THE CHARLTON SOILS

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FOREWORD

THE AUTHORS David E. Hill is Associate Soil Scientist on the Station Staff. Arthur E. Shearin, now retired, was State Soil Scientist of Connecticut and Rhode Island, Soil Conservation Service, U.S. Department of Agriculture. His headquarters for 20 years was the Valley Laboratory of this Station, in Windsor.

THE MONOGRAPH – A BENCHMARK SOIL REPORT Many soils occur over a wide geographic area including several states. Soil scientists of the Soil Conservation Service and the Agricultural Experiment Stations have been examining soils, each in his own state, for many years, recording their properties, and interpreting them for agricultural and other uses. To gain a broader knowledge of the soil throughout its geographical range, available data are being assembled from each state on the important agricultural soils. These soils are known as benchmark soils and this monograph is the Charlton benchmark soil report. A monograph for the Charlton soil is especially significant for Connecticut since it is one of the major soils of the Eastern and Western Highlands covering more than 7 percent of the 3,135,000 acres in the State. The assemblage of all knowledge about the Charlton soils will aid soil scientists and technicians in properly identifying similar soils, interpreting their properties for various uses, and determining the needs for future study.

ACKNOWLEDGMENTS Special credit is due the State Soil Scientists of the Soil Conservation Service in Maine, Massachusetts, New Hampshire, and New York for assembling and reviewing data in their state. The authors wish also to express sincere appreciation to Dr. Arnold J. Baur, Mr. A. H. Paschall, and Mr. Francis W. Cleveland of the Northeast Soil Correlation Staff, Soil Conservation Service, and to Dr. Paul E. Waggoner, Chief, Department of Soils, Climatology and Forestry, for their many helpful suggestions and contributions to this publication.

THE COVER PHOTO The Charlton soils are among the most productive of those used for dairying in New England. The corn grown on contour strips in the foreground will be used as silage and will yield at the rate of 24 tons to the acre. The distant pasture, growing a mixture of tallgrass and legumes, will yield at a rate of 4 tons to the acre. This photo was taken in Durham, Connecticut, by B. W. McFarland.

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INTRODUCTION

Our story of the Charlton soil began some 10,000 years ago, as the great glacier which towered over the land gradually yielded to the warmth of our present climate. As the ice melted, the enfolded soil and rock debris plastered the rock-ribbed hillsides of New England and New York. The deposits, known as glacial till, stood ready to be transformed by the new climate and the reappearing vegetation. In time, climate and vegetation, acting on the parent material, have produced a 2-to-3-foot-thick weathered zone of soil that has a dark surface rich in organic matter and a brown to yellowish brown subsoil, paling with depth to a light olive brown substratum.

The Charlton soils are exemplified by picturesque hillside pastures and are among the most productive soils for dairying in New England. They have formed on upland hillsides where the till is 3 feet or more thick and where the rocks are principally micaceous schists, phyllites, and gneiss with some granite. The till is characteristically loose and friable to firm but yields readily to the shovel.

Its neighbors in the landscape are the Hollis soils found on thin deposits of till, the Paxton soils formed on the compact till of smooth drumlins and the stony, coarse Gloucester soils. Charlton's neighbors with impeded drainage include the moderately well-drained Sutton, the poorly drained Ridgebury and the very poorly drained Whitman soils.

Distribution and Use

Charlton soil covers more acres throughout its range than all, but one, of its more than 100 neighboring soils. Only Hollis which thinly covers its bedrock on hilltops is more extensive. But, those familiar with the New England landscape well appreciate why Hollis is more extensive. The rocky skeleton of New England is exposed throughout its entire length and breadth and here the "skinny" Hollis soils reign supreme.

But the glacier was more generous with its deposits of soil material and stones on the hillsides and in the valleys. Here in deeper till, Charlton predominates, covering fully 10 percent of the landscape.

Charlton soils are found in New York and all New England states, except Vermont (Figure 1). The acreages in each state have been estimated from the random samples of the 1959 Soil Conservation Needs Inventory (Table 1). In New York State the acreage obtained from the Dutchess County Soil Survey Report (Secor, et al., 1955) was added to the random sample estimate from the Adirondack area. The small acreage in eastern Westchester and Putnam Counties is unknown.

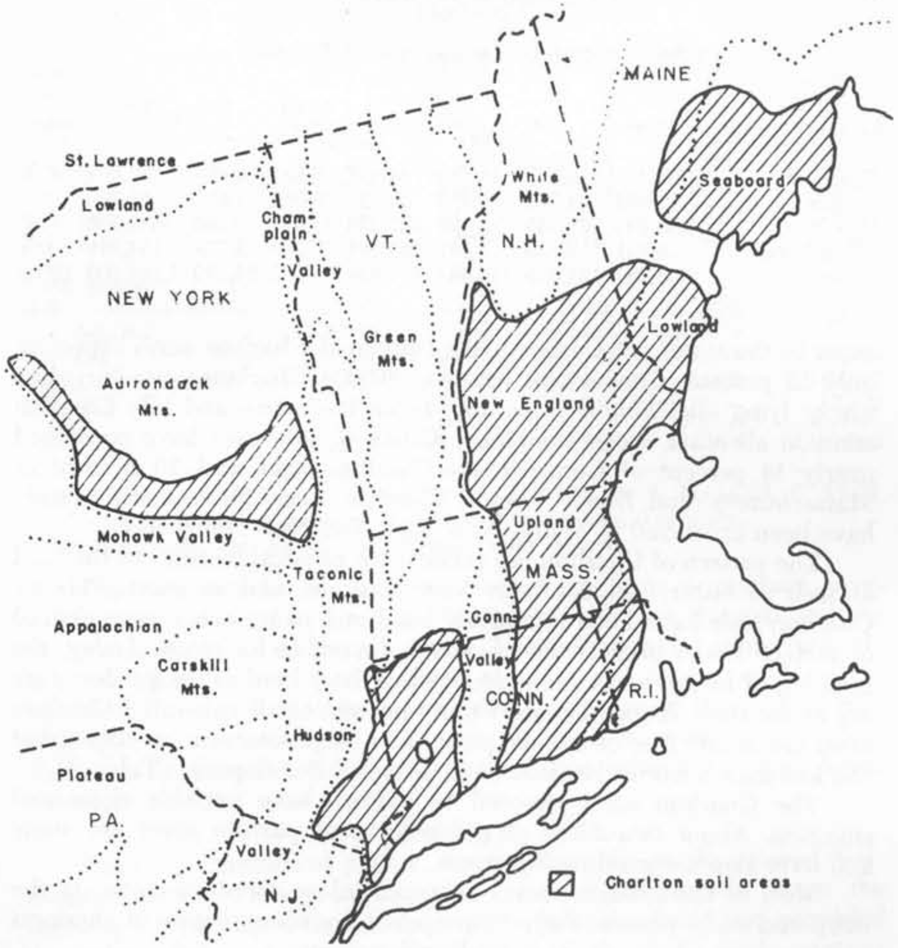

Figure 1. Physiographic provinces of New England and eastern New York (Fenneman, 1938; Lobeck, 1950). Charlton soils cover 2 to 10 percent of the landscape in Charlton soil areas.

The use of Charlton acres is informative. Collectively, more than two-thirds of all Charlton acres are wooded, one-fifth are cropland or pasture, and less than one-tenth are urban or idle land (Table 1). The proportions vary, however, among the states. About 75 percent of the Charlton acres in Maine and New Hampshire are wooded yet in New York, only 40 percent are wooded. Maine has 82,000 Charlton acres growing crops; Connecticut is second with 75,000 acres. Maine's cultivated Charlton acres represent nearly 25 per cent of all Charlton

Table 1. Distribution and use of Charlton soils

Land Use (acres)	Maine	N.H.	Mass.	Conn.	Rhode Island	New York	Total	Percent of all Charlton acres
Cropland	69,437	18,243	14,779	44,137	6,581	4,497	157,674	13.6
Pasture	12,903	4,503	9,426	30,904	2,364	5,688	65,788	5.7
Woodland	254,293	93,035	92,341	345,225	39,437	9,195	833,526	71.7
Idle & Urban	8,451	5,739	14,141	67,568	5,280	3,739	104,918	9.0
Total	345,084	121,520	130,687	487,834	53,662	23,119	1,161,906	100.0

acres in the state, yet Connecticut's cultivated Charlton acres represent only 15 percent. Connecticut has over 67,000 Charlton acres in urban use or lying idle. This is more than twice the urban and idle Charlton acres in all other states combined. Urban or idle uses have consumed nearly 14 percent of Connecticut's Charlton acres and 10 percent of Massachusetts' and Rhode Island's Charlton acres. Few Charlton acres have been urbanized in Maine, New York, and New Hampshire.

The pattern of Charlton use reflects the physical features of the land as well as history. In Southern New England, and in coastal Maine, Charlton soils have been intensively used and many acres were cleared of surface stones because the climate is favorable for crops. Today, the growing of forage and corn silage for the dairy herd is the predominate use of the these cropped acres. Eighty percent of all cultivated Charlton acres are nearly free of surface stones and 60 percent are on slopes that rise less than 8 feet in 100 feet (A-1, B-1, and B-2 slopes), (Table 2).

The Charlton acres devoted to pasture have variable slope and stoniness. About two-thirds of the permanent pasture acres are stony and have slopes exceeding 8 percent.

Most of the Charlton acres in woodland are predominantly on the steep and stony phases. Fully 88 percent have some degree of stoniness and 50 percent have slopes exceeding 8 percent.

Recent changes in land use in southern New England have diverted many Charlton acres from agricultural to urban uses. It follows, then, that most of the Charlton acres devoted to urban uses or lying idle for speculative purposes, are not stony (60 percent) and are on gentle A and B slopes (75 percent).

Physiography

The Charlton soils are found in two sections of the New England province; the New England Upland and the Seaboard Lowland. They are also found in the Adirondack Mountains of New York (Figure 1), (Fenneman, 1938).

The most extensive section, the New England Upland, rises from the southern coast and reaches an elevation of 2,000 feet above sea level in the north. The Seaboard Lowland lies east of the New England Upland and extends to the sea. This lowland belt is a continuation of the New England Upland but its landscape is nearly level to gently rolling. Elevations seldom exceed 200 feet above sea level.

Table 2. Use of slope and stony phases of Charlton soils in New England

Mapping Unit	Cropland (acres)	Pasture (acres)	Woodland (acres)	Idle and Urban (acres)	Total
Non-stony phases					
A-1[1]	2,563	453	2,845	2,805	8,666
B-1, B-2	80,457	16,762	59,074	45,886	202,179
C-1, C-2	40,737	8,043	31,428	12,140	92,348
D-1, D-2, D-3	6,331	3,611	7,851	1,776	19,569
E-1, E-2	648	685	3,187	446	4,966
Stony phases[2]					
A-1	437	246	5,942	922	7,547
B-1, B-2, BC	15,045	17,763	347,342	27,035	407,185
C-1, C-2	8,754	9,817	230,976	8,556	258,103
D-1, D-2, D-3, DEF	2,495	7,935	133,235	5,352	149,017
E-1, E-2	207	473	11,646	–	12,326
	157,674	65,788	833,526	104,918	1,161,906

1. The letters indicate percent slope; A, 0-3; B, 3-8: C, 8-15; D, 15-25; E, 25-35. The numerals indicate erosion; 1-slightly; 2-moderately; 3-severely.
2. Includes stony, very stony, and extremely stony phases.

The Adirondacks of northern New York form a rampart overlooking two valleys, The Hudson-Champlain Valley on the east and the St. Lawrence Valley on the northwest. The Adirondack region, formerly a broad plain, was uplifted millions of years ago as the earth's crust wrinkled. Eons of erosion have produced mountains in the eastern part and hills in the western part. Although mountain tops exceed 4,000 feet above sea level in the east, the Charlton soils are found at much lower elevations.

Geology

The great continental glacier, moving from the north, covered New England about 15,000 years ago. As it moved ponderously across the landscape, it enveloped the existing soil cover, and scoured and crumbled the bedrock below. A warming climate then halted its southerly progress near Long Island. As the snows of winter yield to the spring sun, the towering ice mass gradually yielded to the warming climate. So thick was the mass of ice, however, that it took several thousand years to disappear. The soil materials and stones enveloped in the ice were heaped upon the scoured bedrock.

The heterogeneous mass of mineral debris, ranging in size from large boulders to minute clay particles, is called till. Some of the sand, silt, and clay were sorted by water from the melting ice, choking the valleys and forming smooth plains between the hills. Before the vegetation reappeared, great quantities of dust were carried aloft by strong winds and deposited on the landscape, as a blanket. The past 8,000 to 10,000 years has brought little change to the landscape except that erosion, especially since the time of man, has modified the land's surface.

