Soil quality testing: FAQs

Soil health is fundamental to sustainable agriculture and effective environmental management. Comprehensive soil analyses provides detailed insights into factors that influence land use and productivity. These include physical properties such as texture, structure, and compaction; chemical characteristics like pH, salinity, and nutrient content; and biological indicators, including microbial activity and organic matter levels.

Additionally, soil analysis can detect the presence of contaminants such as heavy metals, pesticide residues, and other pollutants, helping to assess the safety and environmental integrity of a site.

This data empowers you to make informed decisions about fertilizer use, crop selection, and land strategies to boost productivity while reducing environmental impact.

Why is filtration important in soil testing and what types of filtration products are used in soil testing?

Laboratory filtration plays a critical role in soil testing by accurately separating solids and liquids for various analyses. Clarification is one of the most common filtration steps, particularly when dealing with complex soil matrices. Paper filters and glass fiber filters are frequently used to remove particulates and suspended solids from aqueous soil extracts. These filters provide a clear sample by retaining unwanted debris that could interfere with downstream analyses or damage sensitive instrumentation.

Filtration is also important for solids retention when testing nutrients, contaminants, or other chemical components in soil samples. Retaining specific particulate matter allows for targeted testing of soil components, such as organic matter or residual fertilizers.

In some protocols extraction thimbles are used to facilitate the preparation of organics, such as hydrocarbons or pesticides, from soil samples through Soxhlet or other solvent extraction techniques. While not a direct filtration step in the traditional sense, these cellulose or glass fiber thimbles serve a similar purpose by allowing solvents to pass through while retaining soil particles. This prepares the extracted analytes for further filtration and purification before analysis.

Finally, laboratory filtration is often a key part of analytical sample preparation prior to instrumental techniques like high performance liquid chromatography (HPLC) and ion chromatography (IC). These methods require clean, particulate-free samples to process effectively. Filtration protects the instrumentation so detection and quantification of ions, nutrients, heavy metals, or organic compounds are accurate and reproducible. Filtration underpins both the integrity of the sample and the quality of the analytical results in soil testing workflows.

What considerations should be made when selecting a filter paper grade for a soil testing application?

Cellulose filters are used to prepare samples by removing fine soil particles from liquid extracts after chemical treatments such as acid extraction, water extraction, or buffer solutions.

We offer a selection of cellulose filters with varying flow rates, retention levels, loading capacities, and chemical resistance that are available in qualitative, quantitative, and application specific formats.

When selecting a filter paper grade for a soil testing application, one consideration is the particle retention capability of the paper. Soil samples often contain a range of particle sizes, including fine clay and silt, so it's essential to choose a filter paper with an appropriate retention size to retain these particles while allowing liquid to pass through. A finer grade filter paper will offer better retention of small particles but may significantly slow down the filtration process which could be a drawback in high throughput testing environments.

Another key factor is the filtration speed, which is directly related to both the retention size of the filter paper and its thickness. Faster filtration can improve efficiency, particularly when processing multiple soil samples. However, there's often a trade-off between speed and precision. Faster papers generally have larger retention

size, which allow smaller particles to pass through. Therefore, balancing speed and retention is critical, especially for tests requiring clear filtrates for accurate chemical analysis.

Mechanical strength and handling properties should be considered. Soil samples can be heavy or gritty, and the filter paper needs to withstand handling without tearing or collapsing. Wet strength is particularly important, as many papers lose structural integrity when saturated.

When choosing between qualitative and quantitative filter papers for soil testing, it's important to consider the goals of the analysis. Qualitative filter papers are generally used when the objective is to separate solids from liquids for observational or descriptive purposes. In contrast, quantitative filter papers are designed for applications where accurate and reproducible measurements are critical, such as in gravimetric or trace element analysis.

Both qualitative and quantitative filter paper grades contain a high percentage of alpha cellulose. We use these high-quality fibers in all Whatman™ cellulose filter paper.

