Long Island
Pocket Guide to

Landscape Soil Health

Cornell Cooperative Extension Suffolk County
ccesuffolk.org

FOREWORD & ACKNOWLEDGEMENTS

The purpose of this guide is to inform home gardeners and professional horticulturalists of the importance of Long Island soils for proper plant growth in managed landscapes. This booklet was made possible by a grant from the New York State Department of Environmental Conservation Water Quality Improvement Project in conjunction with Suffolk County Soil and Water Conservation District, Peconic Estuary Program, and Cornell Cooperative Extension of Suffolk County.

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SOILS OF LONG ISLAND

Many people think that Long Island is one big sand bar and the only kinds of soil we have are sandy. There are actually many types of sand, and, in truth, Long Island has many different kinds of soils and these soils are grouped by association. A soil association is a landscape area that has a distinctive proportional pattern of soil. An association normally consists of one or more major soils and at least one minor soil, but is named for the major soils. Soil types are given descriptive regional names such as Riverhead sandy loam or Montauk loamy sand.

> The *Soil Survey of Suffolk County, New York* is a comprehensive resource guide that describes all the soil types and associations of Suffolk County. Initially published in 1975 by the U.S. Department of Agriculture Soil Conservation Service (known now as the USDA Natural Resources Conservation Service) in cooperation with the Cornell Agricultural Experimentation Station, the survey is now accessible online, and an interactive Web Soil Survey website offers extensive information on soils across the United States. Refer to the resources section on page 57 to learn how to access the Suffolk County soil survey and Web Soil Survey online.

There are ten soil associations in Suffolk County. Each type of soil making up a particular association has its own type of vegetation associated with it, so you can actually tell by inspection of surrounding vegetation what soil type might be present. An association does not have to be one continuous tract of land. Because of glacial moraine and outwash plains, you may have the same association broken up into several spots.

The main soil associations of Suffolk County are as follows:
Association 1, which comprises 11% of Suffolk County, is made up of Carver coarse sand (supports pitch pine, scrub oak, and white pine), Plymouth loamy sand (supports white and black oak, pitch pine and scrub oak), and Riverhead sandy loam (supports black, white and red oaks, American beech, and sugar maple).

Association 2, which comprises 26% of Suffolk County, is made up of Haven loam (supports black, white and northern red oak as well as beech and maple), and Riverhead sandy loam (supports black, white and red oaks, American beech, and sugar maple). There are four minor soils in this association as well.

Association 3, which comprises 19% of Suffolk County, is made up of Plymouth loamy sand (supports white and black oak, pitch pine and scrub oak) and Carver coarse sand (supports pitch pine, scrub oak, and white pine). There are five minor soil types in this association.

Association 4, which comprises 21% of Suffolk County, is made up of Riverhead sandy loam (supports black, white and red oaks, American beech, and sugar maple), Plymouth loamy sand (supports white and black oak, pitch pine and scrub oak) and Carver coarse sand (supports pitch pine, scrub oak, and white pine). There are four minor soils in this association.

Association 5 is only 4% of Suffolk County and is duneland-tidal marshes and beaches. This association is confined to the south shore with the exception of one tiny spit on the south side of North Fork dropping down from Orient Point. All of Fire Island is association five which runs all the way out past Amagansett, suddenly blossoms north to encompass Napeague and then dies.

Association 6 is 5% of Suffolk County running through the southern portion of Southampton, Bridgehampton and East Hampton. It is comprised of Bridgehampton silt loam, (supports red, white and black oak, white ash, red maple, and white and red pine), Haven loam (supports black, white and northern red oak as well as beech and maple), and five minor soils.

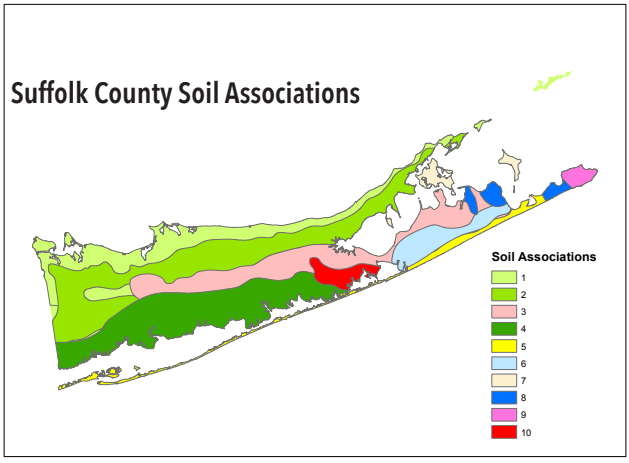
Association 7 is also 5% of Suffolk County, and this association is unique to Shelter Island, Robin's Island, Northhaven and a very small area along the northern edge of Southampton adjacent to Northhaven, Gardiner's island, and the peninsula of North Sea. Association 7 soils include Montauk sandy loam (supports northern red oak, white oak and occasionally yellow poplar, eastern white pine,

red pine, sugar maple, beech and birch), Riverhead sandy loam (supports black, white and red oaks, American beech, and sugar maple), Haven loam (supports black, white and northern red oak as well as beech and maple), and five minor soils.

Association 8 is a mere 3% of Suffolk County. This association is found in the area of west Montauk and in most of the northern part of East Hampton. Association 8 consists of Montauk sandy variant sandy loam (supports northern red oak, white oak and occasionally yellow poplar, eastern white pine, red pine, sugar maple, beech and birch) and Plymouth loamy sand (supports white and black oak, pitch pine and scrub oak). There are six minor soils in this association.

Association 9 is the smallest association in Suffolk County, accounting for only 1% and localized to either side of Montauk Harbor. It consists of Montauk sandy loam and Montauk variant sandy loam (both supporting northern red oak, white oak and occasionally yellow poplar, eastern white pine, red pine, sugar maple, beech and birch) and Bridgehampton silt loam, (supports red, white and black oak, white ash, red maple, and white and red pine). There are three minor soils in this association.

Association 10 represents 5% of Suffolk County and is in two areas that are widely separated–one area in central Suffolk County, and the other on the South Shore. Association 10 is comprised of Plymouth loamy sand (supports white



and black oak, pitch pine and scrub oak) and Carver coarse sand (supports pitch pine, scrub oak, and white pine). There are 5 minor soils in this association.

SOIL CARE & WATER QUALITY BENEFITS

It's important to foster healthy soils and on Long Island it's especially important because of the need to protect our drinking water.

Basic Soil Structure and Function

Soil is a three-dimensional array of pores, particle associations bound together by charges, soil organisms, and organic matter that are further arranged into aggregations. Soils are named for their mineral composites and are configured in percentages of sand, silt and clay. Each of these mineral types vary in particle size. The configuration of these different particle sizes can greatly influence the texture of the soil, drainage, and moisture retention. If we did a rough analysis, we would call an ideal mineral soil one that was 25% air-filled pores, 25% water-filled pores, 45% various combinations of sand, silt and clay, and up to 20% organic matter although usually we end up with only 3-5% on Long Island, which is fine. Soils that have 25% or less clay are good for plant growth.

Soil can change in mineral composition as you dig into the soil profile–from the soil surface to the root zone, to the lower layers that are rarely touched by your shovel. The top ten inches tends to be the richest in soil organic matter and microorganisms and is the part of the soil profile that feeds your plants.

Soil mineral particle sizes are as follows:

Gravel	greater than 2 millimeters (mm)
Very coarse sand	2-1 mm
Coarse sand	1-0.5 mm
Medium sand	0.5-0.25 mm
Fine sand	0.25-0.1 mm

Soil mineral particle sizes, cont.

Very fine sand	0.1-0.05 mm
Silt	0.05-0.002 mm
Clay	less than 0.002 mm

Soil Aggregates

Soil structure depends on aggregates and you can see this for yourself with the naked eye. Aggregate formation is dependent on freezing, thawing, wetting, drying, root growth, and soil organism activity, all of which push the mineral fractions of the soil closer together. When close contact happens, there are additional chemical reactions which cause chemical bonding between clay particles and minerals in the soil. This is called flocculation.

Now that we have aggregates and floccules, something has to stabilize both. That is where such soil "glues" such as fungal threads and byproducts, decomposed organic matter and other chemistry in the soil stabilizes the aggregate structure and in doing so cements the soil pores into place as well so that there are channels for air and water and roots to pass through within and between the aggregates.

Weak soil structure means aggregates are difficult to observe in moist soil and when removed the soil structure will break into just a few observable aggregates. Moderate soil structure means that you can see moderately well-formed aggregates that are distinct in the soil. If you remove a chunk, many nicely formed aggregates are visible. Strongly aggregated soil is very evident even before removal and when a chunk is removed the soil breaks into very obvious aggregates.

Think of the aggregate strength observation in terms of cheese. Aged British cheddar or Applewood cheese, for example, would be a soil with strong aggregates. A cheese with moderate aggregates would be a Grana Padano, and a weakly aggregated cheese would be like Brie. Aggregate strength is not the same as the level of compaction. Soil strength is defined as the resistance to penetration and

compacted soils are defined as having greater resistance to penetration.

Good stability: Small, friable, "sugary" aggregates, no significant clodding, many tiny spaces between and within aggregates, lots of roots.

Moderate stability: Significant quantities of the above type of aggregates, with significant coarse, firm clods–but, significant reduction of soil pores, and moderate numbers of roots.

Poor stability: Coarse, firm to very firm clods, with far fewer small sugary aggregates, no soil pores visually apparent, few roots.

Poor aggregation: a very dense, hard soil which would show fragile, twisted roots at only a depth of 1.5-2 inches, clod-like soil structure with few vertical pores, and roots in a dense "mat" only an inch or two deep, as though grown on a glass plate.

Good aggregate structure or stability means soil that is good for root growth and penetration, good drainage and a soil that will not collapse under weight stress or water stress which could lead to serious engineering issues. Good aggregate structure also generally means that fertilizer or pesticide applications will not be lost to leaching or runoff and that organic matter and soil organisms will be in place and ready to capture and or breakdown extra nutrient or pesticide residues.

TIP: *Aggregate formation is dependent on freezing, thawing, wetting drying, root growth and soil organism activity to push particles together; these must be stabilized in some way. Under ideal conditions, aggregates are cemented in place by fungal byproducts, and decomposed organic matter which acts as "support pantyhose" to keep structure stabilized.*

CHEMICAL SOIL TESTING

Chemical tests provide answers to questions concerning pH, soluble salts, nutrient levels, and levels of other elements and compounds present in the soil. Soil tests for lawn and garden beds are recommended every three years, or whenever you suspect a problem.

What is Included in a typical soil test?

- Soil pH
- Lime requirements
- Soluble salts
- Levels of Phosphorous (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Manganese (Mn), Iron (Fe), and Zinc (Zn)

Why Soil Tests Disagree: When we send tests out to separate labs, we get reports that are completely different. This is influenced by several factors: the kind of test performed, a difference in type of units reported (these can be converted), the type of plant indicated as the crop for that location, or in the case of phosphorous, the type of soil tested. Lime recommendations will be different depending on if the lab has figured in buffering capacity, and depending on soil type. pH tests can also differ based on method used. If something seems off, ask questions.