The veneer of glacial till ranges in thickness from a few inches to

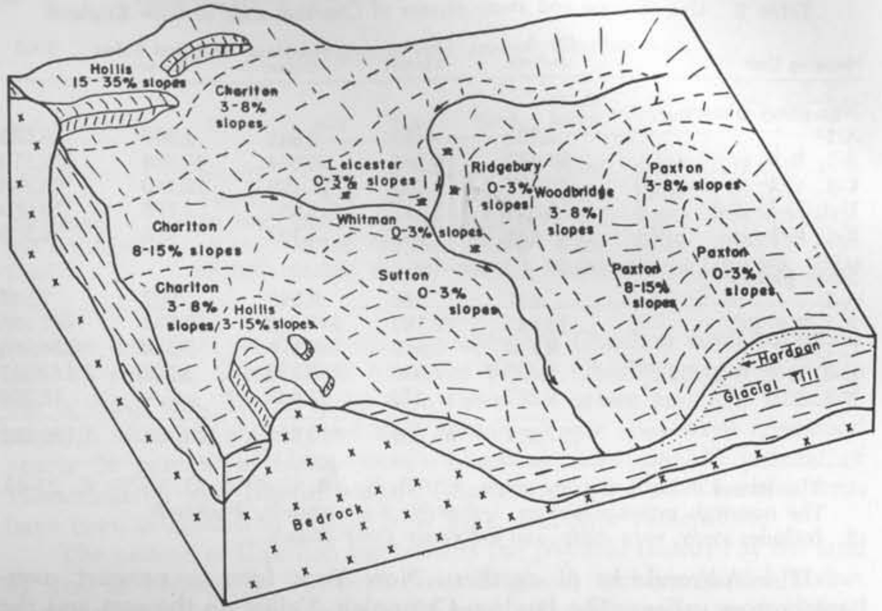

Figure 2. Topographic relationship between Charlton and its neighboring soils in southern New England. The Paxton, Woodbridge and Ridgebury soils have well developed hardpans.

many tens of feet. The thickest deposits form smoothly elongated hills called drumlins. Their shape and characteristic compactness was probably caused by the sheer weight of ice compressing, grinding, and overriding masses of material entrapped at the base of the ice. In many areas, the stubborn bedrock did not yield to the pressure of the ice, and the ice's slow but flowing movement was halted. There stones and finer particles were not carried far from their source, and this material settled gently on the hillsides as the ice melted. The till, thus formed, was not compact, but loose.

Table 3. Stones found in the B horizon of two Charlton soils from New Hampshire. Bedrock consists of thinly-bedded micaceous schist and phyllite.

Rock type	Charlton loam (S55NH-8-1) (percent)	Charlton fine sandy loam (S55NH-8-3) (percent)
Angular to subrounded quartz	4.5	4.6
Angular feldspar	2.0	—
Dark gray, thinly-bedded mica schist or phyllite with little fine-grained quartzite	93.5	13.7
Yellowish-brown, thinly-bedded quartzite	—	23.7
Black, thinly-bedded phyllite	—	58.0

The kinds of stones that the till contains correspond well to the underlying bedrock because they were not moved very far (Table 3). The kinds of stones in the till had an important effect on the development of soil texture. These differences are important criteria for the classification of soil. Thus, Charlton soils are associated with soft, fine-textured micaceous schists and phyllites and Gloucester soils are associated with hard, coarse-textured granites.

The topographic relationship between Charlton and its neighboring soils in seen in Figure 2.

Climate

In Charlton country, the climate is humid and temperate, with long, cool winters and short, mild summers. Average January temperatures range from 18°F in southern Maine and in the Adirondacks of New York to 30°F in southern Connecticut; average July temperatures range from 68°F to 72°F in the same areas (Yearbook of Agriculture, 1941).

The freeze-free season ranges from 120 days in Cheshire County, New Hampshire, and 110 days in Herkimer County, New York, to about 165 days in southern Connecticut and coastal Maine. In southern Maine, the freeze-free season ranges from 139 days inland at Lewiston to 167 at Portland, on the coast, showing the influence of the coastal climate (Havens and McGuire, 1961).

The average annual precipitation within the region of Charlton soils ranges from 35 inches at Hanover, New Hampshire, to 48 inches at Salisbury, New York, and Colchester, Connecticut. Precipitation is distributed fairly evenly throughout the year: 3.2 inches per month in southern New Hampshire, 3.6 inches in coastal Maine and eastern Massachusetts, and 4.0 inches in Connecticut and Rhode Island (Yearbook of Agriculture, 1941).

Rainless periods may occur during summer and early fall. They are usually of short duration, however, those of 1957, 1965, and 1966 were unusually long, creating serious water shortages for crops, forests, and man.

During late summer and early fall severe coastal storms occur; the 1938 and 1955 hurricanes are well remembered. Coastal northeasters contribute much snow, as do storms that originate in the interior, pass over the Great Lakes, and sweep through New Hampshire and Maine.

THE CHARLTON SERIES

History

The Charlton series was first mapped in 1922 in Charlton Township, Worcester Co., Massachusetts and was first described in the soil Survey of Worcester County (Latimer, Martin, and Lamphear, 1927). Before 1922 the Charlton soils were classified as Gloucester soils. Two textures of Charlton were mapped; 1) fine sandy loam and 2) loam with stony phases of both and a slaty phase of the loam.

One notable characteristic of the Charlton series, as described in 1922, was a substratum of "greenish-yellow or greenish-gray, partially-weathered fine sandy or loamy till extending to bedrock without change in color." Small schist fragments were common throughout the soil. Till depths ranged from 10 to 40 feet. In contrast, the Gloucester soils were described as having light gray, loose, sandy and gravelly substrata and were on granitic till 5 to 20 feet thick.

A typical Charlton fine sandy loam profile in a clearing was described as "a mellow, rich-brown fine sandy loam to a depth of 7 to 8 inches. The upper subsoil is a rusty yellowish-brown or ocherous-yellow material, fine sandy loam in texture, rather mealy and . . . at a depth of 15 to 20 inches, grades into a yellow fine sandy loam material similar in structure . . . Below 24 or 26 inches, the subsoil grades into a greenish-yellow, fine sandy, partially weathered till, which extends to bedrock. Both soil and subsoil contain some gravel and a few fragments of schist and granitic boulders, but the stone is much less evident than on the Gloucester fine sandy loam."

Notably the Charlton soil lacked the characteristic heavy, compact, loamy substratum of the Paxton soil. In some places, the upper subsoil of Charlton was more reddish-brown, in others the yellowish-brown subsoil was deep.

Charlton soils occupied "level areas, low hills, and ridges with smooth, gently sloping sides (drumloid hills)." The loamy Charlton was usually found "on low, smooth rounded or oblong drumloid hills . . ."

Since 1922, the Charlton series has been redefined several times, but the basic concepts have changed little. The texture of the solum and the texture, consistence, color, and composition of the underlying till have played important roles in the redefinitions. From 1922 to 1960, Charlton was separated from Gloucester by differences in color, texture, and consistence of the underlying till. Charlton was developed on olive-colored, very friable to firm till derived principally from schistose rocks. Gloucester was developed on light-colored, very friable, coarse-textured till derived principally from granite. Little emphasis was placed on the texture of the solum.

In the 1930's, M. F. Morgan (1930) (1939) of The Connecticut Agricultural Experiment Station associated Charlton soils with smoothly rounded drumlins in the Highlands of Connecticut, providing a setting similar to the Paxton soils. For field differentiation, the dense, compact glacial till of the drumlins, known locally as hardpans, was deeper than 24 to 28 inches beneath the surface in Charlton soils and shallower than 24 to 28 inches in the Paxton soils.

The Charlton soils had a dark grayish-brown surface, a light yellow-brown subsoil, and a yellowish-olive to drab substratum. Closely associated with the Charlton soils and differing slightly in color were the Haddam soils with a reddish cast from admixtures of red Triassic rocks, and the darker Bernardston soils mixed with dark gray phyllite and slate. Two textures for Charlton were recognized; fine sandy loam and loam.

In 1940, the Grafton series was established to separate the Charlton soils that had friable to loose, coarse-textured substrata in tills derived from schistose rocks. In time it became evident that the Grafton series could not be consistently separated from Charlton or Gloucester in the field. The Grafton series was eventually dropped.

In the 1950's, much attention was given to the consistence of the till and the characteristics of hardpan layers. More detailed observations of the depth, continuity, and hardness of hardpan layers led to difficulties in separating Charlton and Paxton soils. Paxton soils have hardpans that are variable in depth, texture, and continuity. In Charlton soils, firm, discontinuous lenses, which behave as hardpans, are now recognized. They restrict drainage and create barriers to roots. Even today, till consistence is poorly defined.

About 1960, the Charlton series was redefined, and emphasis was placed upon the texture of the solum and the C horizons. The Charlton series had fine sandy loam sola and fine sandy loam to loamy sand C horizons. In contrast, the Gloucester series had light sandy loam or loamy sand sola, and loamy sand C horizons. The composition of the till, schistose or granitic, became unimportant.

In the most recent redefinition (see Series Description) fine sandy loam textures predominate in Charlton sola but fine sandy loam or sandy loam textures must predominate in the C horizons. Thin lenses of loamy sand are permitted. Consistence of the C horizons ranges from very friable to firm, but thin, very firm discontinuous lenses may occur within 40 inches of the surface.

Soil Genesis

In the new classification system (Soil Conservation Service Staff, 1968), the Charlton soils belong to:

Order	Spodosol
Suborder	Orthod
Great Group	Haplorthod
Subgroup	Entic Haplorthod
Family	coarse-loamy, mixed, mesic
Series	Charlton

The formative elements of these odd-sounding names tells us something about the morphological and chemical characteristics of the soil. Going from the highest level of classification (the Order) to the lowest (the Series) the soil properties become more specific.

Charlton soils belong to the Spodosol Order, one of ten Orders found throughout the world. All Spodosols (Gr. Spodos – meaning wood-ash) have a spodic (B) horizon which usually underlies a pale, bleached albic (A2) horizon. The spodic horizon is an illuvial accumulation of iron and aluminum accompanied by appreciable amounts of organic carbon. Sometimes the spodic horizon is an accumulation of iron or organic carbon not accompanied by accumulations of crystalline clay.

Since the spodic horizon of Charlton soils consists of the usual accumulation of iron and aluminum oxides accompanied by organic carbon, we may include them in the Orthod Suborder (Gr. orthos-meaning true or the common ones). More specifically, they are in the Great Group known as Haplorthods. Haplorthods (Gr. haplos-meaning simple) are Orthods that are typical of the soils that have been called Podzols and Brown Podzolics. They are found in cool temperate climates and the spodic horizon is thick enough to be observed even after years of cultivation. The overlying albic horizon may or may not be present.

Haplorthods leach in an acidic environment which results in the loss of the alkaline earth metals potassium, sodium, calcium and magnesium. The intensity of weathering in Charlton soils has not been severe enough to translocate large amounts of iron, aluminum, organic matter or clay. The Charlton soils are placed in the Entic Haplorthod Subgroup (Entic derived from recent or immature) because the spodic horizon is weakly developed. These are the former Brown Podzolic soils. The bleached albic horizon is usually absent. We may only speculate that a thin continuous albic horizon existed prior to man's disturbance or that the A1 horizon substitutes for the A2 horizon as a source of translocated iron and aluminum oxides and organic matter in the B horizon. On many cultivated slopes, the incipient albic (A2) and the upper part of the spodic (B) horizon have been truncated by the plow and subsequent erosion. In the remaining part of the B horizon, spodic expression is very weak. Incipient development of the bleached albic (A2) horizon has been preserved only in small discontinuous patches, usually in woodlands (see profile description for S55NH-8-3).

Data from the characterization profiles from Connecticut and New Hampshire reveal that free iron (Fe) exceeds 1.0 percent in the Ap or B21 horizons and decreases with depth. A notable exception is New Hampshire profile S55NH-8-3. The unusually high concentration of iron and its increase with depth is probably related to restriction of drainage by bedrock immediately below the solum.

Charlton's classification in the coarse-loamy, mixed, mesic Family tells us something about its texture, the mineral composition of its sand and coarse silt fractions and the average annual temperature of the soil. The adjectives before Family require explanation. The "coarse-loamy" family of soils have textures in which sand or silt particles predominate; clay contents must be less than 18 percent. From textural analyses, Table 4, it is clear that sands predominate in Charlton. Clay contents throughout all profiles are quite low, ranging from 4 to 9 percent in the upper 6 inches of soil. In Connecticut, the clay maxima occur in the B21 horizon, but is not sufficiently greater than in the A1 horizon above to conclude that downward translocation had occurred. Clay contents in the New Hampshire profiles are uniformly small; those in New York are slightly greater.

The "mixed" family of soils have mixed mineral compositions of the sand and coarse silt fractions (2.0 to 0.02mm). In "mixed" families, only quartz exceeds 40 percent of the composition of silt and sand. The minerals of the fine sand, very fine sand and coarse silt of the two Connecticut profiles, Table 6, is predominantly quartz.

The "mesic" family of soils is found where the mean annual soil temperature varies between 47°F and 59°F and the difference between mean summer and mean winter temperatures is more than 9°F. Toward the northern range of Charlton soils in New England and in the Adirondacks of New York there are undoubtedly small areas in the hills where the mean annual soil temperature is less than 47°F, but the lack of soil temperature data does not permit more accurate separations.

The mineralogical composition of clay in Charlton soil, Table 7, (Sawhney, 1960) shows vermiculite and illite to be the chief components. Abundant vermiculite is present in the A1 and B21 horizons and decreases with depth. In contrast, illite is low in the A1 and B21 horizons and increases with depth. Similar relationships between these two minerals have been observed in most Entic Haplorthods of New England. Formation of vermiculite in the surface horizons is related to the weathering of illite, which loses interlayer potassium and then hydrates (Tamura and Swanson, 1954). Much of the illite and vermiculite has been observed to be randomly interstratifed. Recent studies (Sawhney, 1960) indicate that the vermiculite in the upper part of the solum has become stabilized by the fixation of aluminum in interlayers of the clays. "Chloritized" vermiculite is most stable at the surface. Also very acid soil produced by certain plants may speed weathering and reduce micaceous clays from crystalline to amorphous structures with the accompanying release of Mg, K, Fe, Al (Sawhney and Voight, 1969). This is the heart of the podzolic process and probably occurs where incipient albic (A2) horizons are forming.