Where they differ is in ash content: The non-volatile substances in the material. While qualitative papers might contain ash in the range of 0.06%, quantitative papers are acid treated to reduce ash, often to less than 0.01%.

This low ash content is useful for quantitative analysis. After filtration or sample collection, the filter paper can be ignited and burned off, leaving very little (but predictable) residue, simplifying downstream measurements.

Quantitative filter papers come in three major variations: Ashless, hardened low ash, and hardened ashless.

To learn more about our qualitative filter paper grades **visit here.**

To learn more about our different quantitative filter paper grades **visit here.**

Soil analysis labs often process hundreds of soil samples per day, are there ways to improve efficiency of soil testing workflows?

To simplify soil testing workflows, analysts can target the filtration steps of soil sample preparation. Although filtration itself plays a small part in the overall method of soil testing, during peak periods analysts are likely to hand-fold hundreds of circles of filter paper each day. A simple switch to pre-folded filters in place of flat circles or sheets negates the need for manual folding, saving significant time in sample preparation.

We offer cone, pyramid, fluted, and quadrant folded paper formats. In addition to improving overall lab efficiency, reduced paper handling reduces the risk of cross contamination.

Cone folded filter papers

Pyramid folded filter papers

Quadrant folded filter papers

How are filters used in boron analysis?

Filter papers are commonly used in the laboratory analysis of boron in soil as part of the sample preparation process. In the widely used hot water extraction method, soil is mixed with hot distilled water to release plant-available boron into solution. After shaking and heating, the suspension is filtered using filter paper to separate the liquid extract from soil particles. This clear filtrate is then analyzed using methods such as colorimetry, ICP-OES (inductively coupled plasma optical emission spectroscopy), or spectrophotometry to determine boron concentration. The quality of the filter paper is important, and that it does not leach trace elements including boron, which can skew results.

Boron testing is critical due to it being an essential micronutrient for plant growth. However, the optimal range for boron in soil is narrow—too little can lead to deficiency symptoms like poor root and fruit development, while too much can cause toxicity leading to leaf burn and reduced crop yields. Regular soil testing helps growers manage boron levels accurately through precise fertilizer application, preventing deficiency and toxicity.

Low boron filter papers are available for use in trace-level elemental analysis, including soil testing applications. We offer Grade 1, 2, 6, 40 and 42 filter paper circles supplied with a certificate of analysis which states boron levels.

How and why are extraction thimbles used in soil testing applications?

Extraction thimbles are porous, cylindrical filter holders typically made from cellulose or glass fiber and are essential components in Soxhlet extraction setups, such as those used in EPA Method 3540. In soil testing, they securely hold the solid sample within the extraction apparatus and allow solvents to flow through and extract target organic compounds without dislodging particulate matter. Their design provides a clean separation between the solid matrix and the extracted analytes, which is critical for accurate downstream analysis.

In EPA Method 3540, the thimble aids in the repeated washing of the soil sample with heated organic solvent, typically over several hours. This process provides efficient recovery of semi-volatile organic compounds, such as pesticides, PCBs, or PAHs, by maximizing the contact between the solvent and the sample. The thimble also prevents solid particles from entering the solvent reservoir or condenser, which helps maintain system integrity to avoid contamination or blockages.

Made from high-purity alpha cellulose, our thimbles are suitable for use with mild organic solvents. They are an economical choice for standard extractions where moderate temperatures (typically up to 130°C) and low chemical reactivity are involved.

For more demanding soil analysis procedures, use glass microfiber thimbles. Glass microfiber thimbles are made from borosilicate glass fibers, are chemically inert, and withstand temperatures up to 500°C. These qualities make them ideal for pressurized solvent extraction, accelerated solvent extraction, and analysis involving volatile or semi-volatile organic compounds.

Why is TCLP important in soil testing, and what filtration steps are required before analysis?

