and roots extend into the cracks in dry periods but are seldom found in the pan between the cracks. The pH increases rapidly with depth. In the topmost 2 inches of the fragipan, the pH is 5.6 to 5.8, but it is more than 6.0 at a depth of 3 feet. The fragipan typically contains more flat stones than the layers above; it is commonly 30 to 40 percent stones, by weight.

The underlying glacial till is as dense as the fragipan and about half as channery. In spots it contains thin layers of gravel. The till is as slowly permeable as the pan above it. It is typically slightly calcareous.

In the northern part of the county, the till contains more lime and the fragipan is thinner and contains more clay than in areas farther south. In the northernmost areas, Erie soils are also least acid. The amount of lime in the till decreases, and the thickness of the fragipan increases, from north to south within the county. In the southernmost areas of these soils, free lime may not occur above a depth of 7 feet and the surface soil is very strongly acid. On slightly convex topography where water does not accumulate, the layer above the fragipan is least mottled and there may be a thin, mottled yellowish-brown layer below the plowed layer. In these places Erie soils intergrade to the moderately well drained Langford soils. On the flattest areas and in slight depressions, the plowed layer is slightly darker colored than is normal and the layer above the fragipan is most strongly mottled. In these places Erie soils intergrade to the poorly drained Ellery soils. Though Erie soils are normally associated with Langford soils, they are adjacent to the more strongly acid Mardin soils in some parts of the county. In these places Erie soils appear to receive bases in seepage water from adjacent higher land. Consequently, Erie soils have formed here, instead of Volusia soils, which are more acid and are most commonly associated with Mardin soils.

The water table stands within a few inches of the surface when the frost leaves the ground in spring. During most of April, free water is present above the fragipan. It rises to within 4 inches of the surface after each significant rain. During this period, 6 to 8 consecutive drying days are needed before the soil is ready for tillage. After plants begin to grow in May, free water is present above a depth of 8 inches for only short periods after rains, and it recedes to a depth of 20 inches or more after a week without rain. Normally, tillage is possible after 4 to 6 drying days. By mid-June, the soil can be tilled after 2 or 3 drying days, although water appears above the fragipan after soaking rains.

Plant roots obtain water and plant nutrients mainly from the layers above the fragipan. The rooting depth is mainly between 12 and 18 inches. The root zone can hold between 2½ and 4½ inches of available moisture. This capacity has little meaning in spring when the soil is saturated frequently above the fragipan. It is very important, however, during periods of drought in midsum-

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mer. From 8 to 12 consecutive days without rain, after free water disappears above the fragipan, are enough to slow the growth of crops. The problem of drought is made somewhat less serious by the fact that these soils either lose little water through runoff or receive some water from adjacent higher land. Nevertheless, Erie soils are likely to be too wet at one season of the year and too dry at another. Much depends upon the distribution of rainfall during the growing season.

The total nitrogen supply is moderately high, but nitrogen is released very slowly in spring and early in summer. Consequently, response to nitrogen fertilizers is high. The medium supply of phosphorus is not adequate for good growth of crops. The potassium-supplying power is only medium. The supply may be adequate for good growth for short periods, but the quickly available reserve is limited. Acidity is a major limiting factor for most crops. The cation-exchange capacity of the plowed layer is equal to 9 to 13 tons of ground limestone per acre. In unlimed areas this is commonly 20 to 30 percent filled. To raise the pH of such soils to 7.0 requires 4 to 8 tons of limestone per acre. If the soils have been limed previously to pH 6.0, the requirement is 2 to 3 tons of limestone. Even soils that have been adequately limed need maintenance applications every 4 or 5 years.

Erie channery silt loam, 3 to 8 percent slopes (EbB).—This soil represents the central half of the drainage range for the Erie series. Predominantly, it is typical of the soils described for the series. It occupies gently sloping areas that have slight or no undulations. It typically receives some runoff from higher lying land, but it has enough slope that runoff removes some of the excess water.

Included in the areas mapped are narrow strips of the poorly drained Ellery soils along drainways. Most of these inclusions are shown on the map by means of symbols for intermittent drainways or wet spots. Small knolls of Langford soils are included also. These may occupy as much as 10 percent of some areas, but they do not affect use significantly.

Erie soils generally are not highly productive, but this is one of the better soils of the series. It can be used for crops, pasture (fig. 20), or forest. Under good management moderate yields of common field crops can be obtained. Wetness imposes very severe limitations on the use of this soil for housing.

Control of excess water is the outstanding problem. Many areas can be improved by diverting the runoff from adjacent land. Many areas can also be improved greatly by strategically placed random drains that tap the inclusions of Ellery soils. If adequate measures are taken to control water, this soil is moderately productive of crops like corn. It is probably best suited to mixtures of grasses and water-tolerant legumes for hay or pasture. Winter wheat is grown successfully under proper management, but spring grains are subject to limitations imposed by wet weather in spring. For even moderate yields of all of these crops, adequate amounts of fertilizers and lime are necessary. Spring wetness and midsummer drought con-

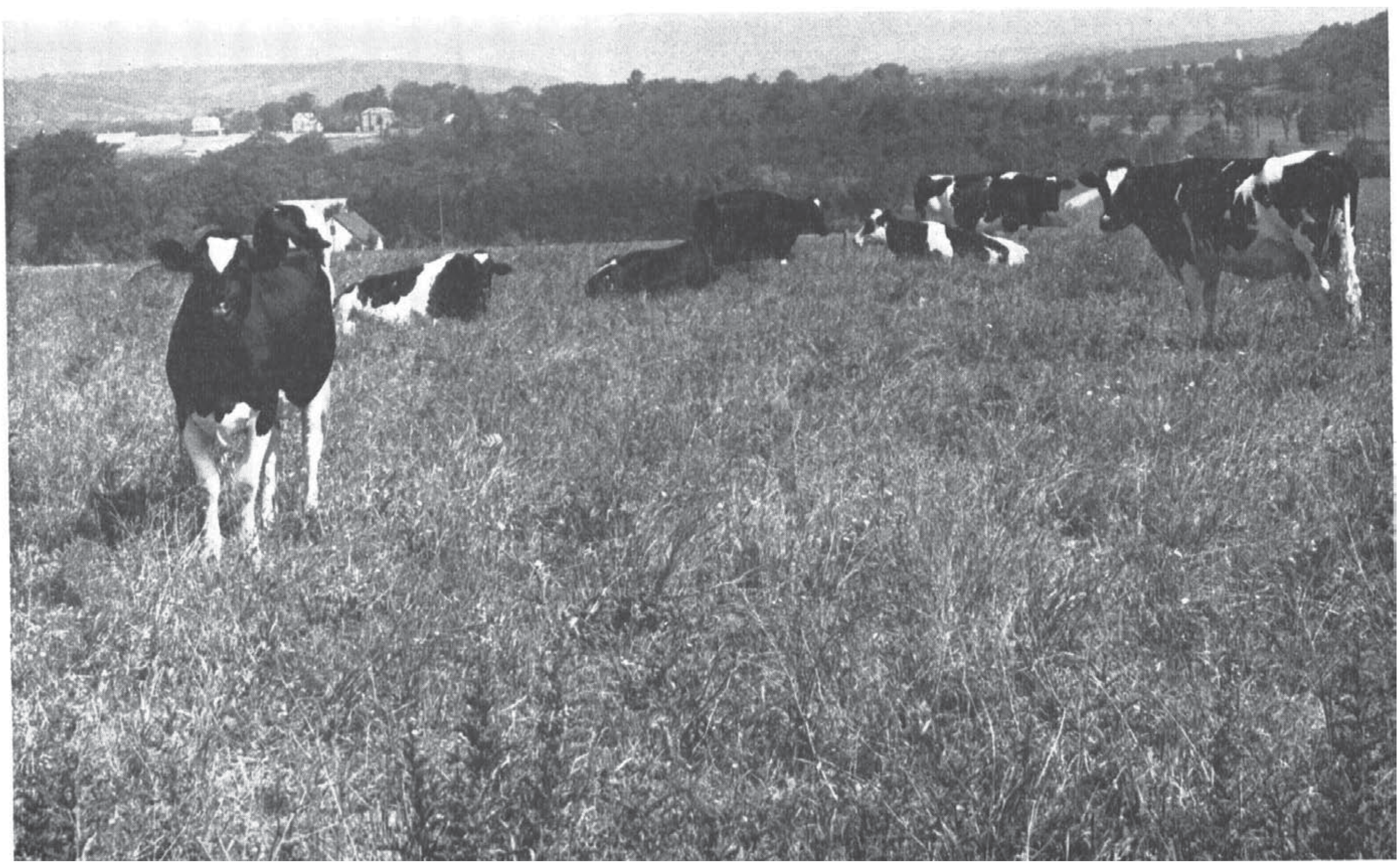

Figure 20.—**Improved pasture on area of gently sloping Erie soils.**

tribute to great variations in production from year to year. This soil can be farmed with at least moderate success, but management requirements are very exacting. (Capability unit IIIw-6; woodland suitability group 9a)

Erie channery silt loam, 3 to 8 percent slopes, eroded (EbB3).—This soil represents the middle half of the drainage range for the series. It has lost a significant amount of its surface layer through erosion. Because the depth to the fragipan is so critical a problem in Erie soils generally, this loss is more damaging than it would be to many soils of the county. Within the areas mapped, eroded and uneroded spots are typically intermingled. The depth to the fragipan in eroded parts ranges from as little as 8 to as much as 12 inches. Eroded soils make up about 50 to 75 percent of most areas mapped.

Long, narrow areas of the poorly drained Ellery soils occur along intermittent drainways. These inclusions may constitute as much as 2 or 3 percent of a given area. Though very small, they may control the timing of spring work. Small knolls of eroded Langford soils are also included. These occupy as much as 10 percent of some areas, but they have little effect on use. The landscape is gently sloping, but it has a few gentle undulations. Most of the eroded spots are on slopes of between 5 and 8 percent.

Seasonal wetness is a major problem, and the limited capacity of the soil to hold water available to plants is a more significant factor than on the uneroded Erie soils that have similar slopes. This soil can be used for crops, pasture, or forest, but the limitations are severe. Hay and pasture are among the better suited crops, but small grains and corn can also be grown. This soil is poor for housing sites.

Control of water to provide drainage and to control erosion is a major management problem. Organic matter has been lost, infiltration rates have been reduced, and the erosion problem has increased as a result of the loss of surface soil. Diversion of runoff from adjacent soils is beneficial, and drains to remove water from the included strips of Ellery soils can greatly improve the timeliness of work. Sod-forming crops help to hold the soil, improve its structure, and increase the organic-matter content. Applications of fertilizers and lime are as important as on the uneroded soil. The available moisture capacity is about three-fourths that of the uneroded soil, and even with the best of practices, the chance of midsummer drought makes yields of all crops that grow through the month of August uncertain. (Capability unit IVe-11; woodland suitability group 9b)

Erie channery silt loam, 8 to 15 percent slopes (EbC).—This soil is in the drier half of the drainage range for the series. It is saturated for shorter periods after rains than the less strongly sloping soils, because the slope is strong enough that a significant amount of water runs off the surface.

This soil typically occurs on the sides of valleys, adjacent to better drained soils at higher elevations. Its wetness is caused partly by seepage water and runoff from the higher soils. It slopes in one direction, but it is crossed by drainways in slight depressions. Along these drainways wetter soils and the poorly drained Ellery soils may occur. Slight irregularities of slope that divert water to either side commonly mark spots of Langford soils, which may occupy as much as 10 percent of some areas but are too small to be mapped separately.

This soil is suited to crops, pasture, or forest. Hay is one of the most productive crops; corn and small grains can be grown. The slope makes use of farm machinery moderately difficult, but it also permits diversion of water if these areas are used for housing. Septic tank sewage disposal is very difficult to establish.

Both wetness and erosion are critical problems. A large volume of water crosses the area and the rate of runoff is relatively rapid. Consequently, special practices are needed to divert water at the top of the slope. The slope is commonly well suited to stripcropping. Stripcropping and cultivation should be at a slight gradient, however, to avoid waterlogging in furrows. Such practices tend to conserve water during periods of low rainfall and to conserve soil when runoff is great. Adequate liming and fertilization are needed for maintenance of a vegetative cover to help control water. They are essential also for even moderate yields of crops. (Capability unit IIIe-11; woodland suitability group 9a)

Erie channery silt loam, 8 to 15 percent slopes, eroded (EbC3).—This soil is in the drier half of the drainage range for the series. It has lost a significant amount of soil through erosion. This loss is especially critical because it has reduced the thickness of soil above the fragipan to 8 to 12 inches over about 75 percent of the area and has thus significantly decreased the water-holding capacity and increased the tendency toward droughtiness during midsummer. The plowed layer is composed of material that was originally part of the subsoil, mixed with remnants of the original surface soil. The plowed layer is lighter colored and generally more channery than that of the uneroded soil previously described.

This soil commonly occurs on the sides of valleys. It is steep enough to dispose of much water by runoff, but it is adjacent to steeper soils at a higher elevation and thus receives runoff from these adjacent areas. Consequently, more water passes over this soil than over most of the other Erie soils. This water is commonly channeled to some degree in shallow drainways. Wet spots are common in the drainways. Shallow gullies start to form in the drainway channels, but these are commonly arrested as fine material is washed away down to the fragipan, which is left exposed as a pavement of small stone fragments. Subsequent tillage obliterates the channel but leaves a very channery strip. Small areas of Langford soils may be found on slightly elevated spots between the drainways.

This soil can be used for crops, but it has severe limitations. Generally, a high proportion of sod-forming crops is desirable in the rotation. Sod crops help to control erosion, restore the structure, and supply organic matter. They grow well in the early part of the summer before the moisture supply becomes limited. This soil can be used for small grains and corn if appropriate measures are taken to control runoff. It is also suited to pasture or forest. Most areas present difficult problems if used for housing sites, although the slope permits establishment of structures for drainage.

A small capacity to store moisture and the loss through runoff of water from midsummer rains contribute to serious droughtiness during dry seasons. Structures to divert water can be effective in controlling further erosion and removing excess water early in spring. Tillage across the slope is important. Stripcropping is desirable if intertilled crops are grown or if the land is plowed frequently. Adequate fertilization and liming are required for even moderate yields. (Capability unit IVe–10; woodland suitability group 9b)

Erie-Ellery channery silt loams, 0 to 3 percent slopes (ErA).—Erie soils, mainly in the wetter half of the drainage range for the series, make up 60 to 85 percent of this complex, and Ellery soils only 10 to 30 percent. Ellery soils have greater limitations and generally control land use. They are described under the heading "Ellery Series."

Erie soils have perceptible slopes. Ellery soils occur as small flat areas, commonly only 10 to 50 feet wide and in places only a foot lower than the associated Erie soils. In many places they form long, narrow, very shallow depressions through which water runs off slowly after rains. The wetness of these depressions generally controls the timing of field operations. Low knolls of Langford soils occur locally, but these have little significance to use of the land.

This complex can be cropped, but it has severe limitations. Generally, seeding of crops that should be planted in the early spring is delayed. Planting of corn is commonly late. Mixtures of grasses and water-tolerant legumes are among the better suited crops. Such mixtures can also be used for pastures. The wetness of these soils is unfavorable for some kinds of trees; red pine, for example, does very poorly. Generally, these areas are poor sites for housing.

Water control is the outstanding management problem. Systematic tile drainage systems that can be installed at reasonable cost are not effective. The impervious fragipan makes it necessary to space tile very closely. Tile drains that follow the slight depressions and drain the small areas of Ellery soils can be effective. They do not, of course, improve the adjacent areas of Erie soils significantly. As these soils typically receive runoff from adjacent soils, structures for diverting runoff are beneficial.

Careful selection of crops that will tolerate wetness is important. Fertilization with nitrogen, phosphorus, and potassium is necessary for even moderate yields, and liming is equally important. (Capability unit IVw–3; woodland suitability group 15)

Fredon Series

The Fredon series consists of deep, somewhat poorly drained, medium-textured soils that formed in moderately to strongly calcareous, layered deposits of gravel, sand, and silt. The deposits are poorly sorted material of the glacial outwash terraces. These soils are the somewhat poorly drained associates of Palmyra, Howard, and Phelps soils. Their somewhat poor drainage is related to their low position in the landscape and to a slowly permeable layer at some depth. This slowly permeable layer in some places is glacial till or lake deposits beneath the glacial outwash. In other places silt within the outwash keeps water from percolating freely.

Fredon soils are mainly in the valleys in low positions. They are associated with Palmyra or Howard soils, which are also on the glacial outwash terraces. The associated wetter soils are members of the Halsey series. The moderately well drained Phelps soils occupy slightly higher positions.

The Fredon soils have four principal parts: (1) a plowed layer of very dark gray or very dark grayish-brown silt loam; (2) an upper subsoil of strongly mottled, olive-brown or light olive-brown, slightly gravelly silt loam; (3) a lower subsoil of olive-gray to dark grayish-brown, prominently mottled gravelly loam or gravelly silt loam; and (4) gray, waterlogged layers of gravel, sand, and silt.

The very dark colored plowed layer is 8 to 11 inches thick. It is 5 to 8 percent organic matter and is correspondingly high in total nitrogen. This layer is porous and permeable. It has medium capacity to supply phosphorus and potassium. The reaction ranges from medium acid to neutral.

The upper part of the subsoil extends to a depth of 14 to 24 inches. Its very pronounced mottling and its dominantly grayish colors show that this layer is wet for long periods. The material is porous, and roots penetrate it easily when it is not too wet. It is slightly acid or neutral. It has medium capacity to supply phosphorus and potassium.

The lower part of the subsoil extends to a depth of 18 to 40 inches. It is typically slightly finer textured than the upper part and is less rapidly permeable to water. It can be penetrated by roots if it is not saturated, but in most places it contains few roots. It is neutral and has medium capacity to supply phosphorus and potassium.

The calcareous substratum is composed of layers of sand, gravel, and silt in varying proportions. Most of the material is moderately to rapidly permeable, but the silt layers in it are slowly permeable. The substratum has a very large reserve of lime, but few roots can reach it.

The texture of Fredon soils in Tompkins County is extremely variable. It ranges mainly from silt loam to sandy loam. Some layers contain gravel. The surface soil is mainly 8 to 11 inches thick, but in some areas that have deposits of eroded material on the original surface, it is as much as 18 inches thick.

Unless drained, Fredon soils are wet late into spring. During April, the water table stands within 4 inches of the surface for moderate periods after rains but falls to 15 inches during periods of drying. At this time of year, from 5 to 8 drying days are commonly needed before these soils can be plowed. During May, the water table is rarely less than 8 inches below the surface, and it falls frequently to 20 inches. At this time of year, 4 to 6 drying days are needed before cultivation. During June, 2 or 3 consecutive drying days will normally permit tillage.

In undrained areas of these soils, roots develop mainly in the plowed layer during spring, but during midsummer they may extend to a depth of 15 to 20 inches. This root zone will hold 3 to 5 inches of water that plants can use. Only during periods of very dry weather is this capacity significant; in spring and early in summer, these soils are excessively wet. In undrained areas free water commonly remains in the substratum and in the lower part of the subsoil for long periods after rains. When free water disappears from the subsoil, plants generally show signs of moisture deficiency after 2 weeks without rains.

The moderately high organic-matter content of the plowed layer is reflected in its moderately high capacity to hold bases. This capacity is equal to 9 to 14 tons of ground limestone per acre. In many soils this is 80 percent filled. In the most acid of the Fredon soils, it is about 50 percent filled. Unlimed soils need up to 4 tons of ground limestone per acre to raise the pH to a value near 7.0. If the plowed layer is at pH 6.0, it needs from 2 to 3 tons of ground limestone per acre. The phosphorus-supplying capacity is moderate, and the potassium reserve is moderate.

If drained, these soils have better moisture relationships during midsummer than do most of the soils of the county.

Fredon silt loam, 0 to 5 percent slopes (FdB).—Most areas of this soil have slopes of less than 3 percent, but a few are gently sloping and up to 5 percent. Included in the areas mapped are spots of Halsey soils, too small to be mapped, which are in slight depressions or in seepy areas adjacent to the outwash terrace faces.

This soil is suited to crops, pasture, or forest. Wetness imposes major limitation on the choice of crops. Undrained areas are used mainly for hay or pasture. Areas that can be drained are suitable for intensive cropping. Wetness limits suitability for many nonagricultural purposes. Some areas are suitable for marshes, dug-out ponds, or wildlife habitats.

Control of wetness is the first management need. Where outlets are available, this soil can be drained by tile or by open ditches, but many areas lack suitable outlets. (Capability unit IIIw-1; woodland suitability group 11a)

Fresh Water Marsh (Fm)

This miscellaneous land type consists of areas around lakes and ponded areas in the uplands. Some of these ponded areas are natural, some are manmade, and some have been made by beavers damming streams. The areas are covered with water most of the year. They normally do not support trees, except along the edges where the water is shallow. They do, however, support a dense growth of coarse marsh plants, and they provide good habitats for beaver, muskrat, and other water-loving animals and for waterfowl. (Capability unit VIIIw-1; woodland suitability group 16)

Genesee Series

The Genesee series consists of deep, well-drained, medium-textured soils. These are very young soils in nearly neutral or calcareous recent alluvium. Some organic matter has accumulated in the topmost layer, but the subsoil has been changed only a little.

Genesee soils occupy nearly level areas near the major streams of the county. The lowest areas are subject to flooding when the streams rise in spring. The highest areas are only 5 to 8 feet higher, but they are covered only during periods of exceptionally high water. Genesee soils typically occupy the highest positions on the flood plains, commonly near the streams, where the alluvial deposits are thickest. In lower areas on the flood plains, either nearer the streams or nearer the uplands, are wetter soils of the Eel, Wayland, or Sloan series. Genesee soils occur mainly in the region dominated by Honeoye and Lansing soils, but they extend into regions occupied by Erie and Langford soils.

Genesee soils have three principal parts: (1) a surface soil of very dark gray loam or silt loam; (2) a subsoil of very dark grayish-brown or dark-brown silt loam to very fine sandy loam; and (3) a substratum consisting of layers of silt loam, fine sandy loam, gravel, and sand.

The dark-colored surface soil is 8 to 12 inches thick. Its dark color is related to a moderately high organic-matter content (mainly 4 to 6 percent). This layer is porous, easily penetrated by roots, permeable to water, and well aerated. It is nearly neutral or slightly acid in most places. It has medium capacity to supply potassium and phosphorus.

The subsoil extends to a depth of 24 to 40 inches in most areas. It is little different from the original deposit. In most areas it is slightly browner than the underlying material, and in some areas structure has begun to form. The subsoil, like the surface soil, is very porous and is permeable to roots, air, and water. It has good water-holding capacity, is nearly neutral, and has medium capacity to supply phosphorus and high capacity to supply potassium.

Silty material similar to that of the subsoil may extend to a depth of several feet. In most areas, however, the substratum consists of layers of coarse and fine sand, some gravel, and silt. This material may be neutral in the topmost part. In most places it is calcareous within 40 inches of the surface. It is permeable to air, roots, and water. This material is lower in plant nutrients than the layers above, but in some areas it has, at the level of the adjacent stream, a zone of free water that is a source of moisture to deep-rooted plants.

The texture of the surface soil is predominantly silt loam. Textures of loam, gravelly loam, and gravelly silt loam may occur in small areas on natural levees near the streams and on similar landforms that were formerly natural levees but are now far from the streams. Layers of sand or gravel occur erratically at varying depths in the topmost 3 feet of some areas. Where streams emerge from the uplands, some areas have the form of small alluvial fans, and some of these fans are moderately gravelly.

When the streams are at flood stage early in spring, some areas of Genesee soils are covered by water. In most years the streams subside by April, and from then on free water is found above 20 inches for only short periods after rains. From 3 to 5 drying days are needed before these soils can be plowed during April; 2 or 3 drying days will permit tillage during May; and only 1 or 2 drying days are needed before cultivation during June. In some years, but not many, the streams rise enough to flood some of these areas during the growing season.

Plant roots extend deeply into these very permeable soils. Deep-rooted crops exploit the topmost 40 inches. This volume of soil will hold from 6 to 8 inches of water that plants can use. Consequently, these soils are among the least droughty of the well-drained soils of the county. Crops show signs of moisture deficiency, but serious damage occurs only during extended droughts.

The moderately high organic-matter content of the surface soil is associated with a moderately high total nitrogen content. Nitrogen becomes available very slowly early in spring and only moderately rapidly during midsummer. Generally, crops respond to nitrogen fertilizers.

These soils are nearly neutral. The surface soil has a moderate capacity to absorb bases. This capacity is equal to 8 to 12 tons of ground limestone per acre in most areas, and it is mainly 80 percent filled with bases. If unlimed, the surface soil needs from none to as much as 3 tons of ground limestone per acre to raise the pH to a value near 7.0. If the surface soil is at pH 6.0, the requirement is 2 to 3 tons. The supply of quickly available potassium is commonly moderately high, and the reserve is high. The capacity to supply phosphorus is moderate.

Genesee soils are potentially the most productive soils of Tompkins County for many kinds of crops.

Genesee silt loam (Gn).—This is the only Genesee soil mapped in Tompkins County. In most areas it is typical of the soil described under the heading "Genesee Series." A few small areas in the southernmost part of the county are medium acid in the surface soil and slightly acid at a depth of 30 to 36 inches.

Most areas are nearly level. There are, however, gently sloping alluvial fans where streams emerge from the uplands. Most of these are gravelly. Some mapped areas include narrow stream-cut escarpments, too small to be shown on the map. In many places this soil occurs as relatively small areas within fields that are dominated by soils of the Eel series. In some places areas of Eel soils, too small to be mapped separately, are included in the mapping unit. This soil is well suited to a wide variety of crops, including those commonly grown on dairy farms, as well as vegetables and small fruits. It is also well suited to pasture or forest. Susceptibility to flooding limits its use for some nonagricultural purposes.

Few special management practices are needed. Some of the small alluvial fans are subject to moderate erosion and need practices for control of runoff. Stream cutting is a problem in some areas; special structures are needed for its control. Although fertility is generally high, this soil is very responsive to fertilization. (Capability unit IIw–2; woodland suitability group 3)

Halsey Series

The Halsey series consists of deep, poorly drained and very poorly drained, medium-textured soils that have formed in poorly sorted glacial outwash. The upper part of these soils is slightly acid or neutral; the substratum is calcareous. The profile consists predominantly of layers of gravel and sand but includes layers of silt also. The very dark colored surface soil and the grayish subsoil are conspicuous features.

Halsey soils occupy level or slightly depressed landforms in the lowest places on the glacial outwash terraces of the valleys. They lie between the present flood plains and the higher terraces that are occupied by Palmyra and Howard soils.

Halsey soils have four principal parts: (1) a very dark gray to black surface soil, the texture of which ranges from silt loam to mucky silt loam; (2) an upper subsoil of gray fine sandy loam or loam, which in places is mottled and contains gravel; (3) a lower subsoil of gray, highly mottled loam or fine sandy loam, which also may contain gravel; and (4) a substratum consisting of layers of gray calcareous gravel, sand, and silt.

The surface soil is between 6 and 10 inches thick in most places. Some areas have deposits of eroded material on the original surface, and in these places the surface soil is between 12 and 18 inches thick. The very dark color results from a high organic-matter content. In the driest areas the surface soil is 8 to 12 percent organic matter; in the wettest areas it is mucky and is 12 to 20 percent organic matter. This layer is porous and is easily penetrated by water and roots. It has medium capacity to supply potassium and phosphorus, but it has a very high total nitrogen content. In most places reaction is nearly neutral; in the most acid areas this layer is slightly acid or medium acid.

The upper part of the subsoil extends to a depth of 14 to 18 inches. Its dominantly gray colors show that this layer is saturated for very long periods. In the very poorly drained areas, it is saturated most of the time, except during dry periods in midsummer, and in these saturated places it is almost free of mottles. In the poorly drained areas, where it is frequently not saturated, this layer is mottled with spots of yellowish brown. It is low in organic-matter content, in contrast to the surface soil. It contains little nitrogen. It has medium capacity to supply phosphorus and potassium. In most areas it is nearly neutral or only slightly acid. Both roots and water penetrate this layer when it is not saturated.

The lower part of the subsoil extends to a depth of 24 to 42 inches. Its dominantly gray colors show that it is saturated for very long periods. Its yellowish-brown mottles result from segregated iron. In most places this part of the subsoil consists of layers of sandy loam and gravelly loam, but in some places it is sandy and free of gravel. Thin, slightly firm layers of silt occur in some places. The organic-matter content is low, the nitrogen content is low, the potassium reserve is medium, and the supply of available phosphorus is medium. Roots can penetrate this layer if it is not saturated, but they seldom do unless the soil has been drained.

The substratum consists of layers of sand and gravel that occur in varying proportions and thicknesses from area to area. Thin layers of silt are present in many areas. The material is calcareous. The gray colors show that the material is saturated for very long periods. Most of the layers are permeable to water and roots, but some layers of silt or silty gravel are slowly permeable.

A slowly permeable layer somewhere in the substratum is responsible for the wetness of these soils. In some places layers of silt among those of gravel and sand are responsible. Everywhere, the gravel and sand are underlain at some depth by slowly permeable glacial till. In some closed basins the till is the main cause of the wetness. Bedrock is at great depth.

The characteristics of the surface soil vary with the wetness of the area. In the driest areas, which are poorly drained, the surface soil is silt loam that has high organic-matter content. In the wettest areas, which are very poorly drained, the material contains so much organic matter that it is mucky. Undisturbed areas of these wettest soils have a layer of muck 2 to 6 inches thick over the mineral soil. These soils occupy depressions and flats that have received water from adjacent land. Therefore, most areas have deposits of silty material on the glacial outwash and the surface soil is typically silt loam free of gravel; in some small depressions the topmost 2 feet is silt loam free of gravel. These silty deposits are not the result of accelerated modern erosion of the adjacent areas. In protected places these silty deposits are absent and the surface soil is gravelly loam or gravelly fine sandy loam very high in organic material. The proportion of layers of sand and gravel in the subsoil and substratum varies widely from area to area. In areas where these soils merge with those of the Lamson series, the topmost 3 feet is predominantly sand. In a few areas the entire subsoil is gravelly fine sandy loam or gravelly loam without distinct layers; ordinarily it consists of alternate layers of sand and gravel. The depth to calcareous material ranges from 24 to 42 inches.

Halsey soils are saturated to the surface early in spring. The very poorly drained areas remain saturated to within a few inches of the surface throughout April and May and are saturated to the surface periodically during midsummer. The poorly drained areas have free water within 6 inches of the surface throughout April. Free water rises to the surface after rains but falls to a depth of 20 inches or more during rainless periods in May. All of these soils are wet too much of the time to permit normal tillage. The poorly drained soils can be used for grass hay without artificial drainage.

Plant roots are confined mainly to the topmost 10 or 12 inches in undrained soils, but they can penetrate to a depth of 18 to 24 inches in most areas if the soils are artificially drained. Available moisture capacity has little significance, because these soils receive much water from adjacent higher land and, even if drained, have water in the substratum much of the time.

Because of the high organic-matter content, the surface soil has very high capacity to absorb bases. This capacity is equal to 11 to 20 tons of ground limestone. In most areas it is 80 percent filled with bases, and the soil is nearly neutral. If unlimed, the surface soil needs from none to as much as 5 tons of ground limestone per acre to raise the pH to a value near 7.0. If the surface soil is at pH 6.0, the amount required is 2 to 4 tons.

Halsey soils are high in total nitrogen. If undrained, they release nitrogen so slowly that crops show evidence of nitrogen deficiency. In drained areas nitrogen deficiency is very evident early in spring but is not conspicuous in most crops in midsummer. Drained areas of these soils have medium capacities to supply potassium and phosphorus.

Halsey soils are potentially good for crops if they can be adequately drained. Most areas, however, lack good outlets. Wetness is the outstanding limitation.

Halsey silt loam (Ha).—This soil is poorly drained. Much of it lies between the very poorly drained mucky Halsey soils and the somewhat poorly drained Fredon soils or the moderately well drained Phelps soils. It receives runoff from adjacent land and has a high water table until late in the season. Some of it is in closed depressions on the terraces, where silts have accumulated. These areas are as wet as others in spring but are dry more of the time in summer than the very poorly drained Halsey soils.

If undrained, this soil can be used for grass hay, pasture, or forest. Areas that can be drained are suited to intertilled crops, but few areas have outlets that permit adequate drainage. This soil is poorly suited to nonagricultural uses. In places it is suitable for marshes and ponds, but each site should be investigated to be sure that water will not be lost through porous layers after the water table falls.

Drainage is the outstanding management need. This soil can be drained if suitable outlets can be found. Erosion is not a problem. The fertility problem is only moderate. (Capability unit IIIw–5; woodland suitability group 14a)

Halsey mucky silt loam (Hc).—This soil is very poorly drained; it represents the wetter half of the drainage range described for the Halsey series. In undisturbed areas the topmost 2 to 6 inches is muck. In pastured areas, the muck has been mixed with the mineral surface soil and the surface layer is mucky silt loam. Most areas have no stones on the surface. Water stands at or within a few inches of the surface throughout the spring and rises to the surface frequently, even during midsummer. This soil occupies depressions or level areas in low positions. Much of it is in the center of small valleys or is adjacent to soils of the flood plains in larger valleys. The adjacent higher soils are mainly the poorly drained Halsey soils, the Fredon soils, or the Phelps soils. In some valleys this soil is associated with shallow muck, and spots of shallow muck are included in some of the areas mapped.

Undrained areas are too wet for agricultural uses, but they support water-tolerant trees or marsh plants. Areas that can be drained are potentially excellent for crops. Some areas are suitable as marshes for wildlife. This soil is too wet for most nonagricultural purposes.

Drainage is the first requirement if this soil is to be farmed intensively. Many areas lack outlets. If outlets can be established, the soil can be drained either by tile or by open ditches. Erosion is not a problem. The fertility requirements are described under the heading "Halsey Series." If adequate drainage can be established, this soil is potentially among the better soils of the county for intensive crop production. (Capability unit IIIw–5; woodland suitability group 14b)

Holly Series

The Holly series consists of deep, poorly drained, medium-textured soils. These are young soils that are forming in acid recent alluvium. Ordinarily, they are strongly acid, but in places they are medium acid. They have a dark-colored surface soil and a gray subsoil that is distinctly or prominently mottled.

Holly soils occupy low areas on first bottoms in the region of acid soils. They are closely associated with Tioga and Middlebury soils, which are better drained, and with Papakating soils, which are very poorly drained. They are subject to flooding and are wet after the floodwaters have receded.

Holly soils have three principal parts: (1) a surface soil of very dark gray or very dark grayish-brown silt loam; (2) a subsoil of gray to light brownish-gray silt loam that is very strongly mottled with yellowish brown; and (3) a substratum of gray, light olive-gray, or light brownish-gray sandy or silty alluvium.

The surface soil is 6 to 10 inches thick. Its very dark color results from an 8 to 12 percent organic-matter content. It is high in total nitrogen content and medium in phosphorus- and potassium-supplying power. It is suitable physically for root development when it is not saturated. The reaction is typically strongly acid.

The dominant gray color and strong mottling of the subsoil indicate that this part of the soil is wet for extended periods but dries periodically. This layer usually extends to a depth of between 24 and 40 inches. The texture is silt loam in most places. Although this layer is porous enough to permit root development, few roots penetrate it in areas that have not been drained. The reaction is strongly acid in most areas. The supplies of potassium and phosphorus are medium.

The substratum consists of layers of sand, silt, and gravel that vary in thickness and arrangement. The alluvial deposit is thick but rests at some depth on glacial till or other slowly permeable material. The upper part is strongly acid, but acidity decreases with depth. The substratum is saturated most of the time.

The surface soil in pastured or plowed areas is mainly 8 to 12 inches thick. In some areas that have received eroded material from adjacent land, the surface soil is 18 inches thick. The texture is typically silt loam but includes fine sandy loam. Gravel is uncommon. Though these soils are predominantly poorly drained, the areas mapped include spots that are somewhat poorly drained.

Holly soils are flooded early in spring when the snow is melting. They may be flooded periodically throughout the growing season if heavy rains occur. During April, the water table is usually within 6 inches of the surface. During May, it is rarely more than 12 inches below the surface. Consequently, these soils are unsuited to cultivated crops, though they can be used for grass hay in most years. In undrained areas plant roots develop mainly in the topmost 12 inches. They will extend below this depth if excess water is removed.

The surface soil is 8 to 12 percent organic matter. It is correspondingly high in total nitrogen content, but it releases nitrogen so slowly that plants show nitrogen deficiency. The high organic-matter content is largely responsible for the high capacity to hold bases. This capacity is equal to 10 to 14 tons of ground limestone in the topmost 8 inches of an acre. In the unlimed areas, this capacity is only about 30 percent filled and 4 to 7 tons of ground limestone are required to raise the pH of the topmost 8 inches of an acre to a value near pH 7.0. In areas that have been limed previously to pH 6.0, the requirement is 2 to 3 tons. These soils have medium capacity to supply potassium and phosphorus if excess moisture is removed. Wetness is the outstanding limitation.

Holly and Papakating soils (Hk).—The name of this mapping unit indicates that any given area may be entirely Holly soils, entirely Papakating soils, or a mixture of the two. There are more areas of Holly soils, however, than of Papakating. Both are wet soils on flood plains. They are intermingled in many areas, and their separation was not considered feasible or highly significant for this survey. Consequently, the user of the soil survey map should expect to find within any given area a range of conditions typical of that described for both Holly and Papakating soils. Papakating soils are described under the heading "Papakating Series."

Unless drained, these soils are unsuited to crops and only poorly suited to pasture. If surface water is removed, some areas can support good pasture, and a few can be used for crops. Some areas have been used as sources of topsoil, and some are suitable for wildlife marshes.

Unless drainage can be established, the use of these soils is so limited that the management must be mainly for nonagricultural purposes. Outlets suitable for drainage generally are difficult to establish. Where outlets can be developed, drainage is possible, but it generally is not highly effective, and the resulting partially drained soils are suited mainly to crops other than those that demand intensive management. If these soils are cropped or used for pasture, they need lime and fertilizer. Generally, the areas that are suitable for improvement are those dominated by Holly soils. (Capability unit IVw-5; woodland suitability group 15)

Honeoye Series

The Honeoye series consists of deep, well-drained, medium-textured soils that have formed in strongly calcareous glacial till. Good physical properties and high lime status are outstanding characteristics.

Honeoye soils occupy gently to moderately sloping areas in the uplands of the northernmost part of the county. They occupy positions from which some water is removed over the surface, and they receive no runoff from adjacent land. They are closely associated with the moderately well drained Lima soils, which are on landscapes from which water is removed more slowly; and also with the somewhat poorly drained Kendaia soils and the poorly drained to very poorly drained Lyons soils, which are nearly level to gently sloping.

Uneroded Honeoye soils have four distinct parts: (1) a plowed layer of very dark grayish-brown gravelly loam or gravelly silt loam; (2) a thin upper subsoil of brown to yellowish-brown gravelly loam or gravelly silt loam; (3) a lower subsoil of dark-brown, gravelly heavy silt loam or gravelly silty clay loam that contains more clay than the layers above or below it; and (4) a substratum of grayish-brown, very dense, very firm gravelly silt loam glacial till.

The very dark color of the plowed layer in uneroded areas is associated with a moderately high organic-matter content (mainly 3 to 5 percent). The total nitrogen content also is moderately high. In most fields the plowed layer is 7 to 10 inches thick. It is physically very good for development of plant roots. It is permeable to air and water and has good moisture-supplying capacity. The reaction is neutral or only slightly acid.

Below the plowed layer of most fields is a thin, well-aerated layer similar to the plowed layer in texture but lower in organic-matter content. This layer ranges from 3 to 5 inches in thickness within single fields. If the Honeoye soil has been plowed deeply, this entire layer is incorporated in the plowed layer. It is a good medium for plant roots, has good water-holding capacity, and is neutral or only slightly acid.

The lower part of the subsoil is mainly 10 to 15 inches below the surface and rests on calcareous glacial till at a depth of 16 to 30 inches. This layer contains more clay than do other parts of the soil, but the soil material is arranged in blocks, among which plant roots penetrate easily. Because of the spaces among the blocks, this layer is permeable and well aerated. It has good water-holding capacity, is high in lime, and is higher in potassium than are other parts of the soil. It can be thoroughly exploited by roots of many crops.

The underlying material is calcareous, slowly permeable, gravelly glacial till. It restricts the downward movement of water, and roots of most crops penetrate it only 4 to 10 inches. In most places this layer is 25 to 40 percent lime. The depth to bedrock is ordinarily more than 8 feet but ranges from 3½ to more than 20 feet.

Most areas of Honeoye soils have gravel in the plowed layer that interferes slightly with some tillage operations.

Honeoye soils are less gravelly, however, than Lansing and Valois soils. Some of the areas mapped have almost no gravel in the surface soil. The amount of gravel and stones increases with depth. The underlying glacial till is commonly 30 to 60 percent stone fragments, by weight. The depth to calcareous material is 20 to 26 inches in most places, but it ranges from as little as 16 to as much as 30 inches. Generally, the depth to lime increases from north to south within the county. Where the depth to lime is greatest, the upper part of the soil is commonly slightly acid or medium acid. Honeoye soils intergrade to the moderately well drained Lima soils. Where the two merge, there may be faint mottles at the top of the glacial till substratum. Thees mottles indicate short periods of wetness at this depth.

Direct measurements of fluctuation of the water table in Honeoye soils are not available, and estimates are based on observations in similar soils. During April, free water may be expected to be more than 20 inches below the surface, except immediately after soaking rains. At this time of year, 3 to 5 consecutive drying days should be necessary before the soil will bear machinery. During May, free water can be expected to stand above the slowly permeable till for short periods after rains, but the soil should be able to support machinery after 2 or 3 consecutive drying days. As the season progresses, the number of drying days necessary before cultivation decreases. During June, only 1 or 2 drying days are commonly required.

Plant roots penetrate a few inches into the firm glacial till. The thickness of the root zone ranges mainly from 20 to 36 inches. This volume of soil will hold between 4 and 6 inches of water that plants can use. Plants begin to show moisture stress when this amount is about one-half to two-thirds exhausted. Generally, this is the case in midsummer. Consequently, reduced growth rates can be expected after 7 to 10 rainless days during this period.

Honeoye soils are among the most fertile in the county. Generally, they need little or no lime, and in some areas they are neutral to the surface, but the surface soil is medium acid (pH 5.6 to 6.0) and requires 2 to 3½ tons of ground limestone per acre to raise the pH to a value near 7.0. The total capacity of the plowed layer to absorb bases is equal to 9 to 13 tons of ground limestone. The total nitrogen supply is moderately high. In spring, nitrogen is released slowly and response to nitrogen fertilizer is high. If moisture conditions are favorable in midsummer, plants may need more nitrogen than is released. If moisture is moderately limiting, the response to nitrogen may be slight. Because of the moderate concentration of clay in the subsoil, the potassium-supplying power of Honeoye soils is slightly higher than that of most soils in the uplands of Tompkins County. It may be adequate for moderate yields, but for high yields, potassium fertilizer is generally needed. The phosphorus-supplying power is medium, and phosphorus fertilizer is essential for good production. Honeoye soils have no special physical limitations and are among the best soils of the county.

Honeoye gravelly silt loam, 2 to 8 percent slopes (HmB).—This well-drained, gently undulating or gently sloping soil represents the central concept of the Honeoye series and makes up more than 75 percent of the acreage of Honeoye soils in Tompkins County. The slopes are mainly slightly convex; low knolls intermingled with small gently sloping spots are characteristic of most areas. Ordinarily, the surface soil is slightly acid or neutral, but in places it is medium acid (pH 5.6 to 6.0). Most areas are uneroded or only slightly eroded, but some of the knolls of undulating landscapes are moderately eroded. Spots of gravel-free soils and spots of Lima soils are included in the areas mapped.

This soil typically occupies the highest points in the local landscape and lies adjacent to the moderately well drained Lima soils and the somewhat poorly drained Kendaia soils, both of which are in slightly lower positions. Where this Honeoye soil intergrades to Lima soils, there may be faint mottles in the lower part of the subsoil or in the underlying glacial till. Areas that are dissected by crossable intermittent drainageways are likely to be associated with spots or narrow strips of the somewhat poorly drained Kendaia soils. Southward in the county, this soil intergrades to the more acid Lansing soils. On the lower slopes of valleys, it is associated with the more clayey Cayuga and Ovid soils and in such places has a slightly more clayey surface soil than is normal.

This soil is well suited to crops, including many kinds of vegetables, to pasture, and to forest. It is especially well suited to legumes that demand high lime status. It is among the best soils on the uplands for nonagricultural uses such as building sites.

This soil requires a minimum of special management. It is subject to slight erosion, but on the short slopes contour tillage and an appropriate cropping system are commonly adequate for control. Contour stripcropping and diversion terraces may be necessary on the longer slopes. Locally, fields can be improved by draining the small wet spots that have been included in the mapping. Fertility is generally high, but fertilization is needed for high yields. (Capability unit IIe–1; woodland suitability group 2)

Honeoye gravelly silt loam, 8 to 15 percent slopes (HmC).—This soil is representative of the drier half of the drainage range of Honeoye soils. The total area is about one-seventh that of Honeoye gravelly silt loam, 2 to 8 percent slopes. The slopes are strong enough to cause moderate difficulty in the use of machinery and to cause moderately rapid to rapid runoff.

This soil occupies moderate slopes on the sides of the main valleys or in moderately sloping side valleys where streams have cut into the glacial till of the uplands. It receives little water from adjacent higher land. Runoff is moderately rapid to rapid. This soil occurs mainly as small areas within fields dominated by the more gently sloping Honeoye soils or by Lima soils. The somewhat poorly drained Kendaia soils occupy nearly level landforms in the same locality. In a few places the mapped areas include spots of Honeoye soils on 15 to 25 percent slopes.

This soil is suited to crops, pasture, or forest. It is especially well suited to deep-rooted legumes. Intertilled crops, including vegetables, may be grown but require special practices for control of runoff. This soil is among the better sites on the uplands for nonagricultural uses that require good drainage.

Runoff and erosion can be controlled by maintaining a dense vegetative cover. Plowing should be as nearly on the contour as possible. On slopes that are more than 400 feet long, contour stripcropping is desirable if intertilled crops are grown. Drainage is no problem, except in a few moderately wet depressions that have been included in the mapped areas. This soil is potentially productive but requires fertilization. (Capability unit IIIe-1; woodland suitability group 2)

Honeoye gravelly silt loam, 8 to 15 percent slopes, eroded (HmC3).—The total area of this soil is small; the acreage is about half that of Honeoye gravelly silt loam, 8 to 15 percent slopes. A significant amount of soil has been lost through erosion, but the degree of erosion has not been uniform, even within single areas. Spots that have lost almost no soil, and spots that have eroded material deposited on the original surface, are scattered within areas of eroded soils. These spots make up 10 to 25 percent of most areas. In most of the eroded places, the plowed layer now includes all of what was originally the upper part of the subsoil and rests directly on the lower and more clayey part of the subsoil. The most strongly sloping spots have lost enough soil that the plowed layer now consists mainly of the lower part of the subsoil. In some of these spots, the plowed layer rests directly on the calcareous glacial till, and in small spots the plowed layer is calcareous.

The plowed layer is more gravelly than that of the uneroded Honeoye soil, because fine material has been removed by erosion. The plowed layer is also significantly lower in organic-matter content, and it absorbs water more slowly. The depth to the slowly permeable glacial till is 4 to 6 inches less than that in the uneroded soil. Runoff is more rapid, continuing erosion is a greater hazard, the nitrogen supply is less, and the available moisture capacity is less than for the uneroded Honeoye soil of similar slope.

This soil occupies moderate slopes on valley sides, or slopes where side streams have cut into the glacial till. Much of the material eroded from it has accumulated on adjacent areas of the more gently sloping Lima or Kendaia soils. The more gently sloping Honeoye and Lima soils commonly dominate the fields within which this soil occurs. The areas mapped include spots of eroded Honeoye soils on 15 to 25 percent slopes.

This soil is suited to crops, pasture, or forest. All of it has been cleared and cultivated. Much of it occurs within fields dominated by other soils and is used in the same way as the associated soils. It is best suited to deep-rooted legumes, such as alfalfa, but vegetable crops, corn, small grains, and hay are grown. It is among the better sites on the uplands for nonagricultural uses that require good drainage.

The choice of crops should be limited mainly to those that form a sod, bind the soil with their root systems, and improve the structure and increase the organic-matter content of the surface layer. If intertilled crops are grown, the rows should be as nearly on the contour as possible and long slopes should be stripcropped. Drainage is not a problem except in small depressions of wet soil that are included in a few of the areas mapped.

This soil is lower in potassium and phosphorus than the uneroded Honeoye soils, and much lower in nitrogen. It can be made moderately productive of most crops if fertilizer is applied and other management needs are met. It is the first of the Honeoye soils to show the effects of midsummer drought. (Capability unit IVe-1; woodland suitability group 2)

Howard Series

The Howard series consists of deep, well-drained, medium-textured soils that formed in moderately calcareous deposits of gravel and sand. These deposits contain less limestone and more sandstone and shale than those in which Palmyra soils formed. Howard soils are thicker above the calcareous gravel than Palmyra soils and are much more acid.

Howard soils occupy either nearly level terraces in the valleys, or hilly areas where glacial rivers dumped their loads at the ice front. The associated, less well drained soils that formed in similar material are members of the Phelps, Fredon, and Halsey series. The associated soils that formed in glacial till are soils of the Lansing or Valois catenas. Genesee and Eel soils occupy the flood plains of adjacent streams.

Howard soils have four principal parts: (1) a plowed layer of dark grayish-brown gravelly loam; (2) an upper subsoil of yellowish-brown or brown gravelly loam; (3) a lower subsoil of dark-brown or dark yellowish-brown gravelly silt loam or gravelly sandy clay loam; and (4) underlying layers of gravel and sand of the glacial outwash deposit.

The dark grayish-brown plowed layer is 3 to 5 percent organic matter. This moderately high organic-matter content is associated with a moderately high total nitrogen content. The soil material is porous and permeable. It is a good medium for root development. Gravel interferes moderately with tillage in most areas. This layer is strongly acid. It has a medium potassium reserve and medium phosphorus-supplying power. In most fields it is 6 to 10 inches thick.

The upper and less clayey part of the subsoil extends to a depth of 18 to 25 inches in most places, but tongues of this material extend downward to a depth of as much as 3 feet. This layer is porous. Both roots and water penetrate it easily. It is strongly to medium acid. The potassium reserve is medium, and the phosphorus-supplying power is medium. The water-holding capacity is moderately good.

The lower and more clayey part of the subsoil extends to a depth of 36 to 48 inches in most places, but tongues extend into the underlying gravel to a depth of as much as 5 feet in some areas. These tongues are very conspicuous in gravel pits. They are 1½ to 2½ feet wide at the top, taper to a point at the bottom, and generally are 5 to 20 feet apart. This part of the subsoil is very gravelly, but clay coats the gravel and fills some of the pores. This layer has higher water-holding capacity than the one below it. It slows the downward movement of water and holds moisture where it is available to plants. It is permeable to water, however, and is easily penetrated by the roots of deep-rooted crops. It becomes less acid with depth, and the lowest part is neutral.

The underlying glacial outwash consists of loose, porous gravel and sand. It retains little water. It is calcareous, but it supplies little potassium or phosphorus for plants. Deep-rooted crops send their roots far into it, however, and undoubtedly derive water from it. The depth to this calcareous gravelly material varies 2 feet or more within distances of 10 feet in many areas. Howard soils intergrade to Palmyra soils as the limestone content of the glacial outwash increases. Where these two soils merge, the horizons of Howard soils are thinnest and the calcareous gravel is 3 feet below the surface between the tongues of clayey material and more than 5 feet below the surface at the point of the tongues. Within Tompkins County, Howard soils are thinnest and highest in lime in the northernmost areas and thickest and lowest in lime in the southernmost areas. They intergrade to Chenango soils as the limestone content decreases. Where these two soils merge, calcareous material is usually 5 feet or more below the surface.

The texture of the surface soil is mainly gravelly loam, but in places it is gravelly sandy loam, and in a few places it is gravelly silt loam.

Free water stands in the upper part of Howard soils for only short periods after rains, even early in spring. Consequently, Howard soils are among the first in the county to be ready for cultivation in spring. During April, 2 to 3 consecutive drying days are generally enough to permit plowing. During May and June, only 1 or 2 drying days are needed.

The roots of deep-rooted plants extend far into the substratum in some areas. Most roots, however, are within the topmost 30 or 40 inches, the zone from which most of the water and plant nutrients are obtained. This volume of soil holds between 4 and 6 inches of moisture in forms commonly considered available to plants. Not all of this is easily available, however, and crops show signs of moisture stress after 10 days without rain.

The plowed layer can absorb bases in an amount equal to that supplied by 7 to 12 tons of ground limestone per acre. An unlimed surface soil, in which this capacity is about half filled, needs from 3½ to 6 tons of ground limestone per acre to raise the pH to a value near 7.0. If the soil has been limed previously to pH 6.0, it needs 1½ to 3 tons. Howard soils have medium phosphorus-supplying power. They contain a moderate amount of quickly available potassium, and their reserve supply is medium. The total supply of nitrogen in the surface soil is moderately high, and nitrogen is released more rapidly than in most soils of the county during spring. Nevertheless, plants show nitrogen deficiency in most areas at this time of year. If the moisture supply is adequate for good growth, nitrogen fertilizers are needed in midsummer for all crops except legumes.

Howard soils are among the most productive soils of the county for many kinds of crops, but the topography of some is unfavorable for cultivation.

Howard gravelly loam, 0 to 5 percent slopes (HdA).—This nearly level or gently undulating soil is typical of the Howard series. It occurs mainly on nearly level terraces in the valleys; a few areas are on the nearly level tops of gravelly deltas on the sides of valleys. This soil is most closely associated with the more strongly sloping Howard soils on terrace escarpments, with Genesee and Eel soils on the first bottoms, and locally with Phelps, Fredon, and Halsey soils, which are on the wetter parts of the terraces. The adjacent soils in glacial till on the valley sides are mainly members of the Lansing or Valois catenas. Some of the areas mapped include spots of the moderately well drained Phelps soils.

This soil is well suited to crops, pasture, or forest. It can be used for many kinds of vegetables, for fruits, and for the common field crops that are grown in support of dairying. It is especially well suited to deep-rooted crops. This is one of the best soils in the county for many nonagricultural purposes; it provides suitable sites for housing and is a source of gravel.

Maintenance of fertility is the first management need. Lime deficiency is the major limitation. Nitrogen, phosphorus, and potassium are needed also. The response to treatment is good, and the cost of intensive fertilization is commonly justified. Some areas can be improved by draining the few included spots of Phelps soils. Erosion is not a problem. (Capability unit I–1; woodland suitability group 1a)

Howard gravelly loam, 5 to 15 percent simple slopes (HdC).—This soil has slopes steep enough to make some tillage operations moderately difficult. The fact that the slope is in only one direction, however, makes fieldwork easier than it would be if the slope were complex. Some areas, mainly where the gradient is more than 10 percent, have been slightly or moderately eroded.

This soil occupies terrace faces in the valleys, long sinuous hills, called eskers, in the uplands, and small hilly areas associated with other Howard soils. A few mapped areas include spots of the moderately well drained Phelps soils.

This soil is suited to crops, pasture, or forest. Most of it is used for crops. It is especially well suited to deep-rooted legumes for hay or pasture. It is less well suited to vegetable crops than the nearly level Howard soils. This is an excellent soil for many nonagricultural purposes; it is suitable for building sites and is a source of gravel.

Like the other Howard soils, this one needs fertilizer and lime. In addition it needs practices that will control loss of water through runoff. It is moderately susceptible to erosion, especially in spring when the subsoil is frozen. Row crops should be grown only infrequently. Most areas can be tilled on the contour, but the slopes generally are too short to justify stripcropping. Most areas need no drainage, but a few could be improved by random tile lines to drain the included wet spots. (Capability unit IIIe–4; woodland suitability group 1a)

Howard gravelly loam, 5 to 15 percent complex slopes (HdCK).—This soil has rolling topography. The landform is typically a series of moderately sloping knolls that slope in many directions. Consequently, contour tillage is impractical, and the use of machinery is moderately difficult. An estimated 5 to 15 percent of the acreage is slightly or moderately eroded. The eroded spots are on the steeper parts of the slopes, and the eroded material has accumulated between knolls. This soil is more variable than either the uniformly sloping or the nearly level Howard soil. The original deposits varied widely in stone content from layer to layer, and the gravel content of the surface soil varies accordingly.

This soil occurs mainly as slopes around depressions on the glacial outwash terraces of the valleys, as dissected terraces in the valleys, and as rolling areas in the uplands where the ice front stood for long periods. It is most closely associated with Phelps, Fredon, and Halsey soils. The areas mapped include spots of the moderately well drained Phelps soil and some of Valois soils.

This soil can be used as cropland, but the complex topography makes intensive cropping and control of erosion difficult. Consequently, most of this soil is best suited to sod-forming crops, including deep-rooted legumes. It is also suited to pasture or forest. It provides some of the best sites in the county for many nonagricultural uses, especially those that involve construction.

Liming should have first priority for most crops. Phosphorus and potassium must be applied for even moderate yields. Nitrogen is deficient except for legumes. The response is great enough to justify intensive fertilization of many fields. Locally, this soil can be improved by draining the few wet spots that were too small to delineate on the map. (Capability unit IVe-8; woodland suitability group 1a)

Howard gravelly loam, 15 to 25 percent slopes (HdD).—This soil occurs as moderately steep and hilly areas, both of which are steep enough that tillage not only is most difficult but also is hazardous. The moderately steep areas have simple slopes in one direction; the hilly areas consist of a complex of hills in which the slopes run in many directions.

This soil is comparable to the soils described for the Howard series. Most of it has had some erosion, and about 50 percent of it has a thinner and lighter colored surface soil than that described as the central concept of the series. On the hilly areas, the texture in places is gravelly fine sandy loam, and in most places eroded material from the hillsides has accumulated in the depressions.

The moderately steep areas are mainly the faces of terraces and are associated with the nearly level and sloping areas of Howard soils. The hilly areas are mainly in the uplands, adjacent to soils of the Valois catena. Small areas of Phelps, Fredon, and Halsey soils occur in the wet spots of both landscapes. The mapping includes a few small areas of hilly Arkport fine sandy loam, the total acreage of which is small.

Although it is possible to cultivate this soil, cultivation is very difficult; most areas are better suited to pasture, hay crops, or forest. This soil is a source of sand and gravel for construction, and some parts of it are suitable for housing. This soil loses much water as runoff during heavy rains and is considerably more droughty than most other Howard soils. It is important, therefore, that deep-rooted legumes be included in the pastures and hay crops. It is advisable to keep this soil in permanent cover as much of the time as possible. If plowing is necessary to reestablish hay crops, it is advisable to plow across the slope to the extent that topography permits and to leave strips of grass to retard runoff. Draining the wet spots will improve the hilly areas in which these spots occur. Both hay and pasture require liming and fertilization for even moderate yields. (Capability unit IVe-8; woodland suitability group 1b)

Howard and Palmyra soils, 25 to 35 percent slopes (HpE).—These soils are so steep that the use of power machinery is extremely difficult or impossible. Any given area may consist of Howard soils, of Palmyra soils, or of some of both. Palmyra soils are described under the heading "Palmyra Series."

Howard and Palmyra soils rarely occur together; the individual areas are mainly one kind of soil or the other. Palmyra soils generally occur in the areas farthest north; and Howard soils are mainly in the areas farthest south. Most areas that have been cleared are moderately eroded, and consequently the soils are thinner over calcareous gravel and have lighter colored surface soils than those described for the Howard and Palmyra series. The texture varies more than in the less steeply sloping Howard and Palmyra soils. The surface texture ranges mainly from gravelly loam to gravelly fine sandy loam. Such variations occur within some individual areas. Where these soils are on the hilly landforms on the sides of valleys, the areas mapped include small areas of Valois gravelly loam. In the southernmost part of the county, a small acreage of Chenango gravelly loam on similar slopes has been included. The acreage is small, and the soil does not differ enough from the steep Howard soil to be mapped separately.

Slope dominates the use capabilities of these soils. The areas can be used for pasture, but most are best used for forest. As pasture, they are relatively unproductive unless they can be limed and fertilized. Applying lime and fertilizer is almost impossible on such steep slopes, since to be most effective the applications should be made in conjunction with plowing. These soils are sources of sand and gravel for construction. (Capability unit VIe-1; woodland suitability group 1b)

Howard and Palmyra soils, 35 to 60 percent slopes (HpF).—This mapping unit consists of very steep areas of Howard and Palmyra soils. Slope so dominates the capabilities of the two soils that they have not been differentiated in mapping. Soils within individual areas vary much more than those described for the Howard and the Palmyra series. The variations result from the mixing of the soils by mass creep downslope when the material is wet, especially when the subsoil is frozen. Accelerated erosion has been slight, because most areas are forested.

This unit occupies the steepest parts of some eskers, the steepest parts of some kames, and the very steeply sloping faces of deltas on the walls of the Cayuga Lake Valley and of Cayuga Inlet Valley. The mapping includes small areas of Arkport and Chenango soils in some places and small areas of Valois soils.

These soils are suited mainly to forestry, recreation, and wildlife. Some areas are sources of gravel for construction. (Capability unit VIIe-1; woodland suitability group 7)

Howard-Valois gravelly loams, 5 to 15 percent slopes (HrC).—Each area of this mapping unit consists of a mixture of Howard soils, which have formed in calcareous gravel, and Valois soils, which have formed in low-lime glacial till. Valois soils are described under the heading "Valois Series."

This unit lies in positions on the sides of valleys or across the uplands where the ice front stood for extended periods. Glacial till deposited directly by the ice is at the surface in somes places, but in many places the till is overlain by water-sorted gravel and sand deposited by water flowing from the melting ice. Valois soils have formed in the glacial till; Howard soils have formed in the glacial outwash. In some places till-like material that has apparently moved down adjacent slopes by slow creep overlies gravel. In these places Valois soils have formed in the till-like material but are underlain by porous gravel at a depth of 5 to more than 10 feet. Soils formed under these three conditions occur in very complex patterns, commonly within single feasible land-use units. In most places they could not be separated consistently at the scale of mapping.

This unit commonly occupies positions midway between the glacial outwash in the valleys and the glacial till on the uplands. Consequently, it is associated on one side with Valois, Langford, and Erie soils, and on the other with Howard soils.

This unit can be used for crops, pasture, or forest. Most of it is better suited to forage crops than to intertilled crops or small grains. Gravel for some uses may be obtained from small areas, but it commonly contains more silt and very fine sand than is desirable for use in concrete. The soils in this unit are well drained, and some parts are suitable for building sites.

Liming is the first requirement for even moderate yields. After liming, fertilization with nitrogen, unless legumes are present to supply it, and with phosphorus and potassium is necessary for even moderate yields of most crops. The slopes are strong enough to make the use of machinery moderately difficult and to create a moderate hazard of erosion. If the soil is to be conserved, it must be kept in sod-forming crops a large part of the time, or structures and contour practices must be used to control runoff. Contour practices are feasible in some areas. In others, the slopes are too complex for contour operations. The wet spots, which occur in some areas where seepage water emerges from the hillside, may be tile drained. (Capability unit IIIe-3; woodland suitability group 1a)

Howard-Valois gravelly loams, 15 to 25 percent slopes (HrD).—This mapping unit consists of a mixture of Howard and Valois soils in patterns so complex that the two soils could not be shown separately. It occurs on the lower parts of valley sides, where it is believed the ice front stood for long periods. Glacial till deposited directly from the ice underlies all areas, but moderately thick deposits of gravel were laid down over the till where streams issued from the ice. In some places till-like material from adjacent higher lying land has moved down the slope over the gravel deposits. The complex patterns of Valois and Howard soils result from this mixture of soil materials. Valois soils have formed in the till or till-like material; Howard soils, in the gravel. Valois soils are described under the heading "Valois Series."

The soils of this unit can be used for crops, but their moderately steep slope makes tillage very difficult. They may be used for pasture or for forest. Hay is the most feasible crop for most areas. Some of the gravel deposits are potential sources of gravel for some purposes, but the material commonly contains too much silt to be good for concrete. These soils are well drained and include sites that are suitable for buildings.

These moderately steep soils are susceptible to erosion and are difficult to cultivate. They are best kept in permanent vegetation. If they are used for hay or pasture, they must, for even moderate yields, be limed and also fertilized with phosphorus and potassium. If legumes are not grown the soils are also deficient in nitrogen. Many areas are so strongly sloping that liming and fertilization are very difficult. Most of the pastures are unimproved. (Capability unit IVe-2; woodland suitability group 1b)

Hudson Series

In the Hudson series are deep, moderately well drained to well drained, fine-textured soils that formed in calcareous clayey lake deposits. The surface soil in an uneroded area is typically silt loam, but the subsoil contains as much clay as that of any soil in the county. The upper part of the soil is medium acid to neutral; the subsoil is neutral or calcareous.

These soils are in valleys that once were occupied by glacial lakes. They are mainly below the 1000-foot contour but occur at higher elevations in places outside the Cayuga Valley.

Because of their location, Hudson soils lose water through runoff and receive little or no water from adjacent areas. Their slope is as little as 2 percent in some places but generally is greater. Hudson soils are on convex landforms that are associated with uniformly, gently to moderately sloping areas on which are the somewhat poorly drained Rhinebeck soils. In the same general localities, depressions are occupied by the poorly drained to very poorly drained Madalin soils. On the slopes to Cayuga Lake, Hudson soils are intermingled with Cayuga soils, which formed in a thin lake deposit over glacial till. In those places soils of the two series cannot feasibly be shown separately at the scale of mapping, and the mapping units are complexes.

Uneroded Hudson soils have four principal parts: (1) a plowed layer of dark grayish-brown heavy silt loam; (2) a thin, leached layer of pale-brown silt loam that is faintly to distinctly mottled; (3) a subsoil of brown to dark grayish-brown silty clay loam or silty clay, unmottled in the upper part but mottled in the lower part; and (4) the underlying calcareous clay and silt of the original lake deposit.

The plowed layer in most fields is 7 to 10 inches thick. It is moderately dark colored because it is 3 to 5 percent organic matter. Because of the organic-matter content, the total supply of nitrogen is moderately high. If the organic-matter content has been maintained, the surface soil is porous and well aerated and is permeable to roots and water. If the organic-matter content has been depleted, this layer is less porous and puddles easily. The plowed layer has a high potassium reserve but supplies only a moderate amount of phosphorus. The reaction ranges from nearly neutral to medium acid.

The pale-brown, leached layer below the plowed soil is present only if the soil has not been plowed deeply and if it is uneroded. In uneroded areas it extends to a depth of 10 to 12 inches. Though it contains less organic matter than the surface soil, it is porous and can be penetrated easily by roots. Faint mottling indicates that water stands for short periods in this layer.

The clayey subsoil extends to a depth of 24 to 42 inches. It is high in clay but is divided into well-expressed, medium and fine blocks. Roots grow between blocks, and some penetrate into the blocks. Because of its blocky structure, this clayey layer is only moderately restricting to root development and water movement. This part of the soil is nearly neutral. It is high in reserve potassium but has only moderate capacity to supply phosphorus. It holds a large amount of water, but much of the water is unavailable to plants. The available moisture capacity is slightly less than that of less clayey subsoils. Where this layer is thickest, free lime may be present as coats and pore fillings in the lower part.

Below a depth of 24 to 42 inches, the original material appears to be unaltered. More than 80 percent of it consists of silty clay or clay in layers that range from ½ inch to more than 12 inches in thickness. These are separated by thinner layers of almost pure silt. The material is strongly calcareous, and free lime can be seen as light-gray films at the contact of the clay and silt layers. Water penetrates this layer extremely slowly. Few roots penetrate more than a few inches.

The silt loam surface soil is higher in clay than the silt loams derived from glacial till. The subsoil contains 30 to 60 percent clay. The amount of clay appears to be related to the proportion of clay and silt layers in the original deposit. The thickness of the lake deposit ranges from as little as 3 feet, where Hudson soils intergrade to Cayuga soils, to more than 20 feet. In some places, especially on the slopes to Cayuga Lake, this deposit rests on bedrock. In most places it rests on glacial till. Bedrock is ordinarily more than 10 feet below the surface, but in some places on valley sides it is only 36 inches below the surface. Hudson soils are mainly free of stones, but the surface soil contains some gravel in areas near the beaches of ancient lakes and where Hudson soils intergrade to Cayuga soils.

Hudson soils are saturated when the frost first leaves the ground in spring. During April, free water is within 10 inches of the surface after rainy periods but falls to a depth of more than 24 inches after a few rainless days. At this time of year, 4 to 6 drying days are commonly needed before the soil will support machinery. During May, free water is present in the subsoil for moderate periods after each rain, mainly at a depth of more than 18 inches. At this time of year, 3 or 4 consecutive drying days will normally permit cultivation. During June, the soil may be cultivated after 1 to 3 drying days.

The roots of most plants are concentrated mainly in the topmost 12 to 14 inches, but alfalfa roots have grown to a depth of 4 feet. Most crops probably obtain moisture and nutrients mainly from the topmost 20 to 24 inches. To this depth, the soil holds from 3½ to 4 inches of water in forms normally considered available to plants, but not all of the water is equally available. Evidence of moisture stress is generally apparent after a week or 10 days without rain during midsummer.

If uneroded, the plowed layer has capacity to absorb bases supplied by 10 to 15 tons per acre of ground limestone. In most fields this capacity is 50 to 80 percent filled. An unlimed plowed layer needs from none to as much as 5 tons of ground limestone per acre to raise the pH to a value near 7.0. If the surface soil is at pH 6.0, the requirement is 2 to 3 tons.

Hudson soils have a very large reserve supply of potassium in the subsoil. Nevertheless, plants that require large amounts of potassium, such as alfalfa, respond to potassium fertilization. The potassium reserve is not depleted so rapidly under intensive cropping as it is on less clayey soils.

Supplies of the other major nutrients are generally deficient for good crop growth. Though the supply of nitrogen is moderately high, nitrogen is released slowly, and crops respond to nitrogen fertilization, especially in the spring. The phosphorus-supplying capacity is medium, and phosphorus fertilization is necessary for good yields.

Though Hudson soils are potentially productive of many crops, they have important limitations. They are erodible; they require more power for plowing than many soils of the county; and they are suitable for tillage within only a narrow range of moisture content. Under management that reduces organic-matter content, the surface soil loses its favorable structure, the difficulty of making a good seedbed increases, and the amount of runoff becomes greater.

Hudson silty clay loam, 2 to 6 percent slopes (HsB).—Areas of this soil have lost variable amounts of the original plowed layer. The present plowed layer is a mixture of part of the original surface soil, the thin leached layer below it, and some of the more clayey subsoil.

The degree of erosion is not uniform within single areas. The landform is convex and commonly contains undulations. Though the slopes are gentle, soil material has been eroded from the most strongly sloping parts and has been deposited on the least sloping parts. When this soil is plowed, clayey spots are apparent on small knolls where the plow turns up former subsoil material, and dark-colored spots are apparent on nearly flat places where eroded material has been deposited. Only about 10 percent of this soil has lost all of the material above the former subsoil. About 20 percent still has a surface layer of silt loam. Some areas include spots of the somewhat poorly drained Rhinebeck soils, too small to be mapped. Most of them have been improved by deposits of soil eroded from the higher land.

This soil is associated mainly with Rhinebeck soils, which are somewhat poorly drained, and with steeper Hudson soils.