But for the most part, Charlton environments are only mildly acid. "Chloritization" is induced, and the formation of aluminum interlayers may decrease the cation exchange capacity of the soil clays by 30 to 40 percent. Thus, abundant aluminum interlayers and low CEC are among the most prominant features of highly weathered acid soil (Frink, 1965).

The distribution of cation exchange capacity in Charlton soils is strongly influenced by organic matter. Capacity is greatest in the organic-rich A horizon and decreases with depth in the B horizon (Table 5). Although most of the exchange in B horizons occurs in soil clays and in amorphous organo-metallic complexes, small amounts of weathered biotite in sand can contribute appreciably to the total exchange capacity of Charlton soils (Hill and Sawhney, 1969).

Base saturation is low in the surface horizons of Charlton soils, Table 5, especially in those long covered by forests. In the cultivated profiles S55NH-8-1 and S60NH-5-8, the greater base saturation clearly shows the influence of lime and fertilizer.

Series Description

Established Series
Rev. AES
8-8-68

CHARLTON SERIES

The Charlton series is a member of the coarse-loamy, mixed, mesic family of Entic Haplorthods. The Charlton soils typically have fine sandy loam texture in the solum and friable fine sandy loam or loam textures in the substratum.

Typifying Pedon: Charlton stony fine sandy loam
(Colors are for moist broken soil.)

02 – 1½-0″ – Partially and well decomposed litter. (1 to 2 inches thick.)

A1 – 0-2″ – Dark brown (10YR 3/3) fine sandy loam; weak fine granular structure; very friable; many fine roots; very strongly acid; abrupt smooth boundary. (1 to 2 inches thick.)

B21 – 2-6″ – Dark brown (7.5YR 4/4) fine sandy loam; weak coarse granular structure; very friable; many fine and medium roots; 5 percent coarse fragments; very strongly acid; clear wavy boundary. (3 to 7 inches thick.)

B22 – 6-18″ – Yellowish brown (10YR 5/6) fine sandy loam; massive, parting readily to soft irregular clods when disturbed; very friable; common fine and medium roots; about 12 percent coarse fragments; very strongly acid; clear wavy boundary. (6 to 16 inches thick.)

B23 – 18-26″ – Light olive brown (2.5Y 5/4) fine sandy loam; massive; very friable; few roots; about 15 percent coarse fragments; very strongly acid; abrupt wavy boundary. (4 to 10 inches thick.)

C – 26-42″ – Grayish brown (2.5Y 5/2) gravelly light fine sandy loam and lenses or pockets of sandy loam or loamy sand; massive except for thin lenses that have weak fine platy structure; friable, some lenses slightly firm; few roots; about 25 percent coarse fragments; strongly acid.

Type Location: New Haven County, Connecticut; southeast corner of the town of Middlebury, 450 feet south of Long Meadow Road, 50 feet west of second class road, and 400 feet northeast of a finger of Long Meadow Road.

Range in Characteristics: Thickness of the solum ranges from about 20 to 30 inches. Depth to bedrock is everywhere more than 40 inches and commonly is more than 10 feet. The surface ranges from essentially stone-free in some cleared areas to extremely stony in unimproved pastures or forest. Stones and weathered schist fragments are common throughout the soil. Pebble-size fragments range from about 5 to 30 percent in the C horizon, and all coarse fragments including stones, average less than 35 percent in the 10-to-40-inch control section. Reaction ranges from very strongly to strongly acid. The A1 horizon has a hue of 10YR, a value of 2 or 3, and a chroma of 2 or 3. The Ap horizon has a value of 3 or 4, and a chroma of 2 to 4. The A horizon is most commonly fine sandy loam, but some is very fine sandy loam or loam. As depth increases within the B horizon, hue becomes less red, value increases, and chroma decreases. The B21 horizon has a hue of 7.5YR or 10YR, and the B22 horizon a hue of 10YR or 2.5Y. In these horizons the value and chroma are 4 to 6. The B23 horizon has a hue of 10YR or 2.5Y; a value and chroma of 4 to 6. The B2 horizon contains 12 percent clay or less and 25 to 50 percent silt. It is dominantly fine sandy loam, but light loam and sandy loam are within the range. The B horizon ranges from massive to weak crumb, granular or angular blocky structure. Consistence is very friable or friable. The C horizon generally has a hue of 2.5Y or 5Y, a value of 4 to 6, and a chroma of 2 to 4. It is dominantly fine sandy loam, sandy loam, or gravelly counterparts of these, but horizontal discontinuous layers, 1 to 6 inches thick or pockets of gravelly loamy sand are common, especially in the first 6 to 12 inches below the solum. The C horizon is dominantly structureless, but most pedons have thin layers with weak fine and medium platy structure; consistence is mainly very friable or friable but thin firm layers or lenses are common.

Competing Series and their Differentiae: These are Agawam, Brookfield, Cheshire, Dutchess, Narragansett, Paxton, and St. Albans soils in the same family. Colrain and Gloucester soils from other families also compete. Agawam soils are essentially free of coarse fragments and are underlain by loamy sand and sand. Brookfield and Cheshire soils have redder colors. In addition, Brookfield soils are high in mica and Cheshire soils formed in till derived principally from reddish colored rocks of Triassic age. Colrain soils have average annual soil temperature of less than 47°F. Dutchess and Narragansett soils have silt loam, very fine sandy loam or loam texture in the sola. In addition, the Dutchess soils contain many dark colored shale, slate and phyllite fragments. Gloucester soils have less than 25 percent silt throughout, and have loamy sand or loamy coarse sand in the lower B and C horizons. Paxton soils have fragipans. St. Albans soils have coarse sandy loam lower B and C horizons and contain many shale and slate fragments.

Setting: The Charlton soils are on till deposits. Slopes generally range from 2 to 35 percent, but some slopes are steeper. The soil formed in acid to neutral glacial till derived mainly from schist and gneiss. The climate is humid and cool temperate. Mean annual temperature ranges from about 44° to 52°F., mean annual precipitation from 35 to 47 inches, and the growing season from about 110 to 165 days.

Principal Associated Soils: The Leicester and Sutton soils are wetter members of a drainage sequence with Charlton soils. Paxton, Ridgebury, and Woodbridge soils have fragipans. The coarser textured Gloucester soils and the shallow-to-bedrock Hollis soils are on areas of till. The Agawam, Enfield, Hinckley, Merrimac, and Windsor soils are on adjoining fluvial and lacustrine terraces.

Drainage and Permeability: Charlton soils are well-drained. Runoff is medium to rapid. Internal drainage is medium; permeability is moderate.

Use and Vegetation: Areas cleared of stones are used mainly for growing hay, pasture, silage corn and orchards. Some areas are used for market garden crops, nursery stock, and other intensive uses. The stony areas are largely in forests or idle; some are in pasture. Forested areas are in oaks, hickories, white pine, hemlock, red maple, sugar maple, gray birch, yellow birch, white ash, and beech.

Distribution and Extent: New England and eastern New York. The soil is of large extent.

Series Established: Worcester County, Massachusetts, 1922.

Remarks: The Charlton series was formerly classified as a Brown Podzolic soil.

National Cooperative Soil Survey, U.S.A.

PROPERTIES OF SAMPLES FROM NEW HAMPSHIRE AND CONNECTICUT

Soil characterization studies in New Hampshire and Connecticut by the Soil Survey Laboratory, Soil Conservation Service, Beltsville, Maryland, and soil research by The Connecticut and New Hampshire Experiment Stations are the chief sources for the physical, chemical, and minerological properties of Charlton soil. Additional physical data from Connecticut and New Hampshire are given by the Bureau of Public Roads in the engineering section (Table 11).

1. Interpretation of physical and chemical data. (Tables 4 and 5)

Profiles S55NH-8-1, S55NH-8-3, and S60NH-5-8

All New Hampshire profiles are characterized by large amounts of very fine sand and coarse silt in the Ap or A1, B21, and B22 horizons to a depth of 21 to 28 inches. Below, coarse silt decreases, very fine sand remains constant, and the coarser sand fractions increase slightly. The clay contents remain relatively constant throughout both profiles. The abundant silt in the surface horizons may be due to aeolian deposition of dust or more intense weathering in the solum, which contains appreciable amounts of fine grained phyllitic schist.

Base saturation is low in profile 8-3. The cation exchange complex is dominated by aluminum and hydrogen ions. Base saturation is appreciably higher in the Ap, B21, and B22 horizons of the cultivated profiles 8-1 and 5-8. This is undoubtedly due to lime and fertilizer. Calcium, magnesium, and potassium have replaced aluminum and hydrogen. Extractable iron is low in profile 8-1 and 5-8 and 2 to 4 times greater in profile 8-3, reaching a maximum in the B23 horizon. This probably reflects the impedance of drainage by bedrock immediately below.

Profiles S58 Conn 2-1, S58 Conn 7-1

Connecticut profiles 2-1 and 7-1 have coarser textures than the profiles from New Hampshire. Silt and very fine sand are less abundant and more uniformly distributed throughout the A and B horizons. The fine sand fraction is considerably greater and the medium sand fraction somewhat greater than in the New Hampshire profiles. More uniform distribution of silt and very fine sand throughout the profile suggests that aeolian activity or weathering has not influenced particle distribution in the Connecticut profiles. Clay contents and extractable iron are greatest in the B21 horizon and decrease with depth, a common feature of Entic Haplorthods.

Base saturation is very low throughout both Connecticut profiles. The greater exchangeable potassium in the A1 horizons is similar to other observations of Charlton soils when compared with exchangeable potassium in coarse-textured Gloucester soils. The greater potassium in the A1 horizons is either associated with vermiculite in the sola of Charlton soils, or is augmented by potassium leached from forest litter.

2. Interpretation of mineralogical data. (Tables 6 and 7)

The iron-rich heavy minerals in the two Connecticut profiles were separated from the silica-rich light minerals using bromoform (specific gravity 2.85). They were placed on a glass slide and examined with a petrographic microscope.

Profile S58 Conn-2-1

Examination of the heavy minerals in the fine sand, very fine sand, and coarse silt in the soil and crushed bedrock indicated that the profile was markedly influenced by the bedrock. The glacial till is 4 to 10 feet thick. Bedrock is the Bolton formation: a staurolite-garnet phyllitic schist (Aitken, 1955). The mineral composition of a crushed bedrock sample taken from the C horizon verified its origin. Staurolite and garnet, although present throughout the profile in all fractions examined, are highest in the fine sands and diminish somewhat in the very fine sands and coarse silt.

Micaceous minerals are abundant in all fractions examined. An examination of the mica in the bedrock by X-ray diffraction revealed that it is randomly interstratified vermiculite and illite. Examination with a microscope revealed the characteristic golden yellow color of vermiculite. The mica in the solum is colorless and was tentatively identified as muscovite and chlorite by petrographic methods.

Epidote can be used as an indicator of mixing of material from sources other than the Bolton formation. Epidote is absent from the Bolton formation, but it is important in the adjacent gneissic bedrock. Epidote is abundant in the A1-A2 and B21 horizons and diminishes with depth, except in the fine sand fraction of the B22-B23 horizon. Here the mica content is exceptionally great. The sample from this horizon probably contained a weathered schist fragment whose identity was masked by the general, weathered color of the horizon. The greater epidote content in the surface horizons indicates that degree of mixing of transported materials is greater at the surface and diminishes with depth.

The light minerals, examined only in the fine sands, revealed that quartz predominates. Quartz decreases with depth as the mica increases. Since little quartz is present in the Bolton formation, this provides further evidence of admixing of foreign gneissic materials rich in quartz.

The dominant clay mineral is vermiculite (Table 7). It is abundant in the surface horizons and decreases with depth. Illite is relatively constant with depth as are small amounts of kaolinite and chlorite and quartz. Small amounts of montmorillonite are found only in the B22-B23 horizon.

Profile S58 Conn 7-1

In general, heavy minerals are more numerous among smaller particles. Their numbers increase slightly with depth in the very fine sand and coarse silt. There is a significant change in the heavy mineral concentration in the A1 horizon. It is greater in the fine sand and smaller in both the very fine sand and coarse silt. The magnetic minerals, magnetite and ilmenite, separated from the heavy minerals with a bar magnet, increase slightly with depth.

The heavy minerals of profile 7-1 contain more species than profile 2-1. The till is thicker, being several tens of feet in depth. In thick tills the parent materials would contain a greater variety of minerals especially since the bedrock formations in the area outcrop along rather narrow belts normal to the direction of glaciation. Plucking and scouring of numerous bedrock formations by the overriding glacier would form a till of heterogeneous composition. Local bedrock is the Hebron schist and gneiss complex.

The heavy mineral species in the fine sand and very fine sand fractions clearly reveal a disconformity between the A1 and B21 horizons. Mica (muscovite and chlorite) is much more abundant in the A1 horizon than in the B21 horizon and lower. The disconformity is less noticeable in coarse silt. Hornblende and epidote contents in the fine sand are very small in the A1 horizon and increase markedly in the B21 horizon and lower.