TCLP filters are specialized glass fiber filters used in the Toxicity Characteristic Leaching Procedure (TCLP). They are used to separate solid particulates from liquid extracts during environmental testing, particularly in the analysis of solid wastes and soils. These filters play a critical role in maintaining integrity and reproducibility of analytical results by producing a clear leachate free of suspended solids. Their composition and pore size are specified in EPA Method 1311 to maintain standardization across laboratories and ensure compliance with regulatory protocols.

In soil testing, TCLP filters are used as part of the EPA's standard method to determine whether a soil or waste sample has the potential to leach toxic substances under conditions that simulate a landfill environment. The TCLP procedure involves mixing a representative soil sample with an acidic extraction fluid, typically acetic acid in a buffered solution, designed to mimic the chemical conditions of leachate in municipal solid waste landfills. The mixture is then agitated for 18 hours to allow soluble contaminants to leach from the solid matrix into the liquid phase.

After agitation, the next critical step is filtration, where the TCLP filter is used. The purpose of filtration is to remove any remaining solid particles from the leachate so only the dissolved constituents are measured during chemical analysis. The filter's pore size is chosen to exclude fine particulates while allowing dissolved metals, organics, and other analytes of interest to pass through. This filtered leachate is then collected and subjected to analytical techniques such as inductively coupled plasma mass spectrometry (ICP-MS) or gas chromatography-mass spectrometry (GC-MS), depending on the target analytes.

The use of TCLP filters in EPA Method 1311 ensures that soil samples are assessed consistently for hazardous characteristics, such as the potential to release toxic metals like lead or arsenic into groundwater. Proper filtration is essential to avoid overestimating or underestimating contaminant levels, as particulate matter could either carry unaccounted-for contaminants or interfere with instrumentation.

How are weighing boats and weighing papers used in soil analysis?

Weighing boats and weighing paper are commonly used to measure and transfer soil samples and reagents during analytical procedures.

In Kjeldahl analysis for total nitrogen determination in soil samples, weighing boats and weighing paper play critical roles to maintain precision and prevent sample loss during the early stages of the procedure. Soil samples must be accurately weighed before digestion, as the initial mass directly influences the final nitrogen calculation.

Weighing boats are used to contain the soil during weighing due to their rigid design, which maintains sample integrity and simplifies transfer into the digestion flask. Our weighing boats are manufactured from low nitrogen parchment paper and contain no glue or chemical additives. The boats dissolve residue-free in the digestion solution without influencing analytical results. Alternatively, weighing paper is used when handling finely ground, dry soil samples, especially in labs aiming to minimize plastic use or when small sample quantities are involved.

Weighing boats

What considerations should be made when selecting a syringe filter to use in analytical chemistry sample preparation?

When determining the best syringe filter to use, it is recommended to follow SOPs or standards that state the parameters of the syringe filter or media to be used.

When selecting a syringe filter, the following considerations should be made:

- Pore size: When using a standard HPLC column (3 µm or larger column packing size), a 0.45 µm filter will offer effective protection. If you're using a UHPLC column with much smaller packing size (less than 3 µm), it's recommended to use a 0.2 µm filter.
- Chemical compatibility of the media: The solvent type and polarity of the sample requires the media to be chemically compatible with it. This helps prevent unwanted extractables, unwanted analyte binding, and provides consistency in membrane pore size throughout sample filtration.
- Sample volume: The total volume of the sample filtered will determine the diameter of the syringe filter required.
- Certification: Syringe filters with HPLC or UHPLC certification may be required.

Puradisc™ syringe filters are general lab syringe filters for many applications. They are available in a range of filtration media and pore sizes to filter samples of diverse chemical solvents, compounds, and sample types. Whatman GD/X™ syringe filters include a glass fiber prefilter designed for filtering high particulate samples.

Are there solutions to reduce laboratory waste when performing sample preparation?

The selection of the correct filtration device can help reduce waste. For example, if you have a smaller sample volume, using a 13 mm syringe filter will generate less waste than using a larger 25 mm version. If a larger volume of sample is required, using one 25 mm syringe filter would generate less waste than using two or three 13 mm devices to filter a sample.