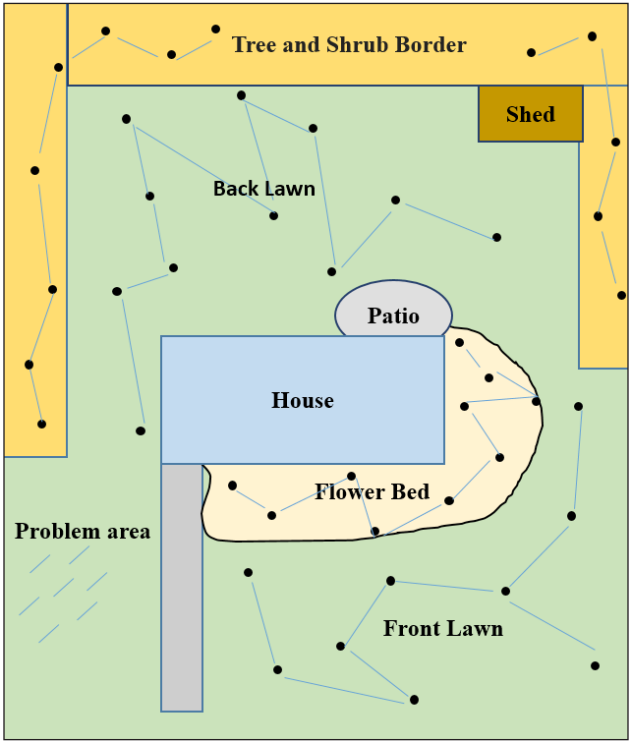
Collecting Soil Samples

When: During the fall or early spring, or when you suspect a problem. It's best to get results as early as possible so if something needs to be adjusted (e.g., pH, nutrient deficiency), there is time for the amendment to take effect. Do not sample when extremely wet or when soil is frozen. For maintenance, test your soil every three years.

How: Using a soil probe or stainless trowel (zinc-coated trowels may affect results if micronutrients are measured) collect soil at a 2-3 inch depth for turf, 4-6 inch depth for other plantings, and 6 to 8 inches for established trees and shrubs.

Where: Take multiple samples at the same depth removing any rocks, roots, and anything not resembling soil. Collect samples in a plastic bucket (not metal), being sure to keep different soil types and garden areas separate. If you have

a problem area, take samples from the problem area for comparison. Take samples from the different garden sites in the landscape. For example, turf soil samples should not be mixed together with vegetable garden samples since pH and nutrient needs differ. Each area to be sampled should be represented by 10-15 soil core sub-samples. Let soil samples air dry away from the sun for a few days to remove excess moisture. Mix sub-samples together to ensure a composite soil sample for each area, and collect two cups from the composite and place in a labelled plastic baggy that securely closes (may be a good idea to double bag your samples).



This yard would have 5 soil samples to submit for analysis: front lawn, back lawn, tree/shrub border, flower bed, and problem lawn area.

TIP: *Except for deeply rooted trees and shrubs, sample only from the top few inches for soil testing. Otherwise, your results may not reflect the true nature of the zone where root growth occurs and where you are interested in making changes or tracking nutrient levels. Do not sample when extremely wet or when soil is frozen.*

INTERPRETING YOUR SOIL TEST

Some soil test labs have very user-friendly results with color-coded bars that inform the reader if levels are too high, too low, or optimal. Recommendations may be included (sometimes for an additional fee), or you can contact your local Extension horticultural office for assistance with interpretation and recommendations.

What is pH?

pH is a measure of the soil's acidity. The lower the pH, the more acid the soil. When pH is low, lime is added to increase or "sweeten" the soil. The pH scale is a logarithm, so a pH of 5 is ten times more acid than a pH of 6, 100 times more acid than a pH of 7, and so on. Depending on the plant species, pH can greatly influence what nutrients are available for the plant to take up. pH is like the bank teller that tells your plants if they can make a nutrient withdrawal, since plants cannot access certain nutrients when the pH is too high or too low. Most plants prefer a pH between 6 and 7, with the exception of plants like rhododendrons and blueberries that prefer a pH less than 6. Turf does best with a pH between 6 and 7.

How does pH affect fertility and fertilizer availability?

- If pH is 4.5, about 75% of applied fertilizer may be unavailable to plants
- If pH is 5, about 54% of applied fertilizer may be unavailable to plants
- If pH is 5.5, about 33% of applied fertilizer may be unavailable to plants
- If pH is 6.0, about 20% of applied fertilizer may be unavailable to plants
- If pH is 7.0, most of the fertilizer is available for plant uptake.

Lime Recommendations: Always base lime applications on soil tests. Lime incorporated pre-plant should be done to a depth of at least 6 inches. Lime applications should never exceed 50 lbs./1000 sq. ft. in a single application–this applies to established plantings as well. Often you will have

to split a greater amount recommended into 2 or even 3 applications, by season. Different soil textures will have different lime recommendations because of how they react with the lime.

Pre-plant liming rate: lbs. lime/1000 sq.ft. (To raise pH to 6.5)
Incorporated into the top 6 inches of soil

Current pH	SAND	LOAM	CLAY
4.0	126	215	300
4.5	100	165	235
5.0	75	125	175
5.5	50	85	110
6.0	25	50	60

How long does it take lime to become chemically active in soil once applied?
3-6 months. Do a pH test about 6 months pre-planting so lime amendments have time to take effect.

What is the difference between calcitic and dolomitic limestone?
Calcitic limestone has less than 5% magnesium. Dolomitic limestone has more than 5% magnesium. Pure magnesium carbonate is known as dolomite.

What kinds of liming materials may I choose from?
- Pulverized: fine, dusty, fairly fast acting
- Granular: slow acting, inexpensive
- Pelletized: fast acting, easy to spread, more expensive

Is there really a difference between lime products?
Yes!!! The following is an excellent way to judge how well your lime works and can save you money:

1. Look on label for the ENV (Effective Neutralizing Value).
2. Divide 100 by this number. The result is the amount of lime needed to provide one unit of 100% effective neutralizing value, which gives you the true measure to get the right amount to reach desired pH.

For example:

Lime #1 has an ENV of 70 and costs $8 for a 50-lb bag. 100 divided by 70 =1.42. So for every pound of lime they recommend you put down, you actually have to put down 1.42 pounds!

Lime #2 has an ENV of 89.7 and costs $15 for a 50-lb bag. 100 divided by 89.7 =1.11. Even though Lime #1 is cheaper by the pound, it will cost more to treat your property because you ultimately have to buy more!

TIP: *Do not sabotage your liming efforts with acidic fertilizers.*

What should I do if I have a high pH?
Sulfur (S) will be recommended if pH exceeds 7.5. Depending on plant sensitivity, never apply more than 1-5 lbs. Sulfur/1000sq.ft per application. If applying sulfur to turf, only apply in the spring and fall.

You can also use iron sulfate at 8lbs./1000 sq. ft. to acidify a high pH soil. Sample soil frequently at 1-2 inches and at 2-6 inches to make sure you are not acidifying just a shallow surface zone since most of us are working with soils that tend to be acid. If you have a lot of free carbonates in soil, it is practically impossible to use sulfur to decrease pH. Long Island soils tend not to be high in carbonates, but here's a fun test to try: take a soil sample, let it dry a bit, and then add vinegar. If you get foaming, carbonates are present and it will be difficult to reduce soil pH using sulfur.

To reduce soil pH add the following pounds of elemental sulfur/1000 sq.ft.

Existing pH	Desired pH	Sandy Loam	Loamy	Clay
8	7	4 lbs.	8 lbs.	11 lbs.
8	6.5	4	11	15
7.5	7	1	3	4
7.5	6.5	3	6	9
7	6.5	1	3	4

I just got my soil test back and it tells me what macro and micronutrients I have, but how do I compare my values to what is normal?

Soil nutrient levels are reported in parts per million (ppm)– older soil analysis reports you may have on file reported nutrient levels in pounds per acre. To convert pounds per acre to ppm, divide the lbs./acre amount by 2; this conversion is only valid for soil core samples collected at the 6- to 8-inch depth.

The following soil nutrient ranges and levels are for ornamental plants and lawns. Consult your Extension Office for vegetable guidelines.

MACRONUTRIENTS

Nutrient	Low (ppm)	Optimal (ppm)	High (ppm)
Phosphorus (P)	1.5	2-4	> 4.5
Potassium (K)	75	75-100	> 150
Magnesium (Mg)	< 32.5	33-50	> 50.5
Calcium (Ca)	< 1750	1750-2600	>2600

MICRONUTRIENTS

Nutrient	Optimal Range (ppm)
Managenese (Mn)	30-40
Iron	10-25
Zinc	0-0.5
Aluminum	10-40

TIP: *Nitrogen is constantly changing in soils, so soil tests for nitrogen are of very limited value for predicting nitrogen needs. On many soil tests, no tested values for nitrogen appear.*

What are soluble salts?
Excessive salt build-up in soil is very bad for both plants and soil structure. They can come from road salt, saltwater overwash or from excess fertilizers (many fast release fertilizers are high in salt.) Excess salts can draw water out of roots and both chloride and sodium can be taken up by the plant to create problems in the upper part of the plant. Salts can inhibit soil microbes and change soil physical structure so that it is no longer optimal for root growth or air and water penetration. Also, plants differ widely in their ability to tolerate soluble salts in soil, so if your soil tests suggest you have high soluble salts, choose your plantings based on their salt tolerance or remediate soil prior to planting!

Many soils analysis labs tests for soluble salts. The following results and recommendations may be obtained:

- **Low Levels:** 0-25 mmho/cm, the recommendation is to do nothing.
- **Moderate Levels:** 25-75 mmho/cm, the recommendation is still to do nothing.
- **High Levels:** 75-100 mmho/cm, the recommendation is heavy watering, and use fertilizers with a low salt index (listed on the fertilizer bag, the closer the value to 100, the greater the salts hazard from that product).
- Greater than 100 mmho/cm is **EXCESSIVE**, and heavy watering is suggested, plus use of salt tolerant species.

What about using gypsum when soluble salts are high?
In the case of a saltwater overwash as can occur during hurricanes, leach with 1 inch of water every other day for 20 days. Or, in combination with this leaching regimen only, apply gypsum at a rate of 46-138 lbs./1000 sq.ft. with more positive effect seen on less sandy soils.

Will adding gypsum improve my soil's structure? Try this test!

1. Take two, 4-oz soil samples from the affected site using a soil corer, dry and crush each sample separately until largest particles are sesame seed sized.
2. Mix generous ½ tsp of gypsum into one of the samples of crushed soil and label it as "plus gypsum."