The disconformity is probably caused by man. The profile, located in the woods on a gently sloping hillside, is adjacent to a pasture. Probably the thin A1 horizon has developed from material washed from the open field. Water carrying sediment will transport micaceous particles farther due to their large plate-like structure rather than the more rounded grains. Segregation of micaceous minerals by water is common.

The heavy minerals in the B21 and lower horizons are constant in species and concentration. Hornblende and epidote predominate. Together, they comprise 80 to 90 percent of the heavy minerals in the fine sands and very fine sands and 70 to 85 percent in the coarse silt. Both are resistant to weathering in Entic Haplorthod soils. They appear only slightly more weathered in the B21 horizon than in the C2 horizon. Hornblende gains become less pleochroic near the surface.

The distribution of light minerals in fine sands also reflects the disconformity between the A1 and B21 horizons. Micas are more numerous in the A1 horizon than in the B21 horizon and lower. Quartz predominates in the B and C horizons and is uniformly distributed. Feldspar increases abruptly in the C2 horizon, and the increase is probably caused by feldspar-rich gneiss fragments in the sample.

The dominant clay minerals are illite and vermiculite (Table 7). The illite content is uniform in the solum but increases sharply in the C1 and C2 horizons. In contrast, the vermiculite is abundant in the solum and decreases markedly in the C1 horizon. Much of the illite and vermiculite is randomly interstratified. Small amounts of kaolinite and iron-rich chlorite are present.

3. Profile descriptions of characterization samples.

Entic Haplorthod; coarse-loamy, mixed, mesic; Unnamed series (Charlton loam taxadjunct – finer texture in upper part of solum – S55NH-8-1)

Horizon	*Depth*	*Description*
Ap	0-9″	Brown to dark brown (10YR 4/3) very friable loam or very fine sandy loam with less than 5 percent coarse skeleton. Particle sizes seem to be principally very fine sand, fine sand or silt and the upper two horizons may have a substantial aeolian component. Weak to moderate fine and medium granular structure. Earthworms and night crawlers are present, with some night crawlers present in the upper B horizon.
B21	9-16″	Yellowish brown (10YR 5/6) very friable, very fine sandy loam with approximately 5 percent coarse skeleton. Particle sizes are in about the same range as in the horizon above. When dug out, the material is about half weak fine granular and half very weak coarse subangular blocky which crushes easily to weak fine granular structure. A few fine unglazed pores occur in the interior of the subangular blocks. This horizon is variable in thickness; on two sides of the soil pit it was only 2-3″ thick.
B22	16-21″	Light olive brown (2.5Y 5/4) very friable, very fine sandy loam, with 10-20 percent coarse skeleton in the 1-3″ diameter range. When broken, the soil is about half weak fine granular and half very weak coarse to medium subangular blocky structure. There are a few unglazed pores. The soil is not distinctly micaceous,

Table 4. Physical properties of Charlton soils in Rockingham and Grafton Counties, New Hampshire; Hartford and Tolland Counties, Connecticut, (Soil Conserv. Svc., 1968)

		Particle size distribution (in mm.) (percent)									
									International		
Horizon	Depth inches	Very coarse sand 2-1	Coarse sand 1-0.5	Medium sand 0.5-0.25	Fine sand 0.25-0.10	Very Fine sand 0.10-0.05	Silt 0.05-0.002	Clay < 0.002	0.2 – 0.02	0.02 – 0.002	> 2
S55NH - 8 - 1	Unnamed series (Charlton loam taxadjunct[1] – finer texture in upper part of solum)										
Ap	0-9	2.1	4.0	4.4	11.4	25.2	46.7	6.2	63.6	15.8	7
B21	9-16	2.9	5.9	5.4	14.0	26.4	41.1	4.3	62.0	14.7	6
B22	16-21	4.0	7.0	6.1	16.1	25.1	37.1	4.6	57.6	15.3	9
B23	21-30	6.2	8.3	7.0	19.8	25.0	28.6	5.1	52.7	14.0	35
C1	30-42	5.6	8.9	7.4	19.5	25.9	27.3	5.4	51.3	14.3	31
C2	42-50 +	4.3	8.3	8.0	18.7	30.3	25.5	4.9	53.7	13.1	16
S55NH - 8 - 3	Charlton stony fine sandy loam taxadjunct – bedrock within 40 inches										
A1	0-1	–	–	–	–	–	–	–	–	–	–
B21	1-8	5.1	7.1	4.5	8.7	22.7	47.3	4.6	53.0	21.8	–
B22	8-18	8.6	10.7	6.1	7.1	24.5	39.9	3.1	47.6	19.0	–
B23	18-28	9.4	12.0	6.3	12.3	19.5	36.1	4.4	44.3	18.5	–
C	28-38 +	10.4	12.5	8.0	17.2	20.6	26.9	4.4	44.6	13.2	–
S60NH - 5 - 8	Unnamed series (Charlton loam taxadjunct[1] – finer texture in upper part of solum)										
Ap	0-8	5.0	5.1	4.3	12.4	25.2	42.2	5.8	56.9	18.7	11
B1	8-11	4.6	4.6	3.8	13.4	27.9	40.5	5.2	60.3	17.3	16
B2	11-15	3.8	5.0	4.2	15.3	30.4	37.7	3.6	62.9	15.9	19
B31	15-18	4.5	6.1	5.5	15.1	27.7	38.2	2.9	58.3	17.5	33
B32	18-28	4.5	5.6	5.2	15.6	29.8	34.4	4.9	60.1	14.6	27
C1	28-41	6.9	9.9	8.1	16.6	27.8	27.8	2.9	54.7	11.2	45
C2	41-51	10.5	12.6	10.1	18.6	23.6	22.6	2.0	49.6	7.6	57
C3	51-64	7.0	12.7	11.0	24.5	26.7	16.7	1.4	53.4	5.2	32
S58 Conn - 2 - 1	Charlton stony fine sandy loam (modal)										
A1	0-0.5	–	–	–	–	–	–	–	–	–	–
A1-A2	0.5-1.5	5.0	8.2	8.7	22.1	16.8	33.2	6.0	45.4	17.9	8[2]
B21	1.5-5	4.4	7.6	8.2	21.5	16.6	34.7	7.0	46.1	17.8	38
B22	5-11.5	6.7	8.1	8.6	22.6	17.8	30.7	5.5	46.7	15.1	30
B23	11.5-17	6.3	8.0	8.5	22.4	18.6	33.0	3.2	49.1	15.9	23
B3	17-23	5.3	8.0	8.8	23.4	19.0	32.6	2.9	50.4	15.1	23
C	23-36 +	5.9	9.2	11.9	30.9	19.0	25.5	0.6	46.4	12.4	45
S58 Conn - 7 - 1	Charlton stony fine sandy loam (modal)										
A1	0-1	3.2	8.9	9.5	21.6	17.8	32.3	6.7	47.9	14.4	3[2]
B21	1-5.5	2.9	7.6	9.2	20.0	18.3	34.2	7.8	49.2	14.5	8
B22	5.5-16	3.3	8.2	9.6	21.0	18.7	32.6	6.6	50.2	13.2	20
B23	16-26	3.2	9.8	10.3	22.9	20.0	30.2	3.6	52.2	11.5	20
C1	26-45	3.2	8.3	9.8	21.8	19.4	31.7	5.8	47.4	16.2	20
C2	45-54 +	3.2	10.0	12.7	27.6	22.5	21.8	2.2	54.8	5.4	23

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[1] Taxadjuncts are soils simliar to a defined soil series, but differing slightly in one of several criteria used to classify the soil. The difference does not warrant the establishment or naming of a new series. This profile is a taxadjunct to the Charlton series because it contains very fine sandy loam in the B21 horizon, a texture excluded from the series definition (see Official Series Description).

[2] Data by The Connecticut Agricultural Experiment Station, New Haven.

Table 5. Chemical properties of Charlton soils in Rockingham and Grafton Counties, New Hampshire; Hartford and Tolland Counties, Connecticut (Soil Conservation Svc., 1968).

Horizon	Depth inches	1:1 H_2O	Organic Matter			Extracted iron % Fe	Cation exchange capacity (sum)	Extractable Cations (meq./100 g. soil)					Base Sat. %
			Organic carbon %	Nitrogen %	C/N			Ca	Mg	H	Na	K	
S55NH-8-1			Unnamed series (Charlton loam taxadjunct – finer textured in upper part of solum)										
Ap	0-9	5.8	1.94	0.16	12	0.8	14.5	4.5	0.9	8.5	0.2	0.4	41
B21	9-16	5.6	0.59	0.06	10	0.7	7.9	1.1	0.3	6.2	0.1	0.2	22
B22	16-21	5.2	0.53	0.07	8	0.6	8.3	0.9	0.3	6.6	0.1	0.4	20
B23	21-30	5.2	0.16	0.02	–	0.6	6.1	0.4	0.2	5.2	0.1	0.2	15
C1	30-42	5.2	0.06	0.02	–	0.7	6.1	0.4	0.2	5.2	0.1	0.2	15
C2........	42-50 +	5.2	0.06	0.01	–	0.6	5.4	0.5	0.2	4.4	0.1	0.2	18
S55NH-8-3			Charlton stony fine sandy loam taxadjunct – bedrock within 40 inches										
A1	0-1	3.8	13.60	0.53	26	1.6	43.8	0.9	0.8	41.5	0.2	0.4	5
B21	1-8	4.6	3.41	0.16	21	2.1	19.4	0.2	0.1	18.9	0.1	0.1	2
B22	8-18	5.0	0.70	0.06	12	2.5	8.1	0.2	0.1	7.8	<0.1	<0.1	4
B23	18-28	5.2	0.47	0.06	8	3.7	7.5	0.3	0.1	6.8	0.2	0.1	9
C	28-38 +	5.2	0.24	0.03	–	3.2	5.6	0.3	0.1	5.0	0.1	0.1	11
S60NH-5-8			Unnamed series (Charlton loam taxadjunct – finer texture in upper part of solum)										
Ap	0-8	5.0	2.76	0.28	10	1.0	21.3	6.9	0.4	13.8	0.1	0.1	35
B1	8-11	4.9	1.51	0.12	12	1.2	14.4	4.2	0.2	9.8	0.1	0.1	32
B2	11-15	5.0	0.98	0.08	12	1.5	12.7	2.2	0.1	10.2	0.1	0.1	20
B31	15-18	5.0	0.72	0.07	10	0.6	10.9	1.8	<0.1	8.9	0.1	0.1	18
B32	18-28	4.6	0.21	–	–	0.4	5.4	0.8	0.1	4.3	0.1	0.1	20
C1	28-41	4.6	0.13	–	–	0.5	4.3	0.6	0.1	3.4	0.1	0.1	21
C2	41-51	4.5	0.16	–	–	0.6	4.0	0.6	<0.1	3.2	0.1	0.1	20
C3	51-64	4.6	0.06	–	–	0.7	2.4	0.5	<0.1	1.9	<0.1	<0.1	21
S58 Conn-2-1			Charlton stony fine sandy loam (modal)										
A1	0-0.5	–	–	–	–	0.7	56.2	2.0	1.0	52.7	0.1	.04	6
A1-A2 ..	0.5-1.5	3.9	24.50	0.80	30	1.2	23.7	0.1	0.2	23.2	<0.1	0.2	2
B21	1.5-5	4.7	7.24	0.19	38	1.4	11.9	0.1	0.1	11.5	0.1	0.1	3
B22	5-11.5	4.6	1.46	0.04	35	1.3	7.5	0.2	<0.1	7.2	<0.1	0.1	4
B23	11.5-17	4.7	0.59	0.03	18	0.9	5.3	0.1	<0.1	5.2	<0.1	<0.1	2
B3	17-23	4.8	0.45	0.03	14	0.8	5.2	0.2	<0.1	5.0	<0.1	<0.1	4
C	23-36 +	5.0	0.31	–	–	0.5	2.8	0.2	<0.1	2.6	<0.1	<0.1	7
S58 Conn-7-1			Charlton stony fine sandy loam (modal)										
A1	0-1	4.0	5.36	0.14	38	0.9	17.1	0.2	0.1	16.4	0.1	0.3	4
B21	1-5.5	4.6	0.98	0.44	22	1.0	9.9	0.2	<0.1	9.6	<0.1	0.1	3
B22	5.5-16	4.6	0.29	–	–	1.0	8.9	0.3	0.1	8.4	<0.1	0.1	6
B23	16-26	4.9	0.26	–	–	0.6	5.0	0.2	<0.1	4.8	<0.1	<0.1	4
C1	26-45	5.3	0.10	–	–	0.6	5.0	0.5	0.1	4.3	0.1	<0.1	14
C2	45-54 +	5.6	0.04	–	–	0.4	3.0	0.3	<0.1	2.6	0.1	<0.1	13

Table 6. Mineral composition of fine sand, very fine sand, and coarse silt fraction
Charlton stony fine sandy loam S58 Conn 2-1

Horizon	Depth (in.)	Heavy Minerals					
		Percent of Total Size Fraction[1]					
		Non-magnetic			Magnetic		
		fs	vfs	cosi	fs	vfs	cosi
A1-A2	½-1½	Not determined					
B21	1½-5						
B22-B23	5-17						
B3-C	17-36						

