TRIP K: GLACIAL HISTORY OF THE FALL CREEK VALLEY AT ITHACA, NEW YORK

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The area includes those parts of Cornell Plantations and experimental fields within three miles east of the Cornell University Campus. It extends on the north to Hanshaw Road, on the east to Monkey Run and Turkey Hill Roads, on the south to Ellis Hollow Road, and on the west to East Ithaca Station, the Cornell Campus, and the University Golf Course. The Savage farm on Triphammer Road has been included as an inset on Map A1. Areas of privately owned land intermingled with Cornell properties are included.

The soil maps are at a scale of about 6.7 inches to 1 mile, which is larger than the scale used for detailed mapping. The large scale was used to permit delineation of areas as small as ½ acre for accuracy of soil identification on experimental areas. A standard soil survey of Tompkins County at 4 inches to 1 mile has been published (United States Department of Agriculture, 1965) and has used a generalized version of the maps presented here. Because of the larger scale of the maps in this bulletin, it has been possible to present not only much more detailed maps, but also much greater categorical detail of the legend than is possible in the survey of Tompkins County.

GEOLOGY AND SOILS

Bedrock Geology

The entire area is underlain by the Enfield formation of Upper Devonian age. The formation consists of dark bluish-gray shale and thin-bedded sandstone, with sandstone beds becoming progressively more abundant in the upper part of the section. The rocks dip gently southward, so that the uppermost sandstones are exposed on the steep upper slopes of Turkey Hill east of Turkey Hill Road, and at lower altitudes immediately south of the mapped area, south of Ellis Hollow Road. Several quarries are opened in the sandstone beds of the formation along the north slope of Hungerford Hill, south of Ellis Hollow Road.

Bedrock is not the parent material of any soils in the area. Exposures of rock are limited to the bed of Fall Creek from the rose gardens downstream to Forest Home, the bed of Cascadilla Creek downstream from the fish hatchery, and minor outcrops in gullies and ditches. However, the Enfield and similar formations have contributed heavily to the glacial drift that blankets most of the area. Typically, 70 to 90 percent of the pebbles, cobbles, and boulders in the drift are derived from the Enfield formation and similar local rocks. The percentage is probably slightly lower in the sand-, silt-, and clay-size fractions, because the finer sediment generally was transported farther by ice or meltwater, and is thereby enriched in limestone and other rock types from source areas north of Ithaca. The Enfield formation is weakly calcareous to noncalcareous. It produces strongly acid soils in the upland regions south of Ithaca where the glacial drift is thin or discontinuous. On weathering, the formation produces thin sandstone slabs and channers in a gray or brown silty clay matrix.

Glacial Geology

At the time when the retreating ice front of the Wisconsin glaciation stood at the Valley Heads moraines south and east of Ithaca, the entire Cornell University property was glaciated. An ice tongue extended southeastward up Sixmile Creek Valley to Slaterville Springs, and another extended northeastward up Fall Creek valley past McLean. Cascadilla Creek valley (Ellis Hollow) was presumably ice-filled, although Snyder Hill by then may have emerged through the ice. The ice tongues were actually little more than lateral protrusions from the thick ice that filled the Cayuga trough. This episode in the glacial history of the area is generally correlated with the late Cary substage of the Wisconsin glaciation in the midwestern glacial sequence. A minimum age of 12,000 years can be assigned from the radiocarbon age of wood overlying Valley Heads outwash in Erie Co., New York (Merritt and Muller, 1959, p. 476). Deglaciation must have been rapid, and by 11,400 years ago the ice front was north of King Ferry. Wood in a kettle north of King Ferry, associated with mastodon remains, dated 11,410 ± 410 years old and could not have been deposited until that locality was ice free (Merritt and Muller, 1959, p. 477).

The parent materials of the area were distributed during each of the following phases of the last glaciation, when (1) ice advanced up the Cayuga trough toward the area, (2) ice overrode the area at the maximum of glaciation, and (3) the ice front retreated and proglacial lakes developed in the valleys. The key regional landscape element is the deep trough now occupied by Cayuga Lake, which permitted ice to reach the latitude of Ithaca before the valleys of Fall Creek, Cascadilla Creek and Sixmile Creek were glaciated, and which maintained an active ice front over Ithaca until after the three lesser valleys were deglaciated.

