The New York City Soil Survey

Vision Report

August 2001

New York City Soil & Water Conservation District

US Department of Agriculture,
Natural Resources Conservation Service

Cornell University,
Agricultural Experiment Station

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Foreword

The Natural Resources Conservation Service (NRCS) was born in the Dust Bowl days of the 1930's as the Soil Conservation Service (SCS). The agency has a long standing tradition of providing quality service in protecting, maintaining, and enhancing our nation's natural resources. In 1994 the United States Department of Agriculture (USDA) removed NRCS from the umbrella of farm agencies and placed it together with Forest Service under the direction of the newly formed Under Secretary for Natural Resources and Environment. This name change and realignment signaled a renewed interest in serving the urban communities and better described NRCS's role in environmental protection and enhancement.

The NRCS stands committed to government that works better and costs less - by cutting red tape, putting the client first, empowering employees to get results, and cutting back to basics. The agency is striving for a productive nation in harmony with a healthy land.

New York City was selected as a pilot project for both the agency's urban initiative and the Department of Agricultural Urban Initiative called the Urban Resources Partnership (URP). Community leaders, non-profit organizations, city agencies, and elected officials identified local needs, issues and concerns for NRCS to address. NRCS partners overwhelmingly agreed that a comprehensive urban soil survey was needed that addressed the unique characteristics of urban soils as well as the specialized needs of urban customers. NRCS took the challenge seriously and completed a detailed soil map of South Latourette Park, Staten Island, as an example of what could be done and the value of the information provided in the soil survey publication.

The South Latourette Park Soil Survey was one of the first attempts made by NRCS soil scientists to map and provide detailed soil series information for human modified soils. The New York City Reconnaissance Soil Survey builds upon the expertise developed in the South Latourette Park Soil Survey on urban soils, but on a broader scale for all five boroughs. The information published will provide technical guidance for future land use decisions, will be a basic tool for research projects in anthropogenic soils, and serves as an educational tool. The non-traditional format and language are utilized to make the survey more user friendly and helpful to both professionals and laypersons. The same format will be used in the development of future highly detailed soil surveys for specific areas such as Gateway National Park Soil Survey and other open areas. Additional soil series are being developed as needed so users will have an accurate description of the soils in any location in comparison to the conventional soil surveys that only describe these areas as urban, human-made, or disturbed. An open soil survey advisory committee provides continued insurance that soil scientists are kept abreast of users' needs. This partnership of NRCS with citizens, agencies, non-profits, and government representatives will continue to be the way the agency does business.

We invite your constructive suggestions and assistance in carrying out this very important task.

Wayne M. Maresch
State Conservationist
USDA - NRCS

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Environmental professionals examining a soil profile.

Introduction

When completed, the New York City Soil Survey will be the most comprehensive inventory of urban soils ever attempted in the United States to date. This Vision Report does an excellent job of outlining the special organization, planning and research needed to carry out such a complex task. The clarity of the writing and the wealth of technical detail give this report a special value. It should be required reading for anyone starting a soil survey in an urban area. Following are some highlights.

The report challenges the Natural Resources Conservation Service, Cornell University and other cooperators to provide a soil survey that truly meets urban needs. This is done by presenting a comprehensive list of issues that must be addressed in order for the soil survey to be useful.

The history and vision of the New York City Soil Survey outlines a well conceived, three-phase strategy for inventorying the soils of the City. The practical and logical approach presented here could be applied with excellent results even in non-urban soil surveys.

The technical report section describes the protocols for classifying, naming, and interpreting the highly modified soils of New York City. These efforts are very timely. An International Committee is currently assessing ways to classify human-influenced or "anthropogenic" soils. Data, concepts, and insights developed during this project will provide much support to these international efforts.

Pioneer soil scientist examining soil sample.

This report fully defines the project goals and clearly specifies the activities required to achieve them. This clear and complete documentation is an unexpected asset. The concepts and procedures developed for this project improve the quality of future soil surveys, especially in urban areas.

The National Cooperative Soil Survey is gaining much insight and practical experience from our soil survey efforts in New York City. We look forward to continuing with this important and exciting work.

Horace Smith
Director, Soil Survey Division,
Natural Resources Conservation,
Service Washington, DC

History and Vision of the NYC Soil Survey

The history of soil surveys in New York City begins at the turn of the century, well before the foundations of modern soil science were laid in the United States. One of the earliest soil surveys in New York State was in the Hempstead Area, including Brooklyn and Queens (Bonsteel, 1903). Typical of early soil surveys, soil series concepts were broadly defined and map units covered large areas. In fact, there were only a few soil series in the entire report. This report was soon out of print. Only a few archive copies are available today.

But that was the last survey covering any part of New York City until today. Meanwhile, soil surveys have been completed for most of the rest of New York State. In fact, some counties originally surveyed before 1920 have been re-mapped twice, during the 1940's and again during the 1970's or 1980's.

The science that deals with the study of soils has developed and advanced by many orders of magnitude since the original soil survey of New York City. At the time of the original survey, very little was known about soils. For instance, we did not know how soils were formed, the internal processes that shaped their development, or the environmental factors that controlled the internal processes.