This soil is suited to crops, pasture, or forest. Crops grown in support of dairying are among those to which it is best suited. Because of the fine texture and relatively poor structure of the surface soil, this soil is less well suited to many vegetable crops than are many other soils of the county. Some areas in the vicinity of Ithaca are used for nonagricultural purposes, including industrial sites and housing, but there are problems of instability and slow permeability.

Although this soil can be productive of suitable crops, it requires very careful management. The surface soil has lost much of its organic matter and has poor structure. Water is absorbed slowly, and erosion is a continuing hazard. Crops that form sod supply organic matter and help to control washing. Contour cultivation, the use of cover crops, stripcropping, and diversion terraces are needed for control of water in some areas. Some fields can be improved greatly by draining the included spots consisting of wetter soils. Nitrogen, phosphorus, and potassium are required for good yields. Nitrogen is especially needed; potassium is in better supply than in most soils of the county. The reaction generally is nearly neutral, but some areas require a moderate amount of lime. (Capability unit IIe-8; woodland suitability group 6a)

Hudson silty clay loam, 6 to 12 percent slopes, eroded (HsC3).—This is a moderately eroded, sloping, clayey soil. It is typical of the central half of the drainage range for the Hudson series. In the most strongly sloping parts, which make up 5 to 20 percent of individual areas, the plowed layer consists mainly of material that was formerly part of the clayey subsoil, and the texture is heavy silty clay loam or silty clay. In 70 to 85 percent of each area, part of the original plowed layer remains, but enough of the more clayey subsoil has been plowed up to make the surface texture a silty clay loam. About 10 percent of each area is uneroded or has a deposit of eroded material on the original surface.

Many areas of this soil occupy convex slopes on the sides of valleys and are crossed by shallow waterways through which water flows from higher land. Most of these waterways can be crossed by machinery but remain wet after rains for moderate periods. The less strongly sloping areas in the same locality are mainly the somewhat poorly drained Rhinebeck soils. In some places this Hudson soil lies adjacent to Cayuga or Ovid soils, or to a complex of Hudson and Cayuga soils. This Hudson soil dominates in some fields; in others it is a minor constituent.

This soil can be used for crops, pasture, or forest. The strong slope, the consequent loss of water needed by crops and continued erosion, and the relatively poor physical condition of the plowed layer make this soil more suitable for hay or pasture than for intertilled crops. Some areas are used for nonagricultural purposes, but instability of the material creates problems in some kinds of construction.

This soil needs intensive practices for control of runoff, and intensive management for maintenance of fertility and structure. If used frequently for intertilled crops, it needs special measures to control water. Limited tillage is desirable. Complete fertilizer is necessary for even moderate yields. Nitrogen, particularly, is deficient. The shallow waterways that cross some areas need special attention; some need permanent sod to control erosion and others need drainage to eliminate wet spots. (Capability unit IVe-7; woodland suitability group 6a)

Hudson silty clay loam, 12 to 20 percent slopes, eroded (HsD3).—This moderately steep soil is in the drier half of the drainage range for the Hudson series. Most areas that have been cleared and cultivated have lost enough of the original plowed layer that some of the clayey subsoil has been turned by the plow. Some spots have lost all of the original surface soil, and in these places the plowed layer is silty clay. Forested areas and a few pastured areas are uneroded.

Most of this soil occupies uniform slopes on the sides of valleys. Many areas are cut by shallow channels that carry water only during wet periods. Some of these channels cannot be crossed by farm machinery. Areas in the Inlet Valley have uneven, hilly topography, and a few small areas, mostly in the Inlet Valley, have slopes of more than 20 percent. In a few places, streams have undercut the base of these slopes and masses of soil material have slipped downhill. This soil is associated mainly with other Hudson soils and with the Hudson-Cayuga complex.

This soil can be used safely for sod-forming crops, pasture, or forest. A row crop can be grown occasionally in order to reestablish sod. Nonagricultural uses currently include recreation, wildlife, and housing. Instability of the soil material creates special problems in some kinds of construction.

This soil is subject to continuing serious erosion. It is also droughty, for it loses much water by runoff. If properly managed it can be made moderately productive of hay crops and pastures. If intertilled crops are grown, strips of sod are needed for water control. Some areas need lime. Phosphorus and potassium fertilizers are necessary for good yields of legumes. Nitrogen fertilizer is needed for crops other than legumes. (Capability unit VIe-1; woodland suitability group 6b)

Hudson-Cayuga silt loams, 2 to 6 percent slopes (HuB).—This mapping unit consists of areas in which Hudson and Cayuga soils are closely intermingled. Both soils have formed in a thin mantle of lake sediments over glacial till. The thickness of the mantle ranges from as little as 20 inches to more than 7 feet and is not uniform, even in a single field. Where it is less than 36 inches, Cayuga soil has formed; where it is more than 36 inches, the soil has developed wholly in the lacustrine material and is a Hudson soil.

Most of the areas of this mapping unit occupy gentle convex slopes of the sides of valleys that were under the water of glacial lakes. The convex landforms lose enough water by runoff to make the soils moderately well drained. The areas receive little or no water from adjacent higher land. Water is channeled into shallow watercourses that flow for only short periods after rains. Most of the watercourses can be crossed with farm machinery, but they contain spots that remain wet after the adjacent fields are dry. On many of the short slopes adjacent to these waterways, most of the lacustrine deposit has been removed and the soil has formed in a mixture of lake clay and glacial till. These spots are the Cayuga soils of the complex. Soils similar to Cayuga soils occupy other spots between the watercourses where the lake deposit is thin. These areas are relatively unaffected by recent erosion, though erosion is evident in spots.

Areas of this complex are associated with mappable areas of Hudson soils, which formed in deep lacustrine sediments, and with Honeoye and Lansing soils, which formed in glacial till. Near streams and ancient beaches, sandy or gravelly spots are included locally. Where these landforms join nearly level areas, Ovid or Rhinebeck soils are the common associates. The mapped areas include spots of the somewhat poorly drained Ovid soils, where the lacustrine deposit is thinnest, and the somewhat poorly drained Rhinebeck soils, where it is thickest. Small spots of the poorly drained Ilion soils are in some of the shallow drainways. These spots occupy less than 7 percent of the delineated areas but interfere with tillage of entire fields.

These soils are suited to crops, pasture, or forest. They can be used for some vegetable crops. Their location with respect to Cayuga Lake makes some areas moderately well suited to some kinds of fruit. Most areas are used principally for production of grain and forage crops in support of dairying. Some are in urban uses. Suitability for nonagricultural uses is limited in some areas by instability of the material and by bedrock, which is ordinarily at least 10 feet below the surface but is at a depth of only 3 feet in some places.

Management needs are moderately exacting. These soils are moderately susceptible to erosion, but the slopes are gentle enough that erosion is not an outstanding problem. In addition to appropriate crop rotations, some areas need contour cultivation, contour stripcropping, or diversion terraces for control of water. Grass strips in the waterways that cross these areas are important in some places. Some areas need lime for legumes, and all areas need fertilizer for high yields of all crops. The fertility needs are about the same as those of Cayuga soils. Maintenance of the organic-matter content is especially important, for structure of the plowed layer is easily destroyed. Many fields can be substantially improved by artificial drainage of the included wet spots. (Capability unit IIe-8; woodland suitability group 6a)

Hudson-Cayuga silt loams, 2 to 6 percent slopes, eroded (HuB3).—This mapping unit consists of mixed Hudson and Cayuga soils that have been moderately eroded.

Most areas have lost through erosion enough of the original surface soil that the plowed layer now includes some of the clayey subsoil. The texture of the plowed layer is mainly heavy silt loam.

These soils are mapped as a complex because the deposit of lacustrine material is not uniform in thickness within the areas that can be mapped. Cayuga soils occupy positions where it is thinnest and where glacial till has been incorporated in the upper part of the soil. Hudson soils are entirely within lake-laid sediments. The depth to glacial till ranges from as little as 20 inches to as much as 7 feet. Bedrock is mainly more than 10 feet below the surface, but it is only 4 to 6 feet deep in some places. The slope range is from 2 to 6 percent, but 4 to 6 percent slopes predominate.

These gently sloping soils are mainly on the sides of valleys that were occupied by glacial lakes. Water from higher adjacent areas is channeled in shallow watercourses that run downslope across these areas. Most of these waterways can be crossed by farm machinery, but they contain spots that remain wet after the rest of the field is dry. The Cayuga soils in this complex occupy the short slopes adjacent to the waterways and also occur as spots throughout the rest of the area. Hudson soils dominate most of the area between the watercourses. This complex typically occupies positions intermediate between areas of Honeoye or Lansing soils in deep glacial till on the uplands and areas of Hudson soils in deep lake sediments in the valleys. Nearly level associated areas are mainly the somewhat poorly drained Rhinebeck or Ovid soils.

These areas of Hudson and Cayuga soils can be used for crops, pasture, or forest. Their capabilities for some intertilled crops are limited by the results of erosion. Their capabilities for hay and pasture, however, are moderately good. Some areas favorably located with respect to Cayuga Lake are suited to fruit. Areas of these soils are moderately well suited to some nonagricultural uses, including building sites. Instability of the upper soil material is a limitation for some uses, and depth to bedrock limits suitability for some kinds of nonagricultural uses locally.

The management needs of these soils are exacting. Though they can be used successfully for intertilled crops, including some vegetables, practices such as cover cropping, contour tillage, and stripcropping are needed on most areas for control of erosion. Drainage of small wet spots that are included along drainways improves some fields. These soils are deficient in nitrogen. Phosphorus fertilizer is essential for good yields. Although the supply of potassium is better than in many soils, crops like alfalfa require some potassium fertilizer. Some areas need lime, though most are nearly neutral. (Capability unit IIIe-10; woodland suitability group 6a)

Hudson-Cayuga silt loams, 6 to 12 percent slopes, eroded (HuC3).—These sloping areas consist of Hudson soils in deep lacustrine deposits intermingled with Cayuga soils in thin lake sediments over till. The wetness is representative of the middle half of the drainage range for both series.

This mapping unit occurs mainly on the sides of valleys, where it occupies moderate slopes that are distinctly convex. In most areas erosion has removed enough of the original surface soil that some of the more clayey subsoil has been incorporated in the plowed layer. The surface soil is heavy silt loam. Some spots are more severely eroded than others. In these places the plowed layer consists of the original subsoil material and the texture is silty clay loam. Locally, the mapping includes gravelly areas along small intermittent drainways that are incised into the till. Some of these small waterways have cut into bedrock and cannot be crossed by machinery. Some areas that are in woods and are uneroded were included also, because of their small extent.

These sloping soils on valley sides are associated with other Hudson-Cayuga units of different slopes, with units of soils that are shallow to bedrock, and with some Honeoye and Lansing soils. The proportion of Hudson soils is smaller, and that of Cayuga soils is larger, on these stronger slopes than in less strongly sloping areas of the Hudson-Cayuga complex. These more strongly sloping areas also have more numerous deeply incised waterways that have cut into the sides of the main valleys. Near these incised waterways, spots of gravel or sand are common. Some of these spots were mapped separately as Arkport or Howard soils; others are so small they were included in areas of this mapping unit.

This mapping unit is suited mainly to pasture or forest, but it can also be used for hay. Some areas in favorable locations are suited to orchards or vineyards. Some are in demand as sites for housing or cottages. Persons interested in nonagricultural uses of these areas should investigate thoroughly the depth to bedrock if it is important for their purposes.

In many areas the most feasible method of erosion control is the use of permanent sod crops and infrequent plowing to renew the stand. Diversion terraces are feasible in some areas but infeasible in many others. Both hay and pasture require fertilization with phosphorus. Though the supply of potassium is better than in many soils of the uplands, fertilization with potassium is essential for good production of legumes. Nitrogen is deficient. If crops other than legumes are grown, fertilization with nitrogen is essential for even moderate rates of production. (Capability unit IVe-7; woodland suitability group 6a)

Hudson-Cayuga silt loams, 12 to 20 percent slopes (HuD).—These are moderately steep areas, mainly on valley sides, where a deposit of lacustrine material overlies till. The thickness of this deposit is uneven. Cayuga soils occur where the thickness is less than 36 inches; Hudson soils, where it is more. The two soils are intermingled to the extent that they could not be mapped separately; this unit, therefore, is a complex of the two. The wetness of the soils is representative of the drier half of the drainage range for the two series.

In these moderately steep areas, the thin lacustrine deposit is extensive and Cayuga soils occupy almost half of the acreage. Many drainways cross these areas. They have cut deeply into the underlying till, and in many places they have cut to bedrock. Most of the cleared and cultivated areas are moderately to severely eroded; areas that are still in woods are slightly eroded or uneroded. Moderately eroded soil is most extensive. This mapping unit is associated with soils that are shallow to bedrock and with other units of the Hudson-Cayuga complex. The depth to bedrock within the areas ranges widely, but in a large proportion of them it is less than 10 feet.

These soils are poorly suited to most crops. They may be used for pasture, forest, or hay. If they are plowed, strips of sod should be left to control runoff. Much of the land is idle. Pastures need fertilizer, especially phosphorus. Some areas are in demand for nonagricultural uses, including housing. Persons interested in such uses should investigate thoroughly the thickness of soil material above bedrock. (Capability unit IVe–7; woodland suitability group 6b)

Hudson and Collamer silt loams, 2 to 6 percent slopes (HwB).—This is an undifferentiated unit of two kinds of soil. Any given area may consist of clayey Hudson silt loam, silty Collamer silt loam, or a mixture of the two. Most of the areas mapped do contain both soils. Collamer soils are described under the heading "Collamer Series."

In parts of the county where this unit has been mapped, the lake deposits consist of relatively thick layers that are predominantly clay, which alternate with equally thick layers that are predominantly silt. If a thick layer of clayey material is at the surface, the soil is in the Hudson series. If a thick layer that is predominantly silt is at the surface, the soil is in the Collamer series. Mapping the two units separately was not found feasible, because the separation could not be made consistently in most of the areas. Both soils are mainly moderately well drained, and both have silt loam upper horizons; thus, the two have been treated as one mapping unit.

This mapping unit occupies gently sloping convex landforms that receive little or no water as runoff from adjacent areas. They lose water at a moderate rate by runoff. Some areas dominate entire fields; others are closely associated with the somewhat poorly drained Niagara or Rhinebeck soils within fields. Some areas contain depressions that consist of Niagara or Rhinebeck soils and are too small to be mapped separately. These depressions occupy less than 5 percent of any given area. Small knolls have lost part of the original plowed layer, but erosion cannot be recognized consistently in mappable areas. The mapping includes some small areas that have a silty surface soil characteristic of Collamer soils, but it lacks the more clayey subsoil. These inclusions are intergrades to the Williamson soils, which have a fragipan. In a few areas Collamer or Rhinebeck soils overlie gravel at a depth of more than 4 feet. Such areas are mainly on nearly level terraces or are associated with the hilly topography of glacial moraines.

These areas of Hudson and Collamer soils are well suited to crops, pasture, or forest. Many are especially well suited to vegetable crops if the structure of the plowed layer can be maintained. Many areas have been selected as sites for nonagricultural purposes. Instability of the material is a critical factor in some areas for certain kinds of construction. Much of the experimental area adjacent to the Cornell University campus consists of these soils.

These soils are potentially productive, but they have moderately exacting management needs. Even on these gentle slopes, they are susceptible to erosion. Contour tillage, stripcropping, diversion terraces, and sod waterways can be used effectively in some areas for control of runoff. The use of sod-forming crops periodically is important, not only for control of erosion but also for maintenance of the organic-matter content. Tile drainage of the inclusions of Niagara and Rhinebeck soils can improve some areas. Some, but not all, areas need lime. All require nitrogen, phosphorus, and potassium fertilizer for good yields. (Capability unit IIe–8; woodland suitability group 6a)

Hudson and Dunkirk soils, 20 to 45 percent slopes (HzE).—This is an undifferentiated unit of soils. Any given area may consist of Hudson soils, Dunkirk soils, or a mixture of the two. Dunkirk soils are described under the heading "Dunkirk Series." The steep slope so dominates the capabilities of this unit that the differences between Hudson and Dunkirk soils are relatively unimportant.

These soils are mainly silt loams and silty clay loams that are well drained. Most cleared areas are moderately or severely eroded. Hudson soils are dominant; Dunkirk soils occur locally in stratified silty sediments, mainly along Fall Creek and Cascadilla Creek. Dunkirk soils are deep, well-drained, stone-free soils that formed in lake-laid silty deposits. In some places the soils are being undercut by streams and masses of soil material have slipped downslope.

This mapping unit occupies mainly dissection forms on the sides of the major valleys, but it also occurs in the Inlet Valley on hilly deposits in association with less steeply sloping Hudson and Dunkirk soils. The mapping includes small areas of Arkport and Howard soils near sidestreams or gorges on both sides of Cayuga Lake and a small acreage of steep Cayuga and Darien soils in the vicinity of Varna.

This unit is suited mainly to pasture, forest, recreation, or wildlife. In some places near Cayuga Lake, it is used as cottage sites. Pastures need fertilizer, especially phosphorus. Some areas need lime. Lime and fertilizer are very difficult to apply on such steep slopes; therefore, most pastures are unimproved. (Capability unit VIe–1; woodland suitability group 6c)

Ilion Series

The Ilion series consists of deep, poorly drained soils that have formed in moderately fine textured, calcareous material derived from a mixture of lake-laid silty clay and loamy glacial till. In some places the two materials were mixed and deposited by the glacier; in others a thin layer of clay was deposited over till, and the two were mixed by upturning of trees, burrowing by animals, and frost action. These soils are mainly only slightly acid or neutral from the surface downward. Free lime occurs in the substratum.

Ilion soils are poorly drained; they have inherited some properties from glacial till, but they contain more clay than the loamy Lyons soils. These conditions are met in three kinds of places. One is in association with Ovid or Cayuga soils, where a thin deposit of glacial-lake clay rests on medium-textured glacial till. Another is in association with Darien soils, where the ice appears to have overridden glacial lake deposits and mixed them with medium-textured till. The third is in depressions on the uplands, where fine-textured material was deposited in local lakes and over the centuries has been mixed with gravelly material that moved downslope from till-mantled, adjacent areas. In all of these places, the soils are wet and are moderately fine textured.

Ilion soils have four distinct parts in undisturbed areas: (1) a surface soil of very dark gray or very dark brown silty clay loam; (2) an upper subsoil of grayish-brown or dark grayish-brown, highly mottled silty clay loam; (3) a lower subsoil of highly mottled silty clay loam or silty clay; and (4) a substratum of dense glacial till. The substratum ranges from loam to silty clay loam in texture and is moderately to strongly calcareous.

The average thickness of the very dark colored surface soil is about 10 inches. The very dark color is associated with high organic-matter content, which ranges mainly from 6 to 10 percent and is, in turn, associated with high total nitrogen content. Reddish-brown mottles along root channels indicate that this layer is wet part of the time. This layer contains some gravel or channery fragments, and some shale. It is porous. It is a good medium for plant roots if it is not saturated. It is very high in potassium reserve and is medium in phosphorus-supplying power.

The upper part of the subsoil in undisturbed areas extends to a depth of 11 to 16 inches. Its dominant grayish colors and profuse mottling result from prolonged periods of wetness that alternate with periods of dryness. In undrained areas this layer contains few roots. It is nearly neutral. It has a very high potassium reserve and medium phosphorus-supplying power. The organic-matter content is much lower than that of the surface soil. A moderate number of flat stone fragments and shale fragments are present in most places.

The clayey lower subsoil extends to a depth of 18 to 26 inches. It shows evidence of prolonged wetness. It is arranged in blocks that have gray coats and strongly mottled interiors. It is slowly permeable to water and contains few roots. This layer is neutral, has a very high potassium reserve, and has medium phosphorus-supplying power.

The underlying, firm, medium-textured to moderately fine textured glacial till is slowly permeable. Few roots reach it. This till is moderately to strongly calcareous.

The thickness of the very dark colored surface soil ranges widely from area to area. In large forested areas, this layer is commonly 4 to 6 inches thick. In pastures and in plowed fields, it is mainly about 10 inches thick. In places that have received eroded material from adjacent soils, it is 16 or 18 inches thick. In such places the texture ranges mainly from silty clay loam to loam, but in some spots it is fine sandy loam. The number of stone fragments in the subsoil differs widely from area to area, but in the surface soil there are generally too few fragments to interfere with cultivation. Variations in texture and stone content are greatest in the upland depressions. The reaction of the upper part of the soil ranges from medium acid to neutral. Depth to free carbonates ranges from 18 to 36 inches.

Undrained Ilion soils have free water at the surface until mid-April of most years. During the latter part of April, free water may be 8 inches below the surface for short periods. Except in very dry seasons, water stands within 12 inches of the surface during most of May and rises to the surface during each rainy period. Undrained areas can rarely be plowed during April and commonly require 5 to 10 drying days in May before they will bear machinery. Even during June, 3 to 8 drying days are commonly required before cultivation. As the season progresses, however, free water falls below 30 inches during rainless periods, and in midsummer it may not be within 4 feet of the surface.

These soils receive so much water from adjacent land that available moisture capacity has little meaning. In undrained areas few roots extend beyond a depth of 12 inches. Where drainage has been established, roots penetrate to a moderate depth, mainly above 18 to 24 inches. In such areas, Ilion soils are conspicuous because they support vigorous growth of crops when crops on adjacent soils show moisture deficiency. They are conspicuous also during wet periods, when crops show pronounced nitrogen deficiency. Many areas have been drained to some degree, but not enough to free the subsoil of water. In these places crops have shallow root systems and may show moisture stress when the water table falls during dry weather.

These wet soils are high in total nitrogen content, but they release nitrogen so slowly that plants commonly show a deficiency. They have a very high potassium reserve and medium phosphorus-supplying power. Some areas need lime, but most are nearly neutral. These soils have a very high capacity to hold bases, equivalent to 13 to 16 tons of ground limestone per acre in most areas. This capacity is 50 to 80 percent filled in most unlimed areas. An unlimed surface soil, therefore, may need from none to as much as 4 tons of ground limestone per acre to raise the pH to a value near 7.0. A surface soil at pH 6.0 needs 2½ to 3½ tons of ground limestone.

Ilion silty clay loam, 0 to 2 percent slopes (IcA).—This nearly level soil represents the wetter two-thirds of the drainage range for the series. It consists of areas on which eroded material has most commonly been deposited. Its very dark colored surface soil is typically 10 to 18 inches thick. It occupies nearly flat areas surrounded in most places by more strongly sloping soils of the Ovid, Darien or Lansing series. Some areas are on uplands in association with Erie soils.

If undrained, this soil is too wet for most crops except grass hay, but many areas have some provision for removal of excess surface water and are used to a limited extent for other crops. If adequately drained, this soil is suited to the rotations common on dairy farms. It includes sites that are suitable for ponds and for wildlife marshes.

The greatest management need is control of excess water. If this soil is farmed intensively, it needs to be drained, and in most places it needs diversions to carry off the runoff from adjacent higher land. Erosion is not a problem. Most areas are nearly neutral and need little or no lime. Phosphorus must be applied for good yields. Nitrogen deficiency is evident in the early part of the year, in spite of the high total nitrogen content of the soil. The potassium reserve is very high. (Capability unit IVw-1; woodland suitability group 14a)

Ilion silty clay loam, 2 to 6 percent slopes (IcB).—This gently sloping soil represents the drier half of the drainage range for the series. It is approximately twice as extensive as Ilion silty clay loam, 0 to 2 percent slopes, and commonly occurs as moderately large areas. It is on long slopes, receives water from the adjacent higher-lying areas, and is typically associated with Cayuga and Ovid soils. Though the slope range is 2 to 6 percent, slopes of less than 4 percent predominate in most areas. The very dark colored surface soil is commonly 8 to 10 inches thick.

Unless excess water is controlled, this soil is suited primarily to pasture or woodland or to hay crops consisting mainly of grasses. If water can be controlled, this soil can be used for the rotations common on dairy farms. It generally is not well suited to many vegetables and to other crops that require high response to fertilization and other management practices. It provides poor sites for most nonagricultural purposes, except ponds.

Water control is the outstanding management need. In many areas diversion of the runoff from adjacent land is the most urgent need. Some areas can be drained adequately with tile; others have poor outlets. Nitrogen is uniformly deficient early in spring, but in drained areas, it may be adequate for many crops during November. Some areas are medium acid and need lime; others are nearly neutral. The potassium reserve is very high. The phosphorus-supplying power is medium. (Capability unit IVw-2; woodland suitability group 14a)

Kendaia Series

This series consists of deep, somewhat poorly drained, medium-textured soils in medium-lime to high-lime glacial till. The series is a somewhat poorly drained associate of both Lansing and Honeoye soils. Where Kendaia soils are associated with Lansing soils, the upper part of the profile is medium acid and the underlying glacial till is moderately calcareous. Where they are associated with Honeoye soils, the upper part is only slightly acid or is neutral, and the underlying till is strongly calcareous. The dark color of the plowed layer is conspicuous in plowed fields, in contrast with the lighter colors of better drained associated soils.

Kendaia soils occupy level to gently sloping areas on which runoff is very slow or on which water from adjacent areas accumulates. They are associated with slightly higher lying Lansing and Conesus soils or with Honeoye and Lima soils on the uplands in the northern part of the county. More than half of the acreage occupies the wettest positions in the immediate locality. Slightly less than half is associated with Lyons soils, which occupy lower lying, wetter positions.

Kendaia soils have four principal parts: (1) a plowed layer of very dark grayish-brown heavy silt loam; (2) an upper subsoil of pale-brown silt loam with common, distinct, yellowish-brown mottles; (3) a dark grayish-brown lower subsoil that is slightly more clayey and has many distinct and prominent, yellowish-brown mottles; and (4) glacial till of dark grayish-brown and grayish-brown, firm, calcareous silt loam that is mottled in the upper part.

The very dark colored plowed layer is mainly 8 to 10 inches thick. Its dark color is caused by the high organic-matter content, which ranges from 5 to 8 percent. Organic matter decomposes slowly because the soils are wet. The plowed layer is very porous and crumbly and contains only a small amount of gravel. The reaction ranges from medium acid to neutral. Potassium is high, and phosphorous-supplying capacity is medium.

The upper part of the subsoil shows evidence of alternate wetness and dryness. The dominant pale-brown colors show the effects of wet conditions, and the highly contrasting mottles show segregation of iron, which takes place when the soil dries. This layer is porous and permeable to roots. It has good water-holding capacity. The reaction ranges from medium acid to neutral. The potassium supply is high, and the phosphorus-supplying power is medium. Roots penetrate this layer during dry periods, but they may be restricted by water in spring or during very wet periods. This horizon extends to a depth of 11 to 18 inches.

In many places the lower part of the subsoil contains slightly more clay than the overlying horizons, but the difference is not consistent from spot to spot. The texture of the lower subsoil ranges from silt loam to silty clay loam. The mottling indicates that this layer also is alternately wet and dry. This horizon is nearly neutral, and in some areas associated with Honeoye soils it contains streaks and pockets of segregated lime that are within 12 inches of the surface. It is permeable to roots and water, but its periodic wetness commonly limits root growth. This layer extends to a depth of between 16 and 36 inches.

The underlying glacial till is firm, calcareous gravelly silt loam. It is slowly permeable to water and is poorly aerated. Few roots penetrate it. This dense substratum is a major factor in the wetness of these soils. The till rests on bedrock at a depth ranging mainly from 5 to 20 feet.

The northernmost areas of these soils are associated with Honeoye and Lima soils and have the highest lime status. In these places the upper part of the soil is nearly neutral and free lime may be found at a depth of 16 to 24 inches. The lime content decreases from north to south. The southernmost areas are associated with Lansing and Conesus soils. In these areas the surface soil is medium to slightly acid and lime is at a depth of 24 to 36 inches. Where the depth to lime exceeds 30 inches, the lower part of the subsoil is moderately firm and resembles in some ways the fragipan of Erie soils, to which Kendaia soils intergrade.

The lower part of the subsoil is less clayey than that of associated better drained soils. In the places that are highest in lime, the clay concentration is no greater than that in the overlying horizons. The surface soil of most areas is nearly stone free, but in some areas it contains a moderate amount of gravel. Many small areas associated with higher lying land have deposits of eroded material that cover the former surface soil. In some of these small areas, the dark-colored surface soil is 18 inches thick.

If Kendaia soils are undrained, the water table fluctuates between 4 and 15 inches below the surface during most of April, and 6 to 8 drying days are required before the soil will support machinery. During May, the water table rises to within 8 inches of the surface after rains but falls to a depth of more than 20 inches during rainless periods. In May, 4 to 6 drying days are commonly needed before the soil can support machinery. Free water stands high in the profile for shorter periods as the season progresses. During June, 2 or 3 consecutive drying days are needed before the soil can be tilled. Many cultivated areas have some provision for removal of water; the devices range from tile drains to crudely constructed furrows that remove only surface water. Consequently, the period required for the soil to dry enough to be tilled differs widely among areas.

Roots penetrate mainly to a depth of between 15 and 24 inches; they are restricted to the topmost 8 or 10 inches in undrained soils during wet periods in spring. Available moisture capacity has little meaning in soils such as these, because water is received from adjacent areas. Crops continue to grow vigorously on these soils during midsummer droughts, after moisture stress is obvious in crops growing on associated better drained soils.

The high organic-matter content is associated with a high total nitrogen content, which indicates slow decomposition of organic material and slow release of nitrogen. Lack of available nitrogen is apparent, and crops on these soils show symptoms of nitrogen deficiency during the spring months. Areas that have been drained release large amounts of nitrogen during the warm midsummer months, and lodging of small grains is most common on these soils. The potassium reserve is high. The phosphorus-supplying power is medium. Both nutrients must be added for optimum yields. Some areas need no lime; others are medium acid. The high organic-matter content contributes to high capacity to absorb bases in the plowed layer. The base-exchange capacity is equivalent to 12 to 16 tons of ground limestone per acre in most areas. Normally it is 60 to 80 percent filled. Unlimed soils need from 0 to 4 tons of ground limestone per acre to raise the pH to a value near 7.0. If the soil is at pH 6.0, the requirement is 2 to 3 tons of lime per acre.

Excess water is the principal limiting factor. If it can be removed, Kendaia soils have very high production potential for a wide variety of crops.

Kendaia silt loam, 3 to 8 percent slopes (KaB).—This gently sloping Kendaia soil is representative of the drier two-thirds of the drainage range for the series. For the most part, the slope is less than 5 percent.

This soil occupies gently sloping landscapes that receive runoff from adjacent Honeoye and Lima soils or Lansing and Conesus soils. In most places it is the wettest soil within single fields. Some areas are extensive. The extensive areas include small knolls of Lima or Conesus soils, which do not affect their use significantly. A large acreage occurs as long narrow areas along drainways through fields dominated by better drained soils. These areas commonly have deposits of eroded material on the original surface. The texture of these deposits ranges from silt loam to fine sandy loam.

This soil is suited to crops, pasture, or forest. In areas that lack artificial drainage, the choice of crops is restricted. Corn, small grain, and hay can be produced. Simple practices to remove excess water from the surface improve these areas significantly as cropland and make them highly productive of many vegetable crops. Wetness limits suitability for many nonagricultural uses, but many areas are good sites for farm ponds.

The removal of excess water is a principal management need. Many areas can be improved by diversion of water that flows from higher lying adjacent soils. Tile drainage is feasible in many areas. Because of the slope, erosion is a moderate problem. Cross-slope cultivation and use of sod in waterways are helpful. Some long slopes may be stripcropped. Some areas need moderate applications of lime; phosphorus and potash are needed for high rates of production. Nitrogen fertilization is important early in spring, but the nitrogen supply may be adequate for many crops during the warm midsummer months if excess water has been removed. (Capability unit IIIw–7; woodland suitability group 11a)

Kendaia and Lyons silt loams, 0 to 3 percent slopes (KnA).—This undifferentiated unit consists of somewhat poorly drained and poorly drained, nearly level soils. Any given area may consist of the somewhat poorly drained Kendaia soils, the poorly drained Lyons soils, or a mixture of the two. Kendaia silt loam is representative of the wetter half of the drainage range for the Kendaia series. Lyons silt loam represents the drier half of the drainage range for the Lyons series, which is described subsequently. It makes up about 20 to 30 percent of many areas and occurs as the lowest lying flat parts, surrounded by the slightly higher lying Kendaia soils.

These nearly level, low-lying areas of the uplands receive runoff from adjacent, gently to moderately sloping Honeoye and Lima soils or Lansing and Conesus soils. They occur as small but mappable depressions, as narrow but mappable areas along drainways, and as extensive flat areas in the uplands. Locally, on the slopes to Cayuga Lake, this unit is associated with the moderately clayey Ovid soils. In these places the texture is commonly finer than in areas associated with Honeoye or Lansing soils. Sandy spots are included, however. These appear to be sands deposited by water in local basins. Some water-deposited material over the till is evident in most areas. The surface is commonly free of stones or contains only a small amount of gravel.

Unless these areas of Kendaia and Lyons silt loams have been artificially drained, wetness limits their use mainly to pasture, long-term hay, or forest. Those areas that are almost exclusively Kendaia soils may be used for other crops, but spring planting is commonly delayed. These soils are drainable by means of tile. If adequate artificial drainage is established, they can be highly productive of a wide variety of crops, including vegetables. Kendaia and Lyons silt loams are also suited to some nonagricultural uses, such as ponds and wildlife marshes, but their wetness drastically restricts their use for housing and other construction.

The major management need is removal of excess water. Both tile and surface drains are feasible in many areas. Wetness can be reduced in some areas by diverting the runoff from adjacent slopes. Once adequate drainage is established, an adequate supply of plant nutrients is most important. The potassium supply is high, and the phosphorus-supplying power is medium. Nitrogen is commonly deficient in spring but may be adequate for good yields of many crops in midsummer. Some areas require lime, but many do not. (Capability unit IVw–3; woodland suitability group 14a)

Lamson Series

The Lamson series consists of deep, poorly drained and very poorly drained, moderately coarse textured soils that have formed in thick lake deposits of predominantly fine and very fine sand. The upper part of these soils ranges from medium acid to neutral, but the substratum is calcareous. Lamson soils occur mainly on the lowest parts of landscapes in which drier areas consist mainly of Arkport, Williamson, or Niagara soils. They are nearly level or slightly depressed. In some places, especially in the Waterburg area, Lamson soils are intermingled with Canandaigua soils. The only mapping unit is one of Canandaigua and Lamson soils.

Lamson soils have four distinct parts: (1) a surface soil of very dark grayish-brown to black fine to very fine sandy loam; (2) an upper subsoil of moderately mottled gray to grayish-brown fine or very fine sandy loam; (3) a lower subsoil of strongly mottled grayish-brown or olive-brown very fine sandy loam; and (4) a substratum of dark grayish-brown to dark-gray loamy fine sand that encloses thin layers of silt and some very thin layers of clay.

The very dark color of the surface soil results from high organic-matter content, which ranges from 4 percent in drained and cultivated sites of the poorly drained soils to more than 15 percent in pastured areas of the very poorly drained soils. The wettest sites have a mucky surface soil that is nearly black. In most places this layer is about 10 inches thick, but it ranges from as little as 6 inches to as much as 16 inches in thickness. It is medium to slightly acid. It is very high in total nitrogen and has medium capacity to supply phosphorus. Its potassium reserve is very low. This layer is an excellent medium for root development if excess water can be removed.

The upper part of the subsoil extends to a depth of 14 to 22 inches. It is dominated by gray colors, showing that it is waterlogged for long periods. It is less mottled than the lower part of the subsoil, probably because of the removal of iron. It is typically slightly more sandy than the lower part of the subsoil, less firm, and more permeable to roots. It is slightly acid or neutral, but it has low capacity to supply the major plant nutrients. Nevertheless, it permits root development and is a good medium from which roots can extract water if the water table is lowered.

The lower part of the subsoil extends to a depth of 24 to 48 inches. It is dominated by grayish-brown or olive-brown colors on which are many, distinct, yellowish-brown and gray mottles. Though its consistence is variable from spot to spot, this part of the soil is slightly finer textured and is firmer in most places than the horizon above it. In some places it is firm enough to restrict water movement. It is slightly acid or neutral. It is generally very low in potassium and medium in phosphorus reserve.

Though the substratum is dominated by fine or very fine sand, the proportions of layers of different grain sizes vary widely within short distances. Most of the layers are fine sand, very fine sand, or loamy fine sand. Silt layers may amount to as much as 20 percent in some places. Very thin layers of clay are present in some places. Where the silt and clay layers are thick enough, the material is slowly permeable. The substratum contains free carbonates at a depth that ranges from as little as 24 to as much as 48 inches, but it is very low in potassium and is only moderate in phosphorus. Few roots penetrate to this layer unless the soil has been artificially drained.

Texture and wetness are the most conspicuous variations within the range of this series. The surface soil is mainly fine sandy loam or very fine sandy loam, but in places it is loamy fine sand or very fine sand. In some places the surface layer is silt loam, very high in organic-matter content. The upper part of the subsoil is mainly loamy fine sand or loamy very fine sand, but in some places it contains thin layers of silt. The lower part of the subsoil in most places is either fine sandy loam or very fine sandy loam, but it also may contain silty parts, either as layers 2 to 4 inches thick or as masses of silty material that are not continuous horizontal layers. The poorly drained soils have a mineral surface soil moderately high to high in organic-matter content. The very poorly drained soils have a mucky mineral surface soil where they have been pastured. In woods, a layer of muck 2 to 6 inches thick covers the surface of some areas.

The very poorly drained soils have water at the surface throughout April and within 4 inches of the surface throughout most of May. The poorly drained soils have water at the surface for long periods during both months, but it sometimes falls to a depth of 6 inches in April and frequently falls to a depth of as much as 20 inches in May. The undrained soils will not support machinery until June or July of most years.

In undrained areas, roots are confined mainly to the topmost layer. In drained areas, they penetrate to a depth of more than 20 inches. Though the soils are sandy, they have moderate capacity to hold water available to plants. They receive much more water than the amount that falls on them as rain. Consequently, droughtiness is rarely a problem in drained areas unless the soils have been overdrained.

The surface soil, with its relatively high organic-matter content, has a moderately high capacity to absorb bases. This capacity is equivalent to 7 to 16 tons of ground limestone per acre in different areas. In many areas, it is 80 percent filled, but in others it is only 60 percent filled. Consequently, unlimed soils need from none to as much as 4 tons of ground limestone per acre to raise the pH to a value near 7.0 in the surface soil. If the surface soil is at pH 6.0, the requirement is 2 or 3 tons per acre. The potassium reserve is very low because of the lack of clay. The phosphorus-supplying power is moderate.

Wetness is the outstanding limitation. If these soils have been drained, they can be among the most productive of the county for a wide variety of crops, including many vegetables.

Langford Series

The Langford series consists of deep, moderately well drained, medium-textured soils that formed in low-lime glacial till. These soils have a fragipan through which water passes slowly and which is the main cause of their slight but significant wetness.

Langford soils occupy undulating to moderately steep landforms where little excess water can accumulate. Consequently, the upper part of the soil is saturated for only short periods during the growing season. Adjacent areas where water does accumulate are occupied mainly by Erie soils. The wettest areas are occupied by Ellery or Alden soils. A few associated areas, mainly of Valois soils, are drier than the Langford soils.

Langford soils have five principal parts: (1) a plowed layer of dark grayish-brown channery silt loam; (2) a thin upper subsoil of yellowish-brown, unmottled channery silt loam; (3) a thin layer of grayish-brown, mottled channery loam or silt loam; (4) a thick, dense, slowly permeable fragipan of channery silt loam or loam; and (5) a substratum of grayish-brown, firm, channery silt loam or loam glacial till.

The associated better-drained Valois soils lack the mottled layer above the fragipan and have a thicker, yellowish-brown upper subsoil. The associated wetter Erie soils lack the yellowish-brown, unmottled upper subsoil and have a fragipan nearer the surface.

The plowed layer of the uneroded Langford soil is 7 to 9 inches thick. It is porous and is good physically for root development. It contains many small, flat stones that are troublesome for tillage and for some harvesting operations but do not seriously interfere with cultivation. The color is moderately dark because the soil is moderately high in organic matter (mainly 3 to 6 percent). The dark color also indicates moderately high total nitrogen content. These properties are generally favorable for plant growth. This layer is strongly or very strongly acid, however, and it has only medium phosphorus- and potassium-supplying power.

The yellowish-brown layer below the plowed layer is 4 to 14 inches thick in uneroded areas. Its color and lack of mottles indicate good aeration most of the time. This layer is loamy and porous. It has good capacity to hold moisture available for plants, and it is easily penetrated by plant roots. It is strongly or very strongly acid and has only medium phosphorus- and potassium-supplying power. It is low in nitrogen content.

The mottled layer above the fragipan is 7 to 10 inches thick. Its grayish color and mottles indicate that it is alternately wet and dry. Its wetness in early spring restricts rooting, but roots penetrate it during summer. Crops benefit from its stored moisture during dry periods, but this layer contributes only a small amount of plant nutrients.

In uneroded areas the top of the fragipan lies 15 to 24 inches below the surface. The fragipan is dense channery loam that extends to a depth of 3½ to 5 feet and is a barrier to both water and plant roots. It has wedge-shaped cracks that are spaced 6 to 18 inches apart and are filled with mottled material like that of the layer above it. Some roots extend downward into these cracks during summer, but those of perennial plants are commonly killed during winter and spring. When the soils are wet, water seeps downslope into these cracks, but very little moves downward into the substratum. In most places the fragipan is strongly acid or medium acid in the upper part but is nearly neutral at a depth of more than 3½ feet. Few roots can reach the layers of low acidity.

The underlying glacial till is channery loam or silt loam. It is almost as dense as the fragipan. The unleached till contains small quantities of lime. This material rests on bedrock, which lies from 5 to more than 20 feet below the surface.

Langford soils occur between the medium-lime soils of the northern part of the county and the very acid soils of the southern part. In the northernmost areas calcareous till is 3½ feet beneath the surface; the fragipan there is thin, less dense, and more clayey than in areas farther south. In the southernmost areas, lime is leached to a depth of more than 5 feet in most places and the fragipan is thick and very dense. These are areas where Langford soils intergrade to Mardin soils.

Langford soils range in wetness from well-drained, like Valois soils, to somewhat poorly drained, like Erie soils. The driest areas have the thickest yellowish-brown layer below the plowed soil; they are mainly on the steepest slopes or on pronounced knolls that receive no water from higher land. The wettest areas have the thinnest yellowish-brown subsoil and the thickest mottled layer; they are mainly on the least strongly sloping landforms or in areas that receive some runoff from adjacent land.

When the frost leaves the ground early in spring, these soils are saturated. Throughout April, free water stands above or in the fragipan, is within 6 inches of the surface during very wet periods, and is commonly above a depth of 30 inches. From 4 to 6 drying days are needed before the soil can be cultivated after rainy periods. After plants begin rapid growth in May, water stands above the fragipan for only short periods after rains and is seldom less than 18 inches below the surface. Only 3 or 4 drying days are needed after soaking rains in May before these soils can be plowed. As the season advances and temperatures increase, the drying period required becomes shorter. By June, only 1 or 2 drying days are necessary.

Few roots penetrate the fragipan. Plants on the uneroded soils must obtain most of their water from the topmost 15 to 24 inches. This part of the soils can hold between 3½ and 5 inches of water that plants can use. From April through June in most years, available moisture capacity has little significance, because free water is held above the fragipan for short but frequent periods. During the height of the growing season, however, the limited available moisture capacity becomes very important. Plant growth begins to be noticeably restricted when one-half to two-thirds of the supply is exhausted. Consequently, crops on these soils show signs of moisture deficiency after 10 to 15 days without rain during July or August, even if the soils were fully charged with water at the start of the dry period.

Langford soils are not high in native fertility, but their physical condition is good enough that the common crops respond well to fertilization and liming. The total nitrogen content of uneroded soils is moderately high. Nitrogen is released so slowly throughout April, May, and early June, however, that crops respond well to nitrogen fertilizers. Even during midsummer, when release of nitrogen is rapid, most crops respond to fertilization with nitrogen because demands of the crops are very high. The ability to supply phosphorus is medium; essentially all crops on these soils need phosphorus fertilizer. Lack of phosphorus is most serious if the soils have not been limed. Most of the readily available reserve of potassium is in the clay fraction. These soils generally are less than 25 percent clay, so the potassium-supplying power is medium. High yields of most crops require liberal fertilization with potassium.

Unlimed Langford soils are strongly or very strongly acid. The plowed layer in most areas has a cation-exchange capacity equal to 8 to 12 tons of ground limestone per acre. In unlimed soils, this capacity is only about 20 or 30 percent filled with bases and 4 to 8 tons of ground limestone are needed to raise the pH to a value near 7.0. Areas that previously have been limed to pH 6.0 need 1½ to 3 tons of ground limestone. Even areas that have been adequately limed need maintenance applications every 4 or 5 years for most crops.

Langford channery silt loam, 2 to 8 percent slopes (LaB).—This soil is mainly in the wetter half of the drainage range for the series. The slope is gently undulating. Only moderate amounts of water run off the surface. Water moves very slowly through the fragipan, so free water stands above the fragipan longer than in more strongly sloping Langford soils. This soil is distinctly drier, however, than the associated Erie soils. The yellowish-brown upper subsoil is commonly only 4 inches thick, and it may be faintly mottled. The grayish-brown mottled layer above the fragipan is 4 to 6 inches thick. The fragipan is only 16 or 18 inches below the surface in most places.

This soil commonly occurs as very slight knolls, or on intervening small, gently sloping areas, in a landscape that slopes gently in one direction. The driest parts are the low knolls. The intervening nearly level areas are the wettest parts and are intergrades to the somewhat poorly drained Erie soils. As much as 10 percent of some areas is within the driest part of the drainage range for Erie soils, but these spots are too small to be mapped separately. In some places on the sides of the larger valleys, this soil is adjacent to steeper Langford soils. On the smooth uplands, it occupies small areas closely associated with more extensive Erie soils. Also on the uplands are the poorly drained Ellery soils, which occur as strips only a few feet wide along the intermittent streams. On the low knolls, spots less than one-fourth acre in size may be eroded enough that the entire yellowish-brown layer has been incorporated in the plowed layer. Such eroded spots may occupy as much as 5 percent of an individual area. In the valleys of Fall Creek and Cascadilla Creek, below the 1,000 foot elevation, this soil commonly has a thin deposit of silty material on the surface. In those places the surface layer contains fewer stones than that of the usual Langford soil, and the soil is 4 to 6 inches thicker over the fragipan than is the usual Langford soil.

This soil is suitable for crops, pasture, or forest. It is among the better soils of the uplands for crops, even though slightly limited by wetness. Deep-rooted perennial crops, like alfalfa, can be grown successfully, but the hazard of winterkilling is more serious than on better drained soils. The planting of spring-seeded crops may be slightly delayed by wetness on the most gently sloping parts, but this problem is much less serious than on the wetter Erie soils of the same general region. Though this soil is more slowly permeable and wetter than is desirable, it provides better sites for housing than most upland soils in the vicinity.

This soil has moderate limitations for cropping and needs special management practices. The cost of establishing tile drains regularly spaced over the entire area would be very high. The depth to the fragipan is such that tile needs to be spaced very closely for uniformly effective drainage. In many areas, however, tile lines that follow small depressions or drainways where water accumulates can improve the potential of an entire field. Such drains can eliminate the small wet spots that may control the use of much larger areas. Though runoff is not rapid, small spots are subject to erosion. In some fields a large volume of water from higher lying land flows across such areas in small drainways. Diversion terraces can be effective in diverting this water. Stripcropping on a low gradient can also be effective in controlling erosion. Adequate fertilization and liming are essential for good crop production. The potential of these soils is high enough to justify maintenance of fertility at a high level. (Capability unit IIe–4; woodland suitability group 8a)

Langford channery silt loam, 3 to 8 percent slopes, eroded (LaB3).—This soil is mainly within the wetter half of the drainage range for the series. In this respect it is similar to Langford channery silt loam, 2 to 8 percent slopes. This soil, however, has lost 4 to 6 inches of soil through erosion on approximately 75 percent of its area. On the uneroded part, the yellowish-brown layer is thin, the mottled layer is thick, and the fragipan lies about 16 to 18 inches below the surface. On the eroded part, most of the yellowish-brown layer has been incorporated into the plowed layer and the depth to the top of the fragipan ranges mainly from 12 to 15 inches. Consequently, the plowed layer contains less organic matter than that of the uneroded soil. In addition, water stands nearer the surface during wet periods, the zone of rooting is shallower, and the ability to supply moisture is less than in the uneroded soil. Free water may stand as near the surface as in the somewhat poorly drained Erie soils during very wet periods, but it falls more rapidly during periods of drying. This soil therefore requires shorter drying periods before tillage than do Erie soils and is better suited to deep-rooted crops, such as alfalfa, than are those soils. It is subject to more serious drought in midsummer than is Langford channery silt loam, 2 to 8 percent slopes.

This soil occupies gentle slopes on which small knolls are scattered. The effects of erosion are prominent on the knolls; the gently sloping parts may have accumulations of eroded material from the adjacent knolls. The gently sloping parts are the wettest. Included in the mapped areas are some small spots of the somewhat poorly drained Erie soils and, locally along the drainways, strips of the poorly drained Ellery soils, a few feet wide. These wet inclusions occupy as much as 2 percent of some areas. Where eroded material has accumulated on them, the additional depth above the fragipan may compensate for the wetness. It is not uncommon to see more vigorous and more persistent stands of alfalfa on such spots than on the eroded knolls. On some of the knolls enough soil has been lost that the plowed layer rests directly on the fragipan. This soil may occur either as relatively large areas that dominate entire fields or, more commonly, as small areas within fields dominated by Erie soils.

This soil is suited to crops, pasture, or forest. Crop yields on it are subject to greater variation from year to year and are generally lower over a period of years than on the uneroded soil of similar slope, partly because of the lower nitrogen content in the plowed layer but mainly because of greater susceptibility to drought in midsummer. Consequently, uses that require large amounts of labor and material are less feasible on this soil than on the uneroded soils. Although drainage is a problem, this soil provides better building sites than do most soils of the uplands.

The management needs of this soil are more exacting than those of Langford channery silt loam, 2 to 8 percent slopes. The reduction of the organic-matter content has increased the problem of crusting and decreased the rate of infiltration of water. Consequently, the erosion hazard is more serious and the control of water is more essential. Diversion terraces and graded strips will help to decrease the erosion hazard and to retain the rainwater in midsummer. Sod-forming crops help to control water and to increase the organic-matter content of the plowed layer.

Maintenance of fertility is especially critical. The supply of nitrogen is low. Liming and the use of phosphorus and potassium are essential for even moderate yields. If well managed, this soil can be made nearly as productive as the uneroded soil in favorable years. Yields are reduced more by drought, however. (Capability unit IIIe–7; woodland suitability group 8a)

Langford channery silt loam, 8 to 15 percent slopes (LaC).—This soil is typical of the drier two-thirds of the drainage range for the series. The yellowish-brown, well-aerated layer below the plowed layer extends almost to the fragipan. The mottled layer above the pan is thin.

The top of the fragipan is mainly between 15 and 24 inches below the surface. The depth to the fragipan is greatest on rolling areas in which strata of gravel are common.

This soil may occupy uniformly sloping areas on valley sides or complex rolling areas in the uplands. Small areas of the well-drained Valois soils are commonly included in the mapped areas, particularly on the rolling landscapes. The mapping also includes small areas that are moderately eroded, which aggregate as much as 15 percent of some areas, and areas of the somewhat poorly drained Erie soils along some drainways. Most of these strips along drainways are only a few feet wide. Some of the spots are as wet as Ellery soils.

This soil is suited to crops, pasture, or forest. Water runs off its slopes rapidly. Consequently, it is more susceptible to erosion and to midsummer drought than are the less strongly sloping Langford soils. It is productive of the crops commonly grown in support of dairying if it is properly managed. Its susceptibility to drought in midsummer should be considered before crops that require large amounts of capital and labor are planted. Although drainage is a problem, as it is on other Langford soils, this soil provides building sites that are much superior to those on most of the soils of the uplands.

This soil has exacting management needs. Potential erodibility and potential drought make control of water important. Diversion terraces, graded strips, contour tillage, and sod waterways help to control runoff and erosion. Adequate liming and applications of complete fertilizer are essential for good growth of plants and consequently are major practices in controlling runoff and erosion. (Capability unit IIIe–6; woodland suitability group 8a)

Langford channery silt loam, 8 to 15 percent slopes, eroded (LaC3).—This soil is typical of the drier two-thirds of the drainage range for the series. In this respect it is similar to Langford channery silt loam, 8 to 15 percent slopes. This soil, however, has lost most of its original plowed layer through erosion on about three-fourths of its acreage. In the uneroded spots the top of the fragipan is at a depth of 15 to 24 inches. In the eroded parts the fragipan is only 10 to 15 inches below the surface. In some small areas the plowed layer rests directly on the fragipan. The present plowed layer consists largely of the former yellowish-brown subsoil material and of some additional organic matter.

This soil occupies uniformly sloping areas or areas that have complex, rolling topography. The degree of erosion is most nearly uniform on the simple slopes. Eroded, uneroded, and some severely eroded spots are intermingled on the rolling areas, which may also include small depressions where eroded material has accumulated. This soil is closely associated with Langford soils on more gentle slopes and with Valois soils on steeper slopes. It may occupy whole fields, or it may occur as small areas within fields dominated by less strongly sloping Langford soils or by the somewhat poorly drained Erie soils.

This soil is not well suited to intensive cultivation. The surface soil is relatively low in organic-matter content and absorbs water slowly. Runoff is rapid, and continued erosion is a serious problem. The thin root zone above the fragipan holds only 2 to 3 inches of water available for plants, and rapid runoff contributes to loss of water that is needed in the summer. Consequently, crops are subject to drought damage, and yields are correspondingly low. Properly managed, this soil can be used successfully for crops. Generally, it is best suited to long-term hay, to pasture, or to forest.

Diversion terraces, stripcropping, contour cultivation, and sod waterways are measures that can contribute to control of erosion and to conservation of moisture. Measures to increase the organic-matter content of the plowed layer are important. Whether the soil is used for crops or pasture, adequate liming and fertilization are essential for even moderate yields. Nitrogen and lime are especially deficient, and the need for them is likely to be critical. (Capability unit IVe–5; woodland suitability group 8a)

Lansing Series

The Lansing series consists of deep, well-drained, medium-textured soils that formed in glacial till containing a moderate amount of lime. If unlimed, the surface soil is strongly acid. The subsoil is neutral. Free lime occurs in the substratum. The subsoil contains distinctly more clay than either the surface soil or the substratum. Lansing soils are among the most productive soils of the county.

Lansing soils occupy convex, gentle to steep slopes on the uplands in the northern one-fourth of the county. They occupy landforms on which excess water cannot accumulate, and therefore they are well drained. Lansing soils are closely associated with the moderately well drained Conesus soils and the somewhat poorly drained Kendaia soils. In some places they dominate entire fields, but in many places they occupy distinct knolls or short slopes within fields that are dominated by moderately well drained and somewhat poorly drained soils. Many areas are on the sides of valleys that drained into glacial Lake Ithaca. In areas that were near the margins of that lake, Lansing soils are associated with Cayuga and Ovid soils, which are finer textured soils derived partly from lake sediments. They are also associated with Palmyra soils, which commonly occupy the terraces of valleys. In the northernmost areas they are associated locally with Honeoye and Lima soils, which developed in high-lime glacial till.

Lansing soils have four distinct parts: (1) a plowed layer of dark grayish-brown gravelly silt loam; (2) an upper subsoil of yellowish-brown to brown gravelly silt loam; (3) a lower subsoil that is grayish brown and more clayey; and (4) a substratum of grayish-brown or olive-brown, calcareous, firm, gravelly silt loam or loam glacial till.

The plowed layer is 7 to 10 inches thick in most fields. It contains a moderate amount of gravel, which interferes slightly with tillage. In uneroded areas the color is moderately dark, which indicates moderately high organic-matter content (mainly 3 to 5 percent). The material is porous and friable. Roots penetrate it easily, and it has good capacity to supply moisture. In unlimed areas the plowed layer is strongly acid. It has a moderate to good supply of the major plant nutrients.

The upper part of the subsoil has been leached. Its yellowish-brown to brown colors indicate lower organic-matter content than that in the plowed layer. The lack of mottles shows that it is well aerated. The layer is porous. Plant roots penetrate it easily, and it has good water-holding capacity. This layer is medium to strongly acid and has only medium capacity to supply nutrients. It extends to a depth of 14 to 22 inches.

The lower part of the subsoil is a zone of moderate clay accumulation, but roots penetrate it easily. It can supply a moderately large amount of water. The clay in it holds a good reserve supply of potassium. This layer is nearly neutral and is favorable for plants. In uneroded areas it extends to a depth of 30 to 42 inches.

The underlying glacial till is moderately calcareous. It is very firm and dense. Roots of most crop plants penetrate it only a short distance. This material is slowly permeable to water. The soil, however, has some runoff and is well drained.

In the northernmost areas Lansing soils intergrade to the high-lime Honeoye soils. In these places the depth to lime is commonly near 30 inches. In the southernmost areas Lansing soils intergrade to Valois soils, in which free lime is about 50 inches deep. Where free lime is deepest, the upper part of the subsoil is thick, the subsoil is the most acid, and the clayey lower subsoil is more than 20 inches beneath the surface. Where free lime is the most shallow, the upper part of the subsoil is thin, and the clayey layer is only 14 or 15 inches below the surface.

Some areas that once were the bottoms of glacial lakes consist of soils that are more clayey than typical Lansing soils and have a less porous and friable surface soil. These soils are intergrades to Cayuga soils. In these areas thin layers of either sandy or clayey material may be found in the profile. Though the plowed layer is typically only moderately gravelly, gravel in the substratum amounts to 30 to 60 percent of the total soil by weight. Bedrock in most places is at least 6 feet below the surface. It may lie within 4 feet of the surface in some places, most commonly on sloping valley sides. In many places it is deeper than 15 feet.

When frost first leaves the ground in the very early spring, the soil is saturated with water. During April, free water stands above 20 inches for only a moderate period after soaking rains. The soil may be tilled during this period after 3 to 5 consecutive drying days. During May, free water stands above the compact till for a short period after rains, but the soil may be cultivated after 2 to 3 consecutive drying days. During June, only 1 or 2 drying days are needed for cultivation. Though the soil may be saturated during periods of very rainy weather, it drys moderately quickly. Spring-seeded crops can be planted in good season unless the spring is abnormally wet.

The roots of plants like alfalfa extend into the underlying till to a depth of 36 to 48 inches. Roots of most plants penetrate the soil to a depth between 30 and 40 inches. This part of the soil holds between 5 and 7 inches of water above the moisture content at which plants wilt permanently. Growth is reduced significantly when one-half to two-thirds of this available moisture has been exhausted. If the soil is fully supplied with water at the beginning of a drought, a crop may be expected to show the effects of lack of moisture after 1½ to 2 weeks.

Lansing soils need lime. The plowed layer has an absorptive capacity equal to 8 to 12 tons of ground limestone per acre. In unlimed soil this capacity is about 50 percent filled. Unlimed soils need from 3 to 4 tons of ground limestone to raise the pH to a value near 7.0. If they have been limed previously to pH 6.0, they need 1½ to 2½ tons. Even soils that have been limed adequately need maintenance applications every 4 or 5 years.

The total nitrogen supply in the plowed layer is moderately high in uneroded soils. Nevertheless, most crops respond to nitrogen applied in spring and early summer, because the soil is too cold to release it. Even if other factors are favorable in midsummer, nitrogen is released too slowly for rapidly growing crops. At this time of the year its availability is commonly adequate for only moderate production. The potassium-supplying power of the surface soil is high and is similar to that of most soils of the uplands in the northwest quarter of the county. When crops are old enough to have roots in the clayey subsoil they can use the reserve supply held in the clay. Consequently, these soils supply more potassium than do soils like Erie or Mardin, but the amount is not great enough to satisfy the needs for very high production. The phosphorus-supplying power is medium, though somewhat higher than that of more acid soils. Lansing soils generally are considered among the moderately fertile soils of the county, and they are among the most productive. Because of the good physical condition and moisture-holding capacity of these soils, crops respond readily to fertilization and liming.

Lansing gravelly silt loam, 0 to 3 percent slopes (LbA).—This soil is among the best of the Lansing soils. Its internal properties permit deep rooting. Its slope is very gentle, so less water runs off the surface than from most Lansing soils. Consequently, it absorbs more of the water of intense midsummer rains than do other Lansing soils, which minimizes the effects of drought. This soil is mainly within the less well-drained half of the drainage range for the series; faint mottling is common above the till, indicating short periods of wetness. Nevertheless, it is dry enough for good production of all of the crops commonly grown in the county.

This soil occupies nearly level to gently sloping landscapes that do not receive water from adjacent higher land. It occurs commonly as small areas and has enough slope that excess water drains to lower places. Much of it is associated with Conesus soils, which are wetter because they receive runoff from other soils, and its use is controlled by the capabilities of these adjacent soils. In some places it occupies the crests of knolls or ridges and is adjacent to more strongly sloping Lansing soils. The mapping has included small areas of the moderately well drained Conesus soils, which occupy as much as 15 percent of some areas. Since Conesus and Lansing soils have similar drainage, the inclusions have little effect on the capabilities of the areas mapped. The small included areas of somewhat poorly drained Kendaia soils in depressions or along drainways are more significant.

This soil is well suited to all of the crops commonly grown in the county if appropriate management practices are used. It can be highly productive of corn, small grains, and vegetable crops. It is also well suited to pasture or forest. It is particularly well suited to alfalfa. It is also among the best sites on the uplands for nonagricultural uses, including housing.

The principal management needs are to maintain fertility and to control acidity. The areas are nearly level and need no special practices for control of runoff. Some fields may be improved by artificial drainage of the small

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included spots of Kendaia soils. (Capability unit I-1; woodland suitability group 4)

Lansing gravelly silt loam, 3 to 8 percent slopes (LbB).—This undulating or gently sloping soil is typical of the central half of the drainage range for the series. It occupies uniform slopes and undulating areas that receive little runoff from adjacent areas. In the undulating areas are very low, broad, elongated ridges a few feet high, and a few, small, shallow depressions. Water runs from the ridges and accumulates in the depressions. Because of the extra water, the depressions contain spots, too small to be shown on the soil map, of the moderately well drained Conesus soils or of the somewhat poorly drained Kendaia soils. These spots are not numerous, but they are troublesome wet spots in some fields in early spring. Some small spots on the ridges have been noticeably eroded, and as a result the surface soil in the small depressions is thicker than the normal one of those soils. These are minor variations; they are mainly in the undulating areas, and are fewer in number or are absent on the uniform slopes. This soil is extensive and in many places it dominates entire fields.

This soil is among the best in the county for crops, pasture, or forest. It is suited to all of the crops commonly grown in the county, including deep-rooted legumes, corn, small grains, and vegetables. It is also among the best on the uplands for many nonagricultural uses, such as housing.

Maintenance of fertility and control of acidity are the outstanding management needs. Control of runoff and erosion can be accomplished largely by maintaining a vigorous crop cover and cultivating on the contour, but contour strips and diversion terraces are needed on some long slopes. Though artificial drainage is generally not necessary, some areas can be improved substantially by tile draining the small inclusions of Kendaia soils. (Capability unit IIe-1; woodland suitability group 4)

Lansing gravelly silt loam, 3 to 8 percent slopes, eroded (LbB3).—For the most part this soil has not been uniformly eroded. An estimated 50 to 75 percent of the acreage has lost enough surface soil that the plowed layer consists mainly of former subsoil material. Most of the rest has been slightly eroded, but the plowed layer consists mainly of original surface soil. These moderately and slightly eroded parts are intermingled within individual areas. Few places have lost enough soil that the more clayey lower part of the subsoil is in the plowed layer.

Except for its eroded condition, this soil is representative of the middle half of the drainage range for the series. Locally, small spots of the somewhat poorly drained Kendaia soils and of the moderately well drained Conesus soils have been included in the areas mapped. These soils constitute less than 10 percent of most areas. The eroded parts have more stone fragments on the surface than do the uneroded soils of similar slope. The loss of surface soil has also reduced organic-matter content and total nitrogen content. As a result, the soil absorbs water less rapidly, more water is lost by runoff, and the plowed layer is subject to the formation of crusts that may interfere with emergence of crops like beans. Erosion has not significantly affected the texture of the plowed layer or its ability to supply potassium and phosphorus but has made it more subject to erosion than that of Lansing gravelly silt loam, 3 to 8 percent slopes.

This soil is typically undulating. Its most severely eroded parts are the most strongly sloping parts of the generally gentle slopes. It occurs in some fields that also include areas of the moderately well drained Conesus and the somewhat poorly drained Kendaia soils. In some places, it dominates entire fields.

This soil is suited to crops, pasture, or forest. Though management needs have been increased by erosion, it is suited to about the same crops as is Lansing gravelly silt loam, 3 to 8 percent slopes. Average yields under good management are slightly less, however, and yields under poor management are distinctly lower. This soil is among the best on the uplands for most nonagricultural uses, including use for homesites.

In addition to the general need for lime, phosphorus, and potassium, this soil needs special fertilization with nitrogen. The total nitrogen supply has been reduced by erosion, and the available nitrogen is correspondingly less. The eroded condition justifies special practices for rebuilding organic-matter content in the surface soil. Increased susceptibility to further erosion demands extra attention to practices such as contour cultivation and stripcropping and the use of diversion terraces to control runoff. Drainage of the included wet spots is important for improved usability and the timing of work of entire fields. (Capability unit IIIe-2; woodland suitability group 4)

Lansing gravelly silt loam, 8 to 15 percent slopes (LbC).—This sloping soil is representative of the drier half of the drainage range for the series. The slopes are strong enough to cause difficulty in the use of machinery. They are not commonly complex, however, and are suited to contour operations. This soil is not extensive.

This soil is associated mainly with less sloping Lansing soils. Adjacent higher soils on long slopes are commonly less strongly sloping. At the foot of such slopes, these soils are commonly associated with the moderately well drained Conesus soils or the somewhat poorly drained Kendaia soils. On the slopes toward Cayuga Lake, the finer textured Cayuga soils are intermingled. Locally, the mapping has included areas that have gradients between 15 and 25 percent and are too small to be mapped separately. Parts of some areas on valley sides have bedrock only 4 to 6 feet below the surface.

This soil is suited to crops, pasture, or forest. It can be highly productive of all of the common crops of the area. It is also among the best soils on the upland for many nonagricultural uses. Special investigation should be made to determine depth to bedrock if such uses require excavation.

Although this soil is suited to most crops, management requirements for crops that require tillage are exacting. In addition to the needs for fertilizer and lime described for the Lansing series, this soil requires intensive practices for control of erosion. Generally, a high proportion of sod-forming crops in the rotation is desirable. If intertilled crops are grown, contour stripcropping is effective for erosion control. Diversion terraces are needed to divert runoff on slopes longer than 600 feet. (Capability unit IIIe-1; woodland suitability group 4)

Lansing gravelly silt loam, 8 to 15 percent slopes, eroded (LbC3).—This strongly sloping Lansing soil has lost enough surface soil to require special adjustments of use and management. The soil has been eroded unevenly from spot to spot. As much as 25 percent of some mapped areas has not been eroded; eroded material has accumulated on the surface of some small areas that are least sloping. On about 75 percent of most areas, the plowed layer is composed mainly of material of the upper part of the original subsoil. In these places the more clayey lower subsoil is commonly only 10 to 12 inches below the surface. Small spots on the most strongly sloping areas commonly have been eroded enough that part of the more clayey lower subsoil has been incorporated in the plowed layer. The plowed layer is generally lighter in color and lower in organic matter than that of the uneroded soil. Its texture has not been changed significantly, however, except on the most severely eroded spots. The plowed layer is generally more gravelly than that of uneroded areas. Organic-matter content has been reduced but is generally still between 2 and 3 percent. The surface soil is less acid than that of uneroded areas.

Many of these areas are in the steeper part of the 8 to 15 percent slope range. Locally, small areas that have slopes between 15 and 25 percent are included in many of the areas mapped. Many of the areas are on the sides of valleys, where they are associated with Lansing soils of lower slope gradient at the top of the slope and with Conesus or Kendaia soils near the bottom of the slope. Shallow drainways that can be crossed with farm machinery cross many of these areas. Parts of some areas on valley sides have bedrock only 4 feet below the surface.

In most places this soil is best used for pasture, long-term hay, or forest. It can be used for intertilled or close-growing crops, but such use should be limited to minimize the risk of further erosion. The areas are among the better ones of the uplands for many nonagricultural uses. Special investigations to determine depth to bedrock are needed if such uses require excavation.

This soil absorbs water more slowly than does Lansing gravelly silt loam, 8 to 15 percent slopes. Consequently, runoff is more rapid and continuing erosion remains a problem. A high degree of erosion control can be accomplished by using a high proportion of sod-forming crops or by reforestation. If intertilled crops are grown, contour stripcropping is effective. Diversion terraces are important in some areas. Permanent sod in the waterways that cross these areas is an effective measure. In any cropping system, adequate liming and fertilization are essential for effectiveness of the cover as well as for good production. This soil requires applications of potassium and phosphorus comparable to those described for the series, but it needs more intensive fertilization with nitrogen. (Capability unit IVe–1; woodland suitability group 4)

Lima Series

The Lima series consists of deep, moderately well drained, medium-textured soils that formed in high-lime glacial till. Lime was so abundant in the original glacial till that it has been removed to only a moderate depth, and the soil above the unleached till is nearly neutral in most places.

Lima soils typically occupy very gently sloping landforms on the highest positions of the landscape. In places they occupy slightly more sloping areas. The slope is distinctly convex in most places. Most areas receive some water from adjacent higher parts of the same mapping unit, or from adjacent areas of the well-drained Honeoye soils, but they lose some water through runoff. The water that runs off the surface of Lima soils typically is concentrated in associated areas of the somewhat poorly drained Kendaia soils. Locally, small areas of Lima soils are associated with the poorly drained Lyons soils.

Lima soils in uneroded areas have four distinct parts: (1) a plowed layer of very dark grayish-brown silt loam that contains a small amount of gravel; (2) a thin upper subsoil of brown silt loam that contains slightly more gravel and has many wormholes filled with dark material from the surface soil; (3) a lower subsoil of yellowish-brown to olive-brown, moderately gravelly, blocky, mottled silt loam or silty clay loam containing more clay than other parts of the profile; and (4) a substratum of gravelly, dark grayish-brown, mottled silt loam that is very strongly calcareous and is very dense.

The very dark color of the plowed layer of uneroded areas is associated with moderately high organic-matter content (3 to 5 percent). The material is very porous and is well aerated most of the time. It forms a good seedbed and plant roots penetrate it easily. It has good moisture-holding capacity. Its reaction ranges from medium acid to neutral. It is moderately high in nitrogen content and has medium capacity to supply phosphorus and high capacity to supply potassium to plants. The plowed layer is 6 to 9 inches thick in most fields.

The thin brown layer in the upper subsoil is present only in uneroded areas. Earthworms have mixed material of the surface soil with it. It is porous and is well aerated most of the time. Plant roots penetrate it easily, and it has good moisture-supplying capacity. It is nearly neutral in most places and in some areas it is medium acid. It contains more nitrogen than do most subsoil layers, and it has high capacity to supply potassium and medium capacity to supply phosphorus. This layer is typically slightly gravelly; the content of gravel is 10 to 15 percent in most places.

The lower subsoil is at a depth of 10 to 15 inches in uneroded areas. It has yellowish-brown to olive-brown colors and extends to a depth that ranges from 16 to 30 inches. This layer contains significantly more clay than does the overlying or underlying material. It is organized in distinct blocks, and both water and plant roots penetrate it easily. The brown colors indicate that it is well aerated much of the time, but its yellowish-brown mottles show that it is waterlogged periodically. This material is neutral or slightly alkaline. In some places free lime is segregated in tiny pockets or as films on the faces of blocks in the lowest part of the layer. The clay in these soils contributes to their more than average ability to supply potassium. The phosphorus-supplying power is medium.