3. Prepare two empty cans (8- or 12-ounce grocery can) with both metal ends removed so you're left with a metal cylinder. Cover one open end of each can with fine screening (e.g., window screen) so water may drain but soil cannot fall through.
4. Place each soil sample in a can; each can should be about 3/4 full. Tap cans on the sides approximately ten times on a hard surface to settle soil.
5. Place cans over separate collection containers and slowly fill to brim with water, but be careful not to disturb the soil. (add the same amount of water to each can).
6. Compare the amount of water collected when cans finish draining. If less than half as much water has passed through the soil that was not mixed with gypsum, the addition of gypsum may help to improve drainage in the location from which the soil was obtained.

PHYSICAL SOIL TESTS

Physical soil tests are those which physically manipulate the soil to determine soil texture, soil compaction potential, the ability of water to drain or infiltrate, the soil aggregate structure stability, etc.

What are the most common physical soil tests?

Particle size analysis evaluates the percentage of sand, silt, and clay of the soil sample. This percentage defines the soil type and texture.

- Percolation test for water infiltration into soil helps determine how well your soil drains.
- Rough compaction test to determine if soil is compacted (an advanced test determines potential for compaction and is called the bulk density test).

Can I determine my soil texture myself or does it have to go out for professional testing?

There are two rough tests you can do to determine soil texture.

The first is the jar test.

1. Fill half a Mason jar with soil, add water until full, and shake for one minute.

2. Let the mixture settle for 30 minutes.
3. After the mixture is allowed to settle for 30 minutes, observe the different layers that have formed.

Gravel and sand, which are heavy, settle in a layer at the bottom. Clay and silt are the next layer, and then the dark layer on top is your organic matter. You can use this rough comparison on different soils or locations on your own property in side by side tests. If it appears you only have one or two layers that have formed, you can further distinguish the soil texture with next test below!

The second test is called the ribbon test.

1. Place 2 teaspoons of the soil in your palm and drip water onto it, kneading until it forms a ball.
2. Does the soil remain in a ball when squeezed? If not, you have mostly sand.
3. If the ball forms, squeeze it between your thumb and forefinger into a ribbon of sorts. The length of the "ribbon" formed is a good indicator of your dominant soil texture.
    - Loam: Weak ribbon of less than 1 inch before breaking.
    - Silty Loam: Ribbon holds together and appears to be "ruffled" or has cracks in it.
    - Clay Loam: Medium ribbon, 1-2 inches before breaking.
    - Clay: Strong ribbon, 2 inches+ before breaking, may explain drainage problems.

What does a professional soil texture analysis do to determine what kind of soil I have?

Your soil will be passed through a series of sieves, and depending on the amount of the fractions that are sieved out with each size of sieve, your soil will be assigned a classification.

Sizes for various particles:

- Gravel: greater than 2 mm
- Very coarse sand: 2-1 mm
- Coarse sand: 1-0.5 mm
- Medium sand: 0.5-0.25 mm
- Fine sand: 0.25-0.1 mm
- Very fine sand: 0.1-0.05 mm

- Silt: 0.05-0.002 mm
- Clay: less than 0.002 mm

Is soil texture an important trait to measure?
Soil texture should be seriously considered since it influences soil moisture potential, nutrient availability and leaching potential, erosion, and more! Here are some traits attributed to some of Long Island's soil types:

Clayey soils have sand-sized granules of soil and make a thin or cloddy crust that cracks apart quickly after rains.

Loamy and silty soils form thicker crusts with smooth surfaces.

Sandy loams and sandier soils leave lots of loose, clean sand grains in any low spots where water runs over the surface.

TIP: *Texture changes for every topsoil source, and for every few inches deeper you go into the soil.*

What is the infiltration rate?
The infiltration rate is the ability of a root zone soil mix to conduct water under saturated conditions. Infiltration rate is reported in inches/hour, and may also be called: saturated hydraulic conductivity, Ksat, or percolation (perc) rate.

What does a percolation test measure?
Healthy soil has a network of pores starting at the soil surface, which allows water to enter unimpeded during a rain or irrigation event. A low rate of infiltration may occur with weakened soil structure and clogged or discontinuous pores from oily deposits and/or compaction of incompatible soil layers such as sod laid over a different soil type with no core aeration following installation.

How is a classic percolation test performed?
1. In an area of your garden, dig a pit one foot deep.
2. Fill the pit with water, and allow the water to drain completely.
3. Refill with water, and allow it to drain again. This may take a bit longer.

4. Measure depth of water, and note the time. After 15 minutes, note the depth of water and calculate the rate of drainage in inches/hour.

Ideal soil drainage can range from 1 to 3 inches per hour. If your drainage is less than 1 inch per hour, you'll need to either improve your drainage or consider plants that are tolerant of wet feet. Drainage greater than 4 inches per hour is considered excessive and will limit plant selection.

TIP: *Earthworms increase the number of pores and soil aggregates that enhances water infiltration.*

How do I increase soil infiltration?

- Decrease compaction and crust formation by maintaining turf cover or using an organic mulch.
- Increase organic matter by incorporating quality compost.
- Don't over rake or leaf blow. These practices are a kind of tillage that damages soil structure, and they increase surface rooting by compacting soil surface through organic material removal and soil packing.

When should I have an advanced physical soil tests done?

Advanced physical tests of soil should be done on new construction sites, during existing construction projects to ensure quality control of new soil loads, and to check for contamination of old soil loads. For soil that is already on site, take undisturbed samples from problem areas and evaluate physical condition. The most advanced soil tests are the aggregate stability and bulk density tests.

TIP: *Cover soil loads to prevent contamination from material blown in or arriving in runoff.*

The bulk density test for compaction potential: Why is it important?

The bulk density of the soil can provide indication of the porosity and structure of the soil, which will govern oxygen and water movement in the soil. It is also a measurement of the degree of compaction of the soil or its potential to compact. For example, if the soil has a high bulk density (compaction), grass seed will be restricted in emergence and

root growth, which will affect total plant growth and yield. Drainage may be reduced as well. Ornamental plants will have reduced growth, and potentially reduced vigor as well.

Ideal Bulk Densities for Various Soils (compare these values with your soil test)	
Soil Textures	Ideal Bulk Densities
Sands, loamy sands	< 1.6 grams/cubic centimeter
Sandy loams, loams	< 1.4 g/cc
Sandy loams, loams, clay loams	< 1.4 g/cc
Silt, silt loams	< 1.3 g/cc
Sandy clays, silt clays, partial clay (34-45% clay) loams	< 1.1 g/cc
Clays (greater than 45% clay)	< 1.1 g/cc

TIP: *Tires from various types of equipment will directly affect soil's bulk density causing extreme compaction, especially if soil is wet.*

SOIL MICROBIOLOGY

Soil microbes are an essential living component of our soils. Millions of different species of fungi, bacteria, protozoa, and others live in the soil and perform very important soil processes. Soil microbes are responsible for: nutrient cycling, providing a conduit for nutrients and water to plant roots (mycorrhizae), for occupying niches in soil ecology that either outcompete or deter pest organisms through predation or pathology, and for maintaining soil structure by providing a framework that holds soil aggregates together and maintains soil pore structure. Most microbes are found in the upper few inches of the soil profile and are also critical to the decay process (e.g., breakdown of thatch). Most beneficial soil microbes are "aerobic", meaning they need oxygen to survive and to carry out crucial soil ecology tasks. When we over water, we can fill up the pores in soil that are normally full of

air and cause a shift to "anaerobic" microbes which are often harmful. The other thing that can cause microbe levels in soil to drop dramatically is to have a pH that is too acid or too alkaline. When soil chemistry is off, soil microbe populations and activities are off as well.

What kinds of microbes are in the soil environment?
In addition to tiny arthropods living in soil pores there are bacteria, actinomycetes, fungi, algae, protozoa, and nematodes living in and among soil pores, particles and organic matter. Organic matter is extremely important to these soil-dwelling powerhouses, providing food, shelter, and storage for nutrients as well as buffering to keep soil pH in the right range. Without the enrichment of organic matter, soil microbes may starve or become dormant. Organic matter is also important for holding on to soil moisture, without which microbes cannot function.

Can I favor one type of microbe over another if I am trying to grow particular plants?
Acid soils favor fungi, while neutral or slightly alkaline soils favor bacteria.

I am concerned about heavy metals; can soil microbes help?
Yes, they can! During respiration, soil microbes secrete metabolic products like sulfide, carbonate and phosphate which bind to and precipitate toxic metal ions. Internally, soil microbes are able to immobilize toxic metal ions by accumulation or sequestration right within their own cellular framework.

I am concerned about pesticide levels in soils; can soil microbes help?
Another important function of soil microbes is the breakdown of pesticides in the soil environment. We know that when we apply a pesticide to soil that often there is a consequent adaptation of microbes so that the next applications will be more rapidly broken down. These microbes are able to use the pesticide as a source of energy or nutrients and thus are able to reduce the presence of certain chemicals in the soil environment.

How can soil microbes get moved around to where they need to be?
Earthworms and soil arthropods such as ants or even certain deep rooted weeds are important for soil microbe transport. As the organisms or roots burrow into the earth, soil and soil microbes get naturally redistributed and portals for oxygen are formed which helps to fuel the microbial life cycle, nutrient cycling, and natural decay. If lawn thatch is a concern, core aeration, for example, helps to move microbes into physical contact with the thatch layer while at the same time introducing more oxygen into the system which favors aerobic microbes and their decay activities.

SOIL AMENDMENTS

Soil amendments improve soil structure, increase organic matter, and even improve the overall appearance of the garden. This section will review some of the soil amendments that are commonly used in lawns and gardens.

Soil Organic Matter

Why is organic matter so important?
Organic matter is the best structural improvement for soil. During your soil test, it can be determined how much organic matter is in your soil. Organic matter is constantly being used up so you will need to replenish your levels periodically. A great way to do this is to leave lawn clippings on the lawn and to mulch your leaves into the lawn. You can also amend soil using compost. Organic matter increases water holding capacity of soil and holds up to 4-6 times its own weight in water. Soil with 5% organic matter holds nearly two gallons of plant available water in every cubic foot of soil by virtue of a negative charge on particles that sticks to and holds onto the positive charge on water molecules. Since many nutrients are also dissolved in water, this means nutrient holding capacity increases as well. Typical soils also have a great deal of nitrogen stored in soil organic matter and give up 1-3% of that each year. So, the simple act of returning clippings or amending your garden beds can provide, for

free, one third of the recommended nitrogen for a lawn annually–and garden beds need even less nitrogen than lawns!

TIP: *Completely broken down organic matter is humus, which is the stable end product that also has a negative charge which holds onto and exchanges positively charged nutrients like potassium, calcium and magnesium. This acts as glue for soil aggregates, the fibrous support hose that keeps air and water exchange going for better drainage, root penetration, and development. It serves as home and food for microbial populations involved in mineralization, nitrogen fixation, and disease control.*

Is there a quick way that I can get an idea of how much organic matter is in my soil without a professional soil test?
Yes, you can do the jar test. Go to page 17 for instruction on how to perform the test.