In the years since then, however, soil science has dramatically changed.

The Model: Soil as a Natural Body

The foundations of modern soil science were not laid in the United States until the late 1920's, and early 1930's. Our model of soil as a natural body became widely circulated with the publication of the 1938 Yearbook of Agriculture. The model was largely theoretical and needed testing and application. This process began in earnest following World War II when newly trained soil scientists began the program to map the soils of the United States.

However, since the soil mapping process was a constantly evolving experimental laboratory for expanding the model of soils, many of the early soil surveys of this period were obsolete by the 1970's. By this time, our knowledge base had advanced to the point where it was possible to construct a comprehensive system of soil taxonomy to organize our knowledge.

The 1975 publication of Soil Taxonomy by USDA ushered in a new era in soil science and began the modern soil survey program. Over the next 25 years, soil surveys were completed over most of the land area of the United States. These surveys included some urban areas, such as The Soil Survey Report of Washington, DC (Smith, 1976), Soil Survey Report of St. Louis County (Benham, 1982), Soil Survey Report of Montgomery County (Brown and Dyer, 1985), and Soil Survey Report of the City of Baltimore (Levine and Griffin, 1998). But most urban areas, like New York City, were never mapped or were mapped very broadly. Where mapping was completed, it was not given nearly the level of attention given to other land use areas. Urban soils were not understood. Where soils elsewhere were viewed as natural bodies having a logical occurrence, urban soils were considered to be disturbed and to have a random and haphazard occurrence. For most purposes of mapping, huge commercial areas of towns and cities were delineated merely as urban land. Most suburban areas were mapped in some combination of urban land, Udorthents (cut and fill), or major soil series. The industrial and mined areas were mapped as Udorthents, "made land", "mine spoil," or "waste."

Understanding Urban Soils

As our model of soil developed with accompanying advances in soil taxonomy, many of the principles that we learned from soil mapping in open areas were considered for application in urban areas. This has led to the realization that the same processes operate on soils irrespective of land uses per se. For instance, soils in an urban area and soils in a forested area both require an understanding of the environmental factors (climate, organisms, parent material, relief, and time) that influence soil development. In our model of soil it is useful to think of soil as being derived from distinct types of parent materials. These include glacial till, lacustrine and marine sediments, glacial outwash, and various types of residuum.

These parent materials are acted upon by various organisms and climatic conditions, and influenced by relief over a period of time. Soil is the result of the complex interactions, and each type is unique. We are able to map, classify, and interpret soils because a given set of environmental factors produces the same soil.

Naturally, things are not so simple. In non-urban areas geology provides a sufficient framework. But in urban areas we also need to know the human influences on soils; we need information on the extent and depth of cutting and filling, the origin of the fill, and when and how the fill was laid down, and the nature of the original parent material. Such information can be found in historical atlases, subdivision maps and engineering plans.

With the above information, we proceed with the same type of analysis as would be performed in a non-urban area. Other factors, such as climate, organisms, relief, and time are assessed. With respect to organisms, humans become the most important in urban areas, by greatly influencing each of the other factors. Humans not only lay down parent materials, but alter the climate of both the soil and the atmosphere, and change the topography and drainage (relief) of the landscape. The challenge for soil scientists is to view the role of organisms, including humans in a more comprehensive fashion. With this concept of urban soils as natural bodies, it is possible to classify and interpret them with the same level of detail as is applied to non-urban soils. Urban soils can now be classified into soil series and studied as distinct entities, with relatively narrow ranges of occurrence.

Soil Quality as a Central Concept in the Urban Ecosystem

There are three major interrelated resources that support our environment: soil, water and the atmosphere. Humans have tended to consider soil chiefly as a producer of food and only recently have begun to understand the importance of soil in ecosystems. Paralleling the advancements in soil science and taxonomy that have changed the concept of urban soils are recent developments in soil analysis and interpretations, giving rise to the importance of soil quality. Soil quality is the character and the capacity of the soil that makes soil suitable to perform various environmental functions, on which ecosystems depend.

Influence of Soil on Ecosystem Processes

Soil characteristics, measured as soil quality, influence ecosystem processes such as the hydrologic cycle. *Infiltration* is one soil characteristic governed by slope of the relief, aggregation, soil structure, organic matter content, rock fragments in the surface layer, roughness of the soil surface, and roots in the surface layer. *Permeability* also affects the hydrologic cycle and is determined by structure, texture, and bulk density. Another important soil characteristic is *water holding capacity*, which is governed by soil structure, organic matter content, texture, bulk density and soil depth. In urban areas, soil properties that influence rooting, water holding capacity, and nutrient availability are important measures of soil quality for plant communities. Likewise, organic matter content, organisms, soil compaction, structure, texture, and other factors that influence runoff and infiltration are all important soil quality parameters in evaluating hydrologic cycles. Soil quality is also important in elucidating fate and transport of contaminants in the soil.

Central Park Great Lawn after soil restoration.

