Site Characteristics
Take note of the land use, the land cover or vegetation, the slope and aspect (direction the slope faces).

Soil Profile
Do you see any horizons?
A dark topsoil layer is usually a good indicator for successful plant growth.
Well expressed, naturally formed horizons below this could be a sign of a stable and relatively undisturbed soil.
Multiple layers could also be a result of filling with different types of materials.

Soil colors can tell something of the origin of soil material, and the wetness.
Is the soil uniformly brown? Then it is probably well aerated.
Different colors may also indicate different sources of material.
Is the soil partially gray, or brown with spots of gray? If so, it may be wet, which is undesirable for the growth of certain plants.

Soil texture has important implications for water and nutrient supply.
Very sandy soils may not hold enough water & nutrients for certain plants.
Too many coarse fragments may take up water & nutrient holding space, and even plant rooting space.
Heavy clay soils may have poor drainage. Gray colors may indicate wetness.
Loamy soils (a mixture of sand, silt, and clay) are generally best for most uses.
What is the % (by volume) coarse fragments? What size are they?
Are they natural rocks or artifacts?

Soil Structure reflects soil physical condition.
Well expressed granular structure in the surface is a good sign of biological activity and health.
Platy structure indicates compaction and possible problems with water movement and root growth.
Subangular blocky structure in the subsoil allows for sufficient pore space for movement of water and air.

Soil Consistence also reflects soil physical health.
Firm layers could restrict water or roots.

A pH test can give you a quick idea of the soil’s chemical status.
The ideal pH for the growth of most plants is between 6.0 and 6.5.
pH values lower than this may need additions of lime (calcium carbonate).
However, most urban soils have high pH values >7.0.

If you’re planning a vegetable garden, you should have your soil tested for contaminants, such as heavy metals, as well as pH and nutrient content.
What is soil?

Soil is a mixture of mineral and organic matter, which forms on the surface of the earth, and changes, or has changed, in response to climate and organisms. Soil is composed of: Solid space & Pore space

- mineral material
- air
- organic material
- water

The proportion of each component can vary from one soil to another.

An "ideal" agricultural soil contains: 50% solid space & 50% pore space

- 45% mineral material
- 25% water
- 5% organic material
- 25% air

Why should we know our soil?

1) Soils perform important functions in our environment;
2) Soils are variable;
3) Soils can be degraded.

1. Functions of Soil

- Sustain biological activity, diversity, and productivity
- Regulate and partition water and solute flow
- Filter, buffer, degrade, immobilize and detoxify organic & inorganic materials
- Store and cycle nutrients and other elements
- Provide support for socioeconomic structures

2. Variability of Soil

Why are soils different? There are 5 soil forming factors:

- Parent material: is the raw material or 'geologic substratum' for soil formation
- Landscape position or topography influences erosion and deposition, water movement, local climate (e.g., north vs south facing slope)
- Climate affects physical, chemical, and biological reactions in soils.
- Organisms affect soil through their activity, and in the decomposition of their wastes and residues.
- Time changes parent material into soil.

The interaction of these 5 factors result in the soil forming processes:

- Additions include organic matter accumulation and other surficial inputs.
- Losses occur through leaching of soluble constituents downward through (and out of) the soil profile by water, and removal of soil material by erosion.
- Translocation involves redistribution of constituents within the soil profile without removal of material by erosion.
- Transformations are physical and chemical changes (e.g., in minerals or organic compounds)

Potential problems with urban soils include:

- Mixing of soil horizons or removal of topsoil
- Cutting & filling or grading of areas to level land (for buildings, ballfields)
- Adding plant growth media to the soil surface
- Environment of soils

Soils in NYC form over time, through a series of processes, from mineral and organic parent materials. In general, soils can be formed directly from the underlying bedrock, or from some type of deposit above the bedrock, such as glacial till or alluvial deposits. Soil formation from mineral and organic parent materials is a complex process that involves physical, chemical, and biological changes over time.

Parent materials for soil in New York City include:

- Deep glacial till: especially on Staten Island;
- "Shallow" glacial till over bedrock: especially in Manhattan and the Bronx;
- Glacial outwash;
- Alluvial or recent stream deposits;
- Tidal marsh deposits;
- Deep glacial till special on Staten Island;
- Parent materials for soil in New York City include:
- Organic materials (very wet areas);
- Sedimentary materials (not shown on map);
- Quaternary sediments, especially along the shore;
- Upland parent materials: soils in upland areas can contain high levels of organic matter. The proportion of each component can vary from one soil to another.

