4. Soils

The topmost layer of the earth upon which we walk, build and plant our crops is called the soil. It is basic to our existence. As we have seen, glacial processes during and after the last ice age are primarily responsible for the materials of which Cape Cod is made, with some later modifications by wind and water and the sea. These basic materials are referred to as "parent material". In Mashpee, they consist of glacial outwash, glacial till, post-glacial aeolian silts and sands, freshwater and marine organic deposits and marine beaches and sand dunes. Since such a short time (in geologic terms) has passed since the ice age, these materials have not yet been significantly altered and the influence of the parent materials is very apparent in Mashpee's soils.

Glacial outwash, as was explained earlier, is stratified sand and gravel which was deposited by the twisting and ever-shifting glacial meltwater streams. This parent material results in soils that have sandy or gravelly, loose and very permeable lower layers. As a result, they do not hold water well and, unless irrigated, do not make prime agricultural soils. However, those same characteristics mean that septic systems appear to work very well and, unless there is a high groundwater table, development for roads and buildings is relatively easy. These materials make up the largest portion of Mashpee.

Glacial till, which appears in the Nantucket Sound ice contact deposits of the New Seabury / Popponesset Beach area, is made up of unsorted and unstratified sediments deposited by, and underneath, the glacier. It consists of a heterogeneous mixture of clay, silt, sand, gravel, stones and boulders. These materials can present occasional problems for both septic systems and land development.

Post-glacial aeolian silts and sands were deposited by wind during the period after the glacial ice melted but before a permanent vegetative cover was established. These fine and very fine sands and silt vary in thickness in Mashpee and lie over older glacial deposits. In some areas, a thin layer of aeolian material has been mixed, by the action of plant roots, animals, insects and frost heaving, with the underlying glacial materials. Where these deposits are relatively thick (up to three feet in some areas), prime agricultural soils are found.

Freshwater and marine organic deposits consist of decaying plant materials that have accumulated in wet areas such as marshes, swamps and bogs. They present extreme limitations for septic systems and other development and agriculture, except the development of cranberry bogs.

Marine beaches and sand dunes are accumulations of sand deposited by the action of waves and wind. They also present severe limitations on development and agriculture, primarily due to their rapidly-shifting, unstable nature and their exposure to violent ocean storms.

A number of factors are involved in the creation of "soil" from "parent material". Time, topography, climate and plant and animal life all interact with the basic sediments underlying Mashpee. Time is important, since significant changes in parent material generally take thousands of years. Only 15,000 years have passed since the glaciers left Mashpee and, therefore, its relatively young soils are only slightly altered from their original state. The shape of the land surface, or its "topography", greatly influences the formation of soils. The length,

steepness and configuration of slopes cause varying surface runoff conditions. The elevation of an area is related to the depth of the water table below the land surface. At higher elevations, soils are generally well drained or even excessively drained. At lower elevations, not only is runoff and the sediments it carries received from higher land, but the surface is also much closer to the water table.

Aside from affecting the usability of an area for farming and development, the presence of water also affects the type and rate of chemical reactions that occur in the soil, such as the leaching of iron, aluminum and other elements from the parent material. As a result of these chemical reactions, soils in moderately or poorly drained areas where the groundwater level fluctuates are often mottled with irregular spots of grey, yellow and brown, while soils in permanently wet areas are often grey, indicating "reduced" iron conditions. The presence of water in the soil is itself affected both by the elevation of the sea and its effect on the groundwater table and by weather and climate.

In addition to precipitation, other climatic factors such as temperature and frost action have a profound influence on the chemical and physical weathering processes which form soils. Climate affects the type of plant and animal life which exists in Mashpee. These include bacteria, fungi, vegetation, insects and animals which all, in turn, have an effect on the chemical and physical environment of the soils. Some bacteria and other micro-organisms change the chemistry of the soil, promoting acid conditions which influence soil forming processes. Earthworms and burrowing animals mix the soil, making it more permeable to air and water, and their waste products help to aggregate the soil particles and improve soil structure.

The existence and type of vegetation affects the soil both physically and chemically. Roots tend to break up and mix the soil. When they die they leave behind their organic material. When larger trees fall, their roots are often ripped out of the ground, deeply mixing the soil. Hardwoods take up bases from the soil (calcium, magnesium and potassium) and return them to the surface as falling leaves, branches and dead tree trunks. Coniferous trees are low in bases, leaving soils beneath them more acid.

The final factor influencing the chemical and physical properties of our soils has been man. We have added lime and fertilizer, making soils less acidic and richer in organic nutrients. Plowing has mixed and rearranged the natural structure of the soil. Artificial drainage and filling has altered wetland soils, while irrigation has changed the environment of drier soils. In Mashpee, many wetlands have been ditched, drained, flooded and sanded in the process of creating cranberry bogs. In addition, many acres which are now covered with "second growth" forests were formerly plowed fields. Even prior to the arrival of the Pilgrims, Wampanoag Indians cultivated the soil, cut trees and burned underbrush, activities which altered our soils. Today, large scale development of roads, houses, golf courses, airports, gravel pits and shopping centers has drastically changed the land surface, essentially destroying or burying the soil.