Soil quality is affected by humans. For instance, if the surface layer of a soil is compacted from human uses of the area resulting in deterioration of structure and a state of aggregation or tilth, there may be a radical increase in runoff that will impair water quality of surface receiving water. The increased runoff promotes erosion and flooding, resulting in further degradation of water quality. The contaminant-laden waters ultimately reach the ocean, potentially damaging estuarine and marine ecosystems. The effects of poor soil quality are far reaching, often beginning with a disruption of a local ecosystem and ultimately causing an imbalance in the global ecosystem.

The human welfare is highly dependent on soil quality particularly in the urban ecosystem, where soil quality is especially fragile, and soil is handled intensively and intimately. The soils in these environments are buffeted by innumerable foot strikes. They act as a storehouse for the enormous amounts of solid wastes generated by humans. The soils absorb some of the noxious gases emitted from the many cars, trucks and buses in urban centers. The physical strength of the soil is taxed to provide foundation for multitudes of structures.

Soil as a Contributor to Quality of Life

Beyond all else, the soil is counted on to contribute to a healthy, high quality living environment with aesthetic qualities that nurture high levels of morale and spirituality in the human population. Unfortunately, monitoring and managing urban soils quality is at best poorly understood. The soil survey of Latourette Park, with new urban soils series and a heavy metals study is a first step towards a more complete understanding of this profoundly important topic.

Reinventing Soil Programs: an Urban Approach to Soil Surveys

As it is clear by now, soil issues in urban environments are distinctly different from those in rural areas. Much of urban "soil" is, by origin, waste materials especially where waterfronts were deliberately expanded. A predominant portion of urban "soil" is also artificial hard surface of asphalt and concrete in various stages of deterioration and decay. Urban soil, including "natural" soil, has been subjected to stresses, such as compaction, vibration, and contaminants, often for long periods.

Furthermore, the interaction between natural drainage and the drainage infrastructure of streets, seepage basins and sewers is also a uniquely urban concern, as well as the type and degree of demands on soils.

The Central Goal: an Inventory of Soil Resources in their Environment and Customer-Centered Products

The goal of any Soil Survey is simply this: an inventory of soil resources in their environment and the creation of “customer-centered products.”

What made the New York City Soil Survey special was its candid recognition of the need to understand the impacts of disturbed, human-influenced soils on a series of environmental contexts. It was not surprising that these issues came to the fore in an urban survey, but it also was not surprising that these same issues were relevant everywhere: in urban, suburban, and rural settings.

Early in the planning for the survey, environmental contexts for soil surveys were identified for determining possible product requirements:

- aquifer recharge, where groundwater under the City itself is a major source of water, as in the federally designated "sole source aquifer" in Brooklyn and Queens;
- leachate control, where active and inactive landfills have been used for dumping of toxic materials, as in the inactive landfills adjoining Jamaica Bay and Pelham Bay;
- habitat protection, especially in threatened freshwater wetlands and salt marshes, and in restricted sites, where pockets of nature survive despite neglect and development;
- sediment control, where waterfront erosion and soil carried by combined sewer overflows are significant sources of polluted near-shore sediment;
- park landscaping and management, in soils of varied origins and qualities, in areas more or less subject to urban stress and pollution;
- development of nature-based alternative infrastructure for storm water management ("Bluebelts") serving an urbanized drainage area, and for bioremediation of landfills;
- construction siting and design, where proposed projects test the carrying capacity and seismic stability of land and infrastructure;and
- urban agriculture and community gardens.

Recognition of the need to understand the impacts of disturbed, human-influenced soils in these environmental contexts has made the New York City Soil Survey program unique among others.

However, we still include in our soil survey products the following basic components:

- identification of landforms, by slope, vegetation and geology, using aerial photography,
- mapping and delineation of soil units, such as central and non-central pedons, similar and dissimilar inclusions, and
- field sampling and analysis.

We also see the New York City Soil Survey as a catalyst for special initiatives to provide an inventory of soil resources to improve our clean water programs as well as a service for customer-centered products.

Goals for the New York City Soil and Water Conservation District

We hope to use soil survey products in three important arenas:

1. Filtration system

An important part of our vision is to educate New Yorkers and agency professionals on the unique importance of soil as the best natural medium for nurturing planted buffers to retain contaminants carried by stormwater. In a city of islands, our environmental policy must be pollution prevention rather than end-of-pipe treatment. Proper knowledge and use of soil is a critical ingredient for our water and land management.

2. Catalyst for biodiversity

Geological history has furnished us a rich potential for biological diversity in this region. Within the area of high population density and impervious surface coverage, our city still harbors rich natural habitats. Our diverse population challenges us to broaden and improve the quality of life by providing open space and community gardens, by extending tree canopy for our large bird populations, by reintroducing native species and by enhancing habitat diversity.

3. Research and service

Various special studies are an important part of the program. Already, soil scientists have completed a soil quality study of the North Meadow area of Central Park for use in developing a renovation plan (Singleton, 1998). This project was an intensive study to measure water infiltration and movement in the upper part of the soil. Other similar studies are anticipated during the course of the survey.