How fast does organic matter break down in soil and what factors affect this breakdown?
Organic matter breakdown is a combination of weathering and microbial action, so anything that affects microbes affects the level of breakdown, namely, moisture, temperature, and soil pH. Soils that are neutral to slightly alkaline breakdown organic matter so liming enhances organic matter breakdown by keeping microbes and earthworms happy. According to research, microbe populations double with every ten degrees Fahrenheit increase in temperature–so when your conditions are too hot and too wet, you may have little organic matter, while freezing temperatures slow things down to a crawl. The rate of breakdown also increases with alternate cycles of wetting and drying.

What are ideal levels of organic matter?
As a goal, most soils should be managed to maintain organic matter levels of at least 4-5% dry weight. Increasing organic matter in an acre of soil by just 1% requires the addition of 20 thousand pounds of humus or 40-50 cubic yards of material. For garden soils, over 10% is excessive.

TIP: *When you are thinking about using a manufactured soil, stay away from high organic silt loam or similar soils because*

while they look like straight organic matter, they actually have 20-60% organic matter rather than 85% or greater. This means fine soil particles that clog up soil pores.

How does organic matter affect water infiltration into the soil?

Organic matter makes water infiltration easier by protecting soil aggregates from having their physical structure broken up by the impact of raindrops which fall at a speed of 20 miles per hour. The kinetic energy of a two-inch rainfall is enough to raise a layer of topsoil seven inches thick by three feet. If soil aggregates break up on impact of precipitation, those particles that are broken off clog pores and seal the surface thus decreasing infiltration during precipitation.

How can I increase organic matter in my soil?

The addition of compost is an easy way to increase organic matter. Allowing grass clippings to remain in place and mulching fallen leaves and allowing them to remain in place also puts organic matter back into the soil. Increasing the percentage of soil organic matter is a slow process. Attempting to add a lot of compost or manure at one time, won't help increase your soil organic matter percentage any faster; you may inadvertently negatively affect soil moisture so don't overdo it. Topdress or incorporate about two inches per year.

Thickness of compost in inches	To cover 1000 sq. ft.
1/8	0.4 cu. yds
1/4	0.8 cu yds
3/8	1.2 cu yds
1/2	1.6 cu yds.

TIP: *Organic matter is added to your garden beds every season by the natural decay of old, dying roots from trees, shrubs, and other perennial and annual plants living in your garden. This dieback of organic matter not only provides organic matter, but also pores space and drainage avenues.*

COMPOST

Living material rots when it is dead. This rotting occurs in stages, and the end stage to the breakdown is called humus. Humus will not break down any further. The process of breakdown is called composting, and the breakdown products are called compost and it is brought about by microorganisms in the soil and the environment. When compost is added to the soil, it provides nutrients for plants and microorganisms, and helps to keep soil pH in the neutral range for optimum plant growth and nutrient availability. Compost, by its effects on soil structure and nutrient retention, also reduces leaching. You can either obtain compost from a supplier or make it yourself.

How can you personally judge compost?

- Color: dark brown
- Structure: loose
- Smell (very important): should be pleasant and "earthy"---if smell is strong or unpleasant, it may indicate that the compost has become anaerobic (pH will be very acid in this case and should not be used), or that it is not finished breaking down.

How is compost judged professionally?
If you purchase bulk compost, you can request a compost analysis to ensure quality.

- Color: brown to black
- Odor: earthy or moldy (never vinegary or like a cow burp)
- Moisture: 15-25%
- Water holding capacity: 150-200%
- Bulk Density: 0.2-0.6 g/cc
- Organic matter: 25-80%
- pH: 5.5-7.5
- Ash: 20-65%
- Nitrogen: 0.4-3.5%
- Phosphorous: 0.2-1.5%
- Potassium: 0.4-1.5%
- Carbon:Nitrogen ratio 25-30:1
- CEC: 50-150 meq/100 g

CEC stands for cation exchange capacity. This is simply how well the compost holds on to nutrients.

What is a phytotoxicity test and why should I do one before I buy or spread compost?
Compost may have high salts content or not be finished breaking down or have been in an anaerobic pile. All of these factors can damage plants. An easy way to confirm that your compost is fine for use is to fill four small pots with the compost and 4 small pots with soil taken from an area you know is fine for growing plants then sprout cucumber seeds in each of the cups. If the leaves of the seedlings turn yellow or get a yellow rim in the compost pots, but not in the soil pots, you know that something is off with the compost.

How long does compost take to produce?
You can have finished compost within 14 days when your outside temperature (day and night) is at least 60 degrees– as long as you're actively turning it and maintaining moisture. You can compost between 40-60 degrees, but it will take a little longer. The composting process stops when the temperature consistently dips below 40 degrees. This signals the end of your composting season. It is sometimes possible to extend your composting season by covering the unit at night or by moving it into a protected area.

What does the carbon/nitrogen ratio refer to in composting?
The carbon/nitrogen or C/N ratio refers to how much carbon as compared to nitrogen your compost mix should have to provide optimum food for organisms that break down your compost. In general, brown and dry organic matter provides the carbon portion while fresh green materials provide the nitrogen portion, and the ideal ratio is 25 to 30 parts dry, brown carbon-containing materials to one part fresh green nitrogen-containing material, or 25-30:1. Too much carbon and decomposition slows down. Too much nitrogen and you will end up with a stinky pile, often smelling of ammonia.

Why do I have to turn compost?
You don't, but a good supply of oxygen will make the composting process hotter and quicker. Each time you turn the pile, you avoid anaerobic activity by maintaining a healthy population of microbes, and you expose more

rotting particles to the heat concentrated at the center of the pile, speeding the process.

How much moisture should my compost have?
Squeeze a handful of compost and if it does not form a ball, there is not enough moisture. If you can wring liquid out, there is too much.

If the compost is too dry, add water with your garden hose and repeat the squeezing procedure. If compost is too wet, and particularly when the wet compost also smells bad, add dry stuff like shredded leaves or sawdust to suck up the excess liquid.

How big should the stuff I add to my compost pile actually be?
There is no hard and fast rule but like in cooking, shredding or breaking up materials in small pieces increases the speed of composting. You can use a regular lawn mower to shred leaves or other soft plant parts into smaller pieces.

Can I add wood ash?
Wood ash has no nitrogen but may contain, depending on the species of wood, less than 10 percent potash (potassium), 1 percent phosphate and trace amounts of micro-nutrients like iron, manganese, boron, copper and zinc. Remember that wood ash will also add trace amounts of heavy metals such as lead, cadmium, nickel and chromium. By far the largest component of wood ash is calcium carbonate (25%) which is lime. Lime, of course, raises the pH. Adding small amounts is fine, but do not continue adding to the same pile.

Is there anything I should not add to my compost pile?
Do not use treated wood or branches, twigs, or needles of pine, redwood, or cedar (they contain resins which can reduce breakdown time). Do not use more than 10% pine needles for this reason. Do not use any of the parts of black walnut in compost because of the chemical contained in walnuts which retards growth of sensitive plants. The same is true for juniper and cypress. There should be no addition of dairy products, meat or bones or of pet waste or untreated

human waste. Do not compost poisonous or diseased plants. Weeds in flower or with seed should not be composted, and do not compost herbicide treated lawn clippings until after at least three mowings.

How do I keep my compost from smelling?
Many times a strong smell indicates that the pile has become anaerobic so you will need to turn over the pile. Excess amounts of fresh green materials can also cause unpleasant ammonia odors and can be corrected by adding more brown materials.

How can I compost tree leaves?
Mow leaves with a regular lawn mower or a recycling one. Mow leaves directly on lawns with a light coating of leaves and grass blades should be seen popping through shredded leaves. You can leave the leaves directly on the lawn to decompose or rake and add to the compost pile.

How hot does the compost pile have to be to kill weed seeds and disease organisms?
When the temperature approaches 150 degrees F, this will kill many weed seeds and disease organisms.

What is the ideal size of a compost pile?
At least 4 feet in diameter and 3 feet in height and the maximum would be about 5 feet in height and l0 feet in diameter.

Do I need to add amendments to my compost pile?
No, but if you want to add soil, or activator you can without harming the compost.

Is there a size limit to what should be composted?
If your woody debris is more than a quarter inch in diameter, put it through the chipper or shredder first before adding to the compost pile. Split old bamboo stems before composting.

When and how often should I turn my compost?
During warm weather, turn the pile once a month but frequent turning when it is cold is not recommended because all the heat driving the composting escapes! If your pile begins to stink, turn it immediately.

When will my compost start to heat up?
The pile should be hot in the center a few weeks after you create it, with heat generally indicating that the pile is decomposing. If no heat, then the pile may be too dry (add water), it may be packed too tightly, or the pile may even be too small! If the compost pile will not heat up for you, even with sufficient aeration, try adding some grass clippings or blood meal for a quick shot of nitrogen.

What size should the compost be for application to the lawn and how much should I apply?
For surface applications to turf, compost should be able to pass through a 3/8" screen. Apply no more than 1/8-1/4 inch as a top dressing to turf. 1/8" topdressing is 1 cubic yard/1,000 square feet. For garden beds, sift out any large particles and incorporate or topdress with 2 inches annually.

How much compost should I amend by soil texture?
One inch is better for average soils, 2-inch rate for very sandy, clay type, or soils low in organic matter. Adding greater amounts may be challenging to incorporate and may not give you any more benefit.

How much of an increase in my organic matter will the addition of compost provide?
Addition of 10-30% by volume of compost to a soil will increase the organic matter 2-5% by weight. Another way of putting it: to increase organic matter in an acre of topsoil by just 1% requires 40-50 cubic yards of compost (or 460 lbs. /1000 square feet for a 7" profile of topsoil).

What insects survive composting?
Bad guy insects are most likely to survive if you are running a cold compost pile, meaning you are not turning it (and if speed of breakdown is not your goal, you can run a cold pile). If the plants you are composting have had a severe insect attack, and you think the eggs are still on the material, then think twice before composting. Aphids and tent caterpillars may survive composting. If you wish to compost insect infested material do so in the center (hottest) part of the pile.

What diseases survive composting?
Most are killed at 122°F, but most compost piles will have variable temps in different parts of the pile and the level of disease destruction may be uneven. Therefore, if a plant is severely diseased, it may be best to discard it even if sources say it is ok to compost. Verticillium and fusarium are the most common disease organisms to survive all kinds of composting.

Can I re-contaminate my compost?
Yes. Avoid adding anything else once your temperatures have peaked for the appropriate amount of time.

Can I compost newsprint?
You can use newspaper shreds as long as they are no more than 10% of the weight of the compost pile.

Mulch

Mulch is an inorganic or organic material spread over soil around and under plants. When used properly, it reduces moisture loss, moderates soil temperature, and helps reduce weed growth. Mulch helps to keep good soil structure by preventing crusting on the surface and by providing fibrous organic material to keep pores open. Water flow is reduced which minimizes erosion and runoff. Mulches also protect plants by preventing the alternate freezing and thawing which causes plants to heave, and when used around trees and shrubs, prevents mower or trimmer damage to trunks.

How does compost differ from mulch?
Compost generally is a much more broken down organic matter that is incorporated into the soil, rather than added as a layer above the soil.

