

## Bona Terra Tilling Guide

To till (1) or not to till (2); a foundational question for creating a restorative garden (3) habitat, regardless of size. There are many factors to consider and key questions to consider for each unique garden space. This document is meant to help clarify your choices and provide the knowledge necessary to spend your time and money optimally to reach your desired garden outcome.

This guide is intended for homeowners in urban and suburban areas. Tilling in a garden context and not for large-scale agriculture. We encourage the use of vertical soil-building (4) methods whenever possible, and this guide is for those that are unable to change the lay of their land and still want to maximize the restorative properties of their garden by tilling.

Restoring garden spaces through natural accumulation (5) alone can take hundreds to thousands of years. Our environment is currently in peril and we do not have hundreds to thousands of years for it to repair itself. Through modern practices we have eliminated vast swaths of the essential foundational soils for terrestrial eco-communities (6). While no-till practices in agricultural systems are essential for reducing agricultural impact on the environment, utilizing tilling methods in urban and suburban areas can have an immediate restorative impact.

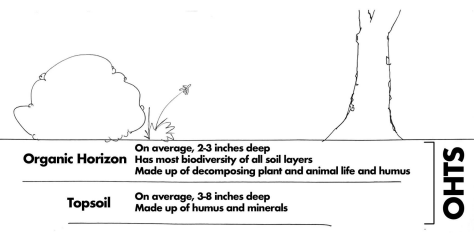
Tilling to prepare a garden can fast-forward restoration so that we can benefit from it in our lifetime.

If keystone plants are what ties our ecosystems together, then the organic horizon and topsoil layers (OHTS) are the foundation on which they sit.

This spongy layer absorbs water, slows runoff, and allows time for rainwater to infiltrate into the ground. As you go deeper into the soil, the weight of the soil above compacts the layers more as you descend.

The sponginess of the OHTS is essential for retaining rainwater long enough for it to have the time needed to absorb into the compacted layers below.

The organic horizon and topsoil contains the highest levels of soil biodiversity with up to 6 billion microorganisms per teaspoon



**Organic Horizon** On average, 2-3 inches deep  
Has most biodiversity of all soil layers  
Made up of decomposing plant and animal life and humus

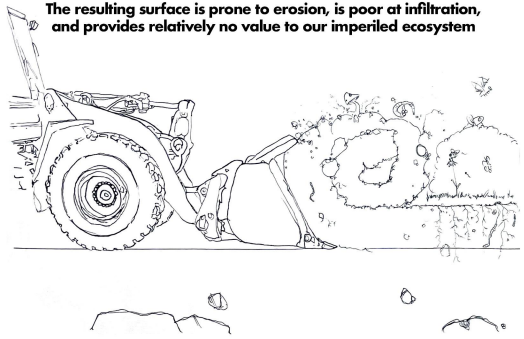
**Topsoil** On average, 3-8 inches deep  
Made up of humus and minerals