Soil scientists have also undertaken a study to determine the level of soil contamination by heavy metals (Russell-Anelli, 1998). This is part of a research project not only to measure levels, but also to determine area distribution and to develop protocols for future studies. Soil scientists anticipate development of class limits and other interpretations related to soil contamination from heavy metals.

Grassroots Requests

Finally, the Soil Survey team has been responsive to many grassroots requests for help including acting as special partners in agency environmental planning. As part of restoration studies, the team is furnishing soils information for the Army Corps of Engineers and the NYC Department of Environmental Protection. The team is also working with the NYC SWCD on watershed planning for Jamaica Bay and the Bronx River watersheds. In addition, the team has provided soils analysis for a newly funded garden for native species in Staten Island, has investigated the predominance of hydric soils in a park slated for a ballfield and has pending a request from the Borough President of Queens to investigate the quality of soil in a former Army base.

Soil sampling was completed with the help of Earth Team volunteers. From right to left, Alexandria Christ (NRCS intern from Germany), Yiyi Wong (NRCS volunteer) Richard Kruzansky (Central Park Conservancy), Luis A. Hernandez (USDA-NRCS) and Rebecca Burt (USDA-NRCS).

The Team for Inter-Agency Collaboration

The soil survey of New York City is a cooperative project. There are a number of participants in addition to a number of professional scientists on the Board of the NYC Soil and Water Conservation District, Cornell University and the Natural Resources Conservation Service. Employees of the NRCS and the Cornell University Agricultural Experiment Station (CUAES) have cooperated for decades as the National Cooperative Soil Survey (NCSS), the government entity responsible for conducting soil surveys in the United States. Other major cooperators in the soil survey have included the federal Environmental Protection Agency (EPA), the NYC Departments of Environmental Protection, Parks & Recreation, Transportation, and General Services. It is hoped that this project with its innovative design and project methods will serve as a standard for inter-agency collaboration.

Now, five years later, the NYC Soil Survey is completing a reconnaissance soil map of the City as a whole. One high-intensity soil survey (1:4,800) for South Latourette Park, Staten Island, has been published. Another, for the three units of Gateway National Recreation Area is in its final stages.

Role of New York City Soil Survey Technical Advisory Committee

The Technical Advisory Committee was established by the NYC Soil and Water Conservation District in late 1996. The TAC has provided guidance and a forum for discussion and feedback among interested parties. The TAC consists of representatives of all of the cooperating Urban Initiative partners, including key staff from the government agencies, scientists and environmental researchers that are potential customers of the Survey, plus academics with a specialty in urban soils from as far away as Maryland. The TAC discussions have spanned the special challenges and opportunities of an urban soil survey such as:

- potential customers and their needs
- implications of the needs for Survey direction, intensity of effort, mapping scale and soil interpretation
- criteria for selecting sites for future Intensive Surveys
- ways to use inter-disciplinary coordination and innovative technologies in mapping, analysis and outreach
- research projects
- staff skills and recruitment
- strategies for providing technical advice
- a proposed federally-designated Urban Major Land Resource Area, from Washington to Boston, focused on urban soils, and
- lessons from the Survey to-date.

Horace Smith, NRCS Chief of the Soil Survey, was among the visitors who have exchanged views with the TAC: he led a discussion of new directions for NRCS, soil science and the Soil Survey nationwide.

Focused discussions have ensued on:

- studies in trace elements concentrations, especially in areas used to grow food for human consumption
- use of latest technology, such as Ground Penetrating Radar and Electromagnetic Induction for urban mapping
- global warming due to urbanization
- the relationship between urban soils and vegetation communities, and
- studies on growth of Jamaica Bay tidal marsh.

Other areas of interest for the TAC are landfill studies - the potential roles of the Soil Survey in "brownfield" issues, in landfill closure, cover and re-use; landfill reclamation; and in problems of leachate and sub-surface combustion and impacts on nearby lands and waters.

Determination of heavy metal concentrations in city soils will guarantee a safer site selection for community gardens.

In the coming years, the TAC will play a critical role in the watershed planning efforts in Jamaica Bay and the Bronx River watersheds.

Future Direction

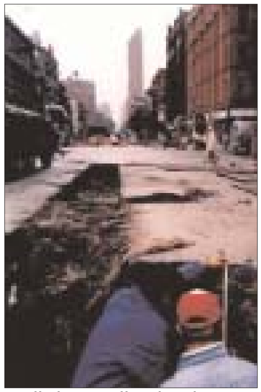
The purpose of the New York City Soil Survey Program is to produce an inventory and evaluation of the soil resources that meets the needs of the multiple users for land use and environmental planning. Issues relating to the soil, its character and quality to perform multiple functions in the urban ecosystem are key to the conduct of this soil survey. These include:

1. The quality of the soil to attenuate and cycle water, nutrients, and contaminants, as well as support life.
2. The morphology and chemical and physical character of the various anthropogenic soils and the development of a mapping and classification protocol.
3. Development of soil interpretations that convey soil potential for use and management.