What should I think about when choosing mulch?
Do not just be lured by visual interest like color. Colored mulches are expensive and unnecessary, and often break down quickly to the point that weeds can grow in them. Consider instead how long your mulch will last, whether it will break down into organic matter that will enrich the soil, will it blow or wash away, and is it going to make a good

home for weeds. The finer the mulch the more quickly it breaks down into something like a soil, the more quickly it serves as a good home for weed growth. The coarser the mulch, the better. An example of coarse mulch is bark or wood chips.

TIP: *If purchasing mulch from a bulk pile, take a stick and prod it in the mulch pile, turning it over a couple of times. Non-uniform mulch with lots of sticks, rocks and leaves probably has not finished decomposing and may be hot or warm to the touch. Dye also is an indicator of possible poor quality mulch.*

Can I use herbicide treated grass clippings as a mulch?
Treated clippings should not be used until two weeks after application and at least three mowings have been done.

Can mulch go bad?
YES! Bad mulch or sour mulch can kill plants. If the mulch smells like vinegar, ammonia, rotten eggs, or anything very strongly, do not use it until you have leached the pile repeatedly with water or do not use it at all. Mulch that has been kept in a very tall pile may often have this problem. The pH of bad mulch will be extremely acidic and can easily kill plants that it comes into contact with. Damage will manifest as leaf yellowing, scorch or defoliation a few hours to a few days after application.

If you have a pile that you fear will sour before you get it spread, keep it on a crowned surface so water will drain away and mix or turn the pile frequently.

The plants most sensitive to sour mulch are bedding plants and low-growing woody shrubs.

What can I do if I accidentally spread sour mulch?
If you have accidentally spread sour mulch, rake it off immediately and drench the area around the plants with water---plants usually recover if you catch them quick enough; mix the sour mulch with a limestone and then reapply the mulch if you are really in a pinch.

How much mulch should I use?
To keep weeds from sprouting you need to eliminate light from reaching the soil surface. This can be done by spreading

finer mulches to two inches thick and for bulky or course mulches to four inches. A good average for any mulch is no more than 3 inches since any more can suffocate roots.

TIP: *A cubic yard of mulch spread 2 inches deep will cover 162 square feet. Got cubic feet? Take your area to be covered in square feet, multiply it by the mulch depth you will be using and divide by 12.*

I never have to water the mulch, right?
Wrong. You may need to water your mulch. If mulch becomes very dry it is very difficult to re-wet, so make sure to water before and after putting your mulch down.

When should I apply mulch?
To keep your plants warm for the winter, mulch when first frosts threaten, or first windy rains start eroding soil in autumn. For weed and water savings, apply mulches in spring after soil has warmed up but weeds have not yet sprouted.

TIP: *When you are working with organic mulches you should always wear a pollen or dust mask to keep from inhaling soil microorganisms that accumulate in very dry mulch. Failure to do so can result in as asthmatic type reaction, or some times in a flu-like illness.*

Can mulch affect the pH of the soil?
Yes, certain mulches affect pH: peat moss, pine needles and oak leaves all acidify the soil as they decay; maple and elm leaves and marble chips make the soil more alkaline. Ground shell mulches raise the pH.

Are there certain mulches that should not be used on young trees?
Straw should not be used on young, thin barked trees due to its attraction for voles to the seeds in the straw and for protective cover.

Does mulching make tree roots come to the surface?
No, it doesn't. Roots at the surface are indicators of extremely poor soil quality or poor planting procedures rather than a "preference" for growth in mulch.

What are the different kinds of mulch and what are the advantages and disadvantages?

- Shredded hardwood or softwood bark is probably the most common mulch and has the good habit of breaking down over time to enrich the soil. However, use large chunks rather than the triple ground finely shredded material because this can pack like soil, become anaerobic, and easily grows surface mushrooms.
- Sawdust sours easily and can cake up and prevent water and air exchange
- Lawn clippings and maples leaves also tend to form an impenetrable mat so shred them first or add needles or coarser leaves like oak to help them stay fluffy.
- Peat moss, a popular choice, is best for plants that prefer acidic soils.
- Pine or cypress bark nuggets decompose more slowly so will not have to be renewed as often. This mulch also allows excellent air and water exchange.
- Straw is usually used as a winter mulch for protection. It does provide good weed suppression for garden paths, especially the vegetable garden.
- Do NOT use hay, since this is likely to contain many, many weed seeds.
- Stones or other inorganic mulches are best used in small amounts in limited areas to highlight or contrast with a particular planting.
- Cardboard and newspapers can be used as mulch and topped with a thin layer of a more attractive and expensive mulch material.
- Buckwheat hulls and cocoa shells are attractive but tend to blow around very easily. Cocoa shells also contain large amounts of potash which is very bad for young maples, lilacs, tomatoes and acid loving plants such as rhododendrons. Cocoa shells become very slimy and slippery when wet.

TIP: *Cocoa shells are bad for dogs because they contain a much higher amount of the chemical that makes dogs sick when they consume chocolate and some dogs will try to eat the mulch.*

How do I reduce vole damage when they tunnel under the mulch and chew at the bark of trees and shrubs?
A good practice is to always keep mulch six inches away from the trunk and to avoid straw mulches to reduce vole damage.

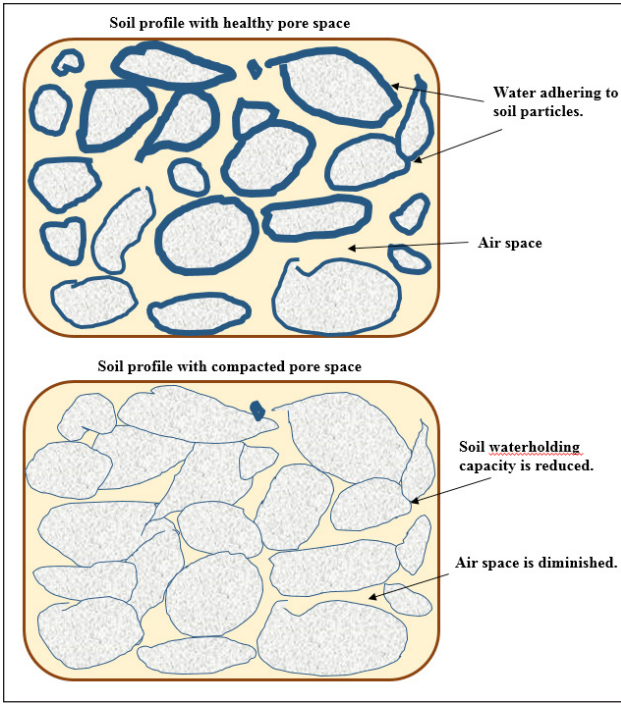
How do I prevent insects from using mulch as a bridge to get into buildings?
Leave a six-inch gap between mulched areas and your foundation.

COMMON SOIL ISSUES

Compaction
Soil is a three dimensional structure composed of organic matter, particles of sand silt and clay, and the space between those particles called pores. Compaction is the reduction of total pore space and/or individual pore space size within the soil profile. There are many causes of compaction, and many inherent soil properties that can make soil easier to compact. Because roots can only move through the pores during growth, or plow them aside by root growth pressure, compacted soil makes it harder for roots to grow on both accounts. Compacted soil also leads to greater issues with runoff because when liquids hit compacted soil they do not penetrate or infiltrate the soil profile, but rather run along the surface like pouring water on a dinner plate.

TIP: *Poorly drained soils are more prone to compaction due to the lubricating effect water has between soil particles*

What are the causes of soil compaction?
- Normal use
- Excessive use (not enough area for number of users), e.g., top pressure from foot traffic on an athletic field.
- Improper soil for intended use of site
- Poor construction techniques which alter or destroy the soil structure
- Poor mixing of soils or amendments or soils brought in that are incompatible with the existing soil.



- Poorly drained sites or outlets for drainage
- Excessive use while soil is wet, such as holding a backyard BBQ after a rain storm.
- Deep compaction during construction (big equipment syndrome)
- Addition of sand to "improve" drainage, or clay to "improve" water holding capacity.

TIP: *Important Compaction Facts: Compaction may extend to 20 inches deep. Deep compaction affects smaller areas than shallow compaction, but persists because shrinking, swelling, freezing, and thawing affect it less. Machinery with axel loads of more than 10 tons may cause compaction below 12 inches.*

What does compacted soil look it?
Look for platy or weak structure, massive clods, greater penetration resistance, higher bulk density, restricted plant rooting, and flattened, turned or stubby plant roots.

What are the effects of compaction on soil pore space?
Discontinuities in air and water inhibit roots from growing

uniformly and may often FAIL to penetrate downward through a layer of contrasting texture even if that layer is less than 1 inch. Thus it is important to core aerate 4-6 weeks after putting down sod. If you suspect compacted soil, have a bulk density test and add compost to improve soil aggregation and drainage.

Where are the worst areas of compaction usually located in the soil profile?
The most serious effects of soil compaction are usually found between the surface and 15 inches deep, or up to 24 inches deep.

Is it really bad to drive over freshly turned soil in terms of compaction?
Loosened soil is especially prone to re-compaction if equipment is driven over it. If possible, freshly plowed soil should not be disturbed for several weeks. Alternate wetting and drying, especially by rainfall, will allow soil to settle gradually and help strengthen its structure.

What is the best solution for compacted soils?
A combination of adding organic matter in the form of compost and aeration is the best mix for compacted soils. For lawns, the best kind of aeration is produced by a machine that has tines that remove ½ inch plugs of soil. Unfortunately, these do not penetrate much more deeply than 4 inches. Rake plugs to the side and use them as a stock pile of soil rather than raking them back into the holes. Next, topdress open holes with 1/8 to 1/4 inch of compost and leave holes open especially during the winter when freezing and thawing will decompact soil even further. As the surrounding soil crumbles into the hole there will be plenty of area for air and water exchange and healthy root growth.

For heavily compacted garden beds with trees and shrubs, tools used to forcefully inject air down into the soil profile are used to break apart soil clods and improve water infiltration. Topdressing with two inches of compost will further aid in correcting compaction. Weathering will aid in slowly incorporating the compost down through the soil profile. There are other methods to improve compaction

in established tree and shrub borders; contact a certified arborist to learn more.

TIP: *For lawns, it is important to NOT drag cores back in spring, this will also drag crabgrass seed and annual bluegrass seed over surface. Turf takes 2 weeks to recover.*

Is your soil compacted?
Try the inexpensive compaction test:

Use a large heavy screw driver with a shaft that is a foot or more long pushed into the ground until you meet resistance. You should do this on a normal day, not after a drought or an especially heavy rainfall. Measure the distance you are able to easily drive the screwdriver shaft into the soil (should be at least six inches---less means compaction).

Drainage
Soil drainage is movement of water from the surface of the soil downward through soil pores. Drainage is affected by restrictions in the soil profile such as compaction or by the layers of soil type which governs the size of the pores through which water travels. The normal height of the water table, the slope and elevation, distance to bedrock, whether the soil is water repellent, and the speed with which precipitation falls all influences how quickly the water infiltrates the soil profile.