The waste involved in the use of a syringe filter, vial, cap, and syringe can be considerable when processing numerous samples. For users concerned about these impacts we offer Mini-UniPrep™ syringeless filters. This solution acts as an all-in-one syringeless filter available in a range of materials, membranes, and pore sizes to suit any application. An additional advantage of our Mini-UniPrep syringeless filters is that multiple samples can be processed at once, and the vials loaded directly into an autosampler.

How important is filtration of the mobile phase in addition to samples for HPLC, UHPLC, and IC?

This is often overlooked by analysts as they will typically purchase HPLC grade reagents from reputable suppliers. Filtration of the mobile phase is as important as filtration of samples as even HPLC grade reagents can contain waste particles that impact both the performance of the system and data quality.

We offer a range of membranes for use in our SolVac™ filter holder. The SolVac filter holder sits on top of the receiving vessel and draws directly from the source bottle, reducing the risks associated with lifting heavy bottles to pour into a funnel.

The SolVac filter holder has a versatile design and fits most HPLC bottles, flasks, and containers, and eliminates the added steps of washing flasks and transferring mobile phase solvent from flask to reservoir. It has a durable plastic construction that is less likely to break than glass funnels, assemblies, or adapters.

A patented magnetic eliminates the possibility of membrane shifting or tearing which can occur with aluminum clamps or threaded holders. The device has a reusable, chemically resistant polypropylene construction that is compatible with common HPLC mobile phase solvents such as methanol, acetonitrile, and tetrahydrofuran.

How is PFAS analysis performed and why are filters recommended for use in sample preparation when performing PFAS testing?

PFAS (per- and polyfluoroalkyl substances) are synthetic chemicals used in products like non-stick cookware, waterproof clothing, and firefighting foams due to their resistance to heat, water, and oil. However, they pose environmental and health concerns because some PFAS persist in nature and accumulate in living organisms.

Liquid chromatography-mass spectrometry (LC-MS) is a widely used analytical technique for PFAS testing and can provide high sensitivity and specificity for the detection and identification of a wide range of PFAS chemicals.

Filtration of both analytical samples and mobile phase solutions using the correct device is a simple and economical way to protect liquid chromatography columns and instruments from unwanted particulate contamination. Particulate can cause blockages in injection ports, pumps, capillary tubes, and columns that can lead to premature column replacement, system downtime and incorrect or inconsistent results.

Choose from our range of syringe filters with various diameters, pore sizes, and membrane options to suit your specific needs

Membrane filters constructed from nylon, regenerated cellulose, or polyether sulfone are typically used in sample preparation steps. Method 1633, Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS, references a 0.2 µm Nylon Acrodisc™ syringe filter.

How does Cytiva support sustainable lab practices?

Since 1733, Cytiva's lab filtration businesses of Whatman and Pall (since 1946) have been positively impacting society and the environment through the way our products have been used in research, manufacturing, quality, and testing.

We prioritize how we incorporate eco-design principles into every phase of our lab filtration products to reduce the environmental footprint. We set a goal to complete product carbon footprints (PCF) on 20% of our top products (by revenue) in 2025.

We will only succeed if we work together across the full value chain, suppliers and customers both. ~95% of our carbon emissions are Scope 3 emissions with raw materials and distribution being the primary categories. As of Q4 2024, 81% of our direct spend has been EcoVadis assessed. Also, we are actively sourcing biobased feedstock for plastic alternatives to reduce our dependence on virgin fossil fuels and the carbon impact of that plastic.

We are actively working towards achieving ISCC Plus certification for our Puradisc, Whatman GD/X and Whatman GD/XP syringe filter products by the summer of 2025. The International Sustainability and Carbon Certification (ISCC) is a leading system supporting sustainable, fully traceable, deforestation-free, and climate-friendly supply chains. This certification will further validate our commitment to sustainable production.

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