The work is planned in three phases: the first phase is to complete the reconnaissance soil survey of the City to better understand soil patterns and distribution. This includes collecting the baseline data for characterization of the various soils and developing soil mapping protocols that can be applied throughout the city. Also included are research projects designed to answer questions regarding the nature and chemical properties of selected soils and identify areas for future studies.

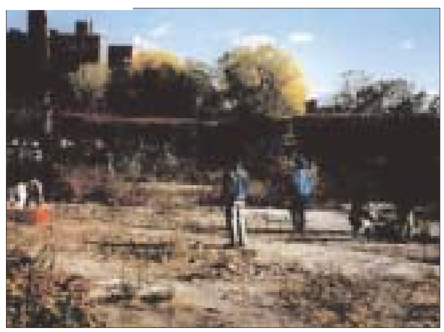
The second phase includes

high intensity soil surveys within priority areas, usually at a mapping scale of l"=6,000". A soil survey report will be published of each area. To date soil surveys have been completed of South Latourette Park and The Gateway National Recreation Area. The soil survey of the Bronx River Watershed Area began in the fall of 2000 and will continue through 2002. A special feature includes a partnership with the Westchester SWCD & Planning Dept. to upgrade their soil survey and integrate the Watershed Plan for the entire river. High intensity soil surveys are also planned for Jamaica Bay and the Arthur Kill watersheds, projected for 2002 and 2003 respectively. Thereafter, surveys are planned for the remaining green space areas and priority watersheds.



Soil data collection in a NYC-DOT construction site near Times Square, Manhattan.

The third phase of the soil survey will be to complete medium intensity soil surveys of most of the remaining areas of the City. These surveys will be conducted usually at a mapping scale of l"=12,000". Individual reports will be published for each Borough.



Soil scientists using Ground Penetrating Radar to detect subsurface features in a Urban Resources Partnership restoration site of South Bronx.

All soil surveys completed will be available in electronic format, including maps, soil descriptions, and interpretations. Electronic formats will be suitable for interactive GIS applications as well as stand alone CD-ROM versions for Windows users. Stand alone versions will be widely marketed to individual users. Research and special studies are an important part of the program. Studies underway include collecting baseline data on heavy metal concentrations of the surface layer of soils throughout the city. Other research focuses on the quality of the soil to perform various functions in the environment. Included are organic matter and organism activity, soil compaction, water infiltration, and other physical and chemical measurements. Special studies are being conducted to answer questions regarding the nature and composition of various fill materials; and soil sampling and investigation methods for proper characterization, classification, and interpretation. The data collected will become part of the electronic database and will be available to users along with the maps and descriptions.

Soil survey team members and volunteers in a sampling site.

Formation of Soils and Characterization

FACT SHEET

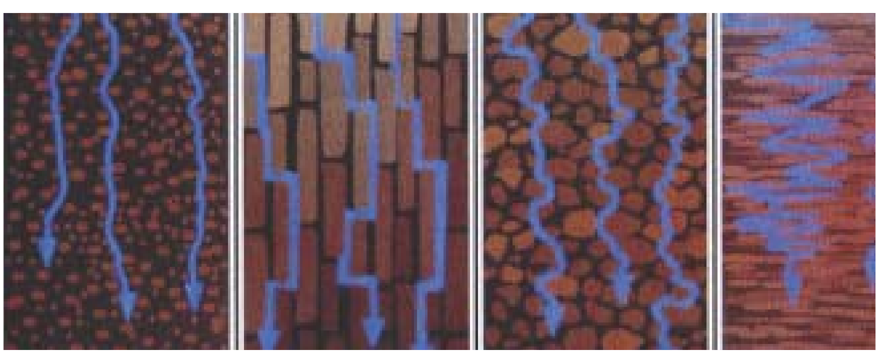
Soils are natural three-dimensional bodies at the earth's surface; they are formed from parent material, acted on by climate and organisms and influenced by relief, working over time. Relief is the topography and drainage of an area -- the slope and shape of the land surface and its relationship to the water table.

Parent materials determine the mineral and chemical makeup of the soil and affect the rate at which soil-forming processes act. Major types include glacial till, glacial outwash, stratified draft, loess, alluvium, lacustrine sediments, marine sediments, various types of residuum, and fill.

Soil quality training in Central Park, Manhattan.

Climate determines the nature and rate of weathering by water and wind, influences the kinds and quantities of biota (vegetation, animals and fungi) and determines the amount of water available for leaching.

All living organisms affect soil formation: animals, plants, bacteria and fungi. Vegetation affects the kind and amount of organic matter entering the soil, and bacteria and fungal growth determine the extent and rate of organic decomposition. Earthworms and burrowing animals keep the soil open and loose. People are an increasingly significant animal affecting soils: depositing organic and inorganic matter, cultivating plants, moving and upturning the earth, aggravating erosion.



Water movement through granular, prismatic, subangular blocky, and platty soil structure, respectively.