All of these soil forming factors have combined to create distinct types of soils in various parts of the Town. These were classified by soil scientists working for the U. S. Department of Agriculture's Soil Conservation Service (now Natural Resource Conservation Service), who have an office in Barnstable which serves Cape Cod and the Islands. These classifications are based largely on the kind, thickness and arrangement of soil layers, or "horizons". Water table, amount

and size of stones, slope and other factors are also taken into consideration. Based on test holes, examination of the soils, topography, the kinds of plants growing on a soil and knowledge of the climate and geologic history of this area, the various classes of soils were mapped on aerial photographs of the Town as part of a countywide soil survey report.

Since individual soils of different classes gradually merge into each other in most cases, and because there are often small patches of soil (inclusions) within an area that differ from those of the rest of the area, the soils maps produced for the Town can only be considered a good approximation of what will be found in any particular spot. However, since the purpose of the soils maps is to separate the landscape into segments that have similar use and management requirements for purposes such as agriculture, forestry, recreation, wildlife habitat and development, the level of detail provided is generally adequate. Where specific information on a small area is required for construction of a septic system, foundation, roadway or similar items, more detailed on-site analyses must be done.

Mashpee's soils were mapped using 21 classifications, including urban land, sand and gravel pits and beaches. Some classifications appear in only limited areas, such as a variety of muck and peat soils that exist in our wetlands. Others cover large areas of the Town and largely define the suitability of lands within the Town for various uses. These are the "Carver", "Hinckley", "Merrimac" and "Enfield" soils. (Soil types are usually named after the place where the soils involved were first found or studied.)

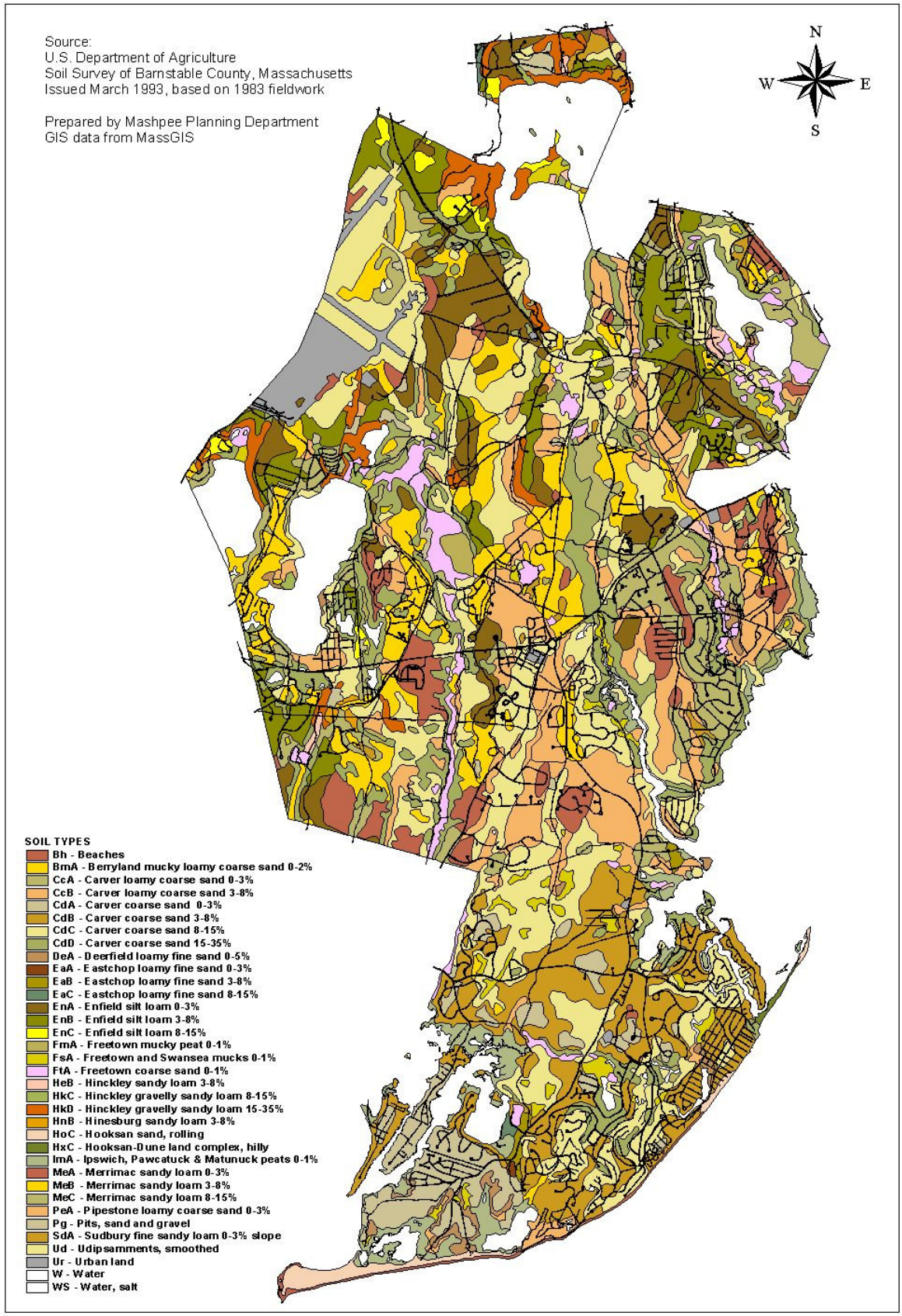
Carver and Hinckley soils both formed in glacial outwash, with Carver being generally sandy, while Hinckley includes some gravelly material. Both developed in dry upland areas where the depth to groundwater is greater than six feet (often much greater). They appear in a variety of landscapes, from level plains to steep hills. As with most of our soils, they are usually covered with a layer of non-decomposed and partially decomposed pine needles, leaves and twigs. These soils present only slight to moderate limitations to residential, commercial and industrial uses due to lack of bedrock or large stones and the ease of on-site sewage disposal in their coarse sands and gravels. Permeability is very rapid, 6 to 20 in./hr. in the Hinckley subsoil (approximately 15 inches thick) and over 20 in./hr. in the Hinkley substratum and Carver subsoil and substratum. However, those same coarse materials and rapid permeability provide for little filtration of sewage effluent, potentially resulting in contamination of groundwater.