The underlying glacial till is very dense and slowly permeable. Its slow permeability is responsible for the periodic waterlogging of the material above it. Roots commonly penetrate it only a few inches. It is filled with gravel and stone, much of which is limestone. From 20 to 40 percent of the fine material is lime. The till rests on bedrock at a depth of mainly more than 8 feet. In some places, especially on the sides of valleys, ledges of bedrock are at a depth of only 3 feet. In other places bedrock lies more than 20 feet below the surface.

The depth to calcareous material is between 18 and 26 inches in most areas. In the northernmost parts of the county, however, the till contains the most lime and calcareous material may be found only 16 inches below the surface in uneroded areas. Lime content decreases and depth to calcareous material increases generally from north to south within the region of Lima soils. In the southernmost areas where Lima soils intergrade to Conesus soils, the calcareous glacial till may be as much as 30 inches below the surface. In the northernmost areas, the entire soil is neutral. Where Lima soils merge with Conesus soils, the upper 18 inches is medium or slightly acid. Within single fields, Lima soils range from the limit of good drainage to the limit of somewhat poor drainage. In the drier parts where Lima soils merge with Honeoye soils, mottling is absent in the upper part of the subsoil and is present only 6 or 8 inches above the slowly permeable till. In the wettest parts where Lima soils merge with the somewhat poorly drained Kendaia soils, the upper part of the subsoil is faintly mottled. In these places mottling is commonly more apparent immediately below the plowed layer and immediately above the glacial till than it is in the upper part of the more clayey subsoil. In most areas the surface soil contains some gravel, but the amount is too small to interfere significantly with tillage. The mapping has included some spots, however, where the surface soil contains enough gravel to interfere significantly with tillage.

When the frost leaves the ground in spring, Lima soils are saturated with water. During April, water stands within 6 inches of the surface during rainy periods, but falls to a depth of more than 24 inches during dry periods. At this time of the year, 4 to 6 consecutive drying days are generally needed before Lima soils can be cultivated. During May, free water rarely stands for long periods above a depth of 16 inches. At this time of year, 3 or 4 drying days are normally adequate before tillage. During June, water stands above the firm till for a short period after each rain, but only 1 or 2 drying days are necessary before the soils can be cultivated.

The depth of rooting of most crops is restricted by the dense glacial till. The main body of roots occupies a zone that ranges from 18 to 30 inches in thickness in most areas and less in eroded areas. This volume of soil will hold between 3½ and 5 inches of water that plants can use. Moisture stress in plants is apparent when about one-half of this amount is exhausted.

Most areas of Lima soils have little need for lime. The plowed layer of uneroded areas has a capacity to absorb bases equal to 9 to 13 tons of ground limestone per acre. In many areas, this is 80 percent filled, and the soil is neutral throughout. In areas that are intergrading to the acid Conesus soils, however, this capacity may be only 60 percent filled. In these places, 2 to 3½ tons of ground limestone are needed to raise the pH to a value near 7.0.

The capacity to supply potassium is high. In most areas it is adequate to support modest yields for several cropping cycles. With continued cropping, however, the reserve is reduced and potassium is needed for even moderate yields. Potassium fertilization is essential for high yields of most crops grown on these soils. The phosphorus-supplying power is medium, and phosphorus is needed for even moderate yields. The supply of total nitrogen is moderately high. Nitrogen is released very slowly in the cool spring months, and response to it is high at this time of year. Crops may also respond to nitrogen in midsummer if adequate moisture is available. If moisture is significantly limiting, little response may be obtained from midsummer applications on the uneroded Lima soils. Lima soils are among the most productive of the county and have only modest management requirements.

Lima silt loam, 0 to 3 percent slopes (LmA).—This very gently sloping soil is representative of the wetter half of the drainage range for the series. Faint mottles are common in the upper part of the subsoil, and the lower part is highly mottled. The surface soil is thicker in many places than that of other Lima soils because there are deposits of eroded material from adjacent areas. In most areas, there is only a small amount of gravel in the plowed layer and the soil is nearly neutral throughout. The depth to the underlying till is commonly slightly less in this soil than in other uneroded Lima soils.

The acreage of Lima soils on 0 to 3 percent slopes is only about one-fifth that of Lima soils on 3 to 8 percent slopes, because special conditions or locations are necessary before level or nearly level soils can be moderately well drained. Lima silt loam, 0 to 3 percent slopes, is located where it receives very little or no runoff from adjacent areas, and it has enough slope that it can dispose of some water externally. It typically occurs as rather small areas. Some of the areas occupy small, nearly level, high points in landscapes dominated by more strongly sloping Honeoye or Lima soils. Many are small, nearly level but slightly elevated areas within fields dominated by the somewhat poorly drained Kendaia soils.

Slopes of 0 to 3 percent are more typical of the somewhat poorly drained Kendaia soils than of the moderately well drained Lima soils. About 10 to 15 percent of most of the mapped areas consists of Kendaia soils that are in the drier half of the drainage range for the Kendaia series.

This soil is suited to crops, including alfalfa and most vegetables, to pasture, or to forest. In very wet seasons, planting of some crops may be delayed by wetness and some water-sensitive crops may be damaged. This soil is suited to many nonagricultural uses, although it presents some wetness problems for uses that require dry sites. Some areas contain good sites for ponds and similar uses.

Removal of excess water is an important management need. This can be accomplished in some areas by diverting the water these areas receive from higher land and by developing channels to remove water from the included spots of Kendaia soils. The drainage of these wettest spots by means of tile is an important practice in many fields. The shallowness of the permeable material above the dense till in places limits the application of regularly spaced tile systems, which are used effectively in some areas. Nitrogen fertilization is even more important on these soils in the early spring than it is on other uneroded soils of the Lima series. There is almost no erosion hazard. (Capability unit IIw–1; woodland suitability group 2)

Lima silt loam, 3 to 8 percent slopes (LmB).—This is the most extensive Lima soil, and it is typical of the central concept of the series. It occupies gently sloping, slightly convex areas, within which 3 to 5 percent slopes predominate.

Many of these areas are large. Some dominate entire fields, but most are associated with Kendaia soils or include patches of Kendaia soils too small to be mapped separately. This soil is also commonly associated with Honeoye soils on similar or steeper slopes. On the broad crests of the divides between major valleys, this soil occupies large uniform areas that are mainly within the less sloping half of the slope range. As the volume of water increases with distance from the divide, the acreage of Lima soils increases and that of Honeoye soils decreases on the most sloping landscapes of the 3 to 8 percent slope range.

This soil is well suited to crops, pasture, or forest. Most of it is used for crops; suitable ones include corn, small grains, hay, and vegetables. This soil is also suited to many nonagricultural uses, but it would present some wetness problems if such uses required dry soil. Many areas of this soil contain sites suitable for ponds.

Though removal of excess water is an important management need, control of erosion is also a moderate problem on this soil. Long slopes need contour cultivation and stripcropping. Some may be improved by diversion terraces. Drainage can be improved by appropriately located surface structures in many places. Tile drainage of the included wet spots has been an effective practice on many fields. This soil is potentially among those most productive of a wide variety of crops. (Capability unit IIe–7; woodland suitability group 2)

Lima silt loam, 3 to 8 percent slopes, eroded (LmB3).—Erosion has significantly affected a major part of each area of this soil; commonly it is not uniform over the entire area. From 10 to 25 percent of each area commonly is uneroded or only slightly eroded. Some parts have deposits of eroded material on the original surface. On 75 percent or more of most areas, however, enough soil has been lost that the plowed layer rests directly on the more clayey lower subsoil. In many spots some of this more clayey material has been incorporated in the plowed layer, and in some places the plowed layer rests directly on the calcareous till. Generally, the permeable material above the till is 4 to 6 inches thinner than it is on uneroded sites. The surface soil absorbs water more slowly and forms a poorer seedbed than does that of the uneroded soil. Organic-matter content is lower and the nitrogen supply is less. The most severely eroded spots are noticeably more gravelly than are uneroded areas.

This soil typically is slightly more sloping than Lima silt loam, 3 to 8 percent slopes; a larger acreage is in the more sloping half of the slope range. It commonly occurs as parts of fields that are dominated either by Lima soils or Kendaia soils on nearly level landforms, or by Honeoye soils on 3 to 8 percent slopes. The mapping has included spots of the somewhat poorly drained Kendaia soils on which eroded material has accumulated and which may control the timing of fieldwork in spring. Also included in a few places are small knolls of eroded Honeoye soils, which do not significantly affect use or management.

This soil is suited to crops, pasture, or forest. Both vegetable crops and crops in support of dairy enterprises can be grown. The soil is suited to many nonagricultural uses, though it presents some problems of excess water if the use is one that requires dry soil.

Though this soil is suited to a wide range of uses, management needs are exacting if intertilled crops are grown. Depending upon size and location of the area, cross-slope cultivation, stripcropping, or diversion terraces may be needed to control runoff. Tile or surface drainage of the included areas of Kendaia soils can improve the timing of field operations. The use of sod-forming crops as much of the time as feasible is desirable to restore organic-matter content and improve the rate of infiltration of water. The water-supplying capacity of the soil has been reduced by erosion; consequently, crops on this soil typically show the effects of drought sooner than those on associated uneroded soils. Most areas need little lime. All are deficient in nitrogen. Both potassium and phosphorus are needed for efficient production. Though this soil is less productive in most years than the uneroded Lima silt loam, 3 to 8 percent slopes, it is capable of good production. Its management needs, however, are exacting. (Capability unit IIIe–8; woodland suitability group 2)

Lordstown Series

The Lordstown series consists of well-drained, very strongly acid soils in medium-textured material that is less than 40 inches thick over bedrock. These soils in the uppermost 24 inches resemble the upper part of Bath soils. They lack the fragipan that is characteristic of Bath soils, because bedrock is too near the surface for one to form. They are filled with flat rock fragments. The soil material has not been moved far by glacial ice. It appears to be crushed and broken rock closely related to that which underlies the soil.

Lordstown soils are found mainly on the hills in the southern part of the county. The largest acreages occur on moderately steep and steep valley sides. Volusia or Erie soils lie at the foot of these slopes; Mardin or Volusia soils occupy adjacent hilltops. In some hilltop areas the soils are shallow or moderately deep over rock. In these places Lordstown soils occupy sloping landforms in association with the gently sloping, somewhat poorly drained Tuller soils. Lordstown soils occur mainly within the region dominated by Mardin and Volusia soils in deep glacial till. The mapping, however, has included some areas in the region of Langford and Erie soils in the central part of the county where the soils are commonly more shaly, less flaggy or channery, and less acid than other Lordstown soils of the county.

Cultivated Lordstown soils have two distinct parts: (1) a plowed layer of dark grayish-brown channery silt loam and (2) a subsoil of a yellowish-brown, unmottled channery silt loam, which rests on bedrock in most places. If bedrock is more than 30 inches below the surface, a thin layer of grayish-brown, very channery or flaggy, loamy material is present between the yellowish-brown subsoil and the rock.

The plowed layer commonly is 3 to 6 percent organic matter. The total nitrogen content is correspondingly high. This layer is porous. Physically, it is an excellent medium for plant roots. Its very strong acidity is unfavorable for many crops, however. It is deficient in phosphorus, especially if it has not been limed. Its potassium-supplying power is only medium.

The yellowish-brown color and the lack of mottles in the subsoil are signs of good aeration. The material is porous and is physically well suited to root development. It has good moisture-supplying capacity. This layer, like the plowed layer, is very strongly or extremely acid. Unlike the plowed layer, it contains little organic matter and nitrogen. It is very deficient in available phosphorus and has only medium potassium-supplying power.

Lordstown soils are 12 to 40 inches thick over bedrock, but the mapped areas include both deeper and shallower soils. These inclusions are members of other series in areas too small to be mapped separately. If the soil is shallower than 12 inches, the yellowish-brown subsoil is absent or is poorly expressed. If bedrock lies deeper than 40 inches, a fragipan is present, and the soil is a member of the Bath series. The bedrock under many areas is broken. Tree roots extend downward in the fractures within the rocks in such places and undoubtedly obtain some moisture from within the broken rock.

On gentle slopes, a thin layer over the bedrock is faintly mottled in some places. There are a few places where the unmottled part of the yellowish-brown subsoil is less than 18 inches thick. Such areas were not mapped separately but were included in Lordstown channery silt loam, 5 to 15 percent slopes.

Spaeth and Diebold (*17*) studied the depth to the water table in Lordstown soils over a 2-year period. No water table was found higher than 15 inches at any season of the year. It was present above 30 inches only 10 percent of the time from the first of April to the middle of May. Consequently, a high water table is rarely troublesome. Lordstown soils may be plowed 4 to 5 days after rains during April and from 2 to 4 days after rains in May. By June, only 1 or 2 days of drying are needed.

The capacity of these soils to store water for use by plants during dry periods varies widely according to the thickness of the soils over bedrock. The shallowest soils hold about 2½ inches of available moisture; the deepest hold as much as 6 inches. The average available moisture capacity in cultivable areas is about 4 inches. This is equivalent to that of some Valois and Bath soils. Plants are seriously affected by 10 to 20 days without rain, even if the soil is fully charged with water when the drought starts.

The many stone fragments are troublesome for tillage and for some harvesting operations. They are especially damaging to field choppers used for forage crops. In most Lordstown soils, these fragments are 30 to 70 percent of the total soil, by weight, or about 20 to 45 percent, by volume. In spite of this, the soils are used successfully for a wide range of crops, including potatoes, where topography is favorable.

The nitrogen supply is moderately high, but crops respond well to nitrogen fertilization in spring when nitrogen is released slowly. In midsummer when the soil is warm, response to nitrogen is erratic from season to season and appears to depend upon an adequate supply of moisture, adequate liming, and phosphorus fertilization. The very strong acidity must be corrected for good yields of the crops commonly grown in support of dairying. The total capacity of the plowed layer to absorb bases is equivalent to 8 to 12 tons of ground limestone per acre. The unlimed soil commonly needs between 4 and 8 tons of ground limestone per acre to raise the pH to a value near 7.0. Even where the soil has been limed to pH 6.0, 1½ to 3 tons of ground limestone are needed. Liming is one of the most important management needs for most crops.

The total supply of phosphorus is medium and availability of phosphorus is medium. Phosphorus is made more available by liming but is deficient even on limed soils. Where Lordstown soils have not been cropped heavily, rapid soil tests frequently indicate medium to high available potassium. The potassium reserve from which the available form can be replenished is only medium, however. This reserve is mainly in the clay, which is ordinarily less than 25 percent of the soil mass. Consequently, yields that Lordstown soils are potentially capable of producing can be obtained only if potassium fertilizer is applied.

Lordstown channery silt loam, 5 to 15 percent slopes (LnC).—This is the best of the Lordstown soils in Tompkins County. Depth to bedrock ranges mainly from 20 to 40 inches. Soil conditions are typical of those described for the Lordstown series. Stone fragments are troublesome, but cultivation is feasible. The slopes make use of machinery moderately difficult. The slopes are commonly uniform, however, and fields can be cultivated on the contour.

This soil occurs in sloping areas in the valleys, where it is associated with steeper and more stony Lordstown soils. It also occupies sloping landforms on the hill crests, where it lies next to Mardin and Volusia soils. Locally, it is associated with gently sloping areas of the somewhat poorly drained to poorly drained Tuller soils. Mapped areas of this soil locally contain inclusions of the sloping Bath soils, the gently sloping Mardin soils, or other nearly level areas where the soil is shallow and mottled. These included areas are too small to be mapped separately. Locally, bedrock is less than 20 inches below the surface, but such spots are not numerous. The mapping has also included about 150 acres of Lordstown soils that have slopes of less than 5 percent. Wet spots of Tuller or Chippewa soils are shown by wet-spot symbols.

This soil is well suited to crops, pasture, or forest. It is used much like Bath soils on similar slopes. It is suited to a wide variety of crops, including potatoes and alfalfa. Bedrock imposes some limitations on some nonagricultural uses.

This soil is permeable and absorbs water well, but the slope is steep enough to make erosion a moderate problem. Most areas are well suited to contour cultivation and stripcropping, which are effective measures for controlling runoff. Bedrock interferes with construction of diversion terraces in most places, but such terraces are practical in some areas. The soil has good capacity to supply moisture for plants and has the potential to be highly productive. Good production, however, demands liberal rates of fertilization with nitrogen, phosphorus, and potassium, as well as high rates of liming for all crops except those that demand acid soils. (Capability unit IIIe-3; woodland suitability group 12a)

Lordstown channery silt loam, 5 to 15 percent slopes, eroded (LnC3).—This is a moderately eroded, well-drained soil on moderate slopes. Erosion is evident mainly in the light color of the plowed layer, the abundance of stone fragments on the surface, and the accumulation of eroded material at the base of slopes. This eroded phase is not consistently more shallow than Lordstown channery silt loam, 5 to 15 percent slopes, because the depth to bedrock is variable from spot to spot in the uneroded soil. Part of the yellowish-brown subsoil has been incorporated in the plowed layer. The thickness of the subsoil is 3 to 8 inches less than in the uneroded soil if bedrock is deeper than 30 inches. Erosion has not been uniform over a single area. It is estimated that from 50 to 80 percent of each delineated area has been affected.

This soil occurs in two distinct topographic positions. One is on sloping parts of valley sides, where this soil is associated mainly with steeper Lordstown soils. The other is on the hilltops, where this soil is associated with more gently sloping areas of Tuller or Volusia soils and with sloping areas of Mardin soils. On the lower parts of valley walls, the adjacent soils may be members of the Valois, Langford, or Erie series. Mapped areas of this soil include small parcels of deeper Bath, Mardin, or Volusia soils, small spots where bedrock is within 12 inches of the surface, and many small areas of uneroded Lordstown soils.

This soil is suited to crops, pasture, or forest. If it is used for crops, the erosion hazard imposes limitations on intensity of use if the soil is to be conserved. Generally, a high proportion of sod-forming crops is desirable. Intertilled crops like corn can be grown safely if special precautions are taken. This soil is suited to alfalfa if it is properly limed and fertilized. Bedrock poses special problems for some nonagricultural purposes.

The organic-matter content of the surface soil is relatively low. Consequently, infiltration of water is slow, and runoff is higher than on the uneroded soil. Erosion is a correspondingly greater problem. The use of machinery is moderately difficult, and some farmers have found that the use of long-term hay or pasture is the most feasible method of conservation with reasonable production. If this soil is used for intertilled crops, it needs such practices as contour cultivation and stripcropping. The moderate depth to bedrock commonly interferes with construction of diversion terraces. Terraces are, however, feasible in some places. If this soil has greater production potential than other soils of the farm, intensive management for cropland may be justified. Management for such use includes special practices for control of runoff, special practices to increase organic-matter content, liberal liming, and intensive fertilization. Liberal fertilization is necessary for good yields, and liming is essential for all crops except those that require acid soil. Fertilization and liming are also effective water-control measures through the effectiveness of the plant cover they generate. These areas are potentially productive, but their management needs are exacting. (Capability unit IVe–3; woodland suitability group 12a)

Lordstown channery silt loam, 15 to 25 percent slopes (LnD).—This is a moderately deep, well-drained soil in which depth to bedrock ranges from 12 to more than 40 inches. The dominant soil is like that described for the Lordstown series. The slopes are steep enough that farm machinery can be used only with difficulty. They are also steep enough that runoff is rapid and erosion is a serious problem.

This soil occurs mainly on the sides of the valley in association with other Lordstown soils. It lies mainly between Volusia or Erie soils on foot slopes of the valley sides and between Bath, Mardin, or Volusia soils on the hilltops. As mapped, it includes a greater range of depth to bedrock than do Lordstown soils on less steep slopes. On slopes of less than 15 percent, the soils less than 20 inches thick over rock were mapped separately from those more than 20 inches thick, to the extent that size of area permitted. On these moderately steep slopes, however, the soils were not mapped separately, partly because depth to bedrock is so variable from spot to spot, and partly because the difference between the soils is less significant.

The layers of bedrock below this soil lie almost horizontally. Hard thin layers appear to have resisted ice action. On the slopes, they are covered with only a thin mantle of soil. Between such hard layers, the softer shales have been worn away, leaving a steplike bedrock surface. Soil material has partly filled these steplike spaces between adjacent hard layers of rock. In these places the soil may be more than 40 inches thick. Consequently, the depth to bedrock ranges from 12 to more than 40 inches within a few feet in many of the areas.

This soil can be used for crops only with great difficulty because of the moderately steep slopes. Much of it is used for long-term hay or permanent pasture. Many areas are forested, and some are idle. The soil is not productive, unless it is adequately limed and fertilized. Plowing, which is the most effective way of preparing the soil for liming and fertilizing, is difficult. If hayfields or pastures are renovated by plowing, the operations should be on the contour and strips of sod should be left to help control erosion until a new sod is established. Intertilled crops can be grown, but with great mechanical difficulty and with substantial danger of erosion. Many of the steepest of these areas are probably best used for forests. The soil is suited to a wide variety of trees. (Capability unit IVe–2; woodland suitability group 12b)

Lordstown channery silt loam, 25 to 35 percent slopes (LnE).—This is a steep, well-drained, shallow to moderately deep soil. The slopes are steep enough that agricultural machinery can be used only with the greatest of difficulty, if at all. The depth to bedrock is extremely variable within short distances. In most areas the bedrock surface on these steep hillsides forms a series of huge steps. The soil material covers the bedrock and forms a uniform slope. The surface of each step is a nearly level layer of hard sandstone. At the edge of each bedrock step, the soil covering is thin. At the base of the step, the covering may be 4 or 5 feet thick. This range from the thickest of the Lordstown soils to soils less than a foot thick occurs within a distance of 10 or 15 feet. The shallowest of these soils included in the mapped areas are too shallow over rock to be members of the Lordstown series. The deepest may have a fragipan and thus resemble Bath soils. Small spots of Tuller soils are included in places where seepage from the bedrock layers makes the soils moderately wet. The mapping has also included a few small areas of deeper, poorly drained Chippewa soils, but these are minor.

Most of the areas are forested. Some areas are pastured, and most of these have been moderately eroded.

This soil occurs mainly on the steep slopes of valley sides in the southern part of the county. The areas are most closely associated with other Lordstown soils. They join Langford, Erie, Mardin, or Volusia soils at the base of some of the slopes. They lie below the Mardin and Volusia soils on the hilltops.

This soil can be used for pasture or forest. It can be used for hay, but with extreme difficulty. It is productive of neither pasture nor hay unless it has been limed and fertilized. The steep slope makes application of such material very difficult, however, so most pastures are unimproved. Such pastures can be renovated and can be moderately productive in spring and fall if long-lived perennial legumes can be established. Production during the midsummer months is commonly low because much rain runs off these steep slopes and the capacity of the soil to store water is limited. Some areas have been reforested. (Capability unit VIe-1; woodland suitability group 12b)

Lordstown soils, 35 to 70 percent slopes (LoF).—The very steep, forested valley sides that are conspicuous in the southern half of the county are the main areas of this mapping unit. The bedrock typically forms a series of huge steps on the very steep slopes. A thin mantle of soil covers most of the area, but bedrock ledges crop out in many places. The depth of soil ranges from none to as much as 4 or 5 feet within short distances. In most places the surface is covered with a litter of both small and large flat stone fragments.

The dominant soil condition is within the range described for the Lordstown series. The areas mapped include an important portion of soils too shallow over rock to be classified in the Lordstown series and small areas of wet Tuller or Chippewa soils where water seeps from the bedrock. These soils are most closely associated with other soils of the Lordstown series. They lie between the deep soils of the Mardin and Volusia series on the hilltops and deep soils of the Erie or Volusia series at the base of the slopes.

These soils are too steep for uses other than forestry, wildlife, or recreation. (Capability unit VIIs-1; woodland suitability group 13)

Lordstown, Tuller, and Ovid soils, shallow and very shallow, 0 to 15 percent slopes (LtB).—This undifferentiated unit contains soils similar to those described for the three series named, except that they are less than 20 inches deep over bedrock. These soils are medium-textured and in places show channery or flaggy fragments on the surface; in other places there are few or no stones. These soils are strongly acid to medium acid in reaction. Some areas of poorly drained and very poorly drained soils are included, but most of the soils are well drained to somewhat poorly drained. Erosion is usually slight. Some areas of bedrock have been exposed by erosion, however, especially where drainageways have cut through the soil to the underlying bedrock. Because these soils are shallow and very shallow over bedrock, erosion is a hazard.

This unit is level to moderately sloping. These slopes are slightly convex over most of the area. Some areas are slightly concave or level. Ordinarily the soils are shallowest on the strongest slopes, because of past erosion.

This unit occurs throughout the county wherever bedrock is close to the surface. It is associated with deeper soils of the three series named and with a miscellaneous land type, Rock outcrop. The underlying bedrock may be sandstone, shale, or limestone; it is exposed as ledges or outcrops and is shown by outcrop symbols on the map.

The soils in this unit have very limited use because of their shallowness to bedrock and low water-holding capacity. Some areas are in forest or pasture; other areas are idle and are used mainly for wildlife food and cover. The remaining areas are used for building sites, recreational areas, railroads, highways, and roads.

These soils should remain in some type of vegetation to reduce erosion. If cultivated, they are droughty and produce low yields even though they may receive liberal applications of lime and fertilizers. The water-holding capacity is low, ordinarily less than 2 inches of available water where the soils are very shallow over bedrock. If cultivated crops are grown, open ditches should be used to improve drainage of wet spots in level places. Areas in pasture benefit from liberal applications of lime and fertilizer but produce low yields during dry years. (Capability unit VIs-1; woodland suitability group 16)

Lordstown, Tuller, and Ovid soils, shallow and very shallow, 15 to 35 percent slopes (LtC).—The soils of this undifferentiated unit are similar to those described for the respective series, except that they are shallow and very shallow, or less than 20 inches deep over bedrock. They are medium textured and channery or flaggy in places, or they may be relatively free of stones. They are strongly acid to medium acid in reaction. They are well drained to somewhat poorly drained, but the areas include poorly drained and very poorly drained seepage spots. Erosion was not differentiated in the mapping, but past erosion has removed soil along drainageways and exposed the bedrock beneath. Areas of rock outcrop or ledges are shown by bedrock symbols on the map.

The slopes are moderately steep to steep and generally are convex. Soil material is very shallow over much of the area. The shallowness may be partly the result of past erosion or may be the natural condition.

The soils in this mapping unit occur adjacent to deeper soils of the series named and to the miscellaneous land type, Rock outcrop. Their potential use is very limited because they are shallow and very shallow and have low water-holding capacity. The major part of the area occupied by these soils is in scrubby timber or is now idle after being used for pasture or crops. Some areas are covered with brush, which makes good wildlife food and cover.

Runoff is rapid and erosion is a hazard. This unit should remain in vegetation as a protection against erosion. (Capability unit VIs-1; woodland suitability group 16)

Lyons Series

The Lyons series consists of deep, poorly drained and very poorly drained silt loams or mucky silt loams that formed in medium- to high-lime glacial till. These soils occupy level or slightly depressed areas on the uplands where the water from the associated soils accumulates and stands for long periods of time. They are too wet for cropland unless they have been artificially drained. In most areas they are nearly neutral.

Lyons soils are associated with Honeoye, Lima, and Kendaia soils on the high-lime till of the northernmost part of the county and with Lansing, Conesus, and Kendaia soils on the medium-lime till of adjacent areas to the south.

Lyons soils have three distinct parts: (1) a surface soil of very dark gray to black silt loam or mucky silt loam that is very high in organic matter; (2) a subsoil of gray silt loam that has common or many, distinct mottles; and (3) the underlying till of calcareous, dense silt loam.

The thickness of the surface soil ranges from 8 to 18 inches. Its nearly black color is associated with very high organic-matter content, which ranges from 8 to as much as 20 percent and is two to four times that in associated well-drained soils. In the poorly drained positions, the surface soil is silt loam and is 8 to 10 percent organic matter. In the very poorly drained positions, a few inches of muck is present on the surface of some areas in forests. In pastured areas the surface material is mixed with the underlying mineral soil, and the topmost layer is 12 to 18 inches thick and is 10 to 20 percent organic matter. This layer is nearly neutral in most places. In the southernmost areas associated with Lansing soils, however, it may be medium acid. The total nitrogen content is high, but the nitrogen is released very slowly for plants. The phosphorous-supplying power is medium, and the potassium-supplying power is high. This layer is porous and is an excellent medium for plant roots if excess water can be removed. If the soils are undrained, roots of trees and most other plants are confined mainly to this layer because of the wet subsoil.

The gray, mottled, silt loam subsoil extends to a depth ranging from 18 to 30 inches. Its color indicates that this layer is saturated most of the time. The mottles indicate that air has access to it at some times. This layer is neutral in most places. If the soil is drained, roots can penetrate it.

The underlying, calcareous glacial till is very dense and slowly permeable. It is a major factor contributing to the wetness of these soils.

Most areas of these soils appear to have a layer of material that was deposited by water above the till. The thickness of this deposit varies widely from area to area, but it is generally enough that the surface soil contains very few or no stones. Depending upon the kind of material deposited, the texture of the surface soil ranges from silty clay loam to loam, but it is predominantly silt loam. In the wettest areas, the organic-matter content is high enough that the material approaches a muck in consistence. In drier areas the material is predominantly mineral, even though organic-matter content is high. In the wettest areas, a layer 2 to 6 inches thick immediately under the surface soil is free of mottles but the subsoil is profusely mottled; in the driest areas, mottles extend from the surface soil downward. The areas associated with Honeoye soils contain the most lime and are neutral or nearly neutral in reaction. In these places free lime may be present at a depth of only 12 inches, but it is mainly at a depth of 18 to 24 inches. In areas associated with Lansing soils, the upper part of the soil is commonly slightly or medium acid and free lime is found below a depth of 24 inches. In a few of the southernmost areas where Lyons soils intergrade to Alden soils, free lime may be at depths greater than 36 inches.

During April, the water table fluctuates between the surface and a depth of 6 inches. In the wettest areas, it is at the surface during the entire month. During May, it recedes between rains. In the driest areas, it may fall to a depth of 20 inches during very dry periods, but mainly it is within 10 inches of the surface. In the wettest areas, free water is rarely deeper than 10 inches. As the season progresses and plants begin to transpire rapidly, the water table recedes more quickly after rains and falls to a greater depth during dry periods. It approaches the surface, however, after each rain that causes runoff from the adjacent soils. Consequently, these soils will rarely bear machinery until June, and the wettest areas will not bear machinery until July. Periodically throughout the growing season, the soil may be saturated to the surface.

Available moisture capacity has little meaning in soils so wet, unless they are artificially drained. Even drained soils receive so much water from adjacent areas that they are recharged frequently during the growing season and are not commonly susceptible to drought.

The surface soil has a very high capacity to absorb bases. This capacity is equal to 14 to 20 tons of ground limestone per acre in most areas. Because the soils are nearly neutral, however, the lime requirement is low. Many areas need no lime. Though the reserve of potassium in the clay fraction is high, the quickly available potassium held by the organic matter is two to three times that of the plowed layers of associated, well-drained soils. This can be exhausted, however, if the soil is drained and farmed intensively. Under such conditions, potassium fertilizer is needed. The phosphorus-supplying capacity is only medium. Total nitrogen content is very high, but if the soil is undrained it releases nitrogen for plants very slowly. Consequently, symptoms of nitrogen deficiency are common. Even if the soil is drained, nitrogen deficiency is noticeable during the spring months. During dry periods of midsummer, crops may not respond to nitrogen fertilizer.

If undrained, Lyons soils are suited mainly to pasture or forest. If drained adequately, they are among the most productive soils of the county for corn, small grains, hay, and vegetable crops.

Lyons silt loam (Ly).—This soil is representative mainly of the wetter half of the drainage range for the series. In wooded areas it has a thin mucky surface layer. Where it is pastured, the mucky part has been mixed with mineral soil. It is neutral to mildly alkaline throughout. In most areas water is either at the surface or within a few inches of the surface until July.

This soil occupies level areas of closed depressions from which water cannot escape. The margins of these depressions are commonly the poorly drained segment of Lyons soils and merge with the somewhat poorly drained Kendaia soils of the adjacent landscapes. Many of the areas are moderately extensive; some are very small. The mapping includes a few wet spots on slopes as strong as 8 percent, because the combined acreage of these spots is small. The spots are kept wet by seepage water from the adjacent higher lying areas. Locally in some of the valleys, this soil has been mapped in association with the finer textured Cayuga, Ovid, and Ilion soils. In these places the surface soil is silty clay loam.

Areas that have not been drained are suited mainly to woodland, pasture, or wildlife. Areas that are adequately drained can be used for vegetable crops, hay, corn, and small grains. Small grains are especially subject to lodging in such areas. Nonagricultural uses include mainly wildlife marshes, ponds, and similar uses.

Drainage is the first management need if this soil is used for agriculture. Most areas are suitable for tile drainage. Surface drains can improve the soil for production of crops like hay. Interception of runoff from adjacent areas by means of diversion terraces can minimize the wetness. (Capability unit IVw–3; woodland suitability group 14b)

Madalin Series

The Madalin series consists of deep, poorly drained and very poorly drained, fine-textured soils that formed in calcareous lake deposits. The poorly drained soils have a thick, nearly black, mineral surface soil that is very high in organic-matter content; the very poorly drained soils have a mucky surface soil. Most of these soils are above pH 6.0 in reaction. Wetness, fine texture, and high organic-matter content are the outstanding features.

Madalin soils occupy flat or slightly depressed areas within the basins of former glacial lakes. The surrounding soils are mainly soils of the Hudson and Rhinebeck series. Some areas are large; many areas within pastures or woodlands are small; some are narrow strips along drainways through fields dominated by the associated Rhinebeck soils.

The poorly drained Madalin soils have four principal parts: (1) a surface soil of very dark gray silty clay loam that is very high in organic-matter content; (2) an upper subsoil of gray or grayish-brown silty clay loam that has few to many mottles; (3) a lower subsoil of gray or grayish-brown silty clay that has many distinct mottles; and (4) a substratum of gray or grayish-brown, calcareous silty clay or clay. The very poorly drained soils have a mucky surface soil much higher in organic-matter content and have few or no mottles in a thin layer immediately below the surface soil.

The surface soil ranges from 6 to 18 inches in thickness. It has high organic-matter content because the soil is too wet for organic matter to decompose rapidly. Organic-matter content ranges from 6 percent in the driest parts of the poorly drained soils to more than 20 percent in the wettest of the mucky, very poorly drained soils. Most roots are confined to this layer if the soil has not been artificially drained. Though nitrogen is high, it is released very slowly in the undrained soil.

The upper part of the subsoil extends to a depth of 12 to 24 inches. Its grayness shows that it is wet for long periods. The mottling of this layer in the poorly drained soils shows that periods of dryness occur frequently; lack of mottles in the very poorly drained ones shows that these soils are wet much longer. Only roots of water-tolerant plants penetrate this layer if the soil is undrained. Organic-matter content is much less in the upper part of the subsoil than in the surface soil, and the boundary is abrupt. The upper subsoil is nearly neutral in most places.

The lower part of the subsoil extends to a depth of 18 to 36 inches. It is very clayey and very slowly permeable. Few roots penetrate this layer, though it is arranged in large prisms or in blocks. Some roots penetrate this layer if the soil is drained. This layer has a very high reserve of potassium if plant roots can reach it.

The clayey calcareous substratum is very slowly permeable; few roots reach it if the soil has not been drained; few roots go into it even if the soil has been drained.

As in most soils that receive runoff from adjacent land, the texture of the topmost horizon varies widely from place to place. These soils are mainly silty clay loam but range from silt loam to silty clay. The thickness of the surface soil is typically about 10 inches but is as little as 6 inches in some of the drier sites. It is as much as 18 inches in some areas that have had deposits of eroded material on the original surface. Thin layers of sandy or silty material may be found in some areas where Madalin soils intergrade to Canandaigua soils.

The texture of the B horizon ranges mainly from silty clay to clay. In most places the subsoil contains almost no sand. Carbonates are ordinarily at a depth of 18 to 24 inches, but where there are deposits on the surface, they may be 6 to 12 inches deeper.

During April, free water stands at the surface in the mucky soils and within 8 inches of the surface in the poorly drained soils. During May, it remains near the surface in the wetter soils but may recede to a depth of as much as 12 inches in the drier ones. These soils can rarely be plowed during April. During May, the better drained parts may be plowed after 5 to 10 consecutive drying days. Such periods are rare. During June, the poorly drained soils may be plowed after 3 to 10 consecutive drying days, but the very poorly drained ones can rarely be tilled.

If these soils are undrained, plant roots are confined mainly to the uppermost 10 inches of the soil. Those of some water-tolerant plants penetrate the subsoil. In drained soils, roots of crop plants may penetrate as deep as 15 or 20 inches. Excess water is the major limiting factor.

Because of its high organic-matter content, the surface soil has very high capacity to hold bases. In most places this capacity is equal to 14 to 20 tons of ground limestone per acre; in some areas of the mucky soils, it is much higher. The capacity is 60 to 80 percent filled, and many areas need no lime. Soils having a pH value as low as 6.0 would need 3 to 5 tons of ground limestone to raise the pH to a value near 7.0. Though the total nitrogen supply is very high, nitrogen is released very slowly. The potassium reserve is very high. The phosphorus-supplying power is medium.

Most areas of Madalin soils are too wet for cultivation, and relatively few large areas in this county are suitable for drainage. Many small areas have been improved enough to be farmed with the associated drier soils. Wetness is the outstanding limitation.

Madalin silty clay loam (Mn).—This is the poorly drained soil of the Madalin series in Tompkins County. It is typical of the soils described for the series. It occurs more commonly within cultivated areas than does the mucky silty clay loam; thus, it more commonly has deposits of eroded material on the original surface. In many of these areas, the surface soil is 18 inches thick.

This soil is nearly level. It occurs mainly along small drainways or in small depressions within areas of the better drained Rhinebeck or Hudson soils. Many of these small areas are spots that once had a mucky surface soil but have now had some degree of drainage and have lost this accumulation of organic matter.

The wettest areas are used mainly for pasture or for woods. Those within cultivated fields have had some degree of drainage, accomplished largely by opening surface channels. A few have tile drains. The degree of drainage that has been established is generally inadequate for intensive use of these areas. Consequently, many of these areas are important mainly because their wetness controls timing of work on the better drained soils in spring. Some areas contain suitable sites for ponds or for wildlife marshes. Most have few capabilities for other kinds of nonagricultural uses.

Drainage is the greatest single management need for agricultural uses. It is especially important where these areas occur within fields dominated by better drained soils. Drained areas may be expected to need little lime, a moderate amount of phosphorus, and a small amount of potassium. They are places in which nitrogen is noticeably deficient in spring but may be abundant in midsummer. (Capability unit IVw–1; woodland suitability group 14a)

Madalin mucky silty clay loam (Mm).—This soil represents the very poorly drained segment of the Madalin series. In forested areas it has 2 to 6 inches of muck over a moderately dark mineral soil. In pastured areas the muck has been mixed with the mineral soil and the surface layer is a nearly black, mucky silty clay loam that is 10 to 14 inches thick. A 2- to 4-inch layer immediately under the surface soil is gray and nearly free of mottles. In other respects this soil is like the soils described for the series.

This soil occupies depressions that lack outlets. It is associated with areas of muck, with the poorly drained Madalin soil, and with Rhinebeck and Hudson soils. The areas are the lowest places on the landscape.

If undrained, this soil is suited mainly to forest or poor pasture. Some areas are excellent wildlife marshes, and some can be used as pond sites. If the soil is drained adequately, it can be used for crops and managed according to the fertility requirements described for the series. Most areas, however, are difficult to drain. (Capability unit IVw–1; woodland suitability group 14b)

Made Land (Mc)

This miscellaneous land type consists of areas that have been filled with a variety of materials. No attempt has been made to differentiate the different kinds of fill. Some areas have been filled with soil material that was hauled to the site or pumped on it by dredges. Some have been filled with trash or rubble and have then been leveled and covered with soil.

Most of these areas are adjacent to cities and villages, chiefly in the vicinity of Ithaca and Cayuga Heights. Some have been leveled and used for commercial establishments, like those along Highway 13, south of Ithaca. Some areas of urban land have been included in this mapping unit because of excavation and mixing of soil materials during building; leveled areas on the South Hill Campus of Ithaca College are examples. A part of a golf course has been included where the materials have been moved and mixed to construct the course. Thus, this unit represents many kinds of soil materials that have been mixed and moved. Because of wide variations in the kind of material, this land type has not been assigned to a capability unit. (Woodland suitability group 16)

Mardin Series

The Mardin series consists of deep, moderately well drained, strongly acid, medium-textured soils that formed in very low-lime or acid glacial till. A fragipan 15 to 20 inches below the surface restricts the downward movement of water and limits the depth of rooting.

Mardin soils occupy gentle to moderately steep slopes on the uplands in the southern half of the county. The slopes are typically slightly convex and occur where large amounts of water from adjacent land cannot accumulate. Ordinarily, these soils slope in one direction. Some are on hillsides where runoff is moderately rapid. Some are small convex landforms that lie slightly higher than the associated, somewhat poorly drained Volusia soils. Within the same locality, nearly level areas and slight depressions are occupied by the poorly drained Chippewa and the very poorly drained Alden soils. Locally, where water from the substratum carries some lime, Erie and Ellery soils are the wet associates.

The cultivated Mardin soils have five distinct parts: (1) a plowed layer of dark grayish-brown channery silt loam; (2) an upper subsoil of unmottled yellowish-brown channery silt loam 4 to 8 inches thick; (3) a layer of mottled channery silt loam or fine sandy loam, 2 to 4 inches thick, immediately above the fragipan; (4) a thick, dense fragipan of acid channery silt loam or loam; and (5) an equally dense substratum of channery silt loam or loam glacial till.

The plowed layer contains many small flat stones that interfere with many tillage and harvesting operations. Its dark color is caused by a moderately high organic-matter content (3 to 6 percent), which is associated with moderately high total nitrogen content. If the soil is uneroded and is adequately fertilized and limed, the plowed layer is porous and is a good medium for plant roots. This layer has only medium capacity to supply most plant nutrients, but it has good water-holding capacity.

The yellowish-brown layer below the plowed layer is loose and porous and has few or no mottles. The colors indicate that it is not waterlogged for long periods. The material is very strongly acid or extremely acid and has only medium capacity to supply phosphorus and potassium. It has good water-holding capacity and is physically a good medium for development of plant roots.

A thin layer above the fragipan is mainly grayish brown but has many yellowish-brown mottles; these colors indicate that this layer is alternately wet and dry. This layer is porous and permits root development when it is not wet. Like the overlying layer, it has good water-holding capacity but is low to medium in available nutrients and is very strongly acid.

The top of the fragipan is 15 to 20 inches below the surface in uneroded soils. The bottom is at a depth of 48 to 60 inches. The fragipan is very dense and very slowly permeable, and it effectively stops downward penetration of roots. Plants may obtain some water and nutrients from the uppermost 3 or 4 inches during summer months.

The underlying glacial till is almost as dense as the fragipan. In the upper part it is medium acid, but in some areas it is neutral at a depth of 5 or 6 feet. Small amounts of free lime occur in some places at a depth below 6 feet.

Mardin soils are closely associated with the well-drained Bath soils and the somewhat poorly drained Volusia soils. Where Mardin landforms merge with drier landscapes of Bath soils, depth to the fragipan is about 20 inches, and the yellowish-brown upper subsoil is thick. Where Mardin landforms merge with uniform slopes of Volusia soils, the fragipan is 15 or 16 inches below the surface and the well-aerated, yellowish-brown upper subsoil is thin. Where Mardin soils merge with Langford soils, the depth to lime and the acidity of the fragipan decrease from the hilltops toward the valleys. In some places on the high uplands, Mardin soils have been mapped where bedrock is only 30 inches below the surface. In such places the fragipan is correspondingly thin and rests on the rock. Bedrock is ordinarily more than 6 feet below the surface, but its depth ranges from as little as 2½ feet to more than 20 feet.

More than 2,000 measurements of the depth to a water table were made on Mardin and similar soils over a 2-year period by Spaeth and Diebold (*17*). From the first of April to the middle of May, the water table was less than 10 inches below the surface 17 percent of the time and was less than 20 inches below the surface 61 percent of the time. The water table fluctuated between 10 and 20 inches during the first half of April and between 15 and 30 inches during the last half of April. During May, free water appeared above the fragipan for brief periods after rains, but it rarely rose higher than 15 inches below the surface. During April, 5 to 6 consecutive drying days are commonly needed before the soil can be plowed. In the middle of May, only 3 or 4 drying days are needed. By late June, 1 or 2 dry days permit cultivation.

The layer from which plant roots can draw nutrients and water is only 15 to 20 inches thick in uneroded soils. Within this depth, these soils can hold between 3½ to 5 inches of water available to plants. Plants begin to show moisture stress after 10 or 15 days without rain, if at the beginning of that period the water content is near field capacity but free water has disappeared above the fragipan.

The unlimed soil is very strongly acid or extremely acid. The plowed layer in most areas has a capacity to absorb bases equal to 8 to 12 tons of ground limestone per acre. Between 4 and 8 tons are needed on unlimed soils to raise the pH value of the plowed layer to 7.0. Between 1½ and 3 tons are needed to raise the pH from 6.0 to 7.0. Acidity is the greatest single limiting factor affecting plant nutrition. Available phosphorus is low in unlimed soils. It is increased by liming, but phosphorus fertilization is needed on limed soils for even moderate yields. Though the potassium supply may be adequate for short periods while crops are being established, the readily available reserve is limited. High rates of production require liberal potassium fertilization. Though the total nitrogen content is high, the release of nitrogen for plants is very slow in spring. Even in midsummer when the release is more rapid, the demands of rapidly growing crops are commonly greater than the supply.

Mardin channery silt loam, 2 to 8 percent slopes (MaB).—The Mardin soil on these gentle slopes is mainly in the wetter two-thirds of the drainage range for the series. It has more favorable slopes but less favorable drainage than the other Mardin soils. The well-aerated, yellowish-brown layer below the plowed layer is thin and is commonly faintly mottled. The fragipan is 15 to 18 inches below the surface.

This gently sloping or undulating soil is on the uplands in the southern half of the county. It occurs mostly in small areas that typically are adjacent to more extensive areas of the wetter Volusia soils. The use of fields in which both of these soils occur is determined in many places by the wetness of the Volusia soils. The mapping includes areas, too small to be mapped separately, of Volusia soils that are in the drier half of the drainage range for that series. These inclusions occupy the most nearly level parts and make up as much as 12 percent of some individual areas. Wet spots of Chippewa soils also are included in some areas. These are indicated by wet-spot symbols wherever feasible. Where Mardin soils are adjacent to Lordstown soils, bedrock may be found locally only 30 inches below the surface. In most areas it is below 6 feet.

This soil can be used for crops, pasture, or forest. It is suited to the crops commonly grown in support of dairying; some of it is used for crops like potatoes. It has moderately good productive potential. This soil presents moderate, but not extreme, problems of water control for nonagricultural uses, such as housing.

Correction of the lime and fertility deficiencies described for the series is the greatest need in most areas. Draining the wet spots in some areas is necessary for use of the full potential of this soil. Drainage in some areas can be improved by diverting surface water that would normally flow over the area from higher adjacent land. On the most strongly sloping areas, contour cultivation and stripcropping may be needed for conservation of water and control of erosion. (Capability unit IIe-4; woodland suitability group 8a)

Mardin channery silt loam, 8 to 15 percent slopes (MaC).—This sloping soil is within the middle half of the drainage range for the Mardin series. Runoff is rapid. Depth to the fragipan ranges from 15 to 20 inches. The yellowish-brown, well-aerated layer below the plowed layer is moderately thick; the mottled layer above the fragipan is thin. Spring wetness is a less serious problem than on gently sloping Mardin soils, but midsummer drought and erosion are more serious problems.

Gradients are steep enough to cause some difficulty in the use of farm machinery. The slope is generally in one direction, but the landform is commonly a series of slight dips and rises at right angles to the general slope. Water crossing these areas is concentrated in the low places, but it is not confined to channels. Spots of Erie soils, too small to be mapped, may be found in the low places; spots of eroded soil may be found on the rises; and the well-drained Bath soils occur on the most conspicuous rises. Individual areas of Mardin soil range from 1 or 2 acres to 20 acres in size. This soil is typically associated with the somewhat poorly drained Volusia soils, and the use of small areas of Mardin soils depends on the capability of Volusia soils.

This soil is suited to crops, pasture, or forest. It is commonly used for crops in support of dairying, but it is used for potatoes in some areas. With good management, it is suited to the exacting requirements of alfalfa. It is potentially productive under good management but requires exacting management for sustained production. In addition to the relatively high requirements for lime and fertilizer described for the series, control of runoff is a major need. The erosion hazard is high if intertilled crops are grown frequently. Conserving water during midsummer is important, for the soil has limited capacity to store water for dry periods. Many areas of this soil are well suited to contour cultivation and stripcropping, measures that conserve both soil and water. (Capability unit IIIe-6; woodland suitability group 8a)

Mardin channery silt loam, 8 to 15 percent slopes, eroded (MaC3).—About 60 to 80 percent of this sloping, moderately well drained soil has lost a significant part of the original plowed layer. The rest is uneroded or has deposits of eroded material on the original surface. Consequently, depth to the fragipan, the water-holding capacity, and other properties vary widely within short distances.

The present plowed layer of the eroded part is composed mainly of former subsoil material mixed with remnants of the original surface soil. It is lighter colored than is typical of the series and contains less organic matter. The well-aerated, yellow-brown layer that is found below the plowed layer of the uneroded soil is very thin or is absent. The fragipan is only 10 to 15 inches below the surface. Though only 3 to 6 inches of soil has been lost, the water-holding capacity of the root zone has been reduced one-sixth to one-third, and the surface soil absorbs water more slowly than that of the uneroded soil. Runoff is greater, and the surface layer is more stony.

This soil is steep enough that machinery is used with some difficulty. It typically slopes in one direction, but a series of shallow dips and low rises at right angles to the general slope gives a slightly rolling or undulating appearance. The sides of the rises are the most severely eroded, and the eroded material has been deposited in some of the slight depressions.

Some areas are small and are closely associated with the wetter Volusia soils. Some large areas occupy whole hillsides. Locally, small areas of eroded Volusia soils were included in the areas mapped.

This soil can be used for crops, but to prevent further damage, the growing of intertilled crops should be limited and intensive water control practices should be applied. Sod-forming crops are best suited. Even exacting crops like alfalfa can be grown, though they are more difficult to maintain than on the uneroded Mardin soils and yields are commonly less. In suitable locations, this soil can be used as housing sites, for which it presents only moderate problems of water control.

The lime and fertility needs described for the series apply generally to this soil, though the need for nitrogen is greater than in other Mardin soils. Diverting surface runoff, cultivating on the contour, and similar practices for water control are important. If intertilled crops are grown, stripcropping is needed. Generally, this soil is better suited to long-term hay and pasture than to regular rotations. It should be plowed only when it is necessary to reestablish the stand and control weeds. (Capability unit IVe–5; woodland suitability group 8a)

Mardin and Langford soils, 15 to 25 percent slopes (MfD).—Any given area of this mapping unit may consist of moderately steep Mardin soils, of moderately steep Langford soils, or a mixture of the two. The differences between the two soils that are significant on more gentle slopes have little significance on moderately steep slopes. This unit is steep enough that machinery can be used only with great difficulty. If unlimed, the soils in it are strongly acid or very strongly acid. They have moderate water-holding capacity, are moderately well drained, and have a fragipan less than 20 inches below the surface.

In the southern part of the county, this unit is dominated by Mardin soils and is adjacent to less steep Mardin soils or the somewhat poorly drained Volusia soils. The areas there may include a small proportion of the well-drained Bath soils or the moderately deep Lordstown soils.

In the central part of the county and in many valleys, this mapping unit is dominated by Langford soils and is associated with Valois and Erie soils. The areas are typically relatively large hillsides. Some are long, narrow areas within more gently sloping landscapes. The degree of erosion has not been indicated, because slope controls capabilities.

It is estimated that about 50 percent of this mapping unit has been moderately eroded.

This unit is suited to pasture and forest. It can be used for crops only with great difficulty. Problems of tillage and the erosion hazard make it poorly suited to intertilled crops, but it is suited to sod-forming crops, such as alfalfa-grass mixtures. It presents only moderate problems of water control if used as building sites.

Correction of the lime and fertility deficiencies described for soils of the two series is essential for even moderate yields of crops or pasture. Unimproved permanent pasture produces relatively low yields. Good pasture and good yields of hay require occasional plowing, liming, fertilization, and reseeding. Much water is lost as runoff. Runoff is rapid; sheet erosion and shallow gullying can occur if the water runs unimpeded. Diversion of excess water can improve many areas. If this unit is plowed, operations should be on the contour. Long slopes should be plowed in alternate strips, between which sod is maintained. (Capability unit IVe–4; woodland suitability group 8b)

Middlebury Series

The Middlebury series consists of deep, moderately well drained, medium-textured soils. These are young soils that are just beginning to form in acid recent alluvium. They are strongly acid. Mottling below 17 inches shows that they are subject to periods of wetness.

Middlebury soils occupy the level first bottoms in the southern part of the county. They are closely associated with the well-drained Tioga soils, the poorly drained Holly soils, and the very poorly drained Papakating soils. The soils on the adjacent uplands are mainly members of the Volusia and Mardin series. Chenango soils occur on adjacent glacial outwash terraces.

Middlebury soils have four principal parts: (1) a surface soil of dark grayish-brown silt loam; (2) an upper subsoil of pale-brown to brown silt loam that has few mottles; (3) a lower subsoil of grayish-brown silt loam that has many yellowish-brown mottles; and (4) a substratum consisting of layers of silt loam, loam, sand, and gravel.

The plowed layer of most cultivated fields is 8 to 12 inches thick. It is 4 to 6 percent organic matter and consequently is dark colored. The material is porous, permeable to water, and well suited to root development. In unlimed areas it is strongly acid. It has medium capacity to supply potassium and phosphorus.

The lack of mottles in the upper part of the subsoil shows that wetness is not a major limitation for extended periods. This layer extends to a depth of 15 to 18 inches. Like the surface soil, it is porous and permits penetration of plant roots and movement of water. It is strongly acid and has medium capacity to supply potassium and phosphorus.

The lower part of the subsoil extends to a depth between 24 and 36 inches. It is strongly mottled, an indication that it is saturated for significant periods. In most areas, but not all, it is more firm and less rapidly permeable than the material above it. Plant roots can penetrate this layer when it is not saturated. Like the material above it, it has medium capacity to supply potassium and phosphorus and is strongly acid.

The underlying substratum varies from area to area. In most places it consists of layers of gravel, sand, and silt or silt loam. Mottling shows that this layer also is saturated for significant periods. Although the upper part is strongly acid, acidity decreases with depth.

The texture of the surface soil in most areas is silt loam, but in some areas it is fine sandy loam or gravelly loam. Layers of gravel are common in the soil, and a gravelly surface soil commonly occurs near streams that flood frequently. The reaction in the upper part is mainly strongly acid. A medium-acid surface soil occurs where Middlebury soils intergrade to the Eel soils of the high-lime areas.

Middlebury soils are flooded when the streams are at flood stage in the early spring. During April, free water fluctuates mainly between a depth of 6 and 18 inches. At this time of year, 4 to 6 consecutive drying days are needed before these soils can be plowed. During May, free water is present above 15 inches for only very short periods after rains and recedes to a depth of 30 inches or more during dry periods. During May, 3 or 4 consecutive drying days are needed before cultivation. During June, 1 or 2 consecutive drying days normally permit tillage.

Most plants can exploit 24 to 36 inches of soil. This volume of soil holds between 4 and 7 inches of water that plants can use. This amount of water is significantly less than that in the associated Tioga soils. Nevertheless, Middlebury soils are probably able to supply as much or more water because the lower part of the subsoil and the substratum hold free water for longer periods when the upper layers are only moist. Middlebury soils are among those that show drought least frequently.

The surface soil is moderately high in organic-matter content, which in turn results in moderately high total nitrogen content. Nitrogen is released slowly enough, however, that most crops respond markedly to nitrogen fertilization. The organic-matter content is also associated with a moderately high capacity to hold bases. This capacity is equal to 8 to 12 tons of ground limestone per acre. In unlimed soils, however, it is only about 30 percent filled, and 3 to 6 tons per acre are needed to raise the pH of the plowed layer to a value near 7.0. Where the soil has been limed previously to pH 6.0, 2 to 3 tons are needed. Like Tioga soils, Middlebury soils have medium capacity to supply potassium and phosphorus.

Flooding in spring is a moderate limitation for many uses. Moderate drainage slightly limits the selection of crops. Nevertheless, Middlebury soils are among the potentially more productive areas of Tompkins County.

Middlebury and Tioga silt loams (Mo).—These two soils have been mapped together because they are closely associated and the acreage of Tioga soils is small. Tioga soils are described under the heading "Tioga Series." The mapped areas include some spots, too small to be mapped separately, of the poorly drained Holly soils. The wetness range is from well drained or moderately well drained to the better drained half of somewhat poorly drained. Individual areas may be dominated by well drained soils, by moderately well drained soils, or by mixed soils covering the entire range of drainage described.

This mapping unit is suited to crops, pasture, or forest. Most of it is suited to vegetable crops and to the crops commonly grown in support of dairying. Susceptibility to flooding limits its use for many nonagricultural purposes, though the high-bottom positions of some areas are suitable for building sites.

This unit has few special management needs. Streambank erosion is a problem in some areas and needs treatment to prevent further damage. Some areas include small wet spots, the drainage of which could improve the entire field. Generally, a drainage system is not justified unless the soils are farmed intensively. Most crops require liming and fertilization for good yields. If properly managed, this unit is potentially highly productive. (Capability unit IIw-3; woodland suitability group 3)

Muck and Peat (Mp)

This unit consists of undifferentiated kinds of organic soils. It includes areas of well-decomposed muck from woody plants, sedges, reeds, cattails, and rushes, and less extensive areas of almost undecomposed peat. These organic deposits are more than 24 inches thick, except where they intergrade to adjacent mineral soils, and in those places they are 18 to 20 inches thick over silt loam or silt clay.

These organic soils occur throughout the county in small closed depressions that mainly have remained undrained. A moderately large area near the margin of Dryden Lake was once drained but has been abandoned. Most areas support mainly a poor growth of trees or reeds and sedges. (Capability unit VIIw-1; woodland suitability group 16)

Niagara Series

The Niagara series consists of deep, somewhat poorly drained soils that have formed in calcareous lake deposits. These soils are predominantly silt and very fine sand but contain a moderate amount of clay. They dispose of water slowly internally. The upper part is medium to slightly acid, but acidity decreases with depth.

Niagara soils occupy very gentle slopes from which water drains slowly or stronger slopes that have some rapid runoff but receive water from adjacent land. They are commonly the intermediate parts of relatively smooth land surfaces on which the higher parts are Collamer soils and the depressions are Canandaigua soils. In some places, however, they are gently sloping but are the lowest parts of the landscape. In others, they are the highest parts of the landscape but have gradients near 2 percent. In some places, as on the Cornell property east of Ithaca, the adjacent higher areas are Williamson soils. Niagara soils in such places contain more lime than do the adjacent higher lying Williamson soils.

Niagara soils have four principal parts: (1) a plowed layer of dark grayish-brown or very dark grayish-brown silt loam; (2) a thin leached layer of very strongly mottled light brownish-gray silt loam; (3) a subsoil of strongly mottled grayish-brown or light olive-brown heavy silt loam or silty clay loam; and (4) a substratum consisting of layers of silt and very fine sand and thin layers of clay.

The very dark color of the plowed layer is associated with a 5 to 8 percent organic-matter content. Thus, nitrogen is moderately high. The material is porous and is easily penetrated by roots and water. It has good water-holding capacity but has only a medium supply of available potassium and phosphorus. In unlimed areas it is typically medium or slightly acid.

The thin leached layer below the plowed layer extends to a depth between 11 and 13 inches. In some places it has been destroyed by plowing. The grayish color and strong mottling show that it is poorly aerated for long periods but dries periodically. Except for lower organic-matter content, it is like the material of the plowed layer.

The slightly clayey subsoil extends to a depth of 24 to 40 inches. Mottling and grayish colors indicate that it also is wet for long periods. It is aerated intermittently When the soil is moist, plant roots can penetrate among the blocks in this layer. This layer typically has a slightly higher reserve of available potassium than does the surface soil. It has only moderate capacity to supply phosphorus. Ordinarily it is nearly neutral, but its upper part in some places is slightly acid.

Among the layers of silt and very fine sand in the substratum are thin layers of clay that act as barriers to water movement. Consequently, water and air penetrate very slowly. Few roots enter this zone, which is commonly wet for long periods. Though the upper part may be free of carbonates, free lime is found above 40 inches in most places.

As in other soils that have formed in layered lake deposits, the texture of the various layers ranges widely. In some places layers of very fine sand occur in the upper part of the soil. Where Niagara soils are associated with Williamson soils, the subsoil is commonly less than 20 percent clay. Where they join Rhinebeck soils, the subsoil is nearly 35 percent clay. This wide range in texture may be found within some individual fields. The depth to free lime ranges from 24 to 40 inches. Where these soils occupy the lowest positions on the landscape, eroded material from adjacent soils has been deposited on the surface, and the dark-colored surface soil is 10 to 16 inches thick.

Niagara soils are saturated when frost leaves the ground in spring. During April, free water may be found at a depth of 4 to 15 inches most of the time. At this time of year, 5 to 8 drying days are needed before the soil can be plowed. Niagara soils frequently prevent plowing of fields in which they are relatively minor parts. In May, free water is within 8 inches of the surface during rainy periods but is not above 20 inches after several days of drying. During this month, 4 to 6 drying days are needed before the soil can be plowed. During June, 2 or 3 drying days permit tillage.

In spring, plant roots are confined mainly to the surface soil, but as the season progresses they extend to a depth of as much as 24 inches. In the middle of the summer, the effective root zone is 15 to 24 inches thick. This zone will hold between 3 and 5 inches of water that plants can use after excess water has drained away. The available moisture capacity, however, is not very meaningful during spring and early summer. These soils receive runoff from adjacent land in most places, and the supply is replenished more frequently than on soils in higher positions. Nevertheless, crops commonly show moisture stress during dry periods of midsummer.

The plowed layer has a moderately high capacity to absorb bases. This capacity is equal to 10 to 14 tons of ground limestone per acre. In an unlimed surface soil this capacity is 50 to 70 percent filled. From 1 to 5 tons are needed per acre to raise the pH of the surface soil to a value near 7.0. If the pH is 6.0, 2 to 4 tons are needed. The capacity to supply phosphorus and potassium to growing crops is only medium.

Wetness is the outstanding limitation. If it can be corrected, these soils are among the more productive of the county. During extreme droughts they are soils on which crops grow better than on most other soils, but also they are soils on which nitrogen deficiency is most pronounced in spring and during periods of wetness.

Niagara silt loam, 2 to 6 percent slopes (NaB).—This is the only Niagara soil mapped in Tompkins County. Though the slope range is 2 to 6 percent, slopes are predominantly less than 5 percent.

Many areas are crossed by waterways along which are long, very narrow strips of the poorly drained Canandaigua soils. Though small in total extent, these included soils are very important because they control the timing of farming operations in spring. For the most part, these included wet soils have a dark-colored, thick surface soil composed of material eroded from adjacent areas. The mapping has also included a few small knolls of Collamer soils, but these have little significance to use or management. In the vicinity of Waterburg, there are thin layers of gravel in some places.

This is the wettest soil that can be used in regular crop rotations without artificial drainage. Forage and pasture crops that contain legumes tolerant of wetness are among the crops best suited to the undrained areas. Many areas have been partially drained by surface structures, however, and some are tile drained. Even removal of surface water permits more intensive use. If adequately drained, this soil can be productive of a wide variety of crops, including vegetables. It is also well suited to pasture and to certain kinds of forest trees. Wetness limits its use for many nonagricultural purposes. Some areas are suitable as pond sites. Such sites need special investigation, however, for if sandy layers are present, they cause leaks. Drainage is the first management need. Both tile and open ditch drainage may be used. In some places diversion of water from adjacent areas is helpful. Though the material is erodible, the slope is such that erosion is not a serious problem. It is a hazard on the most strongly sloping parts, and in some places tillage practices or structures are needed to control washing. (Capability unit IIIw–2; woodland suitability group 11a)

Ovid Series

The Ovid series consists of somewhat poorly drained and moderately well drained, moderately fine textured soils that have formed in a clayey deposit of lake sediments over medium-textured calcareous till. The lake deposit is thin enough that some of the underlying till has been mixed with it. Reaction is medium acid to neutral.

Ovid soils are mainly on the sides of valleys, in places that were once under glacial lakes. They formed where the lake deposits were a few inches to as much as 36 inches thick over till. They are adjacent to Conesus and Lima soils, which formed in glacial till in areas where the lake deposit had been entirely removed; and in some places they are near Rhinebeck or Hudson soils, which formed entirely in the lake deposit where it is more than 36 inches thick. The best-drained soils of the locality are members of the Cayuga series. The wettest soils are in the Ilion series.

Ovid soils in uneroded areas have four principal parts: (1) a plowed layer of very dark grayish-brown, slightly gravelly silt loam; (2) a thin leached layer of light brownish-gray, mottled silt loam or gravelly silt loam; (3) a subsoil of light brownish-gray or olive-brown, mottled gravelly silty clay loam, the zone of highest clay concentration; and (4) the underlying grayish-brown, dense, calcareous, gravelly loam glacial till.

The very dark grayish-brown color of the plowed layer in uneroded areas results from a moderately high organic-matter content (mainly 4 to 6 percent). The plowed layer is porous, holds a good supply of moisture, and permits good root growth. This layer is fine textured enough to lose its porosity if organic matter is lost. It is medium acid to neutral. It is moderately supplied with potassium and phosphorus. Nitrogen is abundant but is released slowly in spring. This layer is 7 to 9 inches thick in most fields.

The thin leached layer is similar in texture and mineral-nutrient content to the plowed layer, but it is low in organic-matter content. It is at least moderately porous, however, and plant roots penetrate it easily. Mottling shows that it is wet periodically. This layer extends to a depth of 12 to 15 inches.

The subsoil extends to a depth of 24 to 36 inches and contains more clay than do the layers above or below it. It is typically gravelly silty clay loam that formed in a mixture of clayey lake sediments and loamy glacial till. Yellowish-brown mottling shows that it is wet periodically. Though this layer is moderately high in clay, it is arranged in blocks. Plant roots penetrate between the blocks, and some go into the block interiors. The moderately high clay concentration is associated with a very high potassium reserve. The phosphorus-supplying power is medium. The reaction is nearly neutral.

The underlying calcareous till is very firm and dense, typical of the gravelly glacial till that underlies Lansing and Honeoye soils. Few roots penetrate it, and it is very slowly permeable to water.

Burrowing by animals, the uprooting of trees, and frost action have mixed the till with the overlying lake sediments. The degree of mixing is greatest where the lake sediments are thinnest. Because the thickness of the lake sediments varies widely within short distances, the texture of Ovid soils also varies within short distances. The plowed layer is mainly silt loam. It typically contains only a small amount of gravel, but in places it is distinctly gravelly. The subsoil ranges from heavy silt loam to heavy silty clay loam. Where the lake deposit is almost 36 inches thick, Ovid soils are nearly the same as those of the Rhinebeck series. Depth to carbonates ranges from 18 to 36 inches.

The Ovid series includes soils of the wetter half of the range of the moderately well drained class and also of the entire range of the somewhat poorly drained class. The driest Ovid soils have a relatively light-colored surface soil and an only moderately mottled upper subsoil. The wettest soils have a moderately dark-colored surface soil and a strongly mottled subsoil. These differences are commonly associated with the slope, and each slope phase recognized as a mapping unit has a narrower range of properties than those described here for the series.

During April, free water is within 4 inches of the surface after some rains and is generally within 15 inches during rainless periods. At this time of year, 5 to 7 drying days are needed before the soils can be cultivated. During May, the water table is below a depth of 10 inches most of the time, and during rainless periods it is below 20 inches. During this month, 4 or 5 rainless days are needed before tillage. During June, free water stands in the profile periodically but falls quickly after rains. Tillage is possible after 2 or 3 drying days.

Though some roots extend to a depth of 36 inches, most are concentrated within the topmost 18 to 24 inches. This volume of soil holds between 3 and 4 inches of water that plants can use. Not all of this moisture is readily available, however, and plants show the effects of moisture stress after 7 to 10 rainless days in summer. The available moisture capacity has little meaning in spring, when the soils frequently have free water above the glacial till.

The plowed layer has a moderately high capacity to hold bases. This capacity is equal to 10 to 14 tons of ground limestone per acre in most areas. Some unlimed Ovid soils need no lime; others need as much as 3 tons per acre to raise the pH in the plowed layer to a value near 7.0. If the soils have been limed previously to pH 6.0, the requirement is 2 or 3 tons of ground limestone. The reserve supply of potassium is very high in the subsoil and medium in the plowed layer. The phosphorus-supplying power is medium. Total nitrogen is moderately high in uneroded soils, but nitrogen is released so slowly that plants respond well to nitrogen fertilization.

Wetness, erodibility, and a tendency toward poor structure in the plowed layer are among the limiting features of Ovid soils. These soils are potentially productive of many crops, but they require careful use and management.

Ovid silt loam, 0 to 6 percent slopes (OaA).—This soil is typical of the somewhat poorly drained part of the series. It receives runoff from adjacent higher land. Except on small spots near the upper limit of the slope range, it is uneroded or is only slightly eroded. The slopes are mainly uniform and, for the most part, they are in the upper part of the slope range; only a small acreage has slopes of less than 2 percent.

The most gently sloping parts are typically the finest textured. In such places the lake deposits appear to have been thickest. In some places 6 to 12 inches of material eroded from adjacent slopes has been deposited on the original surface. The more strongly sloping areas are commonly the most gravelly and are the coarsest textured. In these places the lacustrine deposits appear to have been thinnest.

This soil is adjacent to Cayuga soils or more strongly sloping Ovid soils, from which it receives runoff. It merges with Rhinebeck soils where the lake deposits are thickest and with Kendaia or similar soils where the deposits are thinnest. Locally, near side streams, small spots of gravelly soils were included in the areas mapped.

This soil is suited to crops, pasture, or forest. Intertilled crops may be grown safely. Wetness tends to limit the intensity of cultivation, but vegetable crops, such as beans and peas, are grown. Moderate wetness limits the suitability for many nonagricultural uses, but some areas have been used for housing.

Control of wetness is the most important single management problem. Draining the included spots of the poorly drained Ilion soils is a major need in some areas. Structures to remove or divert surface water are needed in some places. Though erosion is not a major problem, the long slopes should be protected by contour tillage or, in some places, by stripcropping. Waterways should be kept in sod. Nitrogen and phosphorus are the major nutrients needed, though the supply of potassium in quickly available form is inadequate for some crops. Most areas need little lime. (Capability unit IIIw-4; woodland suitability group 11a)

Ovid silty clay loam, 6 to 12 percent slopes, eroded (OcC3).—This soil represents mainly the moderately well drained part of the series, but its suitability for many uses is limited by moderate wetness. An estimated 60 percent of most areas has lost enough surface soil that part of the more clayey subsoil has been incorporated in the plowed layer.

Excess water from adjacent land contributes to the wetness of this soil. The slopes are mainly slightly convex, and runoff is moderately rapid. A large acreage is on the sides of valleys and is crossed by shallow drainways that run downslope. Most, but not all, of these drainways can be crossed by farm machinery. Included wet spots, too small to be mapped separately, delay field operations. Spots of the well-drained Cayuga soils and a very small acreage of Ovid soils on slopes of more than 12 percent are included in the mapped areas also.