The high banks along Fall Creek north of Varna (figure 1) show the glacial stratigraphy. The lower half of the undercut bank over 100 feet in height exposes poorly sorted, crudely stratified sand and gravel, contorted by ice push. About 90 percent of the pebbles in the gravel are sandstone and shale of local derivation, and about 10 percent are limestone and crystalline erratics from the north. The sand, silt and clay matrix of the gravel is strongly calcareous. This stratified sand and gravel records the damming of lower Fall Creek by ice spreading eastward out of the Cayuga trough, while the headwaters of the creek were still ice-free.

Overlying the sand and gravel is about 40 feet of compact, loam till that records the advance of ice up Fall Creek valley. Only about 70 percent of the till pebbles are of local origin, and most of the remaining 30 percent are limestone or dolomite. The tough, blue-gray loam matrix of the till is strongly calcareous. The upper 10 to 20 feet of the till is oxidized, as evidenced by brown colors. The topmost 4 to 6 feet of till is leached of carbonates, and there are gravel layers and silt lenses in the upper 5 to 10 feet that suggest water reworking.

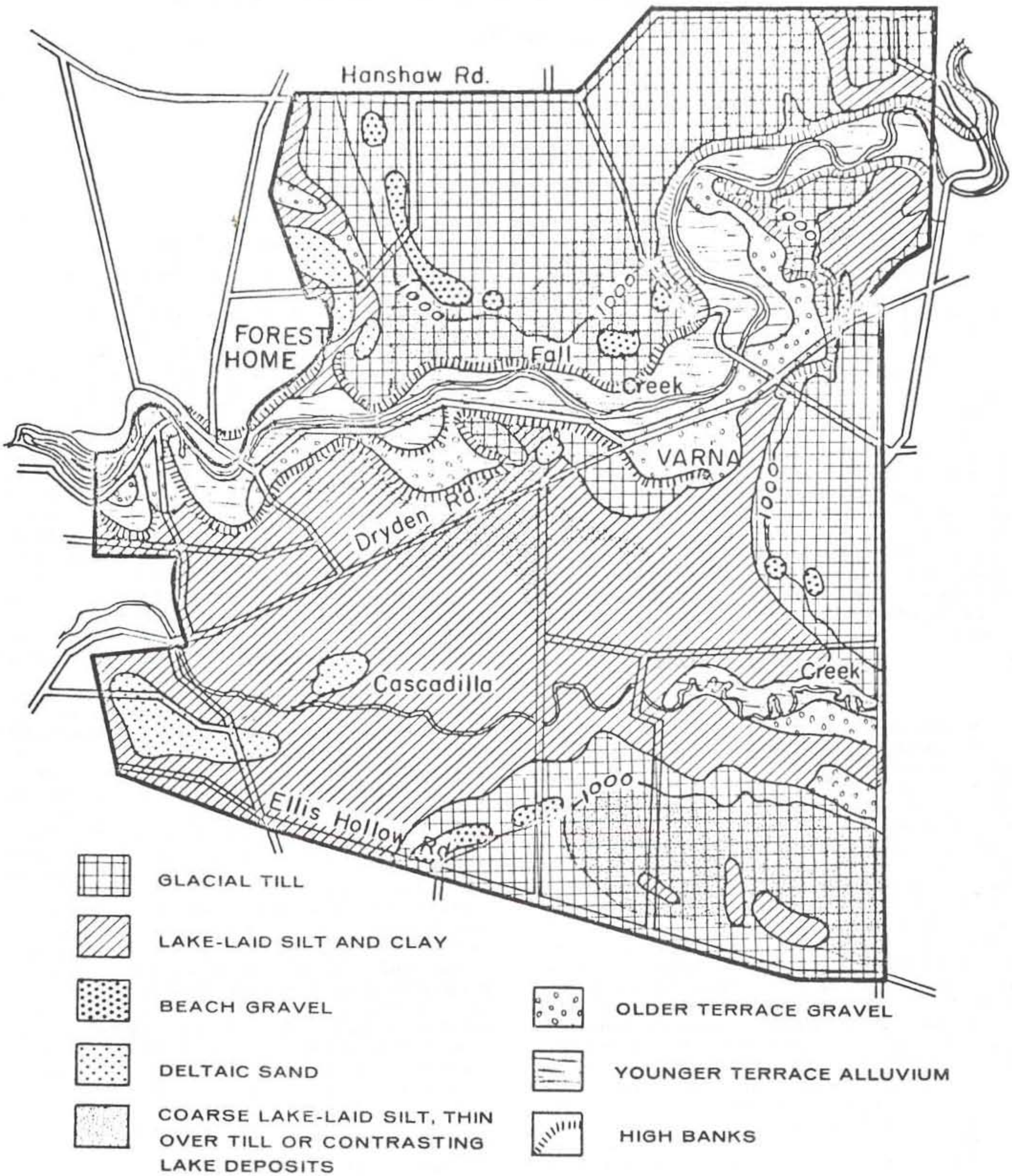

Figure 1. Parent materials of soils of the area.

The till in the high banks is capped by up to 10 feet of water-laid silt, fine sand, and minor amounts of clay. The excellent sorting and horizontal stratification of this layer indicate deposition in a shallow lake with currents sufficient to sweep away most of the clay in suspension. Figure 1 shows the silt to be widespread on the north side of Fall Creek on the Warren, Ketola and Fox farms, and also north of Ellis Hollow Road between Town Line Road and Turkey Hill Road. Over most of the area, the silt is much thinner than in the banks of Fall Creek, generally not exceeding 15 to 20 inches in thickness. The silt extends up to the 1060 foot contour line, and was deposited in a shallow proglacial lake that covered Fall Creek valley east of Forest Home and Ellis Hollow and overflowed south through the steep-walled valley at the head of Ellis Hollow. This lake persisted as long as the retreating ice front pressed against the west slope of Hungerford Hill above the sheep farm, for there was no lower outlet available into Willseyville Creek to the south. Fairchild (1934, p. 249–250) named this Cascadilla Lake, but the area submerged also includes the southern part of what he called Freeville-Dryden Lake.