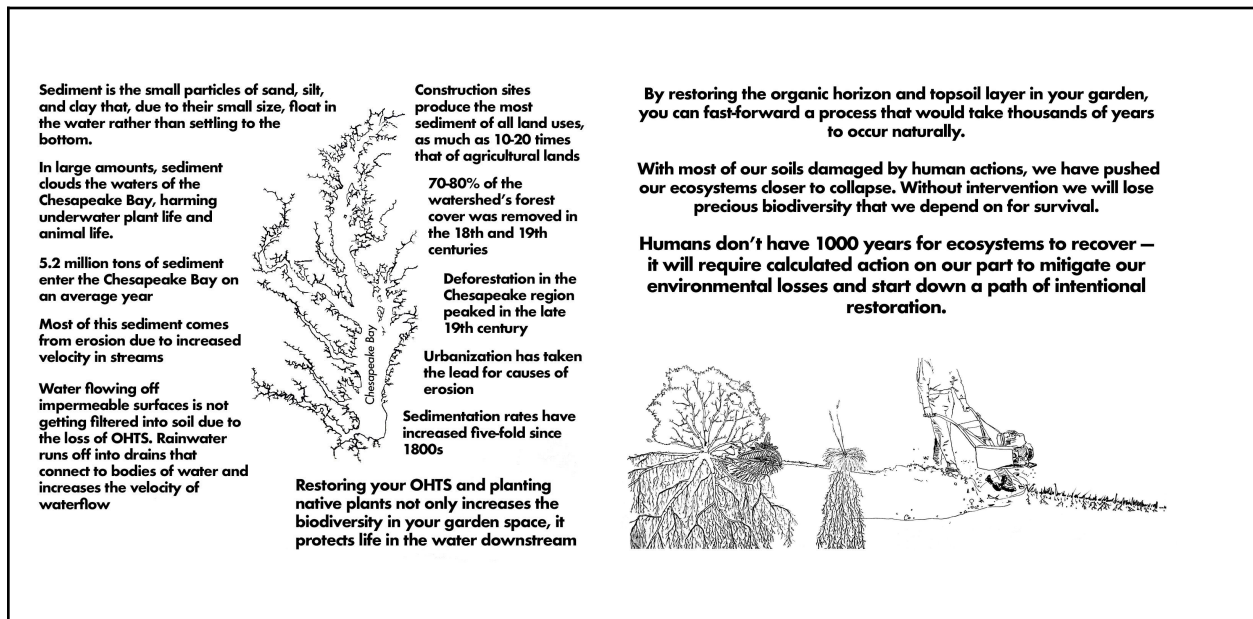
**OHTS**

The OHTS is spongy and unsuitable as foundational material for structures such as buildings, roads, and sidewalks. This layer is removed to create stable building surfaces.

It is typically replaced with sod, a green facade hiding the extreme lack of biodiversity underneath.

The resulting surface is prone to erosion, is poor at infiltration, and provides relatively no value to our imperiled ecosystem





Sediment is the small particles of sand, silt, and clay that, due to their small size, float in the water rather than settling to the bottom.

In large amounts, sediment clouds the waters of the Chesapeake Bay, harming underwater plant life and animal life.

5.2 million tons of sediment enter the Chesapeake Bay on an average year

Most of this sediment comes from erosion due to increased velocity in streams

Water flowing off impermeable surfaces is not getting filtered into soil due to the loss of OHTS. Rainwater runs off into drains that connect to bodies of water and increases the velocity of waterflow

Construction sites produce the most sediment of all land uses, as much as 10-20 times that of agricultural lands

70-80% of the watershed's forest cover was removed in the 18th and 19th centuries

Deforestation in the Chesapeake region peaked in the late 19th century

Urbanization has taken the lead for causes of erosion

Sedimentation rates have increased five-fold since 1800s

Restoring your OHTS and planting native plants not only increases the biodiversity in your garden space, it protects life in the water downstream

By restoring the organic horizon and topsoil layer in your garden, you can fast-forward a process that would take thousands of years to occur naturally.

With most of our soils damaged by human actions, we have pushed our ecosystems closer to collapse. Without intervention we will lose precious biodiversity that we depend on for survival.

Humans don't have 1000 years for ecosystems to recover – it will require calculated action on our part to mitigate our environmental losses and start down a path of intentional restoration.

## Find where and how water flows through your garden

Water flows through gardens as runoff from impermeable surfaces such as driveways, sidewalks, roads, alleys, and roofs. This can cause erosion due to the volume and velocity of the water moving off these surfaces. You will want to identify how this water flows through your garden space in order to slow, mitigate, or divert it. You can use rain barrels, rain gardens, bioswales, and corrugated pipes to slow or divert the water. If you're having trouble identifying the flow of water in your garden, grab an umbrella and go out in your garden in a medium-to-heavy rain event and see where the water flows. Adjust as necessary: you will want to manage the flow of water to prevent erosion until your plants are established, especially on steep slopes. If your slope is particularly steep or you have a high volume of surface runoff, you can benefit from a professional analysis.

## Determining your O horizon and topsoil layer

The primary factor involved when deciding between till or no-till is the amount of organic material that already exists in the soil. The organic horizon and topsoil layer (OHTS) (7) is the accumulation of decomposed material (humus [8]) that has built up over thousands of years, and can take many lifetimes to regenerate through natural means. Due to modern practices, humans have removed the OHTS just about everywhere there is human activity, particularly in areas with new construction, erosion due to agriculture, or lawns. A good OHTS is the most influential aspect of a healthy soil community: if

keystone species (9) are the connection that supports eco-communities , then a healthy OHTS is the foundation on which they rest.

To determine how much of an OHTS you already have in your garden, dig a hole down until you hit a layer of soil with no organic material. The organic material making up the OHTS tends to be dark brown to black and is filled with soil organisms. Inorganic material is made up of sand, clay, and rock, with significantly less life. The depth of an OHTS will vary from a few inches to many feet. A sufficient OHTS will be at least 6 inches, and anything less will require tilling in organic material to restore the area in a few years. Soil building and restoration is the best practice in large-scale agriculture as the plants die off each year, but for the average homeowner or in urban settings, the landscape of drainage pipes, sidewalks and buildings make this vertical soil building of organic material less feasible.

### **Identifying existing plants**

Once you have determined the amount of OHTS in your garden, you will need to find out what type of plants already exist in your garden space. You will have the most success if you take the time to identify these plants and their reproductive mechanisms (10) so that you can take steps towards mitigating the amount of work required to establish your new plantings. There are a number of effective apps (like Seek) to help you identify the existing plants in your garden.