The total acreage of this soil is small. For the most part, it occurs as small, eroded areas within fields dominated by other soils that determine its use. It is suited to crops, pasture, or forest. If it dominates entire fields, however, growing intertilled crops is inadvisable. It is subject to continuing erosion and requires special practices for water control. Rebuilding good structure in the plowed layer is important. Nitrogen is deficient. The potassium reserve is very high, and the phosphorus-supplying power is medium. The reaction is nearly neutral. (Capability unit IVe-6; woodland suitability group 11b)

Ovid and Rhinebeck silt loams, moderately deep, 0 to 2 percent slopes (OrA).—Any given area of this mapping unit may consist of Ovid soils, or Rhinebeck soils, or a mixture of the two. These soils have been mapped separately, rather than in mapping units with the deep members of the Ovid and Rhinebeck series, because they are mainly only 20 to 40 inches deep over bedrock. The rock interferes with any use or management practice that requires excavation. Rhinebeck soils are described under the heading "Rhinebeck Series."

The acreage is small. These soils are nearly level and represent the wettest part of the drainage range for Ovid and Rhinebeck soils in spring. They are, however, among the most droughty in midsummer. The mapped areas include spots where rock crops out at the surface and spots where the soil is deeper than 40 inches.

These soils are suited to crops, pasture, or forest. Wetness seriously interferes with much of the spring planting, and both spring wetness and midsummer drought limit the response of crops to good management. Nevertheless, some crops can be grown successfully. Depth to bedrock and wetness in spring are major limitations for nonagricultural purposes.

Drainage to reduce spring wetness is one of the major needs. Surface structures are the most reliable means of drainage, because in most places the soils are too shallow for tiling. Conservation of moisture, because of midsummer dryness, is also important. Erosion is no problem. The potassium-supplying power is very high, but the supply of potassium in quickly available form may be inadequate. The phosphorus-supplying power is medium. Nitrogen is typically deficient because it is released slowly. Maintenance of good tilth is more difficult on these soils than on less clayey soils. (Capability unit IIIw-3; woodland suitability group 11a)

Ovid and Rhinebeck silt loams, moderately deep, 2 to 6 percent slopes (OrB).—Any given area of this mapping unit may consist of Ovid soils, or Rhinebeck soils, or a mixture of the two. In most areas these soils are mainly only 20 to 40 inches deep over bedrock, and in only a few spots are they shallower or deeper. They are thick enough throughout most of each area that they include all of the layers described for the two series except the substrata. At least 85 percent of each area is uneroded or only slightly eroded. As much as 15 percent of some areas has been eroded enough that some of the moderately clayey subsoil has been incorporated in the plowed layer.

These areas as mapped include spots of Hudson and Cayuga soils, which do not affect most agricultural uses significantly, and wet spots of Ilion and Madalin soils, mainly along drainways, which are highly significant. Exposed bedrock within mapped areas is shown by special symbol wherever feasible.

The total acreage is small. These soils occur mainly as small areas that are closely associated with deeper Rhinebeck or Ovid soils. Few of the areas dominate entire fields. For the most part, they are on slopes of the major valleys and receive runoff from adjacent higher lying land.

These soils are suited to crops, pasture, or forest. Their response to management is low enough, however, that they are generally not well suited to vegetables and similar crops. Ordinarily, they are used as are other soils that dominate in the fields where they occur. Wetness and depth to bedrock should be considered if these soils are used for nonagricultural purposes.

Though most of the acreage is not seriously eroded, these soils are erodible and should be protected by vegetation and by such tillage practices or structures to control runoff as are feasible. Included wet spots need draining, and in most areas surface drains are feasible. Nitrogen, phosphorus, and potassium fertilization is generally needed for even moderate yields, though the reserve supply of potassium is very high. Maintenance of good tilth is important, because if these soils are cultivated, their structure deteriorates rapidly. (Capability unit IIIw-4; woodland suitability group 11a)

Ovid and Rhinebeck silt loams, moderately deep, 6 to 12 percent slopes (OrC).—Any individual area may consist of Ovid soils or Rhinebeck soils, or a mixture of the two. In most areas these soils are mainly only 20 to 40 inches deep over bedrock, though in spots they are deeper or shallower. They are sloping enough that heavy machinery is used with some difficulty. They are predominantly in the drier half of the drainage range for the Ovid or Rhinebeck soils.

These soils are mainly on the slopes of the major valleys. Intermittent waterways running down these slopes have cut to the underlying bedrock and divided most areas into short segments within which machinery can be used. The soils between the waterways have been eroded to varying degree. It is estimated that almost half of the acreage has lost enough soil that the underlying clayey subsoil is now part of the present plowed layer. These soils typically receive runoff from adjacent higher land.

The total acreage is small. In few places do these soils dominate entire fields. Crops can be grown, but growing of sod-forming crops or use for pasture or forest is advisable because these soils are erodible. Shallowness to bedrock and wetness should be considered in plans for any nonagricultural uses. Maintaining a vigorous vegetative cover generally provides runoff control, which is a major need. Lime is needed for such cover on some areas. Nitrogen and phosphorus are generally deficient. The potassium reserve is high, but the supply in quickly available forms in the plowed layer may be inadequate for some crops. (Capability unit IIIe-9; woodland suitability group 11b)

Palmyra Series

The Palmyra series consists of deep, well-drained, medium-textured, gravelly soils that formed in high-lime deposits of glacial outwash sand and gravel. These soils are higher in lime content and are thinner over the gravel substratum than are Howard soils.

Palmyra soils occupy nearly level valley floors where glacial rivers once ran, or hilly areas where great rivers emerged from the glacier and deposited hills of gravel. In both places the deposits are rich in lime. The nearly level areas are associated with wetter Phelps, Fredon, and Halsey soils, which are also in gravel, and with Genesee soils and associated soils on the first bottoms. The hilly areas are associated with soils in glacial till.

Palmyra soils have four principal parts: (1) a plowed layer of very dark grayish-brown gravelly loam; (2) an upper subsoil of thin, yellowish-brown gravelly loam; (3) a layer of brown to dark-brown gravelly clay loam; and (4) calcareous, stratified sand and gravel.

The plowed layer in most places is about 8 inches thick. It is 3 to 5 percent organic matter and is correspondingly moderately high in total nitrogen content. It is loose and porous and is an excellent medium for plant roots. The gravel interferes moderately with cultivation. This layer is only slightly acid in most places. The potassium reserve is medium, and the phosphorus-supplying power is medium.

The upper part of the subsoil is porous gravelly material in which roots grow well. It is rapidly permeable to air and water. It is nearly neutral or only slightly acid. It is low in nitrogen, low to medium in potassium reserve, and medium in phosphorus-supplying power. It is, however, a suitable root zone for most crops. It extends to a depth of 12 to 16 inches.

Clay has accumulated in the lower part of the subsoil. This layer has the highest water-holding capacity and the highest available potassium reserve of any layer in the profile. It is medium in phosphorus-supplying capacity but is low in nitrogen. Reaction is neutral. This moderately clayey layer is largely responsible for the water retention in Palmyra soils; without it they would be very droughty. It extends downward into the gravel and sand of the substratum in V-shaped tongues, to a depth that ranges from as little as 15 inches to as much as 30 inches within a horizontal distance of 5 feet. These tongues are noticeable in gravel pits as dark-colored, very irregular lines.

The substratum consists of alternate layers of sand and gravel that include many fragments of limestone. It is 80 to 95 percent gravel, and water moves through it rapidly. Roots of deep-rooted plants penetrate far into the substratum and undoubtedly obtain some moisture from it, and in some places alfalfa roots have been seen at a depth of 8 feet. The deposit is very thick. Bedrock is mainly more than 20 feet below the surface and is not commonly reached in excavations.

The acreage of Palmyra soils in Tompkins County is small. In most areas the soil profile closely resembles the one described. Depth to carbonates ranges from 15 to 30 inches. The texture of the upper part of the soil is mainly gravelly loam, but in places it is gravelly sandy loam.

Palmyra soils are among the best drained soils in Tompkins County. Free water stands in the profile only after soaking rains, even in the early spring. Commonly, these soils can be cultivated after 2 or 3 consecutive drying days in April and after 1 or 2 consecutive drying days in May or June.

Though deep-rooted crops send their roots far into the substratum, the root zone is ordinarily confined to the topmost 30 inches. The amount of water this volume of soil will hold varies widely from spot to spot within single areas because of the tonguing of the clayey subsoil into the gravel. Probably, 3 to 5 inches of water available to plants is a liberal estimate. This amount of available moisture is supplemented to some degree by the free water that does not drain across the sharp contact between the clayey lower subsoil and the open, loose gravel beneath it. Crops generally show the effects of moisture deficiency after about a week without rain in the middle of the summer.

These soils need little lime. The capacity of the surface soil to hold bases is moderately high and is the result mainly of the organic-matter content. This capacity is equal to the bases supplied by 7 to 12 tons of ground limestone per acre. This capacity is 70 to 80 percent filled in most areas, and 1 ton of ground limestone is enough to raise the pH to a value near 7.0 in most places. The potassium reserve is medium to low, though some potassium is supplied by the clayey subsoil. The phosphorus-supplying power is medium. Although these are among the soils least subject to serious nitrogen deficiency in spring, response to nitrogen fertilizer is generally high at that time of year. Most crops respond to nitrogen in midsummer also, if the moisture supply is adequate. Palmyra soils are among the best soils in the county for many uses, both agricultural and nonagricultural.

Palmyra gravelly loam, 0 to 5 percent slopes (PaA).—This soil is typical of the soils described for the series. It occupies nearly level terraces in valleys and some nearly level tops of deltas on the sides of valleys. Associated wet soils, if they occur, are mainly members of the Phelps, Fredon, or Halsey series. On the adjacent slopes of valley sides are mainly Lansing or Honeoye soils, which formed in till and on the adjacent bottom lands are Genesee or Eel soils. Small patches of Palmyra gravelly sandy loam are included in the mapped areas.

This soil has very high potential for many kinds of crops, for pasture, for forest, and for many nonagricultural uses. Vegetable crops and fruit are grown on these soils in many areas of New York, though they are not presently important on these soils in Tompkins County. The areas are in great demand for housing, as sources of gravel for roads and other construction, for cemeteries, and for many other nonagricultural purposes.

Maintenance of fertility is the major management problem. Most crops need complete fertilizer, and response is so high that intensive fertilization can be justified for many crops. Drainage is not a problem. Problems of erosion are negligible. (Capability unit I-1; woodland suitability group 1a)

Palmyra gravelly loam, 5 to 15 percent simple slopes (PaC).—This soil is steep enough that use of some kinds of machinery is moderately difficult. It slopes uniformly in one direction, however, and in that way favors machine operations. The steepest slopes, mainly those between 10 and 15 percent, include small areas that are slightly to moderately eroded. Erosion probably occurs in spring when the subsoil is frozen. This soil occurs on some valley sides, as narrow strips at the edge of nearly level terraces, and as moderately sloping dissection forms. This is the most extensive Palmyra soil in Tompkins County. The mapped areas include small spots of Palmyra gravelly sandy loam.

This sloping soil is suited to crops, pasture, or forest and to many nonagricultural uses. It is best suited to deep-rooted crops because it has limited moisture-holding capacity and loses some water by runoff. It is less well suited to intensive use for intertilled crops than is Palmyra gravelly loam, 0 to 5 percent slopes.

Maintenance of fertility is the most important management problem. The soil needs little lime, but it needs nitrogen, phosphorus, and potassium fertilizers for good yields of most crops. Response of crops to fertilization is generally less than on Palmyra gravelly loam, 0 to 5 percent slopes, because moisture is more likely to be limiting. The soil is moderately subject to erosion. Sod-forming crops in the rotation are advisable. Some areas are adapted to contour tillage, and some can be incorporated in contour stripcropping systems. Generally, the slopes are short. Practices that contribute to moisture conservation are important. (Capability unit IIIe-4; woodland suitability group 1a)

Palmyra gravelly loam, 5 to 15 percent complex slopes (PaCK).—This soil is typical of the soils described for the series. The topography is rolling—a complex of low hillocks that have slopes in many directions. On such topography, contour operations are impossible and cultivation is generally difficult. Fine material has been washed from the hillocks and has accumulated in low areas, the lowest of which are small inclusions of the moderately well drained Phelps soils. Wetter areas, too small to be mapped separately, are shown by wet-spot symbols. This soil can be used for crops, pasture, or forest. It is best suited to sod-forming crops that require infrequent plowing. It is most productive of deep-rooted plants because it is moderately doughty. It is an excellent site for buildings and in some places is a source of gravel and sand for concrete. Some areas are suitable for roads. A large acreage is in pasture.

Erosion is moderate. Because contour operations are not possible, it is advisable to help control erosion by growing close-growing or sod-forming crops and by using little tillage. Some of the associated small depressions are moderately wet. Most lack outlets suitable for drainage. Moderately high rates of fertilization are necessary for good yields of crops. Legumes may be used effectively to supply part of the nitrogen. The supplies of phosphorus and potassium are inadequate for all crops. (Capability unit IVe-8; woodland suitability group 1a)

Palmyra gravelly loam, 15 to 25 percent slopes (PaD).—The topography of this moderately steep soil is mainly hilly, with slopes in many directions. In places, mainly on the faces of outwash terraces, the slopes run in one direction.

Parts of this soil, particularly in hilly areas, have been eroded to some degree; calcareous gravel may be within 10 inches of the surface in spots, and eroded material has accumulated in the depressions between the hills. In most places, however, this soil is 15 to 20 inches thick over gravel. Consequently, its ability to supply moisture for plants varies widely from the hillsides to the adjacent depressions.

This soil can be cropped, but its steep slope makes use of machinery extremely difficult, and erosion becomes a severe hazard if it is plowed. It is better suited to pasture or woodland. If this soil is needed for crops, intertilled crops should be grown as little as feasible. Moisture deficiency is a major factor. Deep-rooted legumes are among the most productive of the possible hay crops. This soil is also suited to many nonagricultural uses. In several places it is used as sources of gravel and sand for roads and concrete.

To the extent feasible, this soil should be kept in sod-forming crops. If plowed, it should wherever feasible be plowed in strips across the slope. It needs little or no lime, but it is very deficient in nitrogen and potassium. The phosphorus supply is only moderate. Response to fertilization is less than on other Palmyra soils, because moisture is so frequently limiting. (Capability unit IVe-8; woodland suitability group 1b)

Papakating Series

The Papakating series consists of deep, very poorly drained, medium textured to moderately fine textured young soils that are forming in very wet, acid recent alluvium. A thin muck occurs on the surface in undisturbed areas; the surface soil in areas that have been pastured is mucky silt loam. The entire soil is medium to slightly acid.

Papakating soils occupy the lowest-lying bottom lands along streams in the parts of the county where acid soils are dominant on the uplands. They are associated on the flood plains with the well-drained Tioga soils, the moderately well drained Middlebury soils, and the poorly drained Holly soils. The associated soils on terraces are members of the Chenango catena. Bath, Lordstown, Mardin, and Volusia soils occupy the uplands.

Papakating soils in pastured areas have four main parts: (1) a sufface soil of black mucky silt loam; (2) an upper subsoil of gray, unmottled heavy silt loam or silty clay loam; (3) a lower subsoil of dark-gray heavy silt loam or silty clay loam that has prominent yellowish-brown mottles; and (4) a substratum consisting of a variety of layers of sand, gravel, silt, and silty clay or silty clay loam.

The mucky surface soil is 10 to 20 percent organic matter and 10 to 16 inches thick. Reddish-brown spots are prominent where iron has been segregated around root channels. This layer is porous and would be a good medium for plant roots if excess water could be removed. It is slightly acid or medium acid. It has medium potassium-supplying and phosphorus-supplying power.

The gray unmottled upper part of the subsoil is low in organic-matter content. Its grayness and lack of mottles show that it is wet for very long periods. This layer is very high in silt and in places is moderately high in clay. It is generally a poor root zone for most plants. It is slightly to medium acid. It extends to a depth between 14 and 20 inches.

The lower part of the subsoil is similar to the upper part but is profusely mottled. It is massive heavy silt loam or silty clay loam. This layer also is a poor root zone for most crops. It extends to a depth between 30 and 42 inches. It is medium to slightly acid.

The underlying layers consist of varying proportions of gray sand, silt, clay, and gravel and are commonly only slightly acid or neutral. Calcareous material occurs at great depth in some areas.

Papakating soils are flooded early in spring and are likely to be flooded at any time during the summer when heavy rains occur. Free water stands at or very near the surface throughout April and May. The water table falls during dry periods as the season progresses, but rises after each rainy period. The soils are too wet for most agricultural or nonagricultural uses.

The high organic-matter content of the surface soil is associated with high nitrogen content, although nitrogen is released very slowly because of wetness. It is also associated with a high capacity to absorb bases, an amount equal to that supplied by 14 to 20 tons of ground limestone in the topmost 8 inches of an acre. In unlimed areas, this capacity is typically about 60 percent filled, and 2 to 4 tons of ground limestone per acre is needed to raise the pH to a value near 7.0. If the surface soil has been limed to pH 6.0, the requirement is 3 to 4 tons of ground limestone. The capacity to supply potassium and phosphorus is medium. Wetness is the outstanding limitation.

Papakating soils are mapped in an undifferentiated unit with Holly soils in Tompkins County.

Phelps Series

The Phelps series consists of deep, moderately well drained, medium-textured soils that formed in layered water-laid deposits of sand, silt, and gravel. The proportions of sand, silt, and gravel and their relative positions in the soil section vary widely from place to place. The wetness of the soil generally is caused by layers of slowly permeable silt. In some places sand and gravel have been deposited on slowly permeable till in closed depressions. In such places the moderate wetness is caused by the underlying till. The original material contained moderate to large amounts of limestone fragments. The upper part of the soil is medium acid to nearly neutral; the substratum is calcareous.

Phelps soils are on nearly level to gently sloping landforms in low-lying positions adjacent to Howard and Palmyra soils. They are associated with the lower lying, somewhat poorly drained Fredon soils and the poorly to very poorly drained Halsey soils, which formed in similar deposits.

Phelps soils have four principal parts: (1) a plowed layer of dark-brown to dark grayish-brown gravelly silt loam or gravelly loam; (2) an upper subsoil of grayish-brown gravelly loam that is faintly mottled; (3) a firm lower subsoil of dark grayish-brown, mottled, gravelly or gravel free heavy silt loam; and (4) layers of gravel, sand, and silt.

The very dark colored surface soil in plowed fields is 3 to 6 percent organic matter and is 7 to 10 inches thick. It contains gravel, in most places, that interferes moderately with tillage. It is permeable to roots and water. This layer is medium acid to neutral. It has a moderately high total nitrogen content, a medium potassium reserve, and a medium content of available phosphorus.

The upper part of the subsoil extends 12 to 24 inches below the surface. It is permeable to roots and water. Its grayish colors and faint mottles show that it is alternately wet and dry. It is porous and is a good place for roots to develop when it is not wet. It is medium acid to slightly acid. It has a medium potassium reserve and medium amounts of available phosphorus. It varies in thickness from area to area.

The lower part of the subsoil ranges widely in character and thickness. It generally extends to a depth between 24 and 40 inches. It is typically a silty layer that is slowly permeable to water. In some places it is almost pure silt, but in others it is dense gravelly loam or silt loam. It is neutral and has medium supplies of phosphorus and potash. This layer is absent in some of the areas of Phelps soils in this county.

The underlying calcareous deposit in most places consists of alternating layers of sand, gravel, and silt. The proportions and the relative positions of these layers vary widely from spot to spot, even within a single area. In some places silt layers are lacking above a depth of 4 feet.

As the proportions and relative positions of the different layers varied from place to place in the original deposit, the combination of layers and their textures in the areas mapped as Phelps soils are also variable. Some slowly permeable layer is present, however, either within the developed soil or at some depth in the underlying material. In some places these slowly permeable layers are silt deposits that were apparently laid down in very still water, and in others they are glacial till upon which the water-laid deposit rests. The depth to calcareous material ranges from as little as 24 inches to as much as 40 inches in different places. Generally, free lime is shallowest where Phelps soils are associated with Palmyra soils, and deepest where they are associated with Howard soils. As the depth to lime increases, acidity in the upper part of the soil also increases. If unlimed, Phelps soils are strongly acid, about pH 5.5, where they merge with the more acid Braceville soils. In the driest parts, where they merge with the well-drained Howard or Palmyra soils, mottling is lacking in the uppermost 18 to 20 inches. In the wettest parts, where Phelps soils merge with the somewhat poorly drained Fredon soils, the soil is mottled from the plowed layer downward.

During April, water stands within 6 inches of the surface for a moderate period after each rain. It falls to a depth near 20 inches during rainless periods. At this time of year, 4 to 6 consecutive drying days are needed before the soil can be plowed. During May, free water stands above 15 inches for only short periods and falls during very dry periods to 40 inches or more. At this time of year, 2 to 4 drying days are needed before the soil can be cultivated. During June, the water table is high periodically but falls rapidly, and 1 or 2 drying days will generally permit cultivation.

The depth of the root zone is controlled by the depth of the highest slowly permeable layer or by the water table that is perched above it. Generally, this depth is between 15 and 24 inches. This thickness of soil will hold 3 to 5 inches of water that plants can use. These values are not significant in the early part of the season when the soil is frequently saturated. During very dry periods of midsummer, however, drought damage is likely to result in shallow rooting. Phelps soils do not dry so quickly as the associated Howard or Palmyra soils, but after free water disappears from the soil, crops show moisture deficiency after 10 days without rain.

Phelps soils have a low to moderate lime requirement. In some areas, mainly those associated with Palmyra soils, they are nearly neutral at the surface and require no lime. In most other places they are medium acid. The plowed layer has a capacity to absorb bases equal to the amounts supplied by 7 to 13 tons of ground limestone per acre. An unlimed plowed layer needs from none to as much as 4 tons of ground limestone per acre to raise the pH to a value near 7.0. If the surface soil has been limed previously to pH 6.0, the requirement is 1½ to 3 tons of ground limestone. Phelps soils have medium potassium reserve and phosphorus-supplying power. Phelps soils are less desirable for crops than are the associated well-drained soils in gravelly material. They are about as desirable, however, as many of the soils on the uplands.

Phelps gravelly silt loam, 0 to 3 percent slopes (PhA).—This soil represents the wetter two-thirds of the drainage range for the series. In places it receives surface wash from adjacent higher lying soils and has a dark-colored surface soil 10 to 12 inches thick. Included in the areas mapped, because of the small total acreage, are a few spots that resemble Phelps soils and are only 36 inches thick over lake-laid clay. Also included are small knolls of Howard and Palmyra soils and spots of the somewhat poorly drained Halsey soils.

This soil is suited to crops, pasture, or forest. It is less well suited to deep-rooted crops than are the associated well-drained soils. Its nonagricultural uses are limited mainly to those that do not require dry sites; some areas are used for house sites, though they present some water problems. Some areas are suitable sites for dugout ponds; careful investigation, however, is necessary to determine the possibility of leakage through permeable layers.

Much of this soil can be drained feasibly by ditches or tile. If adequate drainage can be established, this soil can be significantly improved and some of it can be made about as productive as any soil in the county. It has essentially no erosion problem. (Capability unit IIw–1; woodland suitability group 2)

Phelps gravelly silt loam, 3 to 8 percent slopes (PhB).—In most areas this soil is representative of the driest one-third of the drainage range for the series, but in some areas it receives seepage water from higher lying soils and is within the wetter half of the drainage range. Generally, it is unmottled or is only faintly mottled immediately below the plowed layer.

This gently sloping soil is mainly in lower lying positions than are the adjacent Howard and Palmyra soils. It commonly lies between these soils and wetter soils in the middle of the valley. A few spots over lake-laid clay that resemble Phelps soils have been included in the mapped areas because of the small total acreage. Also included are spots of the somewhat poorly drained Fredon soils and small knolls of Howard and Palmyra soils.

This soil is suited to crops, pasture, or forest. It is somewhat better suited to crops that are sensitive to wetness than is Phelps gravelly silt loam, 0 to 3 percent slopes. Moderate to slight wetness limits the suitability of this soil somewhat for nonagricultural uses, but it is generally more suitable for housing sites than is Phelps gravelly silt loam, 0 to 3 percent slopes.

Fertilization is needed for good yields. Liming is moderately important in some areas but may not be needed in others. Some areas can be drained; some can be protected from runoff of adjacent areas by diversion terraces. The erosion problem is slight. Nevertheless, some long slopes should be cultivated on the contour or stripcropped. (Capability unit IIe–5; woodland suitability group 2)

Red Hook Series

The Red Hook series consists of deep, somewhat poorly drained, medium-textured soils that formed in poorly sorted glacial outwash. This material was derived mainly from sandstone, siltstone, and shale and contains little lime. Reaction is medium to strongly acid. Free lime occurs only deep in the substratum.

Red Hook soils occupy low-lying positions in association with Chenango and Braceville soils on glacial outwash terraces. They also occur as wet areas at the edge of alluvial fans where the gravelly material is thin over slowly permeable till or lake-laid clay. These soils are not extensive in Tompkins County.

Red Hook soils have four principal parts: (1) a plowed layer of very dark grayish-brown silt loam or gravelly silt loam; (2) a thin upper subsoil of light brownish-gray gravelly silt loam that has prominent yellowish-brown mottles; (3) a lower subsoil of strongly mottled light olive-brown or light brownish-gray gravelly silt loam that is more dense and firm than the material above it; and (4) poorly sorted layers consisting of gravel and sand and some silt.

The plowed layer is 6 to 10 inches thick in most fields. It is 5 to 8 percent organic matter. Its very dark grayish-brown color, an indication of high organic-matter content, is also associated with wetness and slow decomposition of the organic material. This layer is friable and porous. It is permeable to roots and water and has good water-holding capacity. It is medium to strongly acid. It has only medium capacity to supply phosphorus and potassium.

The upper part of the subsoil extends to a depth between 12 and 16 inches. Its mottles and light brownish-gray color are evidence of alternate wetness and dryness. The material is porous and friable; roots can penetrate it when it is not saturated. It has good water-holding capacity. This layer, like the surface soil, is medium to strongly acid and has only medium capacity to supply phosphorus and potassium.

The lower part of the subsoil extends to a depth between 25 and 36 inches. Its denseness restricts permeability. Its mottling shows that it is aerated at times, but its grayness shows that it is saturated for long periods. Few roots penetrate this layer.

The layers in the substratum generally are permeable to water, but they are underlain at some depth by slowly permeable glacial till or lake deposits. Where Red Hook soils lie in closed basins, water stands in these layers at some depth throughout most of the year.

The original deposits from which these soils formed consisted of sand, gravel, and silt in layers that ranged widely in proportion and thickness from area to area. The texture of Red Hook soils is correspondingly variable. The amount of gravel is mainly less than that in the better drained Chenango and Braceville soils of the same catena. The upper part of the soil is typically medium to strongly acid, but it is medium to slightly acid where Red Hook soils intergrade to the poorly drained Halsey soils.

Free water stands in the Red Hook soils late in spring. During April, it is frequently within 4 inches of the surface during rainy periods, but falls to a depth of 15 inches or slightly more during dry periods. At this time of year, 5 to 8 consecutive drying days are generally needed before the soil can be plowed. During May, free water is within 8 inches of the surface for only short periods, and it falls to 20 inches during rainless periods. At this time of year, 4 to 6 drying days are generally needed before the soil can be plowed. During June, the water table rises after heavy rains but falls moderately rapidly, and 2 to 3 drying days will generally permit tillage.

In undrained soils, the roots of most crops can develop only in the plowed layer during spring and early midsummer, but as the season progresses and the water recedes, they penetrate to a depth of 15 to 18 inches. This volume of soil will hold 3 to 4½ inches of available water. Such values, which are not very significant during the early part of the season, indicate the limited capacity of these soils to supply water during the dry periods of midsummer. These soils receive runoff from adjacent land during heavy rains and therefore have more water available in midsummer than is indicated by average rainfall. During extended drought, they commonly show lack of moisture for growing crops within 2 weeks after the time when free water disappears from the lower part of the subsoil.

The plowed layer has a moderately high capacity to absorb bases, equal to the amount supplied by 9 to 14 tons of ground limestone per acre. In unlimed soils this capacity is only 30 to 50 percent filled. An unlimed surface soil needs from 3 to 7 tons of ground limestone per acre to raise the pH to a value near 7.0. If the soils have been limed previously to pH 6.0, the requirement is 2 to 3 tons of ground limestone. The root zone has only medium capacity to supply potassium and phosphorus. The subsoil has a medium potassium reserve.

If undrained, Red Hook soils have very severe limitations because of wetness. Some areas can be drained. The drained soils can be productive of many kinds of crops, including vegetables.

Red Hook gravelly silt loam, 0 to 5 percent slopes (RhA).—This is the only Red Hook soil mapped in Tompkins County. It is typical of the soils described for the series.

It occupies level or gently sloping, low-lying areas adjacent to the Chenango soils of terraces in the valleys or to the margins of alluvial fans on which there are Chenango soils. It commonly receives seepage water. Ordinarily, the slope is less than 3 percent, but in a few areas it is 4 or 5 percent.

This soil is suited to crops, pasture, or forest. Wetness restricts the choice of crops. Some areas can be drained and would then be suited to vegetables and to the crops commonly grown in support of dairying. This soil is too wet for many nonagricultural uses. In places it is suitable for wildlife marshes and dugout ponds.

Drainage is the main need. Adequate outlets are unavailable in some areas. If adequately drained, this soil is potentially productive. Potential production can be realized, however, only if the soil is adequately limed and fertilized. (Capability unit IIIw-1; woodland suitability group 9a)

Rhinebeck Series

The Rhinebeck series consists of deep, somewhat poorly drained, fine-textured soils that formed in clayey, calcareous lake deposits. These soils are medium acid to neutral in the upper part and calcareous in the substratum. Wetness and fine texture are the important limitations.

Rhinebeck soils occur in valleys once occupied by glacial lakes. They are mainly uniformly gently sloping, in contrast to Madalin soils, which occupy associated flat places and depressions. Water accumulates on these soils. In some areas excess water results from slow runoff on slowly permeable material. In other areas, runoff is moderate but excess water flows from higher adjacent land. The moderately well drained Hudson soils occupy the distinctly convex knolls and the landforms dissected by streams within areas of these soils. Where the lake deposit is most silty, Rhinebeck soils join Niagara soils; where it is thin over till, they join Ovid soils.

Uneroded Rhinebeck soils have four distinct parts: (1) a plowed layer of dark grayish-brown heavy silt loam; (2) a thin leached layer of strongly mottled grayish-brown and yellowish-brown silt loam; (3) a layer, in which clay has accumulated, that is strongly mottled brown or olive-brown silty clay loam or silty clay; (4) a thick layer of dark grayish-brown silty clay separated by thin layers of silt.

The 7- to 10-inch plowed layer in uneroded fields is 3½ to 6 percent organic matter and is moderately well supplied with total nitrogen. It is porous and permeable to roots, air, and water in well-managed fields. If the organic-matter content is reduced by intensive cropping or by erosion, this layer loses much of its porosity. It is fine textured enough that it forms hard clods if the soil is plowed too wet or too dry. If unlimed, it is medium acid to neutral. It has a very high reserve of potassium. Its phosphorus-supplying power is medium. Nitrogen is in good supply, but wetness and coldness, especially in the spring, limits its release for use by plants.

The thin leached layer is present only if the soil has not been eroded or has not been plowed deeply. It is mainly only 2 or 3 inches thick. Its lower boundary ordinarily lies at a depth between 11 and 13 inches. In texture,

Figure 21.—**Profile of Rhinebeck silt loam showing dark-colored surface soil, grayish leached zone, and coarse blocky and clayey subsoil.**

reaction, and content of mineral nutrients it is similar to the plowed layer, but it is low in organic-matter content. It is moderately permeable to roots and water. Its mottling shows that it is alternately wet and dry.

The clayey subsoil extends to a depth that ranges from 24 to 36 inches in different areas. It is arranged in large blocks (fig. 21). Roots penetrate between blocks, and in the upper half of this layer, some go into the blocks. The strongly expressed mottling shows that this part of the soil is saturated frequently. This layer is moderately slowly permeable to water. It is nearly neutral in most places. It has a very high reserve of potassium. Its phosphorus-supplying power is medium.

The layers of clay and silt in the substratum are very slowly permeable to water. Roots of deep-rooted plants may penetrate in places, but they extend only short distances. This material is poorly aerated. It contains free lime.

Rhinebeck soils in Tompkins County intergrade to the more silty Niagara soils. In these places the subsoil is commonly about 30 percent clay and contains layers of silt. Where the sediments are finest, the substratum contains a few thin layers of silt and the subsoil is nearly 60 percent clay. In some places there is a relatively thick silt deposit on the surface and the subsoil lies below 15 inches. Layers of reddish-colored clay occur within the lake deposits in some places, especially in Cayuga Valley. In places spots of this reddish material appear at the surface. These spots are inclusions of Odessa soils, which are not extensive enough to be mapped separately in Tompkins County. Locally the lake deposits are thin, and calcareous glacial till may be found at a depth of only 36 inches. In these places Rhinebeck soils intergrade to Ovid soils.

Rhinebeck soils are saturated when frost leaves the ground in spring. During April, free water stands at or near the surface during rainy periods but falls to a depth of 15 inches after several days of drying. At this time of year, 5 to 8 consecutive drying days are generally needed before the soil can be plowed. During May, free water frequently stands within 8 inches of the surface but falls to a depth of more than 20 inches after several days without rain. At this time of year, 4 to 6 consecutive drying days are needed before tillage. During June, free water stands near the surface during very wet periods but falls quickly after rains, and 2 to 3 consecutive drying days generally permit tillage.

Although some plant roots penetrate the soil to a depth of 3 feet, most roots are concentrated in the topmost 18 to 24 inches. This volume of soil holds between 3 and 4 inches of water available to plants. Crops, however, show effects of drought when one-half to two-thirds of this amount has been lost. Available moisture capacity is not meaningful on these soils except during the dry midsummer, when crops show serious moisture stress after a week or 10 days without rain.

The plowed layer of uneroded soils is moderately well supplied with organic matter and nitrogen. Nitrogen is released slowly, however, and most crops respond to nitrogen fertilizer, especially in spring. In most areas the plowed layer has a capacity to absorb bases equal to the amount supplied by 10 to 15 tons of ground limestone per acre. In some places these soils are nearly neutral and need no lime. In others they are medium acid and need as much as 4 tons of ground limestone per acre to raise the pH to a value near 7.0. If the surface soil has been limed previously to pH 6.0, the requirement is 2 to 3 tons of ground limestone. The reserve supply of potassium is very high, though quickly available potassium is limiting in some places. Shallow-rooted crops, especially, may respond to potassium fertilization. The phosphorus-supplying power is only medium.

Rhinebeck soils are among the more fertile soils of the county, but wetness, erodibility, and problems of tilth are important limitations.

Rhinebeck silt loam, 0 to 2 percent slopes (RkA).—This soil represents the wetter half of the drainage range for the series. It is nearly level and has slow runoff. It receives little water from adjacent land. Its surface soil is the darkest colored and the highest in organic-matter content of any of the Rhinebeck soils. The subsoil is the most highly mottled.

This soil is associated with more strongly sloping Rhinebeck soils, with the moderately well drained Hudson soils, and with the poorly drained Madalin soils. Some areas are moderately large. Slight depressions or flat places where water accumulates and where the surface soil is very dark colored are noticeable in plowed fields. These spots are inclusions of Madalin soils. Though these included soils commonly occupy less than 5 percent of the delineated areas, they are important in the timing of field operations in spring.

This Rhinebeck soil is suited to crops, pasture, or forest, but its suitability for crops is restricted by wetness and by its fine texture. It is not well suited to most vegetable crops. Water-tolerant varieties of legumes may be grown for hay or pasture. Corn and small grains are grown successfully, but wetness limits yields in some years. Some areas are suitable sites for ponds. Some areas are used for housing, but they present important water problems. The instability of the material should be considered if this soil is used for some kinds of construction.

Wetness is the most important limitation. Tile must be closely spaced to be effective. Some fields can be improved by tile draining only the wettest inclusions. Some fields can be improved by appropriate surface drains or by diversion of water. Bedding has been used on some areas. Erosion is not a problem. Nitrogen fertilization is important for good yields, and phosphorus is required. Though the reserve supply of potassium is very high in the subsoil, shallow-rooted crops, especially, may respond to potassium fertilization. (Capability unit IIIw–3; woodland suitability group 11a)

Rhinebeck silt loam, 2 to 6 percent slopes (RkB).—This soil is in the middle half of the wetness range for the series. It generally receives some runoff from adjacent land, but its slope is uniform and has enough gradient that some water is removed as runoff. The thin leached layer described for the series has been mixed with the plowed layer in most places. Thin remnants of it may be found in spots within fields.

This soil is associated with other Rhinebeck soils; with Hudson soils, which occupy convex knolls and dissected landforms; and with the dark-colored Madalin soils, which occupy slight depressions. The poorly drained Madalin soils also commonly occur as strips in long, narrow depressions, in which water runs during rains. These strips are too small to be mapped separately, but they are important because they determine the timing of field operations in spring. Also included are moderately eroded spots, which total about 150 acres, where the surface soil is predominantly silty clay loam. Similar spots may be found on small knolls in some other areas.

This soil is suited to crops, pasture, or forest. Its wetness and fine texture limit its suitability for intensively cultivated crops, such as vegetables. Corn, small grains, and hay are commonly grown. Wetness and instability of the soil material also limit its suitability for many nonagricultural purposes. Some areas contain suitable sites for ponds.

Wetness is the most important limitation, and drainage is difficult to establish. Surface structures, such as open ditches and diversion terraces, are effective in some areas. Wet spots may be improved by tiling. Systematic tile drainage is expensive because close spacing is required in these slowly permeable areas.

This soil is erodible, and there is a slight risk of erosion, even on gentle slopes. Consequently, contour or cross-slope tillage and contour strips are suitable practices for some fields. Like other Rhinebeck soils, this soil particularly needs applications of nitrogen and phosphorus. Some crops may respond to potassium fertilizer. A few areas need lime. (Capability unit IIIw–4; woodland suitability group 11a)

Rhinebeck silty clay loam, 6 to 12 percent slopes, eroded (RnC3).—This soil is fine textured, sloping, and somewhat poorly drained. Much of its original surface soil has been removed by erosion. The uneroded soil represents the better drained half of the drainage range for the series. Runoff from the moderate slopes contributes to the relative dryness of the areas, as compared with other Rhinebeck soils. The runoff also caused erosion, but the amount of soil removed has not been uniform. On as much as 75 percent of most areas, enough material has been removed that the plow has mixed the remaining surface soil with part of the more clayey subsoil. As a result, the plowed layer is finer textured, lower in organic-matter content, and more difficult to cultivate than the one less affected by erosion. Little erosion has ocurred on the more gently sloping parts of these same areas. In some places material eroded from adjacent parts has been deposited on the surface.

This soil commonly lies below and adjacent to the better drained Hudson soils, from which it receives runoff. It also receives water from Rhinebeck soils in higher positions. Slopes are mainly uniform or slightly convex. Small drainways in which water is concentrated during rains are present in many areas and control the timing of work in spring.

This soil is suited to crops, if some restriction is placed on the cropping system. It is also suited to pasture and forest. Moderate wetness is a limitation for many nonagricultural uses. Instability of the soil material should be considered for many kinds of construction.

If this soil is used for crops, it is advisable to maintain sod-forming crops as much of the time as feasible. The soil should be plowed in strips across the slope in such a way as to leave buffer strips of sod to control erosion. Drainways should be maintained in permanent sod. Structures to divert water from adjacent higher land are helpful in some areas. Tile drains that remove water from wet spots can improve many of the areas. The need for nitrogen and phosphorus is outstanding. Nitrogen is especially important because much of the reserve supply has been lost. Though the potassium reserve is very high, quickly available forms may be limiting for some crops. This soil is generally less acid than the uneroded Rhinebeck soils, but in places it needs moderate amounts of lime. (Capability unit IVe–6; woodland suitability group 11b)

Rock Outcrop (Ro)

This miscellaneous land type consists of rock ledges, many of which have vertical walls, and gorges in bedrock of various kinds. The mapped areas also include steep slopes of unweathered bedrock that have little or no soil material and support very poor vegetation. These areas are mainly suited to wildlife and recreation. (Capability unit VIIIs-1; woodland suitability group 16)

Sloan Series

The Sloan series consists of deep, very poorly drained, medium to moderately fine textured soils in recent alluvium that is neutral or calcareous. These soils typically have a surface soil of mucky silt loam over a gray, strongly reduced subsoil. They occupy low-lying bottom lands or slackwater areas on flood plains and are closely associated with the poorly drained Wayland soils. Some are in the abandoned meanders of streams. These soils are in the region of high-lime soils on the uplands and terraces. The well drained and moderately well drained Genesee and Eel soils occupy nearby areas on first bottoms.

Sloan soils have three principal parts in places that have been pastured: (1) a surface soil of nearly black mucky silt loam; (2) a subsoil of gray silt loam that is unmottled in the upper part but highly mottled in the lower part; and (3) layers of gray sand, silt, and gravel.

The nearly black color of the surface soil results from high organic-matter content (10 to 20 percent in most pastured areas). In forested areas the topmost 3 to 6 inches is muck. Roots of trees growing on these areas are ordinarily in this layer. The surface soil ranges in thickness from as little as 8 inches to as much as 18 inches where it has not received deposits of eroded material from adjacent land.

The upper part of the subsoil is gray and is nearly free of mottles in most places. The lower part has many mottles on a gray matrix. The texture is generally silt loam, but in some places it is silty clay loam. In places the subsoil contains layers of silty clay loam, and in areas associated with lacustrine sediments, it contains layers of silty clay. It extends to a depth of 30 to 48 inches. The reaction is neutral.

The substratum consists of layers of sand, silt, and gravel, the proportions of which vary widely within the same area. The substratum is almost permanently saturated with water, is light gray in color, and in many places has few mottles. It is neutral in the uppermost part. It is calcareous below 36 inches in most areas.

Sloan soils are saturated from the surface downward during most of April and May. The water table recedes periodically as the season progresses, but it rises to the surface after each major rain. It may recede quickly after a rain during very dry periods of midsummer or it may stand at or near the surface most of the time during wet seasons.

Because of the high organic-matter content, the capacity of the surface soil to absorb bases is very high, an amount equal to that supplied by 14 to 20 tons of ground limestone in the topmost 8 inches of an acre. In most places this capacity is 70 to 80 percent filled. The supply of potassium is high, and the supply of phosphorus is medium. The supply of total nitrogen is high, but the nitrogen is very slowly available. Wetness is a major limiting factor.

Sloan soils in Tompkins County were mapped only in an undifferentiated unit with Wayland soils.

Tioga Series

The Tioga series consists of deep, well-drained, medium-textured soils. These are young soils that are just beginning to develop in recent alluvium on first bottoms. They resemble Genesee soils, but they are strongly acid throughout.

Tioga soils occupy the best-drained positions on the first bottoms in the southern part of the county where the soils on the uplands are strongly acid. They are associated with the moderately well drained Middlebury soils, the poorly drained Holly soils, and the very poorly drained Papakating soils. The total acreage is small in Tompkins County. Most areas are intermingled with areas of Middlebury soils.

Tioga soils have three principal parts: (1) a surface soil of grayish-brown to dark grayish-brown silt loam; (2) a subsoil of pale-brown or brown silt loam that is free of mottles; and (3) a substratum that consists of layers of grayish-brown to light brownish-gray silt loam, loam, gravel, and sand.

The plowed layer is 6 to 10 inches thick in most fields. Its dark or very dark color is associated with 4 to 6 percent organic-matter content. The material is porous, is easily penetrated by roots, and is permeable to air and water. If unlimed, it is strongly acid.

The lack of mottles in the subsoil indicates that this layer is not saturated for long periods. It is permeable material that is easily penetrated by roots and has good water-holding capacity. It is strongly acid but has medium capacity to supply potassium and phosphorus. This layer extends to a depth of 24 to 36 inches.

The substratum consists of layers of silt loam, gravel, sand, and loam that vary from place to place in proportion and arrangement. This material is commonly strongly acid, but acidity decreases with depth.

The surface soil is mainly silt loam, but in some areas it is gravelly loam. The subsoil in some areas contains layers of gravelly material, and in some of the highest positions it is slightly browner than in areas that are flooded frequently. Though reaction is mainly strongly acid, it is only medium acid in the subsoil where Tioga soils intergrade to Genesee soils.

Although most of these soils are subject to flooding very early in spring, free water is present in the topmost 2 feet for only short periods after rains during April and May. From 3 to 5 consecutive drying days are needed during April before the soil can be plowed. During May, 2 or 3 consecutive drying days will permit cultivation, and during June, 1 or 2 drying days are adequate.

Deep-rooted plants can use the topmost 40 inches in these very porous soils. This volume of soil holds between 6 and 8 inches of water that plants can use. Consequently, Tioga soils are among those that supply the greatest amounts of water during dry periods. Though moisture deficiency is sometimes apparent, the frequency of extreme damage to crops is much less than on most other soils of the county. The ability to supply moisture is only moderate in areas that contain large amounts of gravel.

Tioga soils are strongly acid. The surface soil can absorb bases in an amount equal to that supplied by 8 to 12 tons of ground limestone per acre. If unlimed, its capacity is commonly only 30 percent filled. An unlimed surface soil needs 3 to 6 tons of ground limestone per acre to raise the pH to a value near 7.0. If the soils have been limed previously to pH 6.0, the requirement is 2 to 3 tons of ground limestone per acre. Tioga soils have a moderately large supply of total nitrogen, but they release it slowly enough that most crops respond markedly to nitrogen fertilization. They have medium capacity to supply potassium and phosphorus. They are among the most productive soils of the county for a wide variety of crops.

Tioga soils in Tompkins County were mapped only in an undifferentiated unit with Middlebury soils.

Tuller Series

The Tuller series consists of poorly drained to somewhat poorly drained loamy soils that are only moderately deep to bedrock. These soils, like the well-drained Lordstown soils, formed in channery or flaggy loamy material. This material appears to be crushed and broken rock that has been moved very short distances. The depth to bedrock is typically less than 24 inches, but it may be more than 30 inches locally.

Tuller soils typically occupy nearly level to gently sloping hilltops in the southern part of the county. They lie at higher elevations than do Lordstown soils, which occupy the steep slopes of valley sides. They are closely associated with Mardin, Volusia, and Chippewa soils on the hilltops.

Cultivated Tuller soils have three principal parts: (1) a plowed layer of dark grayish-brown channery or flaggy silt loam; (2) a subsoil of grayish-brown, strongly mottled channery heavy silt loam; and (3) a 2- to 3-inch layer of weathered rock material immediately over hard rock.

The plowed layer is loamy, porous, and strongly or very strongly acid. It is filled with flat stone fragments, which interfere seriously with tillage in some places. This layer typically is 4 to 7 percent organic matter and is correspondingly high in total nitrogen. It is strongly or very strongly acid and has medium phosphorus- and potassium-supplying powers.

The subsoil is grayish-brown channery silt loam strongly mottled with yellowish brown and gray. The grayish colors and strong mottling show that it is wet for extended periods but is dry at some seasons of the year. This layer is strongly or very strongly acid in most places. It is suited physically to root development if it is not saturated.

In most places there is a 2- to 3-inch layer of weathered shale or firm, grayish-brown material among the mass of broken rock fragments immediately above the hard-rock surface. This layer is typically encountered at a depth between 20 and 24 inches. Where bedrock is no more than 14 inches below the surface, the firm layer is very thin.

The depth to bedrock ranges from as little as 14 to as much as 24 inches. The range in wetness includes the wetter half of the somewhat poor drainage class and most of the poor drainage class.

From the time frost leaves the ground until May, free water stands within 15 inches of the surface most of the time. During May, these soils may be saturated within 6 inches of the surface after a soaking rain but may not have free water above the bedrock surface after extended periods without rain. The soils can rarely be plowed during April, when 6 to 10 consecutive drying days are needed before the soil will bear machinery. During May, 4 to 8 drying days will permit tillage in most areas. During midsummer, these soils may become very dry. They can hold 2 to 5 inches of water, depending largely upon the depth to bedrock. Crops show moisture stress after 8 to 12 rainless days at this time of year.

Tuller soils are typically strongly or very strongly acid. The subsoil, however, may be medium or slightly acid in some areas adjacent to Erie soils. The surface soil can absorb bases in an amount equal to that supplied by 8 to 12 tons of ground limestone per acre. On an unlimed soil from 4 to 8 tons of ground limestone per acre typically is needed to raise the pH to a value near 7.0. From 1½ to 3 tons are needed to raise the pH from 6.0 to 7.0. Though the surface soil is moderately high in total nitrogen, nitrogen is released very slowly. Available phosphorus is medium. The potassium-supplying power is medium.

Wetness early in the season, droughtiness in summer, shallowness to bedrock, and relatively low fertility limit the suitability of this soil. The deepest areas have been mapped as Tuller channery silt loam, 0 to 6 percent slopes; those less than 18 inches over bedrock are mapped with Lordstown and Ovid soils in an undifferentiated unit.

Tuller channery silt loam, 0 to 6 percent slopes (TeA).—This is the deepest soil of the Tuller series. It is ordinarily between 18 and 24 inches thick, but in places it is as thick as 30 inches. Where the depth to bedrock exceeds 24 inches, a thin fragipan is present and the soil intergrades to a moderately deep Volusia or Chippewa soil.

The surface is nearly level or gently sloping and has few irregularities. Slight depressions are significantly wetter than adjacent parts, however, and the range of wetness within single areas may include more than one drainage class. Included in the mapped areas are spots less than 18 inches thick over bedrock and small areas of deeper Volusia and Chippewa soils. This soil is mainly channery or flaggy, but some spots have few fragments on the surface. These spots are more clayey than is typical of Tuller soils and resemble Allis soils, which were not mapped in Tompkins County.

In Tompkins County this soil is mainly idle or in forest; a small acreage is pastured. Its capabilities for pasture or cropland are limited. It is not well suited to intertilled crops or small grains, but it is moderately productive of hay. Both wetness and shallowness are limitations for most nonagricultural uses.

This soil requires liberal liming and fertilization with phosphate and potash for even moderate yields of hay or pasture crops. Improvement of drainage is very difficult because of shallowness to bedrock; only the simplest forms of surface drainage are feasible on most areas. If these soils are reforested, species tolerant of wetness should be selected. (Capability unit IVw-4; woodland suitability group 15)

Valois Series

The Valois series consists of deep, well-drained, medium-textured soils formed in low-lime glacial till. A weakly developed fragipan occurs at a depth of 2 to 3 feet. The soil over the pan is strongly acid; the fragipan is slightly acid or neutral.

Valois soils occupy steep lower valley slopes in close association with Bath soils. They also occupy rounded knolls in valleys and are closely associated with the porous, rapidly permeable Howard soils in gravel deposits. The moderately well drained Langford soils occupy adjacent areas that have less runoff. The somewhat poorly drained Erie soils are on associated long, uniform gentle slopes that receive runoff from adjacent land. The poorly drained Ellery soils and the very poorly drained Alden soils occur in level areas and in depressions. Valois soils are a minor part of most of these landscapes, but they are dominant in some fields.

Cultivated Valois soils have four distinct parts: (1) a plowed layer of dark grayish-brown gravelly silt loam; (2) a thick subsoil of yellowish-brown gravelly silt loam, free of mottles; (3) a slightly firm to firm fragipan of dark grayish-brown gravelly silt loam that is moderately to slowly permeable; and (4) a firm to slightly firm substratum of dark grayish-brown, weakly calcareous, gravelly loam glacial till.

Valois soils differ from the assoicated Bath soils in that they have a thicker permeable layer over a weak fragipan, as compared with the strong pan of Bath soils. Langford soils have a thinner permeable layer that is mottled in the lower part and rests on a strong fragipan. The yellowish-brown subsoil of Valois soils contrasts sharply with the grayish-brown, mottled subsoil of Erie and Ellery soils.

The plowed layer contains small stones and gravel, which are troublesome but do not prohibit tillage. The organic-matter content is moderately high (3 to 6 percent in most areas) and contributes to the dark color and good structure of the loamy material. Consequently, this layer is porous and friable if it has not been eroded or subjected to intensive cropping. It is strongly or very strongly acid and has only a medium supply of mineral nutrients but is physically good for root development.

The yellowish-brown subsoil in uneroded areas extends to a depth of 24 to 30 inches. It is soft, porous gravelly silt loam and is much lower in organic-matter content than is the plowed layer. Although it is strongly or very strongly acid, it is physically an excellent medium for root development.

The fragipan is slightly firm to firm gravelly silt loam and extends to a depth between 3½ and 5 feet. It has vertical cracks 6 to 18 inches apart which are filled with pale-brown silty material. Water moves laterally in these cracks when the soil is very wet. The upper part of the pan is only medium or slightly acid; the lower part is nearly neutral. Deep-rooted plants derive some nutrients and water from the fragipan, but the amounts are small for most crops.

The glacial till below the fragipan is neutral or weakly calcareous. Roots ordinarily cannot reach it. The texture ranges from fairly dense to loose very gravelly loam or silt loam. Gravelly and sandy lenses are common where Valois soils are closely associated with Howard soils in the valleys.

Free water stands above the fragipan, mainly below 20 inches, when frost first leaves the ground in spring. Generally, the soil can be plowed after 3 or 4 consecutive drying days during April and the early part of May. After the middle of May, free water stands above the fragipan for only short periods after rains, and 2 or 3 consecutive drying days are enough to permit tillage. From the early part of June, the soil can be tilled after 1 or 2 drying days.

Rooting generally occurs within a depth of 2 to 3 feet. This volume of soil holds between 4 and 6 inches of water available to plants. Plant growth is reduced when 3 to 4 inches of this amount has been used.

Valois soils do not supply large amounts of available plant nutrients, but crops on them respond well to fertilizers and lime. The total nitrogen content is moderately high. In spring, however, the soil is too cold to release an adequate amount of nitrogen. In midsummer, it releases moderately large amounts but the demands of plants are also very high. Consequently, crops generally respond to nitrogen fertilization if other conditions are favorable. Phosphorus is available in only medium amounts, too small for good yields; it is most deficient if the soils have not been limed. The potassium-supplying power is medium; enough potassium may be available to satisfy plant needs for short periods, but the reserve supply, which is mainly in the clay minerals, is only medium. Consequently, crops soon use the easily available supply and potassium fertilization is needed.

For the most part, the lack of lime is the greatest single deficiency on Valois soils. The plowed layer has a cation-exchange capacity equal to the amount supplied by 8 to 12 tons of ground limestone per acre. If unlimed, the plowed layer has only 20 to 30 percent of this capacity filled, and 4 to 8 tons of ground limestone per acre are needed to raise the pH to a value near 7.0. If the soils have been previously limed to pH 6.0, the requirement is 1½ to 3 tons of ground limestone. Even soils limed to pH 7.0 need maintenance applications every 4 or 5 years.

Valois soils in Tompkins County were mapped in undifferentiated units with Bath and Lansing soils, and in a complex with Howard soils.

Volusia Series

The Volusia series consists of deep, strongly acid, somewhat poorly drained, medium-textured soils that have formed in firm, slightly acid to medium acid glacial till. A fragipan at a depth of 10 to 15 inches prevents penetration of water and roots. Wetness is an outstanding problem; strong acidity is a major limitation.

Volusia soils occupy nearly level to moderately steep, uniform slopes on the uplands in the southern half of the county. Because of their position, they either have slow runoff or receive runoff from adjacent higher land. They commonly occupy large areas and are the dominant soils in a large proportion of the fields in the southern part of the county. They are associated with the well-drained Bath soils and the moderately well drained Mardin soils, which produce runoff, and with the poorly drained Chippewa soils and the very poorly drained Alden soils, on which water accumulates. Volusia soils occupy landforms comparable to those occupied by Erie soils but are generally at a higher elevation.

Volusia soils have four principal parts: (1) A plowed layer of dark grayish-brown channery silt loam; (2) a thin subsoil of channery silt loam that is very highly mottled; (3) a thick, dense fragipan of channery silt loam; and (4) the underlying firm, channery silt loam glacial till.

The plowed layer contains many small, flat stones that are troublesome in tillage and in some harvesting operations. The moderately dark color indicates a moderately high organic-matter content (mainly 4 to 7 percent).

The total nitrogen content is correspondingly high. This layer is porous and is permeable to water. It is physically a good medium for root development. It is strongly or very strongly acid if unlimed.

The layer between the plowed layer and the fragipan is light olive-brown and dark grayish-brown channery loam or silt loam highly mottled with yellowish-brown. In uneroded soils, this layer is 4 to 6 inches thick. The yellowish-brown iron stains are caused by alternate wetness and dryness. Water stands above the fragipan after each soaking rain. The soil material is moderately porous. It is permeable to water, and roots can develop in it when water does not exclude air. It is strongly or very strongly acid and can supply only moderate amounts of plant nutrients.

The top of the fragipan is 10 to 15 inches below the surface in uneroded areas. In eroded areas the plowed layer commonly rests directly on the fragipan. Very narrow cracks filled with gray silty material divide the pan into sections 6 to 18 inches across. Roots may extend into the cracks, but they commonly die after a long period of wetness. Very few roots penetrate the dense sections between cracks. The pan effectively stops downward movement of water. In sloping areas water seeps downslope through the permeable layers above the fragipan. The fragipan is strongly or very strongly acid. It extends to a depth of 4 to 5 feet.

The underlying glacial till is as dense as the fragipan. The pH commonly increases with depth within the till. The till is calcareous in some places at a depth ranging from 5 to as much as 15 feet.

The driest areas of Volusia soils merge with areas of Mardin soils. In these places the depth to the fragipan is typically about 15 inches and the material immediately below the plowed layer may be slightly yellowish in color. In nearly level areas Volusia soils intergrade to the poorly drained Chippewa soils. In these areas the fragipan is commonly 10 inches below the surface, the surface soil is very dark grayish brown, and the layer between the plowed layer and the fragipan is grayish in color and is very strongly mottled.

The amount of lime in the till increases slightly from the hilltops to the valleys and from south to north. As it increases, Volusia soils intergrade to Erie soils, and pH in the fragipan increases with depth. Tuller soils occur in the same general region but in places where bedrock lies within 24 inches of the surface. In Volusia soils, the depth to bedrock is at least 24 inches, and in most areas it is at least 6 feet. Some areas have more than 20 feet of till above the rock.

When frost leaves the ground in spring, Volusia soils are typically saturated to within a very few inches of the surface. During a 2-year study of Volusia soils, the water table was within 5 inches of the surface 73 percent of the time from the middle of March to the middle of April, and within 10 inches of the surface 98 percent of this period. Generally, the water table fluctuates between the surface and the top of the fragipan until the end of April. By the middle of May, it is within 10 inches of the surface only after rains, but the soil just above the fragipan is saturated most of the time. Data for the period from the middle of May until the end of June show no water above the fragipan 60 percent of the time but water within 5 inches of the surface 16 percent of the time. These soils can rarely be plowed during April, for 6 to 8 consecutive drying days are required, and such periods are rare. From 4 to 7 days of drying weather are required before cultivation in May. During June, 2 to 4 consecutive drying days normally permit tillage.

Though wetness is an outstanding limitation in spring, drought can be a major factor during dry periods of midsummer. Roots can draw water from only 12 to 16 inches of soil in most places. This volume of soil holds between 2½ and 4 inches of water available for plants. Water commonly saturates the layer above the fragipan for several days after a heavy rain.

Strong acidity is the outstanding chemical limitation. If uneroded, the surface layer can absorb bases in an amount equal to that supplied by 9 to 13 tons of ground limestone per acre. If unlimed, it commonly contains less than 20 percent of this amount, and 5 to 9 tons of ground limestone is needed to raise the pH to a value near 7.0. If the plowed layer has been limed to pH 6.0, the requirement is 2 to 4 tons of ground limestone.

The total nitrogen supply is moderately high, but nitrogen, in forms that plants can use, is released very slowly. Nitrogen fertilizer is essential for even moderate yields of crops. The phosphorus-supplying power is medium; it is inadequate for even moderate yields of crops. This deficiency is greatest in unlimed soils. The potassium-supplying power is only medium, and this is inadequate for good yields of most crops. The quickly available reserve of potassium may be adequate for young plants or for rapidly growing plants for short periods. But potassium is held mainly in the clay fraction of a soil, and Volusia soils are generally less than 25 percent clay. Consequently, the supply of quickly available potassium is not replenished rapidly enough to sustain a good rate of growth.

Volusia channery silt loam, 3 to 8 percent slopes (VbB).—This soil is typical of the middle half of the drainage range for the series. The depth to the fragipan is about 12 inches (fig. 22). The highly mottled layer between the plowed layer and the fragipan is 3 to 5 inches thick.

This soil slopes mainly in one direction. The slope is strong enough that runoff is a significant factor. In some areas the slope is so nearly uniform that runoff moves across the entire area. Most areas, however, have slight undulations, and water moving on the surface is diverted around slight rises, some only a foot high. The soil on the rises is typical of the drier half of the drainage range for the series, and spots of the moderately well drained Mardin soils may be included. The soil between the rises controls use. In these places there commonly are small spots of nearly level soils typical of the wettest part of the drainage range for the Volusia series or of the driest part of the range for the Chippewa series. In some places these wet soils occur on long, very narrow strips on which water concentrates as it moves off the area.

Entire fields may consist of this soil. In many areas this soil is adjacent to Mardin soils and receives runoff from them. In some places it is on gentle slopes at the foot of steep or moderately steep hillsides dominated by Lordstown soils. Runoff concentrates on these areas, and additional water from higher land accumulates. On hilltops this soil intergrades to moderately deep Tuller soils. Commonly included in the areas mapped are small areas in

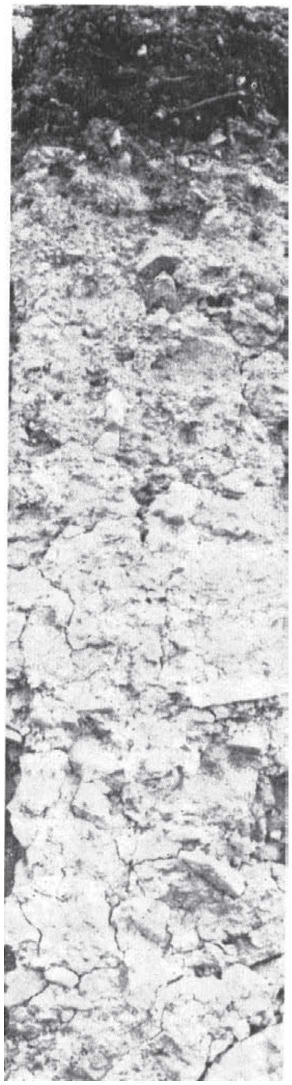

Figure 22.—**Profile of Volusia channery silt loam.**

which bedrock lies 3 to 4 feet below the surface. Also included are some areas on the hilltops where the soils are rich in shale and resemble the more clayey Hornell or Allis soils, neither of which was mapped in this county.

This soil is used for crops, including corn, small grain, and hay. Wetness limits its suitability for crops that are planted early in spring. For the most part, it is best suited to sod-forming crops and pasture. It is also suited to forest, though wetness limits its suitability for some species. Red pine, for example, does very poorly. Some areas can be used as sites for housing, but special devices to remove water are necessary. Suitability for use as sewage-disposal fields is severely limited.

Control of excess water is a major management need. Many areas can be improved by diverting runoff from adjacent higher land. Some areas can be improved by opening shallow drainways from the lowest spots. In some places tile can be used effectively to drain wet spots that limit the use of an area, but systematic tiling of an entire area is commonly not feasible, because tile would have to be very close together to give uniform drainage. Simple structures that help remove water can be highly beneficial. The slopes are steep enough, however, that erosion can become a problem if such structures are built up and down the slope.

As is typical of other Volusia soils, strong acidity and moderate nutrient-supplying capacity are major limitations. For the crops commonly grown, adequate liming is the first need. Applications of nitrogen, phosphorus, and potassium are necessary for even moderate yields, but if the soil is not limed, these fertilizers are ineffective for most crops. (Capability unit IIIw–6; woodland suitability group 9a)

Volusia channery silt loam, 3 to 8 percent slopes, eroded (VbB3).—This is a gently sloping to undulating soil from which a significant part of the original surface soil has been removed by erosion. It is typical of the central half of the drainage range for the series. Erosion has affected from one-half to three-fourths of each area. The uneroded portion has the features described for soils under "Volusia Series." The eroded portion has lost enough soil that the plowed layer rests directly on the fragipan. In some places the topmost few inches of the fragipan has been incorporated in the plowed layer. The plowed layer of the eroded parts is lighter colored than that of the uneroded part. The organic-matter content and the total nitrogen content are lower. Roots are confined mainly to the plowed layer, and the available reserve of moisture to support plants during dry periods is only about 1½ or 2 inches.

Most areas of this soil occur where the surface is distinctly undulating and where slopes are near the upper limit of the slope range. The eroded parts are mainly the most strongly sloping. The more gently sloping 25 to 50 percent of most areas either is uneroded or has accumulated material from the eroded part. Some fields are partly eroded and partly uneroded. Some of the most strongly sloping parts are inclusions of eroded Mardin soils. Also included in the areas mapped are small, flat areas and long, very narrow strips along drainways. The soils of these areas are typical of the wettest soils of the Volusia series or the driest soils of the Chippewa series. They commonly have 4 to 10 inches of eroded material from adjacent areas deposited on the original surface.

This soil commonly occurs as small areas within areas of less strongly undulating Volusia soils. Some areas, however, dominate entire fields. Some occur at the foot of steeper slopes of Lordstown or Mardin soils. In these the erosion may be most severe in channels where runoff from adjacent land has concentrated. Large flat stones are common in these channels. This soil generally is more channery than the uneroded Volusia soil on similar slopes.

This soil is suitable for crops, but its management needs are complex. It is also suitable for pasture and forest. It has special limitations for some crops because it is shallow over the fragipan. Water-control problems limit its suitability for most nonagricultural purposes.

Though wetness is a major limiting factor, erosion is important. Structures to divert water that flows onto this soil from adjacent land help to reduce wetness and to control erosion. Drainage of low spots permits plowing and planting much earlier in spring than is otherwise possible. Tillage should be across the slope to reduce the risk of erosion; stripcropping of long slopes is desirable.

Cultivation strictly on the contour, however, may result in an increase in wetness, because water may be held in furrows during wet periods. Waterways that carry large volumes of runoff should be kept in permanent sod.

Fertility has been reduced by erosion. The nitrogen content is moderately low. Neither the phosphorus-supplying capacity nor the potassium-supplying capacity is adequate for good yields. The lime requirement is almost as high as that of the uneroded soil. Even if lime and fertilizer are applied, yields are noticeably lower than yields from the uneroded soil. Midsummer drought limits yields in many years. (Capability unit IVe-11; woodland suitability group 9b)

Volusia channery silt loam, 8 to 15 percent slopes (VbC).—This somewhat poorly drained soil is steep enough that farm machinery can be used only with some difficulty. It is representative of the drier two-thirds of the drainage range for the series. Runoff is moderately rapid. Large amounts of water are received as runoff and seepage from adjacent higher land.

This soil commonly occurs on foot slopes on the uplands. It is adjacent to higher lying Lordstown or Mardin soils and lower lying Volusia soils of lesser slope. Included in the areas mapped are spots of Chippewa or Alden soils, too small to be mapped separately, where seepage water comes to the surface. Areas at the base of the steeper slopes commonly consist of a series of shallow watercourses and intervening higher areas. Water concentrates in the watercourses. Most of the soils on the intervening strips are within the drainage range for the Volusia series, but small areas of Mardin soils may be found on the most strongly sloping parts. Most of these areas remain wet from seepage water for significant periods after rains. Seepage affects especially the watercourses and the small seep spots that are common in the watercourses. Areas on hilltops, adjacent to Mardin soils, are commonly drier than the areas at the base of long slopes.

This soil can be used for crops, pasture, or forest. Wetness limits the choice of crops but less than on gently sloping Volusia soils. The seepage spots in smaller water channels interfere with cultivation. Severe problems of water control limit the use of this soil as building sites, but the slope is strong enough to provide some possibility of removing excess water by gravity.

Diversion of the water that runs onto this soil is important, both to control wetness and to reduce the erosion hazard. Although erosion has not been general, many areas have had some erosion in watercourses where small channels have been cut to the fragipan. These channels are covered with flat stones left when fine material was washed away. They are obliterated each time the soil is plowed. Draining seep spots and low places where runoff concentrates can greatly improve the productive capacity of an entire field, for in many fields these wet spots, though small in total area, control the timing of planting and consequently control yields. If intertilled crops are to be grown frequently, cross-slope cultivation and stripcropping are advisable. Furrows should have a slight gradient, however, to prevent the accumulation of water during wet periods.

This soil is normally very strongly acid, and adequate liming is among the most important practices. The supply of nitrogen is deficient in spring. The availability of nitrogen in midsummer depends upon the wetness of the season. The supply of phosphorus is uniformly deficient, and the supply of potassium is inadequate for good yields. By careful choice of crops and good management, nevertheless, this soil can be made moderately productive. (Capability unit IIIe-11; woodland suitability group 9a)

Volusia channery silt loam, 8 to 15 percent slopes, eroded (VbC3).—Between 60 and 90 percent of each area of this soil has lost through erosion part or all of the original plowed layer. The plowed layer in the eroded parts now rests directly on the fragipan and is lighter colored and lower in organic-matter content than that in the uneroded parts. Most of this soil is in the drier two-thirds of the drainage range for the series. The slopes are steep enough to make the use of farm machinery somewhat difficult.

This soil most commonly occurs downslope from more strongly sloping Lordstown or Mardin soils, from which it receives water both as surface runoff and seepage. It typically slopes in one direction. Runoff follows shallow depressions down the slope. These depressions are the wettest parts of this soil. The areas between the depressions are distinctly rolling. They consist partly of inclusions of Mardin soils. Seepage spots and small areas of Chippewa or Alden soils occur in the places where water concentrates. The eroded parts include both steep eroded areas between the watercourses and narrow channels in the watercourses that have been cut to the fragipan. These shallow channels show as long, narrow strips covered with flat stones that were left when fine material was washed away. They are obliterated each time the soil is plowed.

Wetness in spring, dryness in midsummer, and susceptibility to further erosion limit the use of this soil. Hay and pasture crops can be grown successfully, but growing intertilled crops is inadvisable, because of the hazard of continued erosion. Limited productivity makes questionable the practicality of large inputs of management and labor. Forest is a suitable use. Serious water problems limit suitability for use as building sites, but in some places the slope makes possible the removal of water by gravity.

Many areas can be improved by diversion of water that drains from adjacent higher land. Drainage of seep spots and wet places in watercourses makes it possible to use machinery during wet periods. Plowing should be across the slope, but at a slight grade so that furrows will not hold excess water. Strips of sod should be left to help control erosion.

This soil needs large amounts of lime, for it is very strongly acid. Its ability to supply nitrogen has been reduced greatly by erosion. It has only medium phosphorus- and potassium-supplying powers. Its productivity is not high under the best of management, but it can be cropped successfully. Yields are severely limited during very dry periods because the available moisture reserve is mainly in the plowed layer and is generally only 1½ to 2 inches of water. (Capability unit IVe-10; woodland suitability group 9b)

Volusia-Chippewa channery silt loams, 0 to 3 percent slopes (VoA).—The Volusia soil in this complex is mainly in the wetter half of the drainage range for the series, and the Chippewa soil is mainly in the drier two-thirds of the drainage range for its series. The Volusia is the more extensive, but the poorly drained Chippewa, although it makes up only 10 to 30 percent of most areas, is the part that limits use and controls the timing of field operations.