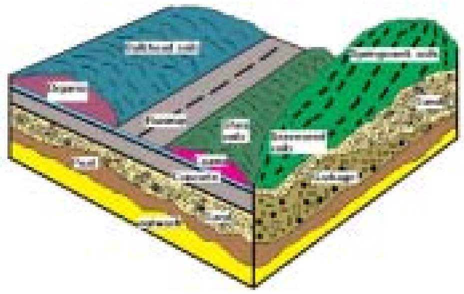
The soil-forming processes that work over time include:

* accumulation of organic matter,
* weathering by water and wind,
* leaching of water soluble salts and minerals down and out of the soil,
* reduction and relocation of iron,
* relocation of clays, and
* the poorly understood processes that form dense subsoil layers (“fragipans”).

Soil maps are prepared in the field using survey tools to examine soil profile. Field observations and laboratory data are used to design map units and provide supportive information for scientific documentation and prediction of soil behavior.

A soil pit is used to expose soil horizons. Horizon depth is determined using a metric tape, then each horizon is described and sampled. The descriptions include observations of specific soil properties such as structure, consistence, porosity, bulk density, texture, color, pH, and coarse fragments, among others.

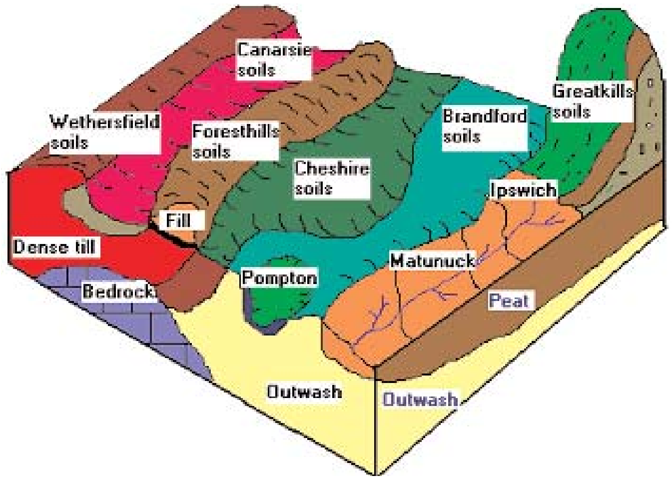
Bulk density of a soil is its dry weight per unit of volume. It is generally determined by the structure of the peds (see Structure), the porosity of the soil, and the mineral or organic nature of the soil material.



Coarse fragments refer to the size and content of rock fragments or human-made artifacts in the soil. Coarse fragments are important to land use; within soil layers they reduce the amount of water available for plant use.

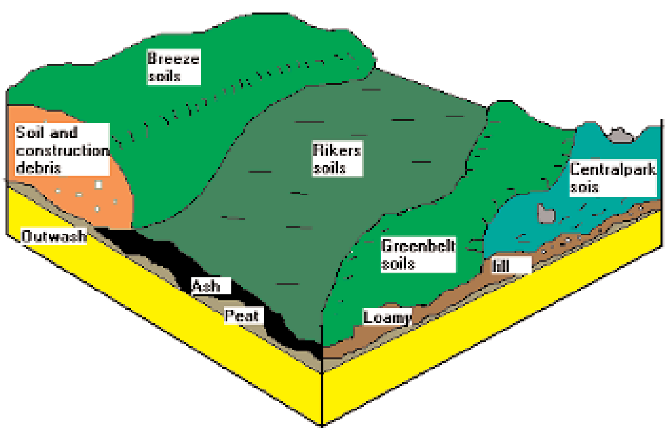
FACT SHEET

Color is determined by the amount of organic matter, the kinds of minerals, or the presence of water in a soil. Iron colors soils red. Calcium carbonate colors soils white. The wetter an "A" horizon is, the darker it is, and "B" horizons that have been saturated for long periods may be gray, or gray with red or orange streaks ("mottles").



Consistence is the firmness of the individual peds and how easily they break apart. A soil with firm consistence will be harder for roots or shovels or plows to move through than one with friable or fragile consistence.

Porosity is the proportion of the soil volume that is occupied by pore spaces.



Reaction, or soil pH, is an expression of the degree of acidity or alkalinity of a soil. It influences plant nutrient availability.

Structure is the natural shape of groups of soil particles or aggregates ("peds") in the soil. It affects the size of the spaces through which roots, air and water may move.

Texture refers to the feel of a soil and is determined by particle size distribution, or the proportion of sand, silt, or clay particles in the soil; sand feels gritty; silt feels smooth or "floury"; clay feels sticky and is hard to squeeze.

Soil Profile

The face of a soil -- the way it looks if you cut a section of it out of the ground -- is called a soil profile. When you learn to interpret it, the profile can tell you about the geology and climate of the landscape over thousands of years, the history of how humans have used the soil, and the soil's properties.

Every soil profile is made up of layers called soil horizons. They can be identified because they have different properties: different colors, particles shapes and feel. They can be as thin as a few millimeters or thicker than a meter.

Plant roots penetrate the soil in search for water and nutrients.

Soil scientists label horizons with a special code to identify them. From top to bottom they are:

* O horizon (organic material),
* A horizon (topsoil),
* E horizon (eluvial material, with minerals leached out),
* B horizon (subsoil, severely weathered parent material, often including minerals leached from A and E),
* C horizon (substratum, similar to the parent material), and
* R horizon (bedrock: we use the term "layer" because no soil development has occurred).