It is important to determine the reproductive method of plants, whether it be by seed (11) or vegetatively (12) in this space because it can be the difference between a thriving garden and one that is rapidly overtaken by weeds. Seed-bearing plants typically can be tilled in and composted on site. Rhizomes (13) and other vegetative plants have an underground network of roots or bulbs (14) that can be tenacious and spread when tilled into the soil. Both can be difficult to remove by tilling or smothering (15) alone, and may need to be solarized (16) or be mechanically removed (17) with their soil. Tilling alone can often spread the plant more thoroughly in the soil, resulting in gardens being quickly overtaken.

### **Remove existing plants**

Once you have determined your existing OHTS and have identified the plants in your garden space, you need to decide your method of removing the existing plant material based on its reproductive method before any organic material is added. Below is a list of possible steps for plant removal and common reasons people use them.

<b>Method</b>	<b>Description</b>	<b>Usage</b>	<b>Seed-bearing Plant Removal</b>	<b>Vegetative Plant Removal</b>
Tilling	Using a rear- or mid-tine tiller or shovel to chop up and integrate organic material 1-16 inches into the soil	If you have a healthy existing OHTS and seed-bearing plants that can be tilled and composted into the soil. Apply newspaper after tilling and raking smooth to block sunlight from the seeds, especially with a shallow till.	Yes	No
Newspaper	A 3-10 sheet-thick layer of newspaper with overlapping edges (similar to shingles on a roof) is left in place for 2-6 months before tilling or planting	Easy to apply, effective for killing sod, turf grass, and placing under trees where cardboard can affect the soil moisture level more than newspaper, but with limited uses beyond that. Can be applied after tilling to block light from any seeds in the soil	Yes	No
Cardboard	A 1-2 sheet-thick layer of cardboard (with plastic tape removed) with seams overlapping (similar to shingles on a roof) is left in place for 6 months to a year before tilling or planting	Useful for killing medium- to difficult-to-remove plants and helpful for weakening aggressive plants (such as wire grass and English ivy) before mechanically removing. Can be mulched over to weigh down the cardboard, create a more presentable look, and later be tilled in together	Yes	Yes, to weaken plants before manual removal
Manual Removal	Pulling out existing plants by hand	If you have experienced and strong help (aka a landscape crew) or you're ready to get dirty. The fastest method, but potentially the most laborious	Yes, to help expedite other processes	Yes
Solarization	Covering the soil with a sheet-plastic (non-woven) for 3 months to 1 year	Useful for removing the most stubborn plants and established vines and woodies (18) (cut to the ground)	Yes	Yes

**Choose your till type**

Once you have decided your method for removing the existing plants, you will need to decide the type of tiller to use and the amount of compost recommended to till into your garden space.

<b>Till Type</b>	<b>Description and Usage</b>	<b>Reference Image</b>
Light-weight tiller	Small, light-weight tiller. Good for removing turf and can be used to remove plant material in small spaces. 1-3" tilling depth; for restoring an OHTS, you will need to manually till deeper with a shovel.	Insert image here
Rear-tine	Middle of the road, easy-to-operate tiller for first-timers. Good for homeowners. Tilling depth 4-10"	Insert image here
Mid-tine	Best design for deep till, but is more physically demanding to operate (requires more skill and strength than the rear-tine). 12-16" tilling depth	Insert image here

**Calculate the amount of compost needed****Basic compost calculation:**

For each inch of tilling depth, add ¼" of compost.

1 yard compost = 27 cubic feet compost recommended per 100 square feet of garden space (a 10'x10' area)

1. First decide your tilling depth (in inches) and divide that number by 4 for the number of inches of compost to add to the surface of the soil before tilling (x)  
**Tilling Depth ÷ 4 = x**
2. Divide the number of inches of compost to add to the surface by 12 to convert it from inches to feet (h)  
**x ÷ 12 = h**
3. Multiply that number by the number of square feet (length x width) in your garden space to calculate the number of cubic feet of compost you will need for your entire space.

**Length x width x h = cubic feet compost needed**

## Garden-prep order of operations

Listed below are the most common methods that we have implemented and found successful in preparing gardens. There are other combinations that can be used, but what we have listed are the basics and the reasons behind using each of them.

***Plant directly:*** If you have a good OHTS with an established garden space, you have the option to plant directly. If you have a less favorable OHTS, your plant options may be limited to those that can grow in poor soil, or that can out-compete the existing vegetation

***Till-Mulch-Plant:*** This is good for getting rid of simple turf grass and seed-bearing plants. If you have a lot of seeds in your soil, it is important to keep your mulch fresh so that the seeds do not have the opportunity to germinate.