The Volusia soil has perceptible slopes. Like other Volusia soils, it is very strongly acid and contains many flat stones. The plowed layer is darker colored and higher in organic-matter content than that in other Volusia soils. The subsoil is grayish brown and is very strongly mottled. The top of the fragipan is at a depth of 10 to 12 inches.

The Chippewa soil occurs as small to moderately large flat areas, small shallow depressions, and long narrow strips along intermittent watercourses. In forested areas the surface soil is nearly black and is only 4 to 6 inches thick. In most cultivated areas eroded material has accumulated, and the surface soil is very dark gray or almost black and is 10 to 15 inches thick. The friable layer between the plowed layer and the fragipan is thin and is slightly more gray than that of Volusia soils.

Lacking some provision for removal of surface water, these soils can be used mainly for hay or other water-tolerant crops. The Volusia soil could be used for other crops, though the limitations imposed by wetness are severe. The spots and strips of Chippewa soil are distributed in such a way that they prevent the use of machinery for several days after the Volusia soil is dry enough to be plowed. Consequently, planting is commonly delayed in spring to the extent that yields are affected seriously. These soils can be used successfully as pasture. Wetness seriously limits their suitability for some tree species, such as red pine, but they are suitable for some other kinds of forest trees. Severe problems of water control limit suitability for many nonagricultural uses. Many of the areas include sites suitable for ponds.

Wetness is the outstanding limitation. Regularly spaced tile drains are ineffective because water moves so slowly through the fragipan. Such systems require very close spacing of tile. Random drains through the strips and spots of Chippewa soils are beneficial, however. Diversions to intercept runoff from adjacent land are feasible. In some areas surface structures that provide shallow channels can improve the soils by removing surface water more quickly. If such devices are installed properly, these soils can be used for rotations that include corn and small grain, even though the hazards of wetness have not been completely eliminated. Some small areas are within fields dominated by better drained soils. In these places the high cost of tile drainage may be justified because it improves the entire field.

Though these soilse are higher in organic-matter content and in total nitrogen content than most Volusia soils, they release nitrogen even more slowly. In spring and early in summer, nitrogen is not released in amounts sufficient to meet the needs of plants. In midsummer, when the soil is warm and only moist, enough nitrogen may be released to sustain plants, but in a wet year the amount released may be inadequate, even at this season. As is typical of other Volusia and Chippewa soils, the need for lime is very high.

Unless large amounts of lime are applied, yields of even the most productive varieties of crops are poor. The phosphorus-supplying capacity is inadequate, particularly if the soils have not been limed. The potassium-supplying capacity is medium. It is adequate if other factors limit the growth of plants, but if lime, phosphorus, and nitrogen have been supplied, applications of potash are needed for even moderate crop yields. (Capability unit IVw-3; woodland suitability group 15)

Volusia and Erie soils, 15 to 25 percent slopes (VrD).—Any given area of this mapping unit may be either Volusia or Erie soils. Erie soils are described under "Erie Series." The slopes are steep enough that machinery can be used only with great difficulty. Because slope and wetness control their capability to a very high degree, the two kinds of soils were not differentiated on the soil map. Generally, areas adjacent to areas of Mardin, Volusia, and Chippewa soils consist of Volusia soils, and areas adjacent to areas of Langford, Erie, or Ellery soils consist of Erie soils. The areas on hilltops and on the highest parts of valley sides in the southern part of the county are mainly Volusia soils. Those in the valleys and in the central part of the county are mainly Erie soils.

Most areas of this mapping unit receive both runoff and seepage water from adjacent higher land. The slope is strong enough that runoff is rapid, but much more water than falls as rain must be disposed of. The soils of this unit are subject to serious erosion, and about 40 percent of the acreage has been eroded enough that the plowed layer rests directly on the fragipan.

Included are many small areas of Mardin and Langford soils, which are on the steepest parts of the slopes or in places where water is diverted to lower lying channels. Though these drier spots have greater potential for production than the rest of the unit, their use and management are controlled by the somewhat poor drainage of the other soils. Small spots of Ellery or Chippewa soils occur where seepage water comes to the surface, but such inclusions are much less common than in less strongly sloping units of Volusia or Erie soils. Eroded and uneroded soils may be intermingled within a single area.

This unit is used mainly for hay, pasture, or forest. Its moderately steep slopes make use of farm machinery very difficult; consequently, it is poorly suited to intertilled crops. It is not productive of hay or pasture unless it has been adequately limed and fertilized. Periodic plowing to reestablish the stands and to incorporate lime and fertilizer is a common means of maintaining productivity. Plowing should be across the slope, and strips of sod should be left to help control erosion. Tree species for reforesting must be selected carefully. (Capability unit IVe-9; woodland suitability group 9c)

Wayland Series

The Wayland series consists of deep, poorly drained, medium-textured soils that are forming in neutral or calcareous recent alluvium. These soils are the poorly drained associates of the moderately well drained Eel soils, the well drained Genesee soils, and the very poorly drained Sloan soils. They are neutral in most areas, but in places are slightly acid in the surface soil. They are prominently mottled below the plowed layer.

Wayland soils occupy low-lying positions on the first bottoms along major streams. They occur mainly in the northern part of the county in association with the high-lime soils on glacial till and outwash, but they also occur in the valleys in regions of Erie and Langford soils.

Wayland soils have three main parts: (1) a surface soil of dark grayish-brown silt loam; (2) a subsoil of grayish-brown and dark grayish-brown silt loam, loam, or fine sandy loam that has many distinct mottles, and (3) a substratum that consists of layers of dark grayish-brown silt loam, fine sandy loam, gravel, and sand.

The surface soil is 7 to 10 inches thick in most areas, though it is as much as 18 inches thick where recent alluvial material has been deposited. Its very dark color is associated with high organic-matter content (8 to 12 percent), which in turn is associated with high total nitrogen content. The fact that organic matter has accumulated shows that it decomposes slowly and releases nitrogen slowly. The surface soil is porous and permeable. It is a good medium for plant roots when it is not saturated. Ordinarily, it is nearly neutral, but in some areas it is slightly acid. It has medium capacity to supply phosphorus and high capacity to supply potassium.

The dominant gray colors and prominent mottling in the subsoil indicate alternate prolonged periods of wetness and periods of good aeration. The soil material is porous in most places and permits rooting when it is not saturated. In some places a dense, thin layer of silt restricts rooting. This layer is slightly acid or neutral, and acidity decreases with depth. It has medium capacity to supply phosphorus and high capacity to supply potassium. It extends to a depth that ranges from 12 to 18 inches, and to more than 36 inches in some places.

The layers of sand, silt, and gravel in the substratum are dominantly dark grayish brown and contain no mottles. The upper part is neutral in some places. Calcareous material ordinarily occurs below a depth of 30 inches. Few roots reach these layers.

The surface soil is stone free. Its texture is mainly silt loam, but in places it is fine sandy loam. The texture of the subsoil and substratum is more variable. Layers of sand and gravel are common in many areas and vary in proportion and thickness within short horizontal distances. Wayland soils are mainly slightly acid or neutral throughout the topmost 30 inches, but in some of the southernmost areas in Tompkins County, the surface soil is medium acid.

Most areas of Wayland soils are flooded early in spring. During April, free water is generally within 6 inches of the surface and reaches the surface during rainy periods. During May, free water is mainly within 12 inches of the surface and is at the surface for short periods. During these months, the soils rarely support farm machinery unless some form of artificial drainage has been established. During June and succeeding months, the soils dry periodically and bear machinery for longer and more frequent periods as the season progresses. Wetness limits the suitability of these soils for the crops commonly grown but permits growth of grass hay.

If the soils are undrained, the roots of most plants are confined to the topmost layer. The subsoil is permeable to roots if water is removed. Available moisture capacity has little meaning, for these soils contain free water at a relatively shallow depth a high proportion of the time.

The high organic-matter content of Wayland soils is associated with high total nitrogen content. Nitrogen is released very slowly, however, and nitrogen deficiency is common, especially in spring. The organic-matter content also is associated with a moderately high capacity of the surface soil to absorb bases, an amount equal to that supplied by 11 to 15 tons of ground limestone per acre. In most areas this capacity is 70 to 80 percent filled. An unlimed surface soil needs from none to as much as 3 tons of ground limestone per acre to raise the pH to a value near 7.0. If the surface soil has been limed previously to pH 6.0, the requirement is 2 to 3 tons of ground limestone. These soils have high capacity to supply potassium and medium capacity to supply phosphorus. Wetness and flooding are major limitations.

Wayland and Sloan silt loams (Ws).—These soils are so closely associated in Tompkins County and are so limited by wetness that they are included in a single mapping unit. Any single area may consist of Wayland soils, of Sloan soils, or of a mixture of the two. They are easily differentiated in the field, for Sloan soils have a mucky surface soil. Sloan soils are described under the heading "Sloan Series."

These soils occupy level areas and depressions on first bottoms. They are associated mainly with Genesee and Eel soils. If undrained, they are suited mainly to pasture or forest. Water-tolerant plants are predominant on both. Most areas are too wet for most nonagricultural uses.

Some areas can be improved by drainage and made suitable for cropping. For the most part, however, suitable outlets are not available. Areas that can be adequately drained have very high potential for intensive cropping. Such areas are rare. Commonly, some degree of drainage can be established by ditches, which permits the growth of some crops, mainly those that are water tolerant. Because these soils are in the lowest areas along streams, they are most subject to flooding during the growing season. Consequently, the flooding hazard is high if they are used for intensive production. (Capability unit IVw–5; woodland suitability group 14a)

Williamson Series

The Williamson series consists of deep, moderately well drained, silty soils that have a fragipan in the subsoil. These soils have formed in silty and very fine sandy lake deposits that are low in clay. Williamson soils are the silty equivalents of the sandy Arkport soils, and with increasing clay they intergrade to the more clayey Collamer soils. They are strongly to medium acid.

Williamson soils are within basins that were occupied by glacial lakes. They occupy landforms that dispose of water externally and for the most part receive little runoff from adjacent land. Some surface water must be lost, because the fragipan is very slowly permeable, and if all the surface water remained, the soils would be wet. Williamson soils join Collamer soils in many places. Their wet associates in Tompkins County are mainly Niagara and Canadaigua soils. Hudson and Rhinebeck soils occur in nearby areas.

Williamson soils have four principal parts: (1) a plowed layer of dark grayish-brown silt loam or very fine sandy loam; (2) an upper subsoil of brown to light yellowish-brown very fine sandy loam, the lower part of which is distinctly mottled; (3) a dense fragipan that is slowly permeable; and (4) layers of very fine sand and silt.

The plowed layer typically is 3 to 5 percent organic matter and is correspondingly moderately high in nitrogen. It is porous and is a good medium for root development. If unlimed, it is strongly acid. Its low clay content indicates a low potassium reserve. It has only a medium supply of available phosphorus. The depth of plowing ranges from 7 to 10 inches in most places.

The upper part of the subsoil is porous and permeable. Roots can penetrate it easily. The upper part is free of mottles, indicating good aeration most of the time, but mottles are distinct in the lower part where water is held above the fragipan for moderate periods in spring. This layer is strongly acid, has a low potassium reserve, and has medium phosphorus-supplying power. It extends to a depth of 16 to 24 inches.

The fragipan of these soils in Tompkins County is thinner and less firm than that of many Williamson soils elsewhere; it ordinarily extends to a depth between 26 and 30 inches, but in some places it extends to 40 inches. It is firm enough to restrict the movement of water and the penetration of roots. The texture is typically silt loam. The upper part is strongly acid, but acidity decreases with depth. This layer is low in potassium reserve and is medium in available phosphorus. It is very low in organic-matter content and nitrogen content.

The underlying lake deposit consists of alternate layers of silt and very fine sand and a few thin layers of clay. The upper part is medium acid, but acidity decreases with depth. Calcareous material is found at a depth that ranges from 42 to more than 60 inches. Few roots reach it.

The plowed layer is mainly very fine sandy loam, but in some places it is silt loam that is high in very fine sand and coarse silt and low in clay. In most places several inches in the upper part of the subsoil is free of mottles. Where Williamson soils join Niagara soils, however, mottles are found immediately below the plowed layer. Layers of very fine sand and silt, in varying proportions from place to place, are typical of the fragipan in this county. Locally, thin layers of gravel may be found in the substratum where Williamson soils are near streams.

In April, free water is within 6 inches of the surface during rainy periods. It falls moderately rapidly, however, and is not above 30 inches after several rainless days. At this time of year, 4 to 6 consecutive drying days are needed before the soil can be plowed. During May, free water is mainly below 18 inches, except for very short periods after rains. During this month, 3 to 4 consecutive drying days are needed before tillage. During June, water appears above the fragipan only for short periods and 1 or 2 drying days will permit tillage.

Though some roots penetrate the fragipan, most are confined to the layer above it and draw water and nutrients from the topmost 18 to 24 inches. This volume of soil holds between 3½ and 5 inches of water available to plants. This amount is not all easily available, however, and crops show the effects of drought after a week or 10 days without rain in midsummer.

The moderately high organic-matter content of the plowed layer is associated with moderately high total nitrogen content. In spring nitrogen is slowly available, however, and nitrogen fertilization is needed for most crops. During midsummer, it is released more rapidly, but rapidly growing crops commonly need supplemental nitrogen. The organic-matter content contributes a high proportion of the capacity of the surface soil to hold bases. This capacity is equal to the amount supplied by 7 to 12 tons of ground limestone per acre. An unlimed surface soil contains about 30 percent of this amount, and 3 to 6 tons of ground limestone per acre is needed to raise the pH to a value near 7.0. If the soils have been limed previously to pH 6.0, the requirement is 1½ to 3 tons of ground limestone. The potassium reserve is low because the clay concentration is low. Though the phosphorus supply is medium, its availability is moderately low in unlimed soils.

Wiliamson soils are potentially highly productive. They are slightly limited by wetness, they are deficient in important nutrients, and they are highly susceptible to erosion. Nevertheless, if properly managed, they are among the more productive soils of the county.

Williamson very fine sandy loam, 2 to 6 percent slopes (WrB).—This soil is gently sloping and is somewhat susceptible to erosion. It has a fragipan that is less strongly expressed than that in many Williamson soils elsewhere, but it is otherwise typical of the soils described for the series. The areas mapped include a small acreage where the slope is more than 6 percent.

This soil is suited to the crops important to dairying, to vegetable crops and specialty crops, and to pasture or forest. It is also suited to many nonagricultural uses, though its instability should be considered for many kinds of construction.

Maintenance of fertility is the outstanding management need. This soil lacks phosphorus, is most deficient in nitrogen and potassium, and requires lime for many crops. Though wetness is a moderate problem in spring, tile drainage is effective, mainly in improving the included wet spots in some fields. The slopes are somewhat susceptible to erosion. If intertilled crops are grown, contour tillage is advisable on short slopes, and stripcropping is needed on longer slopes. Maintenance of good tilth is a problem. Practices designed to maintain organic-matter content and granular structure are very important. If the organic-matter content is depleted, the surface soil crusts easily. (Capability unit IIe-6; woodland suitability group 4)

Formation, Morphology, and Classification of the Soils

This section tells how the soils of Tompkins County were formed and discusses the relative importance of each of the five soil-forming factors in the formation of these soils. Then drainage classes of soils are defined, and soil catenas are described. Next follows a discussion of the nature and significance of fragipans. The soil series are then classified by great soil groups, and each group is described. In table 16 the soil series are listed by great soil groups and by catenas. Finally, a technical description of a soil profile representative of each soil series is given, together with a statement of the range in characteristics of the soils in that series as they occur in Tompkins County.

Soil is the mantle of material that covers the surface of the earth and forms the link between the rock core, or underlying bedrock, and the living things on the surface (*24*). It may be thick or thin, grayish or reddish, gravelly or clayey, but the fact that it supports all life is one important reason for its study. It is mainly a mixture of mineral and organic materials with air and water. The proportion is variable, but all the components are present everywhere in some degree.

A vertical section of soil is composed of a succession of layers. These layers are called horizons, and they tell a

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TABLE 16.—*Soil series, catenas, and great soil groups*

[Great soil groups are designated as follows: (A), Alluvial soils; (G–BP), Gray-Brown Podzolic soils; (HG), Humic Gley soils; (L–HG) Low-Humic Gley soils; (L–HG—HG), Low-Humic Gley soils intergrading to Humic Gley; (SBA), Sols Bruns Acides; and (B), Bog soils. Dashes indicate that the soils representing the given drainage class in the particular catena do not occur in Tompkins County]

Parent material	Well drained	Moderately well drained	Somewhat poorly drained	Poorly drained	Very poorly drained
	GRAY-BROWN PODZOLIC SOILS AND THEIR HYDROMORPHIC ASSOCIATES				
Glacial till:					
Limestone dominant; some shale and sandstone.	Honeoye (G–BP).	Lima (G–BP)	Kendaia (G–BP).	Lyons (HG)	Lyons (HG).
Shale and sandstone dominant; some limestone.	Lansing (G–BP).	Conesus (G–BP).	Kendaia (G–BP).	Lyons (HG)	Lyons (HG).
Limestone dominant; some lacustrine material.	Cayuga [1] (G–BP).	----------	Ovid [1] (G–BP).	Ilion (L–HG)	Lyons (HG).
Glacial outwash:					
Limestone dominant; some shale and sandstone.	Palmyra (G–BP).	Phelps (G–BP)	Fredon (G–BP).	Halsey (L–HG—HG).	Halsey (L–HG—HG).
Shale and sandstone dominant; some limestone.	Howard (G–BP).	Phelps (G–BP)	Fredon (G–BP).	Halsey (L–HG—HG).	Halsey (L–HG—HG).
Lacustrine sediments:					
Pinkish silt and clay, high in lime	----------	Hudson [2] (G–BP).	Rhinebeck (G–BP).	Madalin (L–HG—HG).	Madalin (L–HG—HG).
Yellowish-brown silt and fine sand, medium in lime.	Dunkirk (G–BP).	Collamer (G–BP).	Niagara (G–BP).	Canandaigua (L–HG—HG).	Canandaigua (L–HG—HG).
Yellowish-brown fine sand, alkaline to acid.	Arkport (G–BP).	----------	----------	Lamson (HG)	Lamson (HG).
Gray silt and clay mixed with glacial till and outwash.	----------	----------	Darien (G–BP).	Ilion (L–HG)	Lyons (HG).
	SOLS BRUNS ACIDES AND THEIR HYDROMORPHIC ASSOCIATES				
Glacial till (soils have fragipans):					
Shale and sandstone dominant (subsoil neutral or alkaline).	Valois (SBA)	Langford (SBA)	Erie (SBA)	Ellery (L–HG)	Alden (HG).
Shale and sandstone dominant (soils strongly acid).	Bath (SBA)	Mardin (SBA)	Volusia (SBA).	Chippewa (L–HG)	Alden (HG).
Shale and sandstone dominant; till moderately deep and shallow over bedrock.	Lordstown (SBA).	----------	----------	Tuller [3] (L–HG)	
Glacial outwash:					
Shale and sandstone dominant	Chenango (SBA).	Braceville [4] (SBA).	Red Hook (SBA).	Halsey (L–HG—HG)	Halsey (L–HG—HG).
Lacustrine sediments:					
Brown and yellowish-brown silt and fine sand; acid.	----------	Williamson [3] (SBA).	----------	----------	
	ALLUVIAL SOILS AND THEIR HYDROMORPHIC ASSOCIATES				
Recent alluvium:					
Alkaline sediments dominant	Genesee (A)	Eel [3] (A)	----------	Wayland [3] (L–HG)	Sloan (HG).
Acid sediments dominant	Tioga (A)	Middlebury [3] (A)	----------	Holly [3] (L–HG)	Papakating (HG).
Woody peat and remains of sedges and deciduous trees.	----------	----------	----------	----------	Muck and Peat (B).

[1] Series includes some soils that are moderately well drained.
[2] Series includes some soils that are well drained.
[3] Series includes some soils that are somewhat poorly drained.
[4] Soils have weak fragipan.

great deal about the soil and how plants will perform when growing on it. The kind and arrangement of the horizons are the result of the interaction of the soil-forming factors of climate and vegetation acting on soil parent material, as conditioned by relief over a period of time. Most soils have three main horizons, identified by the letters A, B, and C, but some soils on flood plains—those of the Genesee series, for example—lack a B horizon because they are young, and because new material is added with every flood. Other soils may not have an A horizon, or the horizon may be thin, because all or part of what has developed over the years has been removed by erosion. The material below the A and B horizons, which together are generally considered to make up the soil, is called the C horizon, and it is assumed to be the same as the parent material, or the material from which the soil (A and B horizons) has developed. The master horizons may be subdivided in the study of soils. The A horizon may have an Ap (a plowed surface horizon), and it may have layers identified as A2 and A3. Similarly, the B horizon may be divided into B1, B2, and B3 layers.

The A horizon is at the surface and is commonly called the surface soil. It contains the greatest amount of organic matter and is the horizon in which biologic processes are most active. It is also the horizon that rain reaches first and that therefore has undergone the most severe leaching and normally has lost most of its soluble material. Also, the finely divided mineral material, or clay, has been removed from some soils, as well as oxides of aluminum and iron. The iron is in the same state as the iron in rust on farm equipment left out in the weather. Generally, the A horizon has undergone the greatest amount of leaching and is called an eluviated horizon.

The B horizon, which is immediately below the A horizon, is usually called the subsoil. It has less organic matter and less biological activity and, under moderately good or good drainage, has brighter colors. In some soils part of the material removed from the A horizon has accumulated in the B, giving it a finer texture and a more or less blocky structure. In many soils the bright yellowish-brown or brown colors of this horizon are due in part to iron compounds that have been removed from the surface layer and redeposited as coatings on soil particles in the B horizon.

The C horizon is the deepest of the major horizons. It is usually lighter in color, is lower in content of organic matter, and has less biological activity than the A or B horizons. The rock material that makes up this horizon in mineral soils may have accumulated as a result of the weathering in place of the underlying rock, or, as in Tompkins County, it may have accumulated through deposition by water or by glaciers. This weathered rock material is presumed to be the material from which the soil above has developed. Unweathered bedrock is not considered parent material. Weathering in place or grinding by glacial ice changed the bedrock into parent material.

The formation of soils consists of the development of profiles in weathered material by the soil-forming processes. As stated previously, the dominant factors are climate and vegetation, and since these factors are fairly constant over wide areas, it is possible to get, in a broad way, the same general kind of profile over extensive areas. Local variations are those imparted by differences in the kind of parent material, in drainage, and in relief. In Tompkins County the soils are relatively young, and profile development has not progressed far enough that differences in parent material are hidden; therefore, parent material and the method of its deposition have been used as a means of identifying the soils of the county.

Table 16 shows the classification of the soil series in the county into catenas and great soil groups. For each series the kind of parent material and the drainage classes are shown. A table of this kind, in which all soil series having similar parent material are placed on the same line, but in different columns denoting different drainage classes, is called a catena diagram and is a convenient way to list the soils for identification.

Factors of Soil Formation

A soil at any given point is the result of the interaction of five soil-forming factors, namely, parent material, climate, living organisms, time, and relief. All these factors influence to some degree the genesis or formation of every soil. The relative importance of each factor differs from place to place. In places one factor may dominate in the formation of a soil and fix most of its properties, but this has not happened in Tompkins County. Within the county are visible differences that reflect the influence of parent material, relief, or plant and animal life.

Parent material

All of Tompkins County has been covered one or more times by glaciers; parts of the county have been covered for some time by glacial lakes.

The mineral material from which the soils formed has been moved about from place to place by ice or water and deposited as glacial till, glacial outwash, or lacustrine deposits. More recently, alluvium has been deposited in the valleys along streams. The mineral material came mainly from local acid sandstone, siltstone, and shale bedrock, but in the northwestern part of the county, on either side of Cayuga Lake, there is some that was derived from limestone. Because lime has a great effect on soil-forming processes, the parent materials of Tompkins County have been separated on the basis of their lime content and are called high-lime, medium-lime, low-lime, and very low-lime parent material.

The transported parent material exhibits sorting in different degrees, depending on whether it was deposited by ice or by water and on the speed of the water. *Glacial till* is a mixture of unsorted soil material and angular rock fragments deposited by glaciers. *Glacial outwash* is coarse, gravelly or cobbly material carried by rapidly flowing water and laid down as valley trains, deltas, kames, eskers, or other features. Outwash generally is stratified as a result of sorting and deposition at different times by water flowing at different speeds. Both till and outwash vary in lime content.

For a considerable time after the glaciers melted, lakes occupied the low-lying parts of the county, generally below an elevation of 1,000 feet. Fine particles of sand, silt, and clay were carried out into the lakes and later settled to the bottom. These lacustrine deposits exhibit a cyclic layering of fine sand, silt, and clay that is called varving. The lacustrine deposits are free of stones, and the percentages of sand, silt, and clay vary from place to place. The deposits also vary in depth to lime.

In the valleys along streams, alluvium has been deposited by the streams since the glacial period. Some areas of alluvium are higher above the stream than other areas. Some areas are low lying and are covered by water for long periods. Some alluvium is acid, and some contains lime. In some places muck and peat have formed from plant remains deposited in water that stands in depressions.

Summarizing the preceding statements, the parent materials consist of glacial till, glacial outwash, lacustrine deposits, and alluvium that may be high or low in content of lime, and of organic deposits that contain the remains of decaying plants.

Climate

A humid, cool-temperate, continental type of climate prevails in Tompkins County. Cayuga Lake has a warming influence on the city of Ithaca and the areas on either side of the lake for a short distance back, but the difference is not important relative to soil formation. The general effects of precipitation and temperature are more significant. A complete summary and analysis of precipitation and temperature are given in the section "General Nature of the County."

The average annual rainfall at Ithaca is about 33 inches, and the annual total ranges from 30 to 40 inches. About 16 to 26 inches of rain falls during the growing season, which extends from May through September. The amount and kind of precipitation and the temperature influence the rate and kind of weathering and leaching which help to produce soils. Climate also affects soils indirectly through its influence on the growth of living organisms in or on the soil and decay of plant and animal bodies.

Time

Most soils are formed over long periods of time, perhaps hundreds of thousands of years, but the soils of Tompkins County have been forming for only tens of thousands of years. This is considered a short time for soils to form. Most of the soil materials, such as glacial till, outwash, and lacustrine deposits, were left after the glaciers melted and the lakes dried up. Alluvial materials and plant remains in bogs and swamps are of recent origin and are being deposited at the present time. Soils formed in the recent materials have very weak horizons and almost no profile development, but those formed in the older materials may have distinct horizons and well-developed profiles. Compared with soils in unglaciated areas, the soils in Tompkins County are relatively young. Most are probably 10 to 15 thousand years old, and some are very young.

Relief

The shape of the land surface, commonly called the lay of the land; the slope; and the position in relation to the water table have had great influence on the formation of soils in the county. Soils formed on sloping areas where runoff is moderate to rapid generally are well drained, have a bright-colored, unmottled subsoil, and in most places are leached to greater depths than wetter soils in the same general area. In more gently sloping areas where runoff is slower, the soils generally exhibit some evidence of wetness for short periods of time, such as mottling in the subsoil. In level areas or slight depressions, the soils show marked influence of wetness, such as a dark-colored, thick, organic surface soil and a very strongly mottled or grayish subsoil. Some soils, however, are wet because of a high water table or because of their position. Also, the permeability of the soil material, as well as the length, steepness, and configuration of the slopes, influences the kind of soil that is formed from place to place. Local differences in soils are largely the results of differences in parent material and relief.

Living organisms

The influence of plants and animals living in and on the soil is apparent mainly in the surface soil but goes much deeper. Sudden mass movement of mineral and organic soil material resulting from the windthrow of trees and the burrowing of animals brings weathered fragments of stone and subsoil to the surface where they are subjected to more rapid and intense chemical and physical weathering. Less obvious, but nevertheless persistent, is the cycling of mineral and organic material through the soil by earthworms. Vegetation, particularly the native forests of the county, have furnished a large amount of organic matter, which bacteria and fungi break down into simpler compounds that eventually affect the chemical and physical composition of the soil. In addition, some trees draw bases in appreciable amounts from the lower part of the soil and return them to the surface in fallen leaves and stems. This process has probably delayed to some extent the leaching of bases from the soil.

Soil Drainage Classes

Water is important in the formation of soils. The amount of water that is received by a soil, that percolates through it, and that remains in it is determined by the climate, the permeability of the soil and the underlying material, the relief or lay of the land, and the depth to a normal or a perched water table.

Soils that developed from one kind of parent material but have different characteristics because of differences in relief and drainage make up a sequence, or "chain," which in the United States is called a catena. Six or seven classes of natural drainage can be distinguished in places, but only five are recognized in Tompkins County. The soil series are placed in catenas in table 16, and each drainage class is discussed in the following paragraphs.

Well drained.—In well-drained soils, water runs off the surface and percolates through the soil at optimum rates. The soils remain saturated for short periods only, and enough water is retained to meet the needs of growing crops. In well-drained soils the colors are fairly bright and may be shades of yellow, brown, or red, depending on what was inherited from the parent material. Well-drained soils are generally free of mottles in the upper 30 to 36 inches. They can be worked fairly soon after heavy rains, and they can be worked throughout a wider range of moisture content than soils that have moderately good or poor drainage.

Moderately well drained.—In moderately well drained soils, water runs off the surface and percolates through the soil somewhat slowly. Enough water is held to make the soils wet for a short but significant length of time. Moderately good drainage may be the result of a slowly permeable layer 15 to 20 inches below the surface or of a naturally higher water table than occurs in well-drained soils. Soil colors are uniform in the upper 15 to 20 inches, but at lower depths distinct mottles are present. During dry years these soils may produce yields as good as or better than those on well-drained soils, but deep-rooted legumes normally do not yield so well or persist so long as they do on soils that are well drained.

Somewhat poorly drained.—In somewhat poorly drained soils, excess water is removed so slowly by runoff and percolation that the soils remain wet for significant periods of time, particularly during spring and after heavy rains in summer. These soils may have a slowly permeable layer, or fragipan, 10 to 15 inches below the surface, or the permanent water table may be fairly close to the surface. Plant roots are restricted to the upper 8 to 10 inches of soil; consequently, deep-rooted plants neither produce well nor persist for a great length of time. Shallow-rooted legumes, like birdsfoot trefoil, and grasses are better suited to somewhat poorly drained soils. Soils in the somewhat poorly drained class have a grayish-brown surface layer and are strongly mottled below the plowed layer.

Poorly drained.—Where drainage is poor, water is removed so slowly that the soils remain wet for a large part of the time, and the permanent water table is close to the surface during 8 or 9 months of each year. Generally, poorly drained soils are too wet to produce crops without supplemental drainage either through open ditches or tile. If undrained, they produce good crops of grasses and fair crops of ladino clover and other shallow-rooted legumes. If adequately drained, they may be highly productive of some crops. Poorly drained mineral soils have a dark-gray surface layer and a gray subsoil strongly mottled with yellowish brown and rust brown immediately below the plowed layer.

Very poorly drained.—Very poorly drained soils are sometimes called permanently wet soils. Water is removed from these soils so slowly that the water table remains at or very near the surface for much of each year. These soils commonly have a very dark gray or black surface soil. The upper part of the subsoil is light gray and may or may not be mottled. The lower part is strongly mottled in most places. Most soils in this drainage class occupy level areas or depressions and receive runoff and seepage from surrounding higher land. Also, very poorly drained soils are frequently ponded. They are too wet for cropland without artificial drainage and are usually used as permanent pasture.

Fragipan Horizons

Some of the Sols Bruns Acides and Low-Humic Gley soils, except where bedrock is close to the surface, have a horizon called a fragipan (fig. 23). The term fragipan means approximately "brittle pan" and is used to denote a compact horizon that is rich in silt or sand, or both, and relatively low in clay (*22*). When dry, this horizon appears to be indurated, but the apparent induration disappears if the material is moistened. This is a very dense horizon; the percentage of pore space is so low that even when the pan is saturated with water it appears only partly moist (*4*). Water moves through the fragipan very slowly during spring, and after heavy rains it moves laterally

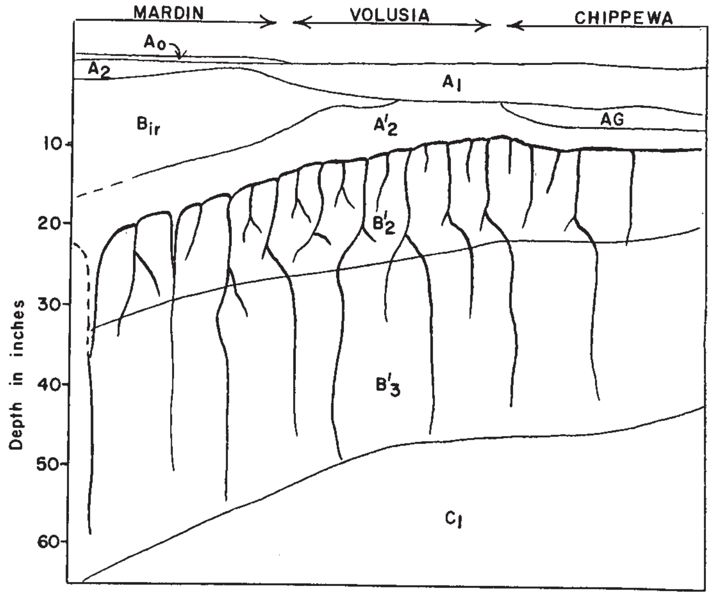

***Figure 23.*—Relationships between expression of fragipan in the Mardin, Volusia, and Chippewa soils (*3*).**

along the top of the pan. Roots are able to penetrate only into cracks or joints or through wormholes. These horizons are more strongly expressed in the somewhat poorly drained and poorly drained soils and are also closer to the surface. In well drained and moderately well drained soils, the fragipan often occurs at a depth of 18 to 28 inches, but the pan is at a depth of 10 to 15 inches in somewhat poorly drained and poorly drained soils.

Classification of the Soils

The soil classification used in the United States consists of six categories. Beginning with the most inclusive, these categories are the order, suborder, great soil group, family, series, and type (*19*, *21*).

There are three orders and thousands of types. The suborder and family categories have never been fully developed and have been little used. Most attention has been given to the classification of soils into soil types and series within counties or comparable areas and to the subsequent grouping of series into great soil groups. Soil types are further broken down into phases, for which finer distinctions in use and management can be made.

Classes in the broadest category of the classification scheme are the zonal, intrazonal, and azonal orders. The zonal order consists of soils with evident, genetically related horizons that reflect the predominant influence of climate and living organisms. The zonal order is represented in Tompkins County by two great soil groups—Gray-Brown Podzolic soils and Sols Bruns Acides.

The intrazonal order consists of soils having evident, genetically related horizons that reflect the dominant influence of a local factor of relief or parent material over the effects of climate or living organisms. The intrazonal order is represented in Tompkins County by three great soil groups—Low-Humic Gley soils, Humic Gley soils, and Bog soils.

The azonal order consists of soils that lack distinct, genetically related horizons because they are young, have resistant parent material, or are on steep slopes. The azonal order is represented in Tompkins County by one great soil group—Alluvial soils.

In table 16 the soil series are listed by catenas and great soil groups. Muck and Peat are very poorly drained organic soils that formed from the remains of sedges and deciduous trees. Alluvial land, Fresh water marsh, Made land, and Rock outcrop are land types that do not belong to any soil series and therefore are not placed in a soil catena.

Great soil groups

Six great soil groups are represented in Tompkins County. The distinguishing characteristics of each of these groups are described in the following paragraphs. Outstanding characteristics of three of these groups are illustrated in figure 24.

Gray-Brown Podzolic Soils.—The Gray-Brown Podzolic group consists of zonal soils of the humid-temperate, forested regions in the northeastern part of the United States. In New York, they occur principally through the Lake Plain sections and the central part of the State (*5*) in the area that has high-lime parent material. They are characterized by a thin leaf litter over a dark-colored A1 horizon that is 3 to 4 inches thick and overlies a leached A2 horizon that is 4 to 6 inches thick. The B horizon is finer textured and browner than either the layers above or below. The C horizon is lighter colored and more alkaline; generally it is highly calcareous. The finer textured B horizon in which clay has accumulated is the outstanding characteristic of Gray-Brown Podzolic soils and is the main one used to identify them in the field. The Gray-Brown Podzolic soils in Tompkins County are those in the Arkport, Cayuga, Collamer, Conesus, Darien, Dunkirk, Fredon, Honeoye (fig. 25), Howard, Hudson, Kendaia, Lansing, Lima, Niagara, Ovid, Palmyra, Phelps, and Rhinebeck series.

Sols Bruns Acides.—The Sols Bruns Acides are zonal soils of the timbered, humid-temperate regions of the northeastern part of the United States. They formed from acid parent materials. In Tompkins County the soils of this group are south of the Gray-Brown Podzolic soils. Sols Bruns Acides are more strongly leached and more acid than Gray-Brown Podzolic soils. They norm-

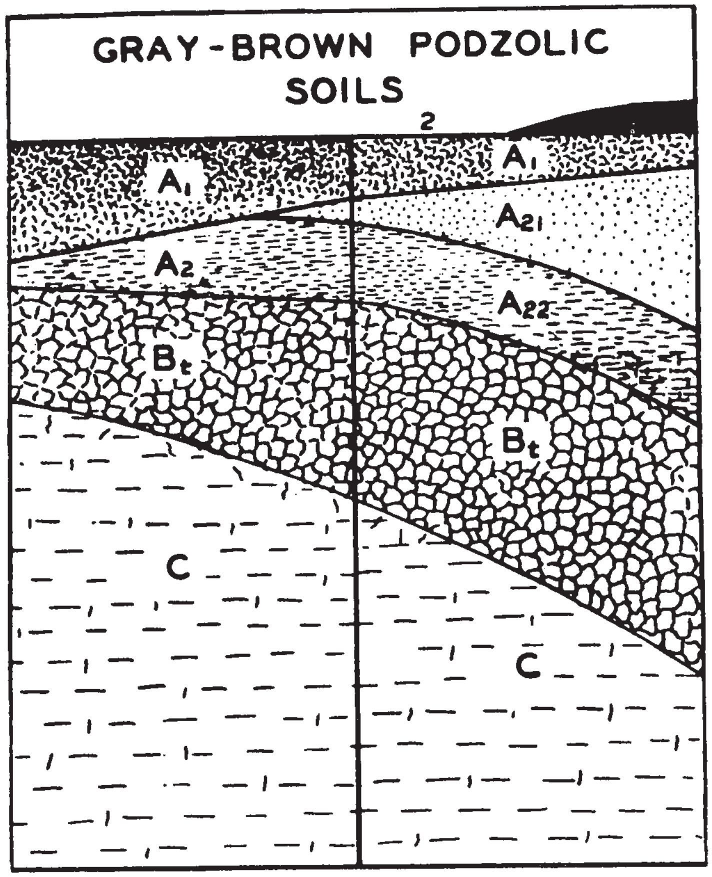

Figure 25.—**Two Gray-Brown Podzolic soils that differ in thickness of horizons and depth to parent material. Honeoye, a high-lime soil, is on the left. Lansing, a medium-lime soil, is on the right.**

ally do not have free lime in the parent material or in the substratum, above a depth of 5 feet (*3*). These soils are characterized by a thin, strongly acid A1 horizon and a strongly acid, yellowish-brown, friable A2 horizon. The B horizon is typically brown; its texture is no finer than that of the layers above; and its structure is weak, subangular blocky. The Sols Bruns Acides in Tompkins County are in the Bath, Braceville, Chenango, Erie, Lang-

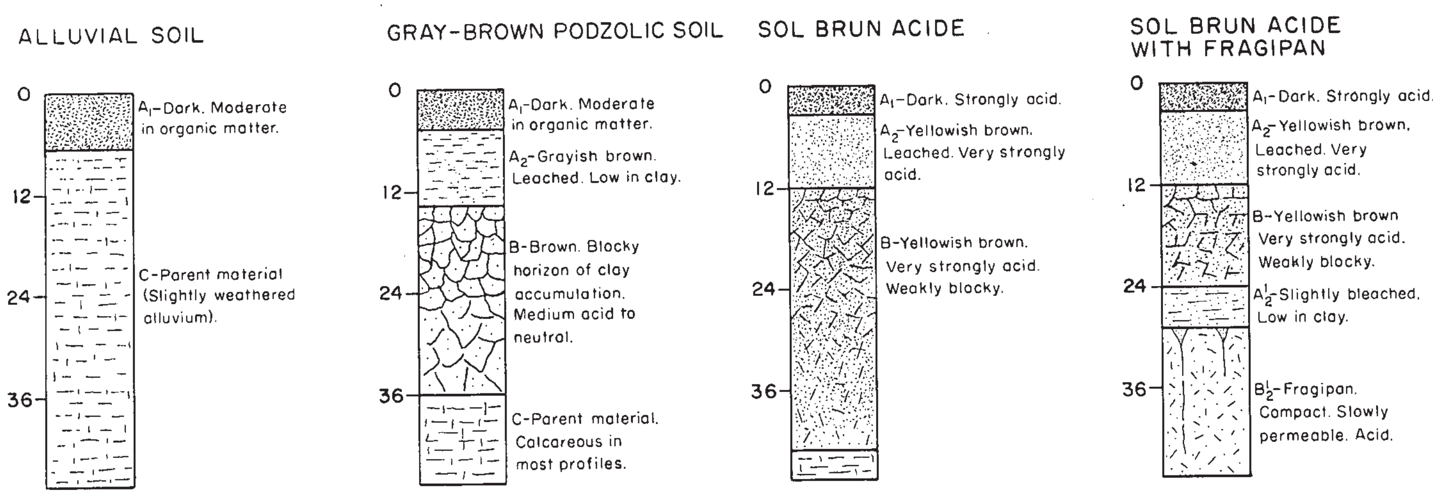

Figure 24.—**Sequence and relative thickness of horizons of soils in three great soil groups.**

ford, Lordstown, Mardin, Red Hook, Valois, Volusia, and Williamson series.

Low-Humic Gley Soils.—The hydromorphic associates of the Gray-Brown Podzolic soils are the Low-Humic Gley soils, which are intrazonal soils that reflect the dominant influence of poor drainage. These soils have a thin surface horizon that contains a moderate amount of organic matter. The A horizon is underlain by a highly mottled gray and brown horizon of mineral material that differs less in texture from the A horizon than does the corresponding horizon in the better drained associated soils. The Low-Humic Gley soils in Tompkins County are those in the Chippewa, Ellery, Holly, Ilion, Tuller, and Wayland series.

Low-Humic Gley soils that have some characteristics of Humic Gley soils and that are classified as intergrades are those in the Canandaigua, Halsey, and Madalin series.

Humic Gley Soils.—The Humic Gley group consists of poorly drained or very poorly drained intrazonal soils that have a mucky A horizon or a thin mineral A horizon rich in organic matter underlain by strongly gleyed horizons. The soils developed under swamp or swamp forest vegetation. The Humic Gley soils in Tompkins County are those in the Alden, Lamson, Lyons, Papakating, and Sloan series.

Bog Soils.—Bog soils are very poorly drained intrazonal soils. When soil parent material is nearly impervious to water or is so located topographically that water stands continually at or on the surface, the plant growth, as it perishes seasonally, builds up a body of organic material, known as peat. Peat deposits in bogs are particularly abundant in cool, moist climates where conditions are favorable for the growth of sphagnum and other mosses, but they also occur in warm-temperate and tropical regions and are sometimes composed largely of the remains of woody plants, grasses, or reeds. Small peat deposits occur in Tompkins County, and also some small muck deposits. Muck is peat in a more advanced stage of decomposition. Usually it has a greater mineral content than peat. It is usually black or very dark brown in color. Some mucks produce high crop yields when artificially drained. Peat and muck are known collectively as Bog soils.

Alluvial Soils.—Alluvial soils are azonal soils that developed from geologically recent alluvium that has not been in place long enough to have well-developed horizons. These soils have a surface layer 8 to 10 inches thick, are relatively high in organic matter, and are underlain by fresh alluvium that has much the same characteristics as when it was deposited. These soils are not extensive in Tompkins County but occur on narrow flood plains along all the major streams of the county where new material is being added continuously. The Alluvial soils in Tompkins County are those in the Genesee, Eel, Tioga, and Middlebury series.

Soil series

In the following pages, each of the soil series represented in Tompkins County is discussed, and a profile of a typical soil of each series is described in detail.

Alden Series.—The Alden series consists of very poorly drained, medium acid to nearly neutral, moderately fine textured or medium-textured Humic Gley soils. These soils have developed in glacial till derived mainly from sandstone and shale but containing a small amount of limestone. They are the very poorly drained soils in the catena that includes the well drained Valois, the moderately well drained Langford, the somewhat poorly drained Erie, and the poorly drained Ellery series. They are also the very poorly drained members of the Bath-Mardin-Volusia-Chippewa-Alden catena.

Alden soils have a thin surface soil of muck or mucky material over an intensively gleyed subsoil that has few to many, faint to distinct mottles. They differ from Ellery and Chippewa soils in having a mucky surface soil and a neutral gray (0 to 1 chroma) gleyed horizon in a distinct fragipan.

Alden soils are of minor extent in Tompkins County and are of little importance agriculturally.

Profile of Alden mucky silt loam, pastured:

A1—0 to 10 inches, very dark gray (10 YR 3/1) and black (10YR 2/1) mucky silt loam; few, fine, dark-brown (7.5YR 3/2) root mottles; weak, fine, crumb structure; very friable; pH 6.6; clear, wavy boundary; 10 to 18 inches thick.

A2g—10 to 23 inches, gray (N 5/0) heavy silt loam to light silty clay loam; common, medium, faint, grayish-brown (2.5Y 5/2) and olive-brown (2.5Y 4/4) mottles; moderate, medium and coarse, subangular blocky structure; friable to slightly firm; pH 6.8; gradual, wavy boundary; 9 to 13 inches thick.

B2g—23 to 36 inches, olive (5Y 4/4) channery heavy silt loam; gray (N 5/0) mottles; moderate, coarse, blocky structure; firm; pH 7.0; diffuse lower boundary; 10 to 14 inches thick.

Cg—36 to 60 inches, olive (5Y 4/4 and 5/4) channery silt loam; gray (N 5/0) vertical streaks 18 to 24 inches apart; firm; calcareous.

Range in characteristics.—The mucky surface layer ranges from 10 to 18 inches in thickness. Locally, Alden soils have 3 to 6 inches of silty clay to silty clay loam beneath the mucky surface layer. The chroma of the intensely gleyed horizons is commonly 0 to 1, but in drained areas the chroma is 2 and the colors are usually gray, bluish gray, or greenish gray. Hues of 5Y to 2.5Y and values of 4 to 5 are common below the gleyed horizon and in the substratum. The depth to carbonates ranges from 30 to 36 inches. The reaction of the surface layer ranges from strongly acid (pH 5.5) to nearly neutral, depending on position and associated soils. In most places Alden soils have a surface layer of muck or mucky material, but where they intergrade toward Chippewa or Ellery soils, they commonly have a surface layer of channery silt loam. Stoniness ranges from none in the silt-filled depressions to channery or flaggy where Alden soils intergrade toward soils that are shallow over bedrock.

Arkport Series.—The Arkport series consists of weak Gray-Brown Podzolic soils developed in well-drained fine sandy loam and very fine sandy loam, which were laid down as sandy lacustrine or deltaic deposits along the margins of glacial lakes. Originally, these deposits were calcareous, but now they are leached of lime to a depth of 40 to 60 inches or more.

The upper part of the soil is dominantly fine or very fine sandy loam. The B horizon is diffuse or banded; the sand grains are bonded by clay bridges. Thin bands of silt commonly occur below a depth of 20 inches. Arkport soils are the well drained members of the catena that includes the moderately well drained Galen, the somewhat poorly drained Minoa, and the poorly drained and very poorly drained Lamson soils. Only Arkport and Lamson soils of this catena were mapped in Tompkins County. Arkport soils are associated mainly with Howard soils on deltas and with silty Niagara and Canandaigua soils on lake plains.

Arkport soils are of minor extent in Tompkins County, but they are important to the agriculture.

Profile of Arkport fine sandy loam, cultivated:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) fine sandy loam; weak, medium to fine, crumb structure; very friable; pH 6.0; abrupt, smooth boundary; 6 to 10 inches thick.

A2—8 to 16 inches, yellowish-brown (10YR 5/4) fine sandy loam; weak, fine, crumb structure; very friable; pH 5.5 to 5.8; gradual, wavy boundary; 6 to 9 inches thick.

B1—16 to 22 inches, brown (10YR 5/3) fine sandy loam with irregular, thin, horizontal bands of reddish-brown very fine sandy loam; sand grains and silt particles joined by clay bridges; weak, fine or medium, subangular blocky structure; friable; pH 6.0; gradual, wavy boundary; 6 to 10 inches thick.

B2—22 to 36 inches, brown (10YR 5/3) to grayish-brown (10YR 5/2) loamy fine sand with discontinuous, thin bands of dark-brown (10YR 4/3) very fine sandy loam; weak to very weak, medium, subangular blocky structure; very friable; pH 6.5 to 7.0; clear, wavy boundary; 12 to 24 inches thick.

C—36 inches +, grayish-brown (2.5YR 5/2) very fine sand, loamy fine sand, and stratified fine sand; weak, medium, platy structure; friable to slightly firm; pH 7.5+; calcareous.

Range in characteristics.—Fine sandy loam and very fine sandy loam are the usual surface textures, but locally the surface texture may be silt loam. Layers of silt 1 to 2 inches thick may occur in the profile; these layers are most common where Arkport soils adjoin soils of the Hudson and Collamer series. Some fine gravel may be mixed with the surface layer and the upper part of the subsoil in areas that are near Howard soils. Reaction varies; in some areas the soil is neutral in the surface layer and calcareous at a depth of 36 inches, and in other areas, particularly in the western part of the county, the soil is medium acid or strongly acid to a depth of 5 feet or more. Similar profiles near Dryden Lake and Vetsburg, near the city limits of Ithaca, are strongly acid to a depth of 5 feet, but are calcareous below that depth. The B horizon of Arkport soils is generally less than 15 percent clay. It has a weaker structure than that of Dunkirk soils.

Bath Series.—The Bath series consists of well-drained, strongly acid, medium-textured Sols Bruns Acides that have a firm fragipan. These soils have developed in deep, firm, acid glacial till derived from gray or olive sandstone and shale. They are the well drained members of a catena that includes the moderately well drained Mardin, the somewhat poorly drained Volusia, the poorly drained Chippewa, and the very poorly drained Alden soils. Bath soils are mapped locally in association with Erie and Ellery soils, which formed in neutral to weakly calcareous parent material.

Bath soils are deeper over bedrock than Lordstown soils, which do not have a fragipan. They generally have a slightly lighter textured and more strongly acid fragipan than the Volusia soils, which have more lime in the substratum.

Bath soils are moderately extensive in Tompkins County and are agriculturally important.

Profile of Bath channery silt loam, forested:

O1—1 inch to 0, looseleaf litter (undecomposed) from mixed hardwoods.

A11—0 to 1 inch, very dark brown (10YR 2/2) silt loam; high organic-matter content; moderate, fine, crumb structure; friable; pH 5.2; fine roots form a dense mat; abrupt, smooth boundary; 1 to 1½ inches thick.

A12—1 to 1½ inches, dark-brown (10YR 4/3 and 3/3) channery silt loam; weak, fine, crumb structure; friable; held in place by mat of roots; pH 4.6; abrupt, smooth boundary; 1 to 1½ inches thick.

A2—1½ to 2 inches, brown and dark-brown (10YR 5/3–4/3) channery silt loam; weak, very thin, platy structure or moderate, fine and coarse, subangular blocky structure; friable to firm; peds have many small pores; pH 4.8; clear, smooth boundary; 0 to ¾ inch thick. This horizon is discontinuous.

B21—2 to 12 inches, dark yellowish-brown (10YR 4/4) channery silt loam; moderate, fine and coarse, subangular blocky structure; coarse peds that break to weak, fine crumbs; friable; many fine roots; pH 4.8; clear, wavy boundary; 8 to 11 inches thick.

B22—12 to 26 inches, yellowish-brown (10YR 5/4) channery silt loam; weak, fine to coarse, subangular blocky structure with a few, weak, fine crumbs; friable to firm; small roots common; pH 5.2; clear, wavy boundary; 10 to 15 inches thick.

A′2—26 to 30 inches, grayish-brown (2.5Y 5/2), light olive-brown (2.5Y 5/4), and dark yellowish-brown (10YR 4/4) channery sandy loam; common, medium, faint mottles; very weak, fine, subangular blocky and weak, medium to thick, platy structure; firm in place, friable when removed; pH 5.4; clear, irregular boundary; 2 to 6 inches thick.

B′x—30 to 40 inches, olive-brown (2.5Y 4/4) very channery silt loam; coarse prisms that break to weak, medium and coarse blocks; light yellowish-brown (10YR 6/4) silt coats on top of prisms and extending downward between prisms; very firm; clay films in pores in lower 6 inches; pH 5.4; gradual boundary; 10 to 14 inches thick.

C—40 to 48 inches, broken channery fragments; olive-brown (2.5Y 4/4) loam in interstices; thin clay films in pores; pH 5.4; underlain by bedrock.

Range in characteristics.—The depth to the fragipan ranges from 18 to 30 inches and is least on gentle slopes. Channery fragments occur throughout the profile. Numerous flagstones and a few erratics make up the remainder of the coarse skeleton. The number of flagstones on the surface and in the soil increases as Bath soils intergrade toward Lordstown soils. The yellowish-brown to strong-brown color of the B horizon is much brighter than that of the moderately well drained Mardin soils. The structure of this horizon may become weak, fine, subangular blocky where these soils intergrade to Valois soils. Bath soils are strongly acid to a depth of 5 to 7 feet; pH values of 4.8 to 5.2 are common in the upper part of the solum. The reaction may be neutral at a depth of 4 to 5 feet where Bath soils intergrade to Valois soils.

Braceville Series.—The Braceville series consists of deep, moderately well drained Sols Bruns Acides developed in glacial outwash derived from acid gray shale, siltstone, and sandstone. These soils are the moderately well drained members of the catena that includes the well-drained Chenango, the somewhat poorly drained Red Hook, and the poorly drained to very poorly drained Halsey soils. Braceville soils formed in outwash in regions where Lordstown, Bath, Mardin and Volusia soils formed on uplands in glacial till. Braceville soils are of minor extent and of little agricultural importance.

Profile of Braceville gravelly silt loam, cultivated:

Ap—0 to 7 inches, grayish-brown (10YR 5/2) to dark grayish-brown (10YR 4/2) gravelly silt loam or silt loam; moderate, coarse, crumb structure; friable when moist, slightly sticky when wet; pH 5.0; clear, smooth boundary; 6 to 8 inches thick.

B2—7 to 13 inches, yellowish-brown (10YR 5/4) gravelly silt loam; weak, medium, crumb structure; friable when moist, firm when dry; many fine roots; pH 5.0; gradual, smooth boundary; 6 to 8 inches thick.

A'2g—13 to 24 inches, grayish-brown (10YR 5/2) to light grayish-brown (10YR 6/2) gravelly silt loam; common, distinct, yellowish-brown mottles (10YR 5/4); weak, fine to medium, subangular blocky structure; friable when moist, slightly plastic when wet; pH 5.0 to 5.3; clear, wavy boundary; 8 to 12 inches thick.

B'xg—24 to 36 inches, grayish-brown (2.5Y 5/2) to light olive-brown (2.5Y 5/4) silt loam or gravelly silt loam; common, fine to medium, faint mottles of yellowish brown (10YR 5/4); massive; firm; slowly permeable; pH 5.5; diffuse boundary; 10 to 18 inches thick.

IIC—36 inches +, dark grayish-brown (2.5Y 4/2) to olive-brown (2.5Y 5/4) sandy or gravelly loam or stratified sand, silt, and gravel; single grain; firm in place; pH 5.5 to 6.0.

Range in characteristics.—The moderately good drainage of these soils is the result of dense, silty layers in the substratum or of compact, impervious glacial till. Typically the soils are strongly acid (pH less than 5.5), but in places the pH of the subsoil is nearly 6.0. The texture of the surface layer is silt loam or loam, and the amount of gravel on the surface varies. The depth to the stratified parent material ranges from 30 to 45 inches and differs widely from place to place.

Canandaigua Series.—The Canandaigua series consists of deep, poorly drained and very poorly drained Low-Humic Gley soils that intergrade to Humic Gley. These soils have formed in silty lacustrine deposits. They are the poorly drained and very poorly drained soils in the catena that includes the well drained Dunkirk, the moderately well drained Collamer, and the somewhat poorly drained Niagara soils.

Canandaigua soils do not have the high percentage of sand that is characteristic of Lamson soils, and they are not so high in clay as Madalin soils. Their lime content is similar to that of Lamson and Madalin soils because of the high base status of the drainage water that accumulates in the low parts of the landscape where Canandaigua soils occur. Poorly drained Canandaigua soils have a surface layer of dark grayish-brown to very dark grayish-brown silt loam, high in organic-matter content. The very poorly drained soils of this series have a surface layer of muck or of mucky silt loam.

Canandaigua soils are not extensive in Tompkins County and are not important agriculturally.

Profile of Canandaigua silt loam, cultivated:

Ap—0 to 8 inches, very dark gray (10YR 3/1) silt loam, high in organic matter; weak, fine and medium, crumb structure; very friable; many fine roots; pH 6.0; abrupt, smooth boundary; 7 to 9 inches thick.

A21g—8 to 12 inches, light brownish-gray (10YR 6/2) and grayish-brown (10YR 5/2) silt loam; few, distinct, yellowish-brown (10YR 5/6) and dark-brown (7.5YR 4/4) mottles; weak, medium, subangular blocky structure; friable; many fine roots; pH 6.2; clear, wavy boundary; 3 to 5 inches thick.

A22g—12 to 16 inches, grayish-brown (2.5Y 5/2) very fine sandy loam; distinct, olive-brown (2.5Y 4/4) mottles; weak, thin, platy structure begining to exhibit cracks or prisms, below which are gray (5Y 5/1) coats of very fine sand or silt; friable; pH 6.2; clear, smooth boundary; 4 to 5 inches thick.

B2g—16 to 24 inches, stratified silt and very fine sand in coarse, crudely shaped prisms that separate into plates 2 to 3 inches thick; interiors of pale brown (10YR 6/3) to light brownish-gray (2.5YR 6/2) with many, fine, strong-brown (7.5YR 5/6) and medium yellowish-brown (10YR 5/6–5/8) mottles; prisms have gray (N 5/0) surfaces that are silty at the top and slightly sticky at greater depth; friable to firm; pH 6.8 to 7.0; gradual, smooth boundary; 8 to 12 inches thick.

Cg—24 inches +, stratified silt and very fine sand with very thin layers of pinkish clay and precipitated calcium carbonate between the layers of sand and silt; in color and mottling, similar to B2g horizon; no prisms; calcareous.

Range in characteristics.—This series includes both poorly drained and very poorly drained soils that formed in silty lacustrine materials. Consequently, the properties of the soils differ from place to place. Some areas receive accumulations of material washed from higher soils and have a dark-colored, organic-matter enriched plowed layer 12 to 14 inches thick. Other areas are under water most of the year and have a mucky surface layer. Gleying is less evident in the areas where surface wash has accumulated. In these areas the gleyed horizons have a chroma of 1 or 2 and have many distinct mottles. In the areas where the surface is mucky, the gleyed horizons are thicker and may or may not have prominent, yellowish-brown or strong-brown mottles. The profile generally is high in silt and very fine sand and is more laminated in appearance than that of Madalin soils. Weak prisms that separate into thin to thick plates have formed in the drier soils; the wetter soils are very weak platy or massive. The depth to calcareous material ranges from 18 to 40 inches in the drier soils and decreases with increasing wetness. The poorly drained profile described for the series is only slightly acid, but in most of the areas mapped the solum is nearly neutral to medium acid. The texture is extremely variable, but silt loam and very fine sandy loam are dominant.

Cayuga Series.—The Cayuga series consists of deep, well drained to moderately well drained Gray-Brown Podzolic soils that developed in reworked lacustrine silt and clay and high-lime glacial till or in a thin layer of lacustrine sediments over high-lime till similar to that in which the Honeoye and Lansing soils developed. Reworking or mixing of the lacustrine materials is the result of frost action, tree throw, deep cultivation, and the burrowing of animals, all of which tend to bring subsoil material and stones to the surface.

In places the upper part of the solum resembles that of the Hudson soils, and the substratum is like that of the Honeoye or Lansing soils. Generally, the texture of the surface soil varies within short distances.

Cayuga soils are the well drained and moderately well drained members of their catena. The somewhat poorly drained Ovid soils and the poorly drained Ilion soils are the only other members of the catena mapped in Tompkins County.

Cayuga soils are moderately extensive in the northwestern part of the county, on both sides of Cayuga Lake.

Profile of Cayuga silt loam, pastured:

Ap—0 to 4 inches, very dark grayish-brown (10YR 3/2) heavy silt loam; moderate, medium, crumb structure; friable; pH 7.0; abrupt, smooth boundary; 4 to 6 inches thick.

A2—4 to 9 inches, brown (10YR 5/3) heavy silt loam; weak, thick, platy structure; friable to slightly firm; some Ap material in worm channels; pH 7.0; clear, smooth boundary; 2 to 5 inches thick.

B21t—9 to 13 inches, dark-brown (7.5YR 4/2) to reddish-brown (5YR 4/3) silty clay loam interiors, and dark-brown (10YR 4/3) ped surfaces; strong, coarse, subangular blocky to blocky structure; thin clay films in lowest 2 inches; pH 6.6; clear, wavy boundary; 2 to 4 inches thick.

B22t—13 to 25 inches, dark-brown (7.5YR 4/2–4/4) silty clay interiors, and grayish-brown (10YR 5/2) and dark grayish-brown (10YR 4/2) ped surfaces; few, fine, faint, dark yellow-brown (10YR 4/4) and pale-brown (10YR 6/3) mottles; strong, coarse and very coarse, blocky structure; firm; thick clay films on ped surfaces; pH 6.8; clear, wavy boundary; 10 to 15 inches thick.

C1—25 to 30 inches, reddish-brown (5YR 4/3) silt loam interiors and light reddish-brown (5YR 6/3) and reddish-brown (5YR 5/3) ped surfaces; thick, platy structure; firm; calcareous; abrupt boundary.

IIC2—30 to 60 inches, grayish-brown (2.5Y 5/2) gravelly loamy glacial till; thick, crudely shaped, platy structure; firm; calcareous.

Range in characteristics.—The texture of the surface soil ranges from loam to silty clay loam. That of the B horizon ranges from gravelly silt loam in soils formed in till to silty clay loam or silty clay in soils formed where the mantle of lacustrine material is 20 inches thick, or thicker. Coarse texture and sandiness are associated with underlying till or a thin mantle of lacustrine sand and silt over till. In places on the slopes bordering Cayuga Lake, Cayuga soils intergrade to Hudson soils, particularly where the lacustrine silt and clay are more than 3 feet thick over till. In places where Cayuga soils are associated with Hudson soils, the subsoil is reddish brown; where they are associated with Dunkirk soils, the subsoil may be yellowish brown. On the steeper slopes bordering the lake, shale may contribute a considerable part of the underlying till. Along some of the smaller streams that emptied into the glacial lake there are some small areas that have a fine sandy loam surface texture. The depth to till ranges from 12 to 36 inches, but typically it is 20 to 30 inches. Stoniness ranges from none to much gravel and many shale fragments. Depth to free lime commonly ranges from 24 to 36 inches, depending on past erosion.

CHENANGO SERIES.—The Chenango series consists of deep, well-drained Sols Bruns Acides developed in glacial outwash sand and gravel derived from acid, gray, fine-grained sandstone, siltstone, and shale. Originally, this parent material contained some limestone, which was subsequently leached out to a depth of 5 to 8 feet. In places clay bridges or a slight accumulation of clay may be found deep in the B horizon.

Chenango soils are the well drained members of the catena that includes the moderately well drained Braceville and the somewhat poorly drained Red Hook soils. The associated soils on the uplands are of the Lordstown, Bath, Mardin, and Volusia series. Chenango soils resemble Howard and Palmyra soils, but they lack the textural B horizon, are more strongly acid, and are deeper to calcareous material.

Chenango soils are moderately extensive and are important agriculturally.

Profile of Chenango gravelly loam, cultivated:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) gravelly loam or gravelly silt loam; moderate, fine, crumb structure; very friable; pH 5.0 to 5.4; smooth, clear boundary; 6 to 9 inches thick.

B1—8 to 13 inches, yellowish-brown (10YR 5/6) gravelly loam to gravelly silt loam; weak, medium, crumb structure; very friable; pH 5.0; clear, smooth boundary; 3 to 6 inches thick.

B2—13 to 26 inches, dark-brown (10YR 4/3) to dark yellowish-brown (10YR 4/4) gravelly silt loam or gravelly sandy loam; weak, medium, subangular blocky structure; very friable; many fine roots; pH 5.0 to 5.4; gradual, wavy boundary; 6 to 15 inches thick.

IIC1—26 to 34 inches, dark grayish-brown (10YR 4/2) to very dark grayish-brown (10YR 3/2) very gravelly loam; structureless; loose; some cobblestones; pH 5.2; gradual, wavy boundary; 8 to 12 inches thick.

IIIC2—34 inches +, dark grayish-brown (10YR 4/2) mixed sand, gravel, and cobblestones; no apparent structure; loose, open, and porous; overlies stratified sand and gravel; pH 5.5 to 6.0.

Range in characteristics.—The texture of the surface layer ranges from gravelly sandy loam to gravelly silt loam. Some of the gravel is rounded and waterworn, and some is local channery material deposited in fans. In places where free lime occurs at a depth of 5 to 8 feet there commonly occurs, in the lower part of the C horizon, a layer that is finer textured than the B or C horizon in the profile described and that resembles the lower part of the B horizon of Howard soils.

CHIPPEWA SERIES.—The Chippewa series consists of deep, medium-textured, poorly drained Low-Humic Gley soils that have a fragipan. These soils developed in glacial till derived mainly from acid, fine-grained sandstone and shale. They are the poorly drained soils in the catena that includes the well drained Bath, the moderately well drained Mardin, the somewhat poorly drained Volusia, and the very poorly drained Alden soils. The Chippewa soils are the acid analogs of the neutral or mildly alkaline, poorly drained Ellery soils.

Chippewa soils have a more acid fragipan than Ellery soils. They lack the mucky surface layer and intense gleying of Alden soils and have a darker colored plowed layer and a more strongly gleyed subsoil than Volusia soils. They are deeper to bedrock than Tuller soils and have a thicker, more strongly expressed fragipan.

The Chippewa soils are widely distributed but are agriculturally unimportant except in a few places.

Profile of Chippewa channery silt loam, pastured:

A1—0 to 4 inches, very dark gray (10YR 3/1) to very dark grayish-brown (10YR 3/2) silt loam; many, prominent, yellowish-brown (10YR 5/8) root mottles; moderate, medium, crumb structure; friable; many fine roots; pH 5.4; clear, smooth boundary; 3 to 5 inches thick.

A2g—4 to 10 inches, dark grayish-brown (2.5Y 4/2) heavy silt loam; many, fine, distinct, yellowish-brown (10YR 5/4) mottles; moderate, fine and medium, subangular blocky structure; friable to slightly firm; few fine roots; pH 5.2; gradual boundary; 5 to 7 inches thick.

IIA′2g—10 to 15 inches, grayish-brown (10 YR 5/) channery silt loam; common, medium, yellowish-brown (10YR 5/4) and gray (10YR 6/1) mottles and few olive-brown (2.5Y 5/4) mottles in lower 2 inches; weak, thin, platy structure that breaks to fine, subangular blocky structure; friable to slightly firm; few roots; pH 5.4; clear, wavy boundary; 4 to 6 inches thick.

IIB'x—15 to 25 inches, olive-brown (2.5Y 4/4) and olive (5Y 4/4) channery heavy silt loam; coarse prisms, 6 to 8 inches across, that have gray (5Y 6/1) silt surfaces; prisms bordered with dark brown (10YR 4/3) inside the silt surface; firm; few fine roots in cracks between prisms; pH 5.6; gradual boundary.

IIC—25 to 36 inches, olive-gray (5Y 5/2) and olive (5Y 5/3) channery silt loam or loam; massive; firm; pH 5.8.

Range in characteristics.—These soil vary mainly in thickness and texture of the material above the fragipan. In places surface wash of silty clay loam or silt loam, high in organic matter, has accumulated to a depth of 12 to 18 inches over the gleyed, channery silt loam or silty clay loam horizon. The plowed surface is darker than that of the associated and better drained Volusia soils. The gleyed horizon has chroma of 1 or 2. Mottles in this horizon range from few, fine, and distinct to many, common, and prominent, and the drainage range is from very poor, as in the Alden soils, to somewhat poor, as in the Volusia soils. Above the pan the pH value is generally less than 5.0, but in the fragipan it ranges from less than 5.0 to as much as 6.0, as Chippewa soils intergrade toward Ellery soils. The channery soil type is most common, but stoniness ranges from few channery fragments on the surface in silty depressions to many flaggy fragments where Chippewa soils intergrade toward the Lordstown or Tuller soils.

COLLAMER SERIES.—The Collamer series consists of deep, moderately well drained Gray-Brown Podzolic soils that developed in stratified silty and very fine sandy lacustrine deposits. These soils have a textural B horizon that developed in stratified or varved silt and very fine sand and that contains a sufficient amount of clay to qualify as an argillic horizon. Collamer soils are the moderately well drained soils in a catena that includes the well drained Dunkirk, the somewhat poorly drained Niagara, and the poorly drained or very poorly drained Canandaigua soils.

Collamer soils are lower in clay than are Hudson soils. They resemble Williamson soils, which formed in similar material, but they contain more clay and lack a fraigpan. Soils of the Collamer and Williamson series overlap or intergrade locally and have stratified beds of calcareous very fine sand and silt in the lower part of their substratum. Collamer soils are not extensive locally, but they are agriculturally important.

Profile of Collamer silt loam, cultivated:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, fine and medium, subangular blocky structure; slightly compacted; friable; pH 6.4; many roots; abrupt, smooth boundary; 7 to 10 inches thick.

A2—8 to 11 inches, brown (10YR 5/3) silt loam; common, medium to coarse, distinct, yellowish-brown (10YR 5/6-5/8), light brownish-gray (2.5Y 6/2), and dark grayish-brown (2.5Y 4/2) mottles; moderate, medium to coarse, subangular blocks that break to thin plates; friable; many roots; pH 6.2; clear, wavy boundary; 3 to 5 inches thick. In places this horizon is light gray (10YR 7/2) to light brownish gray (10YR 6/2) and free of mottles.

B21—11 to 14 inches, mottled yellowish-brown (10YR 5/6) and grayish-brown (2.5Y 5/2) heavy silt loam; moderate, medium to coarse, subangular blocky structure; firm; pH 6.5; clear, wavy boundary; 3 to 5 inches thick.

B22—14 to 27 inches, dark grayish-brown (10YR 4/2) heavy silt loam interiors and gray (N 6/0) silty ped surfaces; common, prominent, yellowish-brown (10YR 5/6) mottles; moderate, medium, blocky structure within moderate, coarse prisms; firm; clay films in lower 6 to 8 inches; pH 6.6 to 7.2; abrupt, smooth boundary; 12 to 15 inches thick.

C—27 inches +, dark grayish-brown (10YR 4/2), varved very fine sand and silt; gray (N 6/0) and yellowish-brown (10YR 5/4) mottles are common; very thin layers of pinkish clay that contains free lime lie between layers of sand and silt; weak, fine to medium, blocky structure; firm; calcareous.