When the ice front had melted back from the west slope of Hungerford Hill, the final stage of late-glacial deposition began. A large lake named Lake Ithaca (Fairchild, 1934, p. 252–257; Engeln, 1961, p. 93–96) formed from the merging of smaller proglacial lakes in each of the tributary valleys around the south end of the Cayuga trough. The overflow of Lake Ithaca was 2 miles south of Brooktondale at an altitude of slightly over 980 feet, into the head of Willseyville Creek. Lake Ithaca was larger, deeper, and less stirred by currents than the earlier, higher Cascadilla Lake, and clay and silt rather than coarse silt and sand are the dominant sediment types below the shoreline level. All of the lake-laid silt and clay below the 1000-foot contour on figure 1 was deposited in Lake Ithaca. Two patches of similar clayey material on the Fox farm and in the pine plantations northeast of Varna were deposited with the silt of Freeville-Dryden Lake, and two silt-filled basins in the southeastern corner of the mapped area form locally thicker patches of Cascadilla Lake silt.

Two deposits of Lake Ithaca deserve special mention for their soil-forming properties. First, beach gravel eroded from the till along the Lake Ithaca shoreline forms thin gravel veneers over till just below the 1000-foot contour south of Cascadilla Creek and just above the 1000-foot contour on the Warren farm (figure 1). Although these gravel beaches are 10 to 20 feet above the present altitude of the floor of the overflow channel, they may have formed before the channel was eroded to its final depth.

The second unusual deposit of Lake Ithaca is the thin sheet of coarse silt and fine sand that overlies contrasting clayey lake deposits from Caldwell Field eastward in an irregular arc through McGowan Woods (figure 1) and across the experimental plots north of the Game Farm. When the water surface lowered about 80 feet from the former Freeville-Dryden and Cascadilla Lakes to the level of Lake Ithaca, upper Fall Creek began dissecting the newly exposed silty plain of Freeville-Dryden Lake, and washed the coarse silt and sand into the shallow northeast arm of Lake Ithaca.