Merrimac soils formed in aeolian deposits of loamy material between 1.5 and 2.5 feet thick underlain by sandy and gravelly outwash materials. They also developed in dry upland areas with a water table greater than six feet below the surface and occur under a wide range of topographic conditions. Merrimac soils are less permeable than the Carver and Hinckley soils (2-20 in./hr in the subsoil and 6-20 in./hr. in the substratum) making them more suitable for agriculture and filtration of sewage effluent.

Enfield soils are similar to Merrimac soils except that their loamy top layer ranges from 1.5 to 3.5 feet thick. They generally occur on slopes of less than 15% and have a water table normally greater than 6 feet below the surface. Permeability is 6-20 in./hr. in the subsoil and 6-20+ in./hr. in the substratum. These are well drained soils that are very suitable for agricultural use in fairly level areas due to a lack of stones and ability of the loamy layer to retain moisture and nutrients.

Town of Mashpee Soil Types

Map 4-4



back of 11x17 soils map

Knowledge of the classes of soil in an area can provide us with effective planning tools for a variety of purposes. As noted above, certain soils are more suitable for agriculture or septic systems. Soil scientists have also determined certain engineering properties of soils relative to their texture, suitability as construction material, grain size, liquid limit and plasticity. Soils have also been tested to determine their available water capacity, acidity, salinity, shrink-swell potential, percent of organic material, percent of clay, erodibility, frequency and duration of flooding, high water table, potential frost action and risk of corrosion. An analysis of all of these factors allowed the Soil Conservation Service to determine the suitability of each class of soil for a wide variety of uses.

Suitability is categorized in terms of slight, moderate or severe limitations on a particular use. Those uses for which suitability has been listed in the Soil Survey of Barnstable County (March, 1993) relate to: ***agricultural yields*** - land capability per acre of crops and pasture, ***woodland management and productivity*** - including management concerns, potential productivity and trees to plant, ***recreational development*** - for camp areas, picnic areas, paths and trails and golf fairways, ***wildlife habitat potential*** - for openland wildlife, woodland wildlife and wetland wildlife, ***building site development*** - for shallow excavations, dwellings without basements, dwellings with basements, small commercial buildings, local roads and streets, lawns and landscaping, ***sanitary facilities*** - septic tank absorption fields, sewage lagoon areas, trench sanitary landfills, area sanitary landfills, daily cover for landfills, ***construction materials*** - roadfill, sand gravel and topsoil, and ***water management*** - indicating limitations for pond reservoir areas, embankments, dikes, levees and aquifer-fed excavated ponds.

Technical Guide Materials are available which also describe suitability for drainage, irrigation, terraces and diversions, grassed waterways, playgrounds, capability and yields per acre for corn, oats, wheat, alfalfa, grass and pasture and woodland management problems such as erosion, equipment limitations, seedling mortality and windthrow hazard. All of these suitability ratings add up to a gold mine of information for land planners, farmers and woodland managers and make the soils map a critical tool in developing a conservation and recreation plan.