Horizon	Light Minerals			
	Percent of Light Minerals in Fine Sands[2]			
	Quartz	Plagioclase	Orthoclase	Micaceous
A1-A2	92.1	1.2	Trace	6.7
B21	82.0	1.6	0.4	16.0
B22-B23	77.3	2.5	Trace	20.2
B3-C	64.0	2.7	Trace	33.3

Percent of Heavy Mineral Fraction[2]

Horizon	Epidote			Staurolite			Muscovite			Chlorite		
	fs	vfs	cosi	fs	vfs	cosi	fs	vfs	cosi	fs	vfs	cosi
A1-A2	26.6	37.4	26.6	13.8	2.5	6.4	16.9	33.4	27.4	1.7	1.1	1.9
B21	19.2	46.9	29.9	22.0	3.2	5.0	5.2	16.5	16.7	2.0	2.3	0.8
B22-B23	8.2	24.3	28.6	4.8	2.1	0.8	50.7	41.7	22.5	19.2	5.9	1.1
B3-C	18.4	17.6	18.7	19.5	1.6	1.1	3.2	36.6	58.4	5.3	21.3	7.5
Crushed Bedrock		–			34.3			10.0			0.8	

Horizon	Garnet			Hornblende			Opaques			Others[3]		
	fs	vfs	cosi	fs	vfs	cosi	fs	vfs	cosi	fs	vfs	cosi
A1-A2	10.4	3.3	3.8	2.4	6.7	14.8	23.1	8.5	8.3	5.1	7.1	10.8
B21	16.4	1.6	1.2	4.4	8.4	15.9	26.0	13.0	14.8	4.8	8.1	15.7
B22-B23	1.7	Tr	2.3	3.1	8.0	11.1	10.6	7.7	18.3	1.7	10.3	15.3
B3-C	16.0	3.6	2.2	4.2	2.3	1.4	28.0	6.9	3.2	5.4	7.1	10.0
Crushed Bedrock		6.8			–			7.5			40.6[4]	

Charlton stony fine sandy loam S58 Conn 7-1

Horizon	Depth (in.)	Heavy Minerals					
		Percent of Total Size Fraction[1]					
		Non-magnetic			Magnetic		
		fs	vfs	cosi	fs	vfs	cosi
A1	0-1	15.4	6.8	9.6	–	Trace	Trace
B21	1-5½	10.3	14.8	13.2	1.9	0.6	0.6
B22	5½-16	10.5	14.8	12.8	2.1	0.7	0.7
B23	16-26	10.6	15.3	14.2	2.3	1.0	0.9
C1	26-45	10.6	15.3	15.0	2.8	1.3	1.2
C2	45-54	10.3	16.2	19.6	2.4	1.0	1.2

Horizon	Light Minerals			
	Percent of Light Minerals in Fine Sands[2]			
	Quartz	Plagioclase	Orthoclase	Micaceous
A1	50.9	2.1	Trace	47.0
B21	90.5	5.6	0.4	3.5
B22	89.5	9.0	0.4	1.1
B23	87.0	8.2	0.8	4.0
C1	92.3	5.3	0.4	2.0
C2	78.6	20.2	0.8	0.4

Percent of Heavy Mineral Fraction[2]

Horizon	Hornblende			Epidote			Muscovite		
	fs	vfs	cosi	fs	vfs	cosi	fs	vfs	cosi
A1	4.7	33.2	39.8	9.4	20.8	21.2	52.4	29.6	23.9
B21	49.8	48.3	33.6	30.3	34.4	26.2	3.4	3.1	18.8
B22	51.3	48.2	33.8	34.5	27.0	26.9	1.8	10.0	13.0
B23	46.9	35.0	44.0	31.3	34.7	27.8	5.0	11.5	5.5
C1	48.6	45.0	47.0	36.0	36.8	26.7	3.1	0.8	6.8
C2	52.9	48.9	49.1	35.4	38.0	36.3	0.7	0.4	0.7

Horizon	Chlorite			Garnet			Opaques			Others[5]		
	fs	vfs	cosi	fs	vfs	cosi	fs	vfs	cosi	fs	vfs	cosi
A1	29.7	6.0	4.2	0.5	1.2	0.7	1.9	3.2	3.8	1.4	6.0	6.4
B21	0.7	1.9	5.4	3.4	2.8	5.4	5.3	4.3	3.5	7.1	5.2	7.1
B22	1.8	3.2	7.3	3.6	1.3	1.8	3.9	6.8	7.6	3.1	3.5	9.6
B23	1.5	9.3	8.5	4.7	0.9	4.1	5.0	5.0	3.7	5.6	3.6	6.4
C1	1.0	1.5	7.2	3.4	1.9	0.8	4.5	7.4	4.5	3.4	6.6	7.0
C2	0.4	1.4	0.7	4.2	3.5	3.6	5.3	3.9	4.6	1.1	3.9	5.0

1. Percent by weight.
2. Percent by number.
3. May include tourmaline, biotite, zircon, chloritoid, tremolite, rutile, kyanite, and sillimanite, but not necessarily in all horizons.
4. Interstratified vermiculite and illite.
5. May include staurolite, sillimanite, tourmaline, biotite, zircon, rutile, chloritoid, enstatite, clinozoisite, hypersthene, tremolite, and kyanite, but not necessarily in all horizons.

Table 7. Mineral composition of the <.002 mm clay fraction (Sawhney, 1960)

Horizon	Percent Minerals Present[1] Qr	Il	Vr	Mt	Kl + Chl[2]
	S58 Conn 2-1				
A1-A2	5	20	55	–	20
B21	10	20	50	–	20
B22	10	20	40	10	20
C	10	30	30	–	30
	S58 Conn 7-1				
A1	–	20	60	–	20
B21	–	15	75	–	10
B22	–	20	70	–	10
B23	–	20	60	–	20
C1	–	50	30	–	20
C2	–	60	20	–	20

[1] Qr = quartz, Il = illite, Vr = vermiculite, Mt = montmorillonite, Kl + Chl = kaolinite or iron-rich chlorite. Individual components of interstratified mixtures are listed wherever present.

[2] Kaolinite was identified by X-ray diffraction. Its presence has not been confirmed by differential thermal analysis. D.T.A. also shows the presence of gibbsite.

B23	21-30″	Light olive brown (2.5Y 5/4) friable sandy loam with 10-20 percent coarse skeleton. When broken the soil material is about half weak fine granular and half weak coarse platy with a little tendency for weak coarse subangular blocky. Glazed coarse pores common, weakly brittle.
C1	30-42″	Light olive brown (2.5Y 5/4) firm gravelly fine sandy loam or loamy fine sand till, 20-40 percent subrounded coarse skeleton mostly 1-3 inches diameter; friable when removed, weak medium platy structure with a few glazed pores on channels visible on the plate edges but barely visible on the plate surfaces or interiors. The surface of the plates tend to be olive brown (2.5Y 4/4) and the interiors light olive brown (2.5Y 5/4). The plates are moderately brittle. The material in place resists removal with a shovel principally because the shovel blade strikes the coarse skeleton. Not distinctly micaceous, plastic, or sticky.
C2	42-50″	Same as above.

Sampled: October 14, 1955 by Alexander, Garland, Van der Voet and Lyford. Description by Lyford. Colors described are for moist soil.

Location: John Stevens Farm, Great Hill, Brentwood, Rockingham County. 0.25 mile south on side T road opposite the Stevens home.

Vegetation: Hay and pasture land. Present crop included bromegrass, Kentucky bluegrass, Ladino clover, and alfalfa. Nearby woods have white pine, red oak, gray birch and red maple as dominant species.

Landscape: Gently sloping area with 8 to 10 percent gradient.

Major profile features:

1. Strongest chroma just below the plow zone, paling with depth – a typical Entic Haplorthod.
2. Overall olive color.
3. Coarser texture with depth.
4. Some platiness and firmness in the lower B and C horizons.

Entic Haplorthod; coarse-loamy, mixed, mesic; Charlton stony fine sandy loam taxadjunct – bedrock within 40 inches – (S55NH-8-3)

Horizon	*Depth*	*Description*
01	3-2.5″	Loose litter, composed mostly of white pine needles.
021-022	2.5-0″	Partially decomposed litter, fibrous and full of fine roots. The forest floor averaged three inches in thickness.
A1	0-1″	Black in the top grading to paler brown below. A fine sandy loam to loam with essentially no coarse skeleton. Roots were numerous. In one or two places there was evidence of a discontinuous bleicherde. The horizon was too thin to sample.
B21	1-8″	Dark yellowish brown (10YR 4/4) friable, fine sandy loam with about a 10-20 percent coarse skeleton. The material breaks into 1-2 inch clods which crush readily to weak fine granular structure. Roots are numerous; pH 5.2.
B22	8-18″	Olive brown (2.5Y 4/4) otherwise much like the material in the horizon above. Roots are fairly few in this horizon. pH 5.4.
B23	18-28″	Essentially the same as the horizon above.
C	28-38″	Yellowish brown to olive brown (10YR 5/6-2.5Y 4/4) not mottled but rather streaked gravelly sandy loam till. More or less massive in place, firm enough so that

a pick was used to dislodge it but a shovel could have been used. Very few roots. There were numerous angular particles but also many subangular 2-3 inch glacial till pebbles.

D 38″+ Rusty colored, thin bedded schistose bedrock.

Sampled: July 22, 1955 by Prince, Garland, Van der Voet, and Lyford. Description by Lyford. Colors described are for moist soil.

Location: Approximately 2.0 miles north-northeast, Epping, Rockingham County, New Hampshire; 600-800 feet north of Route 125 on the Burleigh property.

Vegetation: This area had never been cultivated but it had probably been pastured at one time. The forested area had recently been cut over. The canopy was principally white pine, red and sugar maple, black birch, beech, and hemlock.

Landscape: Gently sloping area with a 5-10 percent gradient. Rolling topography, typically morainic with short convex slopes.

Major profile features:
1. Virgin soil with a very thin A1 horizon and three inches of forest litter.
2. A typical Entic Haplorthod with strongest chroma in the upper B21 horizon fading with depth.

Entic Haplorthod; coarse-loamy, mixed, mesic; Unnamed series (Charlton loam taxadjunct) (S60NH-5-8)

Horizon	*Depth*	*Description*
Ap	0-8″	Very dark grayish brown (10YR 3/2); loam with 3 percent coarse skeleton; moderate medium granular structure; very friable; worm casts; many roots; pH 5.8; horizon abrupt and smooth; 6-9 inches thick.
B1	8-11″	Dark yellowish brown (10YR 4/4); very fine sandy loam with 2 percent coarse skeleton; weak fine granular structure; very friable; worm casts; many roots; pH 5.8; horizon clear and broken; 0-6 inches thick.
B2	11-15″	Strong brown (7.5YR 5/6); very fine sandy loam with 4 percent coarse skeleton; weak fine granular structure; very friable; worm casts; roots common; pH 5.6; horizon clear and wavy; 4-8 inches thick.
B31	15-18″	Light olive brown (2.5Y 5/4); very fine sandy loam with 4 percent coarse skeleton; moderate medium granular structure; friable; worm casts; roots common; pH 6.0; horizon abrupt and smooth; 2-4 inches thick.
B32	18-28″	Olive gray (5Y 4/2); gray (5Y 6/1) fine sands adhered to ped faces; fine sandy loam with 6 percent coarse skeleton; moderate medium granular structure; slight tendency to platiness in place; firm in place, friable when removed; few roots; pH 5.8; horizon clear and wavy; 8-10 inches thick.
C1	28-41″	Olive gray (5Y 4/2) fine sandy loam with 10 percent coarse skeleton; moderate medium granular structure; firm in place, friable removed; weathered dark brown schist fragments common; few roots; pH 5.6; horizon abrupt and wavy; 8-13 inches thick.
C2	41-51″	Olive gray (5Y 4/2); gravelly loamy very coarse sand; single grain; loose; no roots; pH 5.8; horizon clear and wavy; 8-11 inches thick.
C3	51-64″	Olive gray (5Y 4/2); loamy sand with 15 percent coarse skeleton; weak fine granular structure; very friable; no roots; pH 6.0. Sample obtained with bucket auger from bottom of pit.

Sampled: June 23, 1960 by Brasher, Schmidt, Van der Voet, and Kelsey. Colors described are for moist soil. Description by F. Viera and S. Pilgrim.

Location: Meyer property, Sugar Hill, Grafton County. 0.9 mile south of Garnet Hill (Moosilauke Quadrangle).

Vegetation: Hay land. Present crop included red clover, hairy vetch, timothy, quackgrass, daisy and Indian paint brush.

Landscape: Lower slope of drumloidal hill: gently sloping with 6 percent gradient.

Major profile features:
1. Strongest chroma in upper part of solum, paling with depth.
2. Very fine sand and silt content high in the upper 18 inches of the solum.
3. Coarse textured substratum below 41 inches.