Range in characteristics.—The principal types of Collamer soils in Tompkins County are silt loam and very fine sandy loam. A sandy type occurs as smears of very fine sand 10 to 14 inches thick over silt loam along Fall Creek in the vicinity of Freeville and on the property of Cornell University near Ithaca. Most of the very fine sandy loam intergrades to Williamson soils, which have a weak fragipan that lacks the blocky structure of that in the Collamer soils. Colors commonly have 10YR and 7.5 YR hues. Mottles range from medium to coarse and from distinct to prominent in the more silty soils, but in some places the A2 horizon is free of mottles. As Collamer soils intergrade to Niagara soils, the mottled A2 horizon becomes more distinct. The textural profile is intermediate between that of the very fine sandy loam Williamson soils, which have a weak fragipan, and the Hudson soils, which have a textural B horizon that is more than 30 percent clay and is of strong, blocky structure. Calcareous material is generally at a depth of 24 to 42 inches, but the depth to free lime may be 48 inches locally. In these places the solum is strongly acid, but in a modal profile the pH value of the B horizon is generally more than 6.0.

CONESUS SERIES.—The Conesus series consists of deep, moderately well drained, medium-textured Gray-Brown Podzolic soils developed in moderately calcareous glacial till derived mainly from shale and sandstone and to a lesser extent from limestone. These soils are strongly acid in the A2 horizons and the upper part of the B horizon, neutral in the lower part of the B horizon, and calcareous in the substratum. They are the moderately well drained members of the catena that includes the well drained Lansing, the somewhat poorly drained Kendaia, and the poorly drained and very poorly drained Lyons soils.

The profile is intermediate between the profile of the moderately well drained Lima soils, which are associated with Honeoye soils, and that of the moderately well drained Langford soils, which are associated with Valois soils. The solum and the A2 horizon of Conesus soils are thicker than those of Lima soils. Also, these soils lack the fragipan and the yellowish-brown B horizon that are characteristic of Langford soils.

Conesus soils are extensive in Tompkins County and are important agriculturally.

Profile of Conesus gravelly silt loam, cultivated:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) to dark grayish-brown (10 YR 4/2) gravelly silt loam; moderate, fine, crumb structure; friable; pH 6.2; abrupt, smooth boundary; 8 to 10 inches thick.

A21—7 to 11 inches, yellowish-brown (10YR 5/4) gravelly silt loam; weak, fine, crumb structure; very friable; pH 5.4; clear, smooth boundary; 3 to 5 inches thick.

A22—11 to 15 inches, brown (10YR 5/3) gravelly loam to silt loam; weak, fine and medium, subangular blocky structure; few, fine, faint, yellowish-brown mottles in lower 3 inches; friable; pH 5.4; clear, wavy boundary; 4 to 7 inches thick.

B1—15 to 22 inches, dark-brown (10YR 4/3) gravelly silt loam; fine and medium, faint, dark yellowish-brown (10YR 4/4) and grayish-brown (10YR 5/2) mottles; moderate, medium and coarse, blocky structure; slightly firm to firm; pH 5.6; thin clay films in places; gradual boundary; 4 to 7 inches thick.

B2t—22 to 34 inches, dark-brown (10YR 4/3) gravelly silty clay loam; common, medium, faint, dark yellowish-brown (10YR 4/4) and gray (10YR 5/2) and few, fine, yellowish-brown (10YR 5/4) mottles; strong, medium and coarse, blocky structure; firm; thick clay films; pH 6.0; gradual boundary; 12 to 15 inches thick.

C—34 to 42 inches, dark grayish-brown (10YR 4/2) gravelly silty clay loam to gravelly silt loam; few, grayish-brown (10YR 5/2) streaks; strong, medium, blocky or thick, platy structure; firm; pH 6.4 to weakly calcareous.

Range in characteristics.—The depth to carbonates ranges from 30 to 42 inches. Generally, the substratum is neutral below a depth of 36 inches. Channery fragments increase in number as these soils intergrade to Langford soils, and the amount of limestone gravel decreases. The pH values in the upper part of the solum range from 5.5 to 6.5. The depth to the A2 horizon ranges from 12 to 16 inches. The lower part of the A2 horizon has a few faint mottles in most places, but where these soils intergrade to Kendaia soils, the mottles are distinct and 2.5Y hues are common in the B and C horizons.

Darien Series.—The Darien series consists of deep, somewhat poorly drained Gray-Brown Podzolic soils developed in moderately calcareous glacial till derived from shale, sandstone, and limestone that were strongly influenced by reworked lacustrine sediments. Darien soils are closely associated with the poorly drained Ilion soils. They resemble Erie soils, but they have a clayey textural B horizon and lack a fragipan. They are similar to Ovid soils but are lower in lime and have a more clayey substratum.

Darien soils occur in areas of valley plugs or lateral moraines. They are not extensive nor important agriculturally.

Profile of Darien gravelly silt loam, cultivated:

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) gravelly silt loam; strong, fine and medium, subangular blocky structure; friable; pH 6.8; clear boundary; 8 to 10 inches thick.

A2g—9 to 13 inches, grayish-brown (10YR 5/2) gravelly heavy silt loam; common, medium, faint, dark yellowish-brown (10YR 4/4) mottles; moderate, fine to medium, blocky structure; firm; pH 6.4; clear, wavy boundary; 3 to 5 inches thick.

B2g—13 to 30 inches, gray (10YR 5/1) gravelly silty clay loam; many, fine, faint, yellowish-brown (10YR 5/4) mottles; moderate, medium, blocky structure in weak, coarse prisms; firm; plastic; pH 6.8 to 7.0; thin clay films on ped surfaces; gradual boundary; 15 to 20 inches thick.

C—30 to 38 inches, olive-brown (2.5Y 4.4) gravelly silty clay loam; vertical streaks of gray (N 5/0) with dark yellowish-brown (10YR 4/4) borders inside gray streaks that mark boundaries of very coarse prisms; strong, medium and coarse, blocky structure; firm; pH 7.0 to 7.4; calcareous below 38 inches.

Range in characteristics.—The texture of the parent material is variable within short distances both vertically and horizontally. Variations are mainly in thickness of materials over the textural B horizon and in occurrence of layers of sand, silt, or clay in the profile. The depth to carbonates is normally more than 36 inches, and in places the substratum may be only neutral.

Dunkirk Series.—The Dunkirk series consists of deep, well-drained Gray-Brown Podzolic soils that developed in stratified silty and fine sandy lacustrine deposits. These deposits contained sufficient amounts of clay for the development of a textural B horizon and accessory characteristics of consistence and structure. The Dunkirk series is the well drained member of a catena that includes the moderately well drained Collamer, the somewhat poorly drained Niagara, and the poorly drained to very poorly drained Canandaigua series.

Dunkirk soils have less clay in the B horizon than do Hudson soils and lack the mottling that is characteristic of Hudson soils. They are less sandy than Arkport soils and lack the distinct bands of sand in the B horizon. Dunkirk soils occur on convex slopes on the lake plains of ancient Lake Ithaca, which covered much of Tompkins County. They are of minor extent and are not agriculturally important.

Profile of Dunkirk silt loam, cultivated:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam; weak, fine and medium, crumb structure; very friable; many roots; pH 6.2; abrupt, smooth boundary; 7 to 9 inches thick.

B21—8 to 18 inches, dark-brown (7.5YR 4/4) heavy silt loam or light silty clay loam with dark-brown (7.5YR 4/2) ped surfaces; moderate, medium, blocky structure; firm; few roots; pH 6.2; gradual boundary; few clay films on peds in lower part of horizon; 7 to 10 inches thick.

B22—18 to 27 inches, dark-brown (7.5YR 4/4) light silty clay loam; moderate, coarse, blocky or thick, platy structure; firm; pH 6.2; peds coated with thin, dark-brown (7.5YR 4/2) clay films; slightly plastic when wet; gradual boundary; 8 to 11 inches thick.

B23—27 to 40 inches, dark-brown (7.5YR 4/4) heavy silt loam; few, fine, faint, olive-brown (2.5 Y 4/4) mottles; gray ped surfaces; moderate, thick, platy structure; slightly firm; pH 6.6 at 40 inches; abrupt, smooth boundary; 12 to 15 inches thick. Mottles in the lower part of the B horizon are common in this county.

C—40 to 60 inches, dark grayish-brown (2.5Y 4/2) silt loam; thick, platy structure; firm; calcareous at 50 inches; platy structure is the result of varving.

Range in characteristics.—The B horizon of Dunkirk soils is as much as 15 to 30 percent clay where these soils intergrade to Hudson soils. The colors of the solum locally range in hue from 10YR to 5YR; values of 4 to 5 are most common. Faint mottles occur in the A2 horizon where these soils intergrade toward the moderately well drained Collamer soils. Locally, the lower part of the B horizon is mottled, probably as a result of varving or stratification in the parent materials. The pH values range from less than 5.0 to more than 6.0 in soils intergrading toward Hudson soils. Depth to carbonates commonly ranges from 24 to 36 inches, but in places it may be as much as 50 inches.

Eel Series.—The Eel series consists of deep, moderately well drained Alluvial soils developed in alkaline or neutral alluvial sediments on bottom lands along streams. The sediments have washed from soils of uplands that have a medium or high content of lime. These soils receive new alluvium each spring during floods; consequently, they exhibit little profile development, except that the surface layer may be fairly high in organic-matter content. They are the moderately well drained members of the catena that includes the well drained Genesee, the poorly drained Wayland, and the very poorly drained Sloan soils.

These soils occur as relatively small, elongated areas along the larger streams in the central and northern parts of the county, mainly where the soils of the terraces are of the Palmyra or Howard series and the soils of the uplands are members of the Honeoye and Lansing catenas.

Profile of Eel silt loam, cultivated:

Ap—0 to 10 inches, dark grayish-brown (10YR 4/2) to dark-gray (10YR 4/1) silt loam; moderate, medium, crumb structure; friable; high in organic-matter content and full of fine roots; pH 6.5 to 7.0; clear, smooth boundary; 6 to 10 inches thick.

C1—10 to 27 inches, grayish-brown (10YR 5/2) fine sandy loam; common, medium, faint, dark-brown and brown mottles in the lower part; wormholes filled with worm casts and dark-gray material from surface horizon; weak, medium, subangular blocky structure; friable; pH 6.8 to 7.2; gradual, irregular boundary; 12 to 24 inches thick.

C2—27 to 36 inches, dark grayish-brown (10YR 4/2) fine sandy loam or sandy loam; common, distinct, brown and yellowish-brown mottles; weak, medium, subangular blocky structure; slightly firm to friable; pH 7.0 to 7.5; underlain in places by layers or lenses of fine to coarse sand and gravel; calcareous.

Range in characteristics.—The texture of the surface soil is silt loam in most places, but in some it is fine sandy loam. The texture of the substratum ranges from sand to gravel within short horizontal distances.

Lenses and layers of coarse gravel are common at a depth of 36 inches or more.

The modal soils are moderately well drained, but as mapped in Tompkins County, the series includes soils in the better drained half of the somewhat poor drainage class.

Ellery Series.—The Ellery series consists of deep, nearly neutral, poorly drained, medium-textured Low-Humic Gley soils. These soils have formed on nearly neutral to mildly calcareous glacial till derived mainly from local shale and sandstone bedrock and to a lesser extent from limestone. They are the poorly drained members of the catena that includes the well drained Valois, the moderately well drained Langford, the somewhat poorly drained Erie, and the very poorly drained Alden soils. Locally, Ellery soils occur adjacent to Volusia soils in areas that accumulate runoff or drainage water charged with lime. They resemble Chippewa soils but are higher in lime content. They differ from Erie soils in having a strongly gleyed subsoil and a darker colored plowed layer. Ellery soils lack the mucky surface soil and the intensely gleyed subsoil of the Alden soils. They are not so high in lime as Lyons soils, and their carbonates are at a greater depth. They have a fragipan and lack the clay content of the moderately fine textured Ilion soils.

Ellery soils are less extensive than Erie soils in Tompkins County and are agriculturally important only locally.

Profile of Ellery channery silt loam, cultivated:

Ap—0 to 8 inches, very dark gray (10YR 3/1) channery heavy silt loam; weak, fine and medium, crumb structure; friable; many fine roots; pH 7.0 (limed); abrupt, smooth boundary; 6 to 10 inches thick.

A2g—8 to 12 inches, dark grayish-brown (2.5Y 4/2) channery silt loam; distinct, dark grayish-brown (10YR 4/2) and dark yellowish-brown (10YR 4/4) mottles; weak, medium, subangular blocky structure; friable; many fine roots; pH 6.4; clear, wavy boundary; 3 to 5 inches thick.

Bx1g—12 to 23 inches, dark grayish-brown (2.5Y 4/2) channery heavy silt loam; common, distinct, gray (5Y 5/1) and olive-gray (5Y 5/2) and faint, dark grayish-brown (10YR 4/2) mottles; weak prisms, 2 to 6 inches across, that break into moderate, medium, subangular blocks; prisms coated with olive-gray (5Y 5/2) silt; friable to slightly firm; few fine roots between prisms; pH 6.2; gradual boundary; few clay films around stones and in large pores; 9 to 12 inches thick.

Bx2—23 to 36 inches, olive-brown (2.5Y 4/4) channery heavy silt loam; few, fine, distinct, dark-brown (10YR 4/3) mottles; weak, coarse prisms, 8 to 16 inches across, that break into medium and coarse blocks; firm; thin, dark grayish-brown (10YR 4/2) clay films on ped surfaces in places; some surfaces are dark brown (7.5YR 4/4); pH 6.8; gradual, wavy boundary; 12 to 15 inches thick.

C—36 inches, olive-gray (5Y 5/2) and olive (5Y 5/3) channery loam; few, faint, gray (N 5/0) and olive-brown (2.5Y 4/4) mottles; massive (structureless) but breaks into thick and very thick, irregularly shaped platy structure; firm; calcareous.

Range in characteristics.—The surface texture varies depending on the nature of the surface wash received from adjacent soils. It is most commonly channery silt loam, but it ranges locally from channery clay loam to channery silty clay. Variations in the thickness and in the stone content of the surface layer are typical. The thickness commonly is 8 to 12 inches, but this ranges locally from 15 to 18 inches. In some places the surface horizon may be strongly acid (pH 5.1 to 5.5), but the Bx horizons are ordinarily only slightly acid (pH 6.0 or above). The thickness of the solum above the fragipan varies with the amount of material accumulated on the surface. Typically, the depth to the fragipan ranges from 12 to 15 inches. The depth to carbonates ranges from 30 inches, where Ellery soils intergrade to Lyons soils, to 48 inches or more as they intergrade to Chippewa soils. The number of coarse fragments on the surface and in the profile varies and generally increases with depth. Locally, there are channery and gravelly areas. Some flaggy fragments are on the surface where Ellery soils intergrade to soils that are shallow over bedrock.

Erie Series.—The Erie series consists of deep, medium-textured, somewhat poorly drained Sols Bruns Acides that have a dense fragipan. These soils have developed in firm, neutral to weakly calcareous glacial till. The till is mainly a mixture of fine-grained sandstone and shale but includes small amounts of limestone. The Erie series is a member of the catena that includes the well drained Valois, the moderately well drained Langford, the poorly drained Ellery, and the very poorly drained Alden series.

Erie soils are mapped locally with Bath and Mardin soils in areas that receive runoff from soils charged with bases. Erie soils have slightly more lime in the fragipan and substratum than do Volusia soils. They are more strongly mottled than Langford soils and are shallower above the fragipan. They contain less lime than Kendaia soils. Erie soils are better drained than Ellery soils and lack the strongly gleyed horizon in the upper part of the solum that is typical of Ellery soils. Erie soils are very extensive in Tompkins County and are agriculturally important.

Profile of Erie channery silt loam, idle:

Ap—0 to 9 inches, dark grayish-brown (10YR 4/2) channery silt loam; weak, fine, crumb structure; very friable; many fine roots; pH 5.2; clear, smooth boundary; 6 to 10 inches thick.

B2—9 to 15 inches, mottled yellowish-brown (10YR 5/4), grayish-brown (2.5Y 5/2), and light brownish-gray (2.5Y 6/2) channery silt loam; weak, fine and medium, crumb structure; very friable; many fine roots; pH 5.4; clear, wavy boundary; 5 to 7 inches thick.

Bx1—15 to 28 inches, olive (5Y 5/4) channery heavy loam to light clay loam; common, distinct, yellowish-brown (10YR 5/8) mottles; weak, fine and medium, subangular blocky structure; peds coated with light olive-gray (5Y 6/2) silt; slightly firm; few fine roots between peds; pH 5.6; gradual boundary; 10 to 15 inches thick.

Bx2—28 to 42 inches, olive-brown (2.5Y 4/4) and light olive-brown (2.5Y 5/4) channery loam; few, fine, faint, light olive-gray (5Y 6/2) mottles; coarse prisms 6 to 8 inches across that break into moderate, medium and coarse, angular blocks; firm; pH 6.2; gradual boundary; 13 to 16 inches thick.

C—42 to 60 inches, olive (5Y 4/4) channery silt loam with few, fine, faint, olive-brown (2.5Y 4/4) mottles; coarse prisms that break into moderate, thick plates; firm; calcareous till to a depth of 15 feet.

Range in characteristics.—The depth to the fragipan, or Bx1 horizon, ranges from 12 to 15 inches in plowed fields but most commonly is 12 to 14 inches. In forested areas on small knolls, where 3 to 5 inches of a mottled B horizon is present, the depth to the pan ranges from 15 to 18 inches. The upper solum is strongly acid, but pH values of 6.0 or more are typical in the fragipan below a depth of 28 to 30 inches. The pH may not be above 6.0 to a depth of 42 inches or more where Erie soils intergrade to Volusia soils. Typically, the depth to free lime ranges from 36 to 60 inches, but it may be as much as 7 feet.

FREDON SERIES.—The Fredon series consists of deep, somewhat poorly drained Gray-Brown Podzolic soils developed in glaciofluvial materials that are neutral to calcareous 18 to 40 inches below the surface. Coarse fragments in the profile indicate that the parent material was derived mainly from shale and sandstone and to a lesser extent from limestone. Fredon soils are the somewhat poorly drained soils in the Howard catena and in the Palmyra catena. In Tompkins County, they are associated principally with Howard and Phelps soils in the vicinity of Freeville.

Profile of Fredon silt loam, cultivated:

Ap—0 to 9 inches, very dark gray (10YR 3/1) to very dark grayish-brown (10YR 3/2) silt loam; moderate, medium, granular structure; friable to slightly firm; pH 6.5 to 7.0; clear, smooth boundary; 8 to 11 inches thick.

A2—9 to 15 inches, mottled yellowish-brown (10YR 5/4) and light olive-brown (2.5Y 5/4) light silt loam; weak to moderate, subangular blocky structure that breaks into weak, thin, platy structure; friable; pH 6.5; 6 to 12 inches thick.

IIB2g—15 to 25 inches, olive-gray (5Y 5/2) to dark grayish-brown (2.5Y 4/2) gravelly loam to silt loam; common, medium to fine, olive-brown and yellowish-brown mottles; weak, medium, subangular blocky structure; firm; slightly plastic when wet; pH 7.0; gradual, irregular boundary; 6 to 15 inches thick.

IIC—25 inches +, gray (5Y 5/1) gravelly silt loam or stratified coarse gravel and sand derived from shale, sandstone, and some limestone; firm in place; neutral (pH 7.0) to weakly calcareous.

Range in characteristics.—Fredon soils vary considerably in depth to calcareous material. Where they are associated with Howard soils, the depth to free lime may exceed 40 inches, and where they are associated with Palmyra soils, free lime may be at a depth of 18 inches. The texture of the surface soil ranges from sandy loam to silt loam. Typically, these soils are gravelly, but gravel-free areas have been mapped. The surface layer is very dark gray to very dark grayish brown, depending on drainage, and it may be as much as 18 inches thick in places.

GENESEE SERIES.—The Genesee series consists of deep, well-drained, medium-textured Alluvial soils developed in recent alluvial sediments washed from medium-lime and high-lime soils. These soils are the well drained members of the catena that includes the moderately well drained Eel, the poorly drained Wayland, and the very poorly drained Sloan soils. They are on the flood plains of streams throughout the central and northern parts of the county.

Genesee soils are not extensive, and they are agriculturally important in only a few places in Tompkins County.

Profile of Genesee silt loam, cultivated:

Ap—0 to 12 inches, very dark gray (10YR 3/1) loam or silt loam; moderate, medium, crumb structure; very friable; pH 7.0; clear, smooth boundary; 8 to 12 inches thick.

C1—12 to 26 inches, very dark grayish-brown (10YR 3/2) very fine sandy loam; structureless or weak, fine, crumb structure; friable; pH 7.0; gradual, irregular boundary; 12 to 18 inches thick.

C2—26 to 38 inches, very dark grayish-brown (2.5Y 3/2) silt loam; structureless; few, faint, yellowish-brown mottles below 36 inches; pH 7.0; abrupt, smooth boundary; 10 to 20 inches thick.

IIC3—38 inches +, coarse and fine mixed gravel and sand derived from shale, sandstone, and some limestone; calcareous.

Range in characteristics.—Along the larger streams, the texture of the surface and subsurface layers varies widely. The coarser textured materials are generally deposited near the banks, and the finer textured materials are deposited farther out on the flood plain. Lenses of coarse sand or gravel are common below a depth of 24 inches, and in places an overwash of coarse material has been deposited during floods.

HALSEY SERIES.—The Halsey series consists of deep, poorly drained and very poorly drained, medium-textured Low-Humic Gley soils intergrading to Humic Gley. These soils have developed in glaciofluvial materials of late Wisconsin age. They are the most poorly drained members of the Palmyra catena and of the Howard catena. The parent material is derived from shale, sandstone, and limestone. Limestone is dominant in the material underlying soils in the Palmyra catena; shale, siltstone, and sandstone are dominant in the material underlying those of the Howard catena.

In places the poor and very poor drainage of the Halsey soils results from impervious silty layers in the lower part of the substratum, but many areas are in depressions where the water table is high.

Halsey soils were mapped mainly in the vicinity of Etna and Freeville, where they are associated with Howard, Phelps, and Fredon soils. They are also closely associated with the more acid Chenango, Braceville, and Red Hook soils, which formed in similar materials.

Profile of Halsey mucky silt loam, idle:

Ap—0 to 8 inches, very dark gray to black (10YR 3/1–2/1) silt loam, high in organic matter; moderate, medium, crumb or granular structure; friable, with greasy feel and smooth texture; neutral (pH 6.5 to 7.0); clear, smooth boundary; 6 to 10 inches thick.

A2g—8 to 15 inches, gray (10YR 5/1) fine sandy loam or loam; weak, medium to fine, subangular blocky structure when moist; nearly massive when saturated; slightly firm; pH 6.5 to 7.0; may have few, fine, faint, reddish-brown mottles along old root channels; clear, smooth boundary; 6 to 10 inches thick.

B2g—15 to 28 inches, mottled grayish-brown (10YR 5/2) and yellowish-brown (10YR 5/6) fine sandy loam; massive (structureless) when saturated; weak, medium, blocky structure when moist; firm; pH 7.0; gradual boundary; 10 to 15 inches thick.

IIC—28 inches +, gray (10YR 4/1–4/2) gravelly sandy loam; massive; may contain stratified sand and gravel; in places a slowly permeable layer of silt or gravelly silt occurs between 30 and 50 inches, and material is continuously saturated; pH 7.0 to 7.5.

Range in characteristics.—The thickness and the organic-matter content of the surface layer vary widely. In some places this layer is nearly pure muck and is 12 to 18 inches thick, and in others it is mucky silt loam that is 8 to 12 percent organic matter. Some areas have as much gravel as the associated Fredon soils; other areas are practically gravel free in the upper 2 feet. In these areas a considerable amount of silt has been washed in from surrounding higher lying soils or has been deposited in lakes that covered the area after glaciation. Typically, Halsey soils are calcareous at a depth of 24 to 42 inches.

HOLLY SERIES.—The Holly series consists of deep, poorly drained, acid Low-Humic Gley soils that are associated with Tioga, Middlebury, and Papakating soils on first bottoms along streams in the southern part of the county. Holly soils are the acid analogs of Wayland soils, which have formed in neutral or alkaline alluvium. They are not mapped separately in Tompkins County but are combined with the very poorly drained Papakating soils as an undifferentiated unit.

Holly soils are not extensive nor important agriculturally in Tompkins County.

Profile of Holly silt loam, idle:

A1—0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam, high in organic-matter content; rust-brown streaks along root channels; weak, fine to medium, crumb structure; friable; slightly plastic; pH 5.5; clear, smooth boundary; saturated most of the year; 6 to 10 inches thick.

C1g—6 to 10 inches, light brownish-gray (2.5Y 6/2) silt loam; strong-brown (7.5YR 5/6) streaks along root channels; weak, fine, crumb structure; very friable; pH 5.5; gradual, wavy boundary; 3 to 8 inches thick.

C2g—10 to 26 inches, light brownish-gray (2.5Y 6/2) to gray (2.5Y 6/1) silt loam; common, distinct mottles of yellow, gray, and brown; weak, medium, crumb structure; friable; slightly plastic when wet; pH 5.5; gradual, irregular boundary; 12 to 20 inches thick.

C3—26 inches +, light olive-gray (5Y 6/2) sandy or silty alluvium washed from upland glacial till derived from acid shale and sandstone; pH 5.5; saturated almost continuously.

Range in characteristics.—The texture of the surface layer is normally silt loam but is fine sandy loam in places. Erratic lenses of sand and gravel are common at variable depths. Reaction ranges from strongly to slightly acid.

HONEOYE SERIES.—The Honeoye series consists of deep, well-drained, medium-textured Gray-Brown Podzolic soils developed in strongly calcareous glacial till derived from gray limestone mixed with gray sandstone and shale and minor amounts of other kinds of rock. These soils are the well drained members of the catena that includes the moderately well drained Lima, the somewhat poorly drained Kendaia, and the poorly and very poorly drained Lyons soils. They differ from the Lansing soils in having a thinner A horizon and in having carbonates within 30 inches of the surface.

Profile of Honeoye gravelly silt loam, cultivated:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) gravelly loam to light silt loam; strong, fine, granular structure; friable; pH 7.0; clear, smooth boundary; 7 to 10 inches thick.

A2—8 to 13 inches, brown (10YR 5/3) to yellowish-brown (10YR 5/4) gravelly light silt loam; strong, fine, granular structure; friable; pH 7.0; clear, wavy boundary; 3 to 5 inches thick.

B22—13 to 20 inches, dark-brown (7.5YR 4/4) gravelly heavy silt loam; strong to moderate, fine, blocky structure; slightly firm when moist, plastic when wet; pH 6.5; gradual boundary; 5 to 7 inches thick.

B23—20 to 30 inches, dark-brown (10YR 4/3) gravelly silt loam; moderate, fine and medium, blocky structure; slightly firm; thin clay films on ped surfaces; few stones; pH 7.0 or more; clear, gradual boundary; 8 to 10 inches thick.

C—30 inches +, brown (10YR 5/3) to grayish-brown (10YR 5/2) gravelly silt loam or loam; moderate, thick plates that break into strong, fine blocks; few roots; calcareous.

Range in characteristics.—The texture of the parent material ranges from light gravelly loam to gravelly silt loam, and the structure is commonly thick platy. Stoniness ranges from less than 5 percent in the solum to more than 30 percent in the substratum. Boulders of limestone, sandstone, and igneous rock are common throughout the profile. The proportion of shale to other rock material is higher in the silt loams, and the proportion of sandstone is higher in the loams. The reaction of the A2 horizon ranges from medium acid to neutral. Commonly in areas where the reaction of the A2 is near neutral, the B horizon is thin and weakly developed. Locally, these soils are calcareous at a depth of 16 to 18 inches. Depth to carbonates generally ranges from 16 to 30 inches but is most commonly 24 to 26 inches.

HOWARD SERIES.—The Howard series consists of deep, well-drained Gray-Brown Podzolic soils formed in stratified deposits of outwash, deltaic materials, or kame moraines derived from shale, sandstone, and limestone. They are the well drained members of the catena that includes the moderately well drained Phelps, the somewhat poorly drained Fredon, and the poorly drained and very poorly drained Halsey soils. Phelps, Fredon, and Halsey soils are also included in a catena with Palmyra soils.

Howard soils have a thicker solum and greater depth to free carbonates than do Palmyra soils. The upper part of the solum in Howard soils resembles that in Chenango soils, which lack a textural B horizon and are deeper to free carbonates. Howard soils lack the mottling in the lower part of the B horizon that is characteristic of the associated Phelps soils. They are fairly extensive in the valleys of the county and are important agriculturally.

Chemical and physical properties of Howard soils are shown in the section "Laboratory Data."

Profile of Howard gravelly loam, cultivated:

Ap—0 to 9 inches, dark grayish-brown (2.5Y 4/2) sandy loam to loam; strong, fine, granular structure; very friable; pH 5.4; 5 to 10 percent coarse fragments, by volume; clear, smooth boundary; 6 to 10 inches thick.

A21—9 to 16 inches, brownish-yellow (10YR 6/6) fine sandy loam; weak, fine, granular structure; friable; pH 5.2; 0 to 5 percent coarse fragments, by volume; gradual boundary; 5 to 8 inches thick.

A22—16 to 25 inches, yellowish-brown (10YR 5/6) loam; weak, fine, granular structure; very friable; pH 5.2; 0 to 8 percent coarse fragments, by volume; clear boundary, with tongues extending into horizon below; 6 to 9 inches thick.

IIB21—25 to 37 inches, dark-brown (10YR 4/3) to dark yellowish-brown (10YR 4/4) gravelly silt loam; weak, medium, blocky structure; friable; pH 5.6; gradual boundary; 8 to 12 inches thick.

IIIB22t—37 to 47 inches, dark yellowish-brown (10YR 4/4) gravelly sandy clay loam; strong, medium, blocky structure; firm when moist, plastic when wet; pH 6.0; gradual boundary; 8 to 12 inches thick.

IVB3—47 to 57 inches, dark yellowish-brown (10YR 3/4) gravelly silt loam; weak, medium, blocky structure; friable; pH 6.0; gradual boundary; 8 to 15 inches thick.

VC—57 inches +, dark olive-gray (5Y 3/2) mixed gravel and sand; structureless; loose and porous; 60 to 75 percent, by volume, is coarse gravel and cobbles of shale, sandstone, and limestone; calcareous.

Range in characteristics.—The color of the A2 horizon is brown to yellowish brown. Where Howard soils intergrade to Palmyra soils, the horizons may be considerably thinner than those in the profile described. The tongues of A22 material that extend into the B21 horizon are very distinct in some places and lacking in others. Depth to the C horizon is variable within short distances; differences of 1½ to 2 feet are common. Where Howard soils intergrade to the Palmyra soils to the north, the horizons become thinner, the colors darker, and the lime content greater. To the south, Howard soils intergrade to Chenango soils, which are Sols Bruns Acides. In these places the accumulation of clay in the B horizon is deeper in the profile, and the color of the A and B horizons is considerably more yellowish than is typical for Howard soils. The depth to carbonates ranges from 36 to 60 inches.

Hudson Series.—The Hudson series consists of deep, moderately well drained or well drained Gray-Brown Podzolic soils developed in calcareous, clayey, lacustrine materials. They are the well drained and moderately well drained members of the catena that includes the somewhat poorly drained Rhinebeck and the poorly drained and very poorly drained Madalin soils.

Hudson soils are more clayey than Collamer soils, which developed in stratified silty and very fine sandy materials, and they have developed in deeper lacustrine material than Cayuga and Ovid soils.

Hudson soils are moderately extensive in Tompkins County and are important agriculturally.

Profile of Hudson heavy silt loam, cultivated:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) heavy silt loam; weak, fine, subangular blocky structure; friable; pH 6.8; abrupt, smooth boundary; 7 to 10 inches thick.

A2—8 to 12 inches, pale-brown (10YR 6/3) silt loam; few, distinct, dark yellowish-brown (10YR 4/4) mottles; weak, fine, subangular blocky to weak, thin, platy structure; friable; pH 6.8; clear, smooth boundary; 3 to 5 inches thick.

B21t—12 to 20 inches, brown (10YR 5/3) silty clay loam; moderate, fine and medium, subangular blocky or blocky structure; firm; pH 7.0; gradual, wavy boundary; 7 to 10 inches thick. Peds coated with pale-brown silty material in upper part and by thin clay films in lower 2 or 3 inches.

B22t—20 to 36 inches, dark grayish-brown (10YR 4/2) to brown (10YR 5/3) silty clay loam; moderate to strong, medium and coarse, blocky structure; firm; thick clay films on ped surfaces; neutral (pH 7.0) to mildly calcareous; clear, wavy boundary; 12 to 16 inches thick.

C—36 to 40 inches, brown (7.5YR 5/4) heavy silt loam; moderate, coarse, blocky to thick, platy structure; firm; calcareous; secondary lime on ped surfaces.

Range in characteristics.—The surface texture is mainly silt loam and silty clay loam. The modal profile has a silty clay loam B horizon, but the texture ranges from heavy silt loam to silty clay. The depth to sand, silt, gravel, till, or bedrock ranges from 3 feet to 15 feet or more. A little gravel and a few shale fragments occur in these soils as they intergrade to Cayuga and Ovid soils. The depth to carbonates ranges from 20 to 42 inches. The solum is medium acid to neutral. Colors are mainly of 10YR or 7.5YR hue, with values of 4 and 5 and chromas of 3 and 4. Locally, hues of 5 YR may be encountered.

Ilion Series.—The Ilion series consists of deep, poorly drained, moderately fine textured Low-Humic Gley soils developed in thin, lacustrine sediments over calcareous till or a mixture of lacustrine material and till. They are the poorly drained members of the catena that includes the well drained and moderately well drained Cayuga, the moderately well drained and somewhat poorly drained Ovid, and the very poorly drained Lyons soils.

Ilion soils are heavier textured and higher in lime than Ellery soils, and lack the fragipan and the stoniness of those soils. They are similar in texture to Madalin soils but contain coarse fragments. Ilion soils in the region of Lansing and Honeoye soils are more clayey, are lower in lime, and have a brighter colored B horizon than Lyons soils. Where they are associated with Darien soils, they are grayer than the one described for the series.

Ilion soils are not extensive and are agriculturally important only in small areas in Tompkins County.

Profile of Ilion silty clay loam, pastured:

Ap—0 to 10 inches, very dark gray (10YR 3/1) and very dark brown (10YR 2/2) silty clay loam; few, fine, distinct, dark yellowish-brown (10YR 4/4) root mottles; weak crumb structure to moderate, fine and medium, subangular blocky structure; very friable to friable; pH 7.0; many fine roots; few channery fragments and fragments of shale; abrupt, smooth boundary; 7 to 10 inches thick normally, but 16 to 18 inches thick in places.

A2g—10 to 15 inches, dark grayish-brown (10YR 4/2) and grayish-brown (10YR 5/2) silty clay loam stained with material from Ap horizon; few, fine and medium, distinct and prominent, dark-brown (10YR 4/3) to dark yellowish-brown (10YR 4/4) and strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky and blocky structure; firm; pH 6.8; fewer roots than in Ap horizon; few channery and shaly fragments; clear, smooth boundary; 4 to 6 inches thick.

B2—15 to 26 inches, dark-brown (10YR 4/3) and dark yellowish-brown (10YR 4/4) silty clay loam or silty clay; many, distinct, yellowish-brown (10YR 5/6–5/8) mottles; moderate to strong, medium and coarse, blocky structure with gray (5Y 5/1) silty ped surfaces in upper part of the horizon and clay films in lower 5 to 6 inches; firm; pH 6.6; gradual boundary; 7 to 12 inches thick.

IIC—26 to 36 inches, dark yellowish-brown (10YR 4/4) silt loam; fewer mottles in ped interiors; moderate, coarse, blocky structure with gray (2.5Y 6/1) ped surfaces; firm; channery and shaly fragments more common; pH 7.0.

Range in characteristics.—The texture is mainly silty clay loam to silty clay, but locally silt loam, loam, and very fine sandy loam occur within very short distances. Also, in reworked materials, the texture changes abruptly within the profile. Thickness of the dark-colored surface horizon ranges from 4 to 6 inches in forested areas to 16 to 18 inches in pastured areas or plowed fields. Stoniness ranges from a few to many pebbles to a few channery fragments and fragments of shale where local bedrock has been mixed with the soil. The reaction is medium acid to slightly acid where Ilion soils are associated with Darien soils and neutral or mildly alkaline where they are associated with Cayuga soils. The depth to free lime is typically 18 to 36 inches but is variable in areas where the parent material had been reworked.

Kendaia Series.—The Kendaia series consists of deep, somewhat poorly drained, medium-textured Gray-Brown Podzolic soils developed in calcareous glacial till. The till was derived mainly from limestone but includes varying amounts of material derived from shale and sandstone. The modal Kendaia soils are the somewhat poorly drained members of the catena that includes the well drained Honeoye, the moderately well drained Lima, and the poorly drained and very poorly drained Lyons soils. Kendaia soils are also in a catena with Lansing and Conesus soils in Tompkins County.

Kendaia soils are higher in lime content than Erie soils, and they lack the fragipan that is characteristic of Erie soils. They are higher in lime content and less variable and coarser in texture than the somewhat poorly drained Darien soils, which have developed in glacial till that includes reworked gray lacustrine material. Kendaia soils are extensive in the county and are important agriculturally.

Profile of Kendaia silt loam, cultivated:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) heavy silt loam; moderate, fine and medium, crumb structure; very friable; pH 5.8; many fine roots; abrupt, smooth boundary; 6 to 9 inches thick.

A2g—8 to 17 inches, pale-brown (10YR 6/3) silt loam with light grayish-brown (10YR 6/2) ped coatings; common, medium, distinct, yellowish-brown (10YR 5/4) and grayish-brown (2.5Y 5/2) mottles; moderate, fine and medium, subangular blocky structure that breaks into weak, medium or thick, platy structure; friable; pH 5.6; very thin, discontinuous clay films on peds; many fine roots; gradual, wavy boundary; 5 to 9 inches thick.

B2—17 to 24 inches, dark grayish-brown (10YR 4/2) silty clay loam with very dark grayish-brown (10YR 3/2) ped faces; many, fine, distinct to prominent, yellowish-brown (10YR 5/4 to 5/8) and light olive-gray (5Y 6/2) mottles; thick, continuous clay films that are pale brown (10YR 6/3) in upper part and very dark grayish brown (10YR 3/2) in lower part; strong, medium and coarse, blocky and subangular blocky structure; firm to very firm; pH 6.6; clear, wavy boundary; 6 to 10 inches thick.

Cg—24 to 33 inches, dark grayish-brown (2.5Y 4/2) and grayish-brown (2.5Y 5/2) silt loam; many, fine, faint, light olive-brown (2.5Y 5/4) mottles; gray (10YR 6/1) ped coatings; moderate, thick, platy structure; firm; calcareous.

Range in characteristics.—The texture of the surface soil is silt loam or loam. The degree of stoniness varies. In some areas there is a little gravel or a few boulders, but other areas, where these soils intergrade to Erie soils, are channery. The colors range in hue from 10YR to 2.5Y, and a chroma of 2 or 3 is common. Lower chroma and prominent mottles occur where Kendaia soils intergrade to Lyons soils. The pH is generally more than 6.0 but may be less where Kendaia soils are associated with Lansing soils. The depth to carbonates ranges from 16 to 36 inches.

Lamson Series.—The Lamson series consists of deep, poorly drained and very poorly drained Humic Gley soils developed in lacustrine and deltaic fine and very fine sands deposited on flats and in depressions. These soils are the poorly drained and very poorly drained members of the catena that includes the well drained Arkport, the moderately well drained Galen, and the somewhat poorly drained Minoa soils. Arkport and Lamson soils are the only members of the catena that are mapped in Tompkins County. Lamson soils are closely associated with Canandaigua soils, which are finer textured and developed in silt.

Lamson soils are of limited extent in Tompkins County and of little importance agriculturally.

Profile of Lamson fine sandy loam, cultivated:

Ap—0 to 10 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; weak, fine and medium, crumb structure; very friable; pH 5.8 to 6.0; many fine roots; abrupt, smooth boundary; 6 to 10 inches thick.

A21g—10 to 14 inches, grayish-brown (2.5Y 5/2) fine or very fine sandy loam; medium, faint and distinct, olive-brown (2.5Y 5/4), dark yellowish-brown (10YR 4/4), and yellowish-brown (10YR 5/4–5/6) mottles; weak, fine, subangular blocky structure; friable to slightly firm; fewer roots than in Ap horizon; pH 6.0; clear, smooth boundary; 3 to 5 inches thick.

A22g—14 to 21 inches, mottled grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4) fine sandy loam; common, fine and medium, distinct, yellowish-brown (10YR 5/4–5/6) and dark yellowish-brown (10YR 4/4) mottles; weak, fine to medium, subangular blocky structure; friable to slightly firm; few fine roots; pH 6.2; 6 to 8 inches thick.

B2—21 to 27 inches, light olive-brown (2.5Y 4/4) and olive-brown (2.5Y 4/4) very fine sandy loam; common, distinct, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/4) mottles and few gray (N 6/0) mottles; medium and coarse, subangular blocky structure; firm; few roots; pH 6.4; gradual boundary; 12 to 15 inches thick.

IIC—27 to 36 inches, dark grayish-brown (2.5Y 4/2) loamy fine sand; few, fine, faint, olive-brown (2.5 Y 4/4) and light olive-brown (2.5Y 5/4) mottles; weak, thick, platy structure; firm; pH 6.6; underlain by stratified sandy loam and thin layers of silt.

Range in characteristics.—The texture of the plowed layer ranges from silt loam to fine sandy loam. The few areas of the soils in Tompkins County range in drainage from poor to very poor. The profile described is near the center of the poorly drained class. Layers of silt 2 to 4 inches thick may occur in the subsoil where these soils intergrade to Niagara or Canandaigua soils. Medium loamy sand occurs in the lower part of the substratum in places that border deltaic deposits. The depth to carbonates ranges from 24 to 48 inches. A chroma of 1 or 0 is common in the A2 horizon of very poorly drained soils of this series. A mucky surface layer 6 to 16 inches thick may occur in places where water stands at the surface most of the year.

Langford Series.—The Langford series consists of deep, medium-textured, moderately well drained Sols Bruns Acides that have a slightly acid to neutral fragipan. These soils have developed in firm, medium-textured, olive to light olive-brown glacial till that was derived mainly from local sandstone and shale bedrock but includes small amounts of material derived from limestone. The limestone makes the till neutral to mildly calcareous. Langford soils are the moderately well drained members of the catena that contains the well drained Valois, the somewhat poorly drained Erie, the poorly drained Ellery, and the very poorly drained Alden soils.

Langford soils have a fragipan that is slightly clayey and higher in lime than the fragipan of Mardin soils. They are lower in both clay and lime in the solum than Conesus soils, which do not have a fragipan.

Langford soils are very extensive in Tompkins County and are agriculturally important.

Chemical and physical data for Langford soils are presented in the section "Laboratory Data."

Profile of Langford channery silt loam, cultivated:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) channery silt loam; very weak, fine, crumb structure; very friable; pH 5.4; abrupt, smooth boundary; 7 to 9 inches thick.

B2—7 to 15 inches, yellowish-brown (10YR 5/4) channery silt loam; weak, very fine, crumb structure; very friable; pH 5.0; abrupt, wavy boundary; 7 to 14 inches thick.

A'2—15 to 22 inches, grayish-brown (2.5Y 5/2) channery loam or very fine sandy loam; few, distinct, fine and medium, yellowish-brown (10YR 5/6–5/8) mottles; weak, very fine, subangular to weak, thin, platy structure; very friable; pH 5.0; clear, wavy boundary; 7 to 10 inches thick.

B'x1g—22 to 30 inches, dark grayish-brown (2.5Y 4/2 and 10YR 4/2) channery silt loam; weak, medium prisms 6 to 8 inches across, that break into weak, medium, subangular blocks; prisms coated with light brownish-gray (10YR 6/2), light olive-brown (2.5Y 6/2), and grayish-brown (2.5Y 5/4) silty or very fine sandy material; a dark-brown (10YR 4/3) to dark yellowish brown (10YR 4/4) layer ¼ to ⅛ inch thick is inside the prism coating; firm; pH 5.6; gradual boundary; 8 to 12 inches thick.

B'x2g—30 to 52 inches, dark grayish-brown (10YR 4/2) to olive-brown (2.5Y 4/4) channery heavy silt loam; moderate, very coarse prisms, 16 to 18 inches across, that break into moderate, coarse and medium, angular and subangular blocks; prisms are coated with a very thin layer of silt; thin, discontinuous clay films on some ped surfaces and in large pores; firm; pH 6.0 to 6.4; diffuse boundary; 18 to 28 inches thick.

C—52 to 60 inches, light olive-brown (2.5Y 5/4) to olive-brown (2.5Y 4/4) channery silt loam; moderate, thick, crudely platy structure in weak, very coarse prisms; firm; thin, discontinuous clay films on prism surfaces and inside large pores; pH 6.6 to 7.0.

Range in characteristics.—The plowed layer ranges from 4 inches in thickness in old idle fields to 8 or 10 inches in recently plowed fields. In most places it is dark grayish brown in color (hue 10YR) and channery silt loam in texture. The top 4 to 8 inches of the yellowish-brown B horizon is free of mottles, but mottling ranges from prominent below the top 4 inches, where Langford soils intergrade to Erie soils, to faint in the A'2g horizon, where they intergrade to Valois soils. The depth to the fragipan, or B'x1g horizon, ranges from 15 to 24 inches, and the fragipan extends to a depth of 42 to 60 inches. Thus the fragipan typically ranges from 2 to 3½ feet in thickness. The solum of unlimed Langford soils is strongly acid, but the pH is ordinarily 6.0 or more in the fragipan at a depth of 30 to 42 inches. The depth to neutral material ranges from 36 to 42 inches, typically, and the depth to mildly calcareous material from 42 to 60 inches. Channery types are most common in this county, but stoniness ranges from gravelly to flaggy.

Lansing Series.—The Lansing series consists of deep, well-drained Gray-Brown Podzolic soils that developed in moderately calcareous, firm glacial till derived from limestone, sandstone, and shale. These soils are the well drained members of the catena that includes the moderately well drained Conesus, the somewhat poorly drained Kendaia, and the poorly drained and very poorly drained Lyons soils.

Lansing soils have a very strongly acid A2 horizon that is thicker than that of the Honeoye soils. Parts of the A horizon resemble the B horizon of the Sols Bruns Acides in both color and reaction; the lower part is more typical of the Gray-Brown Podzolic soils. The depth to carbonates is greater than in the Honeoye soils. Lansing soils are similar to Bath and Valois soils in the upper part of the solum, but they contain more lime than these soils and lack a fragipan.

Lansing soils are moderately extensive in the northwestern part of Tompkins County.

Profile of Lansing gravelly silt loam, cultivated:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) gravelly silt loam; strong, fine, granular structure; friable; pH 6.0; abrupt, smooth boundary; 7 to 10 inches thick.

A21—8 to 12 inches, yellowish-brown (10YR 5/6) gravelly silt loam; strong, fine, granular structure; friable; pH 5.6; gradual boundary; 4 to 6 inches thick.

A22—12 to 17 inches, brown (10YR 5/3) gravelly silt loam; weak, thin, platy structure to medium, fine, granular structure; friable; peds vesicular; very fine, faint, mottles; pH 5.8 to 6.0; clear boundary.

B2—17 to 32 inches, grayish-brown (10YR 5/2) gravelly heavy silt loam or light silty clay loam; moderate to strong, medium, blocky structure; firm to very firm; thin clay films on ped surfaces; pH 6.0 to 7.0; gradual, wavy boundary; 15 to 20 inches thick.

C—32 to 48 inches, light olive-brown (2.5Y 5/4) to olive-brown (2.5Y 4/4) gravelly silt loam; strong, fine and medium, blocky structure that breaks into weak, medium and thick, platy structure; firm to very firm; weak clay flows on ped surfaces and on small stones; neutral at a depth of 32 inches and calcareous at 42 inches.

Range in characteristics.—Gravelly silt loam is the dominant type of Lansing soils, but channery loam or fine sandy loam occurs in Tompkins County. The A2 horizon extends to a depth of 14 to 22 inches. It is strongly acid to slightly acid. Differences in the thickness of the solum are associated mainly with differences in the thickness of the A21 horizon. These soils contain more shale than the Honeoye soils. Black shale is a minor constituent of the parent rock, and gray shale is most common along the lake slopes. The stone content ranges from a little gravel to more than 60 percent, by weight, of stones that range in size from small pebbles to boulders. The depth to carbonates ranges from 30 to 42 inches but is most commonly between 38 and 42 inches.

Lima Series.—The Lima series consists of deep, moderately well drained Gray-Brown Podzolic soils that developed in highly calcareous glacial till derived from gray limestone and shale and small amounts of sandstone and igneous rock. These soils are the moderately well drained members of the catena that includes the well drained Honeoye, the somewhat poorly drained Kendaia, and the poorly drained and very poorly drained Lyons soils.

Lima soils differ from Conesus soils in that they have a thinner or more weakly expressed A2 horizon and are shallower over calcareous till. Lima soils are not so clayey as Darien soils.

Chemical and physical data for Lima soils are given in the section "Laboratory Data."

Profile of Lima silt loam, cultivated:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam; very weak, fine, crumb structure; very friable; pH 7.0; many fine roots; 5 to 10 percent gravel, by volume; abrupt, smooth boundary; 6 to 9 inches thick.

A2—7 to 12 inches, brown (10YR 5/3) silt loam; weak, medium, subangular blocky structure; ped coats lighter colored than interiors; friable; pH 7.0; small amount of Ap material in worm casts; 10 to 15 percent gravel, by volume; clear, smooth boundary; 3 to 5 inches thick.

B21t—12 to 20 inches, yellowish-brown (10YR 5/4) heavy silt loam; moderate, fine and medium, subangular blocky structure; ped surfaces have thin, discontinuous, dark grayish-brown (10YR 4/2) clay films; friable; 10 to 15 percent gravel by volume; pH 7.0; gradual boundary; 6 to 9 inches thick.

B22t—20 to 24 inches, olive-brown (2.5Y 4/4) gravelly silty clay loam; common to many, medium, distinct, yellowish-brown (10YR 5/4 and 5/6) mottles; strong to moderate, medium, blocky structure; continuous, thick, dark-brown clay films on peds; few, small, black concretions; firm; slightly sticky; pH 7.2; 15 to 20 percent gravel, by volume; clear, wavy boundary; 4 to 6 inches thick.

Cg—24 to 36 inches, dark grayish-brown (2.5Y 4/2) gravelly loam; fine, faint, olive-brown (2.5Y 4/4 and gray (5Y 5/1) mottles; firm; thick, platy structure; calcareous below a depth of 26 inches; limestone and few black shale fragments.

Range in characteristics.—The depth to carbonates is most commonly between 18 and 26 inches, but it ranges from a little less than 16 inches, along the northern boundary of the county in the town of Lansing, to 30 inches where Lima soils intergrade to Conesus soils to the south. The reaction of the solum is slightly acid or neutral in a modal soil but may be strongly acid (pH less than 5.5) in the upper part of the solum in places where Lima soils intergrade to Conesus soils.

Mottles occur in the A2 horizon where Lima soils intergrade to Kendaia soils and where the depth to the compact, high-lime till is 16 inches. Where the depth to the high-lime till is 24 to 30 inches, the A2 and B21 horizons may be almost free of mottles and only the B22 horizon and the upper part of the C horizons are mottled. Boulders and cobblestones occur in the subsoil and substratum.

LORDSTOWN SERIES.—The Lordstown series consists of well-drained Sols Bruns Acides developed on loose, silty, congeliturbate or thin glacial till derived from acid sandstone and shale. These soils are the well drained members of the catena that includes the moderately well drained Arnot (not mapped in this county) and the poorly drained Tuller soils.

Lordstown soils are normally shallow to moderately deep over bedrock, but deep phases may occur locally. Generally the solum rests directly on bedrock, but in places there is a thin C horizon consisting of loose, broken or displaced bedrock and a small amount of till between the fragments.

Lordstown soils lack the dense fragipan of Bath soils and are less than 40 inches deep over bedrock. They do not have a mottled horizon above the bedrock, as do the Arnot soils, but a thin, panlike C horizon may be present in some places where Lordstown soils intergrade to Bath soils.

Lordstown soils are moderately extensive in Tompkins County and are agriculturally important only locally.

Profile of Lordstown channery silt loam, cultivated:

Ap—0 to 10 inches, dark-brown (10YR 3/3) channery silt loam; weak, fine and medium, subangular blocky structure in the upper part and weak, thin, platy structure in lower 2 inches; very friable; many fine roots; pH 5.6; abrupt, smooth boundary; 7 to 10 inches thick.

B2—10 to 22 inches, yellowish-brown (10YR 5/6 and 5/8) channery silt loam; weak, fine, crumb structure; very friable; pH 5.4; gradual boundary; 10 to 13 inches thick.

B3—22 to 26 inches, light yellowish-brown (10YR 6/4) channery silt loam; weak, medium, subangular blocky structure; friable; pH 5.6; 3 to 5 inches thick.

C—26 to 30 inches, weathered, olive-gray fractured bedrock with material like that of the B3 horizon between the channery and flaggy fragments.

IIR—30 inches +, hard sandstone and shale bedrock.

Range in characteristics.—The depth to bedrock commonly ranges from 20 to 40 inches, but the extreme range is from 12 to 40 inches or more. Generally, the profile is strongly acid throughout. The bedrock consists of interbedded sandstone and shale that has been broken and displaced by glacial or frost action. The soils generally have channery fragments and flagstones throughout the profile. Where bedrock crops out on steep slopes, the B3 horizon and commonly the C horizon are lacking.

LYONS SERIES.—The Lyons series consists of deep, poorly drained and very poorly drained Humic Gley soils formed in calcareous glacial till derived from limestone, sandstone, and shale. Lyons soils are the poorly drained and very poorly drained members of the catena that includes the well drained Honeoye, the moderately well drained Lima, and the somewhat poorly drained Kendaia soils. Lyons soils are also catenary associates of Lansing and Conesus soils and are closely associated with Cayuga, Ovid, and Ilion soils in Tompkins County. Lyons soils contain more lime than do Chippewa, Ellery, and Alden soils, and they lack a fragipan. They contain less clay than do Ilion and Madalin soils.

Profile of Lyons mucky silt loam, pastured:

A1—0 to 12 inches, very dark gray (10YR 3/1) to black (10YR 2/1) mucky silt loam; weak, fine, crumb structure; very friable; pH 7.0; clear, wavy boundary; 8 to 18 inches thick.

B2g—12 to 23 inches, gray (N 5/0) heavy silt loam; common, medium, distinct, grayish-brown (2.5Y 5/2) and olive-brown (2.5Y 4/4) mottles; moderate, medium and coarse, subangular blocky structure; friable to slightly firm; pH 7.2; diffuse boundary; 11 to 13 inches thick.

C—23 to 36 inches, olive (5Y 4/4–5/4) silt loam with gray (N 5/0) vertical streaks 18 to 24 inches apart; massive; firm; calcareous.

Range in characteristics.—The texture of the surface layer ranges from mucky silt loam or silt loam to silty clay loam. The thickness of the A1 horizon ranges from 12 to 18 inches and varies most in cultivated fields where material has been washed from adjacent soils and deposited on these low-lying soils. Mottles in the gleyed horizon range from none to many and prominent. The slopes range from 0 to 8 percent but are mainly between 0 and 3 percent. The depth to lime ranges from 18 to 30 inches.

MADALIN SERIES.—The Madalin series consists of deep, poorly drained and very poorly drained Low-Humic Gley soils intergrading to Humic-Gley. These soils formed in beds of calcareous, lacustrine silty clay and clay that contain thin layers of sandy and silty material. They are the poorly drained and very poorly drained members of the catena that includes the well drained and moderately well drained Hudson and the somewhat poorly drained Rhinebeck soils. Typically, the Madalin soils occur along small drainageways and in level areas or slight depressions in the lake-plain region of Tompkins County.

The very poorly drained soils of this series have a mucky silty clay loam surface layer; the poorly drained soils have a very dark gray silty clay loam or silt loam surface layer.

These soils are not very extensive in Tompkins County and are unimportant agriculturally.

Profile of Madalin silty clay loam, pastured:

Ap—0 to 8 inches, very dark gray (10YR 3/1) silty clay loam or heavy silt loam high in organic-matter content; strong, medium, crumb to subangular blocky structure; friable; pH 6.1; clear, smooth boundary; 6 to 10 inches thick.

A2g—8 to 15 inches, grayish-brown (10YR 5/2) silty clay loam; many, medium, faint, yellowish-brown (10YR 5/4) mottles; weak, medium, subangular blocky structure that breaks into moderate, medium, crumb structure; slightly firm; pH 6.3; gradual boundary; 6 to 8 inches thick.

B2g—15 to 26 inches, dark grayish-brown (10YR 4/2) silty clay; common, distinct, pale-brown (10YR 6/3) and grayish-brown (10YR 5/2) mottles; strong, medium, blocky structure; firm; pH 6.5 to 7.0; gradual boundary; 8 to 11 inches thick.

C—26 to 38 inches, dark grayish-brown (10YR 4/2) clay or silty clay; few, faint to distinct, brown and gray mottles; moderate to strong, blocky structure; firm; calcareous.

Range in characteristics.—The texture of the surface layer ranges from silt loam to silty clay loam in the poorly drained soils of this series and from mucky silt loam to mucky silty clay in the very poorly drained soils. In slight depressions and along drainageways, this layer is 16 to 18 inches thick. The texture of the B horizon is silty clay or silty clay loam. The poorly drained soils have many faint and distinct mottles on chromas of 1 or 2 below the surface layer, and the very poorly drained soils have few distinct and prominent mottles on chromas of 0 and 1. The profile described is that of a poorly drained soil, but in the mucky soils drainage ranges into the very poorly drained class.

The depth to carbonates ranges from 18 to 24 inches, except that where the surface soil is deep or mucky, the depth is 6 to 12 inches greater. Thin strata of sandy and silty material may occur in the lower part of the Bg and C horizons.

MARDIN SERIES.—The Mardin series consists of deep, medium-textured, moderately well drained Sols Bruns Acides that have a strongly expressed, acid fragipan. These soils developed on firm, medium-textured, olive-colored, glacial till derived from fine-grained sandstone and shale. They are the moderately well drained members of the catena that includes the well drained Bath, the somewhat poorly drained Volusia, the poorly drained Chippewa, and the very poorly drained Alden soils. Mardin soils may be closely associated with the somewhat poorly drained Erie and the poorly drained Ellery soils, instead of with Volusia and Chippewa soils, in areas that receive seepage water charged with bases.

The Mardin soils have a more strongly acid fragipan and greater depth to neutral materials than Langford soils.

Chemical and physical data for Mardin soils are presented in the section "Laboratory Data."

Profile of Mardin channery silt loam, forested:

O1—1 inch to 0, loose leaf litter from beech, red oak, sugar maple, red maple, black cherry, and ash trees.

A11—0 to ½ inch, black (10YR 2/2) light silt loam high in organic-matter content; weak and moderate, fine, granular structure; very friable; numerous roots; ¼ to ½ inch thick.

A12—½ to 1 inch, dark-brown (10YR 3/3) when moist, gray (10YR 5/1) when dry, silt loam; weak, fine, crumb structure; friable when disturbed; pH 4.0; held together by fine roots; abrupt, smooth boundary; ½ to 1 inch thick.

A2—1 to 2 inches, brown (10YR 5/3) channery silt loam; weak, very thin, platy structure; friable; pH 4.2; abrupt, smooth boundary; 1 to 1½ inches thick.

B2—2 to 16 inches, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/6) channery silt loam; friable; moderate to coarse, subangular blocky structure that breaks into fine, subangular blocky and fine, crumb structure; pH 4.4; roots extend to the pan; clear, wavy boundary; 10 to 14 inches thick.

A'2g—16 to 24 inches, olive (5Y 5/3) and grayish-brown (2.5Y 5/2) channery silt loam or fine sandy loam; common, fine, faint, olive-brown (2.5Y 4/4) mottles; firm in place; weak, thick, platy structure; pH 4.7; clear, irregular boundary; 3 to 8 inches thick.

B'x1—24 to 34 inches, olive-brown (2.5Y 4/4) channery heavy silt loam; olive (5Y 5/3), dark-brown (7.5YR 4/4), and dark yellowish-brown (10YR 4/4) mottles; extremely firm; moderate, very coarse prisms that break into large, subangular blocks; pH 4.8; olive-colored, vertical streaks 10 to 16 inches apart border prisms; gradual boundary; 8 to 12 inches thick.

B'x2—34 to 42 inches, olive-brown (2.5Y 4/4), approaching olive (5Y 5/3), channery loam; strong, coarse prisms about 12 inches across; extremely firm and difficult to remove; prism faces are olive (5Y 5/3) with dark-brown (7.5YR 4/4) borders, ¼ to ½ inch thick, inside olive surfaces; interior of prisms not mottled; pH 5.1; large pores coated with clay films; gradual boundary; 8 to 12 inches thick.

C1—42 to 65 inches, olive (5Y 4/3) channery loam; very firm; massive (structureless); occasional streak from horizon above penetrates this horizon; clay films coat the few pores; pH 5.8 to 6.0; diffuse boundary; 20 to 26 inches thick.

C2—65 to 80 inches, calcareous loamy glacial till in thick, crudely shaped plates.

Range in characteristics.—The depth to the fragipan ranges from 15 to 20 inches. The B2 horizon may be free of mottles to a depth of 16 to 18 inches where Mardin soils intergrade to Bath soils. The fragipan is generally strongly acid, but where these soils intergrade to Langford soils, which are underlain by neutral till at a depth of 48 to 60 inches, the fragipan is medium acid (pH almost 6.0). The depth to bedrock ranges from 2½ to 7 feet or more. The common soil type is channery silt loam.

MIDDLEBURY SERIES.—The Middlebury series consists of deep, moderately well drained Alluvial soils that developed in acid, recent alluvium on bottom lands along streams in the central and southern parts of the county. These soils are the moderately well drained members of the catena that includes the well drained Tioga, the poorly drained Holly, and the very poorly drained Papakating soils. In Tompkins County, Middlebury soils are mapped with Tioga soils in an undifferentiated unit. They occupy a somewhat lower position than Tioga soils, and their natural water table is nearer the surface. All areas are subject to periodic floods, which usually occur during spring. Middlebury soils are not extensive but are important agriculturally.

Profile of Middlebury silt loam, cultivated:

Ap—0 to 8 inches, grayish-brown (10YR 5/2) to dark grayish-brown (10YR 4/2) silt loam; moderate, medium, crumb structure; friable; pH 5.5; clear, smooth boundary; 8 to 10 inches thick.

C1—8 to 17 inches, pale-brown (10YR 6/3) to brown (10YR 5/3) silt loam; weak, medium to fine, crumb structure; friable when moist, slightly plastic when wet; pH 5.5; gradual, irregular boundary; 8 to 15 inches thick.

C2g—17 to 30 inches, grayish-brown (10YR 5/2) silt loam; many, medium mottles of yellowish brown (10YR 5/6); weak, medium, crumb structure to slightly massive (structureless); slightly firm to friable; pH 5.6; gradual, wavy boundary; 10 to 20 inches thick.

C3g—30 inches +, light olive-brown (2.5Y 5/4) to grayish-brown (2.5Y 5/2) silt loam; common, faint and distinct mottles of gray and brown; firm in place; slightly plastic when wet; pH 5.5 to 5.8.

Range in characteristics.—The texture varies; it is generally fine sandy loam or silt loam or, in a few places, silty clay loam. Layers and lenses of gravel and coarse sand are common, especially below a depth of 36 inches. Depth to distinct mottling ranges from 15 to 24 inches.

Niagara Series.—The Niagara series consists of deep, somewhat poorly drained, medium-textured Gray-Brown Podzolic soils that developed in calcareous, stratified, lacustrine silt and very fine sands and some clay. These soils are the somewhat poorly drained members of the catena that includes the well drained Dunkirk, the moderately well drained Collamer, and the poorly drained and very poorly drained Canandaigua soils. Niagara soils are the silty analogs of the clayey Rhinebeck soils and occur in similar positions in the landscape.

In Tompkins County the Niagara soils are associated with the moderately well drained Williamson soils and are in the same general area as Rhinebeck soils. The transition from one of these soils to another is gradual. These soils are of limited extent and are moderately important agriculturally.

Profile of Niagara silt loam, cultivated:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) and very dark grayish-brown (10YR 3/2) silt loam; fine to medium, crumb structure; friable; pH 6.6; abrupt, smooth boundary; 6 to 10 inches thick.

A2g—8 to 13 inches, light brownish-gray (10YR 6/2) silt loam or very fine sandy loam partly mixed with material of the Ap horizon; few, distinct, medium, light olive-brown (2.5Y 5/4), dark-brown (7.5YR 4/4), and yellowish-brown (10YR 5/6) mottles; weak, granular structure that grades to weak, fine and medium, subangular blocky structure; pH 6.2; clear, smooth boundary; 4 to 6 inches thick.

B21g—13 to 24 inches, light grayish-brown (10YR 6/2) and light olive-brown (2.5Y 5/4) silt loam; many, medium, faint, light olive-brown (2.5Y 5/6) and distinct, dark-brown (7.5YR 4/4) mottles; weak, medium, subangular blocks with light yellowish-brown (10YR 6/4) silty surfaces; friable; pH 6.4; gradual boundary; 9 to 12 inches thick.

B22—24 to 30 inches, light olive-brown (2.5Y 5/4) heavy silt loam; few, distinct, dark-brown (7.5YR 4/4) and gray (10YR 6/1) mottles; moderate, medium prisms that break into moderate, medium to coarse blocks; firm; thin, discontinuous clay films on ped surfaces; pH 6.8 to 7.0; abrupt, smooth boundary; 6 to 8 inches thick.

C—30 inches +, stratified very fine sand and silt; very thin layers of pinkish clay and secondary calcium carbonate between layers of sand and silt; moderately thick, platy structure; vertical streaks of gray (N 5/0) material extending down from the B22 horizon form coarse prisms; calcareous.

Range in characteristics.—The color of the plowed layer ranges from dark grayish brown (10YR 4/2) to very dark grayish brown (10YR 3/1) where these soils intergrade to Canandaigua soils. Variations in thickness and in the amount of fine and very fine sand may occur in any horizon. The proportion of clay layers is small. Where the amount of clay increases, Niagara soils intergrade to Rhinebeck soils, which have a silty clay loam or silty clay B horizon. The depth to carbonates ranges from 24 to 40 inches.

Ovid Series.—The Ovid series is in the wetter half of the moderately well drained range and in all of the somewhat poorly drained range. These are moderately fine textured Gray-Brown Podzolic soils that developed in thin lacustrine sediments over high-lime till. In Tompkins County, Ovid soils are the moderately well drained and somewhat poorly drained members of the catena that includes the well drained Cayuga and the poorly drained Ilion soils.

Ovid soils have a finer textured surface layer and a more clayey B horizon than do Lima and Conesus soils. They are similar to Darien soils, but they lack the clayey substratum and are higher in lime. They contain shale fragments and gravel that are not typical of Rhinebeck soils.

Ovid soils are moderately extensive only in the northwestern part of the county, on both sides of Cayuga Lake.

Profile of Ovid silt loam, cultivated:

Ap—0 to 10 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, medium to coarse, crumb structure; very friable; pH 6.0; abrupt; smooth boundary; 8 to 11 inches thick.

A2g—10 to 14 inches, light brownish-gray (10YR 6/2) silt loam; common, medium to coarse, distinct, light-gray (10YR 7/1–7/2) and yellowish-brown (10YR 5/6–5/8) mottles; weak, moderate, subangular blocky structure; peds coated with gray silt; friable; pH 6.2; clear, wavy boundary; 3 to 5 inches thick.

B21g—14 to 20 inches, light brownish-gray (10YR 6/2) heavy silt loam; moderate, medium and coarse, subangular blocky structure; slightly firm; pH 6.0; gradual boundary; 6 to 11 inches thick.

B22—20 to 24 inches, mottled olive-brown (2.5Y 4/4) and olive (5Y 4/3) silty clay loam; few, distinct, dark yellowish-brown (10YR 4/4) and grayish-brown (2.5Y 5/2) mottles; moderate to strong, medium, blocky structure; firm; sticky when wet; pH 6.8; clear, wavy boundary; 3 to 5 inches thick.

IIC—24 to 30 inches, grayish-brown (2.5Y 5/2) gravelly loam; moderate, medium, thick, crudely platy structure; firm in place, friable when disturbed; strongly calcareous till.

Range in characteristics.—In places where Ovid soils are associated with Cayuga and Hudson soils, the thickness of the layer of lacustrine sediments typically varies from 12 to 36 inches. Where the parent material was reworked by natural agencies, the texture varies abruptly, both horizontally and vertically, from silty clay to gravelly loam or gravelly silt loam. Color hues are commonly 10YR but range from 7.5YR to 2.5YR. The range in mottling is wide; at one extreme, the moderately well drained soils have faint mottles in the A2 horizon, and at the other extreme, the intergrades to Ilion soils are mottled throughout. The soils range from nonstony to gravelly, and the underlying till contains a few boulders. Locally, shale fragments occur throughout the profile. Depth to bedrock may range from 1 foot to several feet.

The depth to carbonates ranges from 12 to 30 inches, depending mainly on the thickness of the lacustrine deposit or the presence of till material in the solum.

Palmyra Series.—The Palmyra series consists of deep, well-drained Gray-Brown Podzolic soils that formed on glaciofluvial materials of late Wisconsin age. The underlying stratified sand and gravel was derived mainly from limestone, shale, and sandstone and to a small extent from igneous rock. These soils are the well drained members of the catena that includes the moderately well drained Phelps, the somewhat poorly drained Fredon, and the poorly drained and very poorly drained Halsey soils.

Palmyra soils have a strongly expressed texture and color profile. Their A2 horizon is thinner and less yellowish than the A2 of Howard soils, and the depth to calcareous material is less. Palmyra soils are not extensive and are mainly in the extreme northern part of the county adjacent to Salmon Creek.

Profile of Palmyra gravelly loam, cultivated:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) gravelly loam; strong, fine, granular structure; friable; pH 6.5; smooth, clear boundary; 6 to 10 inches thick.

A2—8 to 12 inches, yellowish-brown (10YR 5/4) gravelly silt loam; weak, fine, granular to very weak, thin, platy structure; friable; pH 6.5; clear, irregular boundary; 4 to 6 inches thick.

B21—12 to 16 inches, grayish-brown (10YR 5/2) to brown (10YR 5/3) gravelly silt loam; weak, medium, subangular blocky structure; friable when moist, slightly plastic when wet; pH 7.0; gradual, irregular boundary; 3 to 6 inches thick.

B22t—16 to 21 inches, dark-brown (10YR 4/3) gravelly clay loam; moderate, medium, subangular blocky structure; friable; slightly sticky and plastic when wet; pH 7.0; clear, irregular boundary; 4 to 8 inches thick.

IIC—21 inches +, grayish-brown (10YR 5/2) mixed sand and gravel; calcareous; estimated to be 80 percent limestone, by volume; the rest is shale, sandstone, or igneous rock.

Range in characteristics.—In most areas of Palmyra soils in Tompkins County, the profile closely resembles the profile described. Tongues of B2 material extend erratically and to variable depths into the C horizon. The depth to calcareous material ranges from 15 to 30 inches.

Papakating Series.—The Papakating series consists of deep, very poorly drained, medium textured to moderately fine textured, acid Humic Gley soils on first bottoms along streams in the southern part of the county. These soils are the very poorly drained members of the Tioga, Middlebury, and Holly catena. They are the acid analogs of the Sloan soils, which formed in neutral or alkaline materials.