Lake Ithaca persisted long enough at the 980-foot level and later at the 940-foot level to deeply mantle all gentle slopes below these altitudes with silt and clay. Over most of the area of figure 1 the Lake Ithaca sediment is gray or gray-brown, reflecting a dominantly local source for the rock fragments. On the Savage farm on North Triphammer Road the Lake Ithaca sediments are slightly redder, reflecting a larger contribution of red-colored sediments carried from the north by the main lobe of ice in the Cayuga trough. The Lake Ithaca sediments are moderately to strongly calcareous.

The mapped area includes three small deltas, one at the western edge of the Warren farm, one a very small spot in the southern part of the Cornell Orchard, and the third extending from the New York Artificial Breeders Cooperative through the vegetable crops gardens at East Ithaca (figure 1). The deltaic sand and fine gravel overlie lake-laid silt and clay, and accumulated where streams discharged into Lake Ithaca.

Postglacial Erosion and Soil Development

As the level of Lake Ithaca fell in postglacial time, progressively lower slopes emerged and the soil-forming processes began. The till on the higher ground north of Fall Creek, on the western slope of Turkey Hill and south of Cascadilla Creek already had been exposed for some time. The soils developed in this till have well expressed fragipans and typically are somewhat poorly drained. The catena of soils that includes the Langford, Erie, and Ellery series is mapped where till extends to the surface.

The thin deposits of coarse silt from Freeville-Dryden Lake and Cascadilla Lake above the Lake Ithaca shore were the next units to be exposed to soil formation. Recognizable remnants of these deposits range in thickness from as little as 12 inches to as much as 30 inches, but they are mainly of the order of 15 to 20 inches thick. The moderately well drained Canaseraga and the somewhat poorly drained Dalton series have been mapped where these mantles of silty or very fine sandy materials are thick enough over the till to be recognized as distinct deposits but not thick enough that the entire solum of the soil is in the mantle. In most places the thickness of the deposit is of the order of 15 inches, which is the minimum required for recognition of these two series. Consequently, these soils have been named 'thin mantle phases" of Canaseraga and Dalton soil types to indicate that they are intergrades to the Langford and Erie soils, which are in glacial till without the mantle. In the soil survey of Tompkins County (United States Department of Agriculture, 1965) the Canaseraga and Dalton series are not recognized and these areas are shown as Langford and Erie soils and are described as inclusions.

The high-level clayey deposits of Freeville-Dryden Lake on the Fox farm and in the pine plantations west of Monkey Run Road and south of Fall Creek have developed fine textured soils that have been included in the Hudson and Rhinebeck series. These are mentioned specifically because they lie at distinctly higher elevations than other areas of lake-laid silt and clay and are slightly older than the deposits of Lake Ithaca.

The beach gravel and deltas of Lake Ithaca were the next units to begin developing soils. The soil on the beach gravel is essentially a Chenango soil, but it overlies glacial till at shallower depth than is typical of the central concept of the series. These soils have been indicated as "Chenango gravelly loam over till." The adjacent lower areas are wet and have many seep spots. These areas have been mapped either as a complex of the poorly drained Ellery and somewhat poorly drained Erie soils or, where better drained, as a gravelly loam type of the Langford series. The Arkport series is mapped on the sandy deltas.

As Lake Ithaca continued to fall, the coarse silt and very fine sand veneer of the Caldwell Field-McGowan Woods area was exposed. This deposit is mainly 30 to 40 inches thick over more clayey sediments typical of the Collamer series. The deposit not only is distinctly coarser, but also is more acid than the materials associated with the Collamer soils.

The soils that have formed in it have been included in the Williamson series, which is characterized by a color B overlying a silty or very fine sandy fragipan. Though these soils are within the range of the Williamson series, they are influenced by more clayey material, like that of Collamer soils, in the lower part of the solum in most areas. Consequently, the fragipan is less strongly expressed than is typical of the central concept of Williamson soils. For this reason, these soils have been identified as "weak fragipan phases" of the Williamson soils. They are intergrades to the Collamer series and are inclusions in map units of the Collamer series in the Tompkins County Soil Survey (United States Department of Agriculture, 1965).