How do I evaluate soil drainage?
The worst time for drainage and erosion problems is from November to April. Selection of planting or building site, and water control systems should be based on this "wet season." Do test borings from your site that are from 3-5ft deep during the wet season. Take these borings at the highest elevation at the site, in depressions, and at the bottom of abrupt slope changes. If you see obvious ponded or spongy areas, take borings in these areas as well.

A soil with good internal drainage has a high proportion of sand or gravel, and will NOT have distinct layers but will show a gradual color change from dark to light at a depth of 3 feet. You should see no free water during excavation. Plants in the area will have a deep, uniformly distributed root system.

A soil with poor internal drainage has a profile with abrupt color changes and mottling within 3ft. of the surface indicates a restrictive soil layer, which inhibits downward movement of water. Soil will look densely packed and free water will accumulate in test boring holes of less than 3 feet if bores are taken during wet season. Water will look like it is oozing into holes near the densest looking layers. Soil may have a foul sulfur like smell and be gray or blue.

Drainage Indicator Plants
If the site has any natural areas and the native soil has not been disturbed or removed, these indicator plants may inform you of the drainage patterns.

- Indicator of poor drainage sites: Willow, pin oak, swamp white oak, tupelo, sedges, alders
- Indicators of moist soils: Sycamore and tulip trees
- Indicators of well drained sites: Sugar maple, red oaks, hickories

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TIP: *Soils that are dark, brown or reddish typically have good drainage. Yellow soils may have some drainage issues. Soils that are mottled, gray, or bluish typically have serious drainage issues.*

How do I know if I have a surface or subsurface drainage problem, and how do I fix it?
You can tell whether you need surface drainage or subsurface drainage simply by walking into a puddle. If it is firm underfoot, the problem is surface drainage. If you sink to your ankle, it's a sub-surface issue. You can also do a soil test boring. If water infiltrates from the sides; it's a surface drainage problem. If you have a high water table, subsurface drainage makes sense. More often what happens is formation of a perched water table at a depth where it will impact the turf roots (in the top 10 inches). This is primarily a subsurface compaction issue.

What is a perched water table?
A perched water table forms when water moves through the soil profile, hits a restricting layer (often an incompatible soil type or a layer of compaction) and backs up into the surface layer, or simply is unable to move deeper into the soil, so the

result in both cases are primarily water filled soil pores that roots will literally drown in.

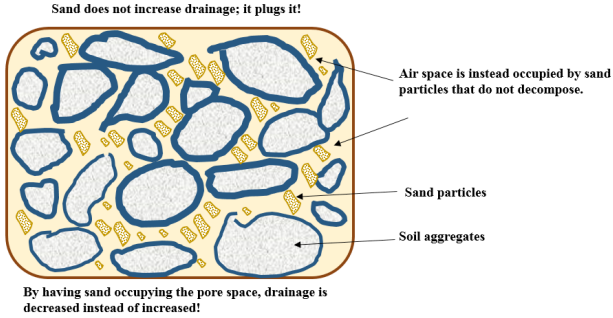
TIP: *If you install dry wells, make sure they are not blind–they should have an outlet somewhere or else they will just back up and you are back to square one. Be aware, however, that dry wells are the worst choice for getting rid of excess water in soils with restricted internal drainage.*

How do I improve subsurface drainage?

There are several different systems that can be installed to improve drainage, but this can be a costly undertaking, especially if landscape plants such as woody plants need to be moved. It's best to contact a landscape professional if you suspect major drainage issues.

How do I improve surface drainage?

Again, if the project is large, consider hiring a professional landscaper. Some options to consider are grading or crowning, but remember to test for compaction to avoid the swamp effect!



TIP: *Subsurface drainage is unnecessary unless you have a persistent rise in the water table that lasts several days after heavy precipitation and/or soil is continuously saturated.*

Soil Incompatibility

Soil incompatibility is when two different soil types are combined or layered, but the resulting effect is negative. Some problems that may occur with soil incompatibility are drainage issues, and poor plant growth and root penetration. This can occur in many ways and the following are some examples:

- **Failure to mix the two or more soil types:** One soil is dug out and the other layered in its place resulting in a perched water table where a sandier soil top layer drains through until it hits the second finer layer and begins to back up, or a finer soil is layered over a sandier soil and the water never drains through at all. Both situations result in a perched water table and in air being driven out of pores so that roots drown. Always scratch up at least a depth of two inches before layering soils so that there is a mixing zone.
- **Failure of mixed soils due to packing of particles:** When a very sandy soil, particularly one with flat, angular sand grains, is mixed with a very fine one, often the fine particles pack around the larger particles resulting in a cement-like consistency of the amended soil. It is usually better to work with the soil that you already have on site and add organic matter to make a better soil.
- **Installation of a prescribed "drainage mix" with top soil layered over:** Often the drainage layer becomes compacted or clogged with fine soil particles from the soil above once again resulting in a perched water table.
- **Failure to core aerate sod after it is installed:** Sod, even washed sod, comes in with a layer of soil which can fail to bond with the soil below. Lack of air in pores and ability of sod to root usually ends up killing or severely damaging the sod. This can all be avoided if sod is core aerated 4 to 6 weeks after installation to puncture holes between the two layers of soil so that water and air can be exchanged and sod can root down into the soil below.

What are manufactured soils?
Manufactured soils are blends of soil, soil components and soil-like material used in horticulture/landscape applications and site restoration. Using manufactured soils allows for "tailoring" of soil properties to specific needs. For example, a potting mix for seedlings may need to be light and well drained to accommodate seedling roots and reduce transport costs. In contrast, a landscape blend may need to be heavier and have a larger mineral component to provide long-term support and nutrition for trees and shrubs.

What is the theory behind manufactured soils?
The theory behind manufactured soil is that the blend of sub-soils, sand, and composts generates a soil that performs equal to or better than native topsoils. Components of manufactured soils range widely. Typical components include: compost, sub-soil, dredge, sand, shredded bark, and other organic materials.

How Are Manufactured Soils Classified?
Manufactured soils can be divided into two categories: topsoil mixes (a.k.a. planting soils) and structural soils. Specifications for the two blends are usually specific to a project and are typically created from non-local soil components that are blended with manufactured or processed inorganic ingredients, (e.g. sand or expanded shale). If possible, they should also be blended with salvaged soil from the site or nearby.

What Are Structural Soils and How Do They Differ from Manufactured Soils?
Structural soils differ from topsoil mixes in that they are designed to provide an engineering function as well as support plant growth. Usually, structural soils blend mineral soil with coarse stone, expanded shale or slate aggregate to make a very porous mix with a high load bearing ability and a rapid infiltration rate which allows the structural soil to be used beneath paved areas but at the same time be suitable for street tree root growth. Structural mixes have less water and nutrient holding capacity.

When are manufactured soils mostly used?
Manufactured soils are generally used where there is no onsite soil or the soil that is present is contaminated or degraded.

TIP: *All bagged topsoils and gardening soils sold in commercial establishments are manufactured soils.*

Best Management Practices (BMPs) for Purchase of Topsoil and Manufactured Soils

- Never buy soil without inspecting it first. In many cases it is easier and less expensive to improve existing soil than to buy topsoil and runs less risk of fouling drainage.
- Always incorporate your purchased soil into the existing soil rather than layering it on top. Otherwise, you are likely to end up with a perched water table where water does not drain correctly through the upper most layer.
- If you must bring in soil, it is important to consider soil texture, organic matter content, pH, and soluble salts. Request to view their latest soil analysis report.
- Be aware there is no official or legal definition for what is commonly referred to as topsoil. A practical definition is the top 6- to 10-inch depth to which soil is plowed or cultivated. This layer differs from those beneath by having higher organic matter content, darker color, better tilth, high biological activity, and possibly less compaction.
- Before introducing new topsoil to a site, loosen subgrade soil by disking or scarifying to a depth of at least 2 inches to prevent incompatibility of the two soil types and to allow a zone of mixing.
- Sand shape is important. Sands that are very spherical may be unstable. Sands that are flat and angular may pack excessively, even though the size distribution is favorable.
- Desirable ranges and textures for sand, silt, and clay in purchased topsoil are: 40-65% sand, 25-60% silt, 5-20% clay, and less than 10% gravel. Examples of soil textural classes that are desirable for landscape use are: sandy loams, silt loams, and loams.

- Organic matter (OM) values for desirable topsoil are: 1.25-3% OM for sandy loam, 2.5-5% OM for silt loam, and 2.5-5% OM for loam.
- Quality topsoil should have less than 0.5 mmhos/cm for a soluble salts test using a 1:2 soil to water ratio.
- Very few labs report this, but the uniformity coefficient (Cu) is very important: the acceptable range is 2-4, optimum range is 2-3. The higher the value, the less uniform the sand or soil mix, the greater the potential for packing, which can mean compaction troubles. Sands with a Cu less than 1 may not pack at all, resulting in unstable surfaces during plant establishment and beyond.
- Always estimate rock volume of a soil prior to purchase. To estimate percent volume of gravel or small rocks:
    1. Use a 1-lb. coffee can, or a 3-lb. can for soils with cobbles or bigger rocks, and fill can to top, packing soil in as you fill.
    2. Next, pour soil out onto a tarp, and clean most of the dirt off the rocks. Anything bigger than 1/8 inches is a rock.
    3. Discard rocks and pour soil back into can, packing as before. Measure down to the top of the packed soil. Volume of rocks is the amount of air space left at the top of the can.

        For example:

        Can is 5.5 inches tall but measurement to top of soil is 2.5 inches after rocks are discarded.

        Rock volume then = 2.5/5.5 or 45%.

        Do you really want to pay for topsoil that is composed of 45% rocks?

TIP: *Fertility can always be fixed. This is not always true of physical properties.*

ASTM Standards for Topsoil

- Not less than 20% fine textured material passing through the #200 sieve and not more than 15% clay.
- 2% by weight of fine textured stable organic material and no greater than 6%.
- Relatively free of stones over 1.5 inches in diameter, and less than 10% gravel by volume (with no noxious weeds)
- Do not use topsoil with greater than 500 ppm soluble salts.
- Distribute to a uniform depth and not over partly frozen, muddy, or frozen slopes or over ice, snow, or standing water puddles.
- Topsoil placed and graded on slopes steeper than 5% shall be promptly fertilized, seeded, mulched, and stabilized by tracking with suitable equipment.

Site Conditions	Intended Use	Minimum Topsoil Depth: inches
Deep sand or loamy sand	Mowed lawn	6
	Tall legumes, unmowed	2
	Tall grass, unmowed	1
Deep sandy loam	Mowed lawn	5
	Tall legumes, unmowed	2
	Tall grass, unmowed	none
	Mowed lawn	4
6" or more: silt loam, loam, silt	Tall legumes, unmowed	1
	Tall grass, unmowed	1

Best Management Practices (BMPs)

BMPs describes feasible and efficient practices that help to reduce or eliminate a problem.