Papakating soils are limited in extent and are not important agriculturally. In Tompkins County they are mapped with Holly soils as an undifferentiated unit.

Profile of Papakating silt loam, pastured:

Ap—0 to 10 inches, black (10YR 2/1) mucky silt loam; many dark-brown (7.5YR 4/4) root mottles; moderate, coarse, crumb structure; friable; pH 5.5; abrupt, smooth boundary; 10 to 16 inches thick.

C1g—10 to 20 inches, gray (5Y 5/1) silt loam or silty clay loam; common, coarse, distinct mottles of dark brown (10YR 4/3); weak, medium, subangular blocky structure that breaks to coarse, crumb structure; sticky and plastic when wet; pH 5.5; gradual boundary; 8 to 12 inches thick.

C2—20 to 34 inches, dark-gray (N 4/0) silt loam or silty clay loam alluvial material; may have lenses and layers of gravel below 34 inches; massive (structureless); firm in place; pH 5.6 to 5.8.

Range in characteristics.—The surface layer may consist of 8 to 10 inches of muck or highly organic mineral soil. Lenses of sand and gravel may occur below 34 inches.

Phelps Series.—The Phelps series consists of deep, moderately well drained, medium-textured Gray-Brown Podzolic soils that formed in glacial outwash derived from limestone, sandstone, and shale. These soils are the moderately well drained members of the catena that includes the well drained Palmyra, the somewhat poorly drained Fredon, and the poorly drained and very poorly drained Halsey soils. They are also the moderately well drained soils associated with Howard soils. Braceville soils are the acid analogs of Phelps soils but lack the textural B horizon. Phelps soils are of moderate extent and are important agriculturally.

Profile of Phelps gravelly silt loam, cultivated:

Ap—0 to 9 inches, dark-brown (10YR 4/3-3/3) gravelly loam or gravelly silt loam; moderate, medium, crumb structure; friable; pH 6.0; many fine roots; abrupt, smooth boundary; 7 to 10 inches thick.

A2g—9 to 15 inches, grayish-brown (2.5Y 5/2) gravelly loam; common, medium, faint, light olive-brown (2.5Y 5/6) and distinct, yellowish-brown (10YR 5/6–5/8) mottles; ped faces light grayish brown (10YR 6/2); moderate, medium and coarse, subangular blocky structure that grades to blocky with increasing depth; firm; pH 6.2; very fine roots in cracks between peds; gradual, wavy boundary; 5 to 10 inches thick.

B2g—15 to 25 inches, dark grayish-brown (10YR 4/2) heavy silt loam interiors with grayish brown (10YR 5/2) and brown (10YR 5/3) ped surfaces; few, distinct, yellowish-brown and light olive-brown mottles; moderate to strong blocky structure; firm; pH 6.6; few pebbles; clear, irregular boundary; 10 to 16 inches thick.

C—25 to 40 inches, dark grayish-brown (10YR 4/2) gravelly loam and dark yellowish-brown (10YR 4/4) silt interbedded; loose gravel and friable silty layers; calcareous; stratified silt and sand in places.

Range in characteristics.—The depth to free lime ranges from 24 to 40 inches. Where the depth to free lime is greatest, the reaction of the A2 and of the upper part of the B horizon may be pH 5.5. Where Phelps soils intergrade to Fredon soils, the A2 horizon is mottled. Where Phelps soils intergrade to Howard soils, moderately good drainage is indicated by mottles in the B2 horizon. The restricted drainage may result from a high water table where the substratum ordinarily consists of stratified sand and gravel. In other places it may result from impervious layers of silt and silty clay loam or glacial till under the glacial outwash in which Phelps soils developed.

Red Hook Series.—The Red Hook series consists of deep, somewhat poorly drained, medium-textured Sols Bruns Acides that developed in glacial outwash derived from acid gray shale, siltstone, and sandstone. Red Hook soils are the somewhat poorly drained members of the catena that includes the well drained Chenango and the moderately well drained Braceville soils. The very poorly drained Halsey soils are the wetter associates. Red Hook soils are the acid analogs of Fredon soils.

Red Hook soils are of limited extent in Tompkins County and of minor importance agriculturally.

Profile of Red Hook silt loam, cultivated:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam or gravelly silt loam; moderate, medium to coarse, crumb structure; friable when moist, slightly plastic when wet; many fine roots; pH 5.5; clear, smooth boundary; 6 to 10 inches thick.

B21g—8 to 12 inches, light brownish-gray (10YR 6/2) silt loam; common, prominent mottles of yellowish brown (10YR 5/4); weak, medium to fine, subangular blocky structure; firm in place; pH 5.5 to 5.8; clear, smooth boundary; 4 to 6 inches thick.

B22g—12 to 26 inches, strongly mottled light olive-brown (2.5Y 5/4) and light brownish-gray (10YR 6/2) silt loam; very weak, medium, subangular blocky structure; firm in place; pH 5.6; fine and medium gravel; gradual, wavy boundary; 8 to 18 inches thick. Silty layer about 2 inches thick between this horizon and the C horizon.

IIC—26 inches +, dark-gray (5Y 4/1) very gravelly loam or mixed sand and gravel; stratified in lower part; structureless; firm in place; pH 5.5 to 6.0.

Range in characteristics.—The texture ranges from loam to gravelly silt loam. The amount of gravel is variable, but in most places it is less than is characteristically present in the associated, better drained soils. The series includes somewhat poorly drained soils that are strongly acid to medium acid. Thin to very thick silty layers occur at variable depths in the profile. These layers are generally the cause of the somewhat poor drainage, but a high water table also may be the cause.

RHINEBECK SERIES.—The Rhinebeck series consists of deep, somewhat poorly drained, moderately fine textured Gray-Brown Podzolic soils that developed in clayey, calcareous, lacustrine sediments. These soils are the somewhat poorly drained members of the catena that includes the well drained and moderately well drained Hudson and the poorly drained to very poorly drained Madalin soils.

Rhinebeck soils are finer textured than Niagara soils which developed in very fine sandy and silty materials, and they lack the stratification in the solum that is common in Niagara soils. They do not have a dark-colored plowed layer like Madalin soils or the low chromas typical of those soils. Rhinebeck soils are not so sandy as Lamson soils.

Rhinebeck soils are moderately extensive and agriculturally important in Tompkins County.

Chemical and physical data for Rhinebeck soils are presented in the section "Laboratory Data."

Profile of Rhinebeck silt loam, cultivated:

Ap—0 to 10 inches, dark grayish-brown (10YR 4/2) heavy silt loam; moderate, fine and medium, granular structure; friable; many fine roots; pH 6.8; abrupt, smooth boundary; 7 to 10 inches thick.

A2g—10 to 12 inches, grayish-brown (10YR 5/2) and olive-brown (2.5Y 4/4) silt loam in about equal amounts; weak, fine and medium, subangular blocky structure; friable; few fine roots; pH 6.7; clear, smooth boundary; 1½ to 3 inches thick. Most of this horizon has been mixed with the Ap horizon.

B2t—12 to 23 inches, olive-brown (2.5Y 4/4) silty clay loam; common, medium, light olive-brown (2.5Y 5/4–5/6) mottles; strong, coarse prisms, 2 to 6 inches across, that increase in size with increasing depth and break into moderate, medium, angular blocks; prisms coated with very sticky, dark-brown (10YR 3/3) and gray (N 5/0) clay; firm; few fine roots in cracks between prisms and in worm casts; pH 6.6; gradual, wavy boundary; 8 to 12 inches thick.

C1—23 to 27 inches, dark grayish-brown (2.5Y 4/2) and olive (5Y 4/4) silty clay loam in laminated layers of silt loam ⅓ to ¼ inch thick, with very thin clay layers and free lime between the silty layers; weak, coarse to very coarse prisms that break into thick plates; firm; no roots; calcareous; clear, smooth boundary.

C2—27 to 50 inches, olive-brown (2.5Y 4/4) silty clay loam with few gray (N 5/0) vertical streaks bordering weak, coarse prisms that break to very thick plates; calcareous.

Range in characteristics.—Fine or very fine sand may occur as thin layers in the profile or as a thin mantle over the profile where Rhinebeck soils intergrade to Niagara or Lamson soils. The reaction of the solum ranges from slightly acid to neutral. A few pebbles and channery fragments occur in the profile where Rhinebeck soils intergrade to Ovid or Darien soils. The depth to carbonates ranges from 24 to 36 inches. Depth to bedrock ranges from 36 inches to several feet.

SLOAN SERIES.—The Sloan series consists of deep, very poorly drained, medium textured and moderately fine textured Humic Gley soils on first bottoms in neutral or alkaline alluvial sediments. These soils are the very poorly drained associates of the well drained Genesee, the moderately well drained Eel, and the poorly drained Wayland soils. Sloan soils contain more lime than do their acid analogs, Papakating soils.

In Tompkins County, Sloan soils are mapped as an undifferentiated unit with Wayland soils. They are of limited extent and of limited importance agriculturally.

Profile of Sloan silt loam, pastured:

A1—0 to 10 inches, dark-gray (10YR 4/1) to very dark gray (10YR 3/1) mucky silt loam; moderate, medium, granular structure; plastic when wet, with greasy feel; high in organic-matter content; pH 7.0; clear, smooth boundary; 8 to 12 inches thick.

C1g—10 to 36 inches, gray (10YR 5/1) silt loam; common, medium, yellowish-brown (10YR 5/6) and grayish-brown (10YR 5/2) mottles; weak, medium, blocky structure or massive; pH 7.0; gradual, diffuse boundary; 20 to 36 inches thick.

IIC2—36 inches +, light-gray (10YR 6/1) stratified alluvial deposits of fine sand, silt, or gravel; neutral; permanently saturated with water.

Range in characteristics.—Sloan soils may have 8 to 18 inches of mucky surface soil. In most places they are saturated continuously. The surface layer may be gray or black.

TIOGA SERIES.—The Tioga series consists of deep, well-drained, medium-textured, acid Alluvial soils on bottom lands along streams. Tioga soils are the well drained members of the catena that includes the moderately well drained Middlebury, the poorly drained Holly, and the very poorly drained Papakating soils. Tioga soils are the acid analogs of Genesee soils.

In Tompkins County, Tioga and Middlebury soils are mapped together as an undifferentiated unit. They are moderately extensive in the southern part of the county and moderately important agriculturally. They are subject to periodic flooding.

Profile of Tioga silt loam, cultivated:

Ap—0 to 9 inches, grayish-brown (10YR 5/2) silt loam; moderate, fine, crumb structure; friable; pH 5.6; clear, smooth boundary; 6 to 10 inches thick.

C1—9 to 20 inches, pale-brown (10YR 6/3) to brown (10YR 5/3) silt loam; weak, medium to fine, crumb structure; friable to slightly firm in place; pH 5.5; less organic matter than in surface horizon; gradual, irregular boundary; 10 to 20 inches thick.

C2—20 to 36 inches, light brownish-gray (10YR 6/2) to grayish-brown (10YR 5/2) silt loam, sandy loam, or fine sandy loam; weak, fine, crumb structure; slightly firm in place; pH 5.5.

Range in characteristics.—The texture of the surface layer is dominantly silt loam, but it ranges from fine sandy loam to loam. In places it is gravelly. Lenses of gravel and sand are common below 36 inches.

TULLER SERIES.—The Tuller series consists of moderately deep, poorly drained and somewhat poorly drained Low-Humic Gley soils developed in acid, gray to dark-gray silt loam glacial till or frost-fractured rock material less than 24 inches deep over bedrock. The till consists mainly of channery and flaggy fragments and shale derived from the underlying dark grayish-brown sandstone and coarse-textured shale. The Tuller series is in the catena that includes the well-drained Lordstown soils.

Tuller soils resemble Volusia and Chippewa soils in profile characteristics but are shallow over bedrock and lack a fragipan. Tuller soils are minor in extent in Tompkins County and are not agriculturally important.

Profile of Tuller channery silt loam, cultivated:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) channery silt loam; few, fine, faint, dark-brown (10YR 3/2) mottles or manganese stains in lower 2 inches; weak, fine to medium, subangular blocks that break into coarse crumbs; friable; pH 5.4; clear, smooth boundary; 7 to 10 inches thick.

A2g—8 to 10 inches, yellowish-brown (10YR 5/8) and gray (10YR 6/1) channery silt loam in equal amounts; weak, medium, subangular blocky structure; peds coated with gray (10YR 6/1) silt; friable to firm; pH 5.4; clear, wavy boundary; 2 to 3 inches thick.

B2g—10 to 22 inches, grayish-brown (2.5Y 5/2) heavy channery silt loam or light channery silty clay loam; many, coarse and medium, prominent, yellowish-brown and gray mottles; moderate, coarse and medium, blocky structure; firm in place; peds coated with silt; pH 5.4; clear, wavy boundary; 10 to 12 inches thick.

Cg—22 to 24 inches, 2-inch layer of weathered shale bedrock; silty clay loam; prominent, yellowish-brown and gray mottles; very thin, platy structure inherited from shale bedrock; slightly firm; pH 5.4; 2 to 3 inches thick.

IIR—24 inches +, hard, thin-bedded sandstone and shale bedrock.

Range in characteristics.—The typical soil of this series is poorly drained, but the series also includes soils that are in the less well drained half of the somewhat poorly drained range. The depth to bedrock is commonly 22 inches but ranges from 14 to 24 inches. The thickness of the soil varies between very shallow and moderately deep, depending on the depth to bedrock.

Silt loam is the predominant texture. Where the depth to bedrock is about 24 inches, the thin C horizon may resemble a weak fragipan. The pH value generally ranges from 5.0 to 5.8 but is as much as 6.0 where Tuller soils intergrade to Erie and Ellery soils.

VALOIS SERIES.—The Valois series consists of deep, well-drained, medium-textured Sols Bruns Acides that have a slightly acid, weakly developed fragipan. These soils have developed in neutral or weakly calcareous glacial till derived mainly from local sandstone and shale bedrock and, to a small extent, from limestone. They are associated with the moderately well drained Langford, the somewhat poorly drained Erie, the poorly drained Ellery, and the very poorly drained Alden soils.

Valois soils have upper horizons that resemble those of Bath soils, but they have a fragipan that contains slightly more lime and clay than the fragipan in Bath soils. Neutral or mildly calcareous parent material is at a lesser depth than in the Bath soils. Valois soils lack the clayey B horizon and higher lime content of Lansing soils. They lack the mottled B horizon typical of Langford soils.

Valois soils are moderately extensive in Tompkins County and are agriculturally important.

Profile of Valois gravelly silt loam, forested:

O1—2 inches to ½ inch, thin forest litter, mainly new leaf drop from oak, sugar maple, and beech trees; abrupt, smooth boundary; 1½ inches to 1 inch thick.

O2—½ inch to 0, discontinuous, very dark gray (10YR 3/1) mor mixed with very little mineral soil and matted with fine roots of moss and dwarf fern; very soft and friable; pH less than 5.0; abrupt, smooth boundary; 0 to 1 inch thick.

A1—0 to 1½ inches, dark grayish-brown (2.5Y 4/2) gravelly silt loam, high in organic matter; very weak, thin, platy structure in place; breaks into weak, fine granular structure when disturbed; very friable; many fine roots; pH less than 5.0; abrupt, smooth boundary; ½ inch to 1½ inches thick.

B21—1½ to 12 inches, yellowish-brown (10YR 5/4) gravelly silt loam; weak, fine, granular structure; very friable; fine and medium roots; pH 5.2; clear, wavy boundary; 8 to 11½ inches thick.

B22—12 to 24 inches, brown (10YR 5/3) gravelly silt loam; weak, fine and medium, subangular blocky structure; friable; few fine and medium roots; pH 5.4; clear, irregular boundary; 8 to 12 inches thick.

A'2—24 to 32 inches, grayish-brown (2.5Y 5/2) gravelly very fine sandy loam or gravelly silt loam, gritty to feel; weak, fine and medium, subangular blocky structure; pH 5.6 to 5.8; clear, irregular boundary; 3 to 8 inches thick.

B'x—32 to 49 inches, dark grayish-brown (10YR 4/2) gravelly heavy silt loam in weak prisms 12 to 18 inches across; prisms are coated with silty material that appear as vertical streaks with light brownish-gray (2.5Y 6/2) centers and thin strong-brown (7.5YR 5/8) margins. These streaks are 1½ inches at the top and become narrower with depth; interiors of prisms break into weak, medium and coarse, subangular blocky structure; slightly firm to firm; few roots 2 millimeters in diameter in cracks; pH 5.8 to 6.2; clear, abrupt boundary with 2-inch layer of sand at contact with substratum; 15 to 20 inches thick.

C—49 to 65 inches, light olive-brown (2.5Y 5/4) gravelly silt loam or loam; weak, coarse prisms that break into moderate, thick, crudely shaped plates; some ped surfaces have very dark grayish-brown coatings; firm; few clay films on prism surfaces and in large pores; pH 6.6 to 7.0.

Range in characteristics.—The thickness of the solum above the fragipan ranges from 24 to 30 inches in uneroded Valois soils. The fragipan is 18 to 36 inches thick and lies over a neutral substratum. The depth to neutral material ranges from 42 inches, as it is where Valois soils intergrade to Lansing soils, to 60 inches or more, as it is where Valois soils intergrade to Bath soils. The depth to weakly calcareous till ranges from 42 to 60 inches. The consistence of the fragipan ranges from slightly firm to firm. Firmness is least evident in loose till mixed with gravelly Howard soil material. Gravelly and channery types occur in the county. The prisms may break to plates instead of to subangular blocks in places where the soils formed in ground moraine material rather than in terminal or lateral moraine material. Gravelly and sandy lenses are common in the substratum.

VOLUSIA SERIES.—The Volusia series consists of deep, medium-textured, somewhat poorly drained Sols Bruns Acides that have a very firm, strongly acid fragipan. These soils have formed in slightly acid to medium acid glacial till derived from fine-grained sandstone and shale. They are the somewhat poorly drained members of the catena that includes the well drained Bath, the moderately well drained Mardin, the poorly drained Chippewa, and the very poorly drained Alden soils.

Volusia soils resemble Erie soils but have a more acid fragipan. They also resemble the better drained segments of Tuller soils, which, however, lack the strongly expressed fragipan of Volusia soils and are underlain by hard bedrock.

Volusia soils are moderately extensive in the southern half of the county and are agriculturally important in some localities.

Profile of Volusia channery silt loam, cultivated:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) channery silt loam; weak, fine, crumb structure; friable; pH 4.8; many fine roots; few flagstones on surface; abrupt, smooth boundary; 6 to 9 inches thick.

A2—8 to 14 inches, light olive-brown (2.5Y 5/4) and grayish-brown (2.5Y 5/2) channery silt loam; many, coarse, distinct, yellowish-brown (10YR 5/6–5/8) mottles; weak, thin to medium, platy structure; friable to slightly firm; pH 5.0; few fine roots; abrupt, wavy boundary; 4 to 6 inches thick.

B'x1g—14 to 28 inches, olive-brown (2.5Y 4/4) channery silt loam; few, medium, faint, gray and brown mottles; weak, coarse prisms 10 to 20 inches across, coated with grayish-brown (2.5Y 5/2) and olive-brown (2.5Y 4/4) silty material; prisms break into moderate, medium, subangular blocks when disturbed; very firm; pH 5.4; diffuse boundary; 10 to 15 inches thick.

B'x2g—28 to 48 inches, olive-brown (2.5Y 4/4) and olive (5Y 5/3) channery silt loam; few, common, gray and brown mottles; weak, coarse prisms 1½ to 2 feet across coated with thin, grayish-brown (2.5Y 5/2) to gray (5Y 5/1) silt; prisms break into moderate, medium and coarse, subangular blocks; very firm; pH 5.8 at 48 inches; diffuse boundary; 20 to 30 inches thick.

C—48 inches +, olive (5Y 5/3) channery silt loam; moderate, medium blocks with gray (5Y 5/1) surfaces; firm; pH 5.8 to 6.2; vertical streaks border prisms; boundaries disappear below 48 inches.

Range in characteristics.—The depth to the fragipan ranges from 10 to 12 inches in plowed fields and from 10 to 15 inches in forested areas. The reaction of the fragipan ranges from pH 5.1 to 6.0, but typically it is 5.4 to 5.6. Stoniness ranges from channery to flaggy. The depth to bedrock ranges from 2½ feet to 5 feet or more.

WAYLAND SERIES.—The Wayland series consists of deep, poorly drained, medium-textured, alkaline to neutral Low-Humic Gley soils that are forming in recent alluvium on first bottoms along streams. These soils are the poorly drained members of the catena that includes the well drained Genesee, the moderately well drained Eel, and the very poorly drained Sloan soils. They are similar to Holly soils in physical characteristics, but Holly soils are acid in reaction.

Wayland soils are on first bottoms in regions where the soils on outwash are members of the Palmyra and Howard series and the soils on uplands are members of the Honeoye and Lansing series. Wayland soils are of moderate extent and of limited importance for agriculture.

In Tompkins County, Wayland soils and Sloan soils are mapped together as an undifferentiated unit.

Profile of Wayland silt loam, idle:

Ap—0 to 9 inches, dark grayish-brown (10YR 4/2) silt loam; weak, fine, granular structure; very friable; many fine roots; pH 6.2; clear, smooth boundary; 7 to 10 inches thick.

C1g—9 to 14 inches, grayish-brown (10YR 5/2) silt loam; common, medium, brown (10YR 5/3) and many, medium, yellowish-brown (10YR 5/6 and 5/8) mottles in upper part; dark-brown (7.5YR 5/6 and 5/8) mottles in upper part; dark-brown (7.5YR 3/2) mottles in lower 2 inches; weak, granular structure; very friable; many fine roots; pH 6.0; clear, smooth boundary; 5 to 8 inches thick.

IIC2g—14 to 19 inches, dark grayish-brown (10YR 4/2) loam or fine sandy loam; many, medium, faint dark-brown (7.5YR 3/2) mottles; slightly firm; few fine roots; pH 6.4; abrupt, smooth boundary; 5 to 7 inches thick.

IIIC3—19 to 24 inches, dark grayish-brown (10YR 4/2) gravelly sandy loam; single grain; loose; coarse sand and gravel; pH 6.6 to 6.8; clear boundary; variable thickness.

IVC4—24 to 30 inches, dark grayish-brown (10YR 4/2) fine sandy loam; massive; slightly firm in place, very friable when disturbed; pH 6.8 to 7.0; grades into calcareous sand and gravel below a depth of 30 to 36 inches in most places.

Range in characteristics.—The color of the surface soil ranges from dark grayish brown (10YR 4/2) to very dark gray (10YR 3/1). The texture is generally silt loam, but in places it is fine sandy loam or silty clay loam. The texture and thickness of the substratum varies considerably because of the alluvial nature of these soils. Lenses of sand and gravel are common below a depth of 36 inches. Wayland soils ordinarily are slightly acid or neutral throughout, but locally the surface soil may be medium acid.

WILLIAMSON SERIES.—The Williamson series consists of moderately well drained Sols Bruns Acides that have a fragipan. These soils have formed in poorly graded lacustrine silt and very fine sands. A prominent property of soils in this series is their narrow range in particle size, which is commonly near the very fine sand-silt boundary. Williamson soils are the moderately well drained members of the catena that includes the well drained Amboy, the somewhat poorly drained Wallington, and the very poorly to poorly drained Birdsall soils. Only the Williamson soils of this catena are in Tompkins County. The normal wet associates are Niagara and Canandaigua soils.

Williamson soils, though developed in similar materials, lack the blocky textural B horizon of Collamer soils and have a fragipan, which is not present in Collamer soils. They also are normally more acid and deeper to carbonates than those soils, though the two series overlap in these properties.

Williamson soils are limited in distribution and are locally important agriculturally.

Profile of Williamson very fine sandy loam, cultivated:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) very fine sandy loam; weak, fine, crumb structure; very friable; pH 6.5 (limed); clear, smooth boundary; 7 to 10 inches thick.

B and A—8 to 14 inches, brown (10YR 5/3) and dark grayish-brown (10YR 4/2) fine sandy loam; weak, fine, crumb structure; friable; worm channels with dark lining; few roots; clear, wavy boundary; 6 to 8 inches thick.

B2—14 to 16 inches, light yellowish-brown (10YR 6/4) fine sandy loam; common, brown and yellowish-brown mottles; weak, fine, subangular blocky structure; friable; pH 5.8; clear, smooth boundary; 2 to 4 inches thick.

B′x—16 to 26 inches, brown (10YR 5/3) very fine sandy loam and yellowish-brown (10YR 5/6) loamy fine sand; moderate, medium and thick, crudely platy structure; firm; pH 5.2; clear, wavy boundary; 9 to 12 inches thick.

C—26 to 40 inches, brown and yellowish-brown (10YR 5/3–5/4) loamy fine sand with irregularly shaped bodies of dark yellowish-brown (10YR 4/4) very fine sandy loam; friable and firm; pH 5.4; clear boundary; 12 to 15 inches thick.

Range in characteristics.—Silt loam and very fine sandy loam are the principal textures. Ordinarily the texture is near the border between the two classes. Both 10YR and 7.5YR hues are common. Mottling is generally confined to the layer just above the fragipan, but the upper Bx horizon may be faintly mottled where Williamson soils intergrade to Niagara soils. The depth to the fragipan ranges from 16 to 24 inches, and locally the fragipan has a thick platy structure rather than the prismatic structure that is characteristic in other areas. The fragipan in Williamson soils may be uniformly massive, or it may consist of thick, brown, massive bands that are higher in clay content than the intervening, very thin, lighter colored bands of very fine sand. The substratum consists of layers of very fine sand and silt in varying proportions. Locally, thin layers of gravel may be found where Williamson soils are near streams. The depth to carbonates normally ranges from 42 to 60 inches, but where Williamson soils intergrade to Collamer soils, carbonates occur at a depth of 40 inches.

Laboratory Data

The physical properties and reaction of selected soils of six series in Tompkins County and the chemical properties of soils of three of these series are shown in tables 17 and 18. The soils sampled are those of the Erie, Howard, Langford, Lima, Mardin, and Rhinebeck series. They were sampled between 1950 and 1959.

The Cornell University Agronomy Service Laboratory, Ithaca, N.Y., analyzed samples of Erie channery silty clay loam, profile F–1; Mardin channery silt loam, profile M–2; and Mardin channery silt loam, profile M–3.[22]

The Soil Survey Laboratory, Soil Conservation Service, Beltsville, Md., analyzed the other samples. Data for profile S58 of the Erie soil were given in the guidebook prepared for Tour 1 of the Seventh Congress of the International Society of Soil Science.

Methods of Sampling and Analysis

Samples of approximately 1 gallon were collected from carefully selected pits. The samples were air dried, rolled, and quartered, and a suitable subsample was passed through a 2-millimeter, round-hole sieve. The material larger than 2 millimeters was weighed air dry for calculation of the percentage larger than 2 millimeters. A subsample of the material smaller than 2 millimeters was ground to approximately 80 mesh with a grinder equipped with ceramic plates for determination of organic-matter content, total nitrogen content, and other properties. The results are reported on an oven-dry basis.

The textural class and pH values as computed by laboratory analysis may differ somewhat from that in the profile descriptions.

Mechanical analysis was made by the method of Kilmer and Alexander (*12*), or by minor modifications of this method. Bulk density of paraffined clods was measured in duplicate. Reaction was measured with a glass electrode in a 1:1 soil-water suspension for all samples, and in a 1:1 soil-0.1 normal KCl suspension for a few. Organic carbon was determined by wet combustion (*14*) for the samples analyzed at Cornell, and by dry combustion (*16*) for the other samples. Total nitrogen was determined by the AOAC modified Kjeldahl procedure (*2*). Free iron oxide was determined by extraction with sodium hydrosulfite and titration with standard potassium dichromate (*11*).

Extractable cations were displaced with normal ammonium acetate and determined by the methods described by Peech and others (*14*). Cation-exchange capacity was determined by distillation of adsorbed ammonia after extraction with NaCl (*14*), and exchangeable hydrogen by difference.

Moisture held at tensions of 1/10 atmosphere, 1/3 atmosphere, and 15 atmospheres was determined by the method described by Richards (*23*). Mineral composition of the clay fraction in one Erie profile and in one Mardin profile was determined by X-ray diffraction.

Profiles Sampled

The following are descriptions of the profiles from which samples were taken.

Erie Soils

Erie soils are classified as Sols Bruns Acides with fragipans. They are somewhat poorly drained, and they developed in glacial till that consists mainly of fine-grained sandstone and shale but contains a small amount of limestone. The physical and chemical properties of three profiles of Erie soils are shown in table 17, and additional data for Erie channery clay loam is shown in table 18.

Erie channery silty clay loam, profile F–1, has three distinct discontinuities in the profile. The proportion of sand is 10.5 percent in the A1 and B2 horizons, increases to 19 percent in the IIA′2, and ranges from 29.4 to 36.5 percent in the fragipan and in the C horizon. The Roman numerals on the horizon designation are used to identify these discontinuities. The other two profiles of Erie soils show only small differences in the sand fraction below the Ap horizon. This indicates that these soils developed in relatively uniform parent material.

A low percentage of coarse fragments is shown in the uppermost three horizons of Erie channery silty clay loam, profile F–1; in the Ap horizon of Erie channery clay loam, S58-NY–55–2 (1–7); and in the Ap and B2g horizons of Erie channery silt loam, S59-NY–55–13 (1–5). The low percentage of coarse fragments in the A horizons is attributed to the accumulation of surface wash and to the

[22] CARLISLE, FRANK JEFFERSON, JR. CHARACTERISTICS OF SOILS WITH FRAGIPANS IN A PODZOL REGION. 1954 [Unpublished doctoral thesis. Copy on file Cornell University, Ithaca, N.Y.]

fact that the larger stones have been picked up to facilitate cultivation.

The silt content of the fragipan horizons of these soils ranges from 44.5 to 48.4. This relatively high content of silt is believed to account for the close packing and the high bulk density of the fragipan. The bulk density averages 2 grams per cubic centimeter and ranges from 1.7 to 2.1.

Erie soils are considered to be Sols Bruns Acides, but in the soils sampled the percentage of clay below the Ap horizon is highest in the fragipan, as is typical of Gray-Brown Podzolic soils.

The moisture-tension data shown for Erie channery clay loam, S58-NY-55-2 (1-7), indicates that the 9-inch Ap horizon holds more moisture than any of the lower horizons, and that each of the lower horizons holds about the same amount.

The reaction of these soils ranges from pH 4.8 to pH 5.6 in the horizons above the fragipan, and from pH 5.6 to pH 8.2 within the fragipan. In all three soils the C horizon is alkaline or calcareous.

The organic-carbon content of the A horizons of Erie channery silty clay loam and Erie channery clay loam averages 3.58 percent. Correspondingly, the percentage of nitrogen is high. The content of organic carbon is significantly less in the B2 horizon of both soils and is low in the fragipan.

The carbon-nitrogen ratio is 11 percent in the Ap horizon of the Erie channery clay loam, S58-NY-55-2 (1-7), and only 6 percent in the upper part of the fragipan. The content of free iron oxide in this profile is 2 percent in the Ap horizon and 1.5 to 1 percent in the other horizons.

The cation-exchange capacity of the Erie soils ranges between 29.5 and 34.2 milliequivalents per 100 grams in the A horizon and generally decreases with depth. This relatively low exchange capacity is due partly to the kind of clay present. Mica is abundant, vermiculite is present in moderate amounts, and chlorite was detected, as shown in table 18.

The base saturation of Erie channery silty clay loam and Erie channery clay loam ranges from 11 to 43 percent in the horizons above the fragipan. It is much higher in the fragipan but differs considerably between the two profiles.

Erie channery silty clay loam, profile F-1.—The sample of this soil was taken from the gas pipeline clearing in the north field of the Mt. Pleasant Experimental Farm. The sampling site is on a long, uniform, 7 percent slope, at an elevation of approximately 1,700 feet. The soil was moist throughout when described and sampled in November 1951. The vegetation at that time consisted of second-growth maple and white pine.

Description of profile:

O1—¼inch to 0, sparse organic layer of white-pine needles and midribs of maple leaves. Current leaf fall covers the ground.

A1—0 to 4 inches, dark grayish-brown (10YR 4/2) silty clay loam; moderate, medium and fine, blocky; friable; pH 6.0. Fine and medium-sized roots are concentrated in this horizon.

B2—4 to 8 inches, yellowish-brown (10YR 5/4) silt loam to silty clay loam with a few small, prominent, strong-brown and reddish-yellow mottles in the lower part; weak, coarse, blocky breaking to weak, medium, blocky; friable; pH 5.2. Large, medium, and fine roots are common. This is a discontinuous horizon that is present only in slight rises in the microrelief.

IIA'2—8 to 12 inches, light olive-brown (2.5Y 5/4) silt loam with numerous large and medium, prominent, yellowish-brown and reddish-yellow mottles; weak, coarse, platy breaking to weak, fine, platy; firm in place but friable when crushed; pH 5.2. Numerous medium and large roots.

IIIB'x1—12 to 25 inches, olive-brown (2.5Y 4/4–5Y 4/3) fine gravelly loam mottled with low-contrast browner and grayer colors and some small dark manganese-oxide stains; weak, medium, blocky; very firm in place; pH increases with depth as follows—5.4 at 16 inches, 5.8 at 18 inches, 6.7 at 20 inches. This horizon is divided into large prismatic, structural units 2 to 12 inches across by streaks of gray (5Y 6/1) silt loam that have thin brownish-yellow to reddish-yellow borders. Thickness of the streaks varies from 1 to 7 millimeters. Fine roots are numerous in the center of the gray streaks but are absent from the interior of the large prisms. In the lower part the prisms are mostly 12 to 16 inches across.

IIIB'x2—25 to 50 inches, olive-brown (2.5Y 4/4) gravelly loam grading to olive (5Y 5/3) with depth; weak, medium, blocky peds have very thin gray coating; very firm in place; pH 7 at 30 inches; calcareous at 40 inches; 12 to 24 inches between gray streaks. Fine roots are present in center of gray streaks but are absent from interior of large prisms.

IIIC—50 to 72 inches, olive (5Y 5/3) gravelly loam; weak, medium, blocky; firm; calcareous. Gray streaks are about 1 millimeter thick and lack brown borders. They terminate between 56 and 61 inches.

Erie channery clay loam, S58-NY-55-2 (1-7).—The sample of this soil was taken near Ellis Hollow Road, about 3 miles east of its junction with Judd Falls Road. The sampling site is on a 3 percent, north-facing slope. It is located on the property of Dr. Earl Stone, 6 feet south of the edge of the road ditch and 125 feet east of the spruce tree at the corner of Dr. Stone's yard. The vegetation at the time consisted mainly of weeds, but Scotch pine seedlings had been planted among the weeds.

Description of profile:

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) channery clay loam; weak, fine, subangular blocks mixed with moderate, medium granules; friable; many fine roots; pH 5.6; clear, smooth boundary; 7 to 10 inches thick.

B2g—9 to 16 inches, grayish-brown (10YR 5/2) channery loam with common, medium, distinct yellowish-brown (10YR 5/6) and many, medium, faint, brown (10YR 5/3) mottles; weak, fine, subangular blocks; friable; few fine roots; pH 5.6; clear, smooth boundary; 5 to 8 inches thick.

Bx1g—16 to 21 inches, channery loam; moderate prisms 2 to 6 inches across; interiors have weak, medium, angular blocky structure; interiors of blocks are dark grayish brown (10YR 4/2) with common, fine, faint mottles; exteriors, which constitute 60 percent of the mass, are grayish brown (10YR 5/2) with many, medium, yellowish-brown (10YR 5/6) mottles; firm to very firm; no roots; pH 5.7; gradual, smooth boundary; 4 to 8 inches thick.

Bx2g—21 to 26 inches, channery loam; strong prisms 4 to 8 inches across are separated by olive-gray (2.5Y 5/2) silt loam in vertical bands ¼ to ¾ inch wide. Inside each band is a strong-brown (7.5YR 5/6) rim ¼ inch wide. Interiors of prisms are dark grayish-brown (10YR 4/2) silty clay loam with few mottles; very firm; no roots; pH 5.8; diffuse boundary; 4 to 12 inches thick.

Bx3g—26 to 56 inches, channery loam; strong prisms 6 to 18 inches across separated by ⅛ to ¼ inch of olive-gray (5Y 5/2) silt loam and bounded by ¼-inch rim of strong-brown (7.5YR 5/6) silty clay loam. Interiors have weak, fine, subangular blocks bounded by thin, discontinuous, very dark brown (10YR 3/3) films; very firm; pH increases with depth; diffuse boundary; 25 to 40 inches thick.

TABLE 17.—*Physical and chemical*

[Lack of data indicates

Soil type and sample number	Horizon and subsample numbers	Depth	Particle-size distribution								
			Sand (2–.05 mm.)	Silt (.05–.002 mm.)	Clay (less than .002 mm.)	Sand					Coarse fragments (more than 2 mm.)
						Very coarse (2–1 mm.)	Coarse (1–0.5 mm.)	Medium (0.5–0.25 mm.)	Fine (0.25–0.1 mm.)	Very fine (0.10–0.05 mm.)	
		In.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Erie channery silty clay loam. Profile F–1.	A1	0–4	10. 5	56. 7	32. 8	0	0	0	4. 9	5. 6	1
	B2	4–8	10. 5	62. 5	27. 0	0	0	0	5. 4	5. 1	8
	IIA'2	8–12	19. 0	65. 3	15. 7	0	0	0	8. 3	10. 7	12
	IIIB' x 1										
	1	12–19	28. 7	48. 1	23. 2	0	0	0	20. 8	7. 9	31
	[3] 2	([4])	16. 5	58. 3	25. 2	0	0	0	7. 3	9. 2	4
	3	19–25	29. 4	46. 6	24. 0	0	0	0	22. 8	6. 6	29
	[3] 4	([4])	18. 3	52. 8	28. 9	-------	-------	-------	-------	-------	18
	IIIB' x 2										
	1	25–32	33. 4	47. 1	19. 5	-------	-------	-------	-------	-------	37
	2	32–38	34. 6	45. 9	19. 5	-------	-------	-------	-------	7. 4	40
	[3] 3	([4])	29. 9	49. 1	23. 0	-------	-------	-------	-------	-------	27
	4	38–44	34. 6	48. 1	17. 3	-------	-------	-------	-------	-------	39
	5	44–50	32. 4	48. 4	19. 2	-------	-------	-------	-------	-------	36
	IIIC										
	1	50–56	32. 0	49. 6	18. 4	-------	-------	-------	-------	8. 9	38
	2	56–62	32. 8	49. 6	17. 6	-------	-------	-------	-------	-------	38
	3	62–68	36. 5	45. 9	17. 6	-------	-------	-------	-------	-------	39
	4	68–72	35. 4	46. 2	18. 4	0	0	0	0	8. 1	37
Erie channery clay loam. S58–NY–55–2 (1–7).	Ap	0–9	25. 2	46. 5	28. 3	2. 0	2. 9	3. 1	6. 8	10. 4	5
	B2g	9–16	41. 2	44. 5	14. 3	6. 3	6. 7	5. 3	10. 0	12. 9	32
	Bx1g	16–21	40. 7	44. 5	14. 8	7. 4	6. 9	5. 1	9. 4	11. 9	40
	Bx2g	21–26	35. 9	47. 5	16. 6	7. 9	7. 0	4. 0	7. 4	9. 6	40
	Bx3g	26–56	32. 1	46. 8	21. 1	4. 8	5. 2	4. 2	8. 2	9. 7	24
	Bx4g	56–78	40. 9	46. 2	12. 9	6. 8	6. 6	5. 0	10. 0	12. 5	25
	C	78–84	44. 6	41. 5	14. 1	7. 8	7. 5	5. 3	10. 6	13. 2	28
Erie channery silt loam. S59–NY–55–13 (1–5).	Ap	0–9	20. 3	55. 2	24. 5	1. 4	1. 8	2. 2	6. 5	8. 4	16
	B2	9–15	26. 6	57. 2	16. 2	1. 5	2. 1	2. 6	8. 0	12. 4	15
	Bx1	15–28	26. 3	46. 1	27. 6	3. 8	4. 5	3. 2	6. 9	7. 9	38
	Bx2	28–42	27. 7	46. 8	25. 5	4. 8	4. 9	3. 2	6. 7	8. 1	30
	C	42–60	27. 3	51. 5	21. 2	6. 7	4. 9	2. 9	5. 8	7. 0	28
Howard gravelly silt loam. S58–NY–55–12(1–6).	Ap	0–8	33. 9	51. 5	14. 6	5. 3	5. 3	4. 0	7. 5	11. 8	24
	A21	8–11	23. 7	58. 5	17. 8	2. 5	3. 0	2. 5	5. 5	10. 2	18
	A22	11–14	29. 5	57. 4	13. 1	4. 7	4. 5	3. 4	6. 3	10. 6	25
	IIB21	14–23	41. 5	47. 1	11. 4	14. 6	9. 5	3. 9	5. 0	8. 5	66
	IIB22t	23–36	47. 8	31. 2	21. 0	20. 4	15. 2	5. 2	3. 2	3. 8	65
	IIIC	36–60	60. 2	26. 3	12. 9	30. 1	19. 7	4. 5	2. 8	2. 8	65
Langford channery silt loam. S59–NY–55–16(1–6).	Ap	0–7	31. 1	54. 0	14. 9	6. 9	4. 9	3. 3	6. 4	9. 6	23
	B2	7–11	27. 3	53. 8	18. 9	5. 3	4. 2	2. 9	6. 1	8. 8	26
	IIA'2	11–15	42. 0	47. 4	10. 6	9. 0	7. 4	5. 0	9. 2	11. 4	26
	IIB'x1g	15–28	43. 0	43. 2	13. 8	8. 0	7. 4	5. 8	10. 5	11. 3	31
	IIB'x2g	28–48	38. 6	44. 2	17. 2	6. 0	6. 1	4. 7	9. 8	12. 0	26
	IIC	48–60	35. 6	45. 8	18. 6	4. 0	4. 8	3. 6	10. 0	13. 2	13
Lima loam. S59–NY–55–5(1–5).	Ap	0–7	36. 6	44. 6	18. 8	1. 4	3. 3	5. 4	12. 1	12. 4	10
	A2	7–12	35. 9	46. 1	18. 0	2. 7	3. 8	5. 5	11. 9	12. 0	16
	B21t	12–20	31. 0	41. 3	27. 7	2. 5	3. 3	3. 6	9. 6	12. 0	15
	B22t	20–24	33. 0	35. 9	31. 1	3. 0	4. 0	4. 4	12. 1	9. 5	19
	Cg	24–36	40. 1	43. 2	16. 7	6. 2	6. 0	5. 1	12. 4	10. 4	27

See footnotes at end of table.

properties of selected soils

determination was not made]

Textural class	Bulk density	pH at 1:1 suspension		Organic carbon[1]	Nitrogen	C/N ratio	Free Fe_2O_3	Extractable cations (milliequivalents per 100 grams of soil)					Cation exchange capacity [2]	Base saturation
		H_2O	0.1N KCl					Ca	Mg	H	Na	K		
	Gm./cu. cm.			Pct.	Pct.		Pct.						Meq./100 gm.	Pct.
Silty clay loam	---	4.9	---	3.59	---	---	---	4.4	1.5	27.9	---	0.36	34.2	18
Silty clay loam	1.50	4.8	---	1.16	---	---	---	1.6	.6	11.0	---	.11	13.3	17
Silt loam	1.74	4.9	---	.29	---	---	---	.5	.2	5.8	---	.06	7.1	11
Loam	2.03	5.6	---	.11	---	---	---	4.5	3.6	.1	---	.11	8.3	99
Silt loam	---	5.7	---	.40	---	---	---	4.8	2.6	4.2	---	.11	11.7	64
Loam	1.98	6.7	---	.11	---	---	---	5.0	.7	3.5	---	.07	9.3	62
Silty clay loam	---	6.2	---	.23	---	---	---	6.3	3.0	2.4	---	.08	11.8	80
Loam	2.10	6.2	---	.11	---	---	---	5.1	2.4	.5	---	.07	8.1	94
Loam	---	7.1	---	.11	---	---	---	3.6	2.2	.08	---	.07	6.7	88
Loam	---	7.5	---	.17	---	---	---	(5)	3.2	---	---	.09	9.8	100
Loam	2.1	8.0	---	.11	---	---	---	(5)	.4	---	---	.05	6.2	100
Loam	---	8.2	---	.11	---	---	---	(5)	1.2	---	---	.09	6.6	100
Loam	2.2	8.2	---	.11	---	---	---	(5)	1.7	---	---	.09	6.1	100
Loam	---	8.2	---	.11	---	---	---	(5)	1.3	---	---	.09	6.0	100
Loam	2.1	8.2	---	.11	---	---	---	(5)	1.3	---	---	.08	6.1	100
Loam	---	8.2	---	.11	---	---	---	(5)	1.1	---	---	.09	5.2	100
Clay loam	---	5.5	---	3.57	0.323	11	2.0	10.0	2.3	16.7	0.1	.4	29.5	43
Loam	---	5.6	---	.51	.068	8	1.4	3.4	.9	6.6	.1	.1	11.1	40
Loam	2.0	5.5	---	.38	.069	6	1.5	3.1	1.0	5.8	.1	.1	10.1	42
Loam	1.7	5.6	---	.26	---	---	1.5	3.4	1.0	5.0	.1	.1	9.6	48
Loam	2.0	6.0	---	.16	---	---	1.0	4.7	1.3	2.7	.1	.1	8.9	70
Loam	2.0	5.8	---	.17	---	---	1.5	3.4	1.1	3.5	.1	.1	8.2	57
Loam	---	8.0	---	.14	---	---	1.1	(5)	---	---	---	---	15.2	---
Silt loam	---	4.9	---	---	---	---	---	---	---	---	---	---	---	---
Silt loam	---	5.1	---	---	---	---	---	---	---	---	---	---	---	---
Clay loam or loam.		5.3	---	---	---	---	---	---	---	---	---	---	---	---
Loam	---	6.7	---	---	---	---	---	---	---	---	---	---	---	---
Silt loam	---	7.7	---	---	---	---	---	---	---	---	---	---	---	---
Silt loam	---	5.9	---	---	---	---	---	---	---	---	---	---	---	---
Silt loam	---	4.6	---	---	---	---	---	---	---	---	---	---	---	---
Silt loam	---	4.8	---	---	---	---	---	---	---	---	---	---	---	---
Loam	---	5.1	---	---	---	---	---	---	---	---	---	---	---	---
Loam	---	6.9	---	---	---	---	---	---	---	---	---	---	---	---
Coarse sandy loam.	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Silt loam	---	5.3	---	---	---	---	---	---	---	---	---	---	---	---
Silt loam	---	5.0	---	---	---	---	---	---	---	---	---	---	---	---
Loam	---	4.8	---	---	---	---	---	---	---	---	---	---	---	---
Loam	---	5.0	4.1	---	---	---	---	---	---	---	---	---	---	---
Loam	---	---	4.2	---	---	---	---	---	---	---	---	---	---	---
Loam	---	---	4.7	---	---	---	---	---	---	---	---	---	---	---
Loam	---	6.7	6.2	---	---	---	---	---	---	---	---	---	---	---
Loam	---	6.8	5.7	---	---	---	---	---	---	---	---	---	---	---
Clay loam or loam.		6.8	5.8	---	---	---	---	---	---	---	---	---	---	---
Clay loam	---	7.0	6.2	---	---	---	---	---	---	---	---	---	---	---
Loam	---	7.7	7.1	---	---	---	---	---	---	---	---	---	---	---

TABLE 17.—*Physical and chemical*

[Lack of data indicates

Soil type and sample number	Horizon and sub-sample numbers	Depth	Particle-size distribution								
			Sand (2–.05 mm.)	Silt (.05–.002 mm.)	Clay (less than .002 mm.)	Sand					Coarse fragments (more than 2 mm.)
						Very coarse (2–1 mm.)	Coarse (1.0–5 mm.)	Medium (0.5–0.25 mm.)	Fine (0.25–0.1 mm.)	Very fine (0.10–0.25 mm.)	
		In.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Mardin channery silt loam. S54–NY–55–2(1–13).	A12	½–¾	34. 1	56. 1	9. 8	9. 3	5. 8	3. 4	7. 3	8. 3	6
	A12/A2	¾–1	23. 6	62. 2	14. 2	4. 2	3. 4	2. 3	5. 7	8. 0	9
	A2	1–2	21. 6	65. 6	15. 6	3. 4	2. 4	1. 8	4. 4	6. 8	23
	B21	2–16	17.3	59.0	23.7	3.8	2.8	1.7	3.7	5.3	30
	[6] B22	3–20	22.4	58.7	18.9	4.9	4.3	2.3	4.7	6.2	27
	IIA'2g	16–24	34.0	52.7	13.3	9.1	7.2	3.8	7.8	6.6	34
	IIB'x1	24–34	31.4	49.0	19.6	7.5	6.1	3.4	6.6	7.8	33
	IIB'x2	34–42	32.1	47.7	20.2	7.4	6.6	3.7	6.8	7.6	46
	IIC	42–52	27.2	48.7	24.1	6.2	5.9	3.0	5.6	6.5	36
Mardin channery silt loam. Profile M–2.	Ap	0–6	23.4	52.2	24.4	--------	--------	--------	--------	7.5	24
	B2	6–9	21.8	56.4	21.8	--------	--------	--------	--------	7.5	24
	IIA'2	9–11.5	31.0	60.3	8.7	--------	--------	--------	--------	11.6	18
	IIB'x1										
	1 (streak)	11.5–23	32.8	53.9	13.3	--------	--------	--------	--------	11.0	19
	2	11.5–17	31.8	45.1	23.1	--------	--------	--------	--------	9.5	37
	3	17–23	37.2	40.3	22.5	--------	--------	--------	--------	10.3	36
	4	23–29	32.3	45.6	22.1	--------	--------	--------	--------	--------	33
	IIB'x2										
	1	29–35	31.9	44.7	23.4	--------	--------	--------	--------	--------	35
	2	35–41	33.0	55.4	22.4	--------	--------	--------	--------	--------	42
	3	41–47	28.9	52.1	23.2	--------	--------	--------	--------	--------	30
	4	47–53	32.4	55.0	22.6	--------	--------	--------	--------	--------	38
	IIC1	53–59	29.2	51.3	22.1	--------	--------	--------	--------	7.1	44
	IIIC2	59–65	42.6	58.9	16.3	--------	--------	--------	--------	5.0	81
Mardin channery silt loam. Profile M–3.	Ap	0–6	28. 0	51. 4	20. 6	--------	--------	--------	--------	--------	24
	B2	6–12	24. 3	48. 3	27. 4	--------	--------	--------	--------	--------	32
	IIA'2	12–16	38. 6	46. 7	14. 7	--------	--------	--------	--------	--------	33
	IIB'x1										
	1	16–20	43. 4	41. 6	15. 0	--------	--------	--------	--------	--------	41
	2	17–21	42. 5	46. 2	11. 3	--------	--------	--------	--------	--------	42
	3	25–32	35. 4	44. 8	19. 8	--------	--------	--------	--------	--------	39
	4	30–40	37. 6	48. 2	14. 2	--------	--------	--------	--------	--------	30
	IIB'x2										
	1	36–40	37. 6	41. 7	21. 7	--------	--------	--------	--------	--------	34
	2	46–50	30. 8	45. 2	24. 0	--------	--------	--------	--------	--------	36
	IIC	58–61	37. 7	41. 6	20. 7	--------	--------	--------	--------	--------	44
Rhinebeck silt loam. S59–NY–55–1(1–5).	Ap	0–10	9. 2	65. 5	25. 3	. 4	. 6	. 6	2. 3	5. 3	1
	A2g	10–12	17. 3	58. 6	24. 1	. 4	1. 2	1. 0	3. 6	11. 1	1
	B2t	12–23	9. 9	57. 3	32. 8	. 1	. 4	. 6	2. 4	6. 4	1
	C1	23–27	1. 9	67. 7	30. 4	. 3	. 2	. 1	. 4	. 9	1
	C2	27–50	1. 9	69. 7	28. 4	. 1	. 1	. 1	. 4	1. 2	1

[1] Determined by wet combustion method (*14*) for the following samples—Erie channery silty clay loam, profile F–1; Mardin channery silt loam, S54–NY–55–2(1–13); Mardin channery silt loam, profile M–2.

Determined by dry combustion method (*16*) for the following samples—Erie channery clay loam, S58–NY–55–2(1–7); Erie channery silt loam, S59–NY–55–13(1–5); Howard gravelly silt loam, S58–NY–55–12(1–6); Langford channery silt loam, S59–NY–55–16–(1–6); Lima loam, S59–NY–55–5(1–5); Mardin channery silt loam, profile M–3; and Rhinebeck silt loam, S59–NY–55–1(1–5).

properties of selected soils—Continued

determination was not made]

Textural class	Bulk density	pH at 1:1 suspension		Organic carbon[1]	Nitrogen	C/N ratio	Free Fe_2O_3	Extractable cations (milliequivalents per 100 grams of soil)					Cation exchange capacity [2]	Base saturation
		H_2O	0.1N KCl					Ca	Mg	H	Na	K		
	Gm./cu. cm.			*Pct.*	*Pct.*		*Pct.*						*Meq./100 gm.*	*Pct.*
Silt loam	------	4. 0	------	7. 60	------	------	1. 52	------	------	------	------	------	------	------
Silt loam	------	4. 0	------	3. 02	------	------	1. 56	------	------	------	------	------	------	------
Silt loam	------	4. 2	------	1. 28	------	------	1. 52	------	------	------	------	------	------	------
Silt loam	------	4. 4	------	. 93	------	------	2. 36	------	------	------	------	------	------	------
Silt loam	------	4. 8	------	. 70	------	------	1. 76	------	------	------	------	------	------	------
Silt loam	------	4. 7	------	. 26	------	------	1. 28	------	------	------	------	------	------	------
Loam or silt loam.		4. 8	------	. 24	------	------	1. 60	------	------	------	------	------	------	------
Loam	------	5. 1	------	. 14	------	------	------	------	------	------	------	------	------	------
Loam	------	5. 8	------	. 19	------	------	------	------	------	------	------	------	------	------
Silt loam	------	5. 8	------	1. 51	------	------	------	4. 2	. 31	7. 1	------	. 10	11. 7	39
Silt loam	------	5. 0	------	. 60	------	------	------	1. 2	. 14	5. 8	------	. 07	7. 2	18
Silt loam	------	5. 2	------	. 11	------	------	------	. 6	. 10	2. 4	------	. 05	3. 2	25
Loam	------	5. 2	------	. 08	------	------	------	1. 4	. 38	4. 0	------	. 08	5. 9	32
Loam	------	5. 1	------	. 09	------	------	------	2. 1	. 64	3. 9	------	. 11	6. 8	41
Loam	------	5. 1	------	. 14	------	------	------	2. 2	. 62	4. 2	------	. 12	7. 1	41
Loam	------	5. 3	------	. 12	------	------	------	2. 7	. 87	4. 0	------	. 16	7. 7	49
Loam	------	5. 4	------	. 14	------	------	------	3. 1	1. 02	4. 0	------	. 15	8. 3	52
Silt loam	------	5. 4	------	. 08	------	------	------	3. 6	1. 01	2. 4	------	. 13	7. 1	65
Silt loam	------	5. 3	------	. 12	------	------	------	3. 0	1. 24	4. 7	------	------	9. 1	48
Silt loam	------	5. 4	------	. 13	------	------	------	3. 5	1. 20	4. 5	------	. 07	9. 3	52
Silt loam	------	5. 6	------	. 11	------	------	------	3. 6	1. 37	4. 5	------	. 08	9. 6	53
Silt loam	------	5. 4	------	. 16	------	------	------	2. 3	. 75	5. 7	------	. 11	8. 9	36
Silt loam	------	5. 0	------	1. 65	------	------	------	1. 8	. 20	10. 5	------	. 07	12. 6	17
Clay loam	------	5. 0	------	. 68	------	------	------	1. 3	. 16	8. 0	------	. 07	10. 5	24
Loam	------	5. 0	------	. 26	------	------	------	. 7	. 10	4. 6	------	. 05	5. 5	16
Loam	------	5. 1	------	. 14	------	------	------	1. 3	. 31	3. 2	------	. 07	4. 9	35
Loam	------	5. 1	------	. 15	------	------	------	. 9	. 15	4. 5	------	. 06	4. 8	6
Loam	------	5. 6	------	. 12	------	------	------	4. 3	. 10	4. 1	------	. 07	8. 6	52
Loam	------	5. 4	------	. 11	------	------	------	2. 3	. 10	3. 2	------	. 12	5. 7	44
Loam	------	5. 9	------	. 08	------	------	------	5. 6	2. 37	------	------	. 10	7. 9	100
Loam	------	5. 6	------	. 10	------	------	------	2. 8	. 95	4. 7	------	. 08	8. 5	45
Loam	------	6. 2	------	. 13	------	------	------	5. 2	1. 72	7. 0	------	. 10	8. 1	14
Silt loam	------	7. 1	6. 4	[2] 1. 37	. 142	10	1. 9	------	------	------	------	------	------	------
Silt loam	1. 7	6. 3	5. 5	. 40	. 062	6	2. 2	------	------	------	------	------	------	------
Silty clay loam	1. 7	7. 2	6. 1	. 37	. 080	5	2. 4	------	------	------	------	------	------	------
Silty clay loam	1. 7	7. 7	------	. 21	------	------	1. 8	------	------	------	------	------	------	------
Silty clay loam	1. 7	7. 7	------	. 25	------	------	1. 8	------	------	------	------	------	------	------

[2] Ammonium acetate for exchange capacity and exchangeable bases; hydrogen by difference (*14*).

[3] Between prisms.

[4] Not measurable.

[5] Calcareous.

[6] Discontinuous horizon.

TABLE 18.—*Mineral composition of clay fraction, bulk density, and moisture tension data for two selected soils* [1]

[Dashes indicate determinations were not made]

Soil and sample number	Horizon	Depth	Mineral composition of clay fraction [2]				Bulk density	Moisture held at tension of—		
			Mica	Kaolin	Vermiculite	Chlorite		1/10 atmosphere	1/3 atmosphere	15 atmospheres
		Inches					*Gm./cu. cm.*	*Percent*	*Percent*	*Percent*
Erie channery clay loam. S58–NY–55–2(1–7).	Ap	0 to 9	Abundant	None	Moderate	Trace	----	44.3	34.1	16.3
	B2g	9 to 16	----	----	----	----	----	24.6	17.0	6.5
	Bx1g	16 to 21	----	----	----	----	2.0	22.7	17.5	6.1
	Bx2g	21 to 26	----	----	----	----	1.7	22.2	19.5	6.3
	Bx3g	26 to 56	Dominant	None	Moderate	Moderate	2.0	22.6	19.0	8.7
	Bx4g	56 to 78	Dominant	None	Trace	Moderate	2.0	20.5	17.5	5.9
	C	78 to 84	----	----	----	----	----	18.0	15.6	4.2
Mardin channery silt loam. S54–NY–55–2(1–13).	A12	½ to ¾	----	----	----	----	----	----	----	----
	A12/A2	¾ to 1	----	----	----	----	----	----	----	----
	A2	1 to 2	----	----	----	----	----	----	----	----
	B21	2 to 16	Moderate	Trace	Dominant	None	----	----	----	----
	B22	[3] 3 to 20	----	----	----	----	----	----	----	----
	IIA'2	16 to 24	----	----	----	----	----	----	----	----
	IIB'x1	24 to 34	Dominant	Abundant	Trace	Moderate	----	----	----	----
	IIB'x2	34 to 42	----	----	----	----	----	----	----	----
	IIC	42 to 52	----	----	----	----	----	----	----	----

[1] Additional chemical and physical data for these soils appears in table 17.
[2] Determined by X-ray diffraction.
[3] See soil profile description for explanation of this overlapping horizon.

Bx4g—56 to 78 inches, channery loam divided into prisms 1½ to 3 feet across by very thin coats of light gray (5Y 6/1). Interiors are grayish brown (2.5Y 5/2) with common, fine, faint mottles; very firm; clear, wavy boundary; 12 to 18 inches thick. (Sampled from 60 to 66 inches; bulk density 2.0).

C—78 to 84 inches +, grayish-brown (2.5Y 5/3) channery loam; weak, lenticular, platy structure; firm; few, fine, faint mottles; calcareous.

Erie channery silt loam, S59–NY–55–13 (1–5).—The site where this soil was sampled is 5 miles southeast of Ithaca, 2.5 miles northeast of Danby, 50 feet east of Marsh Road, and 75 yards south of Steventown Road. The sample was taken from an excavation in an idle field. The site is on a 5 percent, north-facing slope, at an elevation of 1,630 feet. When the sample was taken, the uppermost 42 inches of the soil was moist and the lower part was dry. The soil is slightly eroded.

Description of profile:

Ap—0 to 9 inches, dark grayish-brown (10YR 4/2) channery silt loam; weak, fine, crumb structure; very friable; many fine roots; pH 5.2; clear, smooth boundary; 6 to 10 inches thick.

B2—9 to 15 inches, mottled yellowish-brown (10YR 5/4, grayish-brown (2.5Y 5/2), and light brownish-gray (2.5Y 6/2) channery silt loam; weak, fine and medium, crumb structure; very friable; many fine roots; pH 5.4; clear, wavy boundary; 5 to 7 inches thick.

Bx1—15 to 28 inches, olive (5Y 5/4) channery heavy loam or light clay loam with common, distinct, yellowish-brown (10YR 5/8) mottles; weak, fine and medium, subangular blocky structure; peds coated with light olive-gray (5Y 6/2) silt; slightly firm; few roots between peds; pH 5.6; gradual lower boundary; 10 to 15 inches thick.

Bx2—28 to 42 inches, olive-brown and light olive-brown (2.5Y 4/4–5/4) channery loam with few, fine, faint, light olive-gray (5Y 6/2) mottles; coarse prisms, 6 to 8 inches across, break into moderate, medium and coarse, angular blocks; firm; pH 6.2; gradual boundary; 13 to 16 inches thick.

C—42 to 60 inches, olive (5Y 4/4) channery silt loam with few, fine, faint, olive-brown (2.5Y 4/4) mottles; coarse prisms that break into thick plates; firm; calcareous till to a depth of 15 feet.

HOWARD SOILS

Howard soils are deep, well-drained Gray-Brown Podzolic soils that developed in glaciofluvial sand and gravel deposits of sandstone, shale, and limestone.

The one profile sampled is considered near modal, except for the texture of the Ap, A21, and A22 horizons, which are more silty than usual. Only particle-size distribution and pH were determined.

The maximum clay accumulation is in the IIB22t horizon, as is characteristic of Howard soils. The content of coarse fragments is higher in the B and C horizons than in the A horizon. Reaction increases abruptly in the IIB22t horizon. The C horizon is calcareous at a depth of 38 inches.

The variations in particle-size distribution and the apparent discontinuities are due mainly to stratification.

Howard gravelly silt loam, S58–NY–55–12 (1–6).—The site where this soil was sampled is 1 mile west of Dryden and 100 yards north of Route 38, in an alfalfa field. It is on a 5 percent northwesterly slope. The soil was moist when the sample was taken. It was slightly eroded.

Description of profile:

Ap—0 to 8 inches, dark-brown (10YR 4/3) gravelly silt loam; weak, fine, crumb structure; very friable; pH 5.8; abrupt, smooth boundary; 8 to 11 inches thick.

A21—8 to 11 inches, strong-brown (7.5YR 5/6) gravelly silt loam; weak, fine, crumb structure; very friable; pH 5.6; clear, smooth boundary; 2 to 4 inches thick.

A22—11 to 14 inches, yellowish-brown (10YR 5/6) gravelly silt loam; very weak, thin, platy structure; very friable; pH 5.6; clear, wavy boundary; 3 to 10 inches thick. Pockets of this horizon extend downward 15 to 20 inches into horizons below at intervals of about 10 inches and have been described as inverted cones.

IIB21—14 to 23 inches, dark grayish-brown (10YR 4/2) heavy gravelly loam; weak, medium, subangular blocky structure; friable; peds coated with brown (10YR 5/3) silt; pH 5.6; gradual, irregular boundary; 3 to 11 inches thick.

IIB22t—23 to 36 inches, dark-brown (7.5YR 4/2) and dark grayish-brown (10YR 4/2) gravelly loam with vertical streaks ½ inch to ¾ inch wide of pale-brown (10YR 6/3) silt or very fine sand; moderate, medium, subangular blocky structure; friable; some clay films present; pH 5.8; clear, irregular boundary; 10 to 14 inches thick.

IIIC—36 to 60 inches, dark grayish-brown (10YR 4/2) gravelly sandy loam and coarse loamy sand mixed; structureless; loose; pH 6.8 at 36 inches; calcareous at 38 inches.

Langford Soils

Langford soils are deep, moderately well drained Sols Bruns Acides with fragipans. They developed on firm glacial till that consists mainly of sandstone and shale but contains some limestone.

Only particle-size distribution and pH were determined. The mechanical analysis indicates that the percentage of coarse fragments is nearly constant down to the C horizon. The higher silt content of the Ap and B2 horizons may be due partially to alluvial deposition from a nearby drainageway. The clay content is lowest in the IIA′2, higher in each succeeding horizon below the IIA′2, and highest for this sequum in the C horizon.

In field investigation, it was judged that the profile became less acid with depth, and the pH values shown in the following description of the profile reflect this judgment. Laboratory measurements, however, indicate that the lower horizons are as acid as the upper ones (see table 17).

Langford channery silt loam, S59–NY–55–16 (1–6).—The sampling site was 0.5 mile south of Ellis, 1.75 miles north of Slaterville Springs, and 100 feet west of the junction of Ellis Hollow Road South and Hurd Road.

Description of profile:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2), top inch very dark grayish-brown (10YR 3/2), channery silt loam; very weak, fine, crumb structure; very friable; pH 5.2; abrupt, smooth boundary; 5 to 7 inches thick.

B2—7 to 11 inches, yellowish-brown (10YR 5/4–5/6) channery silt loam; very weak, fine, crumb structure; very friable; pH 5.4; clear, wavy boundary; 3 to 5 inches thick.

IIA′2—11 to 15 inches, light olive-brown (2.5Y 5/4) channery loam with few, fine, distinct, dark-brown (10YR 4/3) and yellowish-brown (10YR 5/8) mottles; weak, fine, subangular blocky or weak, thin, platy structure; very friable; pH 5.6; clear, wavy boundary; 3 to 5 inches thick.

IIB′x1g—15 to 28 inches, dark grayish-brown (2.5Y 4/2) channery loam; weak, coarse prisms 6 to 8 inches across, with cracks between prisms about 2 inches at tip and tapering off to ¼ to ½ inch at bottom; cracks filled with light grayish-brown (2.5Y 6/2) and light olive-brown (2.5Y 5/4) very fine sand with dark-brown (10YR 4/2) borders ⅛ inch to ¼ inch thick inside the light-brown very fine sand; prisms break into moderate, fine and medium, subangular blocks; firm; pH 5.8; diffuse lower boundary; 10 to 15 inches thick.

IIB′x2g—28 to 48 inches, dark grayish-brown (2.5Y 4/2) heavy channery loam; moderate, coarse prisms 16 to 18 inches across that break into moderate, coarse and medium, angular and subangular blocks; prisms coated with very thin layer of silt; firm; pH 6; diffuse lower boundary.

IIC—48 to 60 inches, olive-brown (2.5Y 4/4) channery loam; very coarse prisms that break into medium thick and thick plates; thin clay films on peds; firm; pH 6.6.

Lima Soils

Lima soils are deep, moderately well drained Gray-Brown Podzolic soils. They developed in highly calcareous glacial till consisting of limestone and shale mixed with varying amounts of sandstone and igneous rock.

Only one sample was analyzed, and only particle-size distribution and pH were determined. The texture of the plow layer was established by analysis as loam, though the soil had been classified in the field as silt loam. (Both loam and silt loam occur in Tompkins County, but only the silt loam type was recognized in the mapping unit name. The percentage of coarse fragments is low, except in the C horizon, where it is between 25 and 35 percent (by weight). The reaction is neutral throughout the solum. The C horizon is calcareous. The "clay bulge," or sharp increase in clay, in the B21t and B22t horizons is characteristic of the series.

Lima loam, S59–NY–55–5 (1–5).—This soil was sampled 1 mile east of Lake Ridge Road, north of Fenner Road and east of Davis Road, in a cornfield. The sampling site is on a 3 percent, west-facing slope, at an elevation of 1,010 feet. The soil at this location was slightly eroded. It was moist when the sample was taken.

Description of profile:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) loam; very weak, fine, crumb structure; very friable; pH 7; many fine roots; 5 to 10 percent gravel; abrupt, smooth boundary.

A2—7 to 12 inches, brown (10YR 5/3) loam; weak, medium, subangular blocky structure; ped coats lighter colored than interiors; friable; pH 7; small amounts of Ap material in worm casts; 10 to 15 percent gravel; clear, smooth boundary.

B21t—12 to 20 inches, yellowish-brown (10YR 5/4) clay loam or heavy loam; moderate, fine and medium, subangular blocky structure; ped surfaces have thin, discontinuous, dark-brown (10YR 4/2) clay films; friable; pH 7; 10 to 15 percent gravel; gradual boundary.

B22t—20 to 24 inches, olive-brown (2.5Y 4/4) clay loam; common to many, medium, distinct, yellowish-brown (10YR 5/4–5/6) mottles; strong to moderate, medium, blocky structure; continuous, thick, dark-brown clay films on peds; few small, black concretions; firm; slightly sticky; pH 7.2; 15 to 20 percent gravel; clear, wavy boundary.

Cg—24 to 36 inches, dark grayish-brown (2.5Y 4/2) gravelly loam with fine, faint, olive-brown (2.5Y 4/4 and gray (5Y 5/1) mottles; firm; thick platy structure; calcareous below 26 inches; fragments of limestone and black shale in profile

Mardin Soils

Mardin soils are deep, moderately well drained Sols Bruns Acides with acid fragipans. These soils developed on firm, medium-textured glacial till consisting mainly of fine-grained sandstone and shale.

The three profiles sampled are within an area of 1 acre. One profile, S54-NY-55-2 (1-13), is in a forested area; it has less clay and fewer coarse fragments in the surface layer than do the other two profiles (M-2 and M-3), which are in cultivated areas. The forested soil also has a slightly more silty surface layer. In all three profiles, the A and B horizons are of different materials than the fragipans. In the profile descriptions and in table 17, these discontinuities are shown by Roman numerals. Silt loam is the dominant texture in the upper sequence of horizons, and loam or silt loam in the fragipan. The percentage of coarse fragments above a depth of 6 feet is about the same in all three profiles.

The pH above the fragipan in the forested soil is almost one unit lower than that in the cultivated soil. The content of organic carbon is highest in the surface horizon of the forested soil. In cation-exchange capacity the two cultivated soils are similar, but they differ in base saturation percentage.

The B21 and IIB′x1 horizons of the forested soil were analyzed to determine the mineral composition of the clay fraction (see table 18). In the B21 horizon, vermiculite is the dominant mineral, mica is present in moderate amounts, and kaolin can be detected. In the IIB′x1 horizon, mica is dominant, kaolin is abundant, chlorite is present in moderate amounts, and vermiculite can be detected.

Mardin channery silt loam, S54-NY-55-2 (1-13).—The sample of this soil was taken from a smoothly sloping virgin area on the Mt. Pleasant Experimental Farm, 200 feet north of the pipeline.

Description of profile:

O1—1 inch to 0, recently fallen loose leaves, mostly beech, red oak, sugar maple, red maple, and ash. Remnants of older leaves were too scant to be sampled. Such remnants occur at wide intervals and in pieces 1 inch or so in width, not as a mat.