Some of these horizons may be missing or out of order in a given soil profile (See figure next page). In non-forested areas, the O and E horizons may be missing. In shallow soils or soils that have not been extensively weathered, the B horizon may be missing. Top horizons may be missing in an eroded area. And horizons may be jumbled where soils have been altered by human activity -- cutting and filling.

O Horizon

FACT SHEET

The O horizon is so named because of a predominance of organic material. It is usually found in forested areas and not in agricultural fields, deserts or grassy areas. Some O horizons have been subject to saturation by water for long periods, though they are now drained. Others, often occurring in woodlands, have never been saturated and include three distinct layers: an upper layer of leaves, needles and twigs; a middle layer of partially decomposed matter; and a lower layer, well-decomposed and very dark.

A Horizon

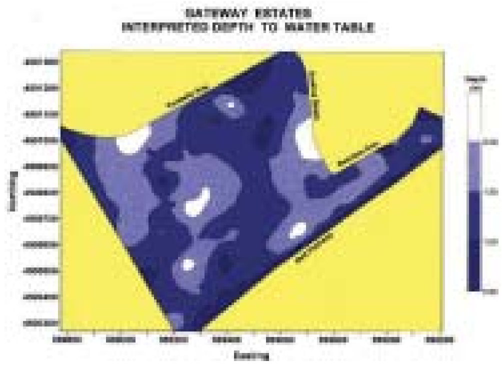
The A horizon is commonly known as topsoil, and in agricultural areas it is the one that is tilled. The letter "A" is used because it is the first mineral horizon of the soil. The A horizon is made up mostly of mineral matter, although it may also include thoroughly decomposed organic material, giving it a darker color. Usually, it is darker than the horizon below it; the wetter the soil, the darker and thicker it is. When there has been much root decomposition and organic matter accumulation, the structure of the A horizon is granular. If compacted, the structure of the A horizon may be platy.

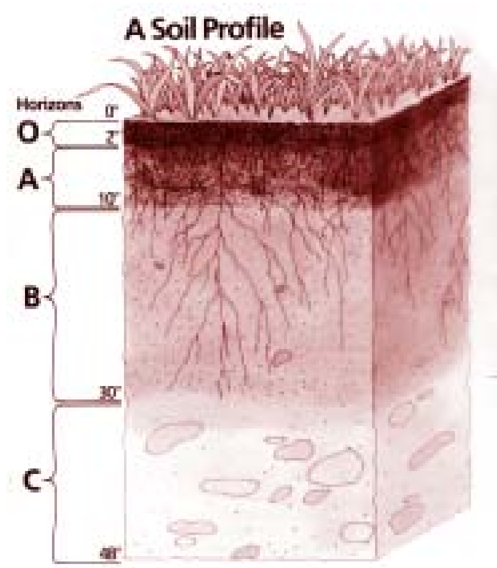
E Horizon

The E horizon usually forms only in forested areas or under some wet conditions: it is particularly common in forests where coniferous trees grow. "E" stands for eluvial -- which means that clay, iron, aluminum, organic and other minerals have been leached from it. It appears white or lighter in color than the horizons above and below it, and often its structure is platy or single-grained.

B Horizon

The B horizon is commonly known as "subsoil" and is often broken down into additional layers (B1, B2, B3). It is generally the second major horizon in the profile, primarily composed of parent material that has been severely weathered to the point that it is different in color, texture, and structure. The B horizon is also called the accumulation horizon, or illuvial horizon, because it is where the material leached from the A and E horizons is deposited. As a result, it may be rich in clays, organic matter, iron, aluminum and other soil constituents moved from above. Many B horizons have a reddish, yellowish brown or tan color that is lighter than the A horizon, but if the soil has been saturated with water for long periods of time, it may be gray, or gray with red or orange streaks (mottles) through it. B horizons may be blocky or prismatic because of the leached material in it; in dry regions it may be columnar because of a high sodium content.





C Horizon

The C horizon, referred to as "substratum," is usually the third major horizon. It is the most similar to the original parent material, with no change in color, no structure formed (it is massive or single-grained), and no minerals leached out or in.

R Layer

The R layer, referred to as "bedrock," is labeled with an "R" for rock. It is the layer of rock that is sometimes found at the base of the profile. It may be the source of the parent material, or the parent material may have been deposited on top of it -- as alluvial, glacial or volcanic material -- before the soil was formed. In the New York City area the R layer is mostly Manhattan Schist, Inwood Marble, Fordham Gneiss or Staten Island Serpentine.

Soil Mapping

Soil mapping is the process by which a land area is analyzed and presented in terms of the quality of its individual soil components. It is accompanied by a set of terms specific to the process.

A soil series is a group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. It represents the central concept of an established range of soil properties. It forms the lowest category of the national soil classification system in the US (Soil Taxonomy) and meets the requirements for categorical detail demanded by the objectives of detailed soil surveys. Examples of New York City soil series are "Verrazano," "Big Apple," and "Jamaica" among others.