BMPs for Fertilizer Use

In the case of fertilizer, BMP's are employed to protect a vulnerable environmental parameter such as the water

quality around Long Island. Nitrogen fertilizer is particularly harmful and typically reaches the water through the processes of leaching and runoff. Nitrate nitrogen has a negative charge which sticks to the positive charge on molecules of water like a magnet and then travels with water through soil pores and down into ground water in the process of leaching. By the same "magnet" mechanism, nitrate nitrogen sticks to water molecules that move across the surface of the ground and into water that flows across the surface of compacted soil and hardscapes in a process called runoff. Once nitrogen reaches the water, it can cause a massive overgrowth of algae. When the algae dies, the bacteria that decompose the dead algae use up all the oxygen in the water causing a massive die of fish and other organisms living in the waterbody.

What are the main reasons for fertilizer leaching and runoff?

Some major reasons for leaching and runoff include:

- Improper application: not calibrating a spreader for example, or careless application to hardscape.
    - **FIX**: calibrate your spreader at least once each season, use a spreader with a side shield to prevent application to hardscape and sweep up any spilled product.
- Over application of fertilizer–many homeowners apply far more nitrogen than needed each year.
    - **FIX**: apply no more than 3 pounds of actual nitrogen/1000 sq. ft. to lawns each season, use slow release fertilizers that have 30-50% slow release nitrogen. For tree and shrub borders, apply 1 lb. of actual nitrogen/1000 sq. ft with a fertilizer ratio of 3-1-2 or 4-1-2.
- Over watering, which pushes nitrogen beyond the root system and into groundwater.
    - **FIX**: pay attention to irrigation system outputs and to natural precipitation
- Applying fertilizers just prior to heavy rain events.
    - **FIX**: pay attention to forecasts and avoid application just prior to precipitation.

- Applying fertilizers at a time of year when they cannot be taken up (do not apply from November 1 – April 1 because this is the period when we traditionally receive most of our rainfall).
    - **FIX**: It is against the law to apply nitrogen fertilizers to lawns November 1-April 1 in Suffolk County and from November 15-April 1 in Nassau County.
- Low pH–at pH 4.5, plants cannot take up nitrates and low pH is very common on Long Island.
    - **FIX**: Test your soil and correct acid pH by adding appropriate amounts of lime and re-testing prior to fertilization.
- Compacted soils do not have good water infiltration rates.
    - **FIX**: Remediate compaction by core aeration and addition of organic matter to soil in the form of compost.
- Poorly vegetated soil–plants slow water flow and facilitate absorption, thus stopping nitrogen from moving off site
    - **FIX**: Install buffers and borders of mixed herbaceous and woody plants. These are small pieces of land with permanent vegetation that can trap up to 75% of sediment and enhance infiltration in the buffer zone. Buffers, when properly installed and maintained can remove up to 50% or more of pesticides and nutrients and can help to trap heavy metals.
- Excess hardscape such as concrete, pavers, etc.
    - **FIX**: Switch to environmentally friendly choices such as permeable paving or decrease hardscape.

BMPs for Turf and Ornamental Plant Fertilization

How much product do we want for each application to turf?

Most universities in the northeastern half on the country recommend a maximum of one pound of actual nitrogen for each application per thousand square feet of turf.

How much product do we want for each application to ornamental garden beds?

Apply no more than one pound of actual nitrogen per growing season.

Calculate how much fertilizer you need: This works for ornamental fertilizers too!

To get the number of pounds of product to deliver one pound of actual nitrogen per thousand square feet of turf, using the turf fertilizer 30-3-9, divide 100 (constant) by 30 (percent nitrogen content of the fertilizer). Thus you would apply 3.33 pounds of fertilizer product per 1000 square feet of turf to apply one pound of actual nitrogen. That one pound of actual nitrogen would have 50% slow release nitrogen based on the guaranteed analysis below.

Turf Fertilizer 30-3-9

GUARANTEED ANALYSIS

Total Nitrogen (N) 30.00%
1.17% Ammoniacal Nitrogen
28.83% Urea Nitrogen*

Available Phosphate (P2O5) 3.00%

Soluble Potash (K2O) 9.00%

Plant nutrients derived from diammonium phosphate, urea, ferrous oxide, polymer coated sulfur coated urea and potassium chloride.

*15.0% slowly available nitrogen from polymer coated sulfur coated urea.

Example of a fertilizer label with guaranteed analysis.

In the fertilizer label image, 30-3-9 is the nitrogen-phosphorous-potassium ratio (N-P-K) in the product. The number 30 represents percent of nitrogen. Each pound of fertilizer has 30% nitrogen.

How do we know how much is slow release nitrogen? We must look at the guaranteed analysis that is also on the label. It may be on the back of the bag separate from the main nitrogen-phosphorous-potassium ratio.

The guaranteed analysis tells us what percentage of the 30 percent nitrogen is fast release and what percentage is slow release. It also tells us how much of the other fertilizer components are in the bag.

This guaranteed analysis tells us there is 15% slowly available nitrogen from polymer coated urea. If we divide 15% slow release nitrogen by the total nitrogen, 30%, we know that we have 50% slow release nitrogen in this fertilizer.

Water and Irrigation

Why do we recommend 1.5 to 2 inches per week of water on a deep and infrequent basis as the BMP for irrigating all kinds of plants on all kinds of soils?
In a typical landscape, 0.2 inches of water moistens soil to a depth of 1 inch, therefore 2 inches total of water should go down about 10" and get to the area where most of a tree's absorbing roots are located. For turf, 1-1.5 inches penetrates to a depth of 6-9 inches, perfect for lawns and garden beds. The object is to have a consistently moist soil profile to a depth of 10-12 inches and then top that up periodically. More often what we have is a couple of inches of moisture on the top, a dry zone below that, and then water deeper in the soil profile, but, because of death of the roots in the dry zone, there is no way to fetch water from deeper in the soil profile so we are left with shallow roots.

What is the one thing every irrigation system should have?
A rain sensor is the one thing every irrigation system should have so that we do not commit the solecism of irrigation while it is raining!!! In addition, everyone should have a rain gauge which is essentially a plastic tube that collects and measures rainfall and costs less than five dollars in most cases! By knowing rainfall amounts, we can manually set our irrigation systems to deliver less which his better for our plants and environment.

How do I know if I am watering often enough?
Use the footprint test: foot prints will still be visible 30 minutes or longer in turf that needs water, but will disappear in a few minutes on turf that is adequately watered.

Most established trees and shrubs, do not need supplemental water, but if droughty conditions occur, irrigate once to twice during the week to replenish soil moisture. Newly planted ornamentals will need water once a week (less if rainfall occurs) so check soil moisture in the top 6 inches every few days during hot weather.

When should I water?
Between midnight and eight AM to correspond with the natural dew period. Watering during the day will not burn plants but evaporation by sun and wind may leave your plants short changed. Watering in the afternoon and evening before midnight means plants are wet far longer than the natural dew period leading to issues with diseases.

Why do overwatered plants and drought-stricken plants wilt?
A drought-stricken plant wilts because it can no longer pull free water up through its roots and into the plant; there may be a thin film of water still in the soil but it is too tightly bound to the soil components to be accessed by the plant. An overwatered plant has been growing in water filled pores but the lack of oxygen has caused the root system to rot so the root system is no longer functional enough to pull water up through the plant to supply its needs.

How should I water my sod during establishment?
You will need to provide light and frequent irrigation for approximately three weeks until sod has rooted below a depth of 1.5 inches. These waterings should occur several times each day and will be about ¼ inch in depth.

What if there is a heat wave of sustained drying wind during establishment? Can I do anything to help the sod survive?
If temperatures are 95°F or higher, or if there is high wind for more than half of the day, set the sprinkler system to go off multiple times between the hours of 11 and 2 to provide only a light sprinkling in addition to regularly scheduled watering. These light sprinkles are designed to cool off the crown of the grass by evaporation in order to prevent "heatstroke" in the turf, which really means keeping the crown cool so no permanent damage occurs.

What tools do I need to determine my irrigation system output?
You will need 4-6 tuna cans, a ruler and a watch.

1. Arrange cans randomly in the area you think will be covered within the zone you will be operating.
2. Write down the start time then run the system until at least one inch of water is in at least one can.
3. Check and note the amount of time it took to reach that one-inch mark, and then shut down system. This is the amount of time you need to run the zone to get the amount of water recommended for established ornamental plantings.

Ideally, how long should it take for my sprinkler system to deliver an inch of water?
Ideally, your system should take about 2 hours to deliver an inch of water. If it is delivering the water more quickly, then it is likely some of it is running off and the full inch is not soaking in.

How can I tell if I am getting adequate coverage within the zone?
Measure the depth of water in the other cans you arranged in the zone for the test conducted to determine your system output. They should all be about 1 inch. If there is only ¾ of an inch or less in some of the cans, especially on the edges of the zone, then replace or adjust the sprinkler, or relocate it within the zone.

Is it okay to just hand water?
For smaller trees, shrubs, and herbaceous plantings, hand watering is fine as long as you deliver enough water to infiltrate the soil profile (remember to avoid runoff!).

For lawns, hand watering should be avoided because it is difficult to eyeball accurately water being delivered to a large expanse of lawn. Exceptions include sprinkling or syringing simply to cool grass down or giving extra water to areas near buildings or sidewalks where reflected heat is causing a problem.

What is the most efficient type of sprinkler?
One that does not throw water high in the air or ones that generate large drops of water; these kinds of sprinklers are susceptible to wind-carry and watering non-target areas.

How deep should the water penetrate?
For lawns and herbaceous garden beds, saturate the soil to a depth of 6-8 inches. Use a screw driver or pencil to determine how deep the water has penetrated. The barrel should be uniformly moist to a depth of 8 inches.

Why can't I apply shallow, frequent watering to established turf and ornamental beds?
Shallow frequent watering results in a shallow profile of soil moisture limited to the surface with a dry zone below where roots cannot survive. As a result, shallow watering leads to a shallow root system which quickly suffers from higher surface temperatures and damage between watering, especially near curbs and pavement. This is one factor that drives the success of crabgrass and other bedding weeds.

TIP: *Everyone's irrigation system delivers water at a different number of gallons per minute so be sure to audit your system to learn the output of your system.*

If my turf is drought stressed, can I go ahead and mow it anyway?
No, it is better to irrigate it then mow the following day.

Do turf or trees and shrubs require more water?
Turf requires more water, however newly transplanted trees and shrubs require supplemental deep watering to ensure successful establishment during the first year of transplant and during periods of drought.

I have a pressure problem in my irrigation system. Where should I start?
Check your main valve and backflow preventer, making sure both are completely open. If the system is not on, you should not be able to hear water moving through the pipes.

The sound of water moving through indicates a leak somewhere. To pinpoint the leak, start with the main line.

If you have a leak, it will be noticeable because the ground will be soft and wet in this location. Next, check each of your laterals with the valve activated. If you have a leak, you should see it when that zone is on.

TIP: *Dry areas may be the result of a clogged irrigation nozzle or broken head or simply a head that is not rotating correctly.*

What precautions do I need for my controllers?
Provide easy access for maintenance and protection from vandalism. Install outdoor controllers in weather resistant enclosures and make sure they are protected from lightning strikes. Sequence valves at controller and label the controllers.