Potential problems with urban soils include:

- Greater variability in horizons and geographic distribution
- Little/no organic matter addition
- Presence of artifacts
- Modified soil temperatures
- High probability of compaction & contamination

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More soils information is available under the Teachers and Students link at http://soils.usda.gov/
Soil Consistence is the ease with which a lump of soil can be crushed by the fingers. It can also describe the difficulty of excavating the soil. Soil consistence, and its description, depends on soil moisture content. Terms commonly used to describe consistence in a moist soil are:

**Loose** – noncoherent when dry or moist; does not hold together in a mass.

**Friable** – when moist, crushed easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

**Firm** – crushed under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

**Very Firm** – needs considerable pressure to crush between thumb and forefinger.

Roots

Root content reflects both plant and soil conditions. It can indicate zones in the soil that are physically restrictive to rooting.

Describe quantity:

- **Few** < 2% of total volume
- **Common** 2-20% of total volume
- **Many** > 20% of total volume

and size:

- **Fine** < 2mm
- **Medium** 2 to 5mm
- **Coarse** > 5mm

Soil pH

The most important effect of pH in the soil is on ion solubility, which in turn affects microbial and plant growth. A pH range of 6.0 to 6.8 is ideal for most crops because it coincides with optimum solubility of the most important plant nutrients. Most of the micronutrients for plant growth, and most heavy metals are more soluble at lower pH. Management of pH is important in controlling movement of heavy metals (and potential groundwater contamination) in soil. In humid areas such as the eastern US, soils become naturally acidic over time as rainwater replaces basic cations (Ca, K, Mg, Na) with hydrogen. Some types of vegetation, particularly conifers, produce organic acids, which can also contribute to lower soil pH values. Addition of certain fertilizers to soil can also produce hydrogen ions. Liming the soil adds calcium, which replaces exchangeable and solution H⁺ and raises soil pH.

In general, soils in urban areas have been found to have higher pH values than undisturbed natural soils. These may be due to additions of basic cations from road salts, concrete, plaster and other “anthropogenic” materials.

Horizon Boundary

How thick is the boundary?

- **Abrupt** < 1"
- **Gradual** 2½ -5"

What is its shape?

- **Smooth**: nearly straight
- **Irregular**: pockets where depth > width

- **Clear**: 1 to 2½"
- **Diffuse**: > 5"
- **Wavy**: pockets where width > depth
- **Broken**: discontinuous

Soil formation is all about processes. In time, processes create a soil from a pile of unconsolidated rubble. With more time, the soil will look less like the parent material it came from.

How are soils different?

Soil forming processes influence the soil physical & chemical properties:

- horizonation
- soil color
- soil texture
- soil structure
- soil consistence
- pH and nutrient supply

3. Degradation of Soil

It can take up to 500 years to form an inch of soil – is this a renewable resource?

Soil can be degraded rather quickly by:

- Erosion
- Contamination
- Compaction

These abuses of soil can affect its ability to perform one or more functions. This ability or capacity is often called soil quality. Soil quality is affected by soil use. For more information on soil quality (assessment of soil quality) visit the NRCS Soil Quality Institute website: http://soils.usda.gov/sqi
Soil Horizonation

A soil profile is a sequence of horizons. Soil horizons form naturally as a result of soil forming processes. Horizon nomenclature reflects the dominant process(es). Horizons may also be the result of natural or anthropogenic deposition.

In describing horizonation, you can use these terms if you wish.

Separate out horizons when there is any difference in the appearance (color, texture, coarse fragments, structure, roots, or feel) of a soil layer.

### Description of Master Horizons

- **O horizons** are dominantly organic soil material. Organic matter is composed of original and decomposed plant, animal, and microbial components. It is very important in soils as it helps aggregate and loosen soil, provides nutrients, and holds water and nutrients. Organic matter is composed of primary and secondary units of organic materials. Minerals and decayed wood are important in creating secondary units of organic materials. Organic materials and decayed wood are important in creating secondary units of organic materials.

**Types of Soil Structure**

- **Granular** – roughly spherical, like grape nuts. Usually 1-10 mm in diameter. Most common in A horizons, where plant roots, microorganisms, and sticky products of organic matter decomposition bind soil grains into granular aggregates. These aggregates are easily broken into fragments by hand. They form by repeated wetting and drying cycles.

- **Platy** – flat peds that lie horizontally in the soil. Platy structure can be found in A, B, and C horizons. It commonly occurs in an A horizon as the result of compaction.

- **Blocky** – roughly cube-shaped, with more or less flat surfaces. If edges and corners remain sharp, we call it **angular blocky**. If they are rounded, we call it **subangular blocky**. Sizes commonly range from 5-50 mm across. Blocky structures are typical of B horizons, especially those with a high clay content. They form by repeated expansion and contraction of clay minerals.

- **Prismatic** – larger, vertically elongated blocks, often with five sides. Sizes are commonly 10-100 mm across. Prismatic structures commonly occur in fragipans.

- **Massive** – compact, coherent soil not separated into peds. Massive structures are common in B horizons. They form by repeated wetting and drying cycles, which break down the organic matter and clay minerals in the soil.