***Till-Cardboard-Mulch-Plant:*** This is good for killing seed-bearing plants since the cardboard adds a light-blocking layer to help choke weeds.

***Compost-Cardboard-Mulch-Wait 6 Months-Till-Mulch-Plant:*** Ideal for ensuring the eradication of existing seed-bearing plant material and adding to the OHT.

***Compost-Cardboard-Mulch-Wait 6 Months-Mechanically Remove-Till-Mulch-Plant:*** If after using cardboard there are remaining vegetative plants, this will remove the rest.

***Solarization-Wait 6-12 Months-Compost-Till-Mulch-Plant:*** For the most aggressive and established existing seed-bearing and vegetative plant material.

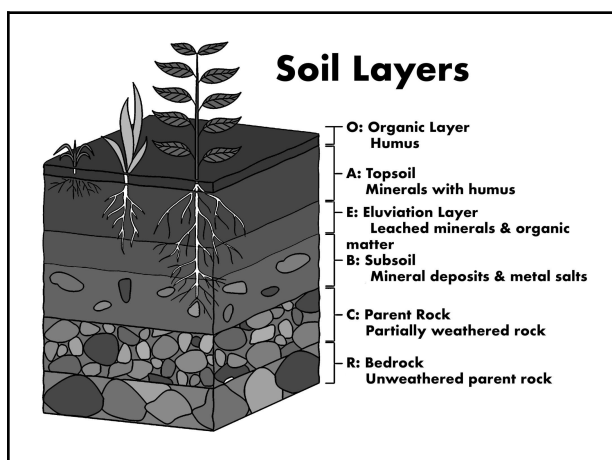
See printable checklist.

## Glossary

- (1) **Tilling:** The process of digging up, integrating organic material, and turning over soil. Tilling aerates the soil and incorporates organic matter to replace a depleted OHTS which aids in water retention, weed control, and increases the vitality of your plantings.
- (2) **No-till:** There are multiple definitions for this term in different contexts, but in the context of this guide we are referring to planting directly into the existing soil

without turning over the soil in the surrounding area with minimal disturbance of soil communities (planting without tilling the surrounding soil).

- (3) **Restoration Gardening:** Gardening practices that give back more resources to the ecosystem than are consumed.
- (4) **Vertical Soil Building:** A process by which you continually add organic material (compost, straw, leaves, sticks, etc.) to the garden space until you create a thick, thriving OHTS.
- (5) **Natural Accumulation:** The process by which organic materials accumulate on the soil surface through natural mechanisms.
- (6) **Eco-Community:** A complex system of micro and macroorganisms in soil that break down decayed plant and animal material to create humus.
- (7) **Organic horizon and topsoil (OHTS):** The O horizon is the top layer of the soil structure, and is mostly made up of organic matter in varying stages of decomposition (humus). This layer is rich with soil communities and nutrients such as carbon, phosphorus, nitrogen, and sulfur. Topsoil is the next lowest level of soil (also called the A horizon), and is made up of humus and minerals. For the purposes of this guide, we have combined the topmost O horizon and the topsoil layer in the acronym OHTS.



- (8) **Humus:** Humus is the organic component of soil. It is a dark, spongy material that retains moisture and nutrients, and is made up of decayed plant and animal material. Humus is the main component of the O horizon and where most life can be found.
- (9) **Keystone species:** Species that play a critical role in maintaining the structure of an ecological community, without which an ecosystem would be changed drastically.
- (10) **Reproductive Mechanisms:** The process by which a plant reproduces, either sexually through pollination or asexually through vegetative propagation, fragmentation, or budding.
- (11) **Seed-bearing Plants:** Plants that reproduce sexually and create seeds.
- (12) **Vegetative Plants/Geophytes:** Plants with underground food storage organs that enable them to go dormant during unfavorable periods. These organs can be divided or cut up and still survive.
- (13) **Rhizome:** A rhizome is a type of geophyte with a horizontal stem that grows just below the soil surface. These stems contain nodes that put out additional stems, some of which grow above ground, creating a colony of the same plant.
- (14) **Bulb:** A bulb is a type of geophyte that consists of a stem surrounded by thick leaves with a border of roots at the bottom. The stem will eventually grow above ground, and the bulb leaves remain underground and store food.
- (15) **Smothering:** Limiting or eliminating sunlight or water flow to the surface of soil in an effort to weaken or eliminate existing plants.
- (16) **Solarization:** A non-chemical method for controlling a wide range of weeds by capturing the radiant heat/light from the sun and preventing water absorption. Soil is covered with a non-woven plastic sheet for 3 months to 1 year.
- (17) **Mechanically (Manual) Removal:** Removing by hand, with garden tools, or shovel.
- (18) **Woodies:** Plants with hardened stems that produce wood as its structural tissue.