A soil phase is a sub-classification within a series: soil phases are differentiated on the basis of slope, stoniness, salinity, compaction, and other characteristics.
Soil map units are the labels by which soil series and phases are identified on soil survey maps.

A single map unit may involve more than one soil series and phase. Soil complexes are map units consisting of two or more soils (or one or more soils plus a "miscellaneous area") that occur in such an intricate pattern or in such small areas that they cannot be shown separately on the map. Moreover, soil inclusions (or "included soils") are small, scattered areas of soils different from those for which the map unit is named.

Metropolitan Initiative

Partnership between Conservation Districts and United States Department of Agriculture

The Metropolitan Initiative was developed by the New York City Soil & Water Conservation District to introduce a strategy for partnership between farmer producers and urban consumers. The technical assistance programs of the U.S. Department of Agriculture, presently focussed on rural areas and farm commodities, should include a more inclusive focus on Metropolitan areas and watershed systems. The programs are equally appropriate for urban conservators working to protect and restore their local natural resources. These urban stewards are as committed as farmers to conserving soil and water and nurturing forests to clean our air.

FACT SHEET

Need for a link

Right now there is a disconnect between farmland and urban centers. Clearly, however, urban consumers rely on agriculture for affordable price and good quality of products, and advocate high quality of water (both for consumption and recreation), and protection of open space and natural resources. If rural and urban citizens wish to curtail sprawl and sustain traditional agricultural operations, we must forge relationships between agricultural and urban communities. In developing a metropolitan initiative, we begin with asking some questions:

- Who is the "client" to be served by urban initiatives?
- What are the mutually beneficial goals for farmers and consumers?
- What changes have taken place in the agriculture industry that affect the farmers' role as conservators?

The answers to these questions may be locality specific. New York City needs may be very different from Chicago and Seattle. We can only proceed with our perspectives.

Partnership as the foundation for urban conservation

The NYC District is an entirely urban district covering all five boroughs of New York City. Its diverse population of eight million residents is best served through local leaders, so the District's focus is on building consensus and fostering partnership. Our primary "clients" are non-governmental organizations, but on everything we do, we work with partners including

Students using soil survey products during NYC Envirothon.

- Environmental stewards - from grassroots groups to established national organizations

- Agencies at all levels of government
- Academic institutions - from universities to research teams
- Neighboring Districts - downstate NY SWCDs, northern New Jersey Districts
- Schools
- Port and water-related businesses
- Elected officials and community planning boards

District work program

Although our primary clients are non-governmental organizations, we take an all-inclusive approach to everything we do. When we sponsor an event, we extend invitations to a broad audience including elected officials and invite partners to co-sponsor. We are careful not to duplicate existing efforts, although we work to integrate regional clean water initiatives. Our role is primarily to act as facilitators or initiators, not as implementers so as not to compete with our stewards or agencies. We also facilitate grant applications to the Bond Act for our partners.

Core program

We have promoted the status of soils from neglected to critical in the urban conservation arena and furnish soils information both to private organizations and to agencies implementing restoration planning. Our stewards act as monitors and watchdogs and are the first line of defense in protecting natural resources. We work with youth through the Envirothon and invite them to our training sessions as future stewards. These form the basis for our three core programs: urban soil survey, stewardship and environmental education. Our outreach includes electronic communications, workshops for stewards and agency professionals, and field trips and boat trips to acquaint stewards with the work of other stewards.

Our partnership with the three estuary programs of our Bight ecosystem also drives our program philosophies to concentrate on habitat, biodiversity, pollution prevention rather than end-of-pipe containment, and waterfront access and recreation. We partner with Lower Hudson Districts on environmental education, and with Southeast New York Districts in a Resource Conservation & Development initiative to facilitate wholesale markets within the City for farm and forest products.

Within our clean water priorities, we partner with local stewards to advance watershed planning for our major waterbodies - currently focussed on the Bronx River, Jamaica Bay and the Arthur Kill. Other program priorities include sediment cleanup, green port expansion, and combined sewer overflow abatement.

Role for the U.S. Department of Agriculture

The urban areas can offer many partnership opportunities for farm protection; the department's expertise in wetland evaluation, nonpoint and stormwater run-off and soils science could offer major technical assistance to urban stewards working to protect and restore their waterbodies. We would recommend a national urban conservation conference using teleconferencing to reach the major audiences coping with sprawl, drinking water quality and clean water requirements. It is critical to create a professional exchange of ideas and a means of sharing experiences to create positive dialogues among urban conservationists and agricultural experts. This could begin to formulate farmer-consumer partnerships and to promote use of environmental resources in other agencies to unify the conservation movement.

For instance, the urban conservation movement abounds in forestry initiatives including street trees, urban forests, community gardens, trails and greenways, and reclamation of brownfields and vacant lots - many of which are funded through transportation funds in which the Forestry Service has a key interest.

It is important, in our estimation, for the national interests to begin exploring how a farmer-consumer partnership can contribute to both communities.