- **Single grain** – in some very sandy soils, every grain is a separate particle. Permeability is rapid, but fertility and water holding capacity are low.

**Soil Horizonation**

- **A horizons** are layers that formed below an O horizon. They are usually the thickest horizons and are dominated by organic matter. They are darker in color than the underlying E horizon and are nutrient-rich. A horizons are found in all soils.

- **E horizons** are layers in which the main feature is loss of some component (silicate clay, iron, aluminum, or some combination of these), leaving a concentration of sand and silt. E horizons are layered, with the mineral fraction left as a residue below the horizon. They are often found in areas with heavy clay soils.

- **B horizons** are layers that formed below an A or E horizon. They often show one or more of the following: (1) lighter, brighter, or redder colors than above; (2) more clay than above; (3) lighter, brighter, or redder colors than above.

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C horizons are layers which are not bedrock and are little affected by soil forming processes and lack properties of O, A, E or B horizons.  
Definition: parent material  
Process: no evidence of soil forming processes (can have weathering)  
ID: unconsolidated material below B; no structure

R horizons are layers of hard bedrock.  
Definition: bedrock  
Process: no soil forming processes, little evidence of weathering  
ID: hard, consolidated bedrock  
Comment: Not found in all soils

Soil Color
Important coloring agents in soil include:
1) Organic matter darkens the soil, depending on the content, and the extent of decomposition;
2) Iron gives soil a brown, yellow, red, color, even shades of blue or green depending upon its amount, oxidation state, and hydration state. When soil is saturated, iron can become soluble and can be removed, leaving the soil with “mottled” brown and gray colors, or complete gray depending on the extent of the wetness.

Other factors affecting soil color include:
- Parent material
- Soil wetness
- Extent of leaching

Why is soil color important?
- Indicative of source, or parent material
- Color differences in a profile can reflect soil forming processes
- Can be an indicator of soil wetness

Describing soil color
Soil Scientists use a color chart, where color for each horizon is matched to a color chip, but a simple description will work as well. Some horizons may have more than one color present, in streaks, spots, or mottles, which may be indicative of wet conditions. These are called “redoximorphic features.” For these horizons, describe the main color, as well as the color of any streaks or spots. Also describe the abundance, size, and contrast of the streaks or spots as follows:

<table>
<thead>
<tr>
<th>Abundance</th>
<th>Size</th>
<th>Contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Few: &lt;2% of total area</td>
<td>Fine: &lt;5mm</td>
<td>Faint: Indistinct</td>
</tr>
<tr>
<td>Common: 2 to 20%</td>
<td>Medium: 5 to 15mm</td>
<td>Distinct: Easily seen</td>
</tr>
<tr>
<td>Many: &gt;20%</td>
<td>Coarse: &gt;15mm</td>
<td>Prominent: Striking</td>
</tr>
</tbody>
</table>
Soil Texture

Soil texture refers to the relative amounts of the three particle size separates in mineral soil material. Derived from weathered rocks, these are:

- **sand** - 2 to 0.05 millimeters - gritty feel - can be seen with eye
- **silt** - 0.05 to .002 millimeters - smooth feel - can be seen with microscope
- **clay** - less than .002 millimeters - sticky feel - can be seen with electron microscope

* sand and silt (mostly quartz) are relatively inert; they form the 'soil skeleton'
* clay particles (layer silicates & oxides) are the active portion of the mineral soil - they have an electrical charge and a high surface area resulting in a high attraction for water, nutrients, other clay particles
* varying proportions of each size give the soil a texture

Soil scientists use 12 textural classes (see triangle), which can be estimated with the fingers (see flowchart).

Why is soil texture important?

It affects:
- water movement and storage
- aeration
- nutrient and contaminant adsorptive capacity
- excavation difficulty or ease of tillage

Materials greater than 2mm are considered coarse fragments. Common coarse fragments in the NYC area include:

- gneiss, schist, granite (from Manhattan & Bronx)
- red sandstone and shale, with associated igneous rocks such as diabase (coarse-grained) and basalt (fine-grained) (from Staten Island & NJ)
- serpentinite (green meta-igneous rock from Staten Island)
- quartz or chert (coastal plain deposits in Staten Island, Brooklyn, Queens)
- human-made "artifacts" are also common in urban areas: glass, brick, wood, concrete, asphalt, etc.

Coarse fragments can also be subdivided by size.
- gravel - 2 to 75mm (2 to 3 inches)
- cobbles - 75 to 250mm (3 to 10 inches)
- stones - 250 to 600mm (10 to 24 inches)
- boulders - >600mm (>24 inches)

In describing soil texture, estimate the percent by volume of coarse fragments in the soil. Describe the amount, size, and type of coarse fragments, especially whether they are natural or artifacts. In addition to influencing the physical properties of a soil, coarse fragments can provide information on parent material or origin of soil material.