Entic Haplorthod; coarse-loamy, mixed, mesic; Charlton stony fine sandy loam (S58 Conn-2-1)

Horizon	*Depth*	*Description*
01	1.5-0.5″	Undecomposed litter.
02	0.5-0″	Black (10YR 2/1) and very dark brown (10YR 2/2) partially decomposed litter.
A1	0-0.5″	Sampled but not described.
A1-A2	0.5-1.5″	Very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) fine sandy loam; massive; well matted with fine roots; boundary abrupt.
B21	1.5-5″	Dark brown (7.5YR 4/4) fine sandy loam, but close to a silt loam; very weak medium and coarse subangular blocky structure; very friable; coarse skeleton 15-20 percent; boundary clear.
B22	5-11.5″	Dark yellowish brown (10YR 4/4) fine sandy loam but close to a silt loam; very weak medium and coarse subangular blocky structure; very friable; coarse skeleton 15-20 percent; boundary clear.
B23	11.5-17″	Olive brown (2.5Y 4/4) fine sandy loam; very weak medium and coarse subangular blocky structure; very friable; coarse skeleton 15 to 20 percent.
B3	17-23″	Olive brown (2.5Y 4/4) gravelly fine sandy loam; very weak medium subangular blocky structure; very friable.
C	23-36″	Olive gray (5Y 4/2) and olive (5Y 4/3) gravelly and stony fine sandy loam; highly micaceous; structureless; very friable to slightly firm.

Sampled:	June 20, 1958 by Alexander, Flach, Grossman, Waggoner, Hill, Sawhney, deRoo, and Shearin. Description by Shearin. Colors described are for moist soil.
Location:	Town of Glastonbury, Hartford County, Connecticut. 0.7 mile northeast of Fire Control Tower on John Tom Hill, east side of Birch Mountain Road near the Hartford-Tolland county line.

Vegetation:	This area has apparently never been cultivated. It contains a canopy of white, red and black oak, red maple, gray and white birch with an understory of mountain laurel, blueberry, witch hazel, chestnut sprouts and other shrubs.
Landscape:	Gently sloping area of about 7 percent gradient facing east-northeast. Elevation is about 800 feet.
Major profile features:	1. A typical Entic Haplorthod profile with strongest chroma in the B21 horizon paling with depth. 2. Overall olive color. 3. Very friable substratum.

Entic Haplorthod; coarse-loamy, mixed, mesic; Charlton stony fine sandy loam (S58 Conn-7-1)

Horizon	*Depth*	*Description*
01	1.5-0.5″	Largely undecomposed leaves and organic debris.
02	0.5-0″	Partially decomposed litter.
A1	0-1″	Very dark grayish brown (10YR 3/2) and dark brown (10YR 3/2) fine sandy loam; well matted with fine roots; massive; boundary abrupt.
B21	1-5.5″	Dark brown (10YR 3/3) fine sandy loam; very weak coarse subangular blocky structure; very friable; coarse skeleton about 10 percent; boundary clear.
B22	5.5-16″	Dark brown (7.5YR 4/4) fine sandy loam; very weak medium subangular blocky structure; very friable; coarse skeleton 15 to 20 percent; boundary clear.
B23	16-26″	Dark yellowish brown (10YR 4/4) fine sandy loam; very weak medium subangular blocky structure; very friable; coarse skeleton about 20 percent; boundary clear.
C1	26-45″	Intermingled light olive brown (2.5Y 4/4) and dark grayish brown (10YR 4/2) gravelly sandy loam with pockets of gravelly loamy coarse sand; massive. This horizon consists of firm to very firm discontinuous tongues or pockets of a weak but brittle pan mixed with very friable material in about equal proportions. Silt films are common in the weak pan.
C2	45-54″	Olive (5Y 4/3) gravelly coarse sandy loam or gravelly loamy coarse sand; very friable to loose.

This profile is considered an intergrade to the Paxton series, but more like the Charlton than Paxton. It lacks the well developed fragipan of the Paxton series but has more of a pan than some Charlton.

Sampled:	June 20, 1958 by Alexander, Flach, Grossman, Waggoner, Hill, Sawhney, deRoo, and Shearin. Description by Shearin. Colors described are for moist soil.
Location:	Town of Tolland, Tolland County, Connecticut. 0.9 mile southwest of Grant Hill School on the north side of New Road.
Vegetation:	This area has apparently never been cultivated. It contains a canopy of white oak, hickory, red maple, yellow and black birch and white ash. Shrub understory was sparse.
Landscape:	Gently sloping area of about 6 percent gradient facing northwest. Elevation is about 755 feet.
Major profile features:	1. Typical Entic Haplorthod profile with strongest colors in the upper B horizon paling with depth. 2. Finer textures in the surface horizons becoming coarser with depth. 3. Discontinuous lenses and pockets of weak and brittle fragipan intermingled with friable material.

FERTILITY

The natural fertility of Charlton soils is meager. Soil nutrients, slowly released from weathering minerals, are leached from the upper soil horizons and are removed by subsurface drainage. The soils become acid as the cations on the exchange sites are replaced by aluminum and hydrogen. The cation exchange capacities of the B and C horizons range from 3 to 19 milliequivalents per 100 grams of soil, Table 5. The exchange capacities of the A horizons range from 14 to 56 milliequivalents per 100 grams of soil; the result of increased organic matter. The pH ranges from 3.8 to 5.2 in the sola and exceeds 5.0 in the substrata.

Crops grown on Charlton soils respond well to lime and fertilizer. At the Agronomy Research Farm, Storrs, Connecticut, on soils similar to Charlton, highest yields of alfalfa were obtained when the plow layer was limed and the pH raised to 7.0; however satisfactory yields were obtained when one-third the amount was applied and the pH was 6.5. Lime penetrates the subsoil following prolonged application. After 17 years, 7 to 10 tons of lime had increased the pH of the layer 8 to 12 inches deep to the same level as the pH in the 0 to 8-inch plow layer. The pH of the soil 24 to 36 inches deep was also increased (Brown and Munsell, 1938). Light applications over prolonged periods or heavy single applications are necessary to raise the pH of lower horizons. A single application of 2 tons of lime per acre temporarily raises the pH of only the surface horizons (Brown, et al., 1956).

Nutrient deficiences can be corrected by fertilization and manuring. Since most of the potash in Charlton soils is in the crystal structure of micaceous minerals and potash feldspars, little is available to the plant.

Annual application of 180 pounds of potash (K_2O) per acre was found to be desirable for long-lived, high-yielding stands of alfalfa.

Exchangeable phosphorus, also deficient in Charlton soils, may be added as superphosphate or other phosphorus carrying compounds. Nitrogen is also a limiting factor in the growth of most forage and pasture crops. The amount and grade of fertilizer added depends upon the crop grown and past fertilization. Nutrient deficiencies may be assessed by laboratory tests.

Boron deficiencies have also been demonstrated on soils similar to Charlton at the Agronomy Research Farm, Storrs, Connecticut. Twenty pounds per acre of borax corrected deficiencies in alfalfa for 5 years. Boron deficiency symptoms in alfalfa should not occur as long as 1.0 parts per million available boron is present in the soil (Brown, Munsell, and King, 1945).

MOISTURE REGIME

The release of moisture from Charlton soils in New Hampshire and Connecticut were determined by the Agricultural Experiment Stations (Prince and Raney, 1961; Hill, 1959). Since bulk density was not reported in New Hampshire, average bulk densities were assigned to the major horizons to convert percent weight to percent volume of water. Water available to plants in Charlton A and B horizons ranged from 0.12 to 0.22 inches of water per inch of soil in New Hampshire profiles and from 0.09 to 0.12 inches of water per inch of soil in A and B horizons of Connecticut profiles.

Clearly, Charlton A and B horizons in New Hampshire can store more available water than can Charlton A and B horizons in Connecticut. This is not surprising because Charlton soils in New Hampshire contain more silt and very fine sand than do Charlton soils in Connecticut, Table 4. The available moisture holding capacities of soil is highly correlated with silt (Hill, 1959).

The Soil Survey Laboratory, Beltsville, Maryland, compared laboratory determinations to field determinations of available water in the sola of the Connecticut profiles. Field determinations were much higher than laboratory determinations, Table 8. Laboratory estimates of available moisture are based on percent moisture at one-third atmosphere (field capacity) less percent moisture at 15 atmospheres (wilting point). Evidently, water at field capacity is held at suctions less than one-third atmosphere; it is probably held at suctions approximating 60 cm.

Water percolating through Charlton soils is seldom restricted within 40 inches of the surface. It may be temporarily restricted by deep

Table 8. Moisture release in Charlton soils from New Hampshire and Connecticut.
(Prince and Raney, 1961) (Hill, 1959)

Horizon	Depth inches	Percent water by weight at suction of .1 atm	.33 atm	.66 atm	2.0 atm	5.0 atm	15 atm	Percent by weight available water	Bulk density	Inches of available water/inch soil (Laboratory measurement)	Inches of available water/inch soil (Field measurement)
S55NH-8-1									Estimated		
Ap	0-9	33.5	18.9	15.3	–	9.3	8.5	10.4	1.30	.13	–
B21	9-16	34.4	14.6	12.6	–	6.4	5.2	9.4	1.45	.14	–
B22	16-21	28.7	12.4	11.4	–	6.0	3.7	8.7	1.45	.12	–
B23	21-30	19.8	14.9	11.4	–	5.4	4.9	10.0	1.45	.14	–
C1	30-42	21.4	13.1	10.4	–	5.4	4.0	9.1	1.70	.10	–
C2	42-50 +	16.8	9.9	8.5	–	5.1	3.8	6.1	1.70	.10	–
S55NH-8-3											
B21	1-8	44.2	26.0	21.6	–	12.7	11.4	14.6	1.45	.19	–
B22	8-18	44.0	20.1	16.5	–	7.5	6.0	14.1	1.45	.20	–
B23	18-28	39.5	20.3	16.0	–	6.6	4.9	15.4	1.45	.22	–
C	28-38	30.3	15.6	13.0	–	6.3	4.6	11.0	1.70	.20	–
S58Conn-2-1									Measured		
B21	1.5-5	–	27.2	–	11.9	–	6.6	20.6	0.96	.20	.23
B22	5-11.5	–	12.8	–	9.0	–	5.2	7.6	1.37	.11	.20
B23	11.5-17	–	9.6	–	7.2	–	4.0	5.6	1.48	.09	.20
									Total inches	1.9	3.2
S58Conn-7-1											
B21	1-5.5	–	14.3	–	9.2	–	5.6	8.7	1.32	.11	.22
B22	5.5-16	–	10.4	–	7.6	–	4.9	5.5	1.44	.08	.13
B23	16-26	–	11.0	–	6.4	–	4.0	7.0	1.43	.10	.11
									Total inches	2.3	3.5

fragipan horizons. In spring, the soils readily yield to the plow because they warm and dry earlier than the associated Paxton soils, which have fragipans at shallow depths restricting drainage.

WOODLANDS – SITE INDEX

Site indices for red pine, white pine, red oak, and mixed oak growing on Charlton soils have been measured in Connecticut, Massachusetts, New Hampshire, and Maine. Site index is an estimation of tree height at 50 years of age, derived from growth rate tables for each species. The average site index, Table 9, for red pine on four plots in 68; for white pine on nine plots, 61; for mixed oak (red, scarlet, white, and black) on seventeen plots, 62. Site indices for the mixed oak plots in Connecticut are higher, averaging 66 for nine plots. Apparently, oaks grow more slowly in the colder interior of New England than along its southern coast.

SOIL INTERPRETATIONS

The following sections demonstrate interpretations of soil data for practical use. In these sections, the Charlton mapping units are grouped for different uses according to their physical, chemical and morphological properties. Estimates of properties were sometimes made if data was missing.

The "Estimated Crop Yields" and "Soil Capability Classification" are two agricultural interpretations. Estimated crop yields predict how much corn, potatoes, or hay may be expected under average and intensive management. In the capability classification, soil mapping units with similar properties are put in groups that suggest similar use and management for agricultural crops.

Interpretations for "Engineering Properties for Road Construction" were made from physical properties of Charlton soil determined in the laboratory by the Connecticut State Highway Department and the U.S. Bureau of Public Roads. The soils can be evaluated for construction material or as sites for construction.

Finally, in "Urban Uses of Soils" Charlton properties are interpreted for several facets of urban use. Of special interest to planners, developers, sanitarians, and financiers are interpretations of Charlton's suitability for topsoil, sand and gravel, and road fill, and limitations for septic tank filter fields, homes with basements, homesite landscaping, streets. parking lots, athletic fields, and sanitary land fill.

Estimated Crop Yields

The estimated yields of principal crops and pastures grown on Charlton soils in New England and New York, under two levels of management are given in Table 10. Dashes indicate that the crop is not commonly grown on the steep or stony phases.