Where the coarse silt veneer thins southward and merges with the normal Lake Ithaca silt and clay across Caldwell Field, the Cornell Orchards, the Poultry Range, and the north edge of the Game Farm, the soils contain more clay but are still dominated by silt. The soils on these areas are identified as members of the catena whose well drained member is Dunkirk. Most of these areas are not so well drained as Dunkirk, however, and Collamer, the moderately well drained member of the catena, is the most extensive soil. Niagara, the somewhat poorly drained member, is a major associate. The poorly drained Canandaigua soils occupy the lowest-lying areas.

The soils of the western part of the Cornell Orchards, those south of Cascadilla Creek, and those on the Reed farm are higher in clay, mainly having silty clay or heavy silty clay loam B and C horizons. Most of these areas are somewhat poorly drained and are included in the Rhinebeck series. On the distinctly convex land forms of these areas, the Hudson series has been mapped, and in the poorly drained depressions and along drainageways, the soil is mainly Madalin. Small areas of soil in fine textured material at the western edge of the Warren farm are also included in these series.

The Savage farm, which is not shown on figure 1, lies well below the beach of Lake Ithaca and is almost entirely on silt and clay typical of those mapped in the Rhinebeck and Hudson soil series. The soils in this area are slightly redder than those in similar materials along Cascadilla Creek and reflect the contribution of red-colored sediments carried by the main lobe of ice in the Cayuga trough.

Fall Creek has had a complex postglacial history. As the succession of proglacial lakes in the Cayuga trough gradually fell to the level of present Cayuga Lake, Fall Creek has energetically re-excavated its interglacial valley. The thin cap of silt from Freeville-Dryden Lake was cut through while Lake Ithaca still drained through Willseyville Creek. Subsequently, Fall Creek established its postglacial course down the side of the Cayuga trough, soon to become superposed across buried rock spurs to give the succession of gorges and falls along the north edge of the campus. North of Varna, Fall Creek has not yet exposed its former rock floor, and flows over till capped by a thin gravel floodplain. The terraces and abandoned meanders of Fall Creek are cut into the stratified sand and gravel that form the bottom half of the valley fill. The gravel is non-calcareous, and when the calcareous fines were washed out by the stream, the gravel terraces developed acid soils.

Four levels of terraces and abandoned meanders apparently record temporary halts in the postglacial downcutting of Fall Creek valley. The highest level, typified by the eastern half of the plant breeding area north of Varna and the terrace that lies south of and at a higher elevation than the rose gardens, is clearly older than the other terraces and is mapped as "Older Terrace Gravel" in figure 1. On these highest terraces a well expressed 'Sol Brun Acide" profile has developed in gravelly material, and on these areas, the Chenango series has been mapped. Though these terraces are the highest in the valley, they lie well below the beaches of Lake Ithaca and must postdate the time at which the ice had receded far enough northward to permit the level of Lake Ithaca to fall at least as low as 900 feet above sea level.

The second series of terraces is only a few feet or a few tens of feet lower than the Chenango terraces described, but the soils on them are clearly much younger. The material is mainly gravelly or very gravelly and appears to be similar lithologically to that of the higher-lying Chenango terraces. The soils, however, have only faintly expressed color profiles and, on this basis, are judged to be distinctly younger than soils of the Chenango terrace. They flood occasionally, but they are distinctly higher than the current first bottomlands. Though higher and certainly somewhat older than the bottomland, these intermediate terraces have little evidence of greater expression of a genetic soil profile. Consequently, these soils have been included in the Tioga series as 'high bottom phases." These areas are typical of the rose gardens and the areas used by plant breeding both east and west of Freese Road (figure 1). The soils are strongly acid, and though pH may be higher deep in the substratum pH does not increase to values of 6 or above within the 3-foot section in most places.

The next lower terraces are subject to more frequent flooding, though they lie only a few feet lower than the "high bottoms." These soils are relatively free of gravel in the topmost two or three feet and are in recent alluvium. They are typically acid in the topmost several inches, but pH increases with depth and is commonly greater than 6 at a depth of 36 inches. The well drained soils have been included in the Tioga series; the moderately well drained soils, in the Middlebury series. Though these areas flood relatively frequently, the rate of deposition is apparently slow, and distinct A1 and very weak color B horizons have developed. The degree of genetic profile expression is comparable to that on the adjacent higher Tioga terraces.