How would I know if my irrigation system has pressure that is too high?
You may see a reduced radius of coverage, a floating fine mist when the system is operating, and/or dry areas between heads. Faster rotation speeds, and leakage at the head and laterals may occur as well.

How do I fix high pressure problems?
Install pressure reducing valves at the beginning of the system, at zone control valves, and at heads.

How would I know if my irrigation system has pressure that is too low?
You may see reduced radius of coverage and large water droplets that cause compaction when they land. You may see donut shaped dry areas, and slow rotation speed or rotation failure of heads.

How do I fix a low pressure problem?
Use smaller nozzles or fewer heads per zone.

Irrigation system check
- Have your irrigation contractor check the following when they service your system:
- Have the crew clean filter screens and nozzles of heads.
- Optimal spray head pressure is 30 PSI. Have crew test heads and replace those that are not up to snuff.

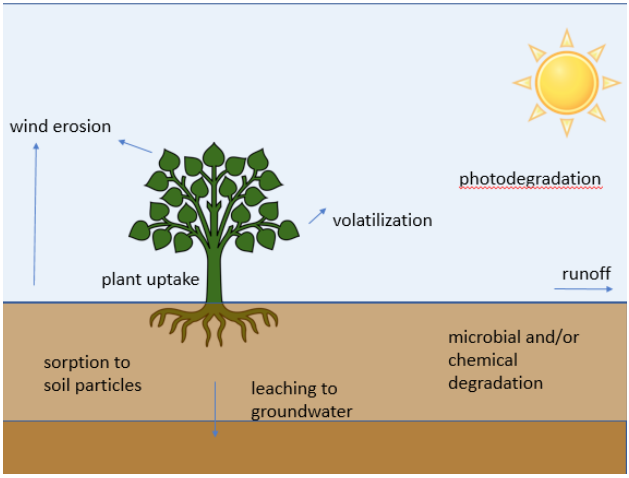
- Have crew check to make sure all nozzles have the same radius within a zone.
- Have crew adjust rotors so they are not watering pavement.
- If any adjustment requires a greater than 20% reduction in radius, change to low angle or low flow nozzles.
- If rotors stall or are not rotating well, then the filter may be clogged. Filters can be cleaned and then the lines should be flushed to make sure the rotors are functioning again.
- If heads refuse to pop up, or the radius is insufficient, then a broken riser or fitting may be to blame.

Pesticide Use

Pesticides are commonly used to manage many garden pests and include insecticides, miticides, fungicides, and herbicides. A major concern of groundwater contamination on Long Island is the leaching and run-off of pesticides into ground and surface waters after application.

The fate of pesticide in the environment once applied includes:

- volatilization into the atmosphere;
- breakdown by light and water;
- uptake by plants;



Simplified pesticide fate processes.

- degraded in soils by natural biological processes;
- adsorbed to soil for future plant uptake or breakdown;
- being carried away from the soil surface by runoff water or;
- being leached through top layers of soil by precipitation or irrigation water leading to potential groundwater contamination.

If soil is already saturated with water when a pesticide application hits it, it is much more likely to leach, or if the soil is unable to absorb any more water, the pesticide can run off. Know your soil's moisture level and do not overwater. Soil contamination through leaching is driven by water moving through soil pores.

If you apply a pesticide just prior to heavy rainfall, your pesticide will be more likely to leach, so pay attention to the forecast.

Heavy rains and over irrigation may erode soil particles with pesticide residues stuck to them from application sites so that they runoff and end up contaminating the surrounding area. Although most pesticides, once adsorbed to soil particles will not leach, the fate of mobile pesticides is a race between any microbial breakdown and leaching into groundwater. So, keep an eye on weather and irrigation!

If your soil is low in organic matter, there will be fewer sites to bind up pesticide residues and fewer places for microbes to live and less food for them. Be sure to maintain soil organic matter levels to at least 2%.

Microbial degradation of pesticides: upper foot of soil has greatest activity, and works best in soil with high organic matter. Organic matter is the single most important soil property affecting pesticide adsorption and breakdown by microbes.

When applying pesticides, make sure the pest is actually there and at levels where treatment is necessary because unnecessary treatments or routine treatments "just in case" can lead to excess pesticide residues in soil.

Be particularly careful when using herbicides because these residues can be very difficult to break down, and products that kill all vegetation can move off site through the soil and

end up damaging off target organisms. Some soil types are more susceptible to movement that others.

Choose the least toxic, most environmentally friendly pesticide product available and follow the label instructions exactly as written to minimize the chances for pesticide contamination. Always use the lowest label rate to target the pest.

Use special care with pesticide application if your soil has a high water table.

Plant buffers and borders to help slow down the movement of water containing pesticide residues and to boost organic matter.

Plant across slopes, not in the direction of the slope, so each row of plantings acts like a ridge to keep pesticides, soil and nutrients from washing downhill.

If practical, delay irrigation for one or more days after a pesticide application except for water needed to activate the pesticide. A delay in irrigation allows more time for adsorption (adsorption is the attraction between a pesticide and a soil particle), plant uptake, and pesticide degradation in the soil. This practice reduces the amount of pesticide available for movement through the soil with irrigation water or additional precipitation.

NEVER dump excess down a storm drain, a regular drain, or in a pond; NEVER dump excess fertilizers or pesticides in a location where the material will run or wash downhill to a body of water.

Know your soil type and its leaching potential (sandy soils with low organic matter have the highest risk).

Calibrate your spreader or sprayer so that you are not over applying pesticide products. Calibration is not difficult.

Dispose of pesticides according to the label and the law. Municipal S.T.O.P. (stop throwing out pesticides) programs for private citizens are often good places to get rid of unwanted pesticide product.

To keep soil safe from contamination, store pesticides correctly and safely: never directly on the floor or ground

or with fertilizers. Storage flooring considered safe: impermeable surface with no cracks and with sealed joints or curbs to prevent leaking. Questionable: Impermeable surface but with cracks or no curbs. Dangerous: permeable surface such as wood or dirt or impermeable with extensive cracking or leak points.

Always mix just enough pesticide for the application you wish to do. Rinse equipment three times and apply rinse water to same location that you treated.

Soil Information Resources & References

Long Island Soil Testing Services: pH and soluble salts only

Horticulture Diagnostic Lab
http://ccesuffolk.org/gardening/horticulture-diagnostic-labs

Regional Soil Testing Labs:

Cornell Nutrient Analysis Laboratory
https://cnal.cals.cornell.edu/

Waypoint Analytical
http://www.waypointanalytical.com/

UConn Soil Nutrient Analysis Laboratory
http://www.soiltest.uconn.edu/sampling.php

Local Resource Offices:

Suffolk County Soil and Water Conservation District
http://www.suffolkcountyny.gov/Departments/SoilWaterConservationDistrict.aspx

Cornell Cooperative Extension of Suffolk County
http://ccesuffolk.org/

Nassau County Soil and Water Conservation District
http://www.nassauswcd.org/

Cornell Cooperative Extension of Nassau County
http://ccenassau.org/

Peconic Estuary Program
https://www.peconicestuary.org/

NYS Department of Environmental Conservation
https://www.dec.ny.gov/

Online Resources

www.soiltest.uconn.edu Interpretation of soil test results.

http://ohioline.osu.edu/factsheet/SAG-16 Understanding soil microbes and nutrient recycling.

http://edis.ifas.ufl.edu/hs 1229 Conversions of parts per million on soil test reports to pounds per acre

https://www.gcsaa.org/docs/default-source/research-and-information/ipm-planning-guide/reference_soil.pdf?sfvrsn=2 Golf Course Superintendents Association of America IPM Planning Guide Soil Reference

www.swcs.org Soil Biology Primer published by the Soil and Water Conservation Society in Cooperation with USDA and NRCS

https://www.princegeorgescountymd.gov/DocumentCenter/Home/View/86 Low-Impact Development Design Strategies: An Integrated Design Approach

https://compostingcouncil.org/test-methods-parameters/ Compost test methods and parameters.

https://soilseries.sc.egov.usda.gov/ Web Site for Official Soil Series Descriptions and Series Classification, USDA

https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm Web Soil Survey, USDA

https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/new_york/suffolkNY1975/suffolk.pdf Suffolk County Soil Survey

https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/new_york/NY059/0/nassau.pdf Nassau County Soil Survey

https://www.health.ny.gov/environmental/outdoors/garden/soil_testing.htm Soil Testing Resources for Gardeners

http://soilhealth.cals.cornell.edu/ Cornell Comprehensive Assessment of Soil Health

https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/edu/ NRCS Soils Education

https://www.astm.org/Standards/D5268.htm ASTM Standard Specification for Topsoil Used for Landscaping Purposes

https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044790.pdf USDA Soil Quality Test Kit Guide

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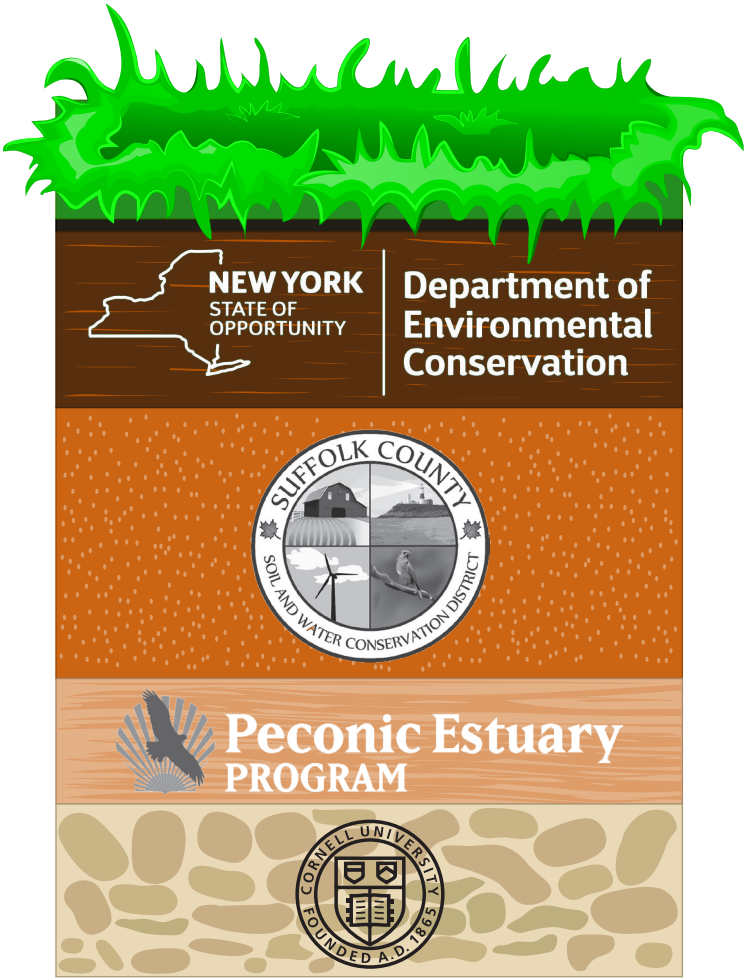

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