Table 9. Site indices for red pine, white pine, and mixed oak on Charlton soils in New England

Soil description	Location and plot number	No. of trees	Age	Height	Site index
	Red Pine[1]				
Charlton stony loam, 9% slope, N.W. aspect	Worcester Co. Mass-45	10	33	49	70
Charlton stony loam, 10% slope, S. aspect	Berkshire Co. Mass-33	10	30	36	58
Charlton stony fine sandy loam, 10% slope, N.E. aspect	Hampden Co. Mass-48	10	31	47	72
Charlton fine sandy loam, 10% slope, S. aspect	Hampshire Co. Mass-7	10	33	49	70
				Average	68
	White Pine[1]				
Charlton stony fine sandy loam, 33% slope, W. aspect	Worcester Co. Mass-5-17	10	91	96	64
Charlton fine sandy loam, 6% slope, S. aspect	Merrimack Co. N.H.-13	5	36	44	64
Charlton very stony fine sandy loam, 8% slope, N. aspect	Carroll Co. N.H.-4	5	70	77	60
Charlton loam, 5% slope, N. aspect	Kennebec Co. Me. 59-6-1	6	35	48	69
Charlton loam, 0% slope	Cumberland Co. Me. 59-3-3	7	63	64	52
Charlton fine sandy loam, 4% slope, E. aspect	Hampshire Co. Mass 3-6	9	44	54	61
Charlton very stony fine sandy loam, 10% slope, E. aspect	Worcester Co. Mass 5-11	10	39	48	62
Charlton very stony fine sandy loam, 9% slope, E. aspect	Worcester Co. Mass 5-12	10	44	51	60
Charlton extremely stony fine sandy loam, 20% slope, W. aspect	Norfolk Co. Mass 8-2	10	43	53	61
				Average	61
	Mixed Oak[2]				
Charlton fine sandy loam, 5% slope, E. aspect	Rockingham Co. N.H.-7-63	5	55	68	65
Charlton fine sandy loam, 2% slope, N. aspect	Strafford Co. N.H.-4-5-63	5	44	52	56
Charlton very stony fine sandy loam, 10% slope, E. aspect	Belknap Co. N.H. 16-B-63	5	66	67	59
Charlton very stony fine sandy loam, 2% slope, E. aspect	Worcester Co. Mass-5-6	4	52	59	58
Charlton very stony fine sandy loam, 4% slope, E. aspect	Worcester Co. Mass 5-7	4	62	60	53
Charlton very stony fine sandy loam, 22% slope, E. aspect	Worcester Co. Mass 5-8	5	52	64	62
Charlton stony fine sandy loam, 24% slope, N.E. aspect	Berkshire Co. Mass 1-16	5	78	76	61
Charlton stony fine sandy loam, 3% slope, N. aspect	Windham Co. Conn 8-1	5	46	69	75
Charlton very stony fine sandy loam, 3% slope	Windham Co. Conn 8-2	5	49	71	72
Charlton very stony fine sandy loam, 4% slope	Windham Co. Conn 8-3	5	61	62	55
Charlton stony fine sandy loam, 5% slope, W. aspect	Windham Co. Conn 8-5	5	57	68	64
Charlton stony fine sandy loam, 9% slope, E. aspect	Windham Co. Conn 8-6	5	38	57	69
Charlton very stony fine sandy loam, 7% slope, E. aspect	Windham Co. Conn 8-7	6	41	59	68
Charlton very stony fine sandy loam, 12% slope, N.W. aspect	New Haven Co. Conn 305-7	5	49	69	70
Charlton very stony fine sandy loam, 20% slope, S.W. aspect	Litchfield Co. Conn 308-7	5	84	75	60
				Average all	62
				Average Conn.	66

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1. Based on "White pine under forest management." by E. H. Frothingham, U.S.D.A. Bulletin No. 13, 1914.
2. Based on "Site index curves for red oak group in Massachusetts." by J. C. Mawson, University of Massachusetts, Department of Forestry and Wildlife.

Yields in Columns A are estimates from average management with insufficient application of lime, fertilizer, and manure. Soil and water conservation is also inadequate. Yields in columns B may be expected under long-term intensive management with sufficient lime, fertilizer, and manure. Erosion control, crop rotation, drainage, and irrigation are used as needed. The selection of proper seed varieties and planting rate, control of plant diseases, insects, and weeds are also important for maximum yields.

In addition to the data in Table 10, in Massachusetts, Mott and Fuller (1967) estimate 300-500 bushels of cucumbers, 125-250 bushels of sweet corn, 150-275 bushels of butternut squash, and 300-500 bushels of apples per acre for the non-stony Charlton mapping units. In Connecticut, Shearin and Hill (1962) estimate 1250-1300 dozen ears of sweet corn per acre for the non-stony Charlton mapping units. In New Hampshire, Van der Voet (1959) estimates 60-80 bushels of grain corn and 45-60 bushels of oats on non-stony phases of Charlton whose slopes are less than 15 per cent.

Capability Classification

The Charlton mapping units have been grouped into six of eight land classes described in the Land Capability Classification of the Soil Conservation Service (U.S.D.A. Agr. Handbook, 210, 1961). The classes

Table 10. Estimated average yields of principal crops on Charlton soils under two levels of management. Yields may vary ± 10% for cultivated crops and ± 12.5% for hay and pasture[1]

Soil mapping unit	Potatoes		Silage Corn		Alfalfa grass hay		Clover-grass hay		Tallgrass hay		Tallgrass-Legume Pasture	
	A	B	A	B	A	B	A	B	A	B	A	B
	Bushels		Tons		Tons		Tons		Tons		Cow acre days[2]	
Charlton fine sandy loam, 0-3% slopes	—	550	12	24	2.5	5.0	2.2	4.5	2.0	4.0	85	285
Charlton fine sandy loam, 3-8% slopes	—	550	12	24	2.5	5.0	2.2	4.5	2.0	4.0	85	285
Charlton fine sandy loam, 8-15% slopes	—	500	11	22	2.5	5.0	2.0	4.0	1.7	3.5	85	285
Charlton fine sandy loam, 15-25% slopes	—	—	9	18	2.2	4.5	1.7	3.5	1.7	3.0	70	255
Charlton fine sandy loam, 25-35% slopes	—	—	—	—	—	—	—	—	—	—	—	—
Charlton stony fine sandy loam, 3-8% slopes[3]	—	—	—	—	2.5	5.0	2.2	4.5	2.0	4.0	85	285
Charlton stony fine sandy loam, 8-15% slopes[3]	—	—	—	—	2.5	5.0	2.0	4.0	1.7	3.5	85	285
Charlton stony fine sandy loam, 15-25% slopes[3]	—	—	—	—	2.2	4.5	1.7	3.5	1.7	3.5	70	255

1. Yields for very stony and extremely phases are not estimated because they are seldom used for agricultural crops.
2. "Cow acre days" is the number of days per year one acre will support a grazing cow giving 25 pounds of milk (3.5% butterfat) per day, without injury to the pasture.
3. The stony phase is only recognized in Connecticut.

are based on limitations for crop production, risks, and response of soil to treatment. Soils in Classes I, II, and III have been classified as suitable for annual or periodic cultivation with narrowing use and greater risk toward Class III. The placing of soils in Class IV suggests occasional cultivation under very careful management. Placing soils in classes VI and VII suggests the soils are not suitable for cultivation but only for pasture, wildlife, or woodland.

The subclasses are identified by the type of limitation: "e" indicates slopes that erode if unprotected; "s" indicates shallowness, stoniness, or droughtiness.

Class I

Charlton fine sandy loam, 0-3 percent slopes
Charlton loam, 0-3 percent slopes

These units consist of nearly level, well-drained, medium to moderately coarse textured soils developed on very friable to firm glacial till. They are nearly free of surface stones, but rock fragments are common in the subsoil. They are moderately permeable and have a moisture holding capacity exceeding 2 inches of water in the top 18 inches of soil. Crops seldom lack moisture during the growing season. Roots freely penetrate the subsoil except where thin discontinuous hardpan is found. The soils are easy to work and respond to fertilization and good management.

These soils are widely used in dairy farming. They are well suited for silage corn, grain corn, small grains, truck crops, hay and pasture. Alfalfa grows well on these soils when they are limed to a pH of 6.0 to 7.0. The soils seldom erode, but organic matter may become depleted.

Subclass IIe

Charlton fine sandy loam, 3-8 percent slopes
Charlton loam, 3-8 percent slopes

These units are found on gently sloping or undulating land. In addition to the crops in Class I, fruit trees are also well suited. The risk of erosion is greater for this unit than for Class I. Erosion control practices usually include contour cultivation, stripcropping, and sod waterways on long slopes. Winter cover crops protect bare slopes following row crops.

Subclass IIIe

Charlton fine sandy loam, 8-15 percent slopes
Charlton fine sandy loam, 8-20 percent slopes
Charlton loam, 8-15 percent slopes
Charlton loam, 3-15 percent slopes

These units are found on sloping or rolling land. The soils are used mainly for hay, pasture, and orchards. Small acreages are used for silage and grain corn, small grains, and truck crops. The risk of erosion limits intensive cultivation for row crops. Erosion control measures usually include contour strip-cropping, waterways and diversion terraces.

Subclass IVe

Charlton fine sandy loam, 15-25 percent slopes
Charlton loam, 15-25 percent slopes

These units are found on strongly sloping or hilly land. They are used mainly for hay, pasture, fruit trees, or are wooded. Steep slopes, and risk of erosion, severely limit cultivated crops.

Subclass IVes

Charlton stony fine sandy loam, 3-8 percent slopes
Charlton stony fine sandy loam, 8-15 percent slopes
Charlton stony loam, 0-8 percent slopes
Charlton stony loam, 8-15 percent slopes

These units are found on gently sloping to rolling stony land and most of the land is wooded. Cleared areas are used for hay and pasture. Scattered areas are used for fruit trees, small grains, and cultivated crops. Stones limit row crop production.

Subclass VIe

Charlton loam, 25-35 percent slopes

This unit is found on steeply sloping or hilly land. Erosion risks are great; hence, the soils are poorly suited for cultivation. Some cleared areas are used for pasture, but most of the land is wooded.

Capability Unit VIs

Charlton very stony fine sandy loam, 3-15 percent slopes
Charlton very stony fine sandy loam, 15-25 percent slopes

These units are found on a variety of slopes but all have very stony surfaces. Most areas are wooded, but small scattered areas have been cleared for pasture or remain idle.

Subclass VIes

Charlton stony fine sandy loam, 15-25 percent slopes
Charlton stony loam, 15-25 percent slopes

These units are found on strongly sloping or hilly, stony land. The soils are mostly wooded. Small scattered areas are used for orchards, pasture, or are idle.

Subclass VIIs

Charlton very stony fine sandy loam, 25-35 percent slopes
Charlton extremely stony fine sandy loam, 0-8 percent slopes
Charlton extremely stony fine sandy loam, 8-25 percent slopes
Charlton extremely stony fine sandy loam, 25-45 percent slopes

Steep slopes and extremely stony surfaces limit the use of these units to woodland or wildlife habitats. Small areas may have been cleared for pasture, but they are largely unproductive.

Engineering Properties for Road Construction

Engineering data for six Charlton soils from Connecticut and New Hampshire are presented in Table 11. The A.A.S.H.O. and Unified Engineering classifications of these materials indicate their use as construction materials or potential construction sites. The A.A.S.H.O. classifications for the C horizons are A-2-4 and A-1-b with a group index of O. Soil materials with an A-2-4 classification provide firm riding surfaces when dry, with little rebound after loading. Soil materials with an A-1-b classification are highly stable under wheel loads regardless of moisture contents, but they may be without well-graded soil binder and may require additional fines to form a firm base.

Both of these materials are easily compacted, but A-2-4 materials heave in frost and lose stability when saturated with water. Adequate drainage must be provided when these materials are used as subgrade.

The A and B horizons are less suitable than C horizons as road subgrade. Most A horizons and some B horizons are classified A-4. They contain much silt and fine sand and little coarse material. They provide a firm riding surface when dry, but they hold large amounts of water and lose stability. The A horizons are good sources of topsoil for final grading.

The plasticity indices (PI) of the C horizons are "non-plastic". Small changes in moisture content change the soil from solid to semi-solid. Excess moisture rapidly produces instability in most Charlton soils except those with an A-1-b classification.

The Charlton subsoil and substrata may be used for making earthen dams if they contain well-graded binder material. They compact well and form an impermeable barrier. Occasionally fines must be added. The soil may be compacted at optimum moisture with sheepsfoot rollers or bulldozers.

Urban Uses of Soils

The Charlton mapping units are interpreted for various urban uses in Table 12. The ratings of these units for various elements of urban use consist of three degrees of limitations: slight, moderate and severe. In the interpretive scheme, such soil properties as depth, structure, permeability, moisture holding capacity and such landscape characteristics as slope, stoniness, size and spacing of bedrock outcrops are weighed before judging the severity of limitation. Areas of slight limitations are

Table 11. Soil engineering data for six Charlton profiles, Tolland County, Connecticut and Rockingham County, New Hampshire.[1] (Ilgen, et al., 1966) (Van der Voet, 1959).