A11—0 to ½ inch, earthworm or night-crawler middens (mounds) 1½ to 2 inches in height, about 3 inches in diameter at the base, and 4 to 12 inches apart. The casts are mixed with fragments of leaves. Several night crawlers and small common earthworms were seen working in the middens in one or two places. The material is silt loam; color when moist, 10YR 2/2; well-developed, medium, granular structure.

A2/A1—0 to ½ inch, discontinuous layer made up of mounds, 2 to 3 inches in diameter and about ½ inch thick, consisting of A2 material brought up by grubs or some other fauna, perhaps ants. The burrows or tunnels from which the material was "shoveled" can generally be found beside the mounds. The mounds were formed on top of the A11 horizon and were subsequently covered with material from the A11 horizon. These mounds are common but not nearly so numerous as the earthworm middens above. The material is silt loam; color when moist, 10YR 5/4 to 10 YR 4/4; moderate, 1/16-inch, granular structure; very friable.

A11—0 to ½ inch, continuous layer of black silt loam; 10YR 2/2 moist; fluffy; weak and moderate, fine, granular structure; high in organic matter. Rootlets occupy fully one-half of the volume. Horizontal roots ⅛ to 1/16 inch in diameter are numerous. Small earthworms 1 inch long are fairly common; six or eight were seen in the 2-foot-square area from which the sample was collected.

A12—½ to ¾ inch, silt loam; 10YR 3/3 moist, 5/1 dry; weak, fine, granular structure; matted and full of roots; difficult to sample; sampled mostly by means of a knife blade. pH 4.

A12/A2—¾ to 1 inch, continuous layer of silt loam; 10YR 4/3 moist; very weak, thin, platy structure; weakly matted with mycelia; much paler than horizon above and is, perhaps, merely the organic-stained upper portion of the A2 horizon. pH 4.

A2—1 to 2 inches, continuous layer of channery silt loam; brown (10 YR 5/3) moist; friable; weak, very thin, platy structure like that of the A2 horizon of the Gray-Brown Podzolic soils. This horizon is noticeably porous when examined under a ten-power microscope and shows some dense "packed" surfaces, which perhaps are the beginnings of subangular blocky structure like that of the horizons below. This horizon is of variable depth; commonly it is not more than ½ inch thick, but in places it is as much as 2 inches thick. pH 4.2.

B21—2 to 16 inches, continuous layer of channery silt loams; 10YR 4/4 moist to slightly paler and, in a few areas, nearly 10YR 5/6; firm to friable in place; moderate, coarse, subangular blocky structure. Peds 1 to 2 inches in diameter are common. They crush easily to moderate, ⅛-inch, subangular blocky peds that have little tendency to slake to weak fine granules. Under greater pressure, the ⅛-inch peds break to weak fine granules. The peds lack clay or silt coats, but they are porous. Roots extend throughout this horizon but stop abruptly at the pan. pH 4.4.

B22—3 to 20 inches, discontinuous layer of channery silt loam; 2.5Y 5/4 moist; friable; weak, ½-inch to 2-inch, subangular blocky structure that crushes readily to weak, ⅛-inch, subangular blocky and weak, fine, granular structure. This particular horizon is undoubtedly a portion of a windthrow mound. pH 4.8.

IIA′2—16 to 24 inches, continuous layer of channery fine sandy loam; 2.5Y 5/3 and 5Y 5/3 moist; faint, fine, common mottles of 2.5Y 4/4; not more than ½ inch thick over the domes but extending to a greater depth between the domes; weakly brittle when moist; very firm and breaks into rather coarse, weak plates when picked out. pH 4.7.

IIB′x1—24 to 34 inches, continuous layer of channery heavy silt loam; 2.5Y 4/4 moist; mottles of 5Y 5/3, 10YR 4/4, and 7.5YR 4/4. These mottled portions are mostly streaks that border the domed, very coarse prisms. Prominent streaks are 10 to 16 inches apart, and many smaller streaks cut through the domes. The interior of the domed prisms is faintly mottled. pH 5.1. This layer is extremely firm, and vigorous blows with the pick are required to break out fragments. Characteristically, the material breaks out in chunks or large clods at the top of the horizon, where the pick can be driven down the cracks between the domes. The clods or chunks can be broken free by leverage.

IIB′x2—34 to 42 inches, layer of continuous channery heavy silt loam; 2.5Y 4/4 toward 5Y 5/3 moist; extremely firm; very vigorous blows of the pick required to break free the material. Streaks are about 12 inches apart and represent the borders of prisms. The streaks are 5Y 5/3 and are bordered with 7.5YR 4/4 material ¼ to ½ inch thick. This changes abruptly to the 2.5Y 4/4 unmottled interior material. The interior material has a few coarse pores, 1 millimeter in diameter, and these are clay coated. pH 5.8.

IIC—42 to 52 inches, channery heavy silt loam; 5Y 4/3 moist; very firm, but distinctly less firm than the horizons above. No mottling except where an occasional streak from the overlying horizon penetrates. Clay flows are visible in the few pores, but in general this material is dense and nonporous. The material is not brittle and crushes rather than breaks when put under pressure. pH 5.8.

Mardin channery silt loam, profile M-2.—A sample of this soil was taken from the north field of the Mt. Pleasant Experimental Farm. The sampling site is on the upper part of a smooth, slightly convex, 5 percent slope, at an elevation of approximately 1,760 feet. The area was in grass pasture at the time of sampling, but it had been plowed a number of times in previous years and the upper horizons were mixed in the plowed layer. The soil was moist throughout when described and sampled in November 1951.

Description of profile:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2–3) channery silt loam; moderate, medium, crumb structure; friable; pH 5. Numerous fibrous roots.

B2—6 to 9 inches, yellowish-brown (10YR 5/4–6) silt loam; weak, medium, crumb structure grading toward weak, fine, blocky; friable; pH 5.3. Numerous fibrous roots.

IIA'2—9 to 11.5 inches, light brownish-gray (2.5Y 6/3) coarse silt loam; moderate, medium, platy structure; friable; pH 5.5. Some faint, yellowish-brown mottles occur as horizontal streaks 2 to 3 millimeters thick and 1 to 2 centimeters long. Some fine roots.

IIB'x1—11.5 to 29 inches, light olive-brown (2.5Y 5/4) gravelly silt loam grading with depth to olive brown (2.5Y 4/3; very weak, fine, blocky structure; very firm in place; pH 5.4. This horizon is divided into large prisms, 12 to 24 inches across, by vertical gray streaks. The large prisms are composed of moderately developed, very coarse, blocky peds 1 to 3 inches across, and the interiors of these very coarse peds are composed of the very weak, fine, blocky peds. The very coarse blocky peds have light brownish-gray (2.5Y 6/2) silty coatings up to 2 millimeters thick. Fine roots are present in the gray streaks and gray coatings. Black manganese-oxide stains occur in the lower part of the horizon.

IIB'x2—29 to 53 inches, olive-brown (2.5Y 4/3) gravelly silt loam grading with depth to grayish olive (4Y 5/3); weak, medium, blocky structure; very firm; pH increases with depth from 5.6 to 6.0. Gray streaks about 1 centimeter wide divide this horizon into prisms, 18 to 24 inches across, composed of weakly developed, very coarse, blocky peds having very thin, gray coatings. Some fine roots are present in the gray streaks. Dark manganese-oxide stains are common.

IIC1—53 to 59 inches, olive (5Y 5/3) gravelly silt loam; very weak, medium, blocky; firm in place; pH 6.1. Small, irregular, gray streaks 2 to 5 centimeters long are common and are oriented in all directions. Dark manganese-oxide stains are common.

IIIC2—59 to 65 inches, pale-olive (5Y 6/3) silty gravel. This is a thin gravel lens in the till. Much silt seems to have been deposited in the pore spaces. The material is single grained and friable, and has a pH of 6.3.

Mardin channery silt loam, profile M–3.—The sample of this soil was taken 40 feet downslope from the site of profile M–2. Slope and vegetation were similar to those at the site of profile M–2. The soil was moist throughout when described and sampled in November 1951.

Description of profile:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2–3) channery silt loam; moderate, medium, crumb structure; friable; pH 5.0.

B2—6 to 12 inches, yellowish-brown (10YR 5/6) channery silt loam; weak, medium, crumb structure, approaching weak, fine, blocky; friable; pH 5.2.

IIA'2—12 to 16 inches, light brownish-gray (2.5Y 6/3) coarse silt loam; moderate, medium, platy structure; friable; pH 5.0. Funnel-shaped extensions of this horizon, 4 to 6 inches wide and about 12 inches deep, extend into the horizon below at the sites of large gray streaks.

IIB'x1—16 to 32 inches, light olive-brown (2.5Y 5/4) gravelly silt loam grading to olive brown (2.5Y 4/3) with depth; very weak, medium, blocky structure; firm in place; pH increases from 5.0 to 5.4 with depth. The horizon is divided into prisms, 12 to 24 inches across, by gray streaks. The upper part of this horizon (16 to 20 inches) is slightly coarser textured and is much more porous than the lower part. Dark manganese-oxide stains are common in the lower part of the horizon.

IIB'x2—32 to 58 inches, olive-brown (2.5Y 4/3) gravelly silt loam; weak, medium, blocky structure; very firm in place; pH 5.4. The large prisms are 18 to 24 inches across. This horizon is similar to the IIB'x2 horizon of profile M–2.

IIC—58 to 61 inches, olive (5Y 5/3) gravelly silt loam; very weak, medium, blocky structure; firm in place; pH 6.5. Dark manganese-oxide stains are numerous. The large vertical gray streaks terminate at a depth of about 65 inches.

Rhinebeck Soils

Rhinebeck soils are deep, somewhat poorly drained Gray-Brown Podzolic soils that developed on clayey, calcareous, lacustrine sediments. The sediments are high in silt and clay and low in sand. Enough clay has accumulated in the B2t horizon to give a distinct clay bulge, if a curve of data is plotted. The silt content is lowest in the A2g and B2t horizons. Except in the A2g horizon, the reaction is alkaline. The C horizon is calcareous. The carbon-nitrogen ratio of the Ap horizon is 10, which is considered normal for cultivated soils in this area. The organic-carbon content of the Ap horizon is 1.37 and decreases rapidly with depth, as expected. The free iron oxide is highest—2.4 percent—in the B2t horizon and lowest—1.8 percent—in the C horizons.

Rhinebeck silt loam, S59–NY–55–1 (1–5).—The sample of this soil was taken ⅔ mile south of the village of Varna; ½ mile east of Ithaca town line; 200 yards north of Game Farm Road; 110 yards east of Lehigh Valley Railroad. The sampling site is in a plowed field, on a 2 percent northeasterly slope, at an elevation of 965 feet. The soil was uneroded or only slightly eroded. It was moist when the sample was taken.

Description of profile:

Ap—0 to 10 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, fine and medium, granular structure; friable; many fine roots; pH 6.8; abrupt, smooth lower boundary; 7 to 10 inches thick.

A2g—10 12 inches, grayish-brown (10YR 5/2) and olive-brown (2.5Y 4/4) silt loam; about equal amounts of each color; weak, fine and medium, subangular blocky structure; friable; few fine roots; pH 6.7; clear, smooth boundary; 1½ to 3 inches thick. Most of this horizon has been mixed with the Ap horizon.

B2t—12 to 23 inches, olive-brown (2.5Y 4/4) silty clay loam with common, medium, light olive-brown (2.5Y 5/4–5/6) mottles; strong, coarse prisms, 2 to 6 inches across, increasing in size with depth and breaking into moderate, medium, angular blocks; prisms coated with very sticky, dark-brown (10YR 3/3) and gray (N 5/0) clay; firm; few fine roots in cracks between prisms and in worm casts; pH 6.6; gradual, wavy boundary; 8 to 12 inches thick.

C1—23 to 27 inches, dark grayish-brown (2.5Y 4/2) and olive (5Y 4/4), laminated silt loam layers ⅛ to ¼ inch thick; very thin clay layers containing precipitated calcium carbonate between silt layers; weak, coarse to very coarse prisms that break to thick plates; firm; no roots; calcareous; clear, smooth boundary.

C2—27 to 50 inches, olive-brown (2.5Y 4/4) silty clay loam with few gray (N 5/0) vertical streaks marking boundary of weak, coarse prisms that separate into very thick plates; calcareous.

General Nature of the County

This section tells something about the history, population, industries, transportation facilities, agriculture and land use, and climate of Tompkins County. It also includes some information about community facilities, water supply, physiography, bedrock geology, and drainage.

History and Population

The Cayuga Indians, part of the Iroquois Confederation, were the first known farmers in Tompkins County. Before 1700 they cleared land within the present site of Ithaca and raised corn, squash, and beans. The county's first white settlers arrived in 1789 and settled on the Indian clearings at Ithaca. In the same year the Iroquois ceded the area to New York State. The area was laid out in sections and lots and was opened to settlement. In 1817 Tompkins County was formed from parts of Cayuga and Seneca Counties. Changes in the boundary continued until 1853. The county was named for Daniel D. Tompkins, a former U.S. Vice President and Governor of New York State.

By 1840 the population had reached 34,299. It remained fairly constant for the next 80 years. In 1880 it was 34,445 and in 1920 it was 35,285. After 1920 the population began to increase, and by 1960 it had reached 66,164.[23] The only city in the county is Ithaca, which has a population of 28,799.[23] The population is increased during the school year by approximately 10,000 to 12,000 students at Cornell University and Ithaca College. The principal villages in the county and their populations are Cayuga Heights, 2,788; Groton, 2,123; Trumansburg, 1,768; Dryden, 1,263; and Freeville, 471.

Industries and Transportation

The major industries in the county are the manufacture of such products as chains, business machines, typewriters, and shotguns. Also, there is one salt mine.

One commercial airport is a major transportation facility, especially for passenger traffic. Two branch lines of the Lehigh Valley Railroad serve the county; one branch follows the Cayuga Inlet Valley and the west side of Cayuga Lake, passing through Ithaca and Trumansburg. The other serves Dryden, Freeville, and Groton on the eastern side of the county.

Two principal State highways cross the county. Route 13 crosses in a northeast-southwest direction and Route 96 in a northwest-southeast direction.

Cayuga Lake is part of the New York State Barge Canal System, and occasional oil barges serve Ithaca and the county. Pleasure craft also use the lake and canal system.

Agriculture and Land Use

The 1959 census shows that 51.8 percent of Tompkins County is in farms. This includes 68,089 acres of cropland, 35,620 acres of pasture, and 28,936 acres of woodland. Dairying is the chief farm business; sales amounted to 5 million dollars in 1959. A few poultry farms are scattered about the county. In the high-lime soils area of the county, cash-grain farming is important.

The number of farms in the county has decreased steadily from 3,700 in 1880, to 2,550 in 1920, and to 1,035 in 1959. The average size of farms has increased from less than 70 acres in 1880, to 100 acres in 1920, to 157 acres in 1959. The number of dairy cows has remained fairly constant during these 80 years, averaging about 13,000, but milk production has increased from less than 50 million pounds in 1880, to 70 million in 1920, and to more than 100 million pounds in 1960.

In 1880, most crops were raised for sale off the farm. The main crops were timothy hay, corn, oats, wheat, barley, buckwheat, and potatoes. About 1920, better transportation facilities made possible shipment of fluid milk to large cities. As a result, emphasis shifted to production of forage and grain crops for feeding to dairy herds. Alfalfa is now the principal hay crop; it was grown on 14,550 acres in 1959. Corn was grown on 10,000 to 13,000 acres annually from 1949 to 1959. Half the corn was made into silage and half was picked for grain, and half of this grain was sold off the farm. Oats were grown on 10,000 to 13,000 acres each year during this period, mostly for on-farm use. Wheat continues to be an important cash crop. It was grown on 5,786 acres in 1959. Acreages of barley, buckwheat, and potatoes have become insignificant.

The 1959 census classes as commercial farms only 654 of 1,035 farms listed. Figures from the office of the County Director of Taxes and Assessments show an additional 1,800 units of land in rural Tompkins County of 2 acres or more. These parcels include rural residences, hobby farms, tree farms, private recreational areas, and idle land. The Federal, State, and county governments own 29,913 acres of land in Tompkins County.

Water Supply

Rural areas depend for water on dug wells, deep wells in both rock and unconsolidated deposits, springs, streams, and constructed ponds. The water supplies are usually adequate but may become critically short locally during prolonged dry periods.

Village water supplies come from deep wells or streams. The city of Ithaca gets water from reservoirs on Sixmile Creek. Cornell University gets its water from Fall Creek. Cayuga Lake provides water for the Miliken Station Power Plant. The Morris Chain Works draws water from Sixmile Creek.

Dryden Lake, Danby Pond, several fresh water marshes, and many small streams are additional sources of water.

Climate[24]

Tompkins County has a climate of the humid, continental type. The summers are warm. The winters are long and cold, and there are frequent periods of stormy weather. Maximum precipitation occurs late in spring and in summer; the winter season is marked by the smallest monthly amounts. Although the county is dominated by atmos-

[23] Figures quoted are from U.S. Census, 1960.

[24] Prepared by A. BOYD PACK, State climatologist, U.S. Weather Bureau, Ithaca, N.Y.

pheric flow from continental sources, the ranges in temperature and in seasonal precipitation are not so great as in the continental-type climates of the north-central United States.

Being in or near the paths of most major weather systems as they move across the continent, Tompkins County is subject to a variety of weather conditions. Table 19 summarizes the climatological data recorded at the station on the campus of Cornell University in Ithaca. Temperatures and other atmospheric conditions tend to change from day to day and week to week. Seasonal weather varies from year to year. There are times, however, when weather conditions persist with little alteration for a period of several days to a week or more. Several days of rather warm temperatures in summer, or of temperatures near zero in winter, are not uncommon. One climatic feature of considerable persistence is that of very cloudy skies in winter.

Variations in topography are an important factor in the climatic conditions of the county. Marked changes in elevation and slope within relatively short distances result in important modifications of the climate. The influence of Cayuga Lake on the climate appears to be confined largely to the immediate shore.

Temperature

On a day to day basis, there tends to be a noticeable variation in temperature, both daily extremes and daily averages. The occurrence of relatively small temperature changes for several consecutive days is somewhat less likely than the occurrence of variable temperatures from day to day. The daily extremes of temperature, however, do not fluctuate as widely as in areas nearer the center of the continent. On the other hand, the county is not dominated by the frequent small daily temperature changes that are characteristic of maritime-type climates.

Sharp drops or rises in temperature within a matter of several hours are rare. Occasionally, in winter and early in spring, however, very cold air masses move in rapidly and temperatures drop as much as 25 to 40 degrees within a 24-hour period. Warming trends of appreciable magnitude are spread over a longer period, and the temperature change is not usually so abrupt.

The temperature and those climatic conditions closely related to temperature, such as snow-cover duration, are greatly influenced by the varied topography. Elevation, aspect and steepness of slope, and air drainage affect the temperature. A comparison between the average monthly maximum and minimum temperatures at two different elevations in Tompkins County is given in table 20.

Only one weather-observing station within the county has been in operation for 30 years or more. This station is on the campus of Cornell University in Ithaca, and during the period of record has been located at an eleva- of 900 to 950 feet. Air drainage at this location is good. The climatic data subsequently discussed are from records at this station, unless otherwise specified.

Table 21 shows how temperatures in other parts of the county, at various elevations and under both good

TABLE 19.—*Summary of climatological records at Ithaca, Tompkins County, N.Y.*

[Elevation 900 to 950 feet]

Month	Temperature					Precipitation									Average total evaporation [4]	Average total solar radiation (x 100)[5]
	Average daily maximum [1]	Average daily minimum [1]	7 years in 10 will have— Maximum equal to or higher than [2]—	7 years in 10 will have— Minimum equal to or lower than [2]—	Average heating-degree days [1,3]	Average total [1]	Minimum [2]	3 years in 10 will have— More than [2]—	3 years in 10 will have— Less than [2]—	Average number of days with 0.10 inch or more [1]	Snow: Average total [1]	Snow: 7 years in 10 will have more than [2]—	Snow: Average number of days on which depth is more than[1]— 1 in.	Snow: Average number of days on which depth is more than[1]— 6 in.		
	° F.	° F.	° F.	° F.		In.	In.	In.	In.		In.	In.			In.	Gr.-Cal. sq. cm.
January	32	16	45	2	1,270	2.0	0.4	2.4	1.5	5	16	9	20	8	(6)	35.4
February	34	16	50	−1	1,130	2.2	.9	2.8	1.4	6	17	10	19	8	(6)	54.5
March	42	23	59	8	995	2.7	1.1	3.2	2.2	7	14	9	12	5	(6)	84.6
April	56	34	75	24	600	3.0	1.4	3.4	2.6	8	4	3	2	(7)	(6)	108.0
May	67	43	83	31	315	3.9	.5	4.1	2.5	8	(8)	0	0	0	4.1	149.1
June	77	53	89	37	100	3.6	1.4	4.3	2.6	7	0	0	0	0	5.3	164.8
July	81	57	90	47	25	3.9	1.3	4.6	3.1	8	0	0	0	0	5.9	172.4
August	80	56	90	43	45	3.8	1.4	4.6	2.7	6	0	0	0	0	5.0	147.0
September	72	49	86	35	180	3.0	.7	3.7	1.9	6	0	0	0	0	3.5	108.3
October	62	40	79	27	445	3.2	.6	3.0	1.9	7	(8)	(9)	(7)	0	2.3	78.0
November	47	31	67	19	780	2.9	.5	3.2	1.9	7	7	2	4	1	(6)	37.9
December	35	20	51	1	1,170	2.3	.4	2.8	1.6	5	12	7	16	4	(6)	30.6
Year	57	37	93	−7	7,055	36.5	26.7	37.8	32.0	80	70	55	73	26	26.1	1,170.6

[1] Based on 20-year record.
[2] Based on 30-year record.
[3] Base of 65° F. daily mean temperature.
[4] Evaporation from free water surface; measurements made from May through October; based on 18-year record.
[5] Based on 10-year record.
[6] No measurement made.
[7] Less than 1 day.
[8] Less than 1 inch.
[9] 1 year in 10 will have more than 1 inch.

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TABLE 20.—*Comparison of average monthly maximum and minimum temperatures at Caldwell Field, town of Ithaca, and Mt. Pleasant Farm, town of Dryden, Tompkins County, N.Y.*

[Averages are for the same 10-year period, 1952–1961]

Month	Average maximum temperature		Average minimum temperature	
	Caldwell (elevation 950 ft.)	Mt. Pleasant (elevation 1,650 ft.)	Caldwell (elevation 950 ft.)	Mt. Pleasant (elevation 1,650 ft.)
	°F.	°F.	°F.	°F.
January	31	27	15	14
February	35	31	16	16
March	41	36	23	22
April	56	52	34	35
May	67	63	42	44
June	77	73	51	54
July	81	77	57	59
August	79	75	55	58
September	73	69	49	52
October	61	58	39	41
November	48	44	32	31
December	35	32	21	19

and poor conditions of air drainage, would tend to compare with temperatures at the Ithaca weather station.

Temperatures of 90° F. or higher occur on an average of 6 to 10 days per year, almost entirely in June, July, and August. The number of days varies from 2 or less in cool summers to 18 or more in abnormally warm summers. Temperatures of 90° or higher occur early in September about 1 year in 3, but they are rare in May. Temperatures of 100° or higher have been officially recorded on only four dates in 30 years. In general, 90° temperatures are less frequent at elevations higher than 900 to 1,00 feet and more frequent in the valleys of lower elevation.

Temperatures of 0° or below occur on an average of 7 to 10 days per winter. In an especially cold winter, the number of such days may be 15 or more; during a mild winter, it may be none to four. Temperatures of 0° or below are to be expected from early in December through the early part of March. In about 2 winters out of 10, a temperature of 15° below zero or lower can be expected on 1 or 2 days. Temperatures colder than 20° below zero have been officially recorded on less than 10 dates in 30 years. In most winters the coldest temperature is between 7° and 14° below zero. From late in November until the end of March, an average of 50 days on which the temperature does not exceed 32° can be expected. Locations having poor air drainage, relatively high elevation, or both, tend to have a higher frequency of similar or colder temperatures.

The last date in spring with a temperature of 32° or below is about May 12, and the first date in fall is about October 5. Ordinarily, the last freeze in spring occurs between May 5 and May 20, and the first in fall between September 25 and October 15. The growing season free of temperatures of 32° or lower is about 146 days in length. Within a 30-year period, the length of the freeze-free growing season has ranged from 118 to 178 days, but in 7 years out of 10 it has been between 125 and 155 days.

Table 22 contains additional freeze data. These data are applicable to locations comparable in elevation and air drainage to the location of the observing station in Ithaca. Freezing temperatures are likely to come earlier in fall and later in spring in areas of poor air drainage, such as bowl-shaped valleys or even low-lying flat valleys, regardless of elevation. On the other hand, areas of good to excellent air drainage at lower elevations are not likely to have freezing temperatures until later in fall and are likely to have their last freezing temperature earlier in spring. At the higher elevations, the effect of altitude tends to counteract the effect of good air drainage, and frosts can be expected earlier in fall and later in spring. Until sufficient microclimatic data are available in the county, the best guide to the frost hazards of a given location will be experience with and observation of freeze-sensitive vegetation.

Additional information on freezing temperatures in spring and fall may be found in literature citations (*8*) and (*9*).

Observations of soil temperatures over several years have shown that in the upper 4 inches (the seeding layer), a temperature of 40° is attained by early or mid-April, and a temperature of 50° by late April or early May.

TABLE 21.—*Effect of elevation and air drainage on temperatures*

[General tendency of temperatures at different elevations and under different conditions of air drainage are compared with temperatures at the weather station on the campus of Cornell University, elevation 900 to 950 feet]

Elevation, air drainage,[1] and season	Temperatures in comparison with those at weather station	
	Daytime maximum	Nighttime minimum
Elevation 1,200 feet or more:		
Air drainage good—		
Winter	Cooler	Similar or cooler.
Summer	Cooler	Warmer.
Air drainage poor—		
Winter	Similar or warmer	Cooler.
Summer	Cooler	Cooler.
Elevation 700 feet or lower:		
Air drainage good—		
Winter	Warmer	Warmer.
Summer	Warmer	Warmer.
Air drainage poor—		
Winter	Warmer	Cooler.
Summer	Warmer	Cooler.
Elevation 700 to 1,200 feet:		
Air drainage good—		
Winter	Similar	Similar.
Summer	Similar	Similar.
Air drainage poor—		
Winter	Warmer	Cooler.
Summer	Warmer	Cooler.

[1] Relatively cool air tends to flow downhill. Air drainage is good if the flow is free and unimpeded by hills, numerous large buildings, or dense woods. Air drainage is poor if the flow is impeded or if there are low bowl-shaped depressions in which air stagnates.

TABLE 22.—*Probabilities of freezing temperatures in spring and fall at Ithaca, Tompkins County, N.Y.*[1]

[Based on period 1932–1961]

Probability	Dates for given probability and temperature					
	16° or lower	20° or lower	24° or lower	28° or lower	32° or lower	36° or lower
Spring:						
1 year in 10 later than	April 3	April 12	April 23	May 16	May 24	June 8.
2 years in 10 later than	March 28	April 7	April 17	May 9	May 19	June 6.
5 years in 10 later than	March 20	March 29	April 9	April 24	May 13	May 26.
7 years in 10 later than	March 12	March 26	March 31	April 16	May 10	May 22.
Fall:						
1 year in 10 earlier than	November 11	November 4	October 24	September 28	September 19	September 9.
2 years in 10 earlier than	November 18	November 8	October 28	October 6	September 25	September 13.
5 years in 10 earlier than	November 28	November 19	November 8	October 17	October 4	September 25.
7 years in 10 earlier than	December 1	November 24	November 13	October 29	October 7	September 29.

[1] The following example illustrates how to use and interpret the data in this table. Take a temperature of 24° or lower. In one year out of 10 (10 percent probability), a temperature of 24° or below can be expected to occur later than April 23; in 5 years out of 10 (50 percent probability), a temperature of 24° or below can be expected later than April 9; in 7 years out of 10 (70 percent probability), a temperature of 24° or below can be expected to occur later than March 31. The fall dates are interpreted similarly for a given temperature, but the occurrence is earlier than the given date. These data apply if slope, air drainage, and other factors are similar to those in the eastern portion of the Cornell University campus in Ithaca. For different conditions, adjustments must be made in the dates given, as explained in the text.

Maximum temperatures in the high 70's and low 80's are reached in July. In fall the upper 4 inches cools to the low 50's by early November and to the low 40's by late November.

Precipitation

The average annual precipitation increases from about 32 inches in the southwest portion of the county to about 38 inches in the northeast portion. About 50 to 55 percent of the annual total—16 inches in the southwest and about 18.5 inches in the northeast—falls during the May–September portion of the growing season. Total rainfall in this 5-month period has ranged from extremes of less than 13 inches to more than 26 inches, but in 7 years out of 10 the total ranges from about 15 to 22 inches.

Precipitation is fairly evenly distributed by months from April through October. Normally, the amount of precipitation during the growing season is adequate and the distribution favorable for the growth of crops and other plants that are otherwise adapted to the county. Almost every summer has one or more short periods of deficient rainfall. In approximately 2 growing seasons out of 15, precipitation will be inadequate for a period so prolonged that growth of crops will be seriously affected. Such drought conditions, for example, occurred in 1962 and 1955 in the county.

Precipitation during the growing season usually comes from showers and thundershowers that last not more than a few hours. Occasionally, however, precipitation results from storms that produce steady but less intense rainfall over a period of 6 to 24 hours. Amounts of 1 inch or more in 24 hours are to be expected in any month but are more common during the growing season. During the warmer months, 2 inches of rain in a day is not uncommon but a fall in excess of 3 inches is unusual. Winter precipitation consists mostly, but by no means entirely, of snow and other frozen forms.

The probability of receiving either a trace or less or at least certain measurable amounts of precipitation in a specified 1-week period is shown in table 23. Similar data for a specified 2-week period are given in table 24. These and other data on weekly precipitation probabilities in Tompkins County and many other areas of the northeastern United States are available in a recent publication.[25]

Snowfall is abundant in Tompkins County. Being in or near the path of many winter storm systems, the county is subject to frequent and heavy snowfall, both in terms of individual storms and monthly amounts. The average winter snowfall is between 60 and 70 inches, but a total of 85 inches or more is not uncommon. Very few winters have a total snowfall of less than 45 inches.

From December through March a total monthly snowfall in excess of 20 inches occurs with some frequency. The highest monthly total in some 80 years of record at Ithaca was 49 inches, in January 1958, and the highest annual total was 115 inches, in the winter of 1957–58.

The snowfall season usually begins in early or mid-November and continues through early April. The ground is covered by at least 1 inch of snow more or less continuously from about early December through the latter part of March and in many seasons during part of both November and April. Snow is likely to accumulate to a depth of more than 12 inches for one or more periods during most winters.

The climate of the county favors a considerable amount of cloudiness, especially in winter. About 175 days per year are cloudy, and about 20 cloudy days can be expected in each of the months of December, January, and February. About 80 days per year are clear, and 110 are partly cloudy. The percentage of possible sunshine increases from an average of about 30 percent in November and December to about 60 percent in June and July.

[25] DETHIER, B. E., McGUIRE, J. K. PROBABILITY OF SELECTED WEEKLY PRECIPITATION AMOUNTS IN THE NORTHEASTERN REGION OF THE UNITED STATES. Agronomy Mimeo. 61-4. Cornell Univ. Agr. Exp. Sta. 1961.

Table 23.—*Probability, in percent, of receiving a specified amount of precipitation during a specified 1-week period at Ithaca, Tompkins County, N.Y.*[1]

Week beginning—	Probability of receiving—				
	Trace or less	At least 0.2 in.	At least 0.6 in.	At least 1 in.	At least 2 in.
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*
January 3	1	67	24	9	1
January 10	1	68	18	4	0
January 17	3	63	19	5	([2])
January 24	2	65	19	5	([2])
January 31	3	67	21	6	([2])
February 7	1	72	25	9	1
February 14	1	79	32	11	1
February 21	0	82	38	16	2
March 1	0	81	37	15	1
March 8	1	80	43	21	3
March 15	2	76	40	21	4
March 22	2	77	40	20	3
March 29	1	82	43	20	2
April 5	2	84	45	20	2
April 12	2	86	49	24	3
April 19	3	80	44	21	3
April 26	2	79	46	25	6
May 3	4	74	44	25	7
May 10	7	76	48	30	9
May 17	6	77	49	30	8
May 24	4	80	51	30	8
May 31	2	81	48	27	6
June 7	3	79	48	28	7
June 14	3	82	51	30	7
June 21	6	78	49	29	8
June 28	7	78	51	32	10
July 5	8	77	47	28	8
July 12	5	82	51	30	8
July 19	2	84	51	28	6
July 26	2	82	51	31	8
August 2	2	80	50	30	8
August 9	6	74	45	28	8
August 16	7	71	45	29	10
August 23	10	68	43	28	10
August 30	13	65	40	26	9
September 6	12	71	44	27	8
September 13	12	70	42	24	6
September 20	10	72	42	24	6
September 27	11	66	36	19	4
October 4	10	66	37	22	6
October 11	8	66	38	22	6
October 18	6	70	42	25	7
October 25	3	75	45	27	7
November 1	2	78	42	22	5
November 8	3	76	41	21	4
November 15	4	71	34	16	3
November 22	7	71	38	20	4
November 29	5	70	33	15	2
December 6	4	69	35	17	3
December 13	2	66	28	12	2
December 20	1	69	32	15	3
December 27	1	72	29	11	1

[1] The following example illustrates how to use data in table 23. Take the week beginning May 10: There is a 7-percent probability of receiving a trace or less of precipitation; a 76-percent probability of receiving a total of at least 0.2 inch; a 48-percent probability of at least 0.6 inch; a 30-percent probability of at least 1 inch; and a 9-percent probability of at least 2 inches.

[2] Less than 0.5 but greater than zero.

The prevailing wind is generally northwesterly throughout the year, but there is a tendency toward the southwest in summer. The wind velocity is about 7 to 10 miles per hour from May through October and 11 or 12 miles per hour during the remaining months. Violent and damaging windstorms are not a serious weather hazard in the county, but wind damage to crops, property, or both in locally severe thunderstorms or more widespread winter storms has been recorded.

Table 24.—*Probability, in percent, of receiving a specified amount of precipitation during a specified 2-week period at Ithaca, Tompkins County, N.Y.*

Two-week period beginning—	Probability of receiving—				
	At least 0.2 in.	At least 0.8 in.	At least 1.4 in.	At least 2 in.	At least 4 in.
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*
January 3	94	41	13	4	([1])
January 17	92	37	10	2	0
January 31	93	45	15	5	0
February 14	98	65	28	10	([1])
March 1	99	71	35	14	1
March 15	97	66	35	17	1
March 29	99	74	38	15	([1])
April 12	99	74	41	19	1
April 26	96	70	42	24	3
May 10	95	72	48	29	5
May 24	97	76	48	28	3
June 7	97	75	48	28	3
June 21	98	76	51	31	5
July 5	97	75	50	30	5
July 19	99	79	51	29	3
August 2	97	74	48	29	4
August 16	92	66	44	29	7
August 30	93	64	41	25	4
September 13	96	68	40	22	2
September 27	90	57	33	18	2
October 11	90	61	38	23	4
October 25	98	74	43	22	5
November 8	95	65	34	15	1
November 22	92	58	30	15	1
December 6	92	52	26	11	1
December 20	94	54	24	10	([1])

[1] Less than 0.5 but greater than zero.

Dense fog is infrequent; it occurs on an average of about 10 days per year. Afternoon humidity in summer averages between 45 and 55 percent. An uncomfortable combination of high temperature and high humidity is infrequent.

In terms of area and number of people affected, heavy snows are probably the most serious of the severe storm hazards. Blizzards—heavy snowstorms accompanied by very poor visibility, high winds, and sharply falling temperatures—are comparatively infrequent. Thunderstorms occur on about 30 days each year. Occasionally these storms may be accompanied by locally damaging winds and by heavy rains of such intensity as to cause flooding and soil erosion. Although hail occurs with some of the more severe thunderstorms, it is not regarded as a serious risk to crops and property. No tornadoes have been recorded, but there is a possibility of such storms. From time to time a severe winter storm of freezing rain may occur.

For the most part, the county is not within the usual path of hurricanes or other severe tropical storms, but a few such storms have passed through New York State within the past decade or two, causing damage from heavy rains and high winds in Tompkins County.

Community Facilities

Ithaca is the site of the main campus of Cornell University. Cornell is a private university, yet it has four divisions supported by the State of New York, including the Colleges of Agriculture and Veterinary Medicine, and is the land-grant university of the State. It is coeducational and nonsectarian. The more than 10,000 students come from 48 States and 72 countries and represent all races, religions, and economic brackets. Ithaca is also the home of Ithaca College, which is noted for courses of study in the fields of music, physical education, physical therapy, drama, radio, and television. In addition to these institutions, Tompkins County has excellent primary and secondary educational facilities. Rural students are transported to consolidated schools by buses.

Electricity and telephone service are available in most parts of the county. One daily newspaper is printed in Ithaca, and several weekly papers are published in the villages of the county. Two local radio stations and one television station serve the Ithaca area.

Churches of many denominations are located throughout the county. Special provisions are made for Cornell students who are of faiths other than the Christian or the Jewish.

An agricultural center, which houses the local units of agricultural agencies, is located in Ithaca. It also serves as a meeting place for groups concerned with agricultural and home-making activities in the county.

The recreational facilities of Tompkins County are numerous and varied. Cayuga Lake offers many opportunities for boating, fishing, and other aquatic sports. Hunting and fishing are favorite pastimes for large segments of the population (refer to the section "Wildlife" for details about kinds of game and fish and where they may be found). Scenic State parks at Enfield Glen, Buttermilk Falls, and Taughannock Falls provide camping, swimming, and picnicking facilities.

Physiography

Tompkins County lies almost entirely within the Allegheny Plateau, a segment of the Appalachian Plateau province. A small part in the northwestern part of the county along both sides of the Cayuga Lake Valley is in the Erie-Ontario Plain (7).

The southern part of the county consists of a high plateau that rises from approximately 1,500 to 2,000 feet above sea level and is dissected by a series of broad valleys. The valleys have fairly straight courses, smooth, gentle lower slopes, and relatively steep upper slopes. There are few tributaries other than narrow ravines that have rolling valley bottoms. The remnants of the plateau still intact are small in area and have a strongly rolling surface.

The Portage escarpment, an irregular formation crossing the county south of Ithaca, separates the high plateau from remnants of a lower plateau and the Erie-Ontario Plain, both of which are north of the escarpment. The boundary between the lower plateau and the plain is indistinct. The area is characterized by one complete north-south ridge and parts of two other ridges, which are separated by the deep valleys occupied by Cayuga and Owasco Lakes and the continuations of these valleys south of the lakes. The plain occupies the western part of the central ridge and the eastern part of the western ridge adjacent to Cayuga Lake. The elevation is generally less than 1,100 feet. The ridges are broad and smooth. They are characterized by mild topography, except for the two deep valleys already mentioned, a few shallower valleys of the same type, such as that occupied by Salmon Creek, and the narrow gorges that have cut back a short distance into the side slopes of the ridges adjacent to the lake and valleys. The ridges have a narrow longitudinal axis of maximum elevation and slope smoothly but gently to within a mile or a half a mile of the lake or valley bottoms. Then the slope steepens rapidly and becomes almost precipitous 100 feet or more above the lake or valley bottoms.

The entire county was glaciated. The last advances of the ice took place 13,000 to 16,000 years ago during the Cary substage of the Wisconsin glaciation. Most of the northern three-fourths of the county was covered by young Cary, which is known as Valley Heads drift. South of the Valley Heads moraine, which roughly follows the divide between the Lake Ontario and the Susquehanna drainage, old Cary, or Binghamton drift, mantles the uplands. The till is predominantly shale, siltstone, and sandstone but contains some limestone. The Binghamton drift has been more deeply leached of carbonates than the Valley Heads. On the lower plateau in the northern section of the county, where the Valley Heads till mantles the bedrock, Langford and Erie soils are dominant. On the Erie-Ontario Plain, limestone is a more conspicuous component of the till, and Lima-Honeoye and Lansing-Conesus soils are dominant. Volusia, Mardin, and Lordstown soils formed in the Binghamton drift and in a small segment of the Valley Heads drift, which mantles the bedrock of the high plateau in the southern part of the county. During the last stages of glaciation, the melting ice was like a dam in the north-sloping troughs of the deeply incised valleys occupied by Cayuga and Owasco Lakes. Water was impounded between the ice and the lowest divide to the south. The lacustrine sediments laid down in these glacial lakes occupy elevations up to 1,000 feet. Hudson and Rhinebeck soils are most extensive in these areas. As the waters receded from these broad valleys, they deposited coarser textured gravelly and sandy material in which Howard, Palmyra, and Chenango soils formed. In close association on the lateral moraine and plugs in the valleys are Valois soils.

Bedrock Geology [26]

Tompkins County is underlain by rocks of the Devonian system consisting of shale, fine-grained sandstone, and thin beds of limestone (fig. 26). The beds are nearly horizontal and show very little folding or faulting. They dip slightly to the south and southwest, at a gradient of 15 to 30 feet per mile. Following is a description of these rocks from the oldest to the youngest.

The Hamilton formation (H) consists of black to bluish-gray shales and thin beds of limestone. In ascending order, the shales are the Marcellus, Skaneateles, Ludlowville, and Moscow. In Tompkins County, the Hamilton formation is exposed only on the lower slopes immediately above the lake waters in the northwestern part of the

[26] This section was written by CARL S. PEARSON, soil technologist, Cornell University.

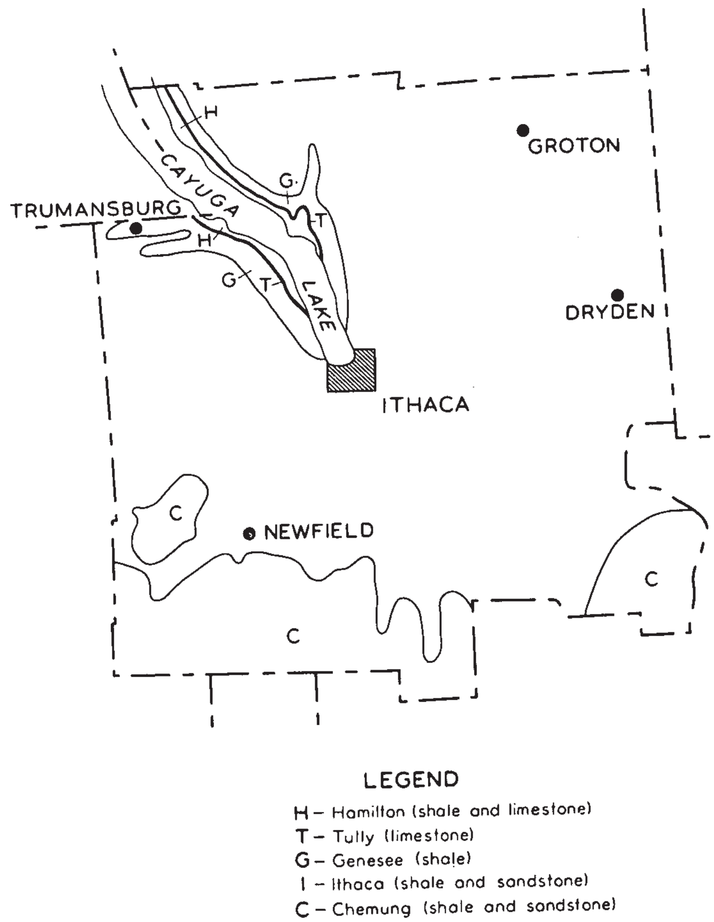

Figure 26.—**Bedrock geology of Tompkins County.**

county. The few feet of exposed rock have contributed very little to the parent material of Tompkins County soils.

Tully limestone (T), which is the basal formation of the Upper Devonian series, consists of about 18 feet of gray limestone that carries considerable pyrite. This formation outcrops on the steep slopes and is of only local importance. Except in the Inlet Valley, soil parent materials show little influence of the Tully limestone.

The Genesee beds (G) consist of dense, black, bituminous layers and thin bands of gray shales that are near the top. Pyrite in small nodules is common, and in places there are a few thin flags of finer grained, calcareous sandstone. Above Cayuga Lake and extending up the valley of Salmon Creek for a short distance, Genesee shales outcrop as a narrow belt on steep slopes, parallel to the direction of ice movement. The influence of these shales on soil parent materials is local.

The Ithaca group (I) of the Portage formation consists of alternating beds of shales and sandstone. The Cashaqua shale is light, soft, and moderately calcareous and is limited at the top by bituminous shales. Enfield shale constitutes the upper part of the Ithaca group. Ithaca shale makes up the bedrock of more than three-quarters of the county and includes the rocks from which the parent material of most of the upland solids have been derived. Soils of the Valois catena, for example, have developed in materials derived from these rocks.

The Chemung group (C) consists of beds of highly fossiliferous sandstone and shale. In the Ithaca region, these beds are made up of Cayuta shale overlain by Wellsburg sandstone. This formation makes up the bedrock of the rugged southwestern part of the county. Much of the parent material of soils of the Bath and Lordstown catenas was derived from the shales and sandstones of the Chemung beds.

Drainage

Tompkins County is in two main drainage systems, the St. Lawrence River system to the north and the Susquehanna River system to the south (fig. 27).

The major streams in the county flow into Cayuga Lake and into the St. Lawrence River system. Salmon Creek flows through Ludlowville and Myers. Fall Creek flows through Groton City, McLean, and Malloryville; at Freeville it joins Virgil Creek from Dryden Lake and flows on to Etna, Forest Home, and the Cornell University campus before reaching Cayuga Lake. Cascadilla Creek flows from Ellis through the Cornell University campus and part of Ithaca. The Cayuga Inlet flows through West Danby; the west branch flows through Newfield before reaching Ithaca and Cayuga Lake. Enfield Creek flows from Millers Corners through Enfield Center, Robert H. Treman State Park, and into the Cayuga Inlet. The Owasco Inlet flows from north of Freeville through Groton and northward into Owasco Lake. Taughannock Creek flows from Schuyler County on the west through Halseyville and Taughannock State Park and into Cayuga Lake. Two other small creeks are Trumansburg Creek, which flows through the village of Trumansburg, and Buttermilk Creek, which flows through Danby and Buttermilk Falls State Park.

The following creeks flow southward into the Susquehanna River system. The west branch of Owego Creek forms the southeast boundary of the county and flows through Caroline and Speedsville. Danby Creek joins Willseyville Creek in Tioga County. Willseyville Creek served as the White Church Outlet of glacial Lake Ithaca. Michigan, McCorn, Jackson, and Cantor Creeks flow southward into adjoining counties and into Cayuta Creek.

The large creeks and their tributaries are mainly dendritic, or branching, in pattern, but numerous small streams along each side of Cayuga Lake form a parallel drainage pattern and are rarely branched except near their source.

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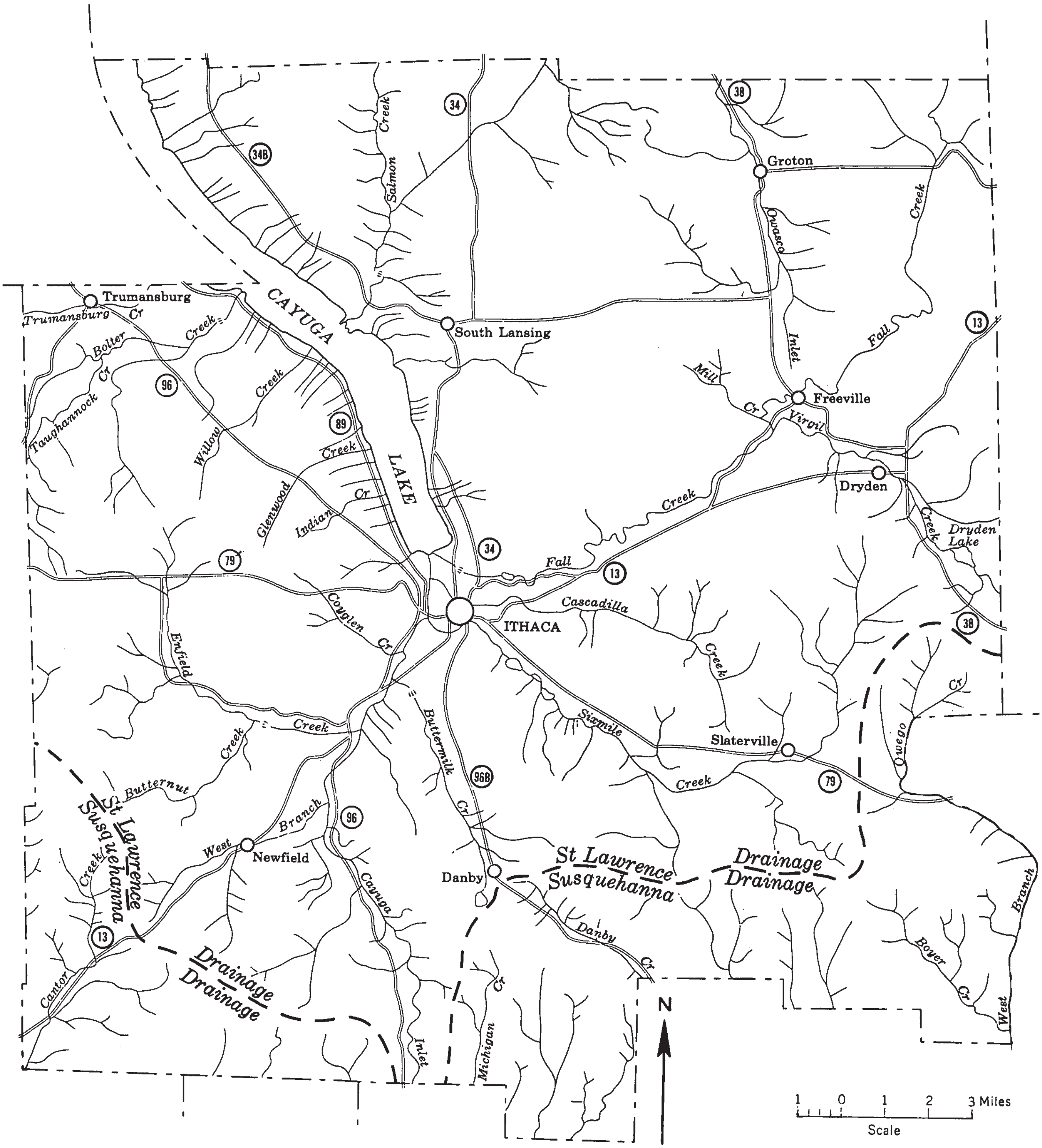

Figure 27.—**Tompkins County drainage.**

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Glossary

Aeration, soil. The process by which air and other gases in the soil are renewed. The rate of soil aeration depends largely on the size and number of the pores in the soil and on the amount of water clogging the pores. A soil with many large pores is generally well aerated.

Aggregate, soil. Many fine soil particles held in a single mass or cluster, such as a clod, crumb, block, or prism.

Alluvial soil. Soil formed from material, such as gravel, sand, or clay, deposited by a stream of water and showing little or no modification of the original material by soil-forming processes.

Base saturation. The relative degree to which a soil has absorbed metallic cations (calcium, potassium, magnesium, etc.). The proportion of the cation-exchange capacity that is saturated with metallic cations.

Bedding. Plowing, grading, or otherwise elevating the surface of fields into a series of parallel beds, or "lands," separated by shallow surface drains.

Bedrock. The solid rock that underlies the soils and other unconsolidated material, or that is exposed at the surface.

Catena, soil. An association of soils developed from one kind of parent material but differing in characteristics because of differences in drainage or relief.

Channery soil. Soil that contains thin, flat fragments of sandstone or siltstone, as much as 6 inches in length along the longer axis. A single piece is called a fragment.

Clean tillage. Cultivation to prevent the growth of all vegetation except the particular crop desired.

Coarse-textured soils. Sand, loamy sand, sandy loam, and fine sandy loam.

Cobblestone. A rounded or partly rounded fragment of rock, 3 to 10 inches in diameter.

Congeliturbate. Soil material disturbed by frost action.

Consistence. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are as follows:

Loose. Noncoherent; will not hold together in a mass.

Friable. When moist, crushes easily under moderate pressure between thumb and forefinger and can be pressed together into a lump.

Firm. When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic. When wet, deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky. When wet, adheres to other material.

Hard. When dry, moderately resistant to pressure; can barely be broken between thumb and forefinger.

Cemented. Hard and brittle; little affected by moisture.

Contour farming (tillage). Conducting field operations, such as plowing, planting, cultivating, and harvesting, in rows that are at right angles to the natural direction of the slope and as nearly level as practical.

Cover crop. A close-growing crop grown primarily to improve the soil and protect it between periods of regular crop production, or one grown between trees and vines in orchards and vineyards.

Deciduous trees. Trees that shed their leaves annually; generally refers to the broadleaf trees.

Erodible. Susceptible to erosion; soil is easily lost through the action of water or wind.

Erosion. The wearing away of the land surface by detachment and transport of soil and rock materials through the action of moving water, wind, or other geological agents.

Field moisture capacity. The moisture content of a soil, expressed as percentage of oven-dry weight, after the gravitational, or free, water has been allowed to drain, usually for 2 or 3 days. The field moisture content 2 or 3 days after a soaking rain. Also called field capacity, normal field capacity, normal moisture capacity, and capillary capacity.

Fine-textured soils. Clay loam, sandy clay loam, silty clay loam, sandy clay, silty clay, and clay.

Flaggy soils. Soils that contain comparatively thin fragments, 6 to 15 inches long, of sandstone, limestone, slate, shale, or, rarely, schist. A single piece is a flagstone.

Flood plain. The nearly level land at the bottom of the valley of a present stream and subject to flooding unless protected artificially.

Fragipan. A dense and brittle pan, or layer, in soils. Its hardness results mainly from extreme density or compactness rather than from high clay content or cementation. Fragments that are removed are friable, but the material is so dense in place that roots cannot penetrate it, and water moves through it very slowly.

Glacial drift. The assorted and unassorted materials deposited by glaciers and by the streams and lakes associated with them.

Glacial till. The unassorted part of glacial drift, consisting of clay, silt, sand, and boulders transported and deposited by ice.

Gley soils. A soil in which waterlogging and lack of oxygen have caused the material in one or more horizons to be neutral gray in color. Gleying is indicated by adding a lower case "g" to the horizon symbol, such as A2g or B2g.

Graded stripcropping. Growing crops in strips that are graded toward a protected waterway.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, covered by grass for protection against erosion; used to conduct surface water away from cropland.

Green-manure crop. Any crop grown for the purpose of being turned under while green or soon after maturity for soil improvement.

Gully. A channel or miniature valley cut by running water, through which water commonly flows only during and immediately after heavy rains or during the melting of snow. Some gullies are dendritic or branching; others are linear, that is, long and narrow and of uniform width. The distinction between a gully and a rill is one of depth. A gully is too deep to be obliterated by normal tillage operations; a rill is of lesser depth and can be smoothed by ordinary farm tillage.

Hardpan. A cemented (indurated) or hardened soil horizon. This horizon, which may be of any texture, is compacted or cemented by iron oxide, silica, organic matter, or other substances.

Horizon, soil. A layer of soil, approximately parallel to the soil surface, that has distinct characteristics produced by the soil-forming processes. Horizons are identified by letters of the alphabet.

Humus. The well-decomposed, more or less stable part of the organic matter in mineral soils.

Infiltration. The downward entry of water into the surface layer of a soil.

Landscape. All the characteristics that distinguish a certain kind of area on the earth's surface and give it a distinguishing pattern in contrast with other kinds of areas. Any one kind of soil is said to have a characteristic natural landscape, and under different uses it has one or more characteristic cultural landscapes.

Leached layer. A layer in which the soluble constituents have been dissolved and washed away by percolating water.

Medium-textured soil. Very fine sandy loam, loam, silt loam, and silt.

Metamorphic rock. A rock that has been greatly altered from its original condition by heat, pressure, and water. Igneous and sedimentary rock may be changed to metamorphic rock, or one metamorphic rock may be changed to another. Gneiss, schist, and slate are examples of metamorphic rock.

Mor. A type of forest humus that consists of relatively pure, unincorporated organic matter (raw humus). It is usually matted, or compacted, or both, and forms a distinct layer above the mineral soil.

Mottles. Irregular spots of color in soil that vary in number and size. Descriptive terms are as follows: Contrast—*faint, distinct*, and *prominent;* abundance—*few, common*, and *many;* and size—*fine, medium*, and *coarse*. The size measurements are as follows: *Fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium*, 5 to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Parent material. The horizon of weathered rock or partly weathered soil material from which soil has formed; horizon C in the soil profile.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability, soil. The quality that enables water or air to move through the soil. Terms used to describe permeability are *very slow, slow, moderate, rapid*, and *very rapid*.

Physiographic province. One of the major geographic divisions of the continent.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of the soil, expressed in pH values or in words as follows:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Residual soil. Soil formed in place by the disintegration and decomposition of rocks and the consequent weathering of the minerals; presumably developed from the same kind of rock as that on which it lies.

Rill. A steep-sided channel resulting from accelerated erosion but usually only a few inches in depth and width; not large enough to be an obstacle to farm machinery.

Runoff. Surface drainage of rain or melted snow.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement of the profile.

Sheet erosion. The removal of a fairly uniform layer of soil or material from the land surface by the action of rainfall and runoff water.

Shrink-swell potential (engineering). Amount that a soil will expand or contract when wet or dry. Indicates kinds of clay in soil.

Solum (pl. sola). The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in a mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying parent material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Stripcropping. Growing crops in a systematic arrangement of strips, or bands, to serve as vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are *platy, prismatic, columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon of a soil with a distinct profile; roughly, that part of the profile below plow depth.

Substratum. Any layer beneath the solum, or true soil; the C or D horizon.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. A terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without causing erosion. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage (diversion terraces) have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea; frequently called second bottom, as contrasted with flood plain; seldom subject to overflow.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. Some of the textural classes are as follows:

Clay. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter.

Loam. Soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

Sand. As a soil textural class, soil material that is 85 percent or more sand and not more than 10 percent clay. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter.

Sandy loam. Soil material in which the percentage of clay is 20 or less, the percentage of silt plus twice the percentage of clay exceeds 30, and the percentage of sand is 52 or more; or soil material that is less than 7 percent clay, less than 50 percent silt, and between 43 percent and 52 percent sand.

Silt. As a soil textural class, soil material that is 80 percent or more silt and less than 12 percent clay. As a soil separate, individual mineral soil particles from 0.002 millimeter to 0.05 millimeter in diameter.

Silt loam. Soil material that is 50 percent or more silt and 12 to 27 percent clay; or 50 to 80 percent silt and less than 12 percent clay.

Tilth, soil. The condition of a soil in its relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil (engineering). Presumably fertile soil or soil material, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Water-holding capacity. The ability of a soil to hold water that will not drain away but can be taken up by plant roots.

Water table. The upper limit of the part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

[See table 15, p. 115, for approximate acreage and proportionate extent of soils; table 8, p. 43, for estimated average acre yields; and table 12, p. 68, table 13, p. 72, and table 14, p. 92, for information on engineering properties of soils]

Map symbol	Mapping unit	Page	Capability unit Symbol	Capability unit Page	Woodland group Number	Woodland group Page
Ab	Alluvial land	116	Vw-1	40	16	57
ArB	Arkport fine sandy loam, 2 to 6 percent slopes	117	IIe-3	23	1a	51
ArC	Arkport fine sandy loam, 6 to 12 percent slopes	117	IIIe-5	28	1a	51
BaB	Bath channery silt loam, 2 to 5 percent slopes	119	I-1	22	5a	54
BaC	Bath channery silt loam, 5 to 15 percent slopes	119	IIIe-3	27	5a	54
BaC3	Bath channery silt loam, 5 to 15 percent slopes, eroded	119	IVe-3	35	5a	54
BaD	Bath channery silt loam, 15 to 25 percent slopes	119	IVe-2	34	5b	54
BgC	Bath and Valois gravelly silt loams, 5 to 15 percent slopes	120	IIIe-3	27	5a	54
BgC3	Bath and Valois gravelly silt loams, 5 to 15 percent slopes, eroded	120	IVe-3	35	5a	54
BgD	Bath and Valois gravelly silt loams, 15 to 25 percent slopes	120	IVe-2	34	5b	54
BoE	Bath and Valois soils, 25 to 35 percent slopes	121	VIe-1	40	5b	54
BtF	Bath, Valois, and Lansing soils, 35 to 60 percent slopes	121	VIIe-1	40	10	56
BvA	Braceville gravelly silt loam, 0 to 5 percent slopes	122	IIw-1	25	8a	55
Ca	Canandaigua and Lamson soils	123	IIIw-5	33	14b	57
CdA	Chenango gravelly loam, 0 to 5 percent slopes	125	I-1	22	1a	51
CdC	Chenango gravelly loam, 5 to 15 percent slopes	125	IIIe-4	28	1a	51
CdD	Chenango gravelly loam, 15 to 25 percent slopes	126	IVe-8	37	1b	51
CfA	Conesus gravelly silt loam, 0 to 3 percent slopes	130	IIw-1	25	4	51
CfB	Conesus gravelly silt loam, 3 to 8 percent slopes	130	IIe-7	25	4	51
CfB3	Conesus gravelly silt loam, 3 to 8 percent slopes, eroded	130	IIIe-8	29	4	51
CnB	Chenango gravelly loam, fan, 0 to 8 percent slopes	126	IIe-2	23	1a	51
DgB	Darien gravelly silt loam, 2 to 8 percent slopes	131	IIIw-4	32	11a	56
EbB	Erie channery silt loam, 3 to 8 percent slopes	136	IIIw-6	33	9a	56
EbB3	Erie channery silt loam, 3 to 8 percent slopes, eroded	137	IVe-11	38	9b	56
EbC	Erie channery silt loam, 8 to 15 percent slopes	137	IIIe-11	31	9a	56
EbC3	Erie channery silt loam, 8 to 15 percent slopes, eroded	137	IVe-10	38	9b	56
EcA	Ellery, Chippewa, and Alden soils, 0 to 8 percent slopes	134	IVw-3	39	15	57
Em	Eel silt loam	133	IIw-3	26	3	51
ErA	Erie-Ellery channery silt loams, 0 to 3 percent slopes	138	IVw-3	39	15	57
FdB	Fredon silt loam, 0 to 5 percent slopes	139	IIIw-1	31	11a	56
Fm	Fresh water marsh	139	VIIIw-1	41	16	57
Gn	Genesee silt loam	140	IIw-2	26	3	51
Ha	Halsey silt loam	141	IIIw-5	33	14a	57
Hc	Halsey mucky silt loam	141	IIIw-5	33	14b	57
HdA	Howard gravelly loam, 0 to 5 percent slopes	145	I-1	22	1a	51
HdC	Howard gravelly loam, 5 to 15 percent simple slopes	145	IIIe-4	28	1a	51
HdCK	Howard gravelly loam, 5 to 15 percent complex slopes	145	IVe-8	37	1a	51
HdD	Howard gravelly loam, 15 to 25 percent slopes	146	IVe-8	37	1b	51
Hk	Holly and Papakating soils	142	IVw-5	39	15	57
HmB	Honeoye gravelly silt loam, 2 to 8 percent slopes	143	IIe-1	22	2	51
HmC	Honeoye gravelly silt loam, 8 to 15 percent slopes	143	IIIe-1	26	2	51
HmC3	Honeoye gravelly silt loam, 8 to 15 percent slopes, eroded	144	IVe-1	34	2	51
HpE	Howard and Palmyra soils, 25 to 35 percent slopes	146	VIe-1	40	1b	51
HpF	Howard and Palmyra soils, 35 to 60 percent slopes	146	VIIe-1	40	7	55
HrC	Howard-Valois gravelly loams, 5 to 15 percent slopes	146	IIIe-3	27	1a	51
HrD	Howard-Valois gravelly loams, 15 to 25 percent slopes	147	IVe-2	34	1b	51
HsB	Hudson silty clay loam, 2 to 6 percent slopes	148	IIe-8	25	6a	54
HsC3	Hudson silty clay loam, 6 to 12 percent slopes, eroded	148	IVe-7	36	6a	54
HsD3	Hudson silty clay loam, 12 to 20 percent slopes, eroded	149	VIe-1	40	6b	54
HuB	Hudson-Cayuga silt loams, 2 to 6 percent slopes	149	IIe-8	25	6a	54

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Woodland group	
			Symbol	Page	Number	Page
HuB3	Hudson-Cayuga silt loams, 2 to 6 percent slopes eroded------	149	IIIe-10	30	6a	54
HuC3	Hudson-Cayuga silt loams, 6 to 12 percent slopes, eroded----	150	IVe-7	36	6a	54
HuD	Hudson-Cayuga silt loams, 12 to 20 percent slopes----------	150	IVe-7	36	6b	54
HwB	Hudson and Collamer silt loams, 2 to 6 percent slopes-------	151	IIe-8	25	6a	54
HzE	Hudson and Dunkirk soils, 20 to 45 percent slopes----------	151	VIe-1	40	6c	54
IcA	Ilion silty clay loam, 0 to 2 percent slopes---------------	152	IVw-1	38	14a	57
IcB	Ilion silty clay loam, 2 to 6 percent slopes---------------	152	IVw-2	39	14a	57
KaB	Kendaia silt loam, 3 to 8 percent slopes------------------	154	IIIw-7	33	11a	56
KnA	Kendaia and Lyons silt loams, 0 to 3 percent slopes---------	154	IVw-3	39	14a	57
LaB	Langford channery silt loam, 2 to 8 percent slopes---------	156	IIe-4	24	8a	55
LaB3	Langford channery silt loam, 3 to 8 percent slopes, eroded--	157	IIIe-7	29	8a	55
LaC	Langford channery silt loam, 8 to 15 percent slopes---------	157	IIIe-6	28	8a	55
LaC3	Langford channery silt loam, 8 to 15 percent slopes, eroded---	158	IVe-5	35	8a	55
LbA	Lansing gravelly silt loam, 0 to 3 percent slopes----------	159	I-1	22	4	51
LbB	Lansing gravelly silt loam, 3 to 8 percent slopes----------	160	IIe-1	22	4	51
LbB3	Lansing gravelly silt loam, 3 to 8 percent slopes, eroded---	160	IIIe-2	27	4	51
LbC	Lansing gravelly silt loam, 8 to 15 percent slopes---------	160	IIIe-1	26	4	51
LbC3	Lansing gravelly silt loam, 8 to 15 percent slopes, eroded--	160	IVe-1	34	4	51
LmA	Lima silt loam, 0 to 3 percent slopes--------------------	162	IIw-1	25	2	51
LmB	Lima silt loam, 3 to 8 percent slopes--------------------	162	IIe-7	25	2	51
LmB3	Lima silt loam, 3 to 8 percent slopes, eroded--------------	163	IIIe-8	29	2	51
LnC	Lordstown channery silt loam, 5 to 15 percent slopes--------	164	IIIe-3	27	12a	57
LnC3	Lordstown channery silt loam, 5 to 15 percent slopes, eroded--	164	IVe-3	35	12a	57
LnD	Lordstown channery silt loam, 15 to 25 percent slopes-------	165	IVe-2	34	12b	57
LnE	Lordstown channery silt loam, 25 to 35 percent slopes-------	165	VIe-1	40	12b	57
LoF	Lordstown soils, 35 to 70 percent slopes------------------	166	VIIs-1	41	13	57
LtB	Lordstown, Tuller, and Ovid soils, shallow and very shallow, 0 to 15 percent slopes---------------------------------	166	VIs-1	40	16	57
LtC	Lordstown, Tuller, and Ovid soils, shallow and very shallow, 15 to 35 percent slopes--------------------------------	166	VIs-1	40	16	57
Ly	Lyons silt loam--	167	IVw-3	39	14b	57
MaB	Mardin channery silt loam, 2 to 8 percent slopes-----------	170	IIe-4	24	8a	55
MaC	Mardin channery silt loam, 8 to 15 percent slopes----------	170	IIIe-6	28	8a	55
MaC3	Mardin channery silt loam, 8 to 15 percent slopes, eroded---	170	IVe-5	35	8a	55
Mc	Made land--	169	(None)	---	16	57
MfD	Mardin and Langford soils, 15 to 25 percent slopes---------	171	IVe-4	35	8b	55
Mm	Madalin mucky silty clay loam----------------------------	169	IVw-1	38	14b	57
Mn	Madalin silty clay loam-----------------------------------	168	IVw-1	38	14a	57
Mo	Middlebury and Tioga silt loams---------------------------	172	IIw-3	26	3	51
Mp	Muck and Peat--	172	VIIw-1	41	16	57
NaB	Niagara silt loam, 2 to 6 percent slopes-------------------	173	IIIw-2	31	11a	56
OaA	Ovid silt loam, 0 to 6 percent slopes---------------------	174	IIIw-4	32	11a	56
OcC3	Ovid silty clay loam, 6 to 12 percent slopes, eroded--------	175	IVe-6	36	11b	56
OrA	Ovid and Rhinebeck silt loams, moderately deep, 0 to 2 percent slopes---	175	IIIw-3	32	11a	56
OrB	Ovid and Rhinebeck silt loams, moderately deep, 2 to 6 percent slopes---	175	IIIw-4	32	11a	56
OrC	Ovid and Rhinebeck silt loams, moderately deep, 6 to 12 percent slopes--	175	IIIe-9	30	11b	56
PaA	Palmyra gravelly loam, 0 to 5 percent slopes---------------	176	I-1	22	1a	51
PaC	Palmyra gravelly loam, 5 to 15 percent simple slopes--------	177	IIIe-4	28	1a	51
PaCK	Palmyra gravelly loam, 5 to 15 percent complex slopes-------	177	IVe-8	37	1a	51
PaD	Palmyra gravelly loam, 15 to 25 percent slopes-------------	177	IVe-8	37	1b	51
PhA	Phelps gravelly silt loam, 0 to 3 percent slopes-----------	179	IIw-1	25	2	51
PhB	Phelps gravelly silt loam, 3 to 8 percent slopes-----------	179	IIe-5	24	2	51
RhA	Red Hook gravelly silt loam, 0 to 5 percent slopes----------	180	IIIw-1	31	9a	56

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Woodland group	
			Symbol	Page	Number	Page
RkA	Rhinebeck silt loam, 0 to 2 percent slopes------------------	181	IIIw-3	32	11a	56
RkB	Rhinebeck silt loam, 2 to 6 percent slopes------------------	182	IIIw-4	32	11a	56
RnC3	Rhinebeck silty clay loam, 6 to 12 percent slopes, eroded---	182	IVe-6	36	11b	56
Ro	Rock outcrop---	182	VIIIs-1	41	16	57
TeA	Tuller channery silt loam, 0 to 6 percent slopes------------	184	IVw-4	39	15	57
VbB	Volusia channery silt loam, 3 to 8 percent slopes-----------	186	IIIw-6	33	9a	56
VbB3	Volusia channery silt loam, 3 to 8 percent slopes, eroded---	187	IVe-11	38	9b	56
VbC	Volusia channery silt loam, 8 to 15 percent slopes----------	188	IIIe-11	31	9a	56
VbC3	Volusia channery silt loam, 8 to 15 percent slopes, eroded--	188	IVe-10	38	9b	56
VoA	Volusia-Chippewa channery silt loams, 0 to 3 percent slopes-	188	IVw-3	39	15	57
VrD	Volusia and Erie soils, 15 to 25 percent slopes-------------	189	IVe-9	37	9c	56
Ws	Wayland and Sloan silt loams--------------------------------	190	IVw-5	39	14a	57
WrB	Williamson very fine sandy loam, 2 to 6 percent slopes------	191	IIe-6	24	4	51

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