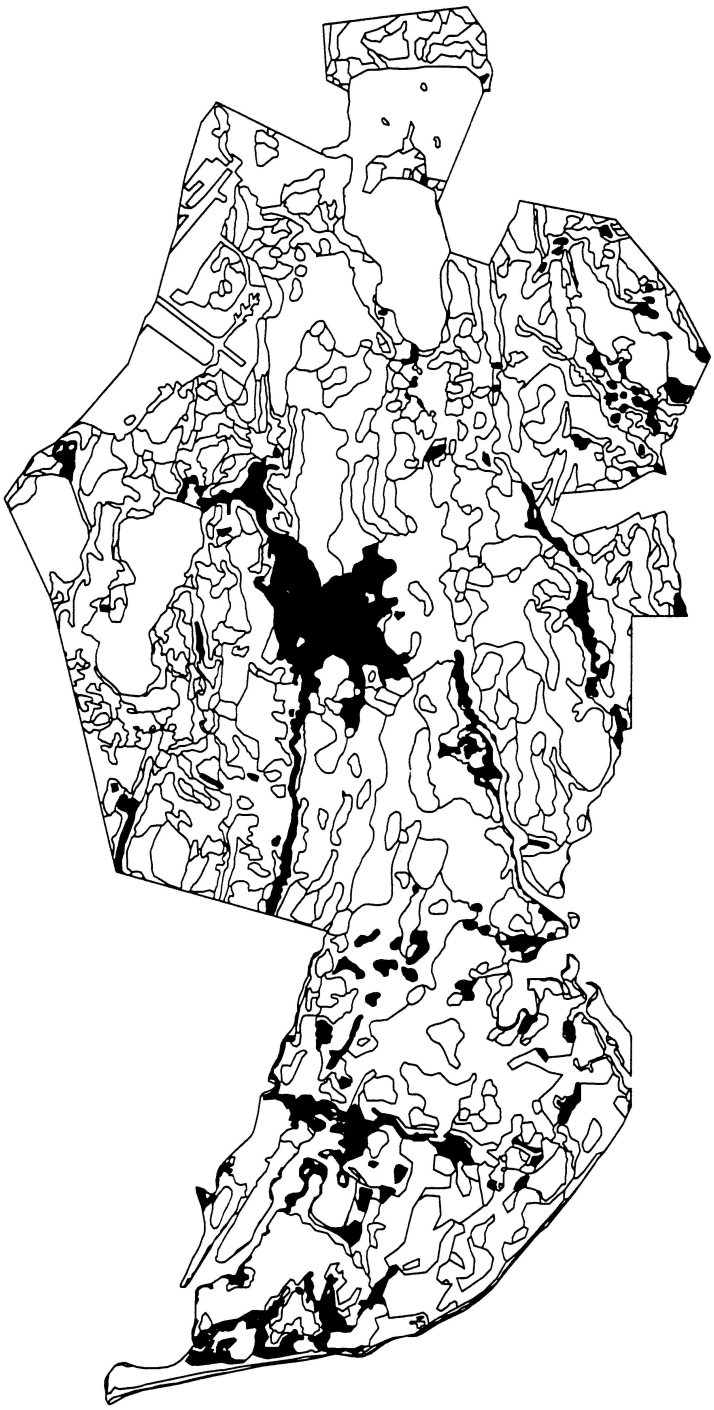
Soil types from the county soil survey were digitized for use by the Cape Cod Commission's computerized geographic information system (GIS) as part of a study of the watershed of Waquoit Bay. All but a tiny corner of Mashpee was included in the area digitized. As a result, the Town has been able to use it's GIS system to produce a series of maps illustrating both soil types (Map 4-4) and soil suitability for recreation and wildlife.

Map 4-5 indicates wetland soils. Map 4-6 illustrates prime farmland soils. Suitability for development of picnic areas is shown on Map 4-7, for playgrounds on Map 4-8, for paths and trails on Map 4-9 and for golf courses on Map 4-10. All of these facilities require soils which remain firm when wet, are not dusty when dry and are not subject to flooding during the usual period of use. Playgrounds require very level slopes and a surface free of stones and boulders. Golf courses can be developed on only moderately sloped areas which are also free of stones and boulders.

Certain soils have greater potential to serve as wildlife habitat. The soils indicated on Map 4-11 have the best potential to serve as open land wildlife habitat, and consist of cropland, pasture, meadows and areas that are overgrown with grasses, herbs, shrubs and vines. According to the

Mashpee Wetland Soils

Map 4-5



April 26, 1996

Mashpee Planning Department; Source: U.S. Soil Conservation Service, Barnstable County Soil Survey

Mashpee Prime Farmland Soils

Map 4-6

April 26, 1996

Mashpee Planning Department; Source: U.S. Soil Conservation Service, Barnstable County Soil Survey