			Moisture – density[4]		Discarded in field sampling		Mechanical analysis[2] Percentage passing sieve									Percentage smaller than						Classification	
Soil and Location	Horizon	Depth	Maximum dry density	Optimum moisture	Larger than 3 inches	From 1 to 3 inches	3 in.	1 in.	3/4 in.	3/8 in.	No. 4 4.7 mm.	No. 10 2.0 mm.	No. 40 0.42 mm.	No. 60 0.25 mm.	No. 200 0.074 mm.	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.	Liquid limit	Plasticity index	A.A. S.H.O.[5]	Unified[6]
Connecticut		inches	Lbs. per cu. ft.	per cent	cent per	per cent																	
Charlton stony fine sandy loam (Modal) 1 mile S. Univ. of Conn. campus in Mansfield on S. Eagleville Rd.	Ap	0-8	101	19	5	–	100	–	98	–	90	83	70	–	38	24	13	5	2	NP[3]	NP[3]	A-4(1)	SM
	B21	8-20	107	9	10	–	100	–	87	–	75	71	61	–	35	29	20	12	7	NP	NP	A-2-4(0)	SM
	C	30-48	120	12	5	–	100	–	66	–	52	48	40	–	20	14	7	3	2	NP	NP	A-1-b(0)	GM
Charlton stony fine sandy loam (Fragipan at 33 inches) 0.9 mile SW. of Grant Hill School in Tolland	B22	5.5-16	115	14	–	–	100	–	79	–	72	69	60	–	32	26	14	5	3	NP	NP	A-2-4 (0)	SM
	C1	26-33	118	10	–	–	100	–	95	–	85	81	66	–	29	22	14	5	3	NP	NP	A-2-4 (0)	SM
	Cx	33-45	120	12	–	–	100	–	88	–	82	78	67	–	34	28	18	7	3	NI	NP	A-2-4.(0)	SM
Charlton stony fine sandy loam (Intergrade to Brookfield in color; fragipan at 36 inches) 100 feet E. of Goose Lane and 1.9 miles SE. of Tolland Center	Ap	0-4	93	23	15	–	100	–	100	–	95	92	81	–	50	41	15	6	4	NP	NP	A-4 (3)	SM
	B22	10-24	105	15	–	–	100	–	88	–	70	64	53	–	32	28	18	9	5	NP	NP	A-2-4 (0)	SM
	C1	24-36	102	13	–	–	100	–	77	–	69	63	51	–	24	19	11	4	2	NP	NP	A-2-4 (0)	SM
	Cx	36-44	110	16	15	–	100	–	82	–	70	64	48	–	27	21	13	5	3	NP	NP	A-2-4 (0)	SM
New Hampshire																							
Charlton loam (Moderately deep over bedrock) 2 miles NNE. of Epping	B21	1-8	94	22	10	5	90	79	76	70	65	59	53	50	41	36	19	8	5	NP	NP	A-4 (3)	GM-SM
	B22	8-18	104	18	10	5	90	79	76	71	66	61	54	51	41	34	19	7	4	NP	NP	A-4 (2)	SM
	C	28-38	116	13	10	5	90	82	76	70	64	56	45	41	29	24	14	7	4	NP	NP	A-2-4 (0)	SM
Charlton loam (Modal) 1,000 yards NW. of northern tip of Lucas Pond	A1	0-7	93	23	10	5	90	80	78	76	73	71	60	57	38	32	21	11	7	43	5	A-5 (1)	SM
	B22	13-24	112	14	10	5	90	67	66	61	58	54	48	43	26	21	14	7	4	NP	NP	A-2-4 (0)	GM
	C	24	118	12	10	5	90	74	70	66	62	58	49	43	26	20	12	7	4	NP	NP	A-2-4 (0)	SM
Charlton fine sandy loam (Coarse substratum)[7] 0.9 mile N. of Deerfield	A1	0-5	86	25	15	10	85	75	72	69	67	65	54	47	29	23	13	7	4	NP	NP	A-2-4 (0)	SM
	B22	9-20	120	10	15	10	85	72	70	65	61	56	44	38	21	17	11	6	3	NP	NP	A-2-4 (0)	SM
	C	20+	126	8	15	10	85	73	71	68	65	60	46	38	20	15	10	5	3	NP	NP	A-2-4 (0)	SM

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1. Tests by the Connecticut State Highway Department (Conn.) and Bureau of Public Roads (N.H.), using standard procedures of the American Association of State Highway officials (A.A.S.H.O.)
2. The mechanical analyses are not designed for determining textural classes of soils because of differences in procedures and calculations.
3. NP = non-plastic.

4. Tests on material passing No. 4 sieve (A.A.S.H.O. Designation T99)
5. Based on Standard Specification for Highway Materials and Methods of Sampling and Testing. (A.A.S.H.O., 1955)
6. Based on Unified Soil Classification System (Waterways Experiment Station, 1953)
7. Originally sampled and described as Gloucester sandy loam (Van der Voet, 1959)

Table 12. Suitability and limitation of Charlton soils for urban uses. (Shearin and Hill, 1968) (Mott and Fuller, 1967) (Midstate Planning Region, Conn., 1969)

	Suitability as source of			Limitations for				Sanitary landfill		
Mapping unit	Topsoil	Sand & gravel	Road fill	Septic tank filter fields	Homes with basements	Homesite Landscaping	Streets, parking lots & athletic fields	Trench type[1]	Side-hill type	Cover moterial
Charlton fine sandy loam 0-3% slopes	Fair	Not Suitable	Good	Slight: slowly permeable layer may be present below 36 inches	Slight: hardpan below 36 inches may cause local impedance of drainage	Slight:	Slight:	Slight:	Moderate: lack of grade	Slight: material may contain stones and boulders
Charlton fine sandy loam 3-8% slopes	Fair	Not Suitable	Good	Slight: slowly permeable layer may be present below 36 inches	Slight: hardpan below 36 inches may cause local impedance of drainage	Slight: erosion control may be needed on newly seeded lawns.	Moderate: some landshaping may be required	Slight:	Moderate: lack of grade	Slight: material may contain stones and boulders
Charlton fine sandy loam 8-15% slopes	Fair	Not Suitable	Good	Moderate: leaching fields may require designs compatible with sloping terrain.	Moderate[2]: hardpan below 36 inches may cause local impedance of drainage	Moderate: slopes may require erosion control	Severe: Considerable landshaping required for parking lots and athletic fields	Moderate: slopes marginal	Slight:	Slight: material may contain stones and boulders
Charlton fine sandy loam 15-25% slopes	Fair	Not Suitable	Good	Severe: steep slopes	Severe[2]: steep slopes; local hardpan may be present below 36 inches	Severe: steep slopes; terracing or natural vegetation	Severe: excessive landshaping required	Severe: excessive slopes	Slight:	Slight: material may contain stones and boulders
Charlton stony fine sandy loam 3-8% slopes	Fair	Not Suitable	Good	Slight: slowly permeable layer may be present below 36 inches	Slight: occasional boulders; local hardpan may be present below 36 inches	Slight: some stone removal and erosion control	Moderate: some landshaping may be required	Slight:	Moderate: lack of grade	Moderate: material may contain numerous stones and boulders
Charlton stony fine sandy loam 8-15% slopes	Fair	Not Suitable	Good	Moderate: leaching fields may require designs compatible with sloping terrain	Moderate[2]; occasional boulders; local hardpan may be present below 36 inches	Moderate: some stone removal and erosion control	Severe: considerable landshaping required for parking lots and athletic fields	Moderate: slopes marginal	Slight:	Moderate: material may contain numerous stones and boulders
Charlton stony fine sandy loam 15-25 slopes	Fair	Not Suitable	Good	Severe: steep slopes	Severe[2]: steep slopes; occasional boulders	Severe: steep slopes	Severe: execussive landshaping required	Severe: excessive slopes	Slight:	Moderate: material may contain numerous stones and boulders
Charlton very stony and extremely stony fine sandy loam 0-3% slopes	Poor	Not Suitable	Good	Moderate: stones and boulders limit tile installation	Moderate: numerous boulders	Severe: excessive stoniness	Severe: numerous stones and boulders	Severe: numerous stones and boulders	Moderate: lack of grade; stoniness	Severe: excessive stones and boulders
Charlton very stony and extremely stony fine sandy loam 3-15% slopes	Poor	Not Suitable	Good	Moderate: slopes and stoniness limit tile installation	Moderate: numerous boulders	Severe: excessive stoniness	Severe: numerous stones and boulders; considerable landshaping	Severe: numerous stones & boulders slopes marginal above 8 percent	Moderate: stoniness; lack of grade below 8 percent.	Severe: excessive stones and boulders
Charlton very stony and extremely stony fine sandy loam 15-25% slopes	Poor	Not Suitable	Good	Severe: steep slopes and stoniness limit tile installation	Severe: numerous boulders; steep slopes	Severe: excessive stoniness and steep slopes	Severe: stones and boulders; excessive landshaping	Severe: numerous stones and boulders; excessive slopes	Moderate: stoniness	Severe: excessive stones and boulders

1. Evaluation of the soil only to a depth of 5 feet.
2. Connecticut rates 8-15% slopes as slight and 15-25% slopes as moderate for homesites with basements.

relatively free of problems, and the land may be easily developed with minimum time and cost. Areas of moderate limitations have a soil or slope problem which must be corrected at additional cost to the developer. Areas with severe limitations have one or more problems that require extensive corrective measures. It is often not feasible to use these areas if more favorable alternative sites are available.

Suitability for topsoil, sand and gravel, and road fill

Charlton's topsoil is not considered among the best for establishing and maintaining lawns and shrubs. Its fair quality stems from its lack of abundant silt which determines its moisture reserve for plant roots. Topsoil from Charlton's stony phases is often poor because of the great proportion of gravel and stones. These not only reduce the moisture reserve but also hinder preparation of a smooth seed bed.

Charlton soils are not suitable as sources for sand and gravel. They contain enough silt and very fine sand to reduce their suitability for pavement bases and for use in concrete.

Charlton soils are good sources for road fill. Properly compacted and drained, material from Charlton's subsoil and substratum makes stable road fill and embankments.

Drainage fields for septic tanks

Most Charlton mapping units are suitable for the disposal of septic tank effluent. Percolation tests in holes 36 inches deep indicate that the soil will transmit water at satisfactory rates. Percolation rates may vary throughout the year and from place to place within and between mapping units. The slowest rates occur in the wet soils of early spring, and the rates increase as the soils dry in late spring and summer. During droughty years, percolation rates may decrease again in late summer. The variations in percolation rates in Charlton soils often cross permeability classes established by the Connecticut State Department of Health for determining the size of leaching fields (Conn. Dept. of Health, 1964). Tests performed in late spring and summer may give optimistic percolation rates. Percolation rates determined in early spring, when the soils are wet, give more conservative estimates of drain field performance. It is difficult to assign a precise "permeability class" to Charlton soils because their site and seasonal variations cross class limits. Numerous tests on Cheshire soil, which is comparable to Charlton, indicate that the probability of their rates falling in or above the 3 to 6 inches per hour class will be 100 percent; in or above the 6 to 12 inches per hour class will be 60 percent; above 12 inches per hour will be 40 percent (Hill, 1966). No tests fell below 4 inches per hour. Clearly, the percolation rates tend towards the favorable percolation classes.

But permeability is only one factor to consider. Special design for tile drainage fields is often necessary on slopes exceeding 8 percent or landshaping may be required to reduce grades to workable levels. Thus, Charlton phases on slopes exceeding 8 percent have slope limitations.

The very stony and extremely stony phases of Charlton soils have numerous stones and boulders which hinder tile installation. If large boulders are numerous it is often necessary to resort to deep leaching wells (leaching cesspools) for effluent disposal. These are especially useful in Charlton soils where most of the stones and boulders are on or near the surface and the underlying till is relatively stone-free.

The presence of hardpan below 40 inches is a minor limitation as long as the natural grade is not altered by landshaping. If all or part of the solum is removed during site preparation, however, the slowly permeable hardpan layers, then exposed, will reduce the effectiveness of effluent disposal.

On-site investigations are necessary to establish percolation rates. stone and boulder distribution and depth to hardpan layers.

Homes with basements

In evaluating soil properties for location of homes with basements, the limitations are related to foundation excavation, stability of footings, installation and performance of footing drains. Charlton mapping units impose few limitations for excavation and construction of basements. Subsurface seepage is seldom present. Numerous large boulders and occasional bedrock outcrops on stony phases may require blasting and use of heavy equipment. Sloping phases offer benefits in terms of reduced volume of earth moved during excavation, walk-out basements, and basement garages.

Homesite landscaping

The soil properties evaluated for homesite landscaping affect not only the initial landscaping of property but also the maintenance of lawns and shrubs. Landscaping includes final grading of property, and planting of trees, shrubs, and lawns. Charlton mapping units on slopes have limitations. During lawn establishment, erosion may occur on unprotected slopes. Stones and boulders may hinder preparation of the seed bed for lawns. Terracing of steep slopes may be costly, but the aesthetic quality of the property may be improved.

Streets, parking lots, and athletic fields

For streets, the soil properties evaluated are those that affect selection of rights-of-way in areas developed for residences, small businesses, and light industry. The soil properties and topographical features evaluated for parking lots and athletic fields affect the development of several acres of flat land. Sloping phases of Charlton are more expensive to develop because of the great volumes of earth that must be moved. On stony phases, numerous boulders and occasional bedrock outcrops obstruct construction and must be removed.

Sanitary land fill

Evaluation of soil properties and topography for sanitary land fill considers the quality of the site for land fills as well as the quality of the soil for cover. Sites suitable for trench fills provide cover material. Charlton mapping units on level to gentle slopes are well-suited for trenches. On steeper slopes, side-hill fills are more practical even though cover material is often lacking. On stony phases of Charlton numerous stones and boulders may limit use for cover material.

ADDITIONAL DATA NEEDED

Of the many soils in the Northeast, the Charlton soils have been studied extensively. Despite the wealth of data available, several deficiencies are worthy of note.

1. Crop yield data for specific forage and row crops under specific management programs would increase precision of yield estimates. Modal Charlton soils are not found on Experiment Station Farms in the Northeast, so data would have to be obtained from farm cooperators.
2. Micromorphological studies of till fabric and pore space distribution in relation to root penetration and soil permeability would establish more precise criteria for separating Charlton and Paxton soils. How dense and continuous must hardpan be to restrict root growth and impede drainage?

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