Adjacent to the present course of the stream are areas where flood waters very frequently cut and recut new channels and deposit much very coarse material. These areas are mainly covered with vegetation. The soil on these areas has little genetic profile and is very heterogeneous. It is mapped as Alluvial land, a unit in which soils are unclassified.

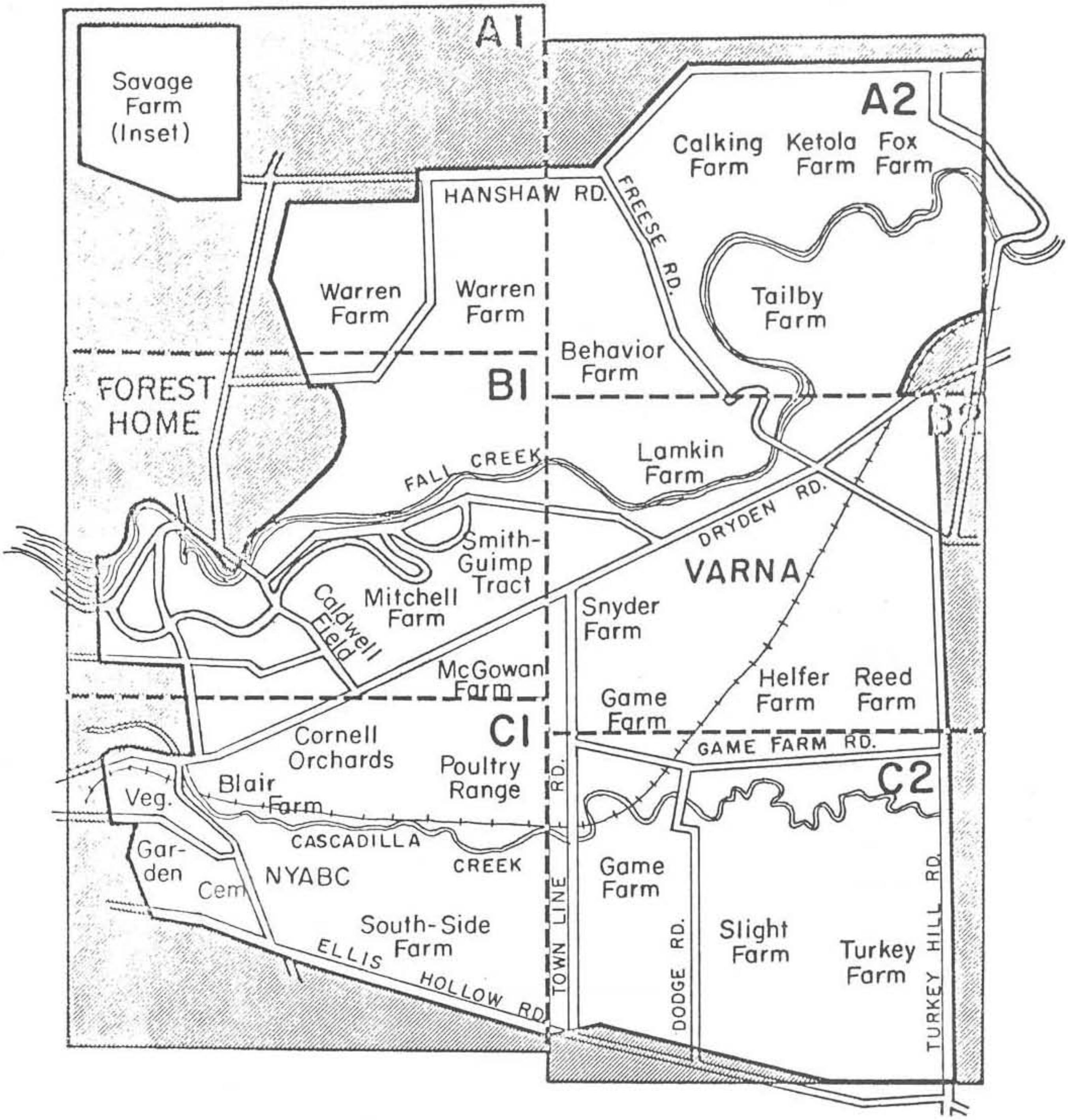

Figure 2. Index to principal Cornell properties and soil survey map sheets